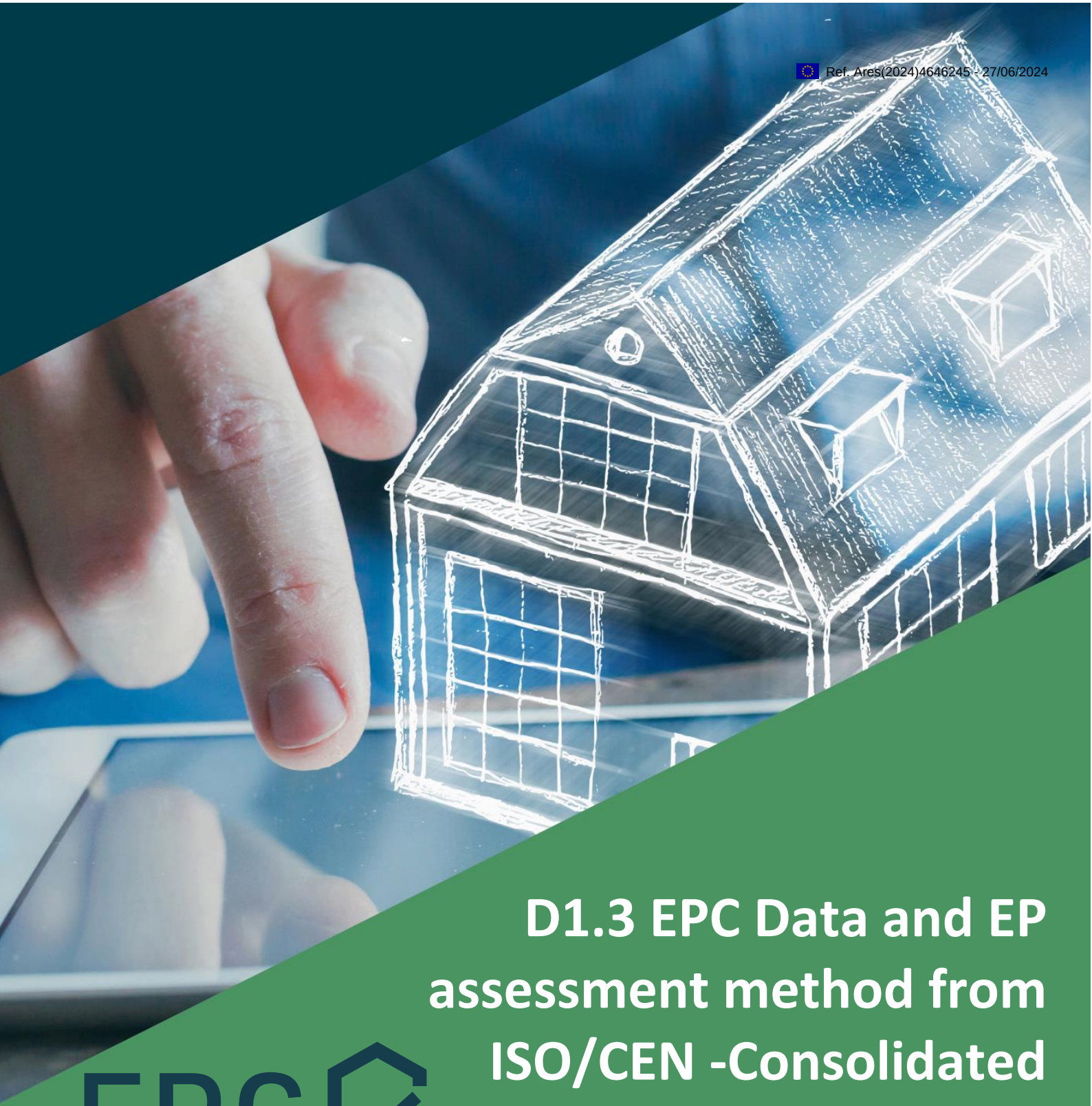

D1.3 EPC Data and EP assessment method from ISO/CEN -Consolidated

EPC RECAST

ENERGY PERFORMANCE CERTIFICATE RECAST

1. Table of Contents

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2. List of Figures

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3. List of Tables

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DATE	VERSION	AUTHOR/CONTRIBUTOR[1]	REVISION BY[2]	COMMENTS
20.06.2024	**Consolidated**	**Baptiste FOURNIER (CSTB)**	**Olivier GRESLOU (CSTB) / Jana BENDZALOVA (ENBEE)**	**Submitted version**

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4. Executive Summary

To make the EPCs more reliable, particular attention must be paid to the reliability of the data that allow the evaluation of the key performance indicators.

These building characterisation data concern the intrinsic characteristics of the various envelope components and HVAC systems, they are qualified and quantified mainly during the on-site inspection of the building and according to some information and documents that can be obtained and consulted before the visit.

For existing buildings, assessors are faced with the crucial problem of the difficulty of collecting reliable data without having to resort to extensive, long, and costly investigations.

Indeed, the assessor only has a short time for the building inspection, so it is essential that he can rely on a structured protocol that allows a reliable of data and information to be collected.

From these observations, some objectives of tasks 1.1, 1.2 and 1.3 of the EPC RECAST project arise: to define a European and harmonized protocol in the form of a "Data Model" for the description of the building. Develop and integrate enrichment and verification methods into this protocol and link this protocol to existing technical components, all to facilitate and make the data collected more reliable. We focus here on the intrinsic characterization of the building and its HVAC systems, the weather data and data related to the building use, are rather defined in a conventional and standard way within the framework of the EPCs.

Considering the process “building energy performance assessment” by simulation, it is necessary to make the link between this data and information collected and the input data of the calculation method adopted for this evaluation.

Developing a ‘Data Model’ that can then generate input data adapted to any 'national' calculation method, whether compliant or not with EU standards, represented one of the first difficulties of this task 1.1.

We had initially imagined a ‘Data Model’ which goes beyond the collected data during the inspection phase, but which also continues with the input data of the calculation methods. After some initial investigations, we did not retain this option, because the national calculation methods differ from each other and generating and implementing such developments is very complex and could not be finalised within the framework of this project.

We therefore opted for the development of a ‘Data Model’ relating to the collection of information and data during the building inspection phase.

Several arguments favour this choice: 1/ The data collection protocol for the description of a building could be harmonized and enriched by the different national practices, it is 'universal', 2/ each country can benefit from this data model since it covers all the possible data to be collected, takes into account national specificities and presents real added value since it takes advantage of the different national good practices which are de facto shared, 3/ whatever the calculation method used, there is always a need to have on-site characterization of the building to then transform the data and information collected into calculation input data, expressed in different ways depending on the calculation methods, 4/ this Data Model was implemented and used in the pilot projects (WP3), the links with the calculation method were made according to the calculation method. 5/ Proof of concept that a detailed hourly method can be used with a generic Data Model.

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Before starting the actual development of the Data Model, we carried out preliminary work to better understand the general framework of the EPCs in the different partner countries and the calculation methods used. We were also interested in the revision of the EPBD, to be aware of any changes, we contributed to the public consultation with suggestions on the 'EPC' subject. The results of this preliminary work are reported in this deliverable.

We also proceeded to the analysis of the ISO/CEN Standards for EP assessment (mandate M480), those relating to HVAC systems, the aim being to identify the input data of these standards to generate in the Data Model the information and the possible data to collect and ensure possible conversion from the EPC RECAST Data Model to standards inputs. We have produced an excel file analysing some of these standards.

We therefore developed the EPC RECAST Data Model, based on generic building description, ensuring that the structure and data model could be efficiently used by assessors, while addressing a detailed calculation method after conversion.

In the EPC RECAST Data Model, for each of the components, we have proposed different data collection possibilities to consider the diversity of situations from the complete lack of information to the most specific case according to technical documents allowing a precise characterisation of the component.

We have considered for the development of the Data Model, the fact that for certain input data of the calculation methods the Member States have defined standard values which depend on certain parameters and criteria, these parameters are integrated into the Data Model because they should be able to be collected to allocate typical values to certain calculation input data.

We have assigned to each type of data collection, an accuracy rating, ranging from 1 to 5. This method allows the assessor to use the most precise method according to the different choices offered to him and promote the collection of detailed information. We also connected the data collected to the enrichment and checking methods developed in task 1.3 and to the available technology components (TCs). The geometrical data is considered by the AR2BUILD technology developed by BIMEO (task 1.2).

This Data Model is described in an Excel file, we have produced it based on the previous considerations and based on the experience of the French EPC. It was enriched and completed to integrate the contributions of other partners, in relation to the practices of their country and the specificities of the calculation methods they use.

The implementation of this Data Model in the EPC RECAST toolbox was part of the tasks within WP2, we worked in collaboration with TECNALIA (WP2 leader) to structure this implementation work. The elements are provided in the deliverables of WP2.

While developing the EPC RECAST Data Model, we were interested in the link between the Data Model and the different calculation methods. Unable to carry out this work on all the calculation methods used at the partners national level, we focused on methods compatible with ISO/CEN standards. It is indeed specified in the GA that the Data Model will be linked to calculation methodologies defined by the international and European standards, in particular the ISO/CEN standards developed under commission Mandate M/480. Since there was no existing calculation tool fully compatible with the PEB standards calculation methods, we ensured the connection of the data model with a method similar to the PEB standards, the French hourly calculation tool for new buildings regulation (COMETH) and also another calculation method based on EnergyPlus software. EPC RECAST project showed that the generic EPC RECAST Data Model can be used regardless of the calculation method, it also showed that data conversion enables the use of this Data Model to finally perform advanced dynamic

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calculation methods. Crossing results from our CEN Standards analysis and result of our construction of EPC RECAST Data Model, we were able to identify conversion methods inspired by standards and already existing partners national EPCs conversions methods. The aim was to gather the most relevant 'conversion methods' and 'standard values' for some HVAC systems.

We, finally worked on the EPC RECAST calculation procedure principles as mentioned in the Grant agreement.

This work was launched in close collaboration with U-Cert project: The EPC RECAST builds on some U-CERT project outcomes and exchanges between EPC RECAST and U-CERT/EPB Center during developments. The main topics discussed were the harmonization of indicators and approaches with ALDREN project by both, EPC RECAST and U-CERT.

EPC RECAST project has identified the choices that cover all important aspects for results from calculation including those, that may be missing in Annex A of some EPB standards.

The EPC RECAST calculation procedure principles try to identify and transform choices in Annex A of EPB standards into more user-friendly questions and sub-questions for description of calculation methodologies, that can be easily answered by assessors, by experts for national calculation methods development and by software companies.

The choices for the EPC RECAST calculation procedure principles are reported in this deliverable.

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5. Introduction

This deliverable follows the deliverable produced in March 2021 and the deliverable produced in April 2022.

The WP1 of the RECAST project will develop innovative well-structured methodologies and protocols leading to the next generation of Energy Performance Assessment and Certification [EPC]. For this, different tasks have been identified and all of them are launched: EPC Data model and EP assessment method from ISO/CEN Standards; Data acquisition protocol for the geometry and semantics within the onsite visit; Data enrichment and consolidation techniques; cross exploitation of energy-related measured data and EP modelling; EPC certificate and renovation roadmap.

Task 1.1 entitled "Linking the ISO/CEN standards for EP assessment (mandate M480) with a consistent data model for EPCs" focuses on the development of EPC RECAST Data Model and its link to calculation methodologies defined by the ISO/CEN standards developed under commission mandate M/480.

The description of Task 1.1 in Grant Agreement is as follows:

This task will define a European harmonized and appropriate data model (DM) to describe the considered dwelling/building and allow the energy performance (EP) assessment in the context of EPC, which will be based in the IFC data model standard.

The Data Model (DM) will be designed in a user-centric approach (users being the professional certifiers), compliant – as an example – with both a robust assessment of heating systems' energy performances, and with the skills, level of detail, means and time that professional certifiers can devote to data collection on site (less than half a day). The DM will be adapted to both dwelling and building scales, to individual and collective HVAC systems. It will encompass the modelling of the building envelope, the HVAC systems and controls, the use and occupancy modes. Some guidelines regarding data collection according to the defined DM will be proposed. The data model will be adapted to the assessment of all energy uses considered for EPCs in the scope of the EPBD Recast.

To allow EP assessment, the DM will be linked to the calculation methodologies defined by the International and European standards, in particular the ISO/CEN standards developed under Commission mandate M/480. Some additional modelling, algorithms, standard values will be developed to operate this connection, especially regarding HVAC systems to allow the assessment of both traditional and more innovative systems. These developments will result in the definition of the EPC RECAST calculation procedure principles.

Many questions started on the definition of data model: what do we mean by data model? Is it possible to have a harmonized data model linked to ISO/CEN standards by considering energy performance assessment methods that are different between the partners countries although they are consistent with the ISO/CEN standards? How to consider the levels of detail for data that allow the EP assessment while exploiting ISO/CEN standards? How to structure data and ensure its quality? How to ensure the reliability of the data collected (data collection on site by certifier is assumed in less than half a day) and produced in the context of EPC? How to define the EPC RECAST calculation procedure principles? How to implement the data model to facilitate its integration in digital tools?

We discussed these questions with each of the project partners. The important points that emerge from this first brainstorming are the following:

1 / The data model is a concept which can be quite broad. Therefore, it is important to specify: which data model for which objective?

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We identify several 'packages' of data:

- data which can be used carrying out an EPC: 1/data that allows to obtain the indicators to be displayed on an EPC, 2/ intermediate data that ensure the quality and reliability of these indicators
- data after obtaining the EPC, taking advantage of this work to go beyond the EPC itself: 1/ data for Building passport with building renovation roadmap and building logbook, 2/ data Interest to the public authorities: data that may increase knowledge of existing building stock 'building observatory', data to structure aid and incentives measures, 3/ Interest to stakeholders: EU taxonomy, banks for example to allow loans for energy performance improvement/ etc.

The main purposes that the EPC RECAST data model should focus on are data collection, accessibility, and reliability to enable the assessment of the indicators that should be displayed in the EPC.

2 / It is necessary to know the general framework of the energy performance certificate of each participating country, to analyse in a precise way the energy performance assessment methods, their associated data models, and their compliance with CEN standards. The template of EPC and the full list of indicators for EPC RECAST certificate will be proposed in Task 1.5 based on user-centric approach.

3 / It is necessary to consider that Energy Performance assessment methods are different from one country to another. The data model must then be able to address to all these methods and check the compliance with CEN standards.

4 / We must analyse the ISO/CEN standards data requirements and establish the corresponding data model considering different data layers, each corresponding to a given level of details and requests.

5 / A lot of things already exist, we must make the best use of existing developments to focus on the points that need improvements and consolidations. We should organize exchanges with EPC RECAST project sisters, and before being aware of their objectives and the deliverables made public.

We agreed with the partners that the calculation method for EP assessment within EPC RECAST framework would not be a single common calculation method. National calculation method from each partner country will be considered.

We started this task by these two main actions:

- Analysis of the general framework of EPCs in the various partner countries: The questionary for this analysis was developed in close collaboration between CSTB, Tecnalia and ENBEE. The final version filled by all partner countries is finalised.
- Identification and analysis on the dataset of ISO/CEN standards (M/480) for EP assessment

We however realised that the first most important point to consider is more the data collection on site considering that many different situations must be able to be covered: from the possibility of non-existence of information or data to the possibility of detailed information and data that can be directly exploited as input for a calculation method.

We finally started defining in close contribution with WP2 tasks, the scheme of EPC RECAST digital semantic data model.

About connection between EPC RECAST Data Model and dataset of input data for EP assessment, we focused on some of ISO/CEN standards related to HVAC systems and developed modelling. This work continues as well as standard values to make these connections.

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We present in this deliverable, the results of the preliminary works, the Developed Data Model, some developed algorithms for connection to the calculation method compatible with ISO/CEN standards and the preliminary choices for the EPC RECAST calculation procedure principles

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6. Preliminary work

6.1 General framework of EPCs in the various partner countries

For the development of the overall EPC Recast methodology we decided to know about the actual framework of EPC in partners countries and about possible recast.
We developed a table about the "general framework" of EP assessment for EPCs, to fill in by the partners to identify the additional input data needed to those required by CEN standards. This table is being improved by several partners to make it relevant It gives general information for following parts:

- Identification of situations for which the EP assessment is mandatory.
- General information of the different EP assessment cases.
- Information displayed on the EPC
- Key performance indicators
- Energy saving measures
- Building and technical systems description
- Additional information
- Energy assessment methodology
- In the case of energy performance assessment using calculation method - Calculated rating
- In the case of energy performance assessment using measurements - Operational rating
- Conversion factors

For each part, one or more explicit questions are addressed and for some different possibilities of answers are proposed. Tecnalia filled in the questionary for Spain with two objectives: test the questionary to get consistent answers and facilitate the work for partners.

The questionary and the version completed by Tecnalia were sent to partners.

We exploited the results of the questionnaires and we gathered them in the form of a PowerPoint presentation (see Annex 1). In the following some important results:

6.1.1 Existing residential buildings

Key performance indicators

First, we tried to know which key performance indicators are displayed on the EPC for residential buildings. For each indicator, three responses are possible to bring additional information about this posting: main indicator, informative indicator, or not considered.

Except for Luxembourg, which does not display this information, *Non-renewable primary energy use* is used by all the countries as a main indicator. Luxembourg rather uses *Total primary energy use* and *Total energy use*[3] to provide information about energy rating. On-site renewable production is displayed instead of *Non-renewable primary energy use,* used by the other countries. However, Luxembourg is not the only country to display *Total primary energy use* as a main indicator, France also does. In the same way, Germany, Slovakia, and Spain also indicate *Total energy use* by the building but as an informative indicator.

[3] Often called « final energy use »

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Information about renewable energies is given differently according to the countries: France, Italy, and Slovakia use the *On-site renewable production* indicator. Besides Italy and Slovakia display the same indicator but about *export.* These indicators are given as informative indicators. As for Germany, it's a *Ratio of renewable energy* that rather be used to provide indications about the renewable energy rating. Slovakia also uses this ratio but as an informative indicator.

Finally, about the environment sustainability rating: France, Italy, Luxembourg, and Spain display CO_2 emissions as a main indicator whereas Germany and Slovakia as an informative one.

Services included

Each country considers different services in their energy and environment sustainability performance main indicator for asset and/or operational rating. *Domestic Heat Water* and *Heating* are considered by all the countries whereas only Luxembourg considers *PV production*. However, all the countries except Luxembourg are interested in *cooling energy*. *Ventilation* is included in France, Germany, Luxembourg, and Italy's main indicators. *Auxiliary energy* is considered by France, Luxembourg, and Slovakia. Finally, France and Spain include *Lightning* in their main indicators.

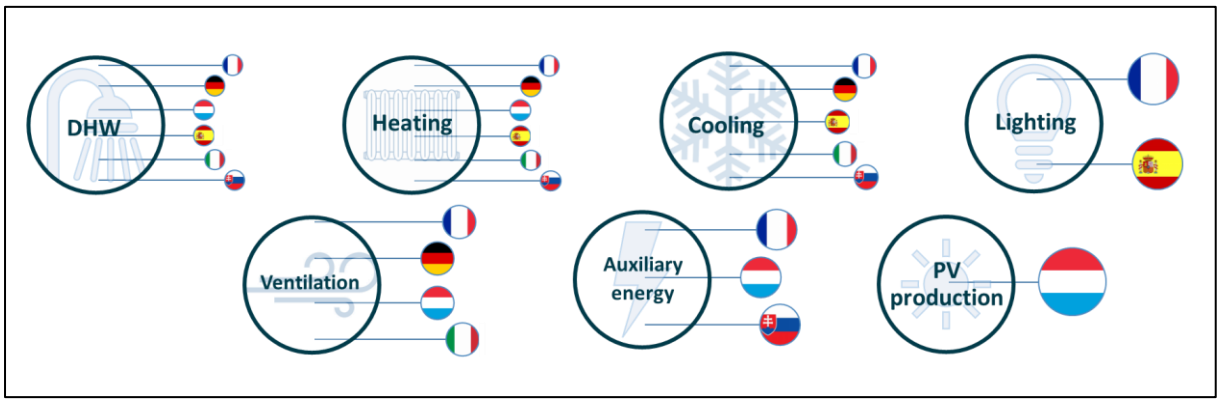

Figure 1 - Services included in each energy and environment sustainability performance main indicator (when considered) for asset and/or operational rating

Other indicators

Other indicators used for energy and sustainability rating are displayed on the EPC. It's difficult to generalize, there are specific to each country, but we can find similarities.

France, Slovakia, and Spain provide *energy consumption per service* on their EPC. Slovakia and Spain also add *energy needs*.

France and Italy also mention renewable energies: France by the type of system installed for the production and Italy with a *renewable primary energy use* indicator [kWh/m²] and *exported energy rating.* France and Italy are also the only ones to display the idea of comfort on their EPC.

As for building envelope, France, Italy, and Luxembourg are talking about it but differently: performance of thermal insulation, thermal inertia, qualitative description, etc.

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ENERGY ASSESSMENT METHODOLOGY

CALCULATION METHOD

In the case of energy performance assessment using a calculation method, all the countries use a quasi-static one with national standards climate data, and occupant behavior. The longest calculation step allowed depends on the country: France, Germany (standard methodology), Luxembourg, and Slovakia recommend a monthly one whereas Italy and Spain an hourly one and Germany (alternative methodology) an annual one.

Calculation results are given for different spatial segmentation of the building depending on the country: Germany, Luxembourg, Slovakia, and France have a calculation for the whole building. Italy does the calculation for homogenous thermal zones and Spain has Multizone analysis with dynamic methods and unizone analysis with simplified methods. In France two methods are possible for an apartment in a collective housing building: either from the 'building' calculation, or a specific calculation by the apartment

If a system is missing, all the countries except Italy treat it under the principle of “Presence of the system” and for Slovakia requirements and energy classes are adapted. As for Italy, it uses the principle of “assumed system”: a default system is calculated.

To perform the calculations, there are two cases: on one hand, France, Italy, Luxembourg, and Spain accept specific tools designed and approved for the country in question. On the other hand, Germany, and Slovakia use commercial tools.

To ensure the reliability or the accuracy of the input data used to perform the calculation, all the countries except Luxembourg, demand a visit compulsorily.

MEASUREMENTS

Only Slovakia uses an operational rating, data comes from bills or smart meters for example. The step-time used is often the year.

6.1.2 New buildings

KEY PERFORMANCE INDICATORS

The same observations that have been done previously for existing buildings can be done for new buildings, except for France which will only display *Total primary energy use* and *CO_2 emissions* as main indicators.

SERVICES INCLUDED

Services included in each performance main indicator are the same for existing and new buildings.

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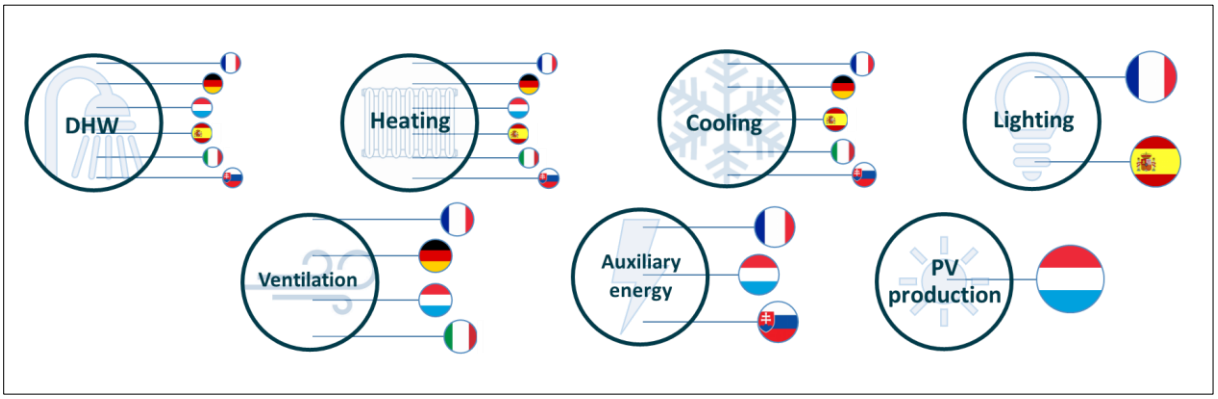

Figure 2 - Services included in each energy and environment sustainability performance main indicator (when considered) for asset and/or operational rating

OTHER INDICATORS

Once again, observations between existing and new buildings are the same.

ENERGY ASSESSMENT METHODOLOGY

CALCULATION METHOD

In the case of energy performance assessment using a calculation method, observations between existing and new buildings are the same, except for calculation tools used by France: for new buildings, EP assessment for EPC is based on thermal regulation calculation method.

6.2 Revision of EPBD

As announced in the European Green Deal, the Commission adopted on 14 October 2020 a strategic Communication "Renovation Wave for Europe - greening our buildings, creating jobs, improving lives". It contains an action plan with specific regulatory, financing and enabling measures for the years to come and pursues the aim to at least double the annual energy renovation rate of buildings by 2030 and to foster deep renovations. This goal requires a revision of the relevant EU legal act, the Energy Performance of Buildings Directive 2010/31/EU (EPBD). The revision will focus on provisions that are central to boosting building renovation.

The Commission gathered the public's view on the Inception Impact Assessment of the EPBD (22 February – 22 March) and launched a public consultation on the revision of the directive (30 March – 22 June).

Within EPC RECAST project, partners were involved to contribute to this consultation and to make suggestions for subjects related to EPC.

The EPC RECAST contributions gave answers to the following questions:

- What is needed to strengthen the information role of EPCs?
- Should the EPC include additional information compared to the current version? If so: what additional information?
- What should be the linkage between EPCs and other schemes? (e.g., Building Renovation Passports, SRI, LEVEL(s), EU Green Taxonomy)

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- How can we improve the value of the recommendations in EPCs?
- What is needed to improve the quality of EPC?
- Is there a need to strengthen the quality control of EPCs? How?
- Is there a need to strengthen the requirements to ensure the presence of EPCs in advertisement media? How?
- How could we encourage the use of metered data and smart meters in connection to the EPC and EPC databases?
- Should there be an obligation for Member States to set up national EPC databases?
- Which kind of public access, regular reporting or other features should an EPC database provide? (Including links with the Building Stock Observatory)
- What is needed to improve the coverage of EPC?
- Is there a need for additional trigger points so to increase the number of buildings with EPCs? If so, which ones?
- What should be the linkage between EPCs and Minimum Energy Performance Standards?
- Is there a need for increased harmonization of EPC levels, between Member States?
- Is there a need for increased harmonization of EPC schemes, systems, and procedures between Member States?

The details of answers to these questions are reported in Annex 2

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7. Analysis of ISO/CEN Standards

According to the EPC RECAST grant agreement, it is specified: "*to allow EP assessment, the DM will be linked to the calculation methodologies defined by the international and European standards, in particular, the ISO/CEN standards developed under Commission mandate M/480, especially regarding HVAC systems to allow the assessment of both traditional and more innovative systems*".

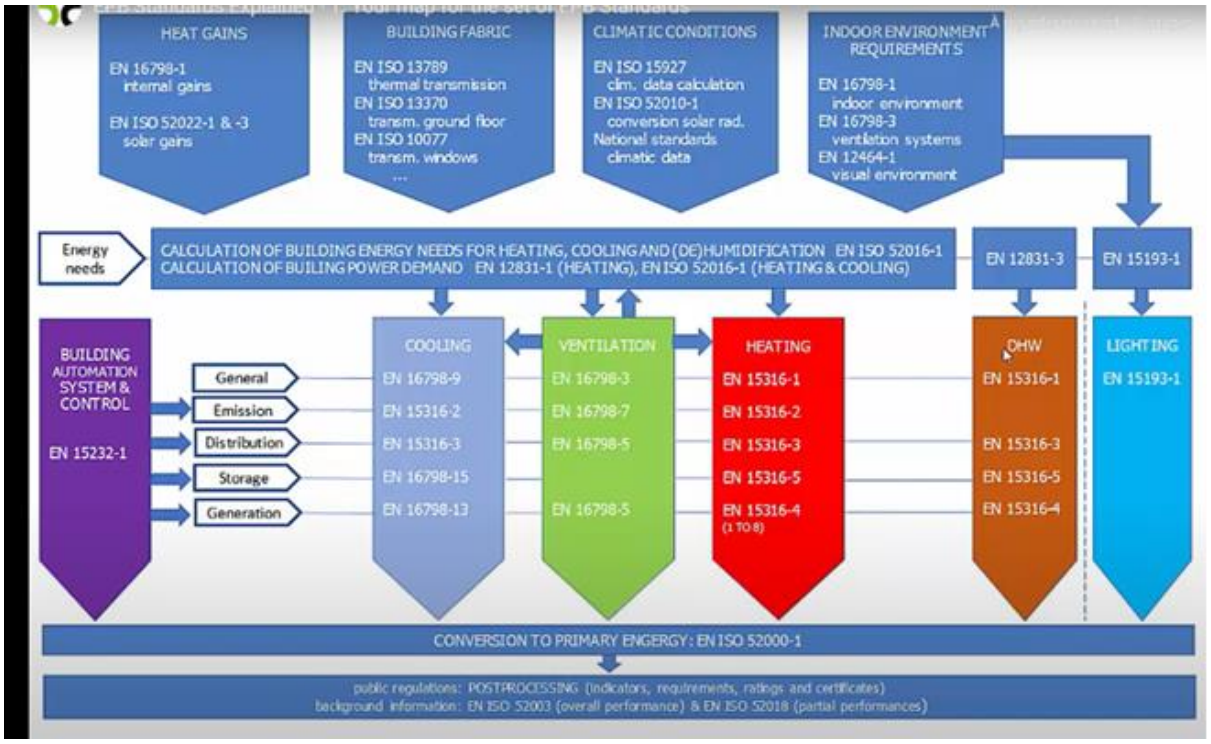

Figure 3 – Energy performance assessment

Figure 3 gives an overview of energy performance assesment and the related ISO/CEN Standards

(https://epb.center/support/overview-epb-standards/)

Figure 4 presents standards that have been developed under mandate M/480 given by the EU Commission to the European Committee for standardisation (CEN):

- The overarching standards whose member states must describe their calculation method according to appendix A
- The standards whose member states shall voluntarily describe their national calculation method according to national annexes.

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Annexes to the Directive 2010/31/EU are amended as follows:

Member States shall describe their national calculation methodology following the national **annexes of the overarching standards (1)** developed under mandate M/480 given by the European Commission to the European Committee for Standardisation (CEN).
This provision shall not constitute a requirement to comply with those standards.
The description of national calculation methods shall be voluntary in the national annexes of the other standards (2) . '

1) **ISO/EN 52000-1,** 52003-1, 52010-1, 52016-1, and 52018-1.

2) EN 12098-1, EN 12098-3, EN 12098-5, **EN 12831-1, EN 12831-3,** EN 15232-1, **EN 15316-1 , EN 15316-2, EN 15316-3, EN 15316-4-1, EN 15316-4-2 , EN 15316-4-3 , EN 15316-4-4, EN 15316-4-5, EN 15316-5, EN 15378-1, EN 15378-3, EN 15459-1,** EN 15500-1, EN 16798-3, EN 16798-5-1, EN 16798-5-2, EN 16798-7, EN 16798-9, EN 16798-13, EN 16798-15, EN 16798-17, EN 16946-1, EN 16947-1, EN ISO 10077-1, EN ISO 10077-2, EN ISO 10211, EN ISO 12631, EN ISO 13370, EN ISO 13786, EN ISO 13789, EN ISO 14683 and EN ISO 6946, ISO/EN 52017-1 and ISO/EN 52022-1.

Need for transparency – Same structure for reporting - Towards harmonization

Figure 4 – Amendment of annexes to the directive 2010/31/EU

Figure 5 is the detailed modular structure of EPBD- CEN package Mandate/480 package. Cases in yellow colour concerns the standards developed on a harmonised way within Mandate 480

Overarching			Building (as such)			Technical Building Systems										
	TC 371			TC 89			TC 228	TC228 / 156	TC 156	TC156	TC 156	TC 228	TC 169	TC 247	TC 228
	Description	Standards		Description	Standards		Description	Heating	Cooling	Ventilation	Humidifi.	Dehumidifi.	DHW	Lighting	Build.control	Electr prod.
sub	M1		sub	M2		sub		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		1	General		1	General									
2	Common definitions		2	Building Energy Needs		2	Needs									
3	Applications		3	Indoor Conditions		3	Maximum Load / Power									
4	Perform. Expression		4	Performance Expression		4	Perform. Expression									
5	Building Boundaries		5	Heat Transmission		5	Emission & control									
6	Building Occupancy		6	Transfer Infiltration, Ventilation		6	Distribution & control									
7	Aggregation of Energy		7	Internal Heat Gains		7	Storage & control									
8	Building Partitioning		8	Solar Heat Gains		8	Generation									
9	Calculated Perform.		9	Building Dynamics		9	Operating conditions									
10	Measured Perform.		10	Measured Performance		10	Measured Performance									
11	Inspection		11	Inspection		11	Inspection									
12	Indoor Comfort		12			12	BMS									
13	External Conditions															
14	Economic Calculation															

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Figure 5 - Detailed modular structure of EPBD – CEN package M480

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We then analysed the standards related to technical building systems (Heating, DHW and cooling systems)

For each of these standards, we were interested in the parameters necessary for the calculation, as a first step to define the data and information to be collected on site. Then we were interested into annexes tables enabling conversion of collected data toward input calculation parameters. We made a list of calculation input parameters but also a list of references to the tables giving these conversion methods, and the required collected data to use this method.

The list of standards considered for this work is summed up in this table:

System standards	Standards topic
EN 15316-1	General
EN 15316-2	Emission & control
EN 15316-3	Distribution & control
EN 15316-5	Storage & control
EN 12098-1	Generation & control
EN 15316-4-1	Combustion boilers
EN 15316-4-2	Heat pumps
EN 15316-4-5	District heating and cooling
EN 15316-4-3	Thermal solar photovoltaics

For instance, the EN 15316-2 standard regarding distribution gives a method to calculate distribution pipes default length from building dimensions. The method is stated in the annex B, in the section B.2.2., giving the details of collected data “input data to the correlation” and the conversion methods called “correlations”.

In most of the cases, the conversion method is a table giving calculation parameters based on collected data entries

These analyses are presented in Annex 3.

To conclude on this analysis of CEN standards, our work enabled us to give a panorama of **standards calculation input parameters**, **standards required collected data** and **standards conversion methods** from collected data toward calculation input parameters. These results are valuated input regarding the associated works on the EPC RECAST Data Model and conversion methods toward calculation parameters.

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8. EPC RECAST DATA MODEL

From the start of the project, the question of the scope of the data model was raised.

Following the Figure 6 below, we can distinguish the block "**Data collection Source of information**" from the block "**Data for EP and other indicators assessment'**, for EP assessment using a calculation method there is the block '**input data'** which contains all the necessary data for the calculation.

The block "Data collection Source of information" consists of collecting data and information on site during the building inspection or before the visit while the block "Data for EP and other indicators assessment' consists of data to feed the Energy performance calculation engine.

Both blocks are normally connected to a given calculation method. However, it is possible to develop a data model that could be used for different calculation methods.

We finally agreed relying on the grant agreement to consider within EPC RECAST project the development of a consistent protocol for data collection.

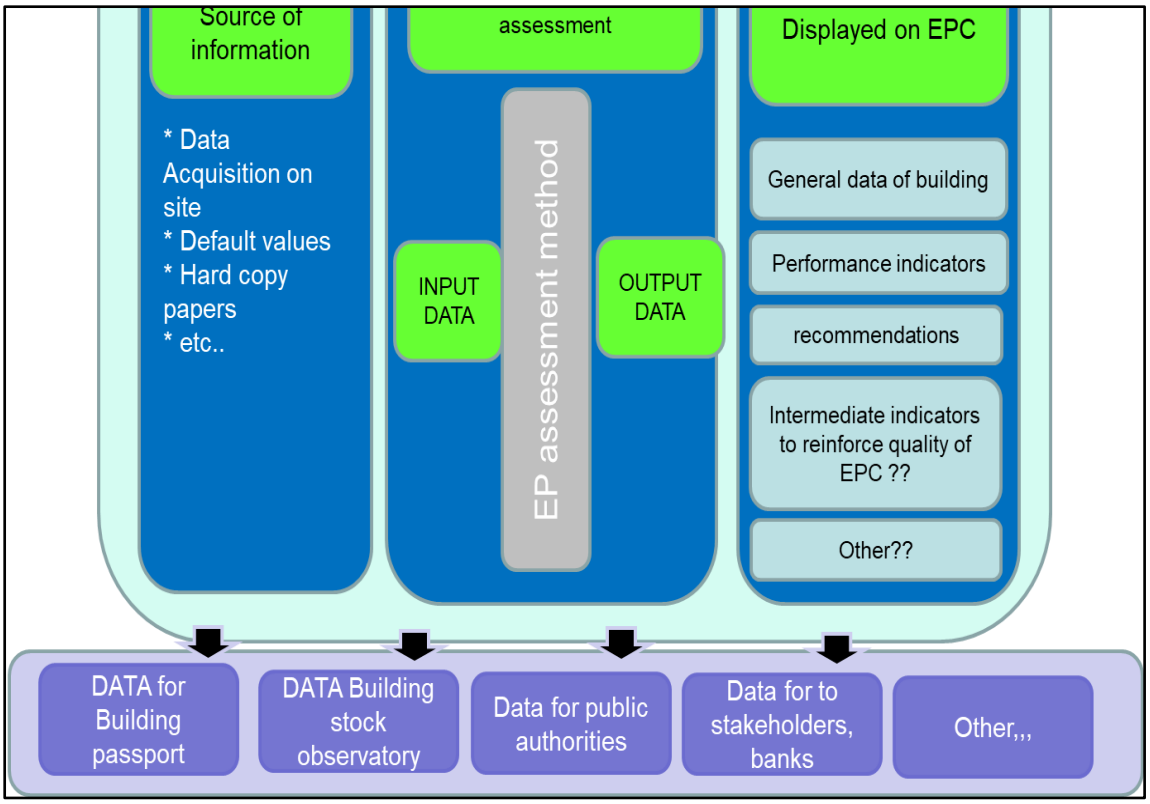

Figure 6 – Different 'types' of data within an EPC process

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8.1 The principle

Figure 7 below shows the 3 phases of the EP assessment process

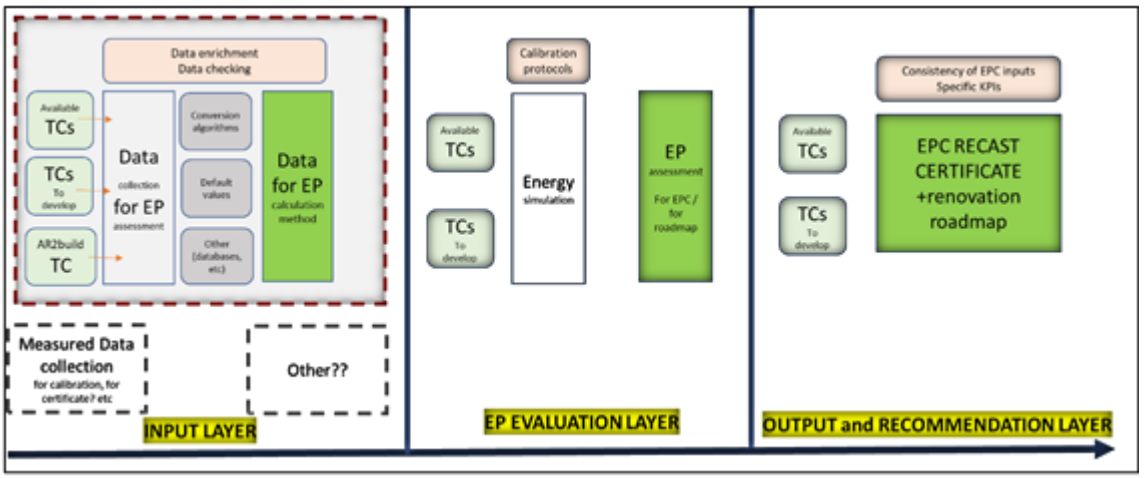

Figure 7 – EPC RECAST EP assessment process

The first layer '**input layer'** concerns the part relating to the collection of information and data, before and during the on-site visit. This phase is very important and must be carried out meticulously, however it involves difficulties and presents some constraints for EPC assessors: 1/ a very limited visit time (around half a day at best), 2/ a very large amount of data and information to collect, 3/ data and information often very difficult to obtain or to assess.

The collection of information and data from this first layer is necessarily carried out to enable the evaluation of the various indicators and data that must appear on the certificate, (third layer: **"output and recommendations"**) according to the required evaluation methods (2nd layer of the process: EP evaluation Layer[3]).

The 'EPC RECAST data model' is in this first layer, it's the called block **'Data collection for EP Assessment'** it is represented in Figure 7 within framed part in dotted red line:

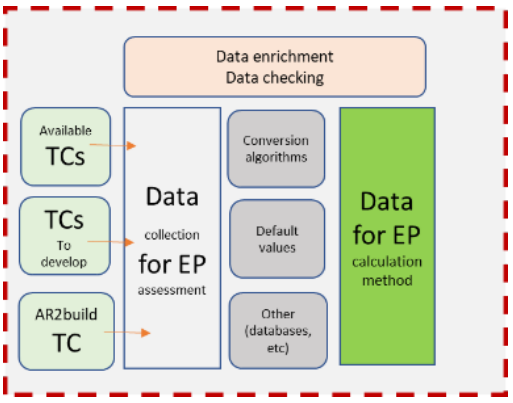

Figure 8

In Figure 8 , the block **'Data collection for EP assessment'** represents the data and information to be collected during the visit based on observations, existing documentation on the building and its environment, the interview with the occupants, etc. This list of data and information to be collected represents the **EPC RECAST Data Model**.

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The EPC RECAST Data Model cannot be used to directly perform an EP assessment through a calculation method (software), it should however allow to obtain all the necessary parameters for the EP assessment using any calculation method.

This **EPC RECAST Data Model** must be 'generic', it must include all the data that all EPC RECAST partners needs to perform their national EPC (current or future),

This **EPC RECAST Data Model** must be accompanied by guides to facilitate and make the collection more reliable according to the different constraints and situations that assessors may encounter; It consists of providing assessors with:

a. A structured and harmonised protocol to guide the data collection

b. Methods and tools to help data collection and/or to check the consistency of collected data. We use for that:

- Specific guides for data collection
- enrichment methods developed in task 1.3
- technological components that have been identified in the beginning of project

For the implementation of the **EPC RECAST Data Model**, we are now discussing with our partner BIMEO on the possible options to exploit and connect image capture and treatment technologies, associated with semantics enrichment to fill in an appropriate Data Model.

In fact, for individual dwelling scale, BIMEO has developed the AR2BUILD technology that exploit image recognition to get a geometrical modelling of the different connected rooms. This technology could be extended and enriched to integrate a structured and step by step procedure allowing data collection and data saving into a report.

In summary:

The EPC RECAST Data Model is a harmonised protocol for collection of data and information to allow EP assessment.

The EPC RECAST Data Model is 'generic' and could be used for any EPC RECAST partner calculation method

The EPC RECAST Data Model is accompanied with some specific guides, some enrichments methods and some technologies components that facilitate the EPC Assessor work and that check the consistency of collected data.

Each EPC RECAST partner contribute to make the **EPC RECAST Data Model** useable for its specific calculation method.

Each EPC RECAST partner contribute to make the connexion between the **EPC RECAST Data Model** and the data set input calculation method.

The following Figure 9 – EPC RECAST data model within the process of EP assessment, gives an overview of **EPC RECAST Data Model** within the process of EP assessment and the links with T1.2, T1.3 and technical components.

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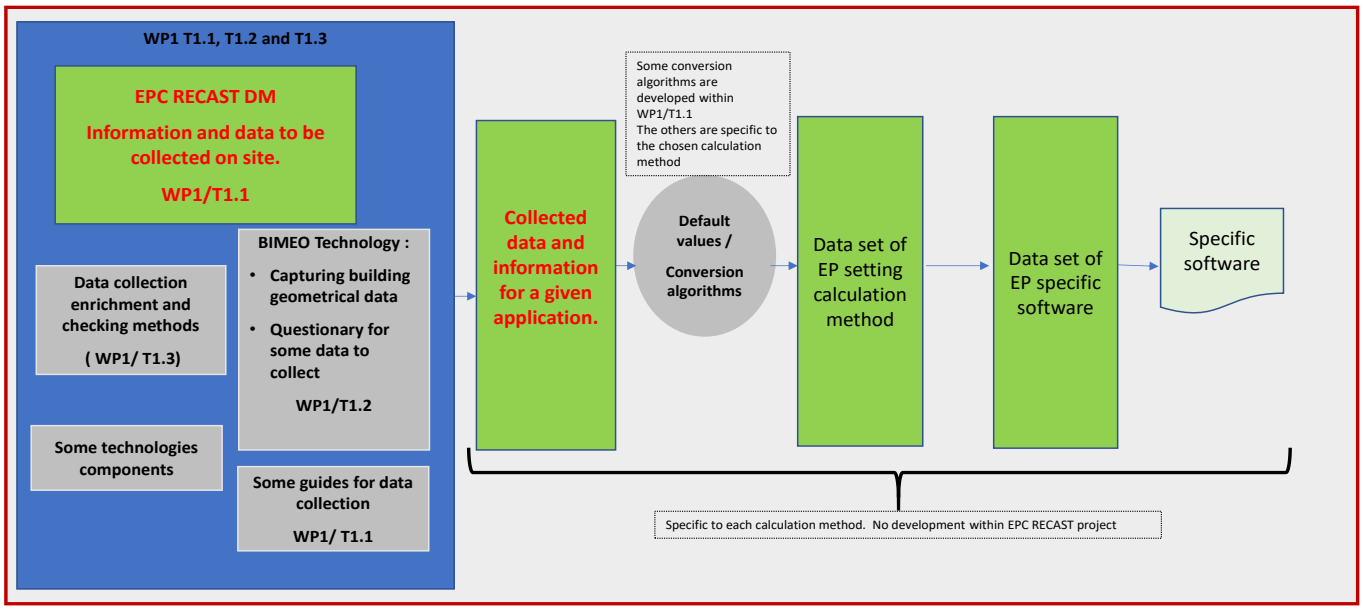

Figure 9 – EPC RECAST data model within the process of EP assessment

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8.2 About data for EP Calculation method

In Figure 8, the block **'Data for EP calculation'** is about producing a set of data for setting calculation input data of the EP calculation method. This set of data is obtained from:

- The information and data collected according to the **EPC RECAST Data Model**
- Transformation procedures: several possibilities are used to go from 'Data collection for EP assessment block' to 'Data for EP assessment block'
    - ✓ Directly: no transformation is needed, the data collected is used as it is
    - ✓ Using default values that depends on some collected information or data
    - ✓ Through a conversion algorithm

The set of data for EP assessment is necessarily relative to a given calculation method, because the calculation input data depends on many elements: the physical phenomena considered, the mathematical model used to express the physical phenomena, the different possibilities of expressing a given characteristic (example: to express the efficiency of a heat pump for heating, we can use an average annual COP, a seasonal COP, a Scop, etc.), etc. However, EPC RECAST Data Model should be linked to ISO/CEN standards for EP assessment (mandate M/480), that's mean the used calculation methods should be compatible with ISO/ CEN Standards. Considering a given calculation method, additional modelling, algorithms, defaults values must be used to operate connexion between the EPC RECAST Data Model and Data for EP calculation method. This Data for EP calculation method is then used to produce the specific software input data. In addition, some of technological components (TCs) valued within the EPC RECAST are specific to a given calculation method or software, we studied the feasibility of adapting them.

For all these reasons and since the project allows the use of any calculation method, this block **'Data for EP calculation'** was not produced within the EPC RECAST project. As explained in the part 10 of this deliverable, the main calculation engine used to approach ISO / CEN Standards in EPC RECAST was COMETH, the French new building energy regulation calculation engine. However, some additional modelling, algorithms, standards values were developed to operate the connection between EPC RECAST data model and COMETH.

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8.3 Development of EPC RECAST Data Model

8.3.1 Introduction

On the development of the EPC RECAST Data Model, we started from the following considerations:

- To present the Data Model according to the structure adopted by the standards for the Energy performance assessment (cf. Figure 10 below)

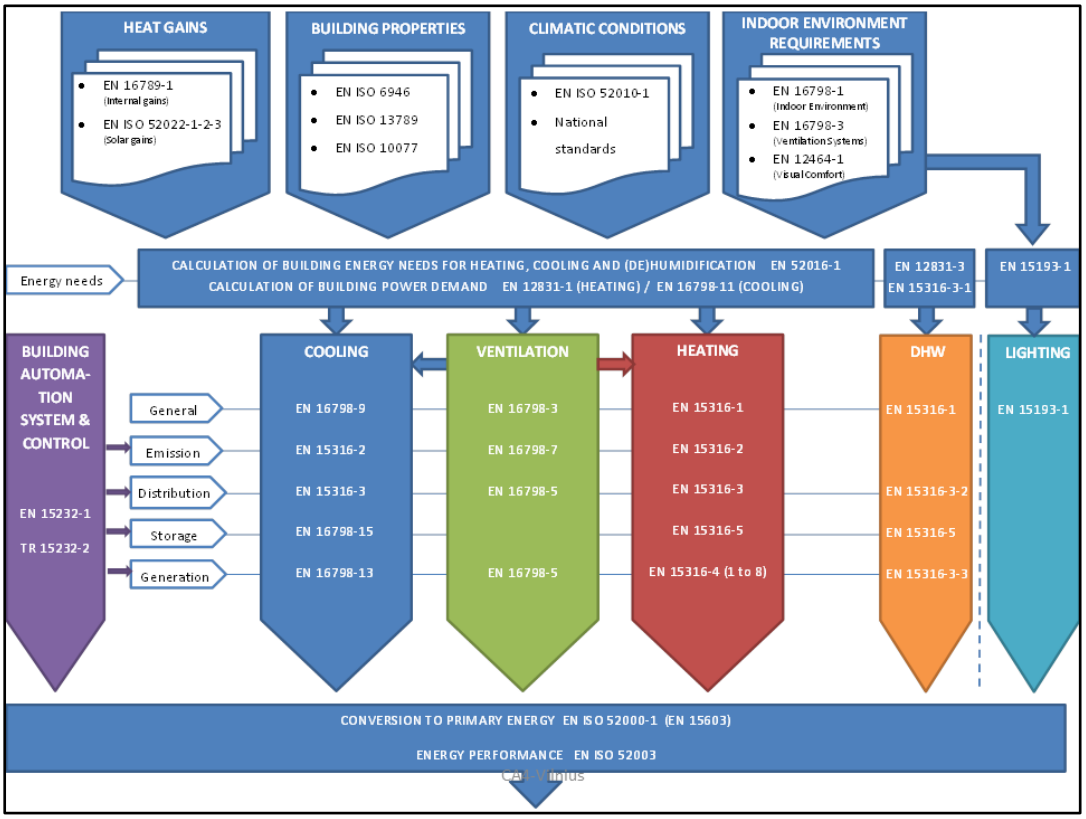

Figure 10 – Structure of energy performance assessment according the EN/ISO Standards

- To structure the Data Model by component. Indeed, an assessor in his data collection approach, works by component: data and information about windows, walls, HVAC systems, etc. The idea is to list for each component all the information needed that allows then determination of calculation parameters.
- To link the data to be collected to a given enrichment method or Technical Component
- To precise the level of precision of the information or data collected if there are several collection possibilities for the same characteristic. Indeed, for each parameter within the EPC RECAST data model, a value for accuracy is given, from 1 to 5, enabling control over the relevance of collected data, and promoting precise collection methods over simplified collection methods and estimates.

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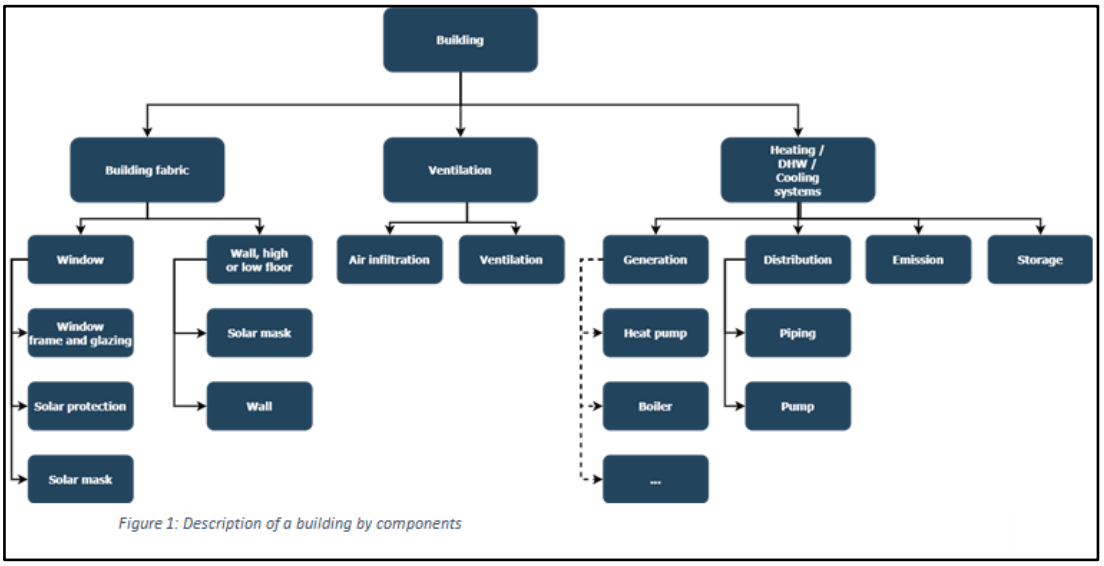

Figure 11 – Description of a building by components

The Figure 11 shows the description of a building by component used for the preparation of the EPC RECAST Data Model. Each component considered in the Mandate M480 to CEN on the elaboration of EPB standards (Figure 10) is included in this description by component.

For each component of the building (Figure 11), the EPC assessor will collect data onsite. This information will then be converted or used directly as input for energy performance assessment method and tools.

For instance, if the component is a window, the assessor can collect data onsite such as glazing type, gas space thickness, frame material. Then, the information will be used, directly or after conversion for calculation of thermal losses, solar gain, thermal bridges, or artificial lighting consumption (Figure 12). Of course, in this example several pieces of information about windows or other components are required to enable calculation of thermal losses, solar gain, thermal bridges, or artificial lighting consumption.

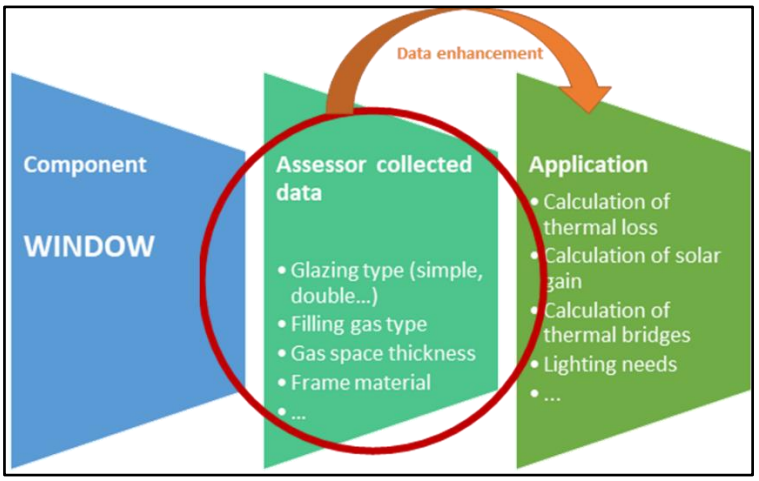

Figure 12- Example of data collection for the component Window

EPC Recast aims to enhance reliability and help assessor for data collection, therefore, the description of EPC RECAST Data Model must consider different possibilities for assessor data collection and

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possible conversions of data. As shown in Figure 13, a same component (here the window) could be considered in the calculation method by different means.

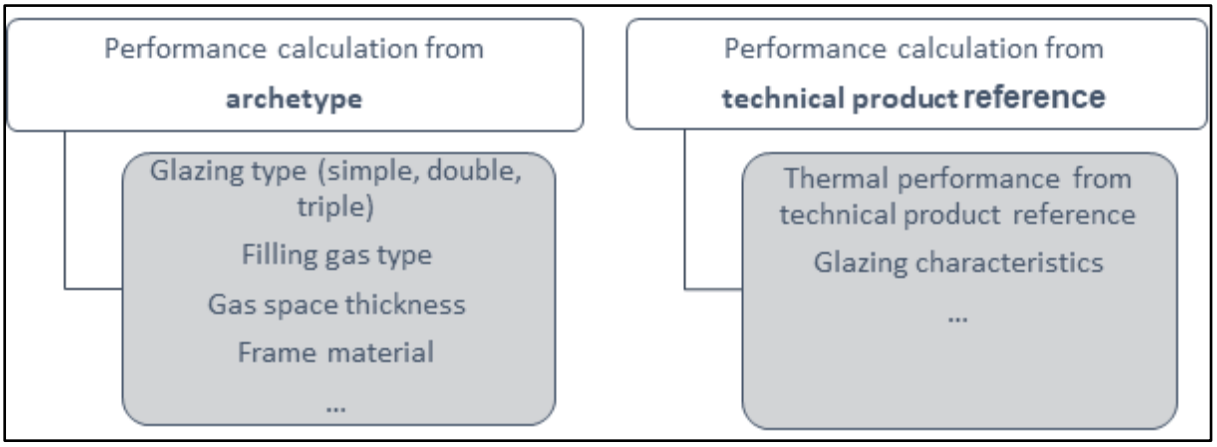

Figure 13 - Two possible set of information the assessor could collect for window energy performance calculation

A **first path** to describe window performance would be to collect key pieces of information on the window, such as glazing type, frame material, filling gas type, gas space thickness and/or year of installation. The information collected will define the **archetype** of the window, and a standard value could be associated to this archetype. For instance, in the French EPC, double glazing, filled with argon, with a space thickness of 16mm has a glazing U-value of 2,6 W/(m².K) based on a table associating archetypes to their U-values (Table 1)

filling_gas_type	inclinaison_window	glass_coating	gas_space_thickness	glazing_type	ug
				Simple window	5,8
air	>75°	0	6	Double window	3,3
air	>75°	0	..	Double window	…
air	>75°	0	20	Double window	2,7
air	>75°	1	6	Double window	2,45
air	>75°	1	…	Double window	…
air	>75°	1	20	Double window	1,4
argon or krypton	>75°	0	6	Double window	3
argon or krypton	>75°	0	8	Double window	2,9
argon or krypton	>75°	0	10	Double window	2,8
argon or krypton	>75°	0	12	Double window	2,7
argon or krypton	>75°	0	14	Double window	2,6
argon or krypton	>75°	0	15	Double window	2,6
argon or krypton	>75°	0	16	Double window	2,6

Table 1 - Extract of the French EPC glazing U-value table from key pieces of information collected by the assessor

A **second possible path** to describe window performance would be to directly use a U-value from window technical product documentation. The assessor would have to collect the technical **product reference** of the window, and then check for existing technical product documentation giving a U-value.

There could be other paths to assess the window glazing performance. Therefore, for all possible components, multiple possibilities of assessor collected data must be considered in EPC RECAST Data Model.

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Another example of possible assessor data collection is given below. For heating, cooling or DHW systems, **the length of pipes ensuring distribution** could either be:

- **Measured directly** by the assessor: then the information would be hard to collect but giving a very good accuracy.
- Assessed **based on building dimensions** such as described in annex B EN 15316-3 (Figure 14): then the information required (building length, width, and height) would be easy to collect, and giving an acceptable accuracy, even though it would not be as accurate as a direct measurement.
- Assessed **based on surface and number of levels** (method used in the French EPC for instance): the information required would be easy to collect, and giving an acceptable accuracy, even though it would not be as accurate as a direct measurement.

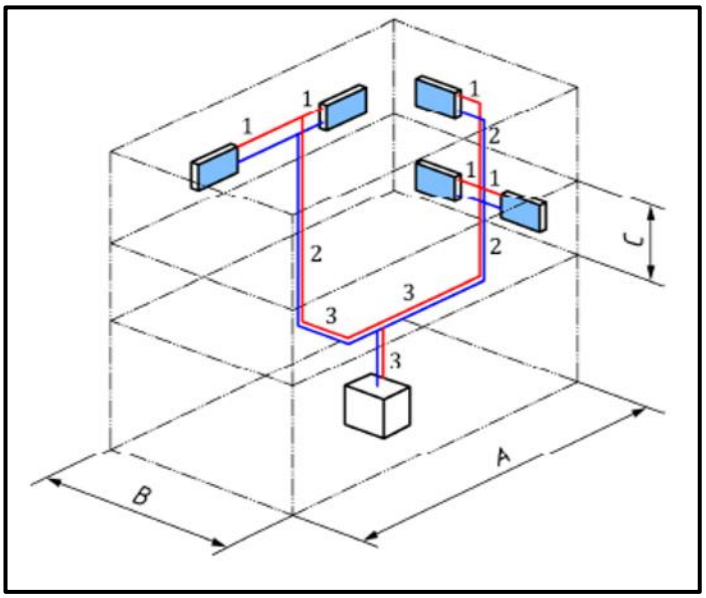

Figure 14 - From EN 15316-3 Table B.1: pipe length calculation based on building dimensions

These examples of the windows and distribution system possible descriptions illustrates the need to consider different input methods to anticipate a comprehensive data model. Therefore, the construction of the data model is based on an assessor input methods inventory, and for each possible input method, complementary information is given.

The accuracy rate given to any parameter of the EPC RECAST Data Model depends on this collection method.

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8.3.2 Input methods inventory

In order to create the **EPC RECAST Data Model**, we had to make an inventory of possible assessor's input methods. We created a spreadsheet including the information on possible assessors input methods, as a basis to create a comprehensive data model including all potential input methods from assessors.

A first inventory of assessor's inputs methods was made using the French EPC input methods and CEN standards input methods as described in CEN standards annexes. The inventory will then be completed by partner countries based on their national EPCs assessor's input methods and based on national experiences.

The spreadsheet (Annex 4) contains several fields required to understand each input method. For each heading an explanation is given below.

Theme: The theme to which each component is associated. Generalities, building fabric, inertia, ventilation, lighting, energy production or heating/cooling DHW systems.

Component / Subcomponent: example *window* or *heating emission.* All component from the figure 1 are described.

Corresponding CEN standard from mandate M480: each component is associated with the corresponding CEN standard, for standards considered in the mandate M480. When available a link is made toward the description of standards input data from the EPC Center website (https://epb.center/). Indeed, for legibility purposes it was not possible to show all input data for standards associated to a component in this spreadsheet.

Method: description of the assessor input method type (based on archetype, technical document…).

Collected data name: for instance, for window technical characteristics description based on archetype, that would be "glazing type", "filling gas type", etc.

Description: Description of the collected data. Sometimes the collected data name requires an additional explanation.

In the spreadsheet, input data collected by assessors is presented in a legible way, therefore, a set of parameters used as input for a standard calculation method can be gathered and merged. For instance, all possible values of temperature variation for emission are presented in one line to improve the legibility of information. The information is still required from the assessor should he or she choose the associated input method.

Service (for system): either DHW, heating or cooling. Indeed, for systems, collected data could be associated to only one or two services, not necessarily DHW, cooling and heating.

Difficulty to collect the information: grade 1 to 5; 1 is the easiest to collect. This field is filled in by comparing the difficulty to collect information for the input data.

Main type of acquisition: observation, measurement, technical document, administrative document.

EPC national model use: Which EPC RECAST partner countries uses this input method in national method.

Calculation application: What key information for energy performance calculation is obtained from this input? For instance, glazing type of a window will be used for calculation of building thermal loss.

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It is often required to collect different pieces of information for a joined use. For instance, besides glazing type, we would require information on filling gas type, gas space thickness, but also information about walls to allow a comprehensive calculation of building thermal loss.

On the other hand, one type of collected data could be used for several application. For instance glazing type of a window will be required for calculation of building thermal losses, but also for the calculation of artificial lighting consumption.

Corresponding CEN standards input data: CEN standards can give one or several input methods for a component description. If the considered input method is used in a standard, the reference of this standard is given.

Possible use of technologies improving data collection (efficiency, accuracy)

Applicable EPC RECAST technology: if a technology can be used to ease the assessor data entry, it is reported here. For instance, the BIMEO technology helps the assessor to describe the geometry of the building.

Data enrichment possibility: This field is an input from task 1.3. If a possible data enrichment collected in task 1.3 is available to the assessor, it is mentioned here. For instance, possible use of a 'vitrometre' as an enrichment mean to give the glazing type of a window is mentioned.

8.3.3 Link with Tasks 1.2, 1.3 and TCs

The CSTB is responsible for tasks 1.1 and 1.3, these two tasks are very interrelated, they were developed within the same team, which facilitated the inclusion of enrichment and verification methods in the EPC RECAST Data Model.

Link with task 1.2 is obvious, because the EPC RECAST Data Model integrates the methodology of capturing the building geometry.

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8.4 Implementation of EPC RECAST Data Model

The implementation of EPC RECAST Data Model is included in WP2 actions, the following Figure 15 is a schematic representation of this implementation as part of T2.1 of WP2.

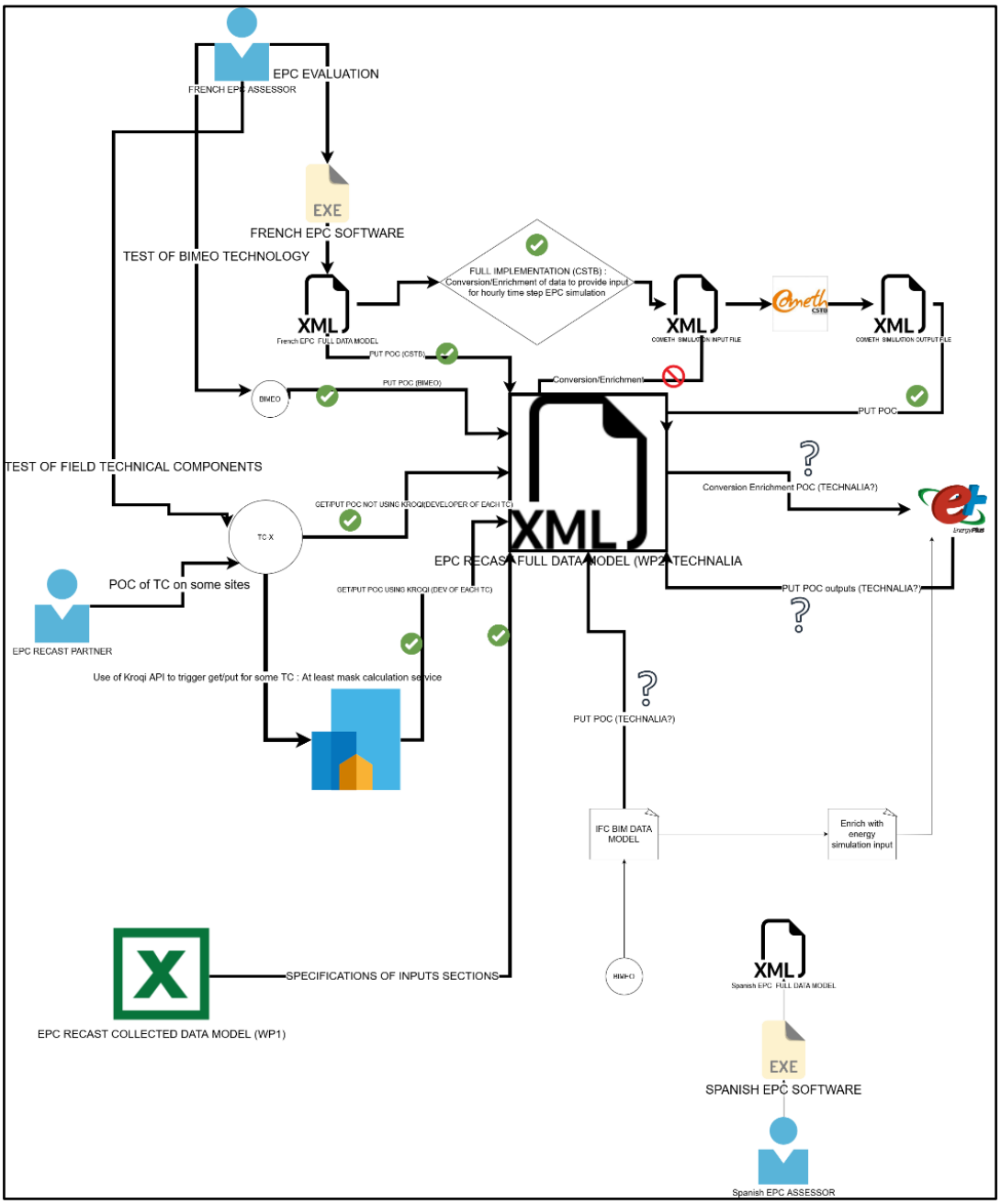

Figure 15- A draft schematic representation of EPC RECAST Data Model implementation

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9. Algorithms and standard values for connection of EPC RECAST Data Model to an ISO/CEN standards compatible calculation method

In relation to the EPC RECAST Data Model construction, we developed conversion methods (algorithms or standards values) to connect the EPC RECAST Data Model toward inputs of a calculation tool compatible with some CEN Standards developed under commission mandate M480.

Crossing results from our CEN Standards analysis and result of our construction of EPC RECAST Data Model, we were able to identify conversion methods inspired by standards and partners national EPCs conversions methods. We aimed to gather the most relevant existing 'conversion methods' and 'standard values' in order to use EPC RECAST Data Model as an input of calculation tools used for pilot projects.

Mandatory input parameters of the calculation tool were created from the EPC RECAST Data model, using conversion algorithms and default data. The proof that a detailed hourly calculation method with input data can be used even though the simplified data model is designed for efficient collecting is a major advance made in EPC RECAST project.

It should be noted that a future research and development is needed to cover all input data needed for full CEN standards implementation. For the building envelope, the input structure is relatively simple and can be standardised. The input of a building envelope is a long list of several instances of a few simple building elements. However, there could be issues on dimensions (internal/ external) and on the level of details for building elements (windows, thermal bridges, floor on ground, layers or U values, etc.). EPC RECAST model used internal dimensions and simplified elements description. Systems input data harmonisation is more difficult as they are very different. The data input structure is a relatively short list of elements which are all different and with several configuration options. Systems are also described in a quite different manners in each MS. Example for Italy shows that the standardisation body tried to develop a common XML structure to upload also the input data of registered EPCs but the work is not finished as it is very complex issue.

The systems description in EPC RECAST calculation tool is based on typology (year of installation) that is very country specific.

9.1 Examples of conversion

Heating distribution length within heated space

When not seized, distribution length is based on a simple rule based on building dimension, as described in EN 15316-3 (EPB standard) Table B.1: 'pipe length calculation based on building dimensions'. For instance, the distribution horizontal length, when missing is directly calculated from served surface length and width (for one floor).

Heat pump efficiency

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For thermodynamic systems, when no coefficient of performance (COP) or energy efficiency ratio (EER) is available, typical values are given depending on:

- service: cooling or heating
- the upstream-downstream type (air-air, air-water…)
- the installation year
- the power level
- for recent devices, the efficiency class when available

The coefficient of performance or energy efficiency ratio is given for an average upstream – downstream temperature pair. This allows for a true dynamic calculation by extrapolating the efficiency value to other temperature pairs during the calculation. In other words, we take into account the variation in efficiency related to the temperature operating points encountered in the case of the building. On the contrary, the seasonal values used in static calculations do not consider the specificities of the building. Missing this effect does not make it possible to properly reflect the under-efficiency of the system in the case where it should work at too high a temperature, in the event of low performance of the envelope for example.

Examples of typical values are given in this table:

Type of upstream / downstream sources	**Year of installation** ***Installed Power***	**COP value**	**EER value**
Exterior air / water	1975	**1.2** (7°C / 32.5°C)	
	1985	**1.7** (7°C / 32.5°C)	
	1995	**2.5** (7°C / 32.5°C)	
	Before 2000	**2.7** (7°C / 32.5°C)	**2.5** (35°C / 9.5°C)
Exterior air / air	Before 2000	**2.8** (7°C / 20°C)	**2.4** (35°C / 27°C)
Water / water	Before 2000 *20 – 80 kW*	**3.4** (8.5°C / 32.5°C)	**3.7** (32.5°C / 9.5°C)
	Before 2000 *> 80 kW*	**2.9** (8.5°C / 32.5°C)	**3.7** (32.5°C / 9.5°C)

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9.2 Adequacy between dynamic method inputs and EPC RECAST Data Model

An EPC Data Model is designed to enable efficient on-site collection and improvement of building information. It is commonly assumed that such a data model is quite simple and can not be used with detailed calculation method, but only with static calculation method. The underlying thinking is that there is no point in having a precise calculation if the input data is imprecise. This idea resulted in the use of static calculation methods for EPC assesment for many countries -for instance Germany, Italy, Slovakia and France for its exisiting buildings uses a static calculation method-.

However, we can object that the use of a simplified data model, plus a simplified calculation method, leads to an accumulation of inaccuracies.

A static method does not take into account many physical phenomena within the building and thus generates inaccuracies. In fact, as described in the following table, a dynamic methods allows to calculate of dynamic phenomena that have a potentially significant impact on the results, while a static method only gives a rough estimates of certain phenomena, or simply does not take it into account. The difference in results depends on the dynamic response of the building itself, climate conditions or action of the occupants. For instance, a building with very low or very high inertia might have significantly different results with dynamic and static calculation methods, because the static method does not take into account the dynamics of inertia well.

Physical phenomena	Description	Static method	Dynamic method
Thermal losses	Losses depending on thermal insulation.	Yes	Yes
Inertia	Time lag and effects due to thermal inertia.	No	Yes
Solar position	Impact on solar gains -link with solar protection position-, lighting consumption…	No, or rough annual estimates not specific to the case	Yes
System efficiency dynamics	Take into account efficiency based on upstream-downstream temperatures, working point of systems.	No, seasonal mean value of effiency	Yes
Aeraulics	Dynamic wind impact on air renewal, pressure balance calculation	No, average air renewal values	Yes
Occupant and automation	Dynamic reactions of occupant or automation systems such as opening of window or solar protections depending on the indoor and outdoor temperatures, or solar position, for the time step	No, only a very rough estimates is possible	Yes
Air humidity	Impact on temperature	No	Yes

Table: Comparison of static and dynamic methods in terms of physical phenomena considered

In EPC RECAST project, we showed that an EPC data model efficient for data collection -EPC RECAST Data Model-, can be converted and used for a detailed dynamic calculation method, enabling to consider dynamic phenomena. The overall accuracy of the processing chain is therefore improved compared to the use of static calculation, and it is demonstrated that the detailed method can be adopted without requesting additional information during data collection.

The overall principle of this data conversion is showed in the following diagram.

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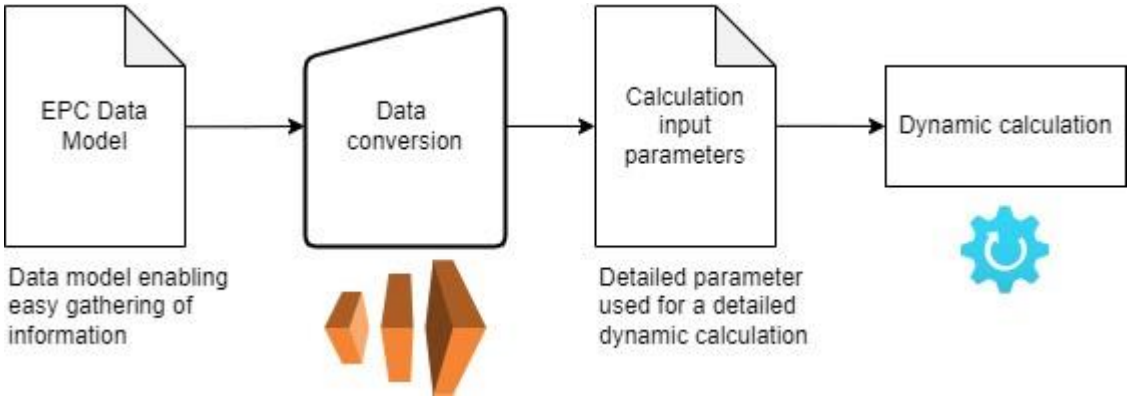

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10. The EPC RECAST calculation procedure principles based on CEN standards

Task 1.1 aims to define a European harmonized and appropriate data model (DM) to describe the considered dwelling/ building and allow the energy performance (EP) **assessment** in the context of EPC. The data model is adapted to the **assessment of all energy uses** considered for EPCs for residential buildings in the scope of the EPBD Recast.

To allow the EP assessment, the DM was developed for **calculation as much as possible** compatible with the International and European standards, in particular the ISO/CEN standards developed under Commission mandate M/480. The developments, e.g., some additional modelling, algorithms, resulted in the definition of the **EPC RECAST calculation procedure principles, based on an existing calculation tool as described in the paragraph 10.3**. Such approach for the EP assessment, in the context of existing buildings EPCs, will allow harmonization with the assessment based on ISO/CEN standards.

One part of harmonisation of EP assessment and comparability are the overarching calculation principles that are related to the decisions at the national level or by assessor, such as e.g. objects and components types included, differentiation of space categories, thermal zoning rules, building use and climate, but also the type of primary energy, consideration of produced renewable energy consumed in building and export, etc.

The most relevant sister project for this task is U-CERT[4] project and specifically the deliverable D3.1[5]. U_CERT deliverable D3.1 proposes a U-CERT project EPB calculation methodology that consists of the combination of the EPB standards and converged set of U-CERT National Datasheets (Annexes A) and that is harmonized where possible and flexible where needed.

The Lead beneficiary for deliverable D3.1 is EPB Center[6] that is a supporting authority for Member States and other stakeholders in the set of EPB standards implementation based on a service contract[7] awarded by the European Commission to support the uptake of the Energy Performance of Buildings standards by providing the technical assistance and capacity building services for involved stakeholders. The EPB Center provides the communication platform to offer these services.

The EPC RECAST proposal for overarching calculation procedure principles builds on some U-CERT project outcomes and exchanges between EPC RECAST and U-CERT/EPB Center during the developments. The main topics discussed were the harmonization of indicators and approaches with ALDREN project by both, EPC RECAST and U-CERT, e.g. ALDREN definition of NZEB, Annex A and ALDREN thermal comfort score. ALDREN thermal comfort score is taken over in U-CERT certificate and will be included also in EPC RECAST certificate.

[4] https://u-certproject.eu/
[5] D3.1 Development of a converged set of national data sheets (towards a U-CERT calculation methodology using the set of EPB standards) (Updated version 27th of August 2021), U-Cert project
[6] https://epb.center/
[7] https://epb.center/about/ec-service-contract/

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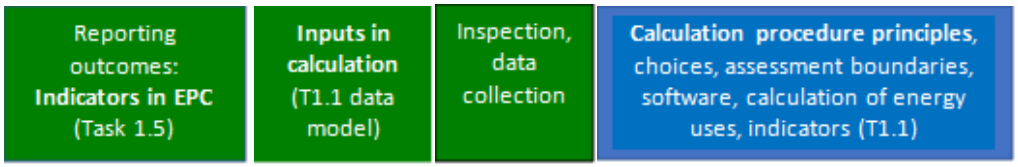
10.1 The EPC RECAST calculation procedure principles

The aim of this chapter is to provide a clear picture and understanding of **what happens between the** inspection and data collection, as the **inputs in calculation** (Task 1.1 - data model) and the results from assessment of energy uses, as **outputs, KPIs reported in EPC** (Task 1.5).

This part of energy assessment is important because it is often **hidden in the software** and underestimated, while it can lead to the important difference in the results from calculation. The main choices and principles should be also reported to stakeholders to understand the KPIs in EPCs or the outcomes from a specific software.



The review of relevant choices for energy performance assessment in ISO/CEN standards and the knowledge of differences between choices in national calculation methods are the basis for proposal for the EPC RECAST calculation procedure principles towards the potential harmonization.

However, the EPC RECAST proposal had to be adapted as much has possible to the revised EPBD published onin May 2024, Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast) at the very end of the project.

The questionnaire (spreadsheet tool) has been developed for comparison of calculation methods based on most important choices in Annex A/B to the overarching standards referenced in the current EPBD and base on the experience of consortium.

The U-CERT deliverable, D3.1 Annex 2: "U-CERT set of National Datasheets", identified in total **237 choices** in 10 calculation EPB standards.

The number of choices is the number of Tables in Annex A, plus (for some EPB standards) choices in Annex A that are not tabulated.

The importance of the choices on the result from calculation is different. Separate tool[8] developed in U-CERT deliverable D3.1, in cooperation with EPB Center experts, as an extra deliverable under the EPB Center Service Contract with DG ENERGY, provides the Categorized overview of all "Annex A" choices of the 10 selected EPB standards. The Table 7 in U-CERT deliverable D3.1 specifies the following categories for types of choices:

A. Important factor for the calculated energy performance
B. Critical for calculation tool development
C. Less crucial detail for calculation methodology
D. Policy choice
E. Categorization

[8] van Dijk, Dick, EPB Center & U-CERT, Categorized overview of all Annex A/B choices in 10 selected EPB standards, August 27, 2021, Spreadsheet tool, https://epb.center/support/documents/categorized_annexab_choices_main_epbstandards/

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F. Post-processing
G. References to other (EPB) standards
H. Measured energy performance
I. Other

More than one choice is possible for types of choices in U-CERT categorization, but Category A excludes C and vice versa and for Categories E to I only single choice is possible.

The national choices are presented in the tables in Annex A of each standard and the recommended choices (default CEN options) are provided in informative Annex B to each standard.

The U-CERT deliverable 3.1 is focused **on the current set of EPB standards** and only choices reported in the current EPB standards are reported and investigated.

In 2017 a high number of (EN) ISO and CEN standards were published to collectively assess the overall Energy Performance of Buildings.

In the course of 2022 (5 years after publication) each of these documents was reviewed (document CEN/TC 371 N 760: Note on upcoming systematic review of standards on the Energy Performance of Buildings (EPB) published in 2017, March 28, 2022).

It has been acknowledged that the set of tables in Annex A in some standards **is not sufficient to describe the calculation method.**

EPC RECAST made proposition to provide input also on missing aspects in Annexes A to overarching standard.

10.2 The spreadsheet tool for EPC RECAST calculation procedure principles description

EPC RECAST project has identified **the choices that cover all important aspects for results from calculation** including those, that may be missing in Annex A of some EPB standards.

The set of questions, in the form of a **separate tool (spreadsheet),** was developed and tested during the pilot phase on the methodologies of partner's countries involved in EPC RECAST project, with U-CERT project and potentially with other interested countries.

All choices (tables from Annex A) are included that are identified in U-CERT project as **A**-Important factor for the calculated energy performance and **B**-Critical for calculation tool development, for the most important overarching standards referenced in the current EPBD.

The EPC RECAST calculation procedure principles try to identify and transform choices in Annex A of EPB standards into **more user-friendly questions and sub-questions** for description of calculation methodologies, that can be easily answered by **assessors**, by **experts for national calculation methods** development and by **software companies**.

The preliminary choices were proposed for the overarching EPC RECAST calculation procedure principles during the development phase that can be different from published version of EPBD recast in May 2024.

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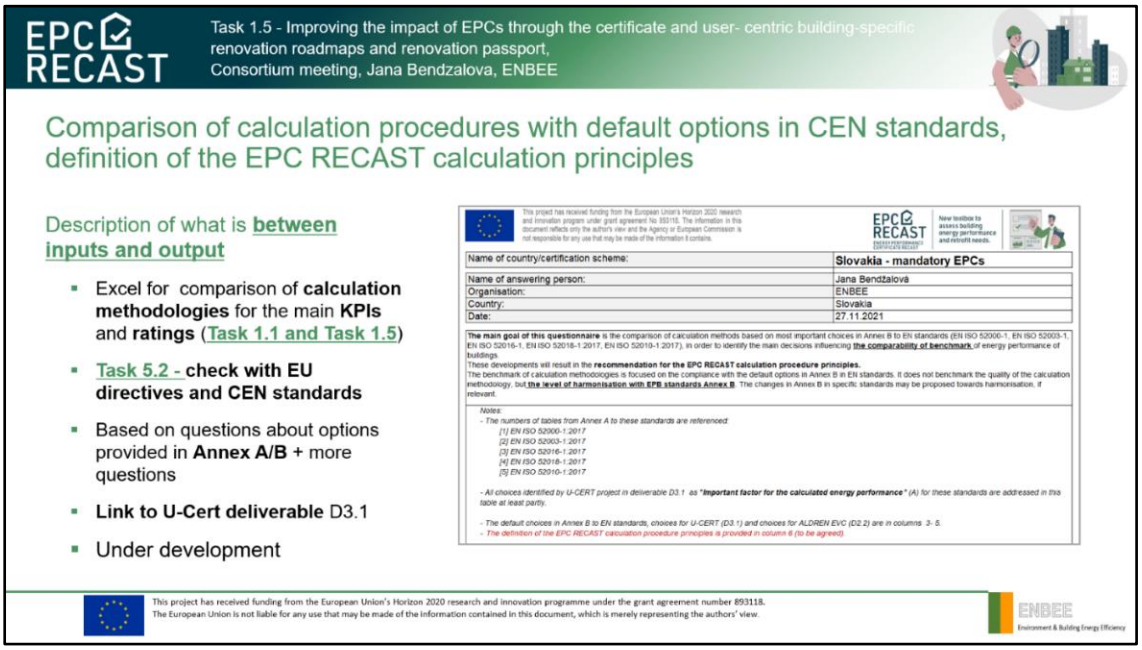

Figure 16 - The spreadsheet for comparison of calculation procedures with default options in CEN standards, definition of the EPC RECAST calculation principles

The benchmark of calculation methodologies for the compliance with the default options in Annex B in EN standards is included.

The potential answers (choices) are prescribed in line with options provided in CEN standards, if possible, or based on the knowledge of calculation methodologies by consortium from previous work, e.g. the Study on Technical assessment of national/regional calculation methodologies for the energy performance of buildings[9].

The intention is not to benchmark the quality of the calculation methodology, but the level of harmonization with Annex B of EPB standards.

The aim of comparison with default options in Annex B is to identify the default options with high **potential for EU harmonisation** and the default options that **do not fit to most of countries** and **propose the revision of the default option in the standard.**

The results were analysed and evaluated in WP5 and in deliverable D5.8

Questions are divided in the topics that cover the scope of Task 1.1 and the scope of Task 1.5 on benchmark of energy performance and key performance indicators included in EPC:

- Pre–processing (Task 1.1)
- Key performance indicators - KPIs (Task 1.5)
- Calculation procedure principles (Task 1.1)
- Measured energy for verification and calibration (Task 1.4, Task 1.5)
- Energy rating – scale (Task 1.5)

[9] J.Zirngibl, J. Bendžalová: Technical assessment of national/regional calculation methodologies for the energy performance of buildings, EC ENER/C3/2013#425/SI2.679523, 2015
https://ec.europa.eu/energy/sites/ener/files/documents/EPB_calculations_in_EU.pdf

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The structure of the spreadsheet tool is in Figure 17 where:

- The type of choice according to U-cert (all A-important for calculation, B-crucial for software) is reported in column A. All choices identified by U-CERT project in deliverable D3.1 as "Important factor for the calculated energy performance" (A) and “critical for calculation tool development” (B) for selected standards are addressed at least partly.
- These overarching standards are covered, that are referenced in current EPBD:
  - EN ISO 52000-1:2017 [1]
  - EN ISO 52003-1:2017 [2]
  - EN ISO 52016-1:2017 [3]
  - EN ISO 52018-1:2017 [4]
  - EN ISO 52010-1:2017 [5]
- The reference to the specific tables in Annexes A is reported, if relevant.
- The default choices in **Annex B**, choices in **U-CERT** (D3.1) and choices in **ALDREN EVC** (D2.2) are in columns 3 to 5.
- **The recommendation for EPC RECAST calculation procedure principles** is in column 6
- Answers to be filled for **evaluated calculation methodology** or **software** are in column 8, 9.
- The prescribed set of answers is only possible, using selection menu in column 8 and free comments are possible in column 9.

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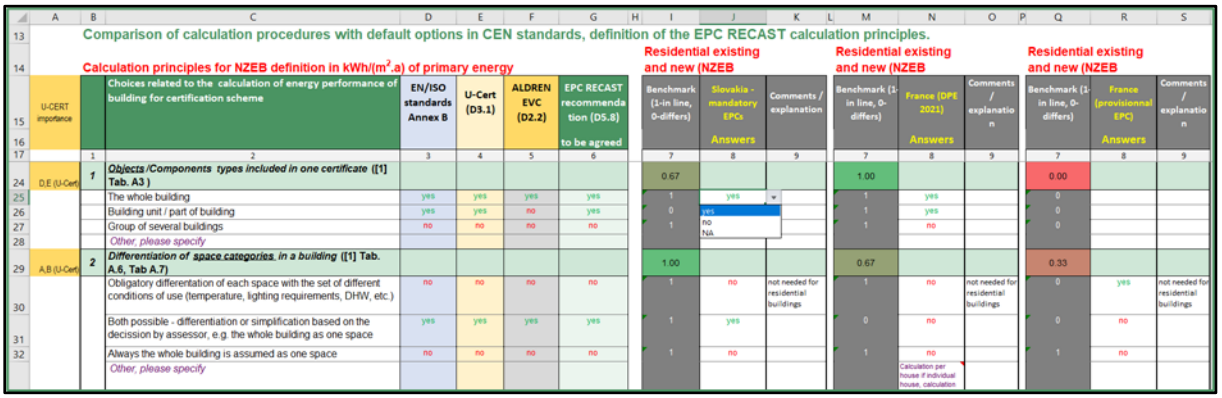

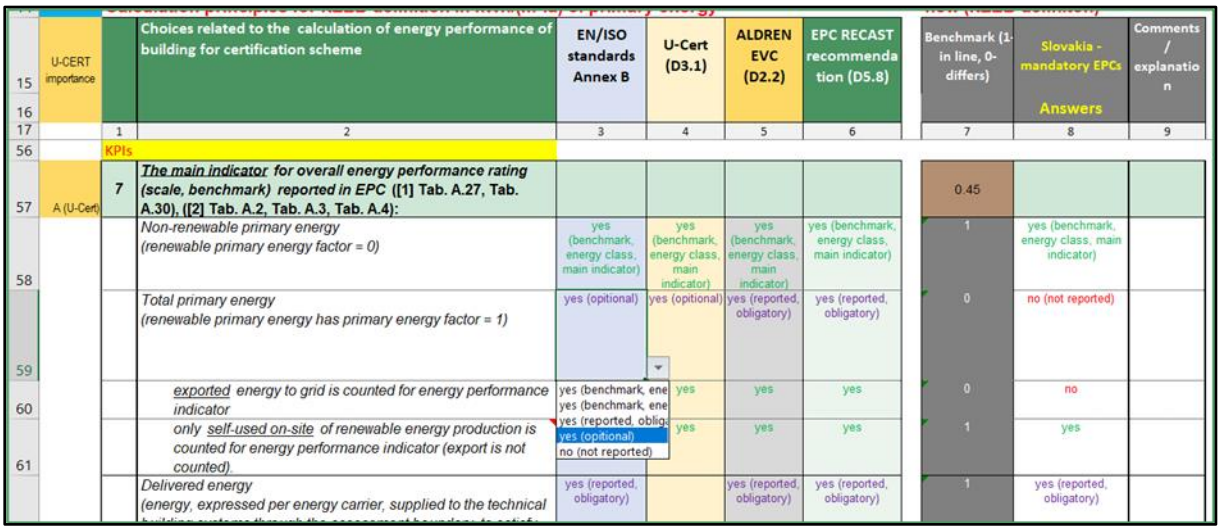

Figure 17 - The questions for comparison of calculation procedures with default options in CEN standards, definition of the EPC RECAST calculation principles

Simple benchmark (1-yes, 0-no) **for compliance with default option in Annex B in CEN standards** is in column 7. Example of Question 4, in Figure 18, shows the case when no country uses the default CEN option: Principle for assumed default system calculation in case of not present system.

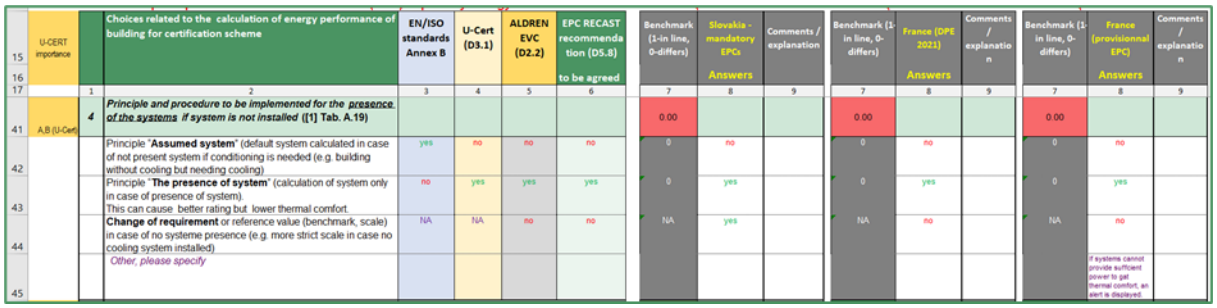

Figure 18 - Example of answers on Question 4: Principle for assumed default system calculation in case of not present system

10.3 Description of calculation methodology

The EPC RECAST calculation procedure principles require to consider the European EPB standards developed under mandate M/480 given to the European Committee for Standardisation (CEN) for assessment of energy performance of buildings.

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Annex A to the EPB standards is an empty template that can be filled in with the national or regional data and choices or by choices for specific application. The template in Annex A to the standard shall be used to specify the choices between methods, the required input data and references to other standards.

Annex B to the standard "Input and method selection data sheet — Default choices" is informative and provides the recommended options for choices.

The specific choices for Annex A "Input and method selection data sheet" to EN ISO 52000-1:2017 [6] for EPC RECAST calculation procedure principles are immediately determined by the choice of the main calculation tool for EPC RECAST project.

Three calculation tools were used in EPC RECAST pilots buildings evaluation that were considered to be close to CEN/ISO standards. They are reported in D5.8.

For the whole chain of calculation the existing calculation tool used to be considered to be close to International and European standards is the calculation engine for the French national energy regulation of new buildings, named COMETH (COre for Modelling Energy and THermal Comfort).

The calculation engine COMETH, was chosen for its proximity to European PEB standards within existing calculation engines. COMETH uses an hourly calculation method. As required, the French calculation method is compatible with the EN ISO 52000-1:2017 standard. COMETH is compatible with CEN standards developed under mandate M480 for systems, the EN 15316 series. For its thermal model and building energy needs calculation, COMETH was based upon the ISO 13790:2008 standard, later replaced by the ISO 52016-1:2017.

The compatibility of the EPC RECAST data model with this type of calculation engine, - which requires detailed data to run, also shows the possible approach to data model for a detailed calculation method such as described in ISO/CEN standards from mandate 480.

Another dynamic calculation engine based on Energy Plus was used for the Spanish pilot cases. As the dynamic calculation engine also used detailed data, it was another proof of possible conversion from EPC RECAST data model to dynamic calculation.

10.4 Conclusion

The aim of this chapter is to provide the methodology and tool for user friendly benchmark of the calculation procedure principles for EU wide **comparability, harmonization, and better understanding** by all stakeholders **of key performance indicators** that are outcomes from **software** or that are reported in **EPCs**.

A clear understanding of indicators (what is between the inputs and the output values) is needed for many purposes. The most important instruments are:

- EU legislation towards the carbon neutrality by 2050 that refers to EPCs, e.g., EU Taxonomy and related technical screening criteria, 30% savings for financial instruments related to Renovation Wave and Recovery plan need a clear understanding of KPIs in EPCs;
- Comparison of calculation methodologies at EU level.
- Reporting choices behind the software calculation code.
- Understanding indicators reported in EPCs by stakeholders (owners, tenants, banks).

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Difference from national Annex A to key standards is the user-friendly structure of questions and sub-questions for full description of calculation methodologies, that can be easily answered by assessors, by experts for national calculation methods development and by software companies.

Software used at the EU level should clearly report these choices, because they are hidden in calculation tool and could not be in line with the national legislation in place. The need for description of calculatino principles in software is evident in Slovakia where the software is not prescribed or certified and any software, also international is often used.

Comparison of calculation methodologies at EU level is needed e.g., for comparison of quantified values proposed by Commission in guidelines and delegated acts developed by Commission based on EPBD recast and for comparison of ambition levels of minimum requirements set by MSs.

Example of importance of evaluation of national calculation methodologies and need for clear reporting of these choices in EPCs is visible in Figure 19 showing the result from study performed in EPC RECAST on family house focused on KPIs (more in deliverable D1.11).

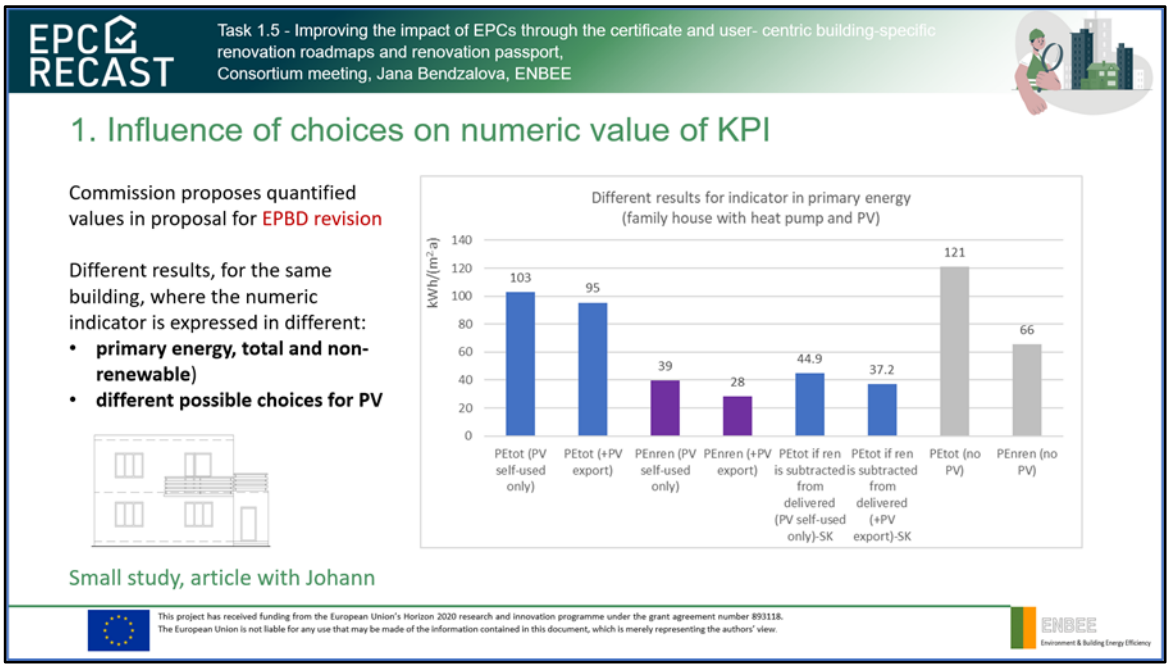

Figure 19 - Influence of choices on numeric value of key performance indicator expressed in primary energy

The preliminary recommendations for EPC RECAST calculation procedure principles are proposed in the spreadsheet (see Annex 5). Proposal after testing during the pilot phase and reviewed at the end of the project based on the experience acquired by the partners (T3.5) and final version of EPBD is in Deliverable D5.8.

More about the key performance indicators to be reported in EPC and the choices for assessment boundaries to be reported in each EPC also presented on example of family house are reported in Task 1.5, in deliverable D1.11.

Recommendation for additional choices to be included in Annex A/B of CEN standards are proposed in Task 5.2. deliverable D5.8.

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11. Conclusions

The Data Model developed as part of EPC RECAST task 1.1 is a structured and harmonized protocol that allows data collection, information, and data reliably during the building inspection phase in the process of carrying out an EPC.

The protocol is based for the characterisation of the building on a structuring by component which follows the structuring of the EU standards for the EP assessment of the buildings.

EPC RECAST simplified Data Model, covers different typical situations that can be encountered especially in existing residential buildings in connection with the various levels of access to information and characterisation of building envelope and HVAC systems. The checking and enriching methods for data collection developed as part of task 1.3 are integrated into the EPC RECAST Data Model as well as available technological components (TCs).

EPC RECAST Data Model was implemented in the EPC RECAST toolbox within WP2 actions.

Once the protocol has been applied to a building, the assessor can then launch the EP assessment using any given calculation method. A step is then necessary for the transformation of some of these data and information into input data for the calculation. In this context, we identified 'conversion methods' inspired by standards, and partners national EPCs existing conversions methods. The aim was to gather the most relevant existing 'conversion methods' and 'standard values' for HVAC systems. We made proposals for the EPC RECAST calculation procedure principles, based on a calculation tool compatible with CEN standards. EPC RECAST project showed possible conversion even to dynamic calculation methods. .

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12. Annexes

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12.1 Annex 1: General frame overview of EPCs in EPC RECAST partners countries

Current EPC in partner countries:
Overview of the general framework

EXISTING RESIDENTIAL BUILDINGS

Overview

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SUMMARY

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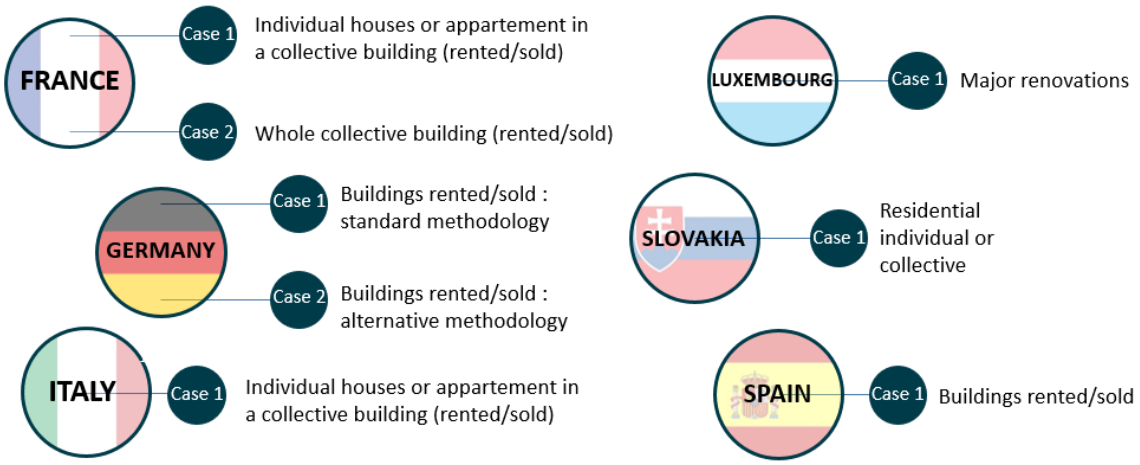
1. Identification of situations for which the EPC is mandatory for **residential** buildings



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2. General information of the different EPC cases for residential buildings

Country	Case	Private / Public	Type of rating	Scope	Comments
FRANCE	1	Private and public	Calculated	Individual houses or apartment in collective building	Methods depends : • On the type of energy systems (individual or collective) • In the case of apartment, two possibilities : individual calculation for each apartment / or from the calculation of the whole building
	2			Whole collective building	
GERMANY	1	Private and public	Calculated (or asset)	Whole building only	There is an innovation clause allowing for several buildings to be assessed together, but it is still unclear how this shall be done
	2				Will be replaced by method based on tabularized values in 2023
ITALY	1	Private and public	Calculated	Individual houses or apartment in collective building	Whole building, single unit, group of equivalent units in the same building
LUXEMBOURG	1	Private and public	Calculated (or asset)	Whole building only	
SLOVAKIA	1	Private and public	Calculated and operational rating	Whole building only	Can be divided in parts with different use if they have separate heating system and different use (building category). If they have the same use, context, orientation, geometry nand are served, if present, by the same heating and cooling system
SPAIN	1	Private and public	Calculated	Part of the building	Entire building or dwelling level

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3. Information displayed on the EPC for residential buildings

a) Key performance indicators

M : Main Indicator ; I : Informative Indicator ; × : Not taken into account

Country	FRANCE	GERMANY		ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
ENERGY AND ENVIRONMENT SUSTAINABILITY RATING		1	2				
Total primary energy use	M	×		×	M	×	×
On-site renewable export counted ?	×				×		
Non-renewable primary energy use	M	M		M	×	M	M
On-site renewable export counted ?	×	×		×		×	×
Total energy use (often called "Final energy use")	×	I		×	M	I	I
On-site renewable export counted ?		×		×	×	×	×
Non-renewable part of Total energy use	×	×		×	×	×	×
On-site renewable export counted ?							
On-site renewable production	I	×		I	M	I	×
On-site renewable export	×	×		I	×	I	×
Ratio of renewable	×	M		×	×	I	×
CO_2 emissions	M	I		M	M	I	M

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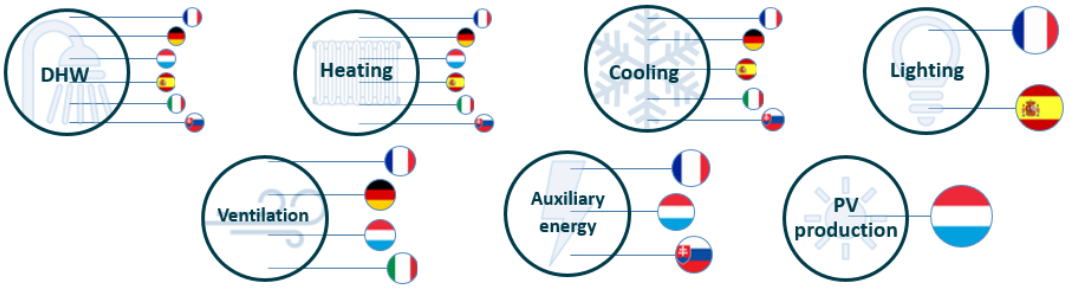
3. Information displayed on the EPC for residential buildings

Services included in each energy and environment sustainability performance main indicator (when taken into account) for asset and or operational rating



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3. Information displayed on the EPC for residential buildings

b) Other indicator(s) used for energy rating and sustainability rating

FRANCE	• **Heat losses** in % • Indicator of **summer comfort** and generic recommendations on how to improve it • **Renewable energy** production : type of system installed • **Ventilation** : type of system installed • **Primary energy** consumption and expenses per use, generic recommendations on the use of heating, cooling and DHW • Qualitative description of **insulation** by component (wall/windows etc.) • Short description of each **equipment** and generic recommendations on energy control and equipment maintenance • CO_2 emission equivalence in km travelled by a car
LUXEMBOURG	• Specific figure "Performance of thermal insulation"
SLOVAKIA	• Energy **needs** • Energy use **per service** has rating (class) • **Delivered** energy – reported, but no rating • **Measured** energy from 3 years – on the first page — reported, but no rating

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3. Information displayed on the EPC for residential buildings

b) Other indicator(s) used for energy rating and sustainability rating

ITALY	• **Building performance indicator**: qualitative indicator (neutral, happy, sad face) related to building energy needs to maintain comfort without taking in account systems and systems' efficiency **(Main Indicator)** • **Reference Values** of non-renewable total energy use indicators (kWh/m2) calculated for similar building (same use, climate, construction type, dimensions, etc.) **(Main Indicator)** • **Renewable part** of total energy use (kWh/m2) **(Main Indicator)** • Total yearly **energy consumptions** of each energy source • **Renewable primary energy** use indicator (kWh/m2 year) • **Non-renewable primary energy use** and energy rating achievable with each recommended energy efficiency measures • **Exported** energy (kWh/year) • **S/V** ratio (Dispersing Area/Gross heated volume) • **Heating** primary energy indicator (kWh/m2 year) • **Equivalent cooling solar area** : ratio between the equivalent glazed area (calculated with specific coefficients) and net area of the building • **Thermal periodic transmittance** : the building thermal inertia • **Energy performance indicator** (renewable and non-renewable) for each system of the building
SPAIN	• Primary energy **consumption non-renewable** (kWh/m²year) per use (heating, cooling, DHW, lighting) • **Energy demand** (kWh/m2 year) per use (heating, cooling) • CO_2 emissions per use ($kgCO_2/m^2$/year)

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[presentation title]
[first name] [last name] [organization]

3. Information displayed on the EPC for residential buildings

c) EN reference standards for the indicators

FRANCE		-
GERMANY	1	Yes, but with national appendices
	2	Yes
ITALY		UNI and CTI technical standards, aligned with the standards prepared by CEN in support of Directive 2010/31 / EU
LUXEMBOURG		German standard DIN V 18599
SLOVAKIA		Yes
SPAIN		-

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[presentation title]
[first name] [last name] [organization]

3. Information displayed on the EPC for residential buildings

d) Energy saving measures

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN	
Energy saving measures recommendations included in the EPC	✓	✓	✓	✓	✓	x	✓
Compulsory or depending on the certifier ?	*Compulsory*	-	*Compulsory*	*Depending on the certifier*	*Compulsory (if there is potential for improvement to the level of requirements for new buildings)*	*Compulsory*	
Measures : general database or specially identified	*Special*	-	*Database*	-	*Special*	*Database*	
Potential energy savings	✓	*Voluntary*	✓	✓	✓	x	✓
Specific evaluation ? Calculation for each proposed measure applied to the building ? Possible range of energy savings achievable but not particularized for the building ?	Specific	-	Calculation for each measure	Possibility to add the specific savings	Specific	Specific	
Cost analysis	✓	*Voluntary*	✓	✓	Possible	x	Possible
Useful information to promote refurbishments	✓	x	✓	x	x	x	

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3. Information displayed on the EPC

Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : two packages of energy saving measures should be defined by the assessor : **priority renovations** and **high-performance** renovation. For each package there is a **description** of renovation action per component, **indication** of the recommended requirement for this component and an **estimation** of total expenses for this package. There is also for each package the indication of the **new labels** after renovation.
- Useful information to promote refurbishments : information on a network set up by the state (advisers and website) and a website on aid

FRANCE

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3. Information displayed on the EPC
Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : there is a table related to recommendations that include : energy saving measures type, if the measure imply a **major renovation**, **payback** time for each single proposed measures, energy **rating** and energy **performance** index – non-renewable (kWh/m²/year) **achievable** with each **single** recommended energy saving measure, energy rating and energy performance index – non-renewable (kWh/m²/year) achievable implementing **all** the recommended energy savings measure.

- Useful information to promote refurbishments : there is a box for additional information about **opportunities**, also in terms of national or local incentive schemes, related to the execution of energy audits and energy requalification interventions, including major renovations

ITALY

3. Information displayed on the EPC
Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : there is a detailed description of each system, result values and recommendations for improvement in 1 page per system (envelope, heating and DHW, cooling and ventilation, lighting/PV) . One page is dedicated to comparison of the energy performance in the current stage and after proposed measures. **Potential energy savings** after implementation of recommended measures are reported in kWh/m²/year and in % for each service and for key perfromance indicators (fianl energy, non-renewable primary energy and for CO2 emissions). Payback period can be reported (optional).

- Useful information to promote refurbishments : no

Slovakia

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3. Information displayed on the EPC

e) Building description

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
General characteristics of the building *Localization, construction year, general dimensions*	✓	✓	✓	✓	✓	✓
Building envelope	✓	✓	x	✓	✓	✓
	Surface per type of wall and thermal performance	*Year of construction, (mean transmission coefficient or mean u-value)*	x	Ratio of surface and volume; ratio between glazed area and floor surface, orientation and thermal properties of the different envelope elements (periodic transmittance)	*Description actual / proposed* *Per construction (walls, roof, windows, ...), U-values, ventilation rates,..*	*Surface per type of wall and thermal performance*
Building technical systems	✓	✓	✓	✓	✓	✓
	Type of equipment per use and system characteristics	Year of construction of heat generator, main energy carriers	System type and characteristics, energy performance index (renewable and non renewable)	Basic description about systems and controls	*Description actual / proposed*	Type of energy systems, total power, performances curves

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[presentation title]
[first name] [last name] [organization]

3. Information displayed on the EPC

f) Additional information

FRANCE	• Recommendations for improving user behavior • Data to be gathered by the public Authorities (ADEME) for data bases, ... • Reference of the software and method version used • Recommendations for equipment maintenance
GERMANY	• Type of data assessment • Reason for EPC • Statistical U-values per building period (case 2) • Efficiency factors for existing systems (case 2)
ITALY	• Software used for the certification complies with national standards • Assessor professional information • Site inspection information
SLOVAKIA	• Measured energy from last 3 years • Administrative data about building, location, assessor, purpose of EPC, building category, • Special Annex to EPC: Additional report with input data and intermediate results from calculation for professionals or for quality control

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4. Energy assessment methodology

In the case of energy performance assessment using calculation method – asset rating

Country	FRANCE		GERMANY		ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Case	1	2	1	2	1	1	1	1
References to CEN standard ?	×		Partially and with national appendices	Yes, but with drawn standards	Directive 2010/31/EU	German standard DIN V 18599	✓	EN 52016
Type of the calculation	Quasi static							
Calculation step (longest allowed step)	Monthly (static calculation for each month)		Monthly	Annual	Hourly	Monthly	Monthly (Hourly allowed)	Hourly
Spatial segmentation of the building	Per house or dwelling	Per building	Entire building as a single homogeneous space		For homogenous thermal zones	Whole building only	Whole building (zonning is allowed during calculation, but the result is for the whole)	Multizone analysis with dynamic methods, and unizone analysis with symplified methods
Climate data	Standard							
Occupant behaviour	Standard							
Standard conditions	French department for climate National standards for other conventional data		National standards		National standards	German standard DIN V 18599	Regulation and national standard	Spanish legislation

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[presentation title]
[first name] [last name] [organization]

4. Energy assessment methodology

In the case of energy performance assessment using calculation method - Calculated rating

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
How are missing systems treated ?	Principle "Presence of system": calculation of system only in case of presence of system. This can cause better rating but lower thermal comfort.	"Presence of system"	"Assumed system" : default system calculated in case of not present system if conditioning is needed (e.g. building without cooling but needing cooling)	Presence of system	"Presence of system" Requirement and energy classes are adapted if cooling is not installed. Thermal comfort is not reported.	"Presence of system"
In case of no system presence, is there a change of reference value (benchmark, scale)?	×	×	×	×	✓	×
Calculation tools	• 3CL method (DEP 2021 method) • Calculation engine supplied to software publishers	Commercial tools	Specific tools designed and approved for the country (normative tools)	Specific tools designed and approved for the country (normative tools) LUX EEB tool H / LESOSAI	Any commercial or own produced tools. Software is not regulated	• HULC • SG SAVE • CYPETHERM HE Plus • CE3X complement • CERMA

***Spain** : HULC (general method - Dynamic calculations), SG SAVE (general method - Dynamic calculations), CYPETHERM HE Plus (general method - Dynamic calculations), CE3X complement (Simplified method based on indirect dynamic calculations), CERMA (Simplified method based on indirect dynamic calculations)*

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4. Energy assessment methodology

In the case of energy performance assessment using calculation method – Asset rating

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Calibration of the model	x	Not compulsary	x	x	x	Not compulsary
Reliability of input data	Visit compulsory, legally enforceable by the buyer/occupant of the dwelling (each input data should be justified)	• Building inspection or photos • Official database available to select estimated values or default values • Quality checks according EPBD §18	• Visit compulsary • Assumed data (eg. For existing envelope elements) are available in national standards • No on-site test or measurement required	x	Inspection on-site required (but not always done). Rough check of inputs in Central database	Visit compulsory. For non-residential buildings provided by BEMs, the quality of input data is usually better than for residential buildings.

Additional comments

Italy : *heating for all type of buildings and heating and DHW in residential building are always considered in the assessment even if not present in the building. Other services (cooling/ventilation for residential buildings and cooling/ventilation/lighting/lift and elevators for non residential buildings) are considered if present.*

Simplified calculation methods are applicable only to existing residential buildings or units, with a net area of less than or equal to 200 m2, except for cases of major renovation.

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4. Energy assessment methodology

In the case of energy performance assessment using measurements – Operational rating

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Indicators obtained from measured data	NA	NA	NA	NA	For heating, the measured energy is normalized to standard conditions. Can be combined with calculation for other services. Then non-ren **primary energy** is indicator.	NA
Data sources	NA	NA	NA	NA	Measured energy (e.g. from bills, smart meters...) can be different interval, but **yearly** is always available. The data check (by correlation is needed)	NA
Type of operational rating (in standard or actual conditions)	NA	NA	NA	NA	In standard conditions	NA
Normalization process (in standard conditions)	NA	NA	NA	NA	Linear regression	NA

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5. Conversion factors used

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Conversion factor from delivered energy to primary energy	Electricity : 2.3	Yes	Defined for each energy carrier in Energy rating calculation regulation	See chapter 6.5 of legislation: https://data.legilux.public.lu/file/eli-etat-leg-rgd-2021-06-09-a439-jo-fr-pdf.pdf	Electricity : 2.2 Gas : 1.1 Wood : 0.1-0.2 DH : 0.28-1.3	NA
Conversion factor from delivered energy to CO2 emissions	• Elec : 64 gCO2eq/kWh to 79 gCO_{2eq}/kWh *(depending on use)* • Wood : 24gCO_{2eq}/kWh PCI to 30gCO_{2eq}/kWh PCI *(depending on the shape of wood : log, pellet…)* • Gaz nat. : 227 gCO_{2eq}/kWh PCI • Gaz prop/butane : 272 gCO_{2eq}/kWh PCI • Fioul : 324 gCO_{2eq}/kWh PCI • Coal : 385 gCO_{2eq}/kWh PCI • Other fossil fuels : 324 gCO_{2eq}/kWh PCI • Renewable used in the building : 0 gCO_{2eq}/kWh	Yes, but CO2-equivalent emissions	NA	See chapter 6.6 of legislation: https://data.legilux.public.lu/file/eli-etat-leg-rgd-2021-06-09-a439-jo-fr-pdf.pdf	• Elec. : 0.167 $kgCO_2$/kWh • Gas : 0.22 $kgCO_2$/kWh • Wood : 0.02 $kgCO_2$/kWh • DH : 0.22-0.36 $kgCO_2$/kWh	NA

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6. Data model

Country	Data model format
FRANCE	✓
GERMANY	✓ *Various XML based schemes*
ITALY	✓ https://www.mise.gov.it/images/stories/normativa/DM_Linee_guida_APE_appendiceB.pdf
LUXEMBOURG	https://guichet.public.lu/dam-assets/entreprises/fr/espace-experts-energie/experts-habitation/habitation/specimens/specimen-cpe-fr.pdf
SLOVAKIA	x
SPAIN	x

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NEW BUILDINGS

Overview

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SUMMARY

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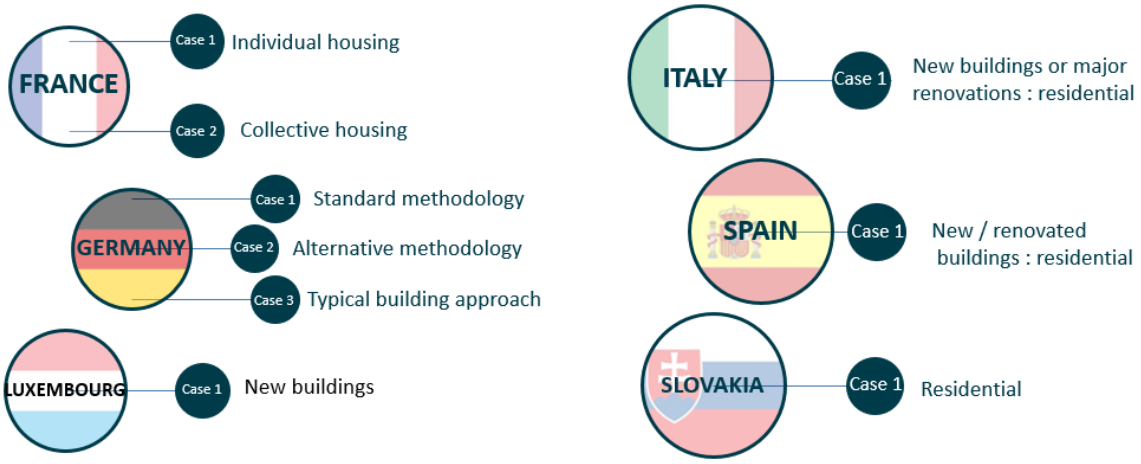
1. Identification of situations for which the EPC is mandatory



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2. General information of the different EPC cases

Country	Case	Private / Public	Other restriction	Type of rating	Scope
FRANCE	1	Private and public	1 or 2 dwellings in the building	Calculated	Part of the building
	2		Strictly more than 2 dwellings in the building		Whole building
GERMANY	1	Private and public	NA	Calculated (or asset)	Whole building only
	2				
	3				
ITALY	1	Private and public	NA	Calculated	Part of the building
LUXEMBOURG	1	Private and public	Calculated (or asset)	Whole building only	
SLOVAKIA	1	Private and public	NA	Calculated rating	Whole building only
SPAIN	1	Private and public	NA	Calculated	Part of the building

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2. General information of the different EPC cases

Additional comments

FRANCE	Entire building or dwelling level.
GERMANY	• Case 1 : Main method, there is an innovation clause allowing for several buildings to be assessed together, but it is still unclear how this shall be done • Case 2 : Calculation with alternative methodology based on EN 832, will be replced by method based on tabularized values in 2023 • Case 3 : Comparison with typical comparable buildings (typical building approach - Modellgebäudeverfahren)
ITALY	Regarding the scope, it is possible to obtain the EPC for : whole building, single unit, group of units in the same building (if they have the same use, context, orientation, geometry and are served, if present, by the same heating system and cooling system.)
SLOVAKIA	Whole building in principle, but it can be divided in parts with different use if they have separate heating system and different use (building category).

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[presentation title]
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3. Information displayed on the EPC

a) Key performance indicators

M : Main Indicator ; I : Informative Indicator ; × : Not taken into account

Country	FRANCE	GERMANY			ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
ENERGY AND ENVIRONMENT SUSTAINABILITY RATING		1	2	3				
Total primary energy use On-site renewable export counted ?	M ×	×		×	×	M ×	×	×
Non-renewable primary energy use On-site renewable export counted ?	×	M ×	×	×	M ×	×	M ×	M ×
Total energy use (often called "Final energy use") On-site renewable export counted ?	×	I ×	×	×	×	M ×	I ×	I ×
Non-renewable part of Total energy use On-site renewable export counted ?	×	×	×	×	×	×	×	×
On-site renewable production	×	×	×	×	I	M	I	×
On-site renewable export	×	×	×	×	I	×	I	×
Ratio of renewable	×	M	×	×	×	×	I	×
CO_2 emissions	M	I	×		M	M	I	M

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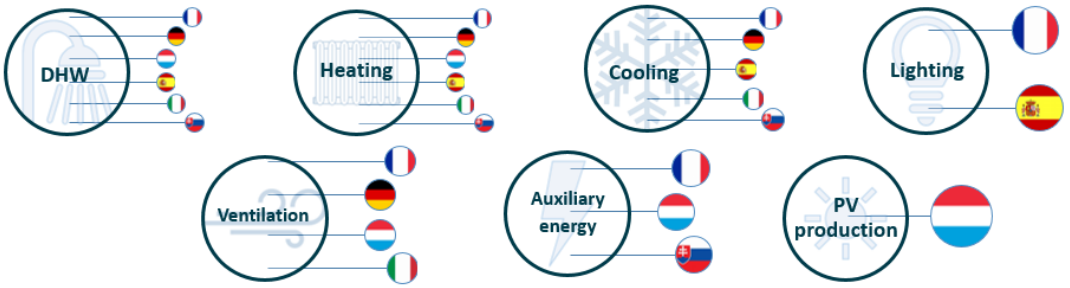
3. Information displayed on the EPC for residential buildings

Services included in each energy and environment sustainability performance main indicator (when taken into account) for asset and or operational rating



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3. Information displayed on the EPC

b) Other indicator(s) used for energy rating and sustainability rating

FRANCE	• Indicator of summer comfort • CO2 emission equivalence in km travelled by a car
GERMANY	• Heat protection in summer (case 1 and 2)
ITALY	• **Building performance indicator** : qualitative indicator (neutral, happy, sad face) related to building energy needs to maintain comfort without taking in account systems and systems' efficiency **(Main)** • **Reference Values of non-renewable total energy use indicators** (kWh/m2) calculated for similar building (same use, climate, construction type, dimensions, etc.). For new buildings, the reference values are the minimum regulation requirement **(Main)** • **Renewable part of total energy use** (kWh/m2) **(Main)** • Renewable primary energy use indicator (kWh/m2 year) • Total yearly energy consumptions of each energy source • Non-renewable primary energy use and energy rating achievable with each recommended energy efficiency measures • Exported energy (kWh/year) • S/V ratio (Dispersing Area/Gross heated volume) • Heating primary energy indicator (kWh/m2 year) • Equivalent cooling solar area, expressing a ratio between the equivalent glazed area (calculated with specific coefficients) and net area of the building • Thermal periodic tramittance, expressing the building thermal inertia • Energy performance indicator (non-renewable and non-renewable) for each system of the building

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3. Information displayed on the EPC

b) Other indicator(s) used for energy rating and sustainability rating

LUXEMBOURG	• Specific figure "Performance of thermal insulation"
SPAIN	• Primary energy consumption non-renewable (kWh/m²year) per use (heating, cooling, DHW, lighting) • Energy demand (kWh/m2 year) per use (heating, cooling) • CO_2 emissions per use (kgCO_2/m²/year)
SLOVAKIA	• Energy **needs** • Energy use **per service** has rating (class) • **Delivered** energy – reported, but no rating • **Measured** energy from 3 years – on the first page -– reported, but no rating

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3. Information displayed on the EPC

c) EN reference standards for the indicators

FRANCE		✓
GERMANY	1	Yes, but with national appendices
	2	✓
	3	Yes, but with national appendices
ITALY		UNI and CTI technical standards, aligned with the standards prepared by CEN in support of Directive 2010/31 / EU
LUXEMBOURG		German standard DIN V 18599
SLOVAKIA		✓
SPAIN		×

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3. Information displayed on the EPC for residential buildings

d) Energy saving measures

Country	FRANCE	GERMANY 1	GERMANY 2	GERMANY 3	LUXEMBOURG	SLOVAKIA	SPAIN
Energy saving measures recommendations included in the EPC	✓	✓		✗	✓	✓	NA
Compulsory or depending on the certifier ?	*Compulsory*	-			*Depending on the certifier*	*Compulsory (if there is potential for improvement to the level of requirements for new buildings)*	NA
Measures : general database or specially identified	*Special*	-			-	*Special*	NA
Potential energy savings	✓	*Voluntary*			✓	✓	NA
Specific evaluation ? Calculation for each proposed measure applied to the building ? Possible range of energy savings achievable but not particularized for the building ?	Specific	-			Possibility to add the specific savings	Specific	NA
Cost analysis	✓	*Voluntary*			✓	Possible	NA
Useful information to promote refurbishments	✓	✗			✗	✗	NA

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Information displayed on the EPC
Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : two packages of energy saving measures should be defined by the assessor : **priority renovations** and **high-performance** renovation. For each package there is a **description** of renovation action per component, **indication** of the recommended requirement for this component and an **estimation** of total expenses for this package. There is also for each package the indication of the **new labels** after renovation.
- Useful information to promote refurbishments : information on a network set up by the state (advisers and website) and a website on aid

FRANCE

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Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : there is a table related to recommendations that include : energy saving measures type, if the measure imply a **major renovation**, **payback** time for each single proposed measures, energy **rating** and energy **performance** index – non-renewable (kWh/m²/year) **achievable** with each **single** recommended energy saving measure, energy rating and energy performance index – non-renewable (kWh/m²/year) achievable implementing **all** the recommended energy savings measure.

- Useful information to promote refurbishments : there is a box for additional information about **opportunities**, also in terms of national or local incentive schemes, related to the execution of energy audits and energy requalification interventions, including major renovations

ITALY

3. Information displayed on the EPC

Energy saving measures : a few details

- Energy saving measures recommendations included in the EPC : The energy saving measure for new buildingss are relevant if there is still potential for improvement. There is a detailed description of each system, result values and recommendations for improvement in 1 page per system (envelope, heating and DHW, cooling and ventilation, lighting/PV) . One page is dedicated to comparison of the energy performance in the current stage and after proposed measures. **Potential energy savings** after implementation of recommended measures are reported in kWh/m²/year and in % for each service and for key perfromance indicators (fianl energy, non-renewable primary energy and for CO2 emissions). Payback period can be reported (optional).

- Useful information to promote refurbishments : no

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3. Information displayed on the EPC

e) Building description

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
General characteristics of the building *Localization, construction year, general dimensions*	✓	✓	✓	✓	✓	✓
Building envelope	✓	✓	x	✓	✓	✓
	Surface per type of wall and thermal performance	*Year of construction, (mean transmission coefficient or mean u-value)*	Ratio of surface and volume; Ratio between glazed area and floor surface; Periodic transmittance	Ratio of surface and volume; ratio between glazed area and floor surface, orientation and thermal properties of the different envelope elements (periodic transmittance)	*Description actual / proposed* *Per construction (walls, roof, windows, ...), U-values, ventilation rates,..*	*Surface per type of wall and thermal performance*
Building technical systems	✓	✓	✓	✓	✓	✓
	Type of equipment per use and system characteristics	Year of construction of heat generator, main energy carriers	System type and characteristics, energy performance index (renewable and non renewable)	Basic description about systems and controls	*Description actual / proposed*	Type of energy systems, total power, performances curves

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3. Information displayed on the EPC

f) Additional information

FRANCE	• Recommendations for improving user behavior • Data to be gathered by the public Authorities (ADEME) for data bases, … • Reference of the software and method version used • Recommendations for equipment maintenance
GERMANY	• Building address • Type of data assessment • Reason for EPC • Statistical U-values per building period (case 2 and 3) • Efficiency factors for existing systems (case 2 and 3)
ITALY	• Software used for the certification complies with national standards • Assessor professional information • Site inspection information
SLOVAKIA	• Administrative data about building, location, assessor, purpose of EPC, building category, • Special Annex to EPC: Additional report with input data and intermediate results from calculation for professionals or for quality control

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4. Energy assessment methodology

In the case of energy performance assessment using calculation method - Calculated rating

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
How are missing systems treated ?	Principle "Presence of system": calculation of system only in case of presence of system. This can cause better rating but lower thermal comfort.	"Presence of system"	"Assumed system" : default system calculated in case of not present system if conditioning is needed (e.g. building without cooling but needing cooling)	Presence of system	"Presence of system" Requirement and energy classes are adapted if cooling is not installed. Thermal comfort is not reported.	"Presence of system"
In case of no system presence, is there a change of reference value (benchmark, scale)?	×	×	×	×	✓	×
Calculation tools	Commercial tools (verified)	Commercial tools	Specific tools designed and approved for the country (normative tools)	Specific tools designed and approved for the country (normative tools) LUX EEB tool H / LESOSAI	Any commercial or own produced tools. Software is not regulated	• HULC • SG SAVE • CYPETHERM HE Plus • CE3X complement • CERMA

***Spain** : HULC (general method - Dynamic calculations), SG SAVE (general method - Dynamic calculations), CYPETHERM HE Plus (general method - Dynamic calculations), CE3X complement (Simplified method based on indirect dynamic calculations), CERMA (Simplified method based on indirect dynamic calculations)*

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4. Energy assessment methodology

In the case of energy performance assessment using calculation method - Calculated rating

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Calibration of the model	×	Not compulsary	×	×	×	Not compulsary
Reliability of input data	Visit compulsory, legally enforceable by the buyer/occupant of the dwelling (each input data should be justified)	• Building inspection or photos • Official database available to select estimated values or default values • Quality checks according EPBD §18	• Visit compulsory • Assumed data (eg. For existing envelope elements) are available in national standards • No on-site test or measurement required	×	Inspection on-site required, but not always done. Rough check of inputs in Central database	Data is usually obtained from building project.

Additional comments

Italy : *heating for all type of buildings and heating and DHW in residential building are always considered in the assessment even if not present in the building. Other services (cooling/ventilation for residential buildings and cooling/ventilation/lighting/lift and elevators for non-residential buildings) are considered if present.*
Simplified calculation methods are applicable only to existing residential buildings or units, with a net area of less than or equal to 200 m2, except for cases of major renovation.

France : *For new buildings : use of the standard document for new building used for the Th-BCE method*

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5. Conversion factors used

Country	FRANCE	GERMANY	ITALY	LUXEMBOURG	SLOVAKIA	SPAIN
Conversion factor from delivered energy to primary energy	Electricity : 2.3	Yes	Defined for each energy carrier in Energy rating calculation regulation	See chapter 6.5 of legislation: https://data.legilux.public.lu/file/eli-etat-leg-rgd-2021-06-09-a439-jo-fr-pdf.pdf	Electricity : 2.2 Gas : 1.1 Wood : 0.1-0.2 DH : 0.28-1.3	NA
Conversion factor from delivered energy to CO2 emissions	• Elec : 64 gCO2eq/kWh to 79 gCO_{2eq}/kWh *(depending on use)* • Wood : 24gCO_{2eq}/kWh PCI to 30gCO_{2eq}/kWh PCI *(depending on the shape of wood : log, pellet…)* • Gaz nat. : 227 gCO_{2eq}/kWh PCI • Gaz prop/butane : 272 gCO_{2eq}/kWh PCI • Fioul : 324 gCO_{2eq}/kWh PCI • Coal : 385 gCO_{2eq}/kWh PCI • Other fossil fuels : 324 gCO_{2eq}/kWh PCI • Renewable used in the building : 0 gCO_{2eq}/kWh	Yes, but CO2-equivalent emissions	NA	See chapter 6.6 of legislation: https://data.legilux.public.lu/file/eli-etat-leg-rgd-2021-06-09-a439-jo-fr-pdf.pdf	• Elec. : 0.167 $kgCO_2$/kWh • Gas : 0.22 $kgCO_2$/kWh • Wood : 0.02 $kgCO_2$/kWh • DH : 0.22-0.36 $kgCO_2$/kWh	NA

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6. Data model

Country	Data model format
FRANCE	✓
GERMANY	✓ *Various XML based schemes*
ITALY	✓ https://www.mise.gov.it/images/stories/normativa/DM_Linee_guida_APE_appendiceB.pdf
LUXEMBOURG	https://guichet.public.lu/dam-assets/entreprises/fr/espace-experts-energie/experts-habitation/habitation/specimens/specimen-cpe-fr.pdf
SLOVAKIA	×
SPAIN	×

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ENGIE
bimeo
ENBEE Environment & Building Energy Efficiency
R2M RESEARCH TO MARKET SOLUTION
REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

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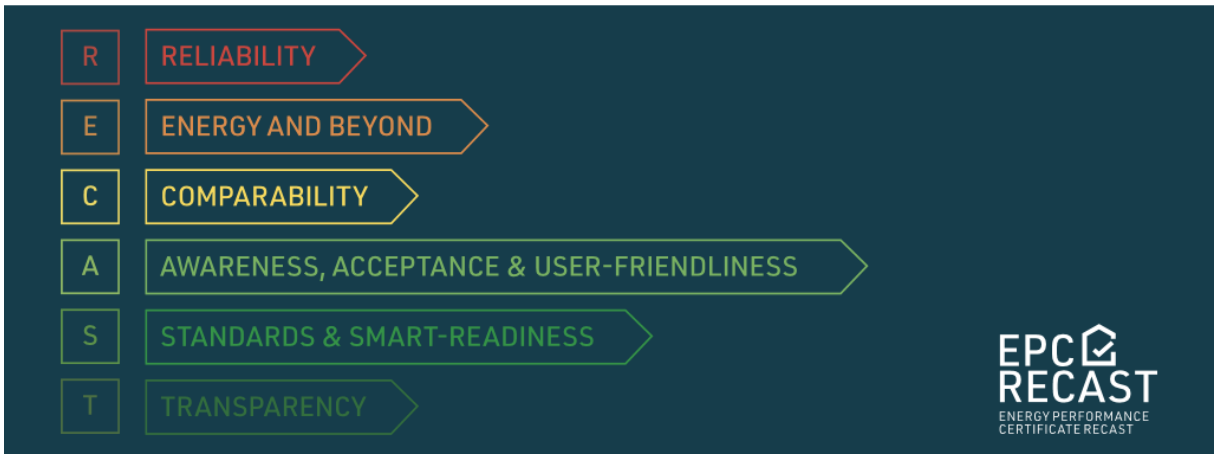

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12.2 Annex 2: Excel spreadsheet for analysis of some ISO/CEN Standards developed under commission mandate M/480

The excel spread sheet can be viewed here:

220426_EPC RECAST_standards an

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12.3 Annex 3: Excel spreadsheet 'EPC RECAST DATA model - version 1

The excel spread sheet can be viewed here

220426_EPC RECAST DM_V1.xlsx

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2. COMMISSION DELEGATED REGULATION (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements (Text with EEA relevance)

3. Guidelines accompanying Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements (2012/C 115/01)

4. COMMISSION RECOMMENDATION (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings

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