EUB
SuperHub

European Building Sustainability performance and energy certification Hub

D2.5 - The EUB SuperHub Transnational framework and passport

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1. table

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Abbreviations

BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Method
CEN	European Committee for Standardization
CMR VOCs	Carcinogenic, Mutagenic, Reprotoxic Volatile Organic Compounds
CQS	Competence Quality Standard
cr	energy carrier
CWA	CEN Workshop Agreement
DBL	Digital Building Logbook
DGNB	Deutsche Gessellschaft für Nachhaltiges Bauen (German Sustainable Building Council - Germany)
DHW	Domestic Hot Water
DMS	Document Management System
EC	European Commission
EPB services	Energy performance of buildings services
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EU	European Union
EUB SuperHub	European Building Sustainability performance and energy certification Hub
HQE	Haute Qualité Environnementale (High Environmental Quality)
IAQ	Indoor Air Quality
ISO	International Organization for Standardization
KGA	Kommunalgebäudeausweis (Vorarlberg, Austria)
KPIs	Key Performance Indicators
LCA	Life cycle assessment
LCC	Life cycle cost
LEED	Leadership in Energy and Environmental Design
LOs	Learning Outcomes
MS	Member State
NZEB	nearly zero-energy building
PPs	Project Partners
PVT	Planning and Verification Tool
SC	Sustainability Certificate
SRI	Smart Readiness Indicator
T	Task
TBS	Technical Building System
VM	Virtual Marketplace
VOCs	Volatile Organic Compounds

Executive summary

This deliverable illustrates the EUB SuperHub certification scheme, a roadmap to implement it across EU and a guide to assess the KPIs of the EUB e-Passport. The document is the result of Task 2.5 linking together different project's outputs in an innovative model of **next generation EPCs**.

All the aspects of a certification scheme such as **quality control, verification, monitoring and inspection procedures,** are described accordingly to the different stages of the EUB SuperHub certification process.

The final output of the certification process is **the EUB e-Passport, a next generation EPC** based **on a common set of KPIs** that will be the object of a new CEN Workshop Agreement on the "Harmonization of KPIs for the next generation of EPCs".

The development of the process follows the recommended actions and the established strategies defined in WP1, WP2, WP3 and WP4, fully described through the entire Deliverable 2.5. Moreover, to be in line with what stated by the European Commission about building certification scheme, a recognition activity has been carried out among the initiatives developed by the EC on this specific topic, ensuring compliance and reliability to the final project output.

Introduction

This document is articulated into three sections. The content of each section is described below.

Chapter 1: EUB SuperHub certification scheme

This section describes the main elements of the EUB SuperHub certification scheme that have been defined to assure the quality and reliability of the EUB e-Passport (final output of the certification processes):

- EUB SuperHub certification process.
  The certification process can be in a "basic" or "advanced" version, depending on the building typology (public or private), dimension and use.
  Both versions are articulated in three phases corresponding to the main project's stages: design, construction/as built, in use. For each of the three phases, the assessment and validation steps, data flows (inputs and outputs), actors involved (roles, responsibilities) are illustrated. The EUB SuperHub certification process is based on a third-party approach to maximise the quality and reliability of the EUB e-Passport.
- EUB SuperHub scheme management and monitoring procedures system, in accordance with the principles of ISO 9001 / ISO 17020 / ISO 17065.
- Competence's requirements for assessors and auditors.
- Content of the EUB e-Passport and visual identity
- Use of the EUB Platform and EUB SuperHub Digital Building Logbook to support the EUB SuperHub certification processes.

Chapter 2: EUB SuperHub Assessment Standard

This section is a guideline on the assessment methodologies of the EUB SuperHub Key Performance Indicators based on D2.2. For each KPI, the assessment methodologies are described to ensure the highest comparability of certification results across Europe.

The reporting format for the KPIs is also provided.

The guideline also specifies:

- applicability of KPIs in relation to the building use, project's stage (design, construction, in use) and building type (new building 'as built', existing buildings in the use phase, existing buildings after under major renovation
- the minimum acceptable quality of data for the characterisation of indicators (minimum requirements for databases, accuracy of measurements, simulation software).

Chapter 3: ROADMAP for the implementation of EUB SuperHub certification scheme

This section describes a reference roadmap to implement the EUB SuperHub certification scheme across the EU.
Based on the "*Market study for a voluntary common European Union certification scheme for the energy performance of non-residential buildings*" report, the implementation conditions and the tasks to be followed to manage, test, verify and monitor the EUB SuperHub certification scheme are described.

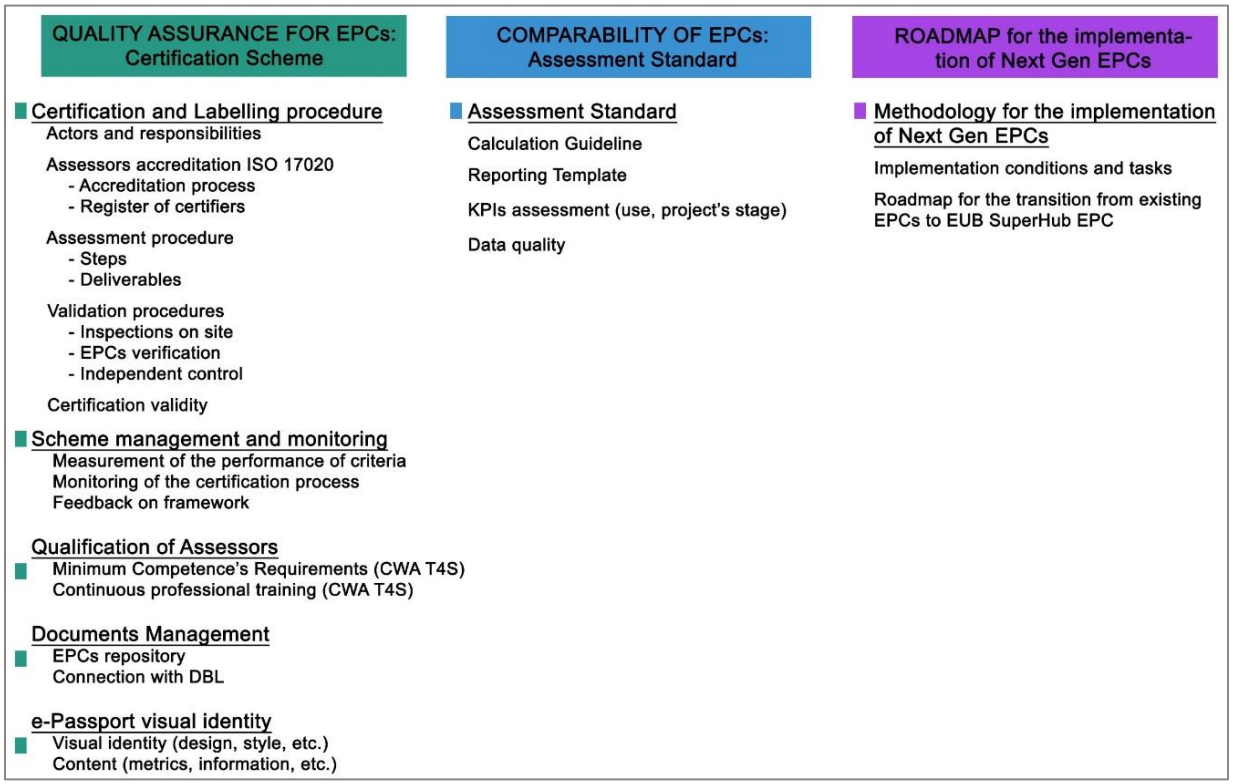


Figure 1: the overall scheme of the topics addressed by T2.5.

[1] https://energy.ec.europa.eu/system/files/2014-12/Final%2520report%2520-%2520Building%2520Certification%2520Schemes%2520-%2520FINAL%252026112014_0.pdf

1 EUB SuperHub certification scheme

The EUB SuperHub certification scheme pursues the objective of the European Commission to establish a voluntary common EU certification scheme for the energy performance of residential and non-residential buildings. This objective is explicitly highlighted in the EPBD recast, released by the European Commission in December 2021[2] and restated within the amendments adopted by the European Parliament on 14 March 2023[3].

In the following sections are described:

- Terms and definitions
- EUB SuperHub certification processes, including the use of the EUB Platform and EUB SuperHub Digital Building Logbook
- EUB SuperHub certification scheme management and monitoring
- Competence's Requirements for the qualification of assessors and auditors.

1.1 Terms and definitions

For the purposes of this section, the following terms and definitions apply:

- **EUB SUPERHUB SCHEME MANAGER**: it is the subject managing the EUB SuperHub certification scheme whose. The main management activities concern:
  - communication and marketing
  - financial aspects and administration
  - organisation, operation and monitoring of the certification process
  - EUB SuperHub repositories (e-Passports, certification bodies, auditors, assessors)
  - training and accreditation of certification bodies and auditors
  - training and qualification of assessors
  - EUB SuperHub Platform and other IT tools.
- **CLIENT**: according to the UNI EN ISO 9000:2016, Clause 3.2.4, is "a *person or organization that could or does receive a product or a service that is intended for or required by this person or organization".*
  Example: Consumer, client, end-user, retailer, receiver of product or service from an internal process beneficiary and purchaser.
  Its activities concern the registration of the building and the appointment of the assessor for the evaluation of the building.
- **CERTIFICATION BODY**: "according to UNI CEI EN ISO/IEC 17000:2020 is "*a conformity assessment body that performs conformity assessment activities, excluding accreditation*".
  Its activities concern the appointment of the auditor and the issue of the final certificate, the EUB e-Passport for the technical design phase.
- **ASSESSOR**: according to UNI ISO 10667-1:2021, 3.5, is "*a person or organization responsible for evaluating and interpreting an assessment*

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0802&qid=1641802763889
[3] https://www.europarl.europa.eu/doceo/document/TA-9-2023-0068_EN.html#title2

participant's performance on the assessment tasks and providing appropriate reporting and feedback to assessment participants and the client".
Its activities address the indicators' characterisation and the drafting of assessment report, describe by the ISO 13491-1:2016.

- **AUDITOR**: according to UNI ISO 20252:2019 is a "*person with the competence to conduct an audit*". His/her activity is to revise the content of the technical reports produced by the Assessors in the different certification phases.
- **ASSESSMENT REPORT**: according to the ISO 13491-1:2016, 3.6, is "*the output based on the results from an assessor*".
  It is a technical document prepared by the Assessor in the "Design" phase of the EUB SuperHub certification process reporting the value of the KPIs and the supporting information.
- **CHECKLIST**: document reporting the list of the building's elements (building materials[4], technical building systems (TBS)[5], etc.) that will be verified during the Construction/As built phase to check the compliance of the construction with the Assessment Report of the Design phase. It is drafted by the Auditor.
- **INSPECTION PLAN**: document describing the inspection activities that will be carried out by the Auditor on the construction site during the construction/as built phase of the certification process to verify the compliance of the building to the Checklist. Source UNI EN ISO 9000 :2016, Clause 3.11.7.
- **COMPLIANCE REPORT**: technical document prepared by the Assessor during the "Construction/As Built" phase providing the information to prove the compliance of the building with regards to the building's elements listed in the Check List.
- **MEASUREMENT REPORT**: technical document prepared by the Assessor in the "In Use" phase of the EUB SuperHub certification process reporting the value of the KPIs and the supporting information.
- **VALIDATION REPORT**: technical document prepared by the auditor reporting the outcomes of the validation processes carried out in the 3 certification phases. It is defined, according to UNI EN ISO 14065, Clause 3.3.4, is "*a validation statement formal written declaration to the intended user, which provides assurance on the statements in the responsible party's assertion*".
- **EUB e-Passport**: performance certificate issued by the Certification Body at the end of each phase (Design, As Built and In Use).

1.2 EUB SuperHub Certification processes

The EUB SuperHub certification process is based on a third-party approach. This means that personal interests, commercial, financial or other pressures or

[4] Building materials of building element which seperate its interior from the outdoor environment (e.g., walls, floor, roof, windows, skylights)

[5] Technical building system (TBS) comprises the technical equipment used for space heating, space cooling, ventilation, domestic hot water preparation, built-in lighting, building automation and control, on-site renewable energy generation and storage, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit.

relationships between those being assessed and those assessing, must be avoided to not compromise the impartiality of the whole process. The use of third-party verification allows to safeguard the impartiality of the certification process, together with detailed guidelines for the assessment and a quality control process.

The third-party verification ensures that the review process is carry on by a professional (Auditor) not involved in the building procurement or linked to any of the parties involved in the building procurement (design, construction, suppliers, installation or maintenance) of the project being certified.

The EUB SuperHub certification process can take place in two versions: Basic and Advanced. The Advanced version foresees two levels of control (auditor + certification body) while the Basic only one (auditor).

The Advanced version is applied to:

- public buildings
- large non-residential buildings (>=1000 m^2 internal useful area)
- buildings funded through public funds and financial incentives.

The Basic version is applied to:

- residential buildings
- small private non-residential buildings (<1000 m^2 internal useful area).

The Advanced EUB SuperHub certification implies a more complex and expensive process (2 levels of control) but it guarantees a deeper verification of final outcomes. The activity of the Auditor (1st level) is monitored and validated by a Certification Body (2nd level). To overcome possible cost barriers and for a more agile process, the Basic version foresees only the activity of an Auditor.

Auditors are qualified according to the Competence Quality Standard of TRAIN4SUSTAIN, described in the CW 17939:2022.

The EUB SuperHub certification process (both Basic and Advanced) is organised in three phases reflecting the main execution stages of a building project (Design, Construction/As Built, In Use):

- Design: phase where the design is refined and plans, specifications and estimates are created[6]. All design information required to manufacture and construct the project are completed. In the Advanced version, the final output of this phase is the "EUB e-Passport - Design". In the Basic version no certificate is issued at this stage.
- Construction / As Built: phase where the construction of the building takes place on the base of the construction documents. The building is concluded but not occupied by users. The final output of this phase in the "EUB e-Passport - As Built" for both Advanced and Basic versions.

[6] Level(s), user Manual 1: Introduction to the Level(s) common framework (Publication version 1.1), chapter 3.1.

- In Use: phase where the building is used, operated and maintained. The final output of this phase in the “EUB e-Passport - in Use” for both Advanced and Basic versions.

The three certification phases for both Basic and Advanced processes are described in the following paragraphs.

1.2.1 Design phase – Advanced

1.2.1.1 Process steps

The certification process in the design phase is described in the table below, including the actors' responsibilities for each stage.

Table 1: Stages description of the EUB certification process for the Design phase (advanced).

Stage	DESCRIPTION	ACTOR
D1	**Activation of the certification process** The activation of the certification process is started by the owner of the building (Client) or by a delegated person. The request is sent to the certification body, attaching the necessary information (building's use and indoor useful area) to quantify the cost of the certification process. The certification body examines the request, quantifies the economic value of the certification process using a reference price list and provides the certification contract to the client. After the acceptance of the contract by the Client, the certification process is activated.	CLIENT and CERTIFICATION BODY
D2	**Appointment of the EUB Assessor** The Client contracts a qualified EUB SuperHub Assessor that will be the responsible for drafting the Assessment Report. The client communicates the name of the assessors to the certification body.	CLIENT
D3	**Appointment of the Auditor** The certification body appoints a qualified EUB SuperHub Auditor that will be responsible for the validation of the Assessment Report drafted by the assessor.	CERTIFICATION BODY
D4	**Indicators' characterization and drafting of the Assessment Report** The Assessor calculates the KPIs foreseen for the design phase and drafts the Assessment Report using the template provided by the certification body. The Assessment Report is sent to the Auditor for the review.	ASSESSOR
D5	**Validation of the Assessment Report** The Auditor revises the Assessment Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Certification Body.	AUDITOR and ASSESSOR

	On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Assessment Report and will send it to the Auditor. The Auditor will revise the updated versions of the Assessment Report until it will be considered fully validated.	
D6	**Issuing of the EUB e-Passport Design Phase** After the reception of the Validation Report from the Auditor, the certification body issues the EUB e-Passport Design, register it in the EUB SuperHub repository and finally sends a copy to the Client.	CERTIFICATION BODY

The assessment and validation processes foresee a flow of input/output data and which are detailed in the table below.

Table 2: Actors, data input/output in the EUB certification process for the Design phase (advanced).

Stage	DESCRIPTION	ACTOR	DATA INPUT	DATA OUTPUT
D1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Building's use and indoor useful area	Certification contract
D2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Assessor's contract
D3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Audit assignment
D4	**Indicators' characterization and drafting of the Assessment Report**	ASSESSOR	Data necessary to calculate the EUB SuperHub KPIs	Assessment Report
D5	**Validation of the Assessment Report**	AUDITOR	Assessment Report	Validation Report
D6	**Issuing of the EUB e-Passport Design Phase**	CERTIFICATION BODY	Validation Report	EUB e-Passport for the Design phase

In the flowchart below (figure 2), all the steps to be followed for the certification process at the Design phase are detailed.

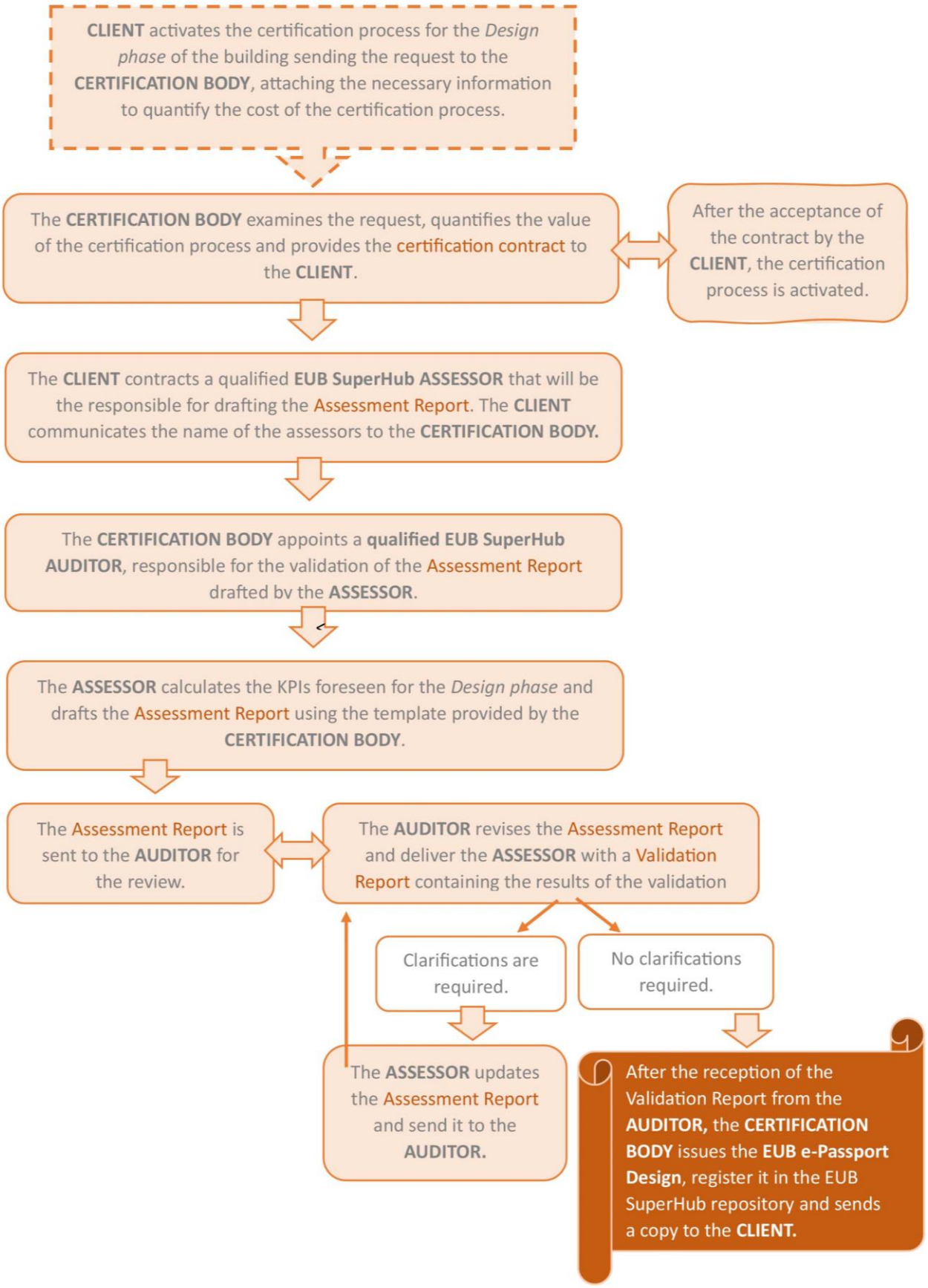


Figure 2: The flowchart related to the Design phase certification process (advanced).

1.2.1.2 DBL and EUB Platform supporting the Design phase

As mentioned in the introduction of the document, the activity of Task 2.5 combines and aligns several project outputs already achieved. Indeed, one of the most important linkages is represented by the interoperability among the EUB Platform functions and the EUB SuperHub Digital Building Logbook, working together to support and facilitate the implementation of the EUB SuperHub certification process for the next generation of EPCs.

The EUB platform, developed within Task 2.3 (*The EUB SuperHub Platform one stop shop features and virtual marketplace*), comprises four main modules, namely the planning and verification tool (PVT) module, e-passport cockpit (e-cockpit), virtual marketplace (VM), and e-training module.

One essential layer within the planning and verification tool (PVT) module is the EUB SuperHub digital building logbook data structure, which is designed within Task 2.4 (*The digital logbook: data requirements, sources and collection process*). It provides all the essential input data needed throughout the building's life cycle to compute the EUB e-Passport Design Phase rating across three domains: energy efficiency, sustainability, and smartness. It acts as a digital container containing all building-related data and is intended as a dynamic tool automatically updated that allows a variety of data, information, and documents to be recorded, accessed, enriched, and organised under the following eight main categories (modules):

1-ADMINISTRATIVE INFORMATION

2-GENERAL BUILDING INFORMATION

3-BUILDING ELEMENT INFORMATION

4-BUILDING OPERATION AND USE

5-BUILDING PERFORMANCE

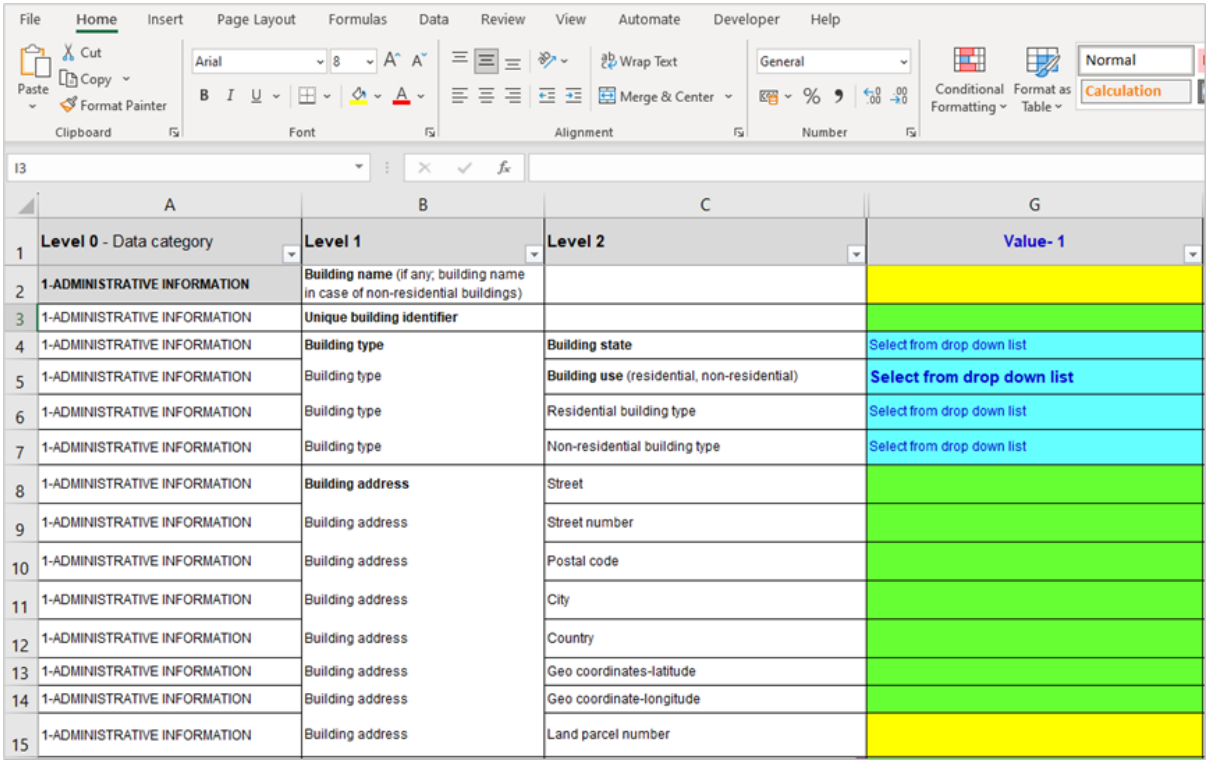
6-SMART READINESS

7-FINANCE

8-BUILDING DOCUMENTATION BIM

The whole EUB SuperHub digital building logbook structure is defined in one Microsoft Excel worksheet containing in total six levels of information (level 0, level 1, level 2, level 3, level 4, and level 5).

Level 0 comprises the eight DBL modules, and level 1 presents the main subcategories of each module (category).



	A	B	C	G
1	**Level 0** - Data category	**Level 1**	**Level 2**	**Value- 1**
2	**1-ADMINISTRATIVE INFORMATION**	**Building name** (if any; building name in case of non-residential buildings)		
3	1-ADMINISTRATIVE INFORMATION	**Unique building identifier**		
4	1-ADMINISTRATIVE INFORMATION	**Building type**	**Building state**	Select from drop down list
5	1-ADMINISTRATIVE INFORMATION	Building type	**Building use** (residential, non-residential)	**Select from drop down list**
6	1-ADMINISTRATIVE INFORMATION	Building type	Residential building type	Select from drop down list
7	1-ADMINISTRATIVE INFORMATION	Building type	Non-residential building type	Select from drop down list
8	1-ADMINISTRATIVE INFORMATION	**Building address**	Street	
9	1-ADMINISTRATIVE INFORMATION	Building address	Street number	
10	1-ADMINISTRATIVE INFORMATION	Building address	Postal code	
11	1-ADMINISTRATIVE INFORMATION	Building address	City	
12	1-ADMINISTRATIVE INFORMATION	Building address	Country	
13	1-ADMINISTRATIVE INFORMATION	Building address	Geo coordinates-latitude	
14	1-ADMINISTRATIVE INFORMATION	Building address	Geo coordinate-longitude	
15	1-ADMINISTRATIVE INFORMATION	Building address	Land parcel number	

Figure 3: Screenshot of the worksheet containing the EUB SuperHub digital building logbook data structure.

The EUB Super Hub DBL addresses all stages of a building's life cycle, including the design phase, which plays a critical role in creating an energy-efficient, sustainable, and smart built environment.

The tables below (Table 3, Table 4, Table 5) detail the complete path to the corresponding input/output data, which are part of the EUB SuperHub digital building logbook, by providing levels (Level 0, Level 1, Level 2, Level 3, etc.).

Table 3 shows the direct connection between the data input/output required to perform the certification process for the Design phase and the supporting tools developed by the EUB SuperHub project.

Within Task 2.2. (Definition of common transnational indicators and assessment metrics for the e-Passport) the consortium team selected 21 transnational KPIs for the next generation of assessment and certification framework of buildings energy performance.

Table 4 outlines the complete path to access all input data necessary for computing the selected EUB SuperHub KPIs in the design phase. It is important to note that some indicators, such as those that require measurements, are not applicable during the design phase.

Exactly as done in the previous table for the data input, also data outputs are supported by the tools developed by the EUB SuperHub project. Table 5 shows this interconnection.

Table 3: Connection of data input to the EUB Platform and EUB DBL in the Design phase

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
D1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Building's use	Function 12.2: Create a new building/ Function 14: Claim a building Function 15.3: Access rights / Function 15.5: Flag for review	Owner / Auditor	1- ADMINISTRATIVE INFORMATION	Building type	●
			Indoor useful floor area			2- GENERAL BUILDING INFORMATION	Building geometry	●
D2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Function 2.1: The VM search function / Function 24.4: Find a planner / Function 2.5: Send a contact request Function	Owner	–		
D3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Function 2.1: The VM search function	Auditor	–		
D4	**Indicators' characterization and drafting of the Assessment Report**	ASSESSOR	Data necessary to calculate the EUB SuperHub KPIs	Function 22: Logbook attributes / Function 15.8: Set benchmarks/Function 18.3: Key Performance Indicators (KPIs) / Function 15.6: Flag for update Function 7.2: Building performance analysis tool	Planner	See Table 4		
D5	**Validation of the Assessment Report**	AUDITOR	Assessment Report	Function 17: Verify the building logbook	Auditor	–		
D6	**Issuing of the EUB e-Passport Design Phase**	CERTIFICATION BODY	Validation Report	Function 18.2: Certificates	Auditor (To be reviewed)	–		

Table 4: Design Phase - overview of data necessary to calculate the EUB SuperHub KPIs

Key Performance Indicator		Unit	Input data to calculate the KPI	Unit	Position of input data within the EUB SuperHub DBL data structure				
					Level 0	Level 1	Level 2	Level 3	Level 4
1	**Total annual primary energy demand per useful floor area**	kWh/(m²yr)	Non-renewable annual primary energy demand per useful floor area	kWh/(m²yr)	5-BUILDING PERFORMANCE	KPIs	Energy consumtpion	Use stage energy performance	●
			Renewable annual primary energy demand per useful floor area	kWh/(m²yr)	5-BUILDING PERFORMANCE	KPIs	Renewable Energy	Use stage energy performance	●
2	**Delivered annual final energy demand per useful floor area**	kWh/(m²yr)	Calculated annual delivered energy used for EPB services for each energy carrier (*cr*)	kWh/yr	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Useful floor area	m²	2-GENERAL BUILDING INFORMATION	Building geometry	●		
3	**Non-renewable annual primary energy demand per useful floor area**	kWh/(m²yr)	Calculated annual delivered energy used for EPB services for each energy carrier (*cr*)	kWh/yr	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Non-renewable primary energy factor for energy carrier (*cr*) (e.g., electricity, natural gas, …)	–	The EUB online platform will incorporate a table of non-renewable primary energy factors.				
			Useful floor area	m²	2-GENERAL BUILDING INFORMATION	Building geometry	●		
4	**Embodied energy**	kWh/m² or MJ	Embodied energy **Production stage** (A1-A3) A1-Extraction and upstream production A2-Transport to factory A3-Manufacturing	MJ					
			Embodied energy **Construction stage** (A4-A5) A4-Transport to site A5-Installation	MJ	Not applicable in the design phase.				
			Embodied energy **Use stage (B1-B5)** B1-Use	MJ	Not applicable in the design phase.				

Key Performance Indicator		Unit	Input data to calculate the KPI	Unit	Position of input data within the EUB SuperHub DBL data structure				
					Level 0	Level 1	Level 2	Level 3	Level 4
			B2-Maintenance B3-Repair B4-Replacement B5-Refurbishement						
			Embodied energy **END-OF-LIFE stage** (C1-C4) C1-De-construction/Demolition C2-Transport to waste processing or disposal C3-Waste processing C4-Disposal of waste	MJ	Not applicable in the design phase.				
5	**Renewable annual primary energy demand per useful floor area**	kWh/(m² yr)	Calculated annual delivered energy used for EPB services for each energy carrier (*cr*)	kWh/yr	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Renewable primary energy factor for energy carrier (*cr*) (e.g., electricity, natural gas, …)	–	The EUB online platform will incorporate a table of renewable primary energy factors.				
			Useful floor area	m²	2-GENERAL BUILDING INFORMATION	Building geometry	●		
6	**Renewable energy ratio** (on-site, nearby)	%	Calculated annual on-site renewable energy generation per useful floor area	kWh/(m²yr)	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Calculated annual nearby delivered energy for energy carrier (*cr*) per useful floor area	kWh/(m²yr)	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Renewable primary energy factor for energy carrier (*cr*) (e.g., electricity, natural gas, …)	–	The EUB online platform will incorporate a table of renewable primary energy factors.				
			Total primary energy demand per useful	kWh/(m²yr)	5-BUILDING PERFORMANCE	KPIs	Energy consumption	Use stage energy	●

Key Performance Indicator		Unit	Input data to calculate the KPI	Unit	Position of input data within the EUB SuperHub DBL data structure				
					Level 0	Level 1	Level 2	Level 3	Level 4
			internal floor area					performance	
7	**Total GHG emissions from primary energy used in building operations**	kg CO_2eq./(m^2yr)	Calculated annual delivered energy used for EPB services for each energy carrier (*cr*)	kWh/yr	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			CO_2 emission factor for energy carrier (*cr*)	–	The EUB online platform will incorporate a table of CO_2 emission factors.				
			Useful floor area	m^2	2-GENERAL BUILDING INFORMATION	Building geometry	●		
8	**Life Cycle Global Warming Potential (GWP)**	kg CO_2eq./m^2 useful floor area, for a reference study period (RSP) of 50 years	Embodied energy **Production stage** (A1-A3) A1-Extraction and upstream production A2-Transport to factory A3-Manufacturing	kg CO_2eq./m^2	5-BUILDING PERFORMANCE	KPIs	Life cycle Global Warming Potential	GHG emissions from energy embodied in construction materials	●
			Embodied energy **Construction stage** (A4-A5) A4-Transport to site A5-Installation	kg CO_2eq./m^2	Not applicable in the design phase.				
			Embodied energy **Use stage (B1-B5)** B1-Use B2-Maintenance B3-Repair B4-Replacement B5-Refurbishement	kg CO_2eq./m^2	Not applicable in the design phase.				
			Embodied energy **END-OF-LIFE stage** (C1-C4) C1-De-construction/Demolition C2-Transport to waste processing or disposal C3-Waste processing C4-Disposal of waste	kg CO_2eq./m^2	Not applicable in the design phase.				
9	**Time outside**	% of time in	–	–	5-BUILDING	KPIs	Thermal comfort	–	●

Key Performance Indicator		Unit	Input data to calculate the KPI	Unit	Position of input data within the EUB SuperHub DBL data structure				
					Level 0	Level 1	Level 2	Level 3	Level 4
	of thermal comfort range	which the indoor temperature is out of a range of 18°C to 27°C during the heating and cooling seasons with and without building services			PERFORMANCE				
10	**Ventilation rate**	L/s	–	–	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Indoor air quality conditions	●
11	**CO_2 concentration**	ppm	–	–	This KPI is not applicable in the design phase.				
12	**Relative Humidity**	%	–	–	This KPI is not applicable in the design phase.				
13	**Total VOCs (Volatile Organic Compounds)**	µg/m³	–	–	This KPI is not applicable in the design phase.				
14	**CMR VOCs concentration (Carcinogenic, mutagenic, reprotoxic volatile organic compounds)**	µg/m³	–	–	This KPI is not applicable in the design phase.				
15	**R value**	decimal ratio	–	–	This KPI is not applicable in the design phase.				
16	**Formaldehyde concentration**	µg/m³	–	–	This KPI is not applicable in the design phase.				
17	**Operational energy costs**	€/(m²yr)	Calculated annual delivered energy used for EPB services for each energy carrier (*cr*)	kWh/yr	5-BUILDING PERFORMANCE	Energy Performance Certification (EPBD)	Energy performance calculation	●	
			Energy price with VAT included for each energy	€/kWh	The EUB online platform will incorporate a table of latest energy prices.				

Key Performance Indicator		Unit	Input data to calculate the KPI	Unit	Position of input data within the EUB SuperHub DBL data structure				
					Level 0	Level 1	Level 2	Level 3	Level 4
			carrier (*cr*) (e.g., electricity, natural gas, district heating system…)						
			Useful floor area	m^2	2-GENERAL BUILDING INFORMATION	Building geometry	●		
18	**Smart Readiness Indicator**	%	–	–	5-BUILDING PERFORMANCE	KPIs	Smart Readiness Indicator	–	●
19	**Summer thermal discomfort in 2030 and 2050**	% of time in which the indoor temperature exceeds 27°C during the cooling season (summer months)	–	–	5-BUILDING PERFORMANCE	KPIs	Climate change and resilience	Resilience	●
20	**Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces**	%	Total number of available parking spaces	–	6-SMART READINESS	E-mobility	●		
			Number of purpose built electrical recharging spaces (Number of E-parking spaces)	–	6-SMART READINESS	E-mobility	●		
			Number of pre-cabled recharging stations	–	6-SMART READINESS	E-mobility	●		
21	**Daylight Provision**	%	–	–	5-BUILDING PERFORMANCE	KPIs	Daylight sufficiency	–	●

Table 5: Connection of data output to the EUB Platform and EUB DBL in the Design phase.

S	Description	Actor	Data output	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
D 1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Certification contract	Function 1.8.1.5: Messages-PVT module	Owner / Auditor	–		
D 2	**Appointment of the Assessor**	CLIENT	Assessor's contract	Function 15.3: Access rights / Function 1.8.1.5: Messages-PVT Module	Owner	–		
D 3	**Appointment of the Auditor**	CERTIFICATION BODY	Audit assignment	1.7.1: Auditor registration function	Auditor	–		
D 4	**Indicators' characterization and drafting of the Assessment Report**	ASSESSOR	Assessment Report	18: Building performance metrics/ Function 15.6 Flag for update	Planner	–		
D 5	**Validation of the Assessment Report**	AUDITOR	Validation Report	Function 15.6: Flag for update / Function 17: Verify the building logbook	Auditor	–		
D 6	**Issuing of the EUB e-Passport Design Phase**	CERTIFICATION BODY	EUB e-Passport for the Design phase	Function 18.2: Certificates	Auditor (To be reviewed)	5-BUILDING PERFORMANCE	EUB SuperHub certification	•
						8-BUILDING DOCUMENTATION BIM	Building certification system	EUB Super Hub certification

1.2.2 Construction/As Built phase – Advanced

The Construction/As Built phase follows the Design phase. A building that is in the Construction/As Built phase refers to a building that has been completed within the last three years and does not have any long-term usage data available yet.

The starting documents of the Construction/As Built phase are a validated Assessment Report and the EUB e-Passport Design. Without them, this phase can't be activated.

1.2.2.1 Certification steps

The certification process in the Construction/As Built phase consists in the verification of the compliance of the constructed building with the Checklist of the building elements (building materials, technical building systems, etc.) that determine its performance with regards to the EUB SuperHub KPIs.

The process is described in the table below, also including actors' responsibilities in each stage.

Table 6: Stages description of the EUB certification process for the Construction/As Built phase (advanced).

Stage	DESCRIPTION	ACTOR
A1	**Activation of the certification process** The activation of the certification process is started by the owner of the building (Client) or by a delegated person. The necessary condition to start the process is that a EUB SuperHub e-Passport Design Phase has been already issued and, consequently, the availability of a validated Assessment Report. The request is sent to the certification body, providing the references of the EUB SuperHub Design Phase certificate and attaching the validated Assessment Report plus the necessary information (building's use and indoor useful area) to quantify the cost of the certification process. The certification body examines the request, quantifies the value of the certification process using a reference price list and provides the certification contract to the client. After the acceptance of the contract by the Client, the certification process is activated. The Certification Body can be a different from the one acting in the design phase.	CLIENT and CERTIFICATION BODY
A2	**Appointment of the Assessor** The client contracts a qualified EUB SuperHub Assessor that will be the responsible for drafting the Compliance Report. The Client communicates the name of the assessors to the Certification Body. The Assessor can be a different professional from the one who acting in the design phase.	CLIENT
A3	**Appointment of the Auditor** The certification body appoints a qualified EUB SuperHub Auditor that will be responsible for the validation of the Compliance Report drafted by the Assessor.	CERTIFICATION BODY

A4	**Checklist preparation** The auditor, based on what stated in the assessment report of the detailed design phase, prepares a checklist containing all the building elements to be verified during this phase. The elements listed in the document are the key ones determining the performance achieved by the building in relation to the KPIs. All those elements will be the coreset of the Compliance Report and the onsite inspections.	AUDITOR
A5	**Time schedule of construction works** The Assessor provides the time schedule of construction activities to the Auditor.	ASSESSOR
A6	**Onsite Inspection plan** Based on of the time schedule (see A5) provided by the Assessor, the auditor drafts a plan for the onsite inspections defining the elements from the Checklist to be verified on the construction site. The Auditor decides the number of necessary visits depending on the size and complexity of the building. A visit always takes place at the end of the construction works when the building is completed.	AUDITOR
A7	**Onsite inspections** On site inspections are carried out by the Auditor following the Inspection Plan. This inspection can be performed visually or using specific measurement instruments.	AUDITOR
A8	**Update of the Assessment Report (if necessary)** If during onsite inspections inconsistencies in relation to the Checklist are verified, the Assessor must update the Assessment Report of the Design phase re-calculating the value of affected KPIs.	ASSESSOR

A9	**Validation of the updated Assessment Report (if necessary)** The Auditor revises the updated Assessment Report and deliver a new Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Certification Body. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Assessment Report and will send it to the Auditor. The Auditor will revise the updated versions of the Assessment Report until it will be considered validated.	AUDITOR and ASSESSOR
A10	**Issuing of an updated version of the EUB e-Passport Design Phase** After the reception of the new Validation Report from the Auditor (see A9), the certification body issues the updated EUB e-Passport, register it in the EUB SuperHub repository and sends a copy to the Client.	CERTIFICATION BODY
A11	**Production of the Compliance Report** The Compliance Report is drafted by the assessor based on the elements included in the Checklist. The Compliance Report contains: ▪ Data sheets of building products installed with the description of the technical properties; ▪ Certificates concerning the physical properties of the elements; ▪ Photo-documentation related to the installation of the elements; ▪ Transport documents proving the delivery of the elements to the construction site.	ASSESSOR

A12	**Final site inspection** At the end of the construction works, the validation of the Compliance Report must be delivered and a final onsite inspection is carried out by the Auditor. If necessary, the certification body, through the auditor, can ask the client for further particular inspections on the building to verify specific elements. Otherwise, it is considered the closing inspection activity that leads to the validation of the compliance report.	AUDITOR
A13	**Validation of the Compliance Report** The Auditor revises the Compliance Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Certification Body. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Compliance Report and will send it to the Auditor. The Auditor will revise the updated versions of the Validation Report until it will be considered validated.	AUDITOR
A14	**Issuing of the EUB e-Passport Construction/As-Built Phase** After the reception of the Validation Report from the Auditor, the certification body issues the EUB e-Passport As Built, register it in the EUB SuperHub repository and finally sends a copy to the Client.	CERTIFICATION BODY

The assessment process and validation to be followed in the Construction/As Built phase needed some key input data to properly work and of course, it produces some key output data, which are detailed in the table below.

Table 7: Actors, data input/output in the EUB certification process for the Construction/As Built phase (advanced).

Stage	DESCRIPTION	ACTOR	DATA INPUT	DATA OUTPUT
A1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	EUB e-Passport Design phase. Assessment Report Design Phase. Building's use and indoor useful area	Certification contract

A2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Assessor's contract
A3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Audit assignment
A4	**Checklist preparation**	AUDITOR	Assessment Report and Design documentation	Checklist
A5	**Time schedule of construction works**	ASSESSOR	Design documentation	Time schedule of construction works
A6	**Onsite Inspection Plan**	AUDITOR	Time schedule of construction works	Onsite Inspection Plan
A7	**Onsite inspections**	AUDITOR	Onsite Inspection Plan	Inspections report
A8	**Update of the Assessment Report (if necessary)**	ASSESSOR	Assessment report Design Phase	Updated Assessment Report
A9	**Validation of the updated Assessment Report (if necessary)**	AUDITOR	Updated Assessment Report	Updated Validation Report
A10	**Issuing of an updated version of the EUB e-Passport Design Phase**	CERTIFICATION BODY	Updated Validation Report	Updated EUB SuperHub e-Passport Design Phase
A11	**Production of the Compliance Report**	ASSESSOR	Data requested by the Checklist	Compliance Report
A12	**Final site inspection**	AUDITOR	On site visits	On site visits report
A13	**Validation of the Compliance Report**	AUDITOR	Compliance report	Validation of the Compliance Report
A14	**Issuing of the EUB e-Passport Construction/As-Built Phase**	CERTIFICATION BODY	Validation Report	EUB e-Passport As Built

In the flowchart below, all the steps to be followed for the certification process at the Construction/As Built phase are detailed.

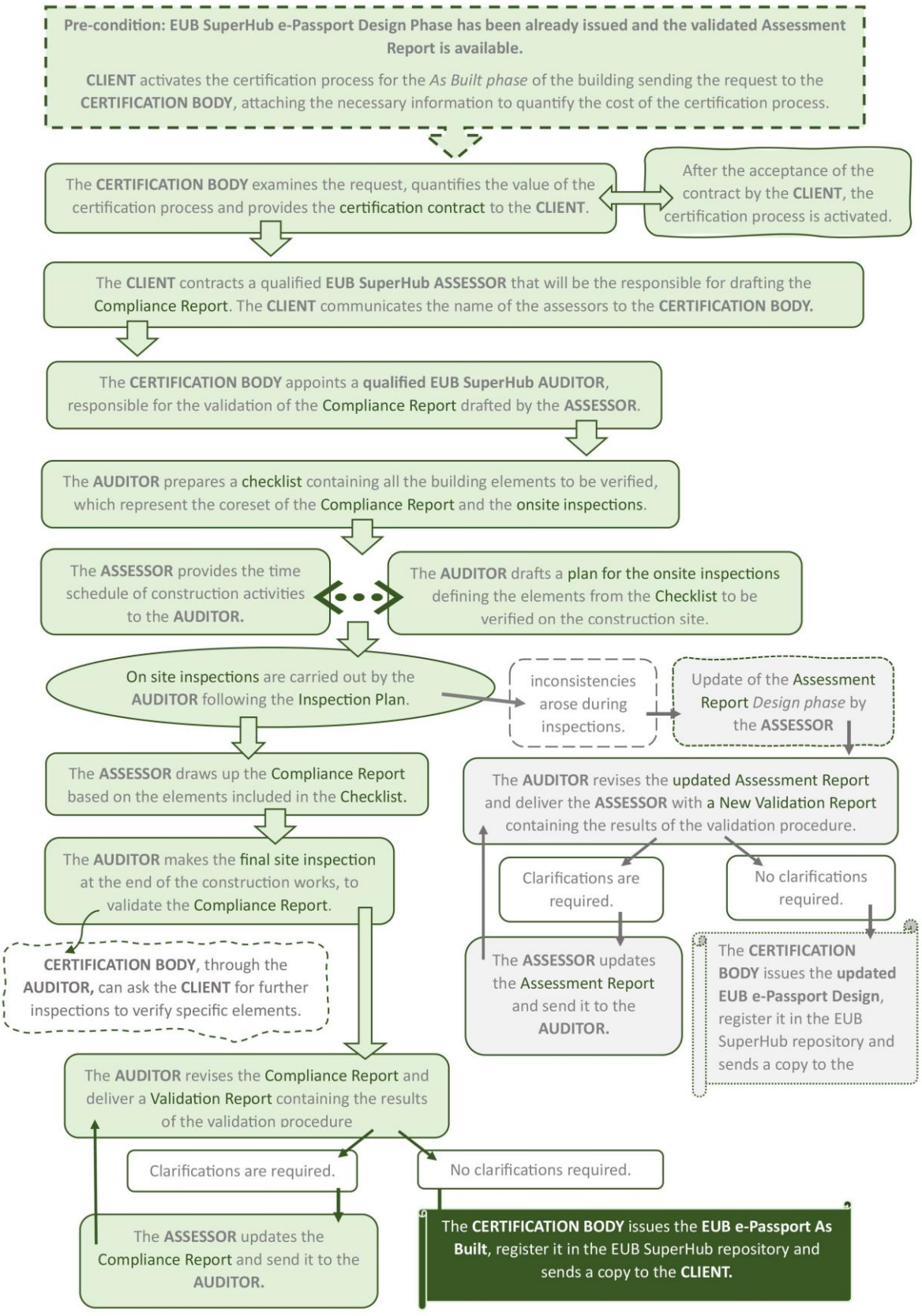


Figure 4: the flowchart related to the Construction/As Built phase certification process (advanced).

1.2.2.2 DBL and EUB Platform supporting the Construction/As Built phase

As described for the detailed design phase, the interoperability among the EUB Platform functions and the Digital Building Logbook, working together to support and facilitate the implementation of the EUB SuperHub certification process for the next generation of EPCs, is evident.

As previously stated in the design phase (1.2.1.2), the EUB platform, developed under Task 2.3 (The EUB SuperHub Platform one stop shop features and virtual market place), provides an evaluation, assessment, and monitoring system for buildings across their entire lifespan, including the construction/as-built phase. The EUB platform comprises four main modules, namely the planning and verification tool (PVT) module, e-passport cockpit (e-cockpit), virtual marketplace (VM), and e-training module.

The Planning and Verification Tool (PVT) module includes one essential layer - the EUB SuperHub digital building logbook data structure - developed under Task 2.4. The elaborated EUB SuperHub DBL data structure contains all the required data for issuing the EUB e-Passport As built. All building related data are organised in one Microsoft Excel worksheet under the following eight main categories (modules):

1-ADMINISTRATIVE INFORMATION

2-GENERAL BUILDING INFORMATION

3-BUILDING ELEMENT INFORMATION

4-BUILDING OPERATION AND USE

5-BUILDING PERFORMANCE

6-SMART READINESS

7-FINANCE

8-BUILDING DOCUMENTATION BIM

There are in total six levels of information (level 0, level 1, level 2, level 3, level 4, and level 5). Level 0 comprises the eight DBL modules, and level 1 presents the main subcategories of each module (category).

The tables below (Table 8, Table 9) detail the complete path to the corresponding input/output data, which are part of the EUB SuperHub digital building logbook, by providing levels (Level 0, Level 1, Level 2, Level 3, etc.).

Table 8 shows the direct connection between the data input required to perform the certification process for the construction/as-built phase and the supporting tools developed by the EUB project.

Exactly as done in the previous table for the data input, also data output are supported by the tools developed by the EUB project. Table 9 shows this interconnection.

Table 8: Connection of data input to the EUB Platform and EUB DBL in the Construction/As Built phase.

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
A1	**Activation of the certification process**	CLIENT and CERTIFICA-TION BODY	EUB e-Passport Design phase. Assessment Report Design Phase. Building's use and indoor useful area	Function 14: Claim a building Function 15.3: Access rights / Function 2.5: Send a contact request / Function 15.5: Flag for review	Owner / Auditor	1-ADMINISTRATIVE INFORMATION	Building type	●
						2-GENERAL BUILDING INFORMATION	Building geometry	●
A2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Function 2.1: The VM search function / Function 24.4: Find a planner / Function 2.5: Send a contact request Function	Owner	–		
A3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Function 2.1: The VM search function	Auditor	–		
A4	**Checklist preparation**	AUDITOR	Assessment Report	Function 15.6: Flag for update	Planner	–		
			Design documentation			8-BUILDING DOCUMENTATION BIM	Design and plans of the building	●
A5	**Time schedule of construction works**	ASSESSOR	Design documentation	Function 1.8.1.5: Messages-PVT Module	Auditor	8-BUILDING DOCUMENTATION BIM	Design and plans of the building	●
A6	**Onsite Inspection Plan**	AUDITOR	Time schedule of construction works	Function 1.8.1.5: Messages-PVT Module	Auditor (To be reviewed)	–		
A7	**Onsite inspections**	AUDITOR	Onsite Inspection Plan	Function 15.6: Flag for update/ Function 22: Logbook attributes	Auditor (To be reviewed)	–		

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
A8	**Update of the Assessment Report (if necessary)**	ASSESSOR	Assessment report Design Phase	Function 15.6: Flag for update /Function 18: Building performance metrics / Function 25: Building performance analysis tool	Planner	–		
A9	**Validation of the updated Assessment Report (if necessary)**	AUDITOR	Updated Assessment Report	Function 15.6: Flag for update Function 17: Verify the building logbook	Auditor	–		
A10	**Issuing of an updated version of the EUB e-Passport Design Phase**	CERTIFICATION BODY	Updated Validation Report	Function 17: Verify the building logbook /Function 18.2: Certificates	Auditor	–		
A11	**Production of the Compliance Report**	ASSESSOR	Data requested by the Checklist	Function 15.6: Flag for update /Function 16: Digital Building Logbook (DBL)	Planner	See Table 9		
A12	**Final site inspection**	AUDITOR	On site visits	Function 15.6: Flag for update/ Function 1.8.1.5: Messages-PVT Module	Auditor/	–		
A13	**Validation of the Compliance Report**	AUDITOR	Compliance report	Function 17: Verify the building logbook	Auditor	–		
A14	**Issuing of the EUB e-Passport Construction/As-Built Phase**	CERTIFICATION BODY	Validation Report	Function 18: Building performance metrics / Function 18.2: Certificates	Auditor	–		

Table 9: Connection of data output to the EUB Platform and EUB DBL in the Construction/As Built phase.

S	Description	Actor	Data output	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
A1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Certification contract	Function 1.8.1.5: Messages-PVT Module	Auditor	–		
A2	**Appointment of the Assessor**	CLIENT	Assessor's contract	Function 1.8.1.5: Messages-PVT Module	Owner	–		
A3	**Appointment of the Auditor**	CERTIFICATION BODY	Audit assignment	1.7.1: Auditor registration function Module	Auditor	–		
A4	**Checklist preparation**	AUDITOR	Checklist	Function 15.6: Flag for update	Planner	–		
A5	**Time schedule of construction works**	ASSESSOR	Time schedule of construction works	Function 1.8.1.5: Messages-PVT Module	Planner	–		
A6	**Onsite Inspection Plan**	AUDITOR	Onsite Inspection Plan	Function 1.8.1.5: Messages-PVT Module	Auditor (To be reviewed)	–		
A7	**Onsite inspections**	AUDITOR	Inspections report	Function 15.6: Flag for update/ Function 22: Logbook attributes	Auditor (To be reviewed)	–		
A8	**Update of the Assessment Report** (if necessary)	ASSESSOR	Updated Assessment Report	Function 15.6: Flag for update /Function 18: Building performance metrics/Function 25: Building performance analysis tool	Planner	–		
A9	**Validation of the updated Assessment Report** (if necessary)	AUDITOR	Updated Validation Report	Function 15.6: Flag for update Function 17: Verify the	Auditor	–		

S	Description	Actor	Data output	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
				building logbook				
A10	**Issuing of an updated version of the EUB e-Passport Design Phase**	CERTIFICATION BODY	Updated EUB SuperHub e-Passport Design Phase	Function 17: Verify the building logbook /Function 18.2: Certificates	Auditor	5-BUILDING PERFORMANCE	EUB SuperHub certification	•
						8-BUILDING DOCUMENTATION BIM	Building certification system	EUB SuperHub certification
A11	**Production of the Compliance Report**	ASSESSOR	Compliance Report	Function 15.6: Flag for update /Function 16: Digital Building Logbook (DBL)	Planner	–		
A12	**Final site inspection**	AUDITOR	On site visits report	Function 15.6: Flag for update/ /Function 16: Digital Building Logbook (DBL) / Function 1.8.1.5: Messages-PVT Module	Auditor/	–		
A13	**Validation of the Compliance Report**	AUDITOR	Validation of the Compliance Report	Function 17: Verify the building logbook	Auditor	–		
A14	**Issuing of the EUB e-Passport Construction/As-Built Phase**	CERTIFICATION BODY	**EUB e-Passport As Built**	Function 18: Building performance metrics / Function 18.2: Certificates	Auditor	5-BUILDING PERFORMANCE	EUB SuperHub certification	•
						8-BUILDING DOCUMENTATION BIM	Building certification system	EUB SuperHub certification

1.2.3 In Use phase – Advanced

The third phase of the building certification process is the “In Use”. A building in the Use phase is a building that has been in operation for more than three years and has long-term usage data available.

During this phase it is evaluated how the building performs after completion and handover to the client. It's the most advanced level as it entails the monitoring and surveying of activity on the completed and operational (occupied by users) building.

This phase can be considered as stand-alone since it is possible to apply a certification process even if the building has not been assessed during the Design and Construction/As Built phases.

1.2.3.1 Certification steps

The assessment process to be followed in the In Use phase, together with the validation of the process, are fully described in the table below, including also actors' responsibilities in each task.

Table 10: Stages description of the EUB certification process for the In Use phase (advanced).

Stage	DESCRIPTION	ACTOR
U1	**Activation of the certification process** The activation of the certification process is started by the owner of the building (Client) or by a delegated person. The request is sent to the certification body, attaching the necessary information (building's use and indoor useful area) to quantify the cost of the certification process. The certification body examines the request, quantifies the value of the certification process using a reference price list and provides the certification contract to the client. After the acceptance of the contract by the Client, the certification process is activated.	CLIENT and CERTIFICATION BODY
U2	**Appointment of the Assessor** The client contracts a qualified EUB SuperHub Assessor that will be the responsible for drafting the Measurement Report. The client communicates the name of the assessors to the certification body.	CLIENT
U3	**Appointment of the Auditor** The certification body appoints a qualified EUB SuperHub Auditor that will be responsible for the validation of the Measurement Report drafted by the assessor.	CERTIFICATION BODY
U4	**Preparation of the Measurement Report** The assessor performs the measurement and monitoring activities necessary to characterise the KPIs foreseen for the In Use phase and drafts the Measurement Report using the template provided by the certification body. The Measurement Report is sent to the Auditor for the review.	ASSESSOR

U5	**Validation of the Measurement Report** The Auditor revises the Measurement Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Certification Body. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Measurement Report and will send it to the Auditor. The Auditor will revise the updated versions of the Measurement Report until it will be considered validated.	AUDITOR
U6	**Issuing of the EUB e-Passport in-use Phase** After the reception of the Validation Report from the Auditor, the Certification Body issues the EUB e-Passport In Use, register it in the EUB SuperHub repository and finally sends a copy to the Client.	CERTIFICATION BODY

The certification process in the In Use phase needs some key input data to properly work. It produces some output data, which are detailed in the table below.

Table 11: Actors, data input/output in the EUB certification process for the In Use phase.

Stage	DESCRIPTION	ACTOR	DATA INPUT	DATA OUTPUT
U1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Building's use and indoor useful area	Certification contract
U2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Assessor's contract
U3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Audit assignment
U4	**Preparation of the Measurements Report**	ASSESSOR	Building's measured data	Measurement Report
U5	**Validation of the Measurements Report**	AUDITOR	Measurement Report	Validation Report
U6	**Issuing of the EUB e-Passport in-use Phase**	CERTIFICATION BODY	Validation Report	EUB e-Passport for the In Use phase

In the flowchart below, all the steps to be followed for the certification process at the In Use phase are detailed.

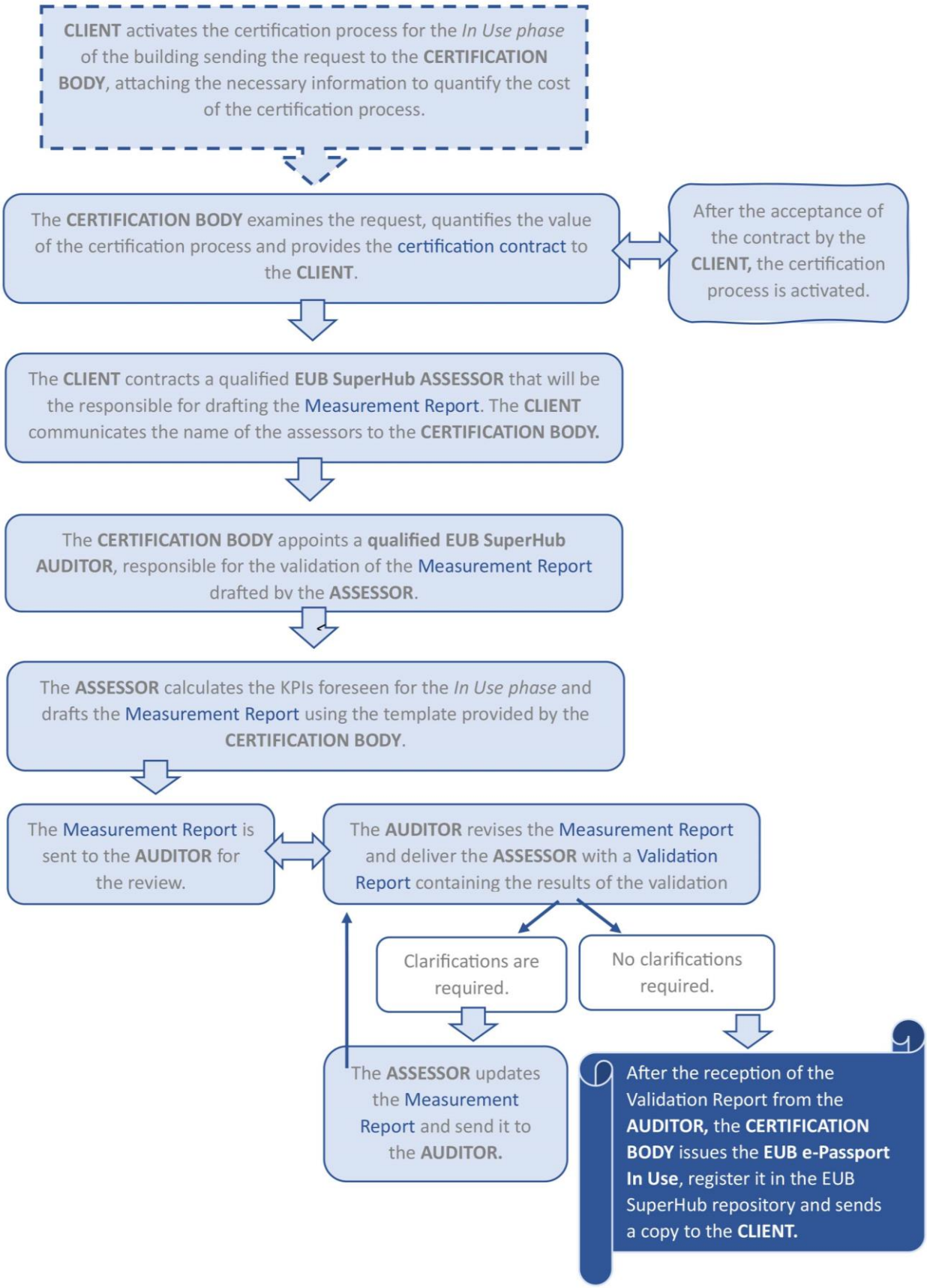


Figure 5: The flowchart related to the In Use phase certification process (advanced).

1.2.3.2 DBL and EUB Platform supporting the In Use phase

Even for the In Use phase, the EUB Platform and the Digital Building Logbook, work together to support and facilitate the implementation of the EUB SuperHub certification process for the next generation of EPCs.

The EUB platform, developed under Task 2.3 (The EUB SuperHub Platform one stop shop features and virtual market place), provides an evaluation, assessment, and monitoring system for buildings across their entire lifespan, including the in use phase as well. As already mentioned, the EUB platform comprises four main modules, namely the planning and verification tool (PVT) module, e-passport cockpit (e-cockpit), virtual marketplace (VM), and e-training module.

The developed EUB SuperHub digital building logbook data structure, which is designed within Task 2.4 (The digital logbook: data requirements, sources and collection process), as one important layer within the planning and verification tool (PVT) module, is the main source of all building related data in the use phase. The suggested EUB SuperHub DBL data structure contains in total eight main categories. The whole data structure is defined in one Microsoft Excel worksheet containing in total six levels of information (level 0, level 1, level 2, level 3, level 4, and level 5).

The tables below (Table 12, Table 13, Table 14) detail the complete path to the corresponding input/output data for buildings in the use phase, which are part of the EUB SuperHub digital building logbook, by providing levels (Level 0, Level 1, Level 2, Level 3, etc.).

Table 12 shows the direct connection between the data input required to perform the certification process for the In Use phase and the supporting tools developed by the EUB SuperHub project.

Table 13 provides an overview of all measured data for buildings during the use phase. This data is contained within the suggested EUB SuperHub digital building logbook data structure.

Exactly as done in the previous table for the data input, also data output are supported by the tools developed by the EUB project.

Table 14 shows this interconnection.

Table 12: Connection of data input to the EUB Platform and EUB DBL in the In Use phase.

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
U 1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Building 's use	Function 14: Claim a building Function 15.3: Access rights / Function 15.5: Flag for review	Owner / Auditor	1-ADMINISTRATIVE INFORMATION	Building type	•
			Indoor useful floor area			2-GENERAL BUILDING INFORMATION	Building geometry	•

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
U 2	**Appointment of the Assessor**	CLIENT	List of qualified Assessors	Function 2.1: The VM search function / Function 24.4: Find a planner / Function 2.5: Send a contact request Function	Owner	–		
U 3	**Appointment of the Auditor**	CERTIFICATION BODY	List of qualified Auditors	Function 2.1: The VM search function	Auditor	–		
U 4	**Preparation of the Measurements Report**	ASSESSOR	Building's measured data	Function 22: Logbook attributes / Function 15.8: Set benchmarks/ Function 18.1: Metered data / Function 18.3: Key Performance Indicators (KPIs) / Function 15.6: Flag for update	Planner	See TABLE 14		
U 5	**Validation of the Measurements Report**	AUDITOR	Measurement Report	Function 17: Verify the building logbook/ Function 15.6: Flag for update	Auditor	–		
U 6	**Issuing of the EUB e-Passport in-use Phase**	CERTIFICATION BODY	Validation Report	Function 18.2: Certificates	Auditor (To be reviewed)	–		

Table 13: In Use Phase – overview of building's measured data

Measured data for buildings in Use Phase	**Unit**	**Position of input data within the EUB SuperHub DBL data structure**				
		Level 0	Level 1	Level 2	Level 3	Level 4
Measured annual delivered final energy demand for each energy carrier (*cr*) (e.g., electricity, natural gas, …)	kWh/y	4-BUILDING OPERATION AND USE	Metered data	Energy consumption	●	
Electricity generation - by photovoltaics (PV) panels	kWh/y	4-BUILDING OPERATION AND USE	Metered data	On-site renewable energy generation	●	
Electricity generation - by small wind turbines	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by solar thermal system	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by biomass	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - heat pump	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Electricity generation - by photovoltaics (PV) panels	kWh/y	4-BUILDING OPERATION AND USE	Metered data	Exported renewable energy generated on-site	●	
Electricity generation - by small wind turbines	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by solar thermal system	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by biomass	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - heat pump	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Electricity generation - by photovoltaics (PV) panels	kWh/y	4-BUILDING OPERATION AND USE	Metered data	Auto-consumed renewable energy generated on-site	●	
Electricity generation - by small wind turbines	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by solar thermal system	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - by biomass	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Thermal energy generation - heat pump	kWh/y	4-BUILDING OPERATION AND USE	Metered data		●	
Metered annual WATER consumption from water bills	m^3/yr	4-BUILDING OPERATION AND USE	Metered data	Water consumption	●	
Volume of DHW delivered per year at specified temperature	m^3/yr	4-BUILDING OPERATION AND USE	Metered data	Domestic hot water (DHW) consumption	●	
KPI 10-Ventilation rate	L/s	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Indoor air quality conditions	●

Measured data for buildings in Use Phase	Unit	Position of input data within the EUB SuperHub DBL data structure				
		Level 0	Level 1	Level 2	Level 3	Level 4
KPI 11-CO_2 concentration	ppm	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Indoor air quality conditions	●
KPI 12-Relative Humidity	%	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Indoor air quality conditions	●
KPI 13-Total VOCs (Volatile Organic Compounds)	µg/m³	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Target pollutants indoor sources	●
KPI 14-CMR VOCs concentration (Carcinogenic, mutagenic, reprotoxic volatile organic compounds)	µg/m³	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Target pollutants indoor sources	●
KPI 15-R value	decimal ratio	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Target pollutants indoor sources	●
KPI 16-Formaldehyde concentration	µg/m³	5-BUILDING PERFORMANCE	KPIs	Indoor air quality (IAQ)	Target pollutants indoor sources	●
KPI 21-Daylight provision	%	5-BUILDING PERFORMANCE	KPIs	Daylight sufficiency	–	●

Table 14: Connection of data output to the EUB Platform and EUB DBL in the In Use phase

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
U1	**Activation of the certification process**	CLIENT and CERTIFICATION BODY	Certification contract	Function 1.8.1.5: Messages-PVT module	Owner / Auditor	–		
U2	**Appointment of the Assessor**	CLIENT	Assessor's contract	Function 15.3: Access rights / Function 1.8.1.5: Messages-PVT module	Owner	–		
U3	**Appointment of the Auditor**	CERTIFICATION BODY	Audit assignment	1.7.1: Auditor registration function	Auditor	–		
U4	**Preparation of the Measurements Report**	ASSESSOR	Measurement Report	18: Building performance metrics/ Function 15.6 Flag for update	Planner	–		
U5	**Validation of the Measurements Report**	AUDITOR	Validation Report	Function 15.6: Flag for update / Function 17: Verify	Auditor	–		

S	Description	Actor	Data input	EUB Platform function(s)	EUB Platform User role	EUB SuperHub DBL		
						Level 0	Level 1	Level 2
				the building logbook				
U6	**Issuing of the EUB e-Passport in-use Phase**	CERTIFICATION BODY	**EUB e-Passport for the In Use phase**	Function 18.2: Certificates	Auditor (To be reviewed)	5-BUILDING PERFORMANCE	EUB SuperHub certification	•
						8-BUILDING DOCUMENTATION BIM	Building certification system	EUB Super Hub certification

1.2.4 Design phase – Basic

1.2.4.1 Certification steps

The certification process in the design phase is described in the table below, including the actors' responsibilities for each stage. The process ends without the issuing of the EUB e-Passport.

Table 15: Stages description of the EUB certification process for the Design phase (basic).

Stage	DESCRIPTION	ACTOR
D1	**Activation of the certification process** The activation of the certification process is started by the owner of the building (Client) or by a delegated person. The request is sent to an EUB SuperHub Auditor, attaching the necessary information (building's use and indoor useful area) to quantify the cost of the certification process. The Auditor examines the request, quantifies the value of the certification process list and provides the certification contract to the client. After the acceptance of the contract by the Client, the certification process is activated. The contract includes both the design and construction/as built phases.	CLIENT and EUB AUDITOR
D2	**Appointment of the Assessor** The Client contracts an Assessor that will be the responsible for drafting the Assessment Report. The client communicates the name of the assessors to the Auditor.	CLIENT

D3	**Indicators' characterization and drafting of the Assessment Report** The Assessor calculates the KPIs foreseen for the design phase and drafts the Assessment Report using the template provided by the Auditor. The Assessment Report is sent to the Auditor for the review.	ASSESSOR
D4	**Validation of the Assessment Report** The Auditor revises the Assessment Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Client. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Assessment Report and will send it to the Auditor. The Auditor will revise the updated versions of the Assessment Report until it will be considered fully validated.	AUDITOR and ASSESSOR

In the flowchart below (figure 6), all the steps to be followed for the certification process at the Design phase are detailed.

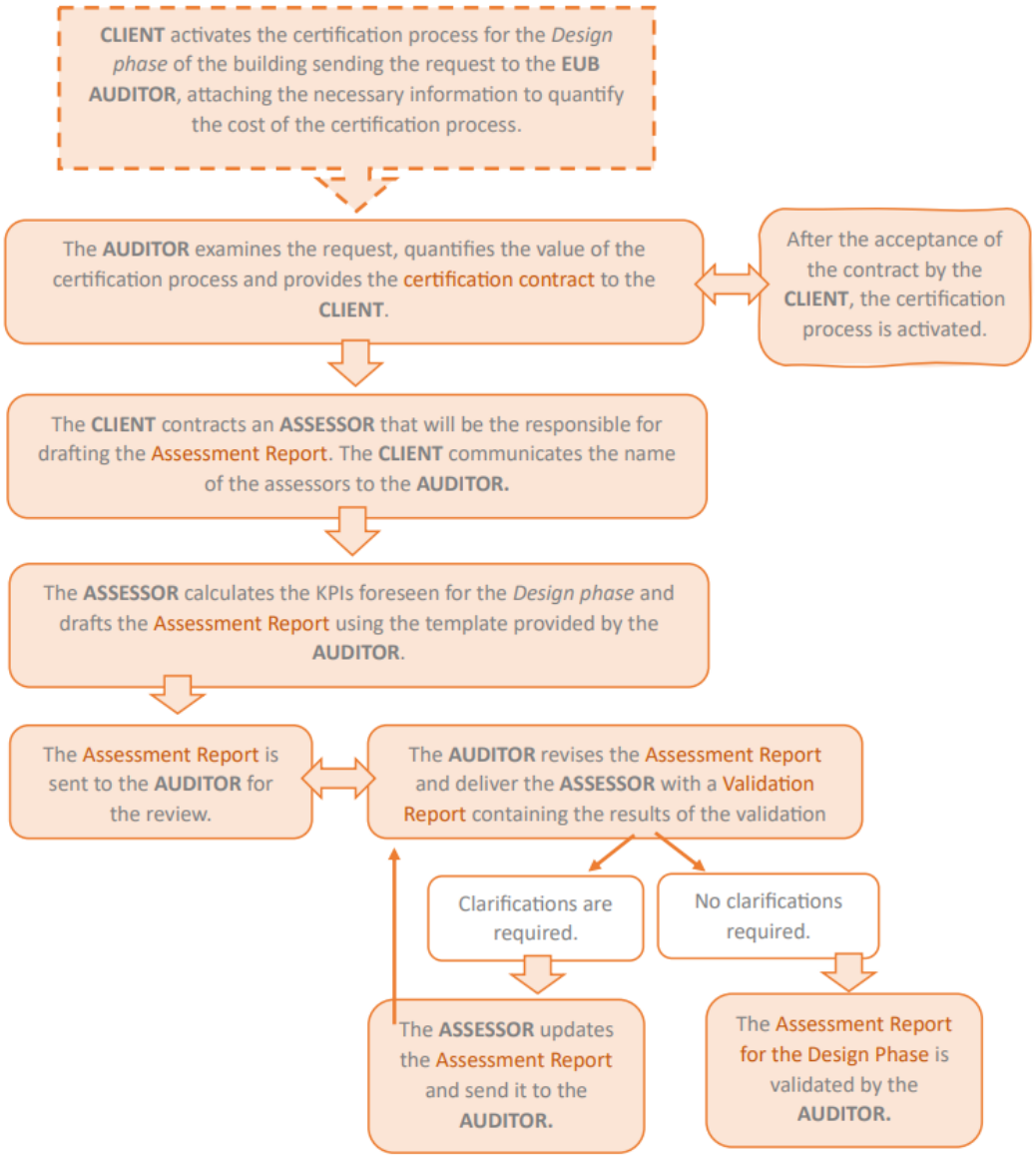


Figure 6: The flowchart related to the Design phase certification process (basic).

1.2.5 Construction/As Built phase - Basic

A building that is in the Construction/As Built phase refers to a building that has been completed within the last three years and does not have any long-term usage data available yet.

1.2.5.1 Certification process for the Construction/As Built phase

The certification process in the Construction/As Built phase consists in the verification of the compliance of the constructed building with the Checklist of the building elements (building materials, technical building systems, etc.) that determine its performance with regards to the EUB SuperHub KPIs. The checklist is prepared by the Auditor based on the Assessment Report produced for the Design phase.

The process is described in the table below, also including actors' responsibilities in each stage.

Table 16: Stages description of the EUB certification process for the Construction/As Built phase (basic).

Stage	DESCRIPTION	ACTOR
A1	**Checklist preparation** The Auditor prepares a checklist, based on the Assessment Report produced for the design phase, containing all the building elements to be verified during this phase. The elements listed in the document are the key ones determining the performance achieved by the building in relation to the KPIs. All those elements will be the coreset of the Compliance Report and the onsite inspections.	AUDITOR
A2	**Time schedule of construction works** The Assessor provides the time schedule of construction activities to the Auditor.	ASSESSOR
A3	**Onsite Inspection plan** Based on of the time schedule provided by the Assessor, the Auditor drafts a plan for the onsite inspections defining the elements from the Checklist to be verified on the construction site. The Auditor decides the number of necessary visits depending on the size and complexity of the building. A visit always takes place at the end of the construction works when the building is completed.	AUDITOR
A4	**Onsite inspections** On site inspections are carried out by the Auditor following the Inspection Plan. This inspection can be performed visually or using specific measurement instruments.	AUDITOR
A5	**Update of the Assessment Report (if necessary)** If during onsite inspections inconsistencies in relation to the Checklist are verified, the Assessor must update the Assessment Report re-calculating the value of affected KPIs.	ASSESSOR

A6	**Validation of the updated Assessment Report (if necessary)** The Auditor revises the updated Assessment Report and deliver a new Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Assessor. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Assessment Report and will send it to the Auditor. The Auditor will revise the updated versions of the Assessment Report until it will be considered validated.	AUDITOR and ASSESSOR
A7	**Production of the Compliance Report** The Compliance Report is drafted by the assessor based on the elements included in the Checklist. The Compliance Report contains: ▪ Data sheets of building products installed with the description of the technical properties; ▪ Certificates concerning the physical properties of the elements; ▪ Photo-documentation related to the installation of the elements; ▪ Transport documents proving the delivery of the elements to the construction site.	ASSESSOR
A8	**Final site inspection** At the end of the construction works, the validation of the Compliance Report must be delivered and a final onsite inspection is carried out by the Auditor. It is considered the closing inspection activity that leads to the validation of the compliance report.	AUDITOR
A9	**Validation of the Compliance Report** The Auditor revises the Compliance Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Assessor. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Compliance Report and will send it to the	AUDITOR

	Auditor. The Auditor will revise the updated versions of the Validation Report until it will be considered validated.	
A10	**Issuing of the EUB e-Passport Construction/As-Built Phase** After the reception of the Validation Report from the Auditor, the EUB SuperHub Auditor issues the EUB e-Passport As Built, register it in the EUB SuperHub repository and finally sends a copy to the Client.	AUDITOR

In the flowchart below, all the steps to be followed for the simplified certification process at the Construction/As Built phase are detailed.

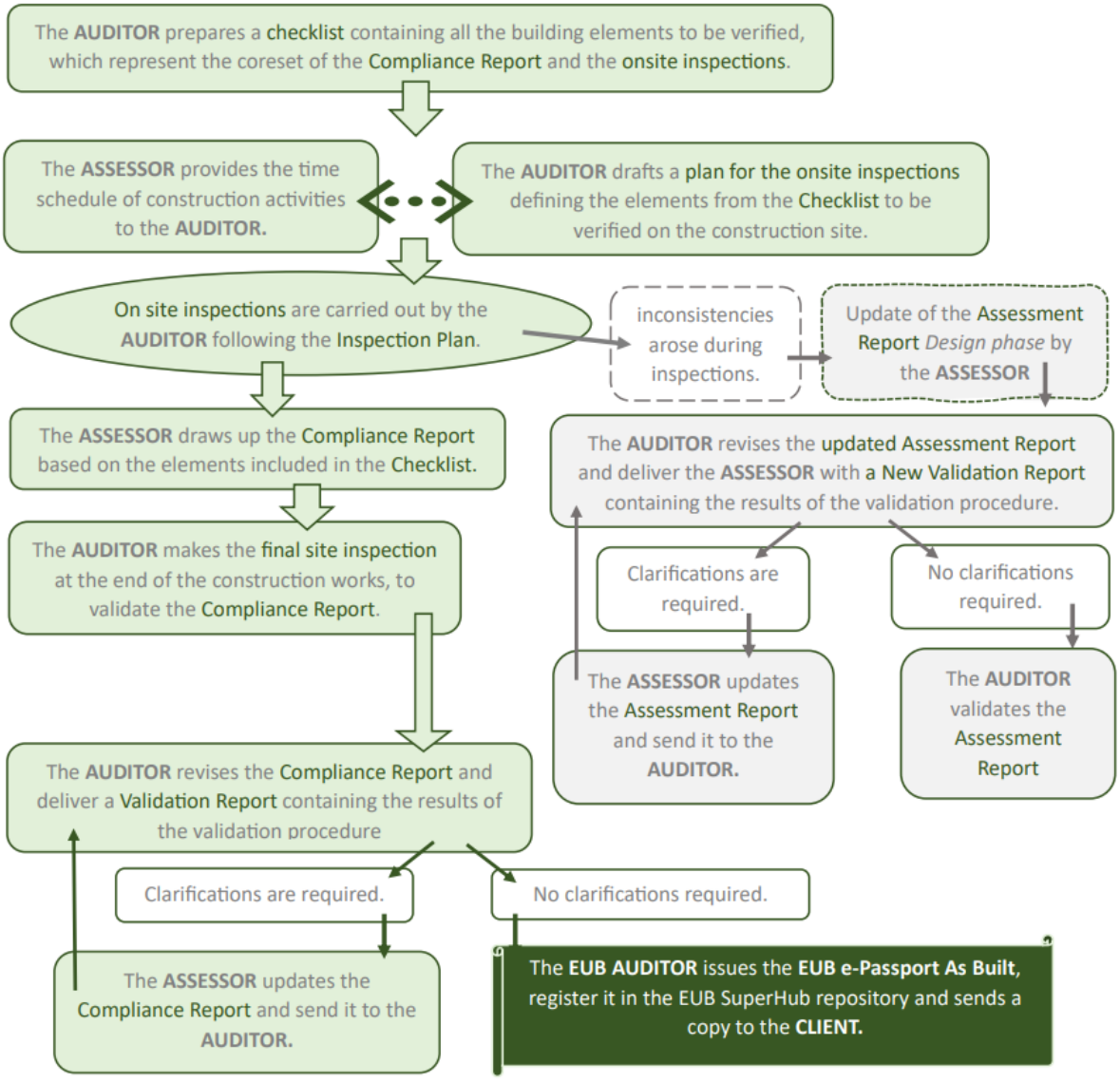


Figure 7: the flowchart related to the Construction/As Built phase certification process (basic).

1.2.6 In Use phase – Basic

During this phase it is evaluated how the building performs after completion and handover to the client. It's the most advanced level as it entails the monitoring and surveying of activity on the completed and operational (occupied by users) building.

This phase can be considered as stand-alone since it is possible to apply a certification process even if the building has not been assessed during the Design and Construction/As Built phases.

1.2.6.1 Certification process for the in use phase(basic)

The assessment process to be followed in the In Use phase, together with the validation of the process, are fully described in the table below, including also actors' responsibilities in each task.

Table 17: Stages description of the EUB certification process for the In Use phase (basic).

Stage	DESCRIPTION	ACTOR
U1	**Activation of the certification process** The activation of the certification process is started by the owner of the building (Client) or by a delegated person. The request is sent to a professional (Auditor) included in the EUB SuperHub certified Auditor list, providing the necessary information concerning building's use and indoor useful area, in order to be able to quantify the cost of the simplified certification process. The Auditor examines the request, quantifies the value of the certification process and provides the certification contract to the Client. After the acceptance of the contract by the Client, the certification process is activated. The Client engages an Assessor, responsible for the drafting of the Measurement Report.	CLIENT and AUDITOR
U2	**Preparation of the Measurement Report** The Assessor performs the measurement and monitoring activities necessary to characterise the KPIs foreseen for the In Use phase and drafts the Measurement Report using the template provided by the Auditor. The Measurement Report is sent to the Auditor for the review.	ASSESSOR

U3	**Validation of the Measurement Report** The Auditor revises the Measurement Report and deliver a Validation Report containing the results of the validation process. If the result is positive (no additions or clarifications are required), the Validation Report is sent to the Assessor. On the contrary, if clarifications are needed, the Auditor will provide the Assessor with the Validation Report. The Assessor will update the Measurement Report and will send it to the Auditor. The Auditor will revise the updated versions of the Measurement Report until it will be considered validated.	AUDITOR
U4	**Issuing of the EUB e-Passport in-use Phase** After the reception of the Validation Report from the Auditor, the EUB SuperHub Auditor issues the EUB e-Passport In Use, register it in the EUB SuperHub repository and finally sends a copy to the Client.	AUDITOR

In the flowchart below, all the steps to be followed for the simplified certification process at the In Use phase are detailed.

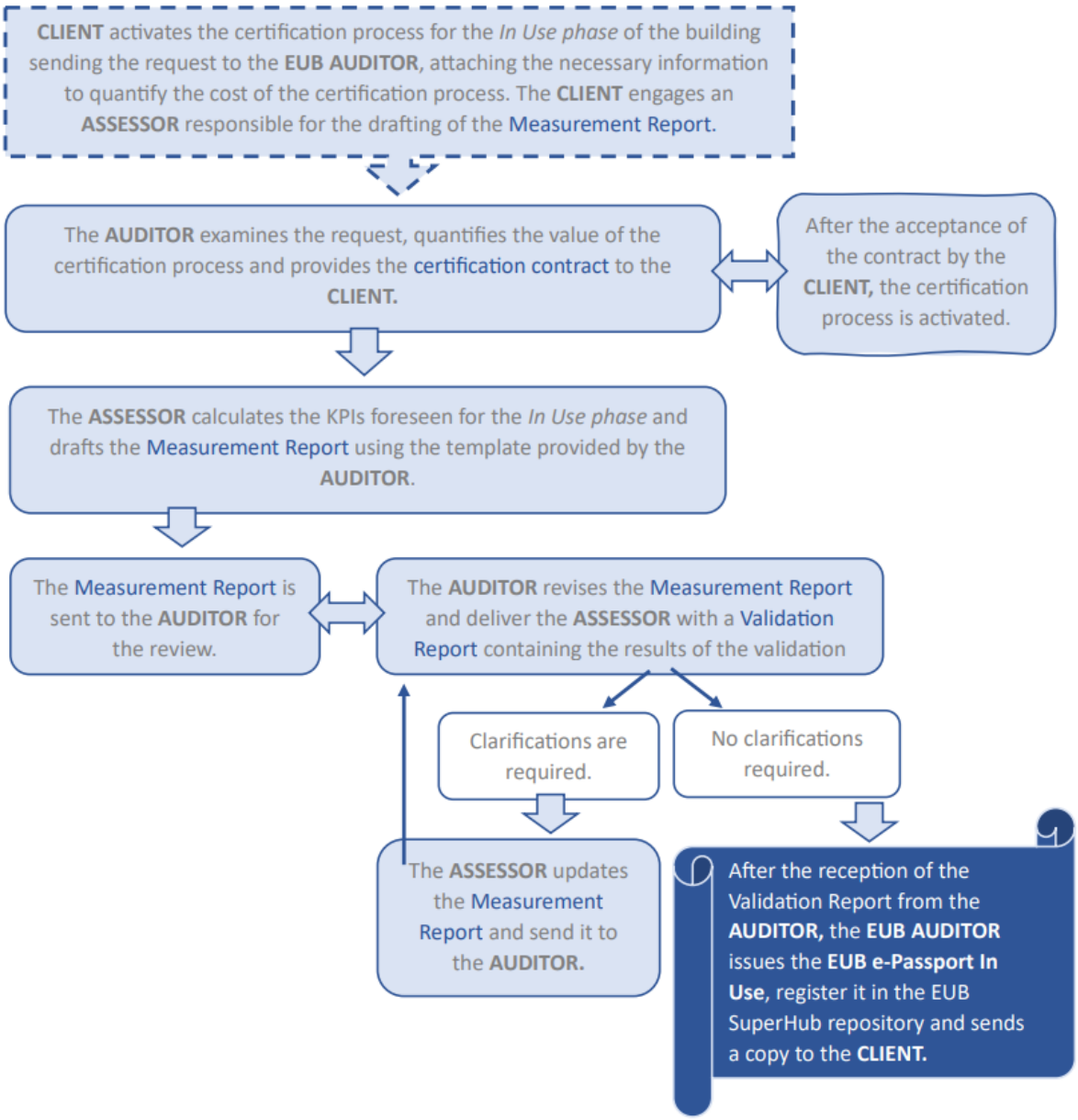


Figure 8: The flowchart related to the In Use phase certification process (basic).

1.3 Scheme management and monitoring

An accurate management and monitoring of a certification scheme are a key requirement to guarantee an high quality and reliability of certificates.

A scheme management and monitoring procedure has been developed for the EUB SuperHub certification, in reference to the technical standards ISO 9001:2008[7], ISO 17020:2012[8] and ISO 17065:2012[9].

In particular, the procedure relies on the process approach identified within ISO 9001, literally the "Plan-Do-Check-Act" methodology, shown in figure below.

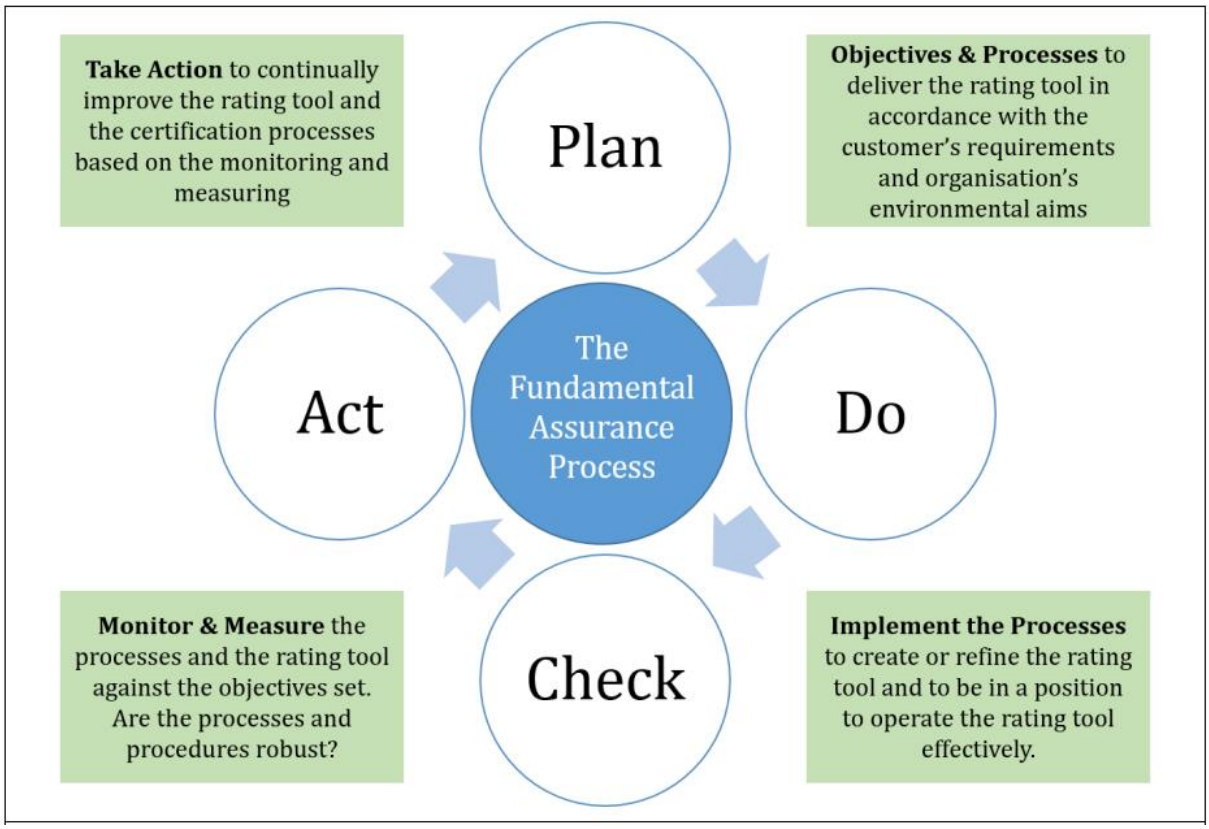


Figure 9: Plan-Do-Check-Act methodology (adapted from ISO9001:2008 p.8)

The management of the EUB certification process is made of clear documentation, as described in the previous paragraphs, which explicitly states the processes and the obligations of each party within the whole certification process development. Indeed, it is fundamental to clearly define the responsibilities of all parties involved, the document management system (through the DBL and EUB Platform), the quality control of the process through the different monitoring activities and of course, the feedback framework addressing the different stages of the certification process.

[7] ISO 9001:2008 Quality management systems – Requirements.
[8] ISO/IEC 17020:2012 Conformity assessment – Requirements for the operation of various types of bodies performing inspection.
[9] ISO/IEC 17065:2012 Conformity assessment – Requirements for bodies certifying products, processes and service.

Many essential quality assurance considerations must be considered for the development, management and monitoring of the EUB SuperHub building certification process. In particular the third-party verification, the conformity to the standards and legislations, the affordability and operativity of KPIs measurement and of course, the strategy for collecting feedback from users involved in all the certification process, in order to monitor the whole management, ensuring quality results. All these elements are all linked and interdependent on each other.

The monitoring procedure of the EUB SuperHub building certification process is articulated in two different typologies of monitoring:

- "Internal" monitoring: it examines all the aspects belonging to the process of the EUB certification process and also the technical features concerning the KPIs affordability and operativity;
- "External" monitoring: it refers to the assessment of compliance in relation to the already existing standards, regulations, directives related to the building certification processes.

Internal monitoring procedures are performed both, to check the technical features concerning the KPIs affordability and operativity and to identify if the EUB certification process meets the aims and intent that it was designed for.

Indeed, those procedures also foresee evaluating perceptions of key stakeholders involved in the certification process (mainly the assessor and the auditor) through the use of open feedback channels, such as questionnaires, surveys, etc. This part of feedback collection is fundamental to collect suggestions in order to improve the process and to identify any kind of issue link to it.

On the other side, the external monitoring is more focused on the compliance with the experience of mature existing standards, regulations, directives related to the building certification processes. The aim is indeed, to furthering the implementation of EUB SuperHub building certification process globally.

In the following paragraphs, the monitoring procedures adopted by EUB SuperHub to the whole certification process approach are detailed.

1.3.1 Monitoring of the certification process

The monitoring framework of the EUB certification process is part of the "internal" monitoring procedure and is strictly related to the evaluation of the process aspects. It affects, indeed, the issues covering the certification processes adopted in the three phases (Design, Construction/As Built and In Use) previously described.

The feedback framework on process "internal" monitoring of the EUB certification process must incorporate practices to review the certification process and its management system at different stages. There are different processes that must be used to achieve the expected results:

- QUESTIONNAIRE TO ASSESSOR/AUDITOR.
  The use of targeted questionnaire during the internal monitoring of the EUB certification process is foreseen in order to check the performance of the

process in terms of quality of the output, conformity of results, drafting timeline, difficulties in relation to the KPIs calculation, lack of information, data availability, efficiency, numbers of complaints, common issues and complaints etc.
The questionnaire is addressed both, to the assessor and to the auditor; each of the two provides answers calibrated on their responsibilities and tasks within the certification process.

- QUESTIONNAIRE TO CERTIFICATION BODY.
  Feedback coming from certification bodies are fundamental to get recommendations, suggestions for the EUB certification process improvement. Questions are calibrated on specificities and required feedback collection.
- QUESTIONNAIRE TO R&D STAKEHOLDERS.
  Academic, researchers, users, etc. are required to answer questionnaire on the EUB certification process in order to provide information and suggestions based on recent research and development studies.

The continual feedback loops required provides a statement of the performance effectiveness of the EUB certification process, thus being able to make the necessary improvements. Indeed, the process has to meet the stakeholder's requirements in addition to the objectives of the EUB SuperHub project. By monitoring all these elements, it is possible to detail and implement the recommended actions to improve the whole EUB building certification process, including, for example, scheme management, conformity assessment, general administration, affordability measurement, data storage and management, certification reliability, etc.

The robustness of the process is to be tested in the local context, in order to check all possible considerations that are context related. Furthermore, feedbacks from real testers of the process are realistic and calibrated to the requirements of the construction sector.

1.3.2 Monitoring of KPIs affordability and operativity

The monitoring framework of the affordability and operativity of EUB KPIs is part of the "internal" monitoring procedure, exactly as described before for the certification process. It is strictly focused on technical aspects related to the evaluation of the affordability and operativity of the KPIs selected by EUB SuperHub project.

The feedback framework for the "internal" technical monitoring is based on different strategies, listed below:

- TECNICAL COMMITTEE.
  The organisation of technical committees, strictly focused on KPIs calculation procedures and assessment, is the proper way to collect feedback arising from technician and expert in the different fields addressed by the KPIs. By analysing those feedback, issues and gaps are highlighted,

ensuring good technical monitoring quality of KPIs affordability and operativity.

- QUESTIONNAIRE.
  The questionnaire addresses the stakeholders involved in the KPIs calculation for the EUB certification process and in the validation of the assessment report containing KPIs results, namely, assessor and auditor are the two actors addressed. By this way, all the issues related to any kind of problems correlated to the KPIs calculation, are highlighted, like for example data availability, affordability of the measurements, inspection concerns, assessment schedule, etc.
- SAMPLE TEST.
  In parallel with the other two monitoring strategies, sample tests on the assessment reports are necessary to evaluate the quality of the final outputs. Thanks to this verification it is possible to monitor problematic cases, and also to check if there are repetitiveness of some calculation mistakes or if some KPIs are very complicated to be calculate, if data are critical to be collected, etc.

The “internal” technical monitoring is fundamental also to check the professional capabilities in assessing the EUB KPIs.

1.3.3 Monitoring of legislative and standardisation frameworks

As mentioned before, the experience of mature standards like ISO 9001:2008, ISO 17020:2012 and ISO 17065:2012 have been considered to develop the building certification process of EUB SuperHub project. The objective is to being recognised as one of the different certification processes globally established.

Certainly, the certification process must be complete, unambiguous and not in conflict with each other or any statutory and regulatory requirements.

The three standards mentioned above have been analysed to align the content of the EUB SuperHub certification process with what stated in the ISO 9001:2008 concerning the quality management systems, with what specified in ISO 17020:2012 on conformity assessment inspection and with what declared in ISO 17065:2012 concerning conformity assessment service.

Of course, the content of the EPBD recast proposal, drafted by the European Commission for the Directive of the European Parliament, which represents a comprehensive action plan to renovate the EU's buildings, bringing down energy consumption and reducing building-related emissions, has been strongly taken into account.

Furthermore, the recent amendments adopted by the European Parliament on 14 March 2023 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings[10], have been deeply analysed. Indeed, there are several sections of the document that deepen the theme of the conformity assessment of the certification process, considering a common

[10] https://www.europarl.europa.eu/doceo/document/TA-9-2023-0068_EN.pdf

approach to the energy performance certification of buildings, renovation passports, smart readiness indicators and building inspections. All those processes must be carried out by qualified or certified experts, whose independence and transparency are to be guaranteed on the basis of objective criteria.

1.4 Qualification of the assessor and the auditor

The qualification of the actors involved in the building certification processes plays a crucial role in final quality of the EUB e-Passport. This aspect is strongly highlighted in the recent amendments adopted by the European Parliament on 14 March 2023 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings, where it is stated that "*...A common approach to the energy performance certification of buildings, renovation passports, smart readiness indicators and the inspection of heating ventilation, air conditioning systems, electrical installations and air-conditioning systems, carried out by qualified or certified experts, whose independence is to be guaranteed on the basis of objective criteria, contribute to a level playing field as regards efforts made in Member States to energy saving in the buildings sector and will introduce transparency for prospective owners or users with regard to energy performance in the Union property market. In order to ensure the quality of energy performance certificates, renovation passports, smart readiness indicators and of the inspection of the thermal characteristics of the building heating and air-conditioning and controls systems throughout the Union, an independent control mechanism should be established in each Member State*[11]".

This sentence considers not only the importance in having a third-party certification, to safeguard the impartiality of the certification process, but also a certified qualification for the actors involved in the process. Indeed, the competency requirements of the actors involved in the administration, development and assessment of the certification process and the appropriate training that they will receive, should be clearly expressed. This should cover the relevant professional experience, level of qualifications, and continued professional development commitments.

In order to guarantee all those crucial aspects related to the qualification of the actors involved in the EUB SuperHub building certification process, the CEN Workshop Agreement (CW 17939:2022), developed in accordance with the CENCENELEC Guide 29 and in the framework of the European Union's Horizon 2020 research and innovation programme under grant agreement No 894514 — TRAIN4SUSTAIN-H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-EE-2019, has been taken as reference document for the harmonization and standardization of qualification and training processes of sustainability experts across the EU.

It is well known that the competence level of sustainability experts and the underlying training and education contents, varies significantly between the EU Member States. The CWA 17939 fostered a common understanding of sustainable competences across Europe developing a Competence Quality Standard (CQS), on which this CWA is based, in sustainable building for facilitating transnational

[11] Energy performance of buildings (recast) by EU Parliament, March 2023, p.30.

recognition of learning outcomes and competence levels of existing qualifications and vocational trainings.

The CQS is a tool to evaluate, scoring and report in a comparable and harmonised way the level of competence, skills and knowledge of white and blue collars in sustainable building. The CQS is a tool useful to stimulate demand for competent construction sector professionals through raising acceptance of sustainability qualifications on the EU construction market. To this end, comparability of qualifications and competences is key for increased transparency and penetration power in the market, avoiding confusion and uncertainty[12]. These prerogatives perfectly meet the request of the EC on sustainability building experts qualification and their independence and transparency in the market.

The TRAIN4SUSTAIN Competence Quality Standard is a tool useful to evaluate and report, through the Skill Passport, the level of competence of white collars and blue collars in sustainable building. It provides the Learning Outcomes (LOs), expressed in terms of knowledge and skills, necessary to achieve recommended competence's levels in relation to a set of Areas of Expertise. Indeed, a Learning Outcome is a statement regarding what a learner knows, understands and is able to do on completion of a learning process.

Its structure is organized in four dimensions. Three of them are "vertical" and correspond to the dimensions of sustainable development as identified in the Agenda 2030 of United Nations: Environment, Society and Economy. The fourth dimension, Process, is "horizontal" and deals with the competences necessary to design, construct and operate a sustainable building.

The following table describes the scope of the four Dimensions.

Dimension	Scope
ENVIRONMENT	to protect the planet from degradation, including through sustainable consumption and production, sustainable managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.
SOCIETY	to provide a healthy environment to all human beings.
ECONOMY	to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social, and technological progress occurs in harmony with nature.
PROCESS	to raise the capacity of professionals in deploying and manage effective processes during the design, construction and operation of buildings targeted to maximise the performance towards the 3 sustainable development dimensions.

Figure 10: Table describing the scope of the four Dimensions of the CQS.

[12] https://store.uni.com/cwa-17939-2022

Each Dimension is articulated in four hierarchic levels; from the higher to the lower level are listed below:

- Level 1 – Thematic Fields

- Level 2 – Macro Areas of Expertise

- Level 3 – Areas of Expertise

- Level 4 – Learning Outcome

Starting from the Thematic Fields, they represent macro sustainability subjects in relation to the four Dimensions of the framework. They are 18, coded with 2 letters and listed in the table below:

Environment	
EN	Energy
WA	Water
MA	Materials
HA	Habitat
Society	
CO	Comfort and well being
SA	Safety
AC	Accessibility
MO	Mobility
SE	Services
AD	Adaptation and resilience to climate change

Economy	
EQ	Economical Quality
Process	
BD	Sustainable Building Design
ID	Innovative digital solutions
SC	Sustainable construction
MN	Maintenance and operating
BE	Built Environment Certification systems
IS	Interdisciplinary Skills
LD	Listed Buildings

Figure 11: Thematic Fields of the CQS.

Macro Areas of Expertise represent a particular aspect pertaining to the Thematic Fields. They are 44, coded with 2 letters and 1 number. Below some examples:

Society	
CO	Comfort and well being
CO1	Indoor air quality
CO2	Thermal comfort
CO3	Visual comfort
CO4	Acoustic comfort
CO5	Electromagnetic pollution
CO6	Ergonomics
SA	Safety
SA1	Fire protection
SA2	Earthquake
AC	Accessibility
AC1	Barrier free accessibility
MO	Mobility
MO1	Alternative mobility
SE	Services
SE1	Communication
SE2	Services for inhabitants
AD	Adaptation and resilience to climate change
AD1	Climate change resilient buildings

Process	
BD	Sustainable Building Design
BD1	Integrative design
ID	Innovative digital solutions
ID1	Building Information Modelling
ID2	Small urban Information Modelling
ID3	GIS Systems
ID4	Lean Management
ID5	Measuring
ID6	Digital Twins Solutions
SC	Sustainable construction
SC1	Sustainable construction management
MN	Maintenance and operating
MN1	Maintenance
BE	Built Environment Certification systems
BE1	Energy Performance Certification
BE2	Building sustainability certification systems
IS	Interdisciplinary Skills
IS1	Procurement
IS2	Quality assurance
IS3	Collaboration and Communication
IS4	Information management
IS5	Safety Assurance

Figure 12: Two examples of the Macro Areas of Expertise included in the CQS.

Areas of Expertise represent the specific subjects belonging to each Macro Area of Expertise. They are 108, coded with 2 letters and 2 numbers. Below an example:

Society		
CO	Comfort and well being	
CO1	Indoor air quality	CO1.1 Low Emitting materials CO1.2 Indoor air pollutants management CO1.3 Outdoor air pollutants management
CO2	Thermal comfort	CO2.1 Indoor Thermal Comfort CO2.2 Outdoor Thermal Comfort
CO3	Visual comfort	CO3.1 Daylighting CO3.2 Indoor lighting CO3.3 Outdoor lighting
CO4	Acoustic comfort	CO4.1 Sound insulation CO4.2 Room acoustics CO4.3 Indoor noise management CO4.4 Environmental noise management
CO5	Electromagnetic pollution	CO5.1 Management of ELF magnetic fields (50 Hz / 60 Hz) CO5.2 Management of indoor exposure to electromagnetic fields (100 kHz-300 GHz)
CO6	Ergonomics	CO6.1 Ergonomic and Active Furnishing
SA	Safety	

SA1	Fire protection	SA1.1 Risk to occupants and facilities from fire
SA2	Earthquake	SA2.1 Risk to occupants and facilities from earthquake
AC	Accessibility	
AC1	Barrier free accessibility	AC1.1 Accessibility of public spaces AC1.2 Design for All
MO	Mobility	
MO1	Alternative mobility	MO1.1 Sustainable mobility strategies
SE	Services	
SE1	Communication	SE1.1 Communication services
SE2	Services for inhabitants	SE2.1 Functional mix SE2.2 Infrastructure and connectivity
AD	Adaptation and resilience to climate change	
AD1	Climate change resilient buildings	AD1.1 Resilience to extreme weather events AD1.2 Sustainable drainage AD1.3 Resilience to heatwaves AD1.4 Resilience to windstorms AD1.5 Resilience to wildfire

Figure 13: Society Areas of Expertise included in the CQS.

Learning Outcomes (LOs) are the elementary units of the Competence Quality Standard. They are defined as "statements of what a learner knows, understands and is able to do upon completion of a learning process".

Following the European Qualification Framework (EQF), in the TRAIN4SUSTAIN Competence Quality Standard the Learning Outcomes are defined in terms of knowledge and skills. The level of competence of a white or blue collar in relation to a specific subject (Area of Expertise) depends on the Learning Outcomes acquired through both formal, informal and non-formal learning. In this sense, Learning Outcomes provide the information concerning what are the knowledge and skills necessary to achieve a certain competence's levels in relation to a specific sustainability subject (Areas of Expertise).

In the Competence Quality Standard, Learning Outcomes are described:

- in concrete terms, they illustrate what the learner knows (knowledge) and what is able to do (skill);

- from the perspective of the learner (white or blue collar), not from the perspective of the trainer.

Below a revealing example of the articulation of the LOs description in relation to the indoor air pollutant management.

Table A.39 – CO1.2 – Indoor air pollutants management

CO1.2	Indoor air pollutants management					
LO code	**LO Description**	**Knowledge**	**Skill**	**B/W**	**Comp. Level**	**Project's stage**
CO1.2.1	Understanding the importance of indoor air pollution control	Minimal knowledge of: - air pollution sources and their impact on human health; - hazardous substances emitted by insulation and fit-out materials.	Participating in discussions within a design team to control indoor air pollutants and how can be introduced into the design process.	W	1	Co
CO1.2.2	Applying basic solutions to control indoor air pollution	Basic knowledge of: - air pollution sources and their impact on human health; - pollutants predominantly from indoor sources; - main standards on Indoor Air Quality (IAQ); - simple calculation methods (rules of thumb, graphic methods).	Performing simplified verifications for alternative ventilation strategies, based on predefined ventilation airflow rates.	W	2	D
CO1.2.3	Proposing conceptual solutions to control indoor air pollution	Medium knowledge of: - air pollution sources and their impact on human health; - metrics on pollutants predominantly from indoor sources (Total VOCs, CMR VOCs, formaldehyde, CO2 and other bio-effluents); - main standards on Indoor Air Quality (IAQ); - ventilation strategies to control indoor pollution sources; - risk assessment for damp and mould and mitigation strategies.	Selecting and proposing alternative strategies to control indoor air pollutants, focussing on design of the building fabric and ventilation system to meet target ventilation rates. Designing solutions for cold bridging and damage from humidity (damp and mould) identified in renovated buildings and air-tightness buildings.	W	3	Co, D
CO1.2.4	Engineering solutions to control indoor air pollution	Advanced knowledge of: - air pollution sources and their impact on human health; - metrics on pollutants predominantly from indoor sources (Total VOCs, CMR VOCs, formaldehyde, CO2 and other bio-effluents); - all relevant standards on Indoor Air Quality (IAQ); - ventilation strategies to control indoor pollution sources; - risk assessment for damp and mould and mitigation strategies. - advanced software based on CFD models for assessing air pollutant concentration.	Engineering strategies to control indoor air pollutants, defining the most effective solution with respect to building constraints, cost/benefit analysis, standard requirements on IAQ. Considering the expectation levels on indoor environmental quality (standard EN 16798-1) as basis for the ventilation design, and methods based on perceived air quality or concentration limits of a pollutant in indoor air (e.g. CO2). Performing IAQ analysis by means of dynamic simulations based on Computational Fluid Dynamic (CFD) models.	W	4	D

Figure 14: LOs description in relation to the indoor air pollutant management.

Based on this approach, shortly described in this document but fully searchable in the full text of CWA 17939, the minimum competence's requirements of the actors involved in the EUB SuperHub building certification process are identified.

Furthermore, this approach has been taken also in D2.2, for detailing the competence requirements necessary to calculate or measure EUB SuperHub KPIs for the Next Generation of EPCs.

As deeply described in the previous paragraphs, the two main actors actively involved in the EUB SuperHub building certification process are the Assessor (his/her activities address the indicators' characterisation and the drafting of assessment report) and the Auditor (a person with the competence to conduct an audit". His/her activity is to revise the content of the technical reports produced by the Assessors in the different certification phases).

In the following paragraphs, the minimum competence's requirements and the continuous professional training, of both actors, are detailed according to the CWA 17939.

1.4.1 Assessor: minimum competence's requirements (CWA 17939)

To be able to properly perform the EUB building certification and of course, to evaluate the KPIs results, the assessor, involved in all the three certification phases, must be qualified accordingly to the CQS developed by TRAIN4SUSTAIN in the CWA 17939. The qualification of the assessor involved in the building certification processes plays a crucial role in final quality of the EUB e-Passport. Indeed, the assessor must have all the professional skills and knowledge related to the EUB KPIs that must be calculated.

For each KPI, the necessary minimum knowledge and skills that must be owned are expressed through the LOs, which are specified in the KPI template. Within this document the assessors' required competences are expressed as the minimum

level of competence in relation to the Areas of Expertise of the CW 17939:2022, TRAIN4SUSTAIN.

Based on this premise, the assessor must own the minimum knowledge, established by the CQS of TRAIN4SUSTAIN, related to all the KPIs included in the EUB e-Passport. Specific skills are described in each KPI template document.

Concerning the validation of the assessor qualification, it must be ensured by a third-party verification. The validation consists in a confirmation of the Learning Outcomes acquired by the assessor through formal, non-formal and informal learning processes.

To ensure an effective validation, the process must include:

- CV examination, supplemented with evidence of work and training experience claimed by the candidate;

- Examination of the qualifications owned by the candidate:

- Test and/or technical interview to investigate the level of competence of the candidate.

The organisations validating the competence assessments must be accredited by a national accreditation body in relation to the EN ISO/IEC 17024 standard, in order to guarantee the consistence of assessments and the necessary requirements of independence, impartiality, transparency, competence and absence from conflicts of interest.

The competence assessment of the assessor has a validity of 5 years. Before that period, the assessment can be updated upon request of the candidate following one of these situations:

- new relevant experiences acquired through professional practice;

- new qualifications acquired through formal training;

- new competences acquired through informal and non-formal learning.

In any case, the continuous professional training must be guaranteed to maintain the role of the assessor and so, the possibility to perform EUB building certification.

1.4.2 Auditor: minimum competence's requirements (CWA 17939)

Exactly as stated for the role of the assessor, also the auditor must be qualified accordingly to the CQS developed by TRAIN4SUSTAIN in the CWA 17939. Indeed, to be able to properly perform the validation of the EUB building certification produced by the assessor, the auditor must have all the professional skills and knowledge related to the EUB KPIs that must be calculated. Furthermore, he must be able to conduct auditor activities related to the management of the EUB building certification process.

For each KPI, the necessary minimum knowledge and skills that must be owned are expressed through the LOs, which are specified in the KPI template. Within this

document the auditors' required competences are expressed as the minimum level of competence in relation to the Areas of Expertise of the CW 17939:2022, TRAIN4SUSTAIN.

Based on this premise, the auditor must own the minimum knowledge, established by the CQS of TRAIN4SUSTAIN, related to all the KPIs included in the EUB e-Passport. Specific skills are described in each KPI template document.

As mentioned before, the auditor must also know how to manage the EUB certification processes and how to perform the validation of the activities of the assessor; it means that specific courses addressed to the auditor are set up in order to provide them with the necessary competences and skills. The validation of the auditor qualification must be ensured by a third-party verification. The validation consists in a confirmation of the Learning Outcomes acquired by the auditor through formal, non-formal and informal learning processes.

To ensure an effective validation, the process must include:

- CV examination, supplemented with evidence of work and training experience claimed by the candidate;

- Examination of the qualifications owned by the candidate:

- Test and/or technical interview to investigate the level of competence of the candidate.

The organisations validating the competence assessments must be accredited by a national accreditation body in relation to the EN ISO/IEC 17024 standard, in order to guarantee the consistence of assessments and the necessary requirements of independence, impartiality, transparency, competence and absence from conflicts of interest.

The competence assessment of the auditor has a shorter validity duration in relation to the one of the assessor; indeed, it lasts 3 years. Before that period, the assessment can be updated upon request of the candidate following one of these situations:

- new relevant experiences acquired through professional practice;

- new qualifications acquired through formal training;

- new competences acquired through informal and non-formal learning.

In any case, the continuous professional training must be guaranteed to maintain the role of the auditor and so, the possibility to perform EUB building certification validations.

1.5 Documents management and repository

As mentioned in the introduction of the document, the activity of Task 2.5 combines and aligns several project outputs already achieved. Indeed, one of the most important linkages is represented by the interoperability among the EUB Platform

functions and the EUB SuperHub Digital Building Logbook, working together to support and facilitate the implementation of the EUB SuperHub certification process for the next generation of EPCs.

As fully described in previous paragraphs, for all the three phases of the certification process, tables describing the direct connection between the data input/output required to perform the certification process have been produced. Through the reading of those tables, it is possible to clearly identify where the main documents are both, accessible and stored.

The EUB SuperHub Digital Building Logbook data structure, developed within Task 2.4 (The digital logbook: data requirements, sources and collection process), contains all relevant building-related data over the whole lifecycle of a building, covering buildings in the design phase, construction/as built phase and use phase and providing different types of stakeholders with different information for different purposes at the right time. As already mentioned, it contains eight main categories (Figure 15).

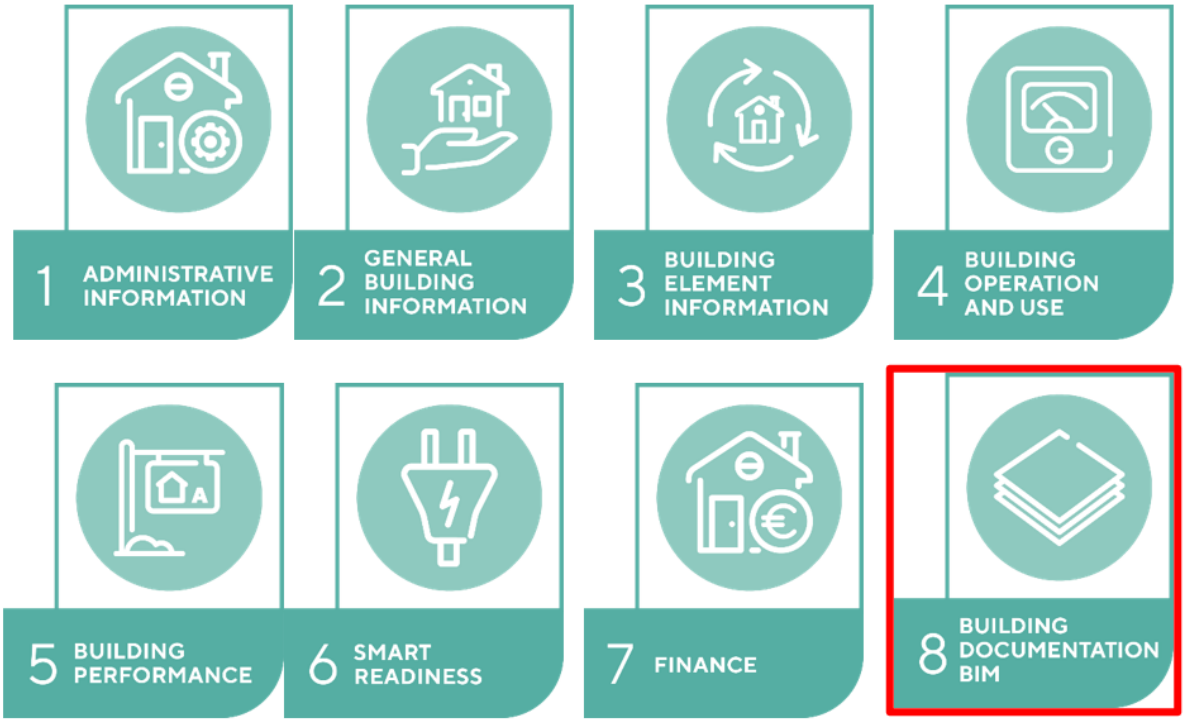


Figure 15: The main categories of the evaluated EUB SuperHub digital building logbook

The consortium made the decision to create a single category that would include all documentation related to the building. The last category named "8. BUILDING DOCUMENTATION BIM" comprises a variety of documents, including permits, manuals, design and plans of the building, tenancy agreement, utility contracts, utility bills, documents related to building construction and maintenance, energy performance certificates, EUB e-Passports (EUB e-Passport Design, EUB e-Passport As Built, EUB e-Passport In Use), sustainability certificates, reports on the inspection of heating and air-conditioning systems, valuation reports, insurance documents, weather files, BIM and building pictures (Figure 16).

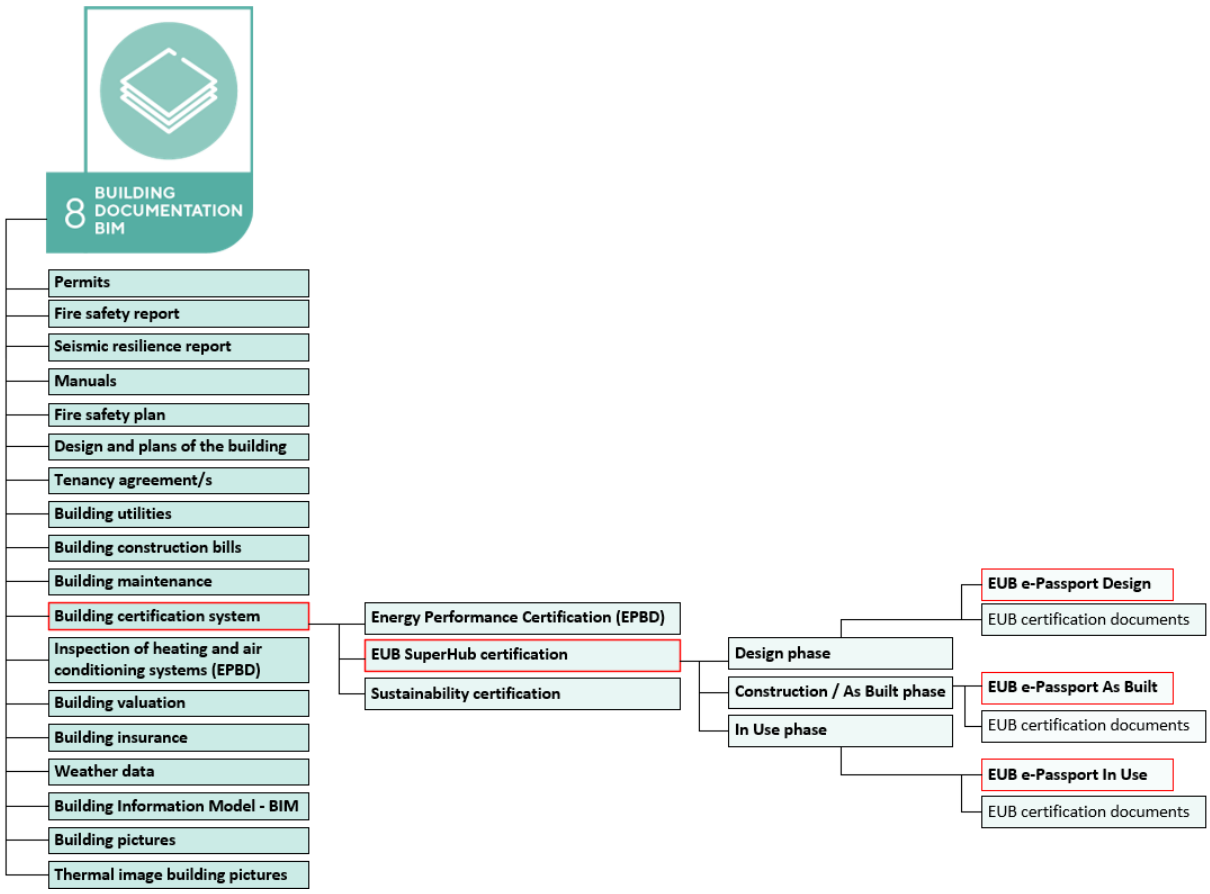


Figure 16: 8- BUILDING DOCUMENTATION BIM – overview of main subcategories

The subcategory called "Building certification system" includes the documents referring to the following certification systems:

- Energy Performance Certification (EPBD) - Energy Performance Certificate (EPC),
- EUB SuperHub certification covering three phases (Design, Construction/As Built and In Use phase),
- Sustainability certification (e.g., DGNB, BREEAM, LEED, Protocollo ITACA, KGA in the state of Vorarlberg in Austria).

Based on the all building-related data contained in the EUB SuperHub digital building logbook, an EUB-e Passport will be generated within the EUB platform as the final output of the suggested building certification process. This passport will then be uploaded to the category 8-Building documentation BIM of digital building logbook. Additionally, the EUB platform will create a set of EUB certification documents for each phase, which will also be uploaded to the digital building logbook (EUB certification process).

As part of Task 3.2, which involves the development of tool modules (planning and verification tool module, e-cockpit, virtual marketplace, and e-training module) and alpha testing, a web-based graphical user interface (GUI) will be created in English language to serve as the front-end for the EUB platform. This development will also include **document management system (DMS)**.

A document management system (DMS) is a system that allows the creation, storage, managing, indexing, protection, and retrieval of all types of digital documents (e.g., documents, images, spreadsheets, and more) that are easy to find and retrieve when needed.

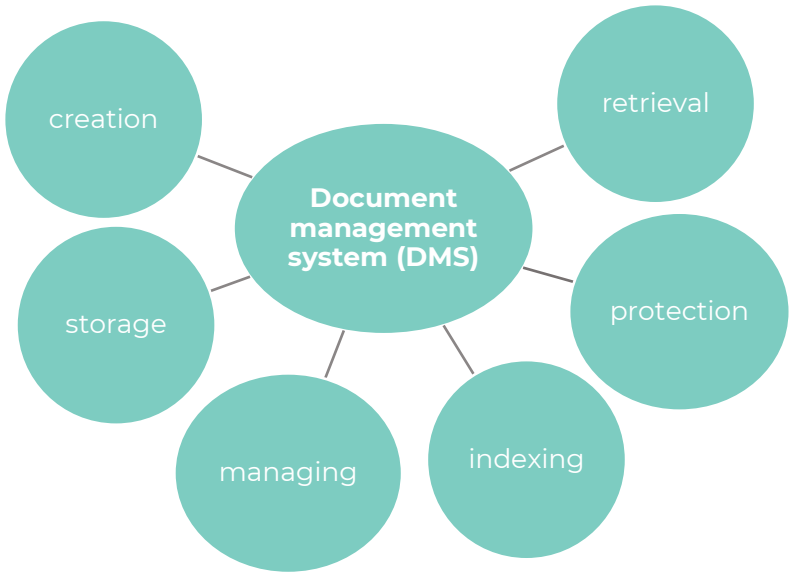


Figure 17: Document management system (DMS)

The key DMS features are:

- creating and editing documents (e.g., Certification contract, Assessment report, Validation report),
- storing documents (into category 8-Building documentation BIM),
- organising documents by matter (by subcategories in 8-Building documentation BIM),
- tracking version history,
- securely sharing and collaboration on documents (e.g., sharing a Certification contract between a client and a certification body),
- providing access control,
- providing security features,
- applying custom metadata (metadata is typically used to describe the contents of a document. This can include information like the author, the date the document was created, and keywords that describe the document's topic),
- indexing - finding content efficiently (quickly and easily locate specific documents when needed).

There are two types of documents in the EUB platform:

- Input documents, which are created externally and can be uploaded to the EUB platform (e.g., EPCs, energy bills, reports, etc.),
- Output documents, which are generated within the EUB platform, and can be accessed and downloaded by authorized persons (e.g., EUB e-Passport, EUB certification documents such as Certification contract, Assessment report, Validation report).

Both input and output documents need to be stored in the category 8-Building documentation BIM. The documents should be indexed according to their relevant subcategories (e.g., Permits, Fire Safety Reports, Seismic Resilience Reports, Manuals, etc.) for ease of access and management. Indexing, as an important component of a document management system, helps to track stored electronic documents. Document retrieval, as another key element of document management system, allows users to access documents. Document security is also vital in the document management system. The repository, where all documents are stored, needs to be safe and secure.

1.6 EUB e-Passport and its visual identity

The crucial ending results of the building certification scheme is the EUB e-Passport, an electronical identity card of the building which can clearly communicate the performance of a building in a specific certification phase. It is made up of several KPIs results, rating the smart readiness and the sustainability performances of a building.

The main function of the e-Passport is to allow the transnational comparison among the results of assessment of buildings. The EUB SuperHub KPIs must be considered as a common core set of indictors for the future national EPCs. The e-Passport doesn't express a rating and it doesn't make use of benchmarks. The comparison of assessments' results is done in absolute terms (indicators' values) and not using scores. The use of scores would mean to define European benchmarks not able to reflect the local conditions. That would be in contrast with the proposal of the new EPBD (Brussels, 15.12.2021 – COM (2021) 802) that foresees the definition of energy consumption benchmarks on the base of the conditions of national building stocks.

Actually, it is not possible to compare the energy performance of buildings using national EPCs. Different standards and units of measures are used. The EUB SuperHub KPIs overcome the problem, proposing common metrics and calculation methods that will allow to compare the next generation EPCs. For each KPI, it is described how to compare the values using the principle of the functional equivalent as described in EN 15978 "Assessment of environmental performance of buildings".

The EUB e-Passport has a distinct clear brand identity, developed in T4.4, based on the study on existing local and EUB SuperHub related national markings in connection with EPCs, KPIs etc. in Europe and globally. The Brand Identity aims at harmonising these marking systems and to come up with the clear, easily identifiable synthesis of the existing brands in order to facilitate the future use of the EUB SuperHub brand.

The brand will distinguish the projects approach on certifications while fitting well into existing local, regional, national and transnational marking systems emphasizing the key metrics related to smartness, health, sustainability.

The EUB e-Passport meant to contain visual identity elements that are designed for the EUB SuperHub project. The main visual items of the EUB e-Passport would be the icons designed for the 21 KPIs, the re-branded EUB SuperHub project logo (please read about these elements in the deliverable D4.4) and the layout and the colour code used for it. Since the EUB SuperHub certification process addresses the three phases reflecting the main execution stages of a building project (Design, Construction/As Built, In Use) of course, also the e-Passport reflects this distinction. Indeed, three typologies of EUB e-Passport can be issued:

- EUB e-Passport Design phase
- EUB e-Passport As Built phase
- EUB e-Passport In Use phase.

1.6.1 Layout and design

The EUB e-Passport design has been primary focused on to steer the passport users among technical information i.e.: the KPI calculation results and their actual meaning, KPI thematic areas and building and building assessment core information. Therefore, the layout follows a very structured view with organizing the displayed information in a tabular format on multiple pages.

The e-Passport design is expandable in the above-mentioned layout, in case more (or less) information would be desired to be included as useful content to be displayed.

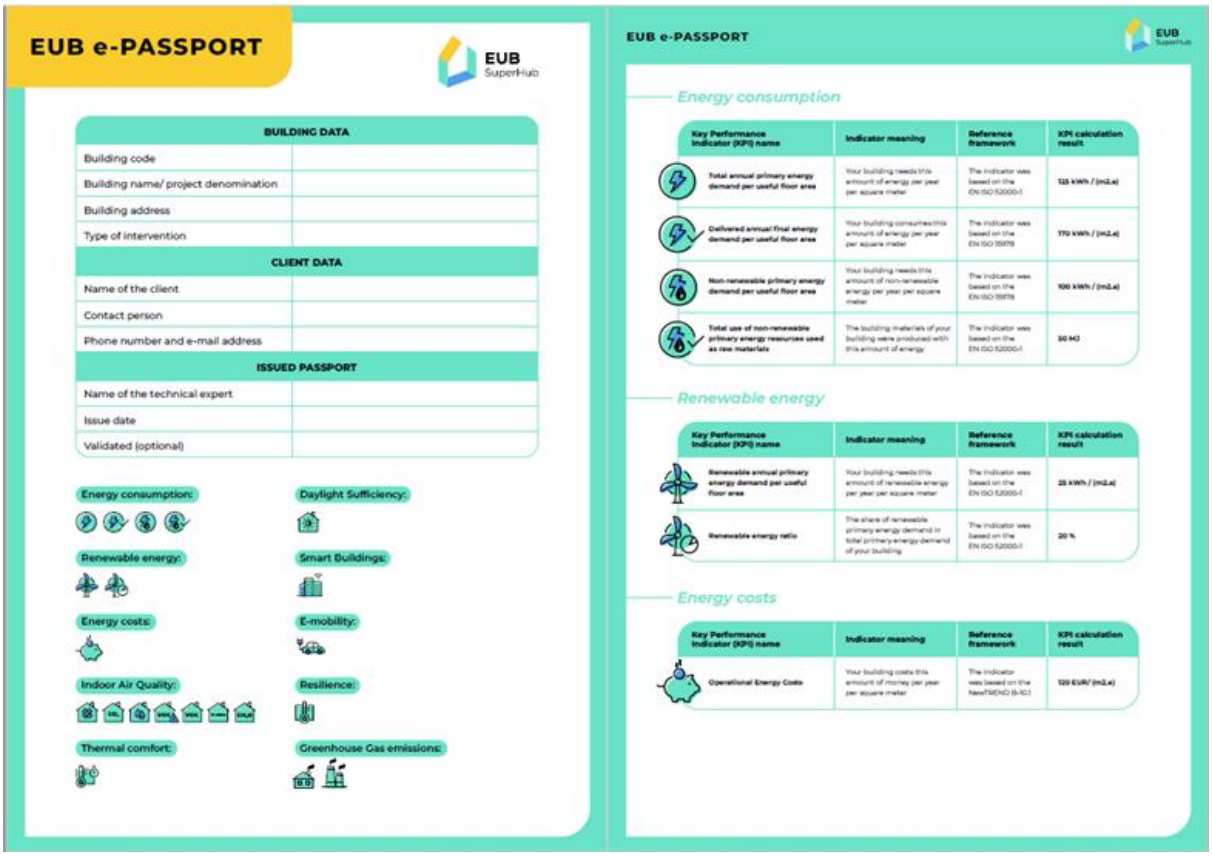


Figure 18: Print screen of the first two pages of the preview of the EUB e-Passport.

1.6.2 Content and information

The EUB e-Passport contains all the major information needed to get a comprehensive "picture" of the building using the project's Key Performance Indicators, as well as in the assessment details and the project itself. The e-Passport has three main parts, as the following:

- **Cover page of the e-Passport** – this page contains the building data, client data and the basic information about the issued EUB e-Passport.
- **Main technical content of the e-Passport** – KPIs are displayed with unique icons, with their name, explanation about them, the reference standard that defines the indicator and the calculated value.

- **Back page of the e-Passport** – information on the project, calculation methods and assessment and certification procedures via links to the actual project deliverable e.g.: D2.5 and to the platform itself (QR code).

With the help of the building data, the EUB e-Passport can be actually linked to a valid EPC in any EU MSs and can be used as a complementary document that very much enhances the information provided by the EPC issued under the actual regulation of each Member States.

The main technical content displayed in this e-Passport is actually suitable for any expert to understand the methodology of the assessment of a certain KPI via the identification of the Reference Framework aka the standard calculation methodology for an indicator.

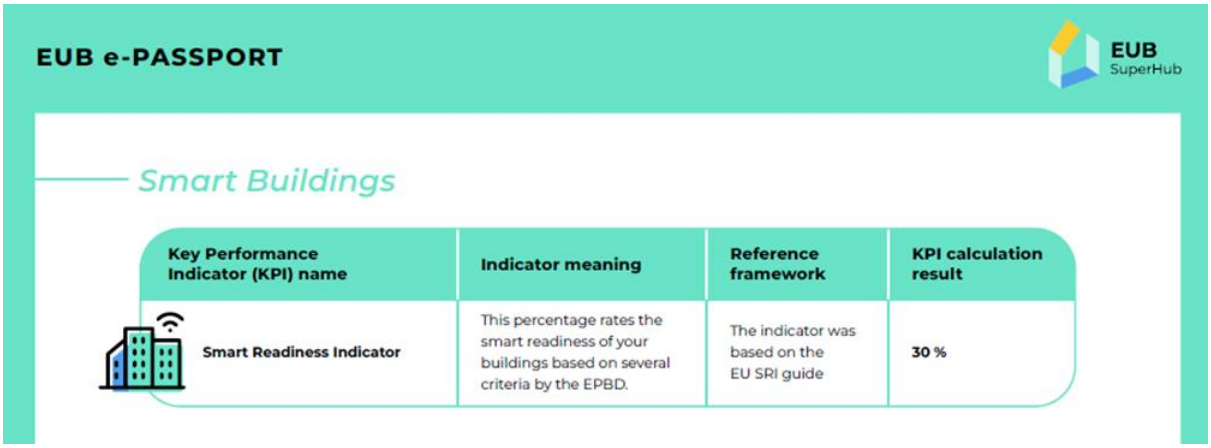


Figure 19: Print screen of a displayed KPI within the EUB e-Passport.

The EUB e-Passport can be viewed electronically and printed as a PDF for instance, and it is also suitable to navigate to the EUB SuperHub project website, to the EUB Platform and it is also uploaded on the EUB DBL. Indeed, as mentioned in paragraph 1.5 of this document, the last category of the DBL, named "8. BUILDING DOCUMENTATION BIM", comprises a variety of documents, including the EUB e-passport (EUB e-Passport Design, EUB e-Passport As Built, EUB e-Passport In Use), as showed in the image below.

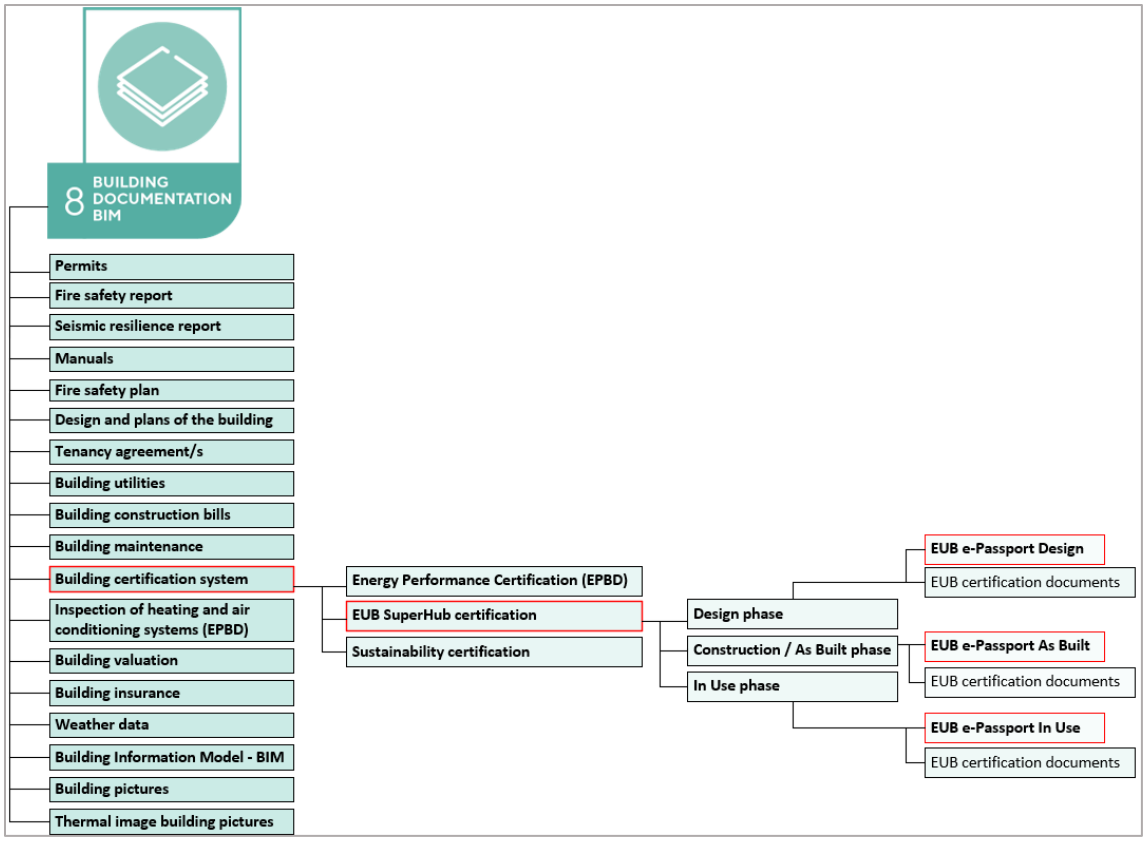


Figure 20: Storage of the EUB e-Passport on the DBL.

This facilitates the proper linking of background information needed to be explored for a given passport user/holder.

2 EUB SuperHub Assessment Standard

Having thoroughly investigated, in the previous chapter, the EUB SuperHub certification scheme process and its final main output represented by the EUB e-Passport, this second part of the document consists in a guideline on the EUB SuperHub Key Performance Indicators (KPIs) and its starting point is based on the work carried out in WP2 - Task 2.2.

For each KPI, the assessment methodologies are described in order to ensure the highest reliability and comparability of certification results across Europe. Furthermore, the reporting format for the KPIs is also provided through the KPI template. This reporting format for the KPIs is also supported by the activity brought forward by the CEN Workshop Agreement, activated by PPs of EUB SuperHub project, for the harmonisation of the KPIs for supporting the next generation of EPCs.

2.1 KPIs Assessment Guideline

Starting from what defined in D2.2 concerning the KPIs selection for the next generation of EPCs, the assessment guideline on EUB SuperHub KPIs is further detailed in this document. It is fundamental for ensuring reliability and comparability of calculation and measurements results.

The assessment guideline specifies many key aspects related to the KPIs to be assessed, like for example the applicability of KPIs in relation to the building use, to the project's stage (design, construction / as built, in use), but also the applicability of KPIs in relation to the building type (new, under major renovation, existing from more than 3 years). Reliability and comparability of the certification process final results are strictly connected with KPIs applicability because all those factors affect the calculation or measurement activity.

Considering quality of data to be used to evaluate the KPIs, it is foreseen a minimum acceptable quality of data for the characterisation of the indicators (minimum requirements for databases, accuracy of measurements, simulation software).

All these elements, and many others, are included and described in the KPI template elaborated to ensure high comparability of certification results.

To be able to guarantee a high level of comparability of the results, it's fundamental to draw up a standard reporting format for the EUB SuperHub KPIs, in order to provide, for each KPI, the same specifications and information. Furthermore, to ensure a high level of quality result, it's fundamental to extensively detail step by step the calculation or measurement method description of each KPI, based, of course, on the certification phase addressed.

Below the KPI template, containing all the relevant information to ensure high reliability of the EUB e-Passport as final output of the EUB building certification process.

The KPI template must be filled out for each EUB SuperHub KPI; below the explanation of all the items identified.

Table 18: KPI template for the assessment guideline

KPI TEMPLATE	
Name of the KPI	Full name of the KPI analysed
Description	What the indicator measures and how
Scope	If the KPI addresses residential buildings, non-residential buildings, or both
System boundary	Where does the assessment boundary is set? Building? Site? Location?
Unit of measure	How the KPI is measured
Applicability	Certification case: • New building • Renovated building • Existing building (occupied from more than 3 years) Building use: □ Residential • Single house • Multi-apartment □ Non residential • Office • School • Retail • Etc. Project stage: • Design • Construction / As Built • In Use
Reference Standards	If EU, national or regional reference standards are available for the KPI calculation or measurement
Assessment method	□ Calculation process (Step by step instructions) □ Measurement process (Step by step instructions)

Comparability of results	Information about how to compare the value of each indicator at transnational level. The comparability can be reached with different methodologies depending on the nature of indicators and done on the basis of a functional equivalency. The functional equivalent is a description of technical characteristics and functionalities of the building. This description forms the basis for transparent comparison. The assessment results are compared using a common unit of reference. A common reference unit is qualified with a dimension (e.g., per m^2, per year, per m^2 per year, etc.). The functional equivalent of a building shall include the following information: building type, relevant technical and functional requirements, patter of use (occupancy), required service life, exposure to climate.
Data	▯ Data source It depends on the type of source investigated to find the required data. It's important to check the reliability of the source, the updating of the data, the accuracy of the information, etc. ▯ Data quality It relies on different factors: • Databases: it's fundamental to check the quality of the data contained in databases, their updating, reliability, availability, etc. • Accuracy of the measurements: the instruments used to perform the measurements, the number of measurements performed, etc. • Software used: its compliance with the regulation, its accuracy, etc.
Assessors and auditor' required competences	Minimum level of competence in relation to the Areas of Expertise of the CW 17939:2022, TRAIN4SUSTAIN

In the paragraphs below, filled out KPI templates are provided for each of the 21 KPIs identified in the EUB SuperHub project.

2.1.1 KPI 1_Delivered annual final energy demand per useful floor area

KPI TEMPLATE	
Name of the KPI	**Delivered annual final energy demand per useful floor area**
Description	Delivered energy means energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account or to produce the exported energy. Energy can be delivered to the building and exported from the building through the system boundary. It is important to differentiate between: • Delivered final energy demand and • Net delivered final energy demand. The delivered final energy demand is used for satisfying the uses taken into account or to produce the exported energy. Net delivered final energy demand, required to meet the energy demand of considered energy performance of buildings services (EPB services) of the assessed building only, represents delivered minus exported energy, both expressed per energy carrier. NOTE: For defined energy uses, delivered energy can be calculated or measured.
Scope	KPI addresses residential and non-residential buildings with the default building services (also called EPB services) specified in Table B.18 of EN ISO 52000-1. NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices specified in Table B.18 of EN ISO 52000-1.
System boundary	Calculation or measurement of the energy flows (delivered and exported energy) is performed at the assessment boundary. Inside the assessment boundary, the energy losses are taken into account by technical building system efficiency factors and thus are already accounted for in delivered energy values. NOTE: The assessment boundary is set at the point(s) where delivered and exported energy are measured or calculated. Although energy can be imported or exported from/to the building from on-site, nearby, and distant sources, the assessment boundary does not change.

Unit of measure	**Delivered annual final energy demand per useful floor area** for EPB services E_{del} in [kWh/(m²a)]
Applicability	Certification cases: • **New building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator • **Existing building** in the use phase (with long-term use data of at least three years) - both methods, calculated (asset) and measured (operational) methods can be applied for the calculation of this indicator • **Renovated building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator Building use: • Residential - Single-family house - Multi-family house - Apartment block (Multi-apartment residential building) - Home for elderly and disabled people (e.g., retirement house, nursing home) - Residence for collective use (e.g., dormitory) • Non residential - Office - Educational building (e.g., kindergartens, primary schools, secondary schools, universities) - Hospital - Hotel and restaurant - Sport facility - Wholesale and retail trade services building Project stage: • Design • Construction / As Built In Use
Reference Standards	The energy calculation method for energy performance available across the EU include: • use of national standards still applied (e.g., EN 15603[13] and its associated standards - EN 15316 series),

[13] EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

	• use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or • use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480. According to EN ISO 52000, there are two types/methods of the energy performance of building assessment: • calculated (asset) assessment method, • measured (operational) assessment method. The assessment type and subtype used specified in Table 3 of EN ISO 52000-1 should be reported in all cases for the purposes of comparability.
Assessment method	• **Calculation process** The calculation direction goes from the needs (for space heating/cooling, domestic hot water preparation) to the delivered energy. **Calculated delivered annual final energy demand per useful floor area** for EPB services $E_{del,calc}$ in **kWh/(m²a)** through the system boundary required to meet the energy demand of considered uses and to generate the exported energy: $E_{\mathrm{del,calc}} = \frac{\sum E_{\mathrm{del},cr,\mathrm{calc}}}{A_{\mathrm{use}}}$ where: $E_{\mathrm{del},cr,\mathrm{calc}}$ is the calculated annual delivered energy for energy carrier (*cr*) [kWh/a] A_{use} – is the useful floor area [m²] **Calculated (asset) assessment method for calculating the delivered annual final energy demand per useful floor area:** 1. calculate energy needs (e.g., for space heating, cooling, domestic hot water preparation), 2. calculate annual delivered energy to the building site through the system boundary for each energy carrier (*cr*) required to meet the energy demand of considered uses and to generate the exported energy, 3. calculate the **delivered annual final energy demand per useful floor area $E_{del,calc}$** in **kWh/(m²a)** to the building site by summing up the calculated annual delivered energy for each energy carrier (*cr*) (from step 2) and then dividing by useful floor area. **Calculated net delivered annual final energy demand per useful floor area** for EPB services

	***E*del,net,calc** in **kWh/(m²a)** through the assessment boundary: $$E_{\text{del,net,calc}} = \frac{\sum E_{\text{del},cr,\text{calc}} - \sum E_{\text{exp},cr,\text{calc}}}{A_{\text{use}}}$$ where: $E_{\text{del},cr,\text{calc}}$ is the calculated annual delivered energy for energy carrier (*cr*) [kWh/a] $E_{\text{exp},cr,\text{calc}}$ is the calculated annual exported energy for energy carrier (*cr*) [kWh/a] A_{use} – is the useful floor area [m²] **Calculated (asset) assessment method for calculating the net delivered annual final energy demand per useful floor area:** 1. calculate energy needs (e.g., for space heating, cooling, domestic hot water preparation), 2. calculate annual delivered energy to the building site through the assessment boundary for each energy carrier (cr) required to meet the energy demand of considered uses and to generate the exported energy, 3. calculate the total annual delivered final energy demand to the building site by summing up calculated annual delivered energy for each energy carrier (cr) (from step 2), 4. calculate annual exported energy from the building site through the assessment boundary for each energy carrier (cr), 5. calculate the total annual exported energy from the building site by summing up calculated annual exported energy for each energy carrier (cr) (from step 4), 6. calculate the **net delivered annual final energy demand** per useful floor area $E_{\text{del,net,calc}}$ in kWh/(m²a) by subtracting the total annual exported energy from the total annual delivered energy and then dividing by useful floor area. • **Measurement process** The measured delivered annual final energy demand per useful floor area to meet the energy demand of considered EPB services ***E*del,meas** in kWh/(m²a) to meet the energy demand of considered uses and to generate the exported energy is calculated in the same way as the calculated delivered annual final energy demand per useful floor area $E_{\text{del,calc}}$ in kWh/(m²a) using the measured delivered energy amount $E_{\text{del;}cr,\text{meas}}$ instead of the corresponding calculated amounts $E_{\text{del;}cr,\text{calc.}}$: $$E_{\text{del,meas}} = \frac{\sum E_{\text{del},cr,\text{meas}}}{A_{\text{use}}}$$

	where: $E_{del,cr,meas}$ is the measured annual delivered energy for energy carrier (*cr*) [kWh/a] A_{use} – is the useful floor area [m²] **Measured (operational) assessment method - delivered annual final energy demand per useful floor area:** 1. measure annual delivered energy to the building site through the assessment boundary for each energy carrier (*cr*) required to meet the energy demand of considered uses and to generate the exported energy, 2. calculate the **delivered annual final energy demand per useful floor area $E_{del,meas}$** in **kWh/(m²a)** to the building site by summing up measured annual delivered energy for each energy carrier (*cr*) (from step 1) and then dividing by useful floor area. The measured net delivered annual final energy demand per useful floor area $E_{del,net.meas}$ in kWh/(m²a), required to meet the energy demand of considered EPB services, are calculated in the same way as the calculated net delivered annual final energy demand per useful floor area $E_{del,net,calc}$ in kWh/(m²a) using the measured delivered and exported energy amounts $E_{del;cr,meas}$ and $E_{exp;cr,meas}$ instead of the corresponding calculated amounts $E_{del;cr,calc}$ and $E_{exp;cr,calc}$.: $$E_{\mathrm{del,net,meas}} = \frac{\sum E_{\mathrm{del},cr,\mathrm{meas}} - \sum E_{\mathrm{exp},cr,\mathrm{meas}}}{A_{\mathrm{use}}}$$ where: $E_{del,cr,meas}$ is the measured annual delivered energy for energy carrier (*cr*) [kWh/a] $E_{exp,cr,meas}$ is the measured annual exported energy for energy carrier (*cr*) [kWh/a] A_{use} – is the useful floor area [m²] **Measured (operational) assessment method – net delivered annual final energy demand per useful floor area:** 1. measure annual delivered energy to the building site through the assessment boundary for each energy carrier (*cr*) required to meet the energy demand of considered uses and to generate the exported energy, 2. calculate the total annual delivered energy to the building site by summing up measured annual delivered energy for each energy carrier (*cr)* (from step 1),

	3. measure annual exported energy from the building site through the assessment boundary for each energy carrier (*cr*), 4. calculate the total annual exported energy from the building site by summing up measured annual exported energy for each energy carrier (*cr*) (from step 3), calculate the **net delivered annual final energy demand per useful floor area $E_{del,net,meas}$** in **kWh/(m²a)** by subtracting the total annual exported energy from the total annual delivered energy and then dividing by useful floor area.
Comparability of results	The results of this indicator are comparable between the buildings: • if the buildings are of the same building type at the same European climate zone (5 European climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation), • if the same assessment method (either calculated or measured) and subtype is used, if the same building services are considered when calculating this indicator.
Data	• **<u>Data source (for calculation)</u>** For the calculation of the **calculated delivered annual final energy demand per useful floor area $E_{del,calc}$** in **kWh/(m²a)**, the following values are required: - $\Sigma E_{del,cr,calc}$ is the sum of all <u>calculated</u> annual delivered energy to the building site for energy carrier (*cr*) to meet the energy demand of considered uses and to generate the exported energy in [kWh/a] - A_K is useful floor area in [m²] For the calculation of the **calculated net delivered annual final energy demand per useful floor area $E_{del,net,calc}$** in **kWh/(m²a)**, the following values are required: - $\Sigma E_{del,cr,calc}$ is the sum of all <u>calculated</u> annual delivered energy to the building site for energy carrier (*cr*) to meet the energy demand of considered uses and to generate the exported energy in [kWh/a] - $\Sigma E_{exp,cr,calc}$ is the sum of all <u>calculated</u> annual exported energy from the building site for energy carrier (*cr*) in [kWh/a] - A_K is useful floor area in [m²] • **<u>Data source (for measurement)</u>**

	For the calculation of the **measured delivered annual final energy demand per useful floor area $E_{del,meas}$** in **kWh/(m²a)**, the following values are required: - $\Sigma E_{del,cr,meas}$ is the sum of all measured annual delivered energy to the building site for energy carrier (*cr*) to meet the energy demand of considered uses and to generate the exported energy in [kWh/a] - A_{use} is useful floor area in [m²] For the calculation of the **measured net delivered annual final energy demand per useful floor area $E_{del,net,meas}$** in **kWh/(m²a)**, the following values are required: - $\Sigma E_{del,cr,meas}$ is the sum of all measured annual delivered energy to the building site for energy carrier (*cr*) to meet the energy demand of considered uses and to generate the exported energy in [kWh/a] - $\Sigma E_{exp,cr,meas}$ is the sum of all measured annual exported energy from the building site for energy carrier (*cr*) in [kWh/a] A_{use} is useful floor area in [m²]
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **delivered annual final energy demand per useful floor area**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11)

	• EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.2 KPI 2_Total annual primary energy demand per useful floor area

KPI TEMPLATE	
Name of the KPI	**Total annual primary energy demand per useful floor area**
Description	Primary energy is the energy found in nature from renewable and non-renewable sources, which has not undergone any conversion or transformation process, such as sunlight, wind, biomass, coal, crude oil, natural gas, or uranium. The term total primary energy is used when both non-renewable and renewable sources are considered. This indicator measures the total energy performance of a building. The total primary energy takes into account the actual energy demand for the building itself and the energy needed to deliver this energy to the building, such as extraction, refining and transportation. Hence it provides a more holistic view of the energy performance of the building. The total primary energy is measured by assigning the

	correct primary energy factor per energy carrier to the actual metered or calculated energy that is consumed, to meet different energy needs associated with its typical use. In practice, this equates to the energy required to heat and cool spaces, to supply hot water, to light spaces and to run the technical building systems. If energy is exported from the building, this should also be considered. The primary energy use is calculated based on the quantities of energy carriers required and the primary energy factors associated with each energy carrier. It is important to differentiate between: • Total primary energy demand and • Net primary energy demand. The total primary energy demand is the energy found in nature and used to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy. The net primary energy demand means subtracting any exported renewable primary energy from the total primary energy demand.
Scope	KPI addresses residential and non-residential buildings with the default building services (also called EPB services) specified in Table B.18 of EN ISO 52000-1. NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices specified in Table B.18 of EN ISO 52000-1.
System boundary	Delivered and exported energy from or to the building are calculated or metered (measured) at the assessment boundary. Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**. NOTE: The assessment boundary is set at the point(s) where delivered and exported energy are measured or calculated. Although energy can be imported or exported from/to the building from on-site, nearby, and distant sources, the assessment boundary does not change.
Unit of measure	Total annual primary energy demand per useful floor area E_{Ptot} in [kWh/(m^{2}a)] to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy
Applicability	Certification cases:

	• **New building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator • **Existing building** in the use phase (with long-term use data of at least three years) - both methods, calculated (asset) and measured (operational) methods can be applied for the calculation of this indicator • **Renovated building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator Building use: • Residential - Single-family house - Multi-family house - Apartment block (Multi-apartment residential building) - Home for elderly and disabled people (e.g., retirement house, nursing home) - Residence for collective use (e.g., dormitory) • Non residential - Office - Educational building (e.g., kindergartens, primary schools, secondary schools, universities) - Hospital - Hotel and restaurant - Sport facility - Wholesale and retail trade services building Project stage: • Design • Construction / As Built In Use
Reference Standards	The energy calculation method for energy performance available across the EU include: • use of national standards still applied (e.g., EN 15603[14] and its associated standards - EN 15316 series), • use of national or regional calculation methods and associated software tools

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	(which must comply with Annex I of the EPBD) or • use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480. According to EN ISO 52000, there are two types/methods of the energy performance of building assessment: • calculated (asset) assessment method, • measured (operational) assessment method. The assessment type and subtype used specified in Table 3 of EN ISO 52000-1 should be reported in all cases for the purposes of comparability.
Assessment method	The formula used for calculating total primary energy demand is the same for both calculated (asset) and measured (operational) rating methods. **The total annual primary energy demand per useful floor area E_{Ptot}** in **kWh/(m²a)** to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy, represents the sum of non-renewable and renewable primary energy demand: $$E_{Ptot} = E_{Pnren} + E_{Pren}$$ where: E_{Pnren} – is non-renewable annual primary energy demand per useful floor area for EPB services [kWh/(m²a)] → see indicator named *Non-renewable annual primary energy demand per useful floor area* E_{Pren} – is renewable annual primary energy demand per useful floor area for EPB services [kWh/(m²a)] → see indicator named *Renewable annual primary energy demand per useful floor area* **The net annual primary energy demand per useful floor area** for EPB services **$E_{Ptot,net}$**, in **kWh/(m²a)**, represents the total primary energy demand subtracted by the exported renewable primary energy demand: $$E_{Ptot,net} = E_{Ptot} - E_{Pren,exp}$$ E_{Ptot} – is the total annual primary energy demand per useful floor area to satisfy the EPB services or to produce the exported energy [kWh/(m²a)] $E_{Pren,exp}$ – is the exported renewable annual primary energy demand per useful floor area [kWh/(m²a)]

Comparability of results	The results of this indicator are comparable between the buildings: • if the buildings are of the same building type at the same European climate zone (5 European climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation), • if the same assessment method (either calculated or measured) and subtype is used, if the same building services are considered when calculating this indicator.
Data	Data required for the calculation of **the total annual primary energy demand per useful floor area E_{Ptot}** in **kWh/(m²a)** to satisfy the EPB services or to produce the exported energy: • E_{Pnren} – is non-renewable primary energy demand per useful floor area per year for EPB services [kWh/(m²a)] → see indicator (03) named *Non-renewable annual primary energy demand per useful floor area for EPB services* E_{Pnren} in kWh/(m²a) • E_{Pren} – is renewable primary energy demand (on-site, nearby) per useful floor area per year for EPB services [kWh/(m²a)] → see indicator (5) named *Renewable annual primary energy demand (on-site, nearby) per useful floor area for EPB services* E_{Pren}, *in kWh/(m²a)* Data required for the calculation of **net primary energy demand per useful floor area per year** for EPB services $E_{Ptot,net}$, in **kWh/(m²a)**,: • E_{Ptot} – is the total annual primary energy demand per useful floor area to satisfy the EPB services or to produce the exported energy [kWh/(m²a)] • $E_{Pren,exp}$ – is the exported renewable annual primary energy demand per useful floor area [kWh/(m²a)] Primary energy factors (total, non-renewable, renewable) are defined at a national level.
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **total annual primary energy demand per useful floor area**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,)

	• EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.3 KPI 3_Non-renewable annual primary energy demand per useful floor area

KPI TEMPLATE

Name of the KPI	**Non-renewable annual primary energy demand per useful floor area**
Description	Non-renewable primary energy means energy from non-renewable sources which has not undergone any conversion or transformation process. The indicator uses non-renewable primary energy factors defined for different fuels to calculate the non-renewable primary energy demand based on the delivered final energy demand, which is obtained either through a calculation or from metered data.
Scope	KPI addresses residential and non-residential buildings with the default building services (also called EPB services) specified in Table B.18 of EN ISO 52000-1. NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices specified in Table B.18 of EN ISO 52000-1.
System boundary	Delivered and exported energy are calculated or metered (measured) at the assessment boundary. Multiplying non-renewable primary energy factors with the delivered/exported energy to calculate non-renewable primary energy demand follows **outside the assessment boundary**. NOTE: The assessment boundary is set at the point(s) where delivered and exported energy are measured or calculated. Although energy can be imported or exported from/to the building from on-site, nearby, and distant sources, the assessment boundary does not change.
Unit of measure	Non-renewable annual primary energy demand per useful floor area for EPB services E_{Pnren} in [kWh/(m^{2}a)]
Applicability	Certification cases: • **New building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator • **Existing building** in the use phase (with long-term use data of at least three years) - both methods, calculated (asset) and measured (operational) methods can be applied for the calculation of this indicator • **Renovated building** in the design/construction/'as built' phase (without long-term use data) - only the calculated

	(asset) method can be applied to calculate this indicator Building use: • Residential - Single-family house - Multi-family house - Apartment block (Multi-apartment residential building) - Home for elderly and disabled people (e.g., retirement house, nursing home) - Residence for collective use (e.g., dormitory) • Non residential - Office - Educational building (e.g., kindergartens, primary schools, secondary schools, universities) - Hospital - Hotel and restaurant - Sport facility - Wholesale and retail trade services building Project stage: • Design • Construction / As Built • In Use
Reference Standards	The energy calculation method for energy performance available across the EU include: • use of national standards still applied (e.g., EN 15603[15] and its associated standards - EN 15316 series), • use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or • use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480. According to EN ISO 52000, there are two types/methods of the energy performance of building assessment: • calculated (asset) assessment method, • measured (operational) assessment method. The assessment type and subtype used specified in Table 3 of EN ISO 52000-1 should be reported in all cases for the purposes of comparability.

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Assessment method	The formula for calculating non-renewable primary energy demand is the same for both the calculated (asset) and measured (operational) assessment methods. The calculated non-renewable primary energy demand is calculated using the calculated amounts of delivered energy carriers, whereas the measured non-renewable primary energy demand is calculated using the measured amounts of delivered energy carriers instead of calculated ones. • **Calculation process** **Non-renewable annual primary energy demand** per useful floor area for EPB services $\boldsymbol{E_{Pnren}}$ in **kWh/(m²a)** is calculated by multiplying calculated delivered energy for each energy carrier (*cr*) with the non-renewable primary energy factors corresponding to each energy carrier and then dividing by useful floor area: $$\boldsymbol{E_{Pnren}} = \frac{\sum\left(E_{del,cr,calc} \cdot f_{Pnren,del,cr}\right)}{A_{use}}$$ where: $E_{del;cr,calc}$ – is the calculated annual delivered energy for energy carrier (*cr*) [kWh/y] $f_{Pnren:del;cr}$ – non-renewable primary energy factor for the delivered energy carrier (*cr*) [–] A_{use} – useful floor area [m²] Format for reporting the results of an assessment using the calculation method specified in Level(s) (*Level(s) indicator 1.1: Use stage energy performance*) could be used. • **Measurement process** **Non-renewable annual primary energy demand** per useful floor area for EPB services $\boldsymbol{E_{Pnren}}$ in **kWh/(m²a)** is calculated by multiplying measured delivered energy for each energy carrier (*cr*) with the non-renewable primary energy factors corresponding to each energy carrier and then dividing by useful floor area: $$\boldsymbol{E_{Pnren}} = \frac{\sum\left(E_{del,cr,meas} \cdot f_{Pnren,del,cr}\right)}{A_{use}}$$ where: $E_{del,cr,meas}$ – is the measured annual delivered energy for energy carrier (*cr*) [kWh/y] $f_{Pnren,del;cr}$ – non-renewable primary energy factor for the delivered energy carrier (*cr*) [–] A_{use} – useful floor area [m²]

	Format for reporting the results of an assessment using the measured (operational) assessment method specified in Level(s) (*Level(s) indicator 1.1: Use stage energy performance*) could be used. In cases where more than one energy carrier is used for the same building system (e.g., hot water from a gas boiler and from onsite solar thermal) two rows should be made for hot water, one for each energy carrier. There must always be a dedicated row for each energy carrier for any given service.
Comparability of results	The results of this indicator are comparable between the buildings: • if the buildings are of the same building type at the same European climate zone (5 European climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation), • if the same assessment method (either calculated or measured) and subtype is used, • if the same perimeters (on-site, nearby, distant) are used when calculating this indicator, • if the same building services are considered when calculating this indicator.
Data	• **<u>Data source (for calculation)</u>** For the calculation of the **non-renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{Pnren}}$ in **kWh/(m²a)** the following values are required: • $E_{del,cr,calc}$ – the calculated annual delivered energy for energy carrier (*cr*) [kWh/a] • $f_{Pnren,del,cr}$ – non-renewable primary energy factor for the delivered energy carrier (*cr*) [–] • A_{use} – useful floor area [m²] • **<u>Data source (for measurement)</u>** For the calculation of the **non-renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{Pnren}}$ in **kWh/(m²a)** the following values are required: • $E_{del,cr,meas}$ – is the measured annual delivered energy for energy carrier (*cr*) [kWh/a] • $f_{Pnren,del,cr}$ – non-renewable primary energy factor for the delivered energy carrier (*cr*) [–] • A_{use} – useful floor area [m²]

Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **non-renewable annual primary energy demand per useful floor area**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9)

	• ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.4 KPI 4_Embodied energy

KPI TEMPLATE	
Name of the KPI	Embodied energy
Description	**The part of the EN 15978 indicator "Total use of non-renewable primary energy resources" limited to the life cycle of products** is frequently called **embodied energy** and is a commonly specified environmental impact indicator used in Life Cycle Assessment. It is interesting to note that this indicator is not as such among the EN 15978 tables of indicators, it is a sub-indicator. This indicator measures the embodied non-renewable primary energy of materials, products and services used for the building construction, its service life, until its end-of-life, considering the life cycle of these materials, products, and services. According to **ISO 6707-3:2022** (Buildings and civil engineering works - Vocabulary - Part 3: Sustainability terms), **embodied energy** is defined as follows: *"total of all the energy used in the processes associated with the extraction, production, transportation, installation, use, refurbishment, replacement and disposal at the end of life of products and services, but excluding the energy used for operation".* So, embodied energy is not limited to the "cradle-to-gate" perimeter of products life cycle, but it includes all the processes until their end-of-life. It supposes to have an EPD database compliant with **EN 15804:2012+A2:2019**, but in certain countries, environmental product data is limited to "cradle-to-gate". Embodied energy considers all the products during the reference study period of the building (RSP, 50 years by default), including the initial construction and the replacement of products having a service life shorter than the RSP.

<table>
<tr><td>Scope</td><td>KPI addresses both residential and non-residential buildings.
This indicator supposes a good knowledge of construction products and services attached to the building. So, it is adapted to new construction and to recently renovated buildings.</td></tr>
<tr><td>System boundary</td><td>All the construction elements are considered: from foundations to finishings.
The minimum scope of the indicator includes the following building parts and elements:

<table>
<tr><th>Building parts</th><th>Related building elements</th></tr>
<tr><td colspan="2">Shell (substructure and superstructure)</td></tr>
<tr><td>Foundations (substructure)</td><td>• Piles
• Basements
• Retaining walls</td></tr>
<tr><td>Load-bearing structural frame</td><td>• Frame (beams, columns, and slabs)
• Upper floors
• External walls
• Balconies</td></tr>
<tr><td>Non-load bearing elements</td><td>• Ground floor slab
• Internal walls
• Partitions and doors
• Stairs and ramps</td></tr>
<tr><td>Facades</td><td>• External wall systems
• Cladding and shading devices
• Façade openings (including windows and external doors)
• External paints, coatings, and renders</td></tr>
<tr><td>Roof</td><td>• Structure
• Weatherproofing</td></tr>
<tr><td>Parking facilities</td><td>• Above ground and underground</td></tr>
</table>

The elements defined in Level(s), including also technical services / equipment, and external works on the plot of land, should be included, and if not, replaced by default values.

The life cycle perimeter for calculating this indicator covers the “cradle to grave” processes (raw materials extraction, transport to manufacturing facilities and manufacturing processes), for all the construction materials, products, components, and services used in the construction of the building, its service life and end-of-life. The rules for determining their impacts and aspects are defined in EN 15804 and EN 15978.</td></tr>
</table>

	Theoretically, the full life cycle of the building and its immediate surroundings on its site (curtilage), have to be considered. Are excluded: operational energy use (B6), operational water use (B7) and building related users' activities not covered in B1-B7 modules (B8). If module D exists for products in terms of embodied energy, module D1 captures net embodied energy beyond the system boundary and must be reported separately as additional information. Transparency and details are recommended in result presentation, in order to facilitate results understanding and comparability.
Unit of measure	Embodied energy is measured as: [kWh / m^2] or [MJ] (net calorific value) The EN 15978 standard mentions MJ for all energy indicators, but for ensuring homogeneity with the other energy KPIs, it is preferable to use kWh / m^2 (per useful floor area and for building RSP = 50 years). *RSP = reference study period*
Applicability	Certification case: 1. **New buildings after construction – new buildings 'as built'** (without long-term use data) In the case of new buildings after construction, the indicator must be calculated considering all the materials used for the building construction, and potential replacements of products in the future. It may be useful, according to the objective of the assessment, to separate results for the initial building construction and for the building service life. 2. **Existing buildings in the use phase** (with long-term use data of at least three years) In the case of existing buildings in the use phase, this indicator is generally not applicable because the existing data for old materials used for the building construction, components and transport are unreliable, and there is often a lack of information on the actual embodied material. 3. **Existing buildings after major renovation** (without long-term use data)

	In the case of existing buildings after major renovation, the indicator must be calculated considering the life cycle of materials, products and services newly installed for their renovation. For those retained in-situ, pre-existent processes are ignored, while future processes are considered. For removed existing elements, only the end-of-life and module D are included. The future replacements of products, etc., during the reference study period (RSP) after renovation, should be included. (to be checked / updated after EN 15978 revision). Note : Different approaches or methods might be used for this 3rd case. The chosen one should be clearly identified/described. Building use: Residential • Single house • Multi-apartment Non residential • Office • School • Retail • Etc. Project stage: • Design: yes, at detailed design stage • Construction / As Built: yes • In Use: not relevant if the building is more than 10 years (problem of availability of adequate data)
Reference Standards	**EN 15978**, Sustainability of construction works - Assessment of environmental performance of buildings – Calculation method (2011) (under revision in 2022-2023). **EN 15804**:2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
Assessment method	Embodied energy is obtained through a **calculation process**, not a measurement process. According to the existence or not of a national database of EPDs of construction products with sufficient data quality and availability, the calculation method is based on a Bill of

	Materials (BoM) (method 1) or based on EPDs compliant with EN 15804 (method 2). 1. **Use of a Bill of Materials** (see Level(s) framework) The following steps should be followed to compile the BoM: • Compile the Bill of Quantities: A BoQ comprises the building elements accounting for at least 99% of the mass of the building. • Identify the basic components of each building element. A breakdown of its constituent materials has to be carried out. The mass of each constituent material has to be determined. • Aggregation by material: The mass for each constituent material should thereafter be aggregated to obtain the total mass for each type of material. • Once the BoM has been compiled, it is possible to calculate the indicator associating to each constituent material the relative embodied primary non-renewable energy by multiplying the specific mass (i.e., kg) with its corresponding embodied energy coefficient (i.e., MJ/kg or kWh/kg). • The results are then aggregated at the building scale. • A reporting format with sufficient detailed interim figures is recommended. 2. **Use of a database of EPDs compliant with EN 15804** (calculation at the building scale, compliant with EN 15978) • Compile the Bill of Quantities: A BoQ comprises the building elements accounting for at least 99% of the mass of the building. • Identify in the database the EPDs corresponding to the products put in place. • Estimate the number of replacements of each product during the RSP (reference study period = 50 years) • Take the primary non-renewable energy indicator.

	• Multiply the quantities and the value of the primary non-renewable energy for each product. • Aggregate at the scale of the building, keeping available interim results (e.g. per life cycle module and per family of products).
Comparability of results	The results of this indicator are comparable between the buildings: • If the buildings are of the same building category, in the same climatic zone, • If the same life cycle modules are taken into account, • If the same method is used (1 or 2) • If the data quality and the completeness of building description are comparable
Data	Data source: - Building project documents, especially the Bill of Quantities - Bill of Materials (for method 1) - EPDs database (for method 2) - Embodied energy coefficients for all materials (method 1) - Realistic products service lives (for both) Data quality: - See data quality requirements of the European Level(s) framework. - Refer to **prEN 15941** Data quality (formal vote in September November 2023).
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the embodied energy: MA1.1.5 – MA1.1.9 – MA1.2.1 - MA1.2.2 - MA1.2.3 - MA1.2.6 – MA2.1.2 - MA2.1.3 - MA2.1.4 – MA2.1.5 – MA2.1.6 – MA2.2.6 – MN1.3.1

2.1.5 KPI 5_Renewable annual primary energy demand per useful floor area

KPI TEMPLATE	
Name of the KPI	**Renewable annual primary energy demand per useful floor area**
Description	Renewable primary energy means energy from renewable non-fossil sources (e.g., wind, solar thermal and solar photovoltaic, geothermal energy, ambient energy, tide, wave, hydropower,

	biomass, biogas, etc.) which has not undergone any conversion or transformation process. Renewable energy can be produced: • On-site (e.g., PV panels, wind turbines, solar panels on the building roofs, heat pumps located on the building site) • Nearby (e.g., renewable energy from district heating systems, PV panels, solar panels, wind turbines) • Distant (e.g., renewable electricity from the electricity grid, PV panels, solar, panels, wind turbines) It is noteworthy that PV or solar panels can be counted as onsite, nearby, or distant energy sources, depending on where the panels are located relative to the building. The same goes for wind turbines. To avoid double-counting of renewable energy it is important to denote renewable primary energy demand with subscript following the chosen perimeters: $E_{Pren,onst}$ – renewable primary energy demand produced on-site $E_{Pren,nrby}$ – renewable primary energy demand produced nearby $E_{Pren,dist}$ – renewable primary energy demand produced distant
Scope	KPI addresses residential and non-residential buildings with the default building services (also called EPB services) specified in Table B.18 of EN ISO 52000-1. NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices specified in Table B.18 of EN ISO 52000-1.
System boundary	Delivered and exported energy are calculated or metered (measured) at the assessment boundary. Multiplying renewable primary energy factors with the delivered/exported energy to calculate renewable primary energy demand follows **outside the assessment boundary**. NOTE: The assessment boundary is set at the point(s) where delivered and exported energy are measured or calculated. Although energy can be imported or exported from/to the building from on-site, nearby, and distant sources, the assessment boundary does not change.
Unit of measure	Renewable annual primary energy demand per useful floor area for energy performance of

	buildings services (EPB services) E_{Pren} in [kWh/(m²a)]
Applicability	Certification cases: • **New building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator • **Existing building** in the use phase (with long-term use data of at least three years) - both methods, calculated (asset) and measured (operational) methods can be applied for the calculation of this indicator • **Renovated building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator Building use: • Residential - Single-family house - Multi-family house - Apartment block (Multi-apartment residential building) - Home for elderly and disabled people (e.g., retirement house, nursing home) - Residence for collective use (e.g., dormitory) • Non residential - Office - Educational building (e.g., kindergartens, primary schools, secondary schools, universities) - Hospital - Hotel and restaurant - Sport facility - Wholesale and retail trade services building Project stage: • Design • Construction / As Built • In Use
Reference Standards	The energy calculation method for energy performance available across the EU include: • use of national standards still applied (e.g., EN 15603[16] and its associated standards - EN 15316 series),

[16] EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

	• use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or • use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480. According to EN ISO 52000, there are two types/methods of the energy performance of building assessment: • calculated (asset) assessment method, • measured (operational) assessment method. The assessment type and subtype used specified in Table 3 of EN ISO 52000-1 should be reported in all cases for the purposes of comparability.
Assessment method	The formula for calculating renewable annual primary energy demand per useful floor area is the same for both calculated (asset) and measured (operational) assessment methods. The calculated renewable primary energy demand is based on the calculated amounts of delivered energy carriers, whereas the measured renewable primary energy demand is calculated using the measured amounts of delivered energy carriers. • **Calculation process** **Renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{\mathrm{Pren}}}$ in **kWh/(m²a)** is calculated by multiplying the calculated annual delivered energy for each energy carrier (*cr*) with the renewable primary energy factors corresponding to each energy carrier and then dividing by useful floor area: $\boldsymbol{E_{\mathrm{Pren}}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{calc}} \cdot f_{\mathrm{Pren,del},cr}\right)}{A_{\mathrm{use}}}$ where: $E_{\mathrm{del},cr,\mathrm{calc}}$ is the calculated annual delivered energy for energy carrier (*cr*) [kWh/a] $f_{\mathrm{Pren,del},cr}$ – renewable primary energy factor for the delivered energy carrier (*cr*) [–] A_{use} – useful floor area [m²] Format for reporting the results of an assessment using the calculation method specified in Level(s) (*Level(s) indicator 1.1: Use stage energy performance*) could be used. • **Measurement process** **Renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{\mathrm{Pren}}}$ in **kWh/(m²a)** is calculated by multiplying

	measured annual delivered energy for each energy carrier (*cr*) with the renewable primary energy factors corresponding to each energy carrier and then dividing by useful floor area: $\boldsymbol{E_{\mathrm{Pren}}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{meas}} \cdot f_{\mathrm{Pren,del},cr}\right)}{A_{\mathrm{use}}}$ where: $E_{\mathrm{del},cr,\mathrm{meas}}$ is the measured annual delivered energy for energy carrier (*cr*) [kWh/a] $f_{\mathrm{Pren,del},cr}$ – renewable primary energy factor for the delivered energy carrier (*cr*) [–] A_{use} – useful floor area [m²] Format for reporting the results of an assessment using the measured (operational) assessment method specified in Level(s) (*Level(s) indicator 1.1: Use stage energy performance*) could be used. In cases where more than one energy carrier is used for the same building system (e.g., hot water from a gas boiler and from onsite solar thermal) two rows should be made for hot water, one for each energy carrier. There must always be a dedicated row for each energy carrier for any given service
Comparability of results	The results of this indicator are comparable between the buildings: • if the buildings are of the same building type at the same European climate zone (5 European climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation), • if the same assessment method (either calculated or measured) and subtype is used, • if the same perimeters (on-site, nearby, distant) are used when calculating this indicator, • if the same building services are considered when calculating this indicator.
Data	• **Data source (for calculation)** For the calculation of the **renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{\mathrm{Pren}}}$ in **kWh/(m²a)** the following values are required: • $E_{\mathrm{del},cr,\mathrm{calc}}$ – the calculated annual delivered energy for energy carrier (*cr*) [kWh/a] • $f_{\mathrm{Pren:del;}cr}$ – renewable primary energy factor for the delivered energy carrier (*cr*) [–] • A_{use} – useful floor area [m²] • **Data source (for measurement)**

	For the calculation of the **renewable annual primary energy demand per useful floor area** for EPB services $\boldsymbol{E_{Pren}}$ in **kWh/(m²a)** the following values are required: • $E_{del,cr,meas}$ – the measured annual delivered energy for energy carrier (*cr*) [kWh/a] • $f_{Pren,del,cr}$ – renewable primary energy factor for the delivered energy carrier (*cr*) [–] • A_{use} – useful floor area [m²]
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **renewable annual primary energy demand per useful floor area**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9)

	• EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) • ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.6 KPI 6_Renewable energy ratio

<table>
<tr><th colspan="2"><u>KPI TEMPLATE</u></th></tr>
<tr><td>Name of the KPI</td><td>Renewable energy ratio (on-site, nearby)</td></tr>
<tr><td>Description</td><td>Renewable energy ratio (on-site, nearby) is the ratio of the renewable primary energy demand produced on-site and nearby to the total primary energy demand. According to the EN ISO 52000-1, this KPI excludes distant produced primary energy demand.
<table>
<tr><th>Perimeter choice</th><th>Choice – RER calculation (renewable energy)</th><th>Choice – RER calculation (total energy)</th></tr>
<tr><td>On-site</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Nearby</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Distant</td><td>No</td><td>Yes</td></tr>
</table>
NOTE: When calculating this indicator, the perimeter choices must always be clearly declared if they differ from default choices.
One main sustainability target within the European Union is to increase the share of renewable primary energy demand in total primary energy demand to lower the dependency of the EU on fossil energy sources and to reduce the greenhouse gas emissions caused by fossil energy sources.</td></tr>
<tr><td>Scope</td><td>KPI addresses residential and non-residential buildings with the <u>default building services</u> (also called EPB services) specified in Table B.18 of EN ISO 52000-1.
NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices specified in Table B.18 of EN ISO 52000-1.</td></tr>
<tr><td>System boundary</td><td>Dividing the renewable primary energy demand with the total primary energy demand follows outside the assessment boundary.</td></tr>
</table>

	NOTE: The assessment boundary is set at the point(s) where delivered and exported energy are measured or calculated. Although energy can be imported or exported from/to the building from on-site, nearby, and distant sources, the assessment boundary does not change.
Unit of measure	Renewable energy ratio (on-site, nearby) $RER_{onst,nrby}$ in [%]
Applicability	Certification cases: • **New building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator • **Existing building** in the use phase (with long-term use data of at least three years) - both methods, calculated (asset) and measured (operational) methods can be applied for the calculation of this indicator • **Renovated building** in the design/construction/'as built' phase (without long-term use data) - only the calculated (asset) method can be applied to calculate this indicator Building use: • Residential - Single-family house - Multi-family house - Apartment block (Multi-apartment residential building) - Home for elderly and disabled people (e.g., retirement house, nursing home) - Residence for collective use (e.g., dormitory) • Non residential - Office - Educational building (e.g., kindergartens, primary schools, secondary schools, universities) - Hospital - Hotel and restaurant - Sport facility - Wholesale and retail trade services building Project stage: • Design • Construction / As Built • In Use

Reference Standards	The energy calculation method for energy performance available across the EU include: • use of national standards still applied (e.g., EN 15603[17] and its associated standards - EN 15316 series), • use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or • use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480. According to EN ISO 52000, there are two types/methods of the energy performance of building assessment: • calculated (asset) assessment method, • measured (operational) assessment method. The assessment type and subtype used specified in Table 3 of EN ISO 52000-1 should be reported in all cases for the purposes of comparability.
Assessment method	• **Calculation process** The renewable energy ratio (onsite, nearby) $RER_{onst,nrby}$ in % is calculated by formula: $$\boldsymbol{RER_{onst,nrby} = \frac{E_{Pren,onst,nrby}}{E_{Ptot}} \cdot 100}$$ where: E_{Ptot} – is the total annual primary energy demand per useful floor area based on the calculated delivered energy [kWh/(m²a)] $E_{Pren,onst,nrby}$ – is the renewable annual primary energy demand per useful floor area in [kWh/(m²a)] for the purpose of *RER* calculation, including the on-site and the nearby produced renewable primary energy demand based on the calculated renewable energy. • **Measurement process** The renewable energy ratio (onsite, nearby) $RER_{onst,nrby}$ in % is calculated by formula: $$\boldsymbol{RER_{onst,nrby} = \frac{E_{Pren,onst,nrby}}{E_{Ptot}} \cdot 100}$$ where: E_{Ptot} – is the total primary annual energy demand per useful internal floor area based on the measured delivered energy [kWh/(m²a)] $E_{Pren,onst,nrby}$ – is the renewable annual primary energy demand per useful floor area in [kWh/(m²a)]for the purpose of *RER* calculation, including the on-site and the nearby produced

[17] EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

	renewable primary energy demand based on the measured renewable energy. NOTE: The renewable energy ratio $RER_{onst,nrby}$ cannot be calculated using measurement approach if the contribution of renewable sources (e.g., thermal solar contribution, heat captured by a heat pump from the environment) cannot be measured. The renewable energy ratio $RER_{onst,nrby}$ can be calculated using the same above given formula based on measured value only in case all contributions of renewable sources are measured! **NOTE**: When calculating this indicator using either calculated or measured method, the calculated *RER* value must always be clearly denoted with subscript/s declaring which perimeter/s is/are considered: RER_{onst} – renewable energy ratio (on-site) [%] RER_{nrby} – renewable energy ratio (nearby) [%] $\boldsymbol{RER_{onst,\ nrby}}$ – renewable energy ratio (on-site, nearby) [%] – default choices according to EN ISO 52000-1 $RER_{onst,\ nrby,\ dist}$ – renewable energy ratio (on-site, nearby, and distant) [%]
Comparability of results	The results of this indicator are comparable between the buildings: • if the buildings are of the same building type at the same European climate zone (5 European climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation), • if the same assessment method (either calculated or measured) and subtype is used, • if the same perimeters (on-site, nearby, distant) are used when calculating this indicator, • if the same building services are considered when calculating this indicator.
Data	• **Data source (for calculation)** For the calculation of the **renewable energy ratio (onsite, nearby)** $\boldsymbol{RER_{onst,nrby}}$ in **%** the following values are required: • E_{Ptot} – the total annual primary energy demand per useful floor area based on the calculated delivered energy [kWh/(m²a)] • $E_{Pren,onst,nrby}$ – the renewable annual primary energy demand per useful floor area for the purpose of *RER* calculation, including the on-

	site and the nearby produced renewable primary energy demand based on the calculated renewable energy [kWh/(m²a)] For the calculation of the renewable annual primary energy demand per useful floor area $\boldsymbol{E_{Pren,onst,nrby}}$ in [kWh/(m²a)] the following values are required: • $E_{del,cr,calc,onsite}$ – the calculated annual on-site delivered energy for energy carrier (*cr*) [kWh/(m²a)] • $E_{del,cr,calc,nrby}$ – the calculated annual nearby delivered energy for energy carrier (*cr*) [kWh/(m²a)] • $f_{Pren,del,cr}$ – renewable primary energy factor for the delivered energy carrier (*cr*) [–] • **Data source (for measurement)** For the calculation of the **renewable energy ratio (onsite, nearby)** $\boldsymbol{RER_{onst,nrby}}$ in **%** the following values are required: • E_{Ptot} – is the total annual primary energy demand per useful internal floor area based on the measured delivered energy [kWh/(m²a)] • $E_{Pren,onst,nrby}$ – the renewable annual primary energy demand per useful floor area for the purpose of *RER* calculation, including the on-site and the nearby produced renewable primary energy demand based on the measured renewable energy [kWh/(m²a)] For the calculation of the renewable annual primary energy demand per useful floor area $\boldsymbol{E_{Pren,onst,nrby}}$ in [kWh/(m²a)] the following values are required: • $E_{del,cr,meas,onsite}$ is the measured annual on-site delivered energy for energy carrier (*cr*) [kWh/(m²a)] • $E_{del,cr,meas,nrby}$ is the measured annual nearby delivered energy for energy carrier (*cr*) [kWh/(m²a)] • $f_{Pren,del,cr}$ – renewable primary energy factor for the delivered energy carrier *cr* [–]
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **renewable energy ratio**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11)

	• EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) • ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.7 KPI 7_Total GHG emissions from primary energy used in building operations

KPI TEMPLATE	
Name of the KPI	Annual use stage energy-related Global Warming Potential (GWP)

<table>
<tr>
<td>Description</td>
<td>This indicator gives a measurement of the quantity of greenhouse gases (GHG) of the building, emitted directly and indirectly during its use stage, due to energy consumption for a list of uses or services, knowing the energy sources / carriers involved.
The variety of GHG are represented by the Global Warming Potential (GWP), which is an aggregated indicator using characterization factors for the radiative forcing impact of one mass-based unit of each greenhouse gas relative to that of CO_2, over a given period of time (100 years in general).
GWP is supposed to represent the potential contribution of a system to the earth's global warming and the associated effects on climate change.

The indicator is an extension of indicator “Delivered annual final energy demand per useful floor area” in terms of GHG emissions. The knowledge of the energy sources/carriers linked to the flows of delivered final energy is necessary. Note that the GWP indicator is based on <u>final</u> energy, not on primary energy.

Regarding the description form of indicator 1, attention is drawn on the following points:
- only “delivered final energy” is considered here, without reduction due to exported energy
- delivered final energy can be calculated or measured</td>
</tr>
<tr>
<td>Scope</td>
<td>The scope includes both residential and non-residential buildings.
The building services (also called EPB services) considered are mentioned in the following table:
<table>
<tr><th rowspan="2">Building service (or EPB service)</th><th colspan="2">Building service considered in the calculation of indicator (Yes/No)</th></tr>
<tr><th>Residential buildings</th><th>Non-residential buildings</th></tr>
<tr><td>Heating</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Cooling</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Ventilation</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Humidification</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Dehumidification</td><td>Yes</td><td>Yes</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>Domestic hot water</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Lighting</td><td>No</td><td>Yes</td></tr>
<tr><td>External lighting</td><td>No</td><td>No</td></tr>
<tr><td>People transport (e.g., elevators)</td><td>No</td><td>No</td></tr>
<tr><td>Appliances</td><td>No</td><td>No</td></tr>
<tr><td>Others</td><td>No</td><td>No</td></tr>
</table>

NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices.
</td></tr>
<tr><td>System boundary</td><td>The system boundary is the same as for indicator “KPI_1 Total annual primary energy demand [...]”, for consistency reasons.

Other systems than energy-related ones can contribute to use stage GWP as the provision of potable water, wastewater treatment or refrigerants leakage, but here they are <u>excluded</u> from the scope.</td></tr>
<tr><td>Unit of measure</td><td>2 possibilities:
- kg CO_2 eq. / m² useful internal floor area, for a reference study period (RSP) of 50 years
kg CO_2 eq. / (m².y) (per useful internal floor area and per year)</td></tr>
<tr><td>Applicability</td><td>The scope includes both residential and non-residential buildings.

Project stages:
• Design
• Construction / As Built
In Use</td></tr>
<tr><td>Reference Standards</td><td>o ISO 14067 (Product Carbon Footprint)
o ISO 16745-1 (Carbon metric of an existing building during use stage)
o EN 15978-1 (Assessment of environmental performance of buildings - under revision in 2022 and 2023)
o EN 15804 :2012+A2:2019 (EPDs for construction products)</td></tr>
<tr><td>Assessment method</td><td><u>Calculation method:</u>
GWP linked to annual energy consumption: each type of energy flow is multiplied by an emission factor drawn from an official national</td></tr>
</table>

	database, and multiplied by the RSP (50 years), or kept per year. It is assumed that emission factors are constant during the RSP, representing current situation. Assessment approach: During the design stage (new building or building under renovation) the indicator can't be calculated if the energy sources are not chosen yet. Results reporting: transparency is required, and sub-indicators should be visible.
Comparability of results	The results of this indicator are comparable if: • The final energy figures coming from indicator 2 respect its comparability conditions • the building type, its main functionalities and the conditions of use are the same (included in the "functional equivalent" of the building under assessment) • the climate is the same (in practice it often means buildings are located in the same urban or rural area) • the assessment boundaries are the same (spatial and temporal) • the area unit is the same (useful internal floor area) • the emissions factors per energy carrier is of the same (good) quality level • the main assumptions and scenarios are the same • the greenhouse gases taken into account are the same (at least for the significant ones) • the same standards and assessment methods are used • the assessments are made by trained/qualified assessors
Data	The necessary data are: • Final energy consumption per use and per energy carrier (from indicator KPI 1) • Emission factors for energy carriers For the electricity consumptions, it is important to distinguish use by use, because the emission factors generally differ according to the use, for

	instance heating, domestic hot water, cooling, etc., because the temporality or seasonality implies different combinations of energy sources, more or less carbon intensive. Note: The existence of a Building Logbook can facilitate data collection
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **annual use stage energy-related Global Warming Potential (GWP)**: • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9)

	• EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.8 KPI 8_Life Cycle Global Warming Potential (GWP)

KPI TEMPLATE	
Name of the KPI	Life Cycle Global Warming Potential (GWP)
Description	This indicator measures the building's contribution to the earth's global warming and the associated effects on climate change throughout its life cycle. The greenhouse gases (GHG) emitted through the different stages of the building life cycle, from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building material, are summed up. Global Warming Potential uses characterization factors describing the radiative forcing impact of one mass-based unit of each greenhouse gas relative to that of CO_2 over a given period of time (100 years in general).
Scope	Both residential and non-residential buildings.
System boundary	The assessment boundary is set at the building and its site (plot of land) including at least: - Shell (substructure and superstructure): foundations, load bearing structural frame, non-load bearing elements, façades, roof, parking facilities - Core: fittings and furnishings, in-built lighting system, energy system, ventilation system, sanitary system, other systems - External works: utilities, landscaping **Full life cycle**: from cradle to grave as defined in EN 15978, reported separately for: - product stage (A1-5), - use stage (B1-7), - end of life stage (C1-4) - additional benefits and loads (D). Note: The use stage includes:

	- B1: Use - B2: Maintenance - B3: Repair - B4: Replacement - B5: Refurbishment - B6: Operational energy use - B7: Operational water use Note: The part of the produced on-site energy that is exported outside the building is considered in module D. Results about module D shall be presented separately, because of different nature. For **major renovations** of existing buildings, the system boundary shall encompass all life cycle stages that relate to the extension of the building's service life (the stages relating to the original production (A1-3) and construction (A4-5) are ignored).
Unit of measure	kg CO_2 eq. / m^2 useful internal floor area, for a reference study period (RSP) of 50 years.
Applicability	All residential and non-residential buildings. Project stage: • Design • Construction / As Built Renovation (with a specific methodology for major renovation to take into account the extension of the service life)
Reference Standards	• EN 15804:2012+A2:2019, Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products • EN 15978-1, Sustainability of construction works — Methodology for the assessment of performance of buildings — Part 1: Environmental Performance (under revision in august 2022) • ISO 14040 and ISO 14044 • European Commission's Product Environmental Footprint (PEF) method • prEN 15941:2021, Sustainability of construction works - Data quality for environmental assessment of products and construction works - Selection and use of data • ISO 15686-8:2008, Buildings and constructed assets — Service-life planning — Part 8: Reference service life and service-life estimation • Note: Environmental data sets for construction products which are compliant with EN 15804 (the latest version or the previous one) are much more numerous than those compliant with PEF method.

Assessment method	This protocol is defined step by step: 1. Defining the goal and intended use of the assessment, and the specification of the object of assessment (this preliminary information may be shared by all environmental indicators) 2. Selecting software tools and databases (compliant with EN 15978 and EN 15804) 3. Setting up the model of building adapted to the calculation process for life cycle GWP 4. Defining scenarios for the building life cycle 5. Data selection and quality check 6. Processing the data and assumptions using the LCA tool 7. Using the LCA tool to calculate the chosen environmental impacts (here GWP) 8. Interpretation of results, carrying out a hot spot analysis 9. *(optional)* Comparison of results with other buildings (paying attention to the comparability criteria listed hereafter) 10. *(optional)* Opportunity to improve the design so as to get a better result 11. Completing the reporting format with the results and main assumptions, together with a concise background report **Calculation method:** GWP is calculated as follows: • Life cycle of products: linear combinations based on the bill of quantities for initial construction, the number of replacements, and the corresponding EPDs. Data gaps may be filled by conservative assumptions with average or generic data. • GWP linked to energy and water consumption: each type of flow is multiplied by an emission factor drawn from an official national database, and multiplied by the RSP (50 years). **Assessment approach:** Ideally, all the life cycle stages of all elements present in the building and on its site, including necessary replacement of products during the RSP, must be included. The cut-off rules described in EN 15804 for construction products shall be followed.

<table>
<tr><td></td><td>An alternative simplified method may consider incomplete life cycle, limited to:
- Product stage (A1-A3) (it corresponds to a “cradle-to-gate” assessment)
- Part of use stage (B4-B6)

Results: The results are to be reported separately for each life cycle stage (from A to D), as presented in the following table (extract from Level(s) user manual for indicator 1.2).

<table>
<tr><th>Indicator</th><th>Unit</th><th>Product (A1-3)</th><th>Construction process (A4-5)</th><th>Use stage (B1-7)</th><th>End of life (C1-4)</th><th>Benefits and loads beyond the system boundary (D)</th></tr>
<tr><td>(1) GWP - fossil</td><td>kg CO_2 eq</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(2) GWP - biogenic</td><td>kg CO_2 eq</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>GWP – GHGs (1+2)</td><td>kg CO_2 eq</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(3) GWP – land use and land use change</td><td>kg CO_2 eq</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>GWP – overall (1+2+3)</td><td>kg CO_2 eq</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Notes:
Impacts referred to the use of 1 m² of useful internal floor per year for a default reference study period of 50 years[1].</td></tr>
</table>

This way of reporting may accept, if LCA practice is not mature enough, only a part of results.</td></tr>
<tr><td>Comparability of results</td><td>The results of this indicator are comparable if:
• the building type, its main functionalities and the conditions of use are the same (included in the “functional equivalent” of the building under assessment)
• the reference study period is the same (included in the “functional equivalent”)
• the climate is the same (in practice it often means buildings are located in the same urban or rural area)
• the assessment boundaries are the same (spatial and temporal)
• the area unit is the same (useful internal floor area)
• the quality and completeness of input data (e.g. bill of quantities, EPDs quality) is of the same (good) level
• the main assumptions and scenarios are the same
• the greenhouse gases taken into account are the same (at least for the significant ones)
• the same standards and assessment methods are used
• In case of renovation projects, the renovation level is similar (light, medium, deep), and the initial building state is close
the assessments are made by trained/qualified assessors</td></tr>
<tr><td>Data</td><td>• Bill of quantities (complete and detailed)
• Lifespan of each product or element
• EPDs corresponding to products</td></tr>
</table>

	• Generic or default data if specific EPDs are missing (so as to avoid empty boxes) • Final energy consumption per energy carrier • Water consumption • Emission factors for energy carriers and for water (including pre- and post-use treatment) Note: The existence of a Building Logbook can facilitate data collection
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the embodied energy: MA2.1 (MA2.1.1, MA2.1.2, MA2.1.3, MA2.1.4, MA2.1.5, MA2.1.6)

2.1.9 KPI 9_Time outside of thermal comfort range

KPI TEMPLATE	
Name of the KPI	Time outside of thermal comfort range
Description	This indicator measures the percentage of the year when building occupiers are not comfortable with the thermal conditions inside a building. Thermal comfort is guaranteed when the indoor temperature in those spaces or zones that account for >10% of the total useful floor area of a building is within a range of 18°C to 27°C. Linked to this, the indicator also seeks to measure the ability of a building (with and without building services) to maintain pre-defined thermal comfort conditions during the heating and cooling seasons. Because of a combination of factors including poor insulation, low-quality windows, cold bridging through the building fabric, high levels of air infiltration, and insufficient or poorly maintained heating systems, a significant portion of the housing stock in the EU is unable to provide adequate levels of thermal comfort. The control of thermal comfort is an important factor to consider in all buildings because uncomfortable circumstances can put more vulnerable residents at risk from illnesses, reduce the productivity level of the occupants, and/or may necessitate the usage of additional cooling/heating energy. As the control of

	overheating is specifically addressed by the Energy Performance of Buildings Directive 2010/31/EU (EPBD), this indicator primarily focuses on summertime thermal comfort, but it also considers residents' capacity to maintain a comfortable indoor temperature in winter. EUB SuperHub indicator 19 (Summer thermal comfort in 2030 and 2050) can be used to determine future climate scenarios and report on them in order to address the possibility that adverse climate circumstances would exacerbate both of these issues in the future.
Scope	Both residential and non-residential buildings.
System boundary	The assessment boundary is the building. Heat losses and gains, both internal and external, that may affect. the comfort conditions within the building, as well as the heating and cooling energy that may be required to maintain these conditions, are to be factored into calculations.
Unit of measure	The percentage of time in which the indoor temperature is out of a range of 18°C to 27°C during the heating and cooling seasons with and without building services.
Applicability	Both residential and non-residential buildings. Project stage: • Design • Construction / As Built • In Use
Reference Standards	- The calculation of the reported performance shall be based on a dynamic energy simulation complying with the ISO EN 52000-1 series. - An overheating assessment that forms part of a National Calculation Method shall be accepted if it is based on a dynamic simulation method. If a more advanced calculation method is used, it shall also be compliant with the ISO EN 52000-1 series. The calculation of this indicator can be carried out only if the indoor air temperature and relative humidity of the analyzed building are within the range of values ditched by the standard EN ISO 7730.

Assessment method	This indicator's objective is to calculate the percentage of the year when the indoor temperature in those spaces or zones that account for >10% of the total useful floor area of a building is out of a range of 18°C to 27°C. The assessor shall be able to: • Document the evaluated zones in the building • Document the used building thermal and physical values • Document the building's actual or simulated heating and cooling systems • Document the building's use and occupancy profile used • Document the dynamic simulation method used. **Calculation method:** • Identify whether the national/regional calculation method is dynamic and whether an overheating assessment is also required in order to obtain a building permit. • If the national/regional calculation method is dynamic, this may be used to calculate the time out of range. If not, a dynamic simulation method and the software tool will need to be selected for use. • Determine if default values for the building occupancy and conditions of use patterns are stipulated in a national calculation method, or whether real-life assumptions can be made. Determine also whether the weather files are stipulated. • Run the simulation in order to obtain the internal temperatures per hour for a year for each thermal space or zone that accounts for >10% of the total useful floor area of a building. • Calculate the average value of the global building indoor temperature, weighted on the surface areas and the occupancy intensity of the different thermal spaces or zones. If the simulation does not automatically calculate the time out of range, the result shall

	be analyzed in order to derive the percentages for the upper and lower temperature bands.
Comparability of results	The results of the indicator are comparable between the buildings that share the same usage, cooling and heating season, and climatic location as long as the same dynamic simulation method is used.
Data	The input data collected by the assessors shall be compliant with the input data required in the ISO EN 52000-1 series. Examples of requested input data are listed below: • about building envelope and windows U values and construction method (can be substituted by data from construction year class for existing buildings) • Building openings and orientation • Building Details usage and occupancy profiles • Building heating systems Building cooling systems
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **percentage of time outside of thermal comfort range:** • EN1.1 – Energy Simulation (EN1.1.4, EN1.1.5) • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11) • EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11)

	• EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.10 KPI 10_Ventilation rate

KPI TEMPLATE	
Name of the KPI	**Ventilation rate**

Description	According to EN 16798-1, the ventilation rate is the magnitude of outdoor air flow to a room or building through the ventilation system or device. A ventilation system is a combination of appliances or building components designed to supply indoor spaces with outdoor air and/or to extract polluted indoor air. The system may be mechanical (e.g. using a combination of air handling units, ducts and terminals), natural (e.g. achieving air flow via temperature differences and wind via façade grills) or a hybrid combination of both mechanical and natural aspects18. To ensure suitable Indoor Air Quality (IAQ) level, a number of different performance aspects must be addressed, such us the ventilation rate; indeed, the indicator measures the ventilation rate in each main room of the building, in relation to the expected use patterns.
Scope	KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to buildings equipped with a mechanical ventilation.
System boundary	The assessment boundary of the ventilation rate is the building equipped with a mechanical ventilation.
Unit of measure	Ventilation rate (air flow) is measured as: [l /s]

Level(s) indicator 4.1: Indoor air quality, European Commission - Joint Research Centre, January 2021.

Applicability	Certification case: • New building: Based on the calculation of the total ventilation rate as described in the EN 16798-1. • Renovated building: Based on the calculation of the total ventilation rate as described in the EN 16798-1. • Existing buildings (in use): Based on the calculation of the total ventilation rate as described in the EN 16798-1. Or Based on measurement method described in EN 12599: 2012 - Ventilation for buildings - Test procedures and measurement methods to hand over air conditioning and ventilation systems, where are described checks, test methods and measuring instruments in order to verify the fitness for purpose of the installed systems (air speed, ventilation filters and their suitability for the building location, indirect measure useful to understand the proper system design, etc.). Building use: • Residential · Single house · Multi-apartment · Non residential · Office · School · Retail · Etc. Project stage: • Design • Construction / As Built • In Use

Reference Standards	Ventilation rate indicator is developed in accordance with **Level(s)**[19] (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the calculation of the ventilation rate at the design phase is the **EN 16798-1: 2019** *Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*". When considering ventilation needs, the expected use patterns should be considered, especially if occupant densities might vary significantly from one zone to another or in the same zone, but during different times of day or week. **CEN/TR 16798-2** is the reference for the identification of the four categories of indoor environmental quality, which correspond to different expectation levels. The reference standard for the measurement of the ventilation rate is the **EN 12599: 2012** - *Ventilation for buildings - Test procedures and measurement methods to hand over air conditioning and ventilation systems*. This European Standard enables the choice between simple test methods, when sufficient, and extensive measurements, when necessary. It applies to mechanically operated ventilation and air conditioning systems. The measuring methods in this European Standard can be used in the frame of the energy inspection of air conditioning systems according to EU Directive 2010/31/EU "Energy performance of buildings Directive" (see EN 15239, EN 15240).
Assessment method	• Calculation process The underlying calculation method for the ventilation rate at the detailed design phase is provided by the "**EN 16798-1** - *Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*". The standard defines three different methods for the assessment of the air quality. Method 1: based on perceived air quality. Method 2: based on the use of limit values for the concentration of pollutants.

https://environment.ec.europa.eu/topics/circular-economy/levels_en

Method 3: based on pre-defined ventilation flow rates.

In term of accuracy of the final result, **method 1** is the one to be preferred and the calculation methodology is described in detail below.

Detailed description of Method 1
It is based on the methodological approach to quantify the ventilation rates needed in different zones of the building.

STEP 1: Apply the EN 16798-1 method for designing ventilation rates, based on predefined ventilation airflow rates.
Tables below (example for office building and for residential), taken from of EN 16798-1, provides default airflow rates for the four categories of IAQ (I, II, III and IV) in both units of l/s/person and l/s/m^2. These values range from 5.5 to 20 l/s/person and from 0.55 to 2 l/s/m^2. When applied to a specific building zone situation (in terms of occupant density), the default ventilation rate units that result in the required should be used for a given category. Through this method, predefined ventilation rates can be referred to, depending on the category of IAQ that is aimed for in the design.

Category	Total design ventilation air flow rate for the room	
	l/(s per person)	l/(s.m^2)
I	20	2
II	14	1,4
III	8	0,8
IV	5,5	0,55

Category	Total ventilation including air infiltration (1)		Supply air flow per person (2)	Supply air flow based on perceived IAQ for adapted persons (3)	
	l/(s.m^2)	Ach	l/(s per person) [a]	q_p l/(s per person)	q_B l/(s.m^2)
I	0,49	0,7	10	3,5	0,25
II	0,42	0,6	7	2,5	0,15
III	0,35	0,5	4	1,5	0,1
IV	0,23	0,4			

[a] Supply air flow for Method 3 is based on Formula (1) from 6.3.3.2

STEP 2: Define the outdoor air quality categories (ODA(P) and ODA(G)) for the building location.

Category	Description
ODA 1	Pure air which may be only temporarily dusty (e.g. pollen)
ODA 2	Outdoor air with high concentrations of particulate matter and/or gaseous pollutants
ODA 3	Outdoor air with very high concentrations of gaseous pollutants and/or particulate matter

STEP 3: Define an occupation schedule for each building zone. An occupation schedule will be required to help estimate the energy consumption of the ventilation system. These schedules are also relevant for the purposes of calculating design air flows and air changes. Specifically relevant information for the ventilation system in the occupation schedule includes the minimum ventilation rate (in l/s/m^2).

STEP 4: (optional) define material specifications and VOC emissions for fit-out and insulation materials. The combination of SUP category and ODA category will inform designers about what filters should be specified.

- Measurement process

The metering strategies for the measurement of the ventilation rate in as-built performance and in-use phase are different but all useful to evaluate the real performance of the building.
The reference standard to be used is the **EN 12599: 2012** which provides test methods and measuring instruments to assess the air flow injected by the terminals of a mechanical ventilation
system measuring the velocity of the outgoing air using different methodologies (different kind of anemometers could be used)
The standard applies to ventilation and air conditioning systems designed for the maintenance of comfort conditions in buildings.
Testing during occupation captures any additional impacts on IAQ caused by the activities of occupants and the installation of furniture and equipment.

It is also important to add that, while many aspects of indoor air quality can be physically measured, whether or not these measurements correlate with occupant satisfaction will depend on the subjective perception of occupants. Since the purpose of building design and of building system operation is to provide a satisfactory living or working space for occupants, some basic principles for carrying out a

	survey relating to perceptions of the indoor environment have been developed by **ISO 28802**[20].
Comparability of results	Comparability relies on the definition of the expected use patterns of the building, on the occupation schedule for each building zone, on the intended use and on the pollutant classification of the building (in relation to its fit-out materials, internal finishes, etc.). Concerning the calculation of the ventilation rate, it's also important to be consistent on the definition of the floor area taken into account in the calculation steps, (m^2), because definition of net floor area varies according to the country. The reference to standard has to be the same when comparing results.
Data	• Data source (for calculation) - the dimension of the building zones in which the ventilation rates are calculated/ measured, its intended use and its internal distribution of the spaces; - the expected use patterns of the building (as per CEN/TR 16798-2, four categories of indoor environmental quality have been identified, and they correspond to different expectation levels); - the occupation schedule for each building zone; - A description of the ventilation system including the nominal and/ or actual air change rate capacity of the installed ventilation systems; - material specifications for insulation and fit-out materials (pay attention to manufacturer declarations and product labels that provide information on the tested emissions of VOCs and other hazardous substances). The objective is to identify the typology and the concentration of indoor pollutants in order to classify the building as low, medium or high pollutant. • Data source (for measurement) In addition to the requirements mentioned in the calculation part, the assessor will need to inquire about the elements needed to perform in-situ measurements are the equipment necessary to

ISO 28802: Ergonomics of the physical environment. Assessment of environments by means of an environmental survey involving physical measurements of the environment and subjective responses of people.

	evaluate the selected parameters (anemometer, flow hood, fan anemometer, etc.) • Data quality (for calculation) - The accuracy of the description of the ventilation system. - The accuracy of the description of the materials used for building insulation and also the fit-out materials. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the ventilation rate. - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the ventilation rate: EN3.2.1 - EN3.2.2 - EN3.2.3 - EN3.2.4 - EN3.2.5 – EN3.2.7 - EN3.2.10 – EN3.2.11

2.1.11 KPI 11_CO_2 concentration

KPI TEMPLATE	
Name of the KPI	CO_2 concentration
Description	The carbon dioxide (chemical formula CO_2) is a chemical compound occurring as a colorless gas with a density about 53% higher than that of dry air. Carbon dioxide molecules consist of a carbon atom covalently double bonded to two oxygen atoms. The term "concentration" is used to describe the amount of gas by volume in the air, measured as parts-per-million (ppm). Indoor air quality can have multiple effects on the human health, its quality depends on multiple variables that are closely related to pollutant levels and air conditions (e.g. CO_2 and humidity). To ensure suitable Indoor Air Quality (IAQ) level, a number of different performance aspects must be addressed to ensure that the, the CO_2 concentration are within the safe limits. Furthermore, the measurement of the CO_2 concentration is an indirect measure that allows to understand if the mechanical

	ventilation works properly and if there are anomalies. At design stage, the predictive estimation of CO_2 concentration is very difficult to perform. On the contrary, in the use stage of the building, the CO_2 concentration is a simple parameter to measure. For that reason this KPI is only metered. The measurement must be in compliance with the requirements of the **EN 15251: 2007** *Indoor Environmental Criteria* and with **EN 16798: 2019** *Energy performance of buildings - Ventilation for buildings.*
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the CO_2 concentration is the building.
Unit of measure	CO_2 concentration is measured as: particle per million [ppm].
Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): CO_2 concentration in-situ measurement is measured according to EN 15251 and EN 16798. Building use: • Residential · Single house · Multi-apartment · Non residential · Office · School · Retail · Etc. Project stage: • In Use
Reference Standards	CO_2 concentration indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the CO_2 concentration is the

	EN 15251: 2007 *Indoor Environmental Criteria*. The standard identifies parameters to be used by monitoring and displaying the indoor air quality in existing buildings. It specifies criteria for measurements which can be used, if required, to measure compliance by inspection. The other reference standard for the measurement of the ventilation rate is the **EN 16798-1: 2019** *Energy performance of buildings - Ventilation for buildings*.
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the CO_2 concentration** in in-use phase, it is necessary to measure the CO_2 concentration of the internal air and of the external air next to the building, at the same time, through the use of a carbon dioxide detector. The measurement of the CO_2 concentration must be performed in all the main rooms with full occupancy of the building, measuring at the same time the CO_2 concentration in indoor air and the CO_2 concentration in outdoor air. Thanks to these two measures, it will be easy evaluate the increase in CO_2 of indoor air compared to outdoor air for each main room. The measurement should be made in building rooms in which its known that users spend most of their time in and cover various representative periods of time, as defined in **EN 15251: 2007.** The measurement is performed using carbon dioxide detectors. **Detailed measurement description based on UNI EN 16798-1.** STEP 1: Measure the indoor concentration of CO_2 within the main building rooms, equipped or not with the mechanical ventilation. Calculate the average of the values acquired during the monitoring. STEP 2: measure the external concentration of CO_2 ensuring that the measurement is carried out over the same period of time of the indoor one. Calculate the average of the values acquired during the monitoring.

STEP 3: Assess the increasing of CO_2 within the indoor air in relation to the external one, in each room following the formula below:

$\Delta C = C_{out} - C_{ext}$ [ppm]

where:
ΔC = difference of CO^2 concentration [ppm];
C_{out} = average value of indoor CO^2 [ppm];
C_{ext} = average value of the external CO^2 [ppm]

STEP 4: Assign the score to the rooms evaluated. Compare the increasing of the CO_2 of the *i-th* environment with the air quality categories defined by the UNI EN 16798-1 standard. Identify the corresponding air quality category and assign the Z category index according to the following table:

Category	**Increasing of the CO_2 in relation to the external concentration [ppm]**	**Z category index**
Category I	≤ 380	5
Category II	≤ 550	3
Category III	≤ 950	0
Category IV	>950	-1

STEP 5: Calculate the Z_m value referred to the building as the weighted average of the Zi category indices assigned to the main rooms on the relative usable surfaces:

$$Z_m = \frac{\sum Z_i \cdot S_{u,i}}{\sum S_{u,i}} = [-]$$

where:
Zi = i-th environment category index [-];
Su,i = useful area of the i-th environment [m^2]

STEP 5: compare the average value of the Z_m category index with the performance scale benchmarks and assign the score.

Comparability of results	Concerning the CO_2 concentration measurement, comparability relies on the reference standard to be used for data assessment and the typology of instrument used (calibration, resolution, etc.). Nevertheless, the CO_2 concentration levels in indoor rooms are in general comparable between the buildings without restriction on type, use and location.
Data	• Data source (for calculation) - Not applicable. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation of the CO_2 measurement device (in most cases the carbon dioxide detector) used to perform the measurement and its sensitivity and accuracy. - Documentation about the outdoor CO_2 concentration. - Documentation about the duration of the measurement and external conditions. - Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if available). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the CO_2 concentration. - Information on the ventilation system (if available in the building). - Information about any possible issue that may affect the final result of the measurement.

Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the CO_2 concentration: CO1.2.1 – CO1.2.2 – CO1.2.3 – CO1.2.4 – CO1.2.5 – CO1.2.6 – CO1.3.1 – CO1.3.6.

2.1.12 KPI 12_Relative Humidity

KPI TEMPLATE	
Name of the KPI	Relative Humidity
Description	The relative humidity is the amount of water vapour present in air expressed as a percentage of the amount needed for saturation at the same temperature. The relative humidity can't be calculated, only measured in the in-use phase. The measurement must be in compliance with the requirements of the **EN 15251: 2007** *Indoor Environmental Criteria* and with **EN 16798: 2019** *Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*. The level of relative humidity is an important influencing factor on occupant comfort. Excessively high humidity (> 90%) increases the intensity of hot or cold temperatures, while excessively low humidity (< 20%) can cause irritation of the eyes, nose and throat. Poor control of humidity from outdoor air or from kitchen and bathroom areas can create ideal conditions for mould growth, which in turn can provoke respiratory or allergenic health issues[21]. Studies relating to homes suggested that around 17% of the EU population (approximately 80 million people) live in homes in which damp and associated mould growth may provoke health effects[22].
Scope	KPI addresses both residential and non-residential buildings.

[21] Level(s) indicator 4.1: Indoor air quality, European Commission - Joint Research Centre, January 2021.
[22] Grun G., Urlaub S., Foldbjerg P., Towards an identification of European indoor environments' impact on health and performance – Mould and dampness. Frauhofer-Institut fur Bauphysik IBP

System boundary	The assessment boundary of the relative humidity is the building.
Unit of measure	Relative humidity is measured as: [%].
Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): Relative humidity is measured according to what stated in EN 15251 and EN 16798. Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: - In Use
Reference Standards	Relative humidity indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the ventilation rate is the **EN 15251: 2007** *Indoor Environmental Criteria*. The standard identifies parameters to be used by monitoring and displaying the indoor air quality in existing buildings. It specifies criteria for measurements which can be used, if required, to measure compliance by inspection. The other reference standard for the measurement of the ventilation rate is the **EN 16798-1: 2019** *Energy performance of buildings - Ventilation for buildings.*
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the relative humidity** during the occupation of the building (in-use phase), the verification of the relative humidity

	must be performed in all the main rooms of the building in order to be able to characterise the way in which the user manages the installations establishing, therefore, the user profile of the building. The relative humidity measurement must be carried out also for the external air. It is recommended to perform the measurement for a period sufficient to establish a complete time profile of internal thermo-hygrometric conditions, using a datalogger for data collection (better with stand-alone power supply and with adequate storage capacity). For the measurement it is necessary the use of hygrometric sensors (psychrometric, dew point, capacitive type) with the following minimal requirements: • range: 10 ÷ 90 % • uncertainty: ±3% • resolution: 0.1% Furthermore, the measurement of the relative humidity is an indirect measure that allows to understand if the mechanical ventilation works properly and if there are anomalies not identified at the design stage.
Comparability of results	Concerning the relative humidity measurement, comparability relies on the reference standard to be used for data assessment and the typology of instrument used (calibration, resolution, etc.).
Data	• Data source (for calculation) - Not applicable. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation about the relative humidity devices (psychrometer or hygrometer, datalogger, etc.) used to perform the measurement and its sensitivity and accuracy. - Documentation about the duration of the measurement and the external conditions.

	- Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if present). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the relative humidity. - Information on the ventilation system (if available in the building). - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the relative humidity: CO2.1.7 – CO2.2.4.

2.1.13 KPI 13_ Total VOCs

KPI TEMPLATE	
Name of the KPI	Total VOCs
Description	The Total Volatile Organic Compounds (TVOCs) are compounds that have a high vapor pressure and low water solubility. TVOCs are emitted as gases from certain solids products or liquids; they include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. **WHO guidelines** for indoor air quality: selected pollutants[23], are a key document to be referred to, which specifies that indoor air has a special role as a health determinant and that the management of indoor air quality requires approaches different from those used for outdoor air. People are spending an increasing

https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf

	amount of time indoors. There they are exposed to pollutants generated outdoors that penetrate to the indoor environment and also to pollutants produced indoors, for example as a result of space heating, cooking and other indoor activities, or emitted from products used indoors. Multiple variables of indoor air quality (IAQ) impact on the human health and several are closely related to Volatile Organic Compounds (VOCs). The TVOC emissions can be limited through the careful selection of VOC free construction products and materials. This KPI can't be calculated, only measured in the in-use phase. The measurement of TVOCs must be in compliance with what stated in **EN 16516**: *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*[24]. This European Standard specifies a horizontal reference method for the determination of emissions of regulated dangerous substances from construction products into indoor air. Another key reference standard explaining the methods to be followed for determining the VOCs in indoor air is the **ISO 16000-6:2021** *- Indoor air — Part 6: Determination of organic compounds (VVOC, VOC, SVOC) in indoor*[25].
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the total VOCs is the building.
Unit of measure	Total VOCs is measured as: [µg/m^3].

https://standards.iteh.ai/catalog/standards/cen/858d31b1-10ac-427b-8ac8-f3d8dcf66f58/en-16516-2017

https://www.iso.org/obp/ui#iso:std:iso:16000:-6:ed-3:v1:en

Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): Total VOCs is measured according to what stated in EN 16516 and in the ISO 16000-6:2021. Reference limit values for TVOCs concentration in indoor air are indicated within the WHO Guidelines. Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: - In Use
Reference Standards	TVOCs indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the TVOCs is the **EN 16516**, according to it, the Total Volatile Organic Compound (TVOC) is the sum of the concentrations of the identified and unidentified volatile organic compounds (as defined in 3.1.3.11 of EN 16516), calculated by summing the reference room concentrations in relation to the external values of these pollutants. Another key standard to be referred to, is the **ISO 16000-6:2021** - *Indoor air — Part 6*, this document specifies a method for determination of volatile organic compounds (VOC) in indoor air and in air sampled for the determination of the emission from products or materials used in indoor environments (according to ISO 16000-1) using test chambers and test cells. The method uses sorbent sampling tubes with subsequent thermal desorption (TD) and gas chromatographic (GC) analysis employing a capillary column and a mass spectrometric (MS)

	detector with or without an additional flame ionisation detector (FID). Of course, the reference limit values for TVOCs concentration in indoor air are indicated within the **WHO Guidelines**.
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the Total VOCs** in the in-use phase, it is necessary to measure the internal air TVOCs concentration level for the occupant's health. The measurement of the TVOCs could be performed both in presence of mechanical ventilation and in case of natural ventilation. The verification of the TVOCs concentration level must be performed in all the main rooms of the building and, simultaneously, in the external area closed to the building. For each pollutant measured, is to be checked the quantitative increase of the indoor air value in relation to the external air value. The reference values for the TVOCs in indoor air are highlighted in the WHO guidelines. The instruments to be utilised for the measurement may vary in relation to what pollutant is necessary to assess, in most cases VOCs detectors are used, located on tripod at a height of 1.5 metres. It is recommended to perform the measurement for a period sufficient to establish the TVOCs concentration level trend (not less than a week). **Detailed measurement description.** STEP 1: Measure the indoor concentration of each pollutant (Benzene - Toluene - Styrene - Tetrachlorethylene - Trichlorethylene) within the selected main rooms. STEP 2: Measure the concentration of each pollutant outside the building, with the same method of analysis used for the indoor selection. STEP 3: For each pollutant "i", measure the increase (ΔCi) of the indoor air compared to the external one, using the following formula:

<table>
<tr><td></td><td>$\Delta Ci = C_{out} - C_{ext}$ [µg/m^3]

where:
C_{out} = value of the individual indoor VOC [µg/m^3];
C_{ext} = value of the individual external VOC [µg/m^3]

STEP 4: For each pollutant "i", calculate the average increase of pollutant (ΔCmi) as the average of the results of the measures carried out inside the building, as follow:

$\Delta Cmi = \Sigma(\Delta Ci) / \Sigma ni$

where: Σ ni = total number of measurements.

STEP 5: Calculate the average index of the pollutant "i" (Ki) as the ratio between the average concentration ΔCmi of substance "i" and the relative reference value VGi, as follow:

$Ki = \Delta Cmi/VGi$

STEP 6: Sum the indices determined for each pollutant to calculate the building index K_a.

$K_a = \Sigma Ki$

Based on the sum of the results, it is possible to define the building performance scale according to the following table:

<table><tr><th>Building K_b index*</th><th>Performance scale</th></tr><tr><td>< 0,1</td><td>5</td></tr><tr><td>0,1 and 0,3</td><td>3</td></tr><tr><td>0,3 and 0,5</td><td>0</td></tr><tr><td>0,5 and 1</td><td>-1</td></tr></table>
*K_b index is equal to the main index building</td></tr>
<tr><td>Comparability of results</td><td>Concerning the TVOCs concentration measurement, comparability relies on the reference standard to be used for data assessment, duration of the measurement and the typology of instrument used (calibration, resolution, etc.).</td></tr>
<tr><td>Data</td><td>• Data source (for calculation)
- Not applicable.

• Data source (for measurement)</td></tr>
</table>

	- Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation about the relative total VOCs devices (VOCs detectors are used, located on tripod) used to perform the measurement and its sensitivity and accuracy. - Documentation about the duration of the measurement and the external conditions. - Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if present). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the total VOCs. - Information on the ventilation system (if available in the building). - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the Total VOCs: CO1.1.1 – CO1.1.2 – CO1.1.3 – CO1.1.4 – CO1.1.5 – CO1.2.1 – CO1.2.2 – CO1.2.3 – CO 1.2.4 – CO1.2.5 – CO1.2.6.

2.1.14 KPI 14_CMR VOCs concentration

KPI TEMPLATE	
Name of the KPI	CMR VOCs concentration
Description	The abbreviation of CMR stands for: Carcinogen, Mutagen, Reprotoxic and refers to substances which are chronically toxic and have very serious impacts on health. CMR VOCs are

	classified as Carcinogenic, Mutagenic or toxic for Reproduction according to Regulation (EC) No 1272/2008[26]. Concentrations of CMR VOCs are consistently higher indoors than outdoors. **WHO guidelines[27]** for indoor air quality, is a key document to be referred to, which specifies that indoor air has a special role as a health determinant and that the management of indoor air quality requires approaches different from those used for outdoor air. CMR VOCs can't be calculated, only metered. The measurement of CMR VOCs must be in compliance with what stated in **EN 16516**: *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air[28]*. This European Standard specifies a horizontal reference method for the determination of emissions of regulated dangerous substances from construction products into indoor air. Another key reference standard explaining the methods to be followed for determining the CMR VOCs in indoor air is the **ISO 16000-6:2021** *- Indoor air — Part 6: Determination of organic compounds (VVOC, VOC, SVOC) in indoor[29]*. People are exposed to air pollutants both outdoors and indoors and they are spending an increasing amount of time indoors. There they are exposed to pollutants generated outdoors that penetrate to the indoor environment and also to pollutants produced indoors, for example as a result of space heating, cooking and other indoor activities, or emitted from products used indoors. Multiple variables of IAQ impact on the human health and several are closely related to CMR VOCs. CMRs entering routes into organisms include inhalation (of dust, fumes, gas, vapours), ingestion (by eating, drinking, smoking with dirty hands or by accidental ingestion) and penetration through (intact or damaged) skin and mucous membranes. In addition to Total VOCs estimation, a value for total CMR VOCs is necessary to separately

[26] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.
[27] https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf
[28] https://standards.iteh.ai/catalog/standards/cen/858d31b1-10ac-427b-8ac8-f3d8dcf66f58/en-16516-2017
[29] https://www.iso.org/obp/ui#iso:std:iso:16000:-6:ed-3:v1:en

	identify the more hazardous substances that may be emitted.
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the CMR VOCs concentration is the building.
Unit of measure	CMR VOCs concentration is measured as: [µg/m^3].
Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): CMR VOCs is measured according to what stated in EN 16516 and the ISO 16000-6:2021. Reference limit values for CMR VOCs concentration in indoor air are indicated within the WHO Guidelines. Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: - In Use
Reference Standards	CMR VOCs indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the CMR VOCs is the **EN 16516** *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*. Another key standard to be referred to, is the **ISO 16000-6:2021** - *Indoor air — Part 6*, this document specifies a method for determination of volatile organic compounds (VOC) in indoor air and in air sampled for the determination of the emission from products or materials used in indoor environments (according to ISO 16000-1)

	using test chambers and test cells. The method uses sorbent sampling tubes with subsequent thermal desorption (TD) and gas chromatographic (GC) analysis employing a capillary column and a mass spectrometric (MS) detector with or without an additional flame ionisation detector (FID). Of course, the reference limit values for CMR VOCs concentration in indoor air are indicated within the **WHO Guidelines**.
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the CMR VOCs** in the in-use phase could be performed both in presence of mechanical ventilation and in case of natural ventilation. During the occupation of the building (in-use phase), the verification of the CMR VOCs concentration level must be performed in all the main rooms of the building and, simultaneously, in the external area closed to the building. For each pollutant measured, is to be checked the quantitative increase of the indoor air value in relation to the external air value. Since the building is in use, all the variants that may affect the measure must be noticed, as for example: number of occupants, smoking habit, typology of the furniture, etc. The reference values for the CMR VOCs in indoor air are highlighted in the WHO guidelines. The instrument to be used for the measurement may vary in relation to what pollutant is necessary to assess, in most cases CMR VOCs detectors are used, located on tripod at a height of 1.5 metres. It is recommended to perform the measurement for a period sufficient to establish the CMR VOCs concentration level trend (not less than a week). **Detailed measurement description.** STEP 1: Measure the indoor concentration Carcinogenic, Mutagenic, Reprotoxic pollutants within the selected main rooms.

	STEP 2: Measure the concentration of each pollutant outside the building, with the same method of analysis used for the indoor selection. STEP 3: For each pollutant "i", measure the increase (ΔCi) of the indoor air compared to the external one, using the following formula: $\Delta Ci = C_{out} - C_{ext}$ [µg/m^3] where: C_{out} = value of the individual indoor CMR VOCs [µg/m^3]; C_{ext} = value of the individual external CMR VOCs [µg/m^3] STEP 4: For each pollutant "i", calculate the average increase of pollutant (ΔCmi) as the average of the results of the measures carried out inside the building, as follow: $\Delta Cmi = \Sigma(\Delta Ci) / \Sigma ni$ where: Σ ni = total number of measurements. STEP 5: Calculate the average index of the pollutant "i" (Ki) as the ratio between the average concentration ΔCmi of substance "i" and the relative reference value VGi, as follow: $Ki = \Delta Cmi/VGi$ STEP 6: Sum the indices determined for each pollutant to calculate the building index K_a. $K_a = \Sigma Ki$
Comparability of results	Concerning the CMR VOCs concentration measurement, comparability relies on the reference standard to be used for data assessment, duration of the measurement and the typology of instrument used (calibration, resolution, etc.).
Data	• Data source (for calculation) - Not applicable. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.).

	- Documentation about the occupancy of the measured rooms. - Documentation about the relative CMR VOCs devices (CMR VOCs detectors are used, located on tripod) used to perform the measurement and its sensitivity and accuracy. - Documentation about the duration of the measurement and the external conditions. - Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if present). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the CMR VOCs concentration. - Information on the ventilation system (if available in the building). - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the CMR VOCs concentration: CO1.1.1 – CO1.1.2 – CO1.1.3 – CO1.1.4 – CO1.1.5 – CO1.2.1 – CO1.2.2 – CO1.2.3 – CO 1.2.4 – CO1.2.5 – CO1.2.6.

2.1.15 KPI 15_R value

KPI TEMPLATE	
Name of the KPI	R value
Description	The R value is the main metric that links to the **EU LCI (Lowest Concentration of Interest) values. The R value for an individual VOC is the ratio of the measured concentration to the EU-LCI value**. For example, a measured concentration of 24 µg/m3 and an EU LCI value of 200 µg/m3 would correspond to an R value of

	0.12[30]. When more than one substance with an EU-LCI value is measured, the R values of each substance are added together. The harmonisation process for the LCI values (Lowest Concentration of Interest) is not finalised yet. The LCI approach was developed to assess the health effects of compounds from building materials. It was originally part of a basic scheme for the evaluation of VOC emissions. The R value is a metered indicator, it can be measured during the in-use phase. The measurement must be in compliance with what stated in **EN 16516**: *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor* air31. This European Standard specifies a horizontal reference method for the determination of emissions of regulated dangerous substances from construction products into indoor air. Another key reference standard explaining the methods to be followed for determining the pollutant mass concentration in indoor air is the **ISO 16000-6:2021** - *Indoor air — Part 6: Determination of organic compounds (VVOC, VOC, SVOC) in indoor32*. Concerning the LCI values, the main document to which refer to is the **Agreed EU-LCI values33**, developed by the European Commission, released in December 2021. Since each individual VOC has its own potential toxicity upon exposure to humans, the R value has been developed, trying to translate data from total VOC measurements into potential human health risks. The LCI concept was first developed by the European Collaborative Action on Indoor Air Quality and its Impact on Man when considering the best way to evaluate emissions from solid flooring materials. Nowadays, the European Commission subgroup on EU-LCI values task is to derive and recommend EU-wide harmonized health-based reference values for the assessment of product emissions, based on the

https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-02/UM3_Indicator_4.1_v1.1_37pp.pdf

https://standards.iteh.ai/catalog/standards/cen/858d31b1-10ac-427b-8ac8-f3d8dcf66f58/en-16516-2017

https://www.iso.org/obp/ui#iso:std:iso:16000:-6:ed-3:v1:en

https://ec.europa.eu/growth/sectors/construction/eu-lci-subgroup/eu-lci-values_en

	so-called 'lowest concentration of interest' (LCI) concept[34]. Indeed, the R value normalises each individual VOC concentration against a specific LCI value for that individual VOC. This creates a coefficient for each VOC and, when coefficients for individually identified VOCs in the same sample are totaled together, the overall R value can be generated. An R value >1 would then suggest that the VOC content in indoor air is a concern for human health impacts[35].
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the R value concentration is the building.
Unit of measure	R value is measured as: [decimal ratio].
Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): R value is measured according to what stated in EN 16516 and in ISO 16000-6. Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: - In Use

https://ec.europa.eu/growth/sectors/construction/eu-lci-subgroup_en

Level(s) indicator 4.1: Indoor air quality, European Commission - Joint Research Centre, January 2021.

Reference Standards	R value indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the R value is the **EN 16516** *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*. Another key standard to be referred to, is the **ISO 16000-6:2021** - *Indoor air — Part 6*, this document specifies a method for determination of volatile organic compounds (VOC) in indoor air and in air sampled for the determination of the emission from products or materials used in indoor environments (according to ISO 16000-1) using test chambers and test cells. Concerning the LCI values, the main document to which refer to is the **Agreed EU-LCI values.**
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the R value** during the occupation of the building (in-use phase), the verification of the mass concentration of pollutants in the indoor air is crucial to ensure health safety of building occupants. Those concentration levels must be related to the LCI pollutant related value. For the measurement procedures, make reference to what stated in the description template of total VOCs, CMR VOCs and formaldehyde concentration. **Detailed measurement description.** The Ri value is the ratio of Ci / LCIi where: - Ci is the mass concentration in the air of the reference room; - LCIi is the LCI value of compound i. Accordingly, for the **measurement of the R value** in-use phase, it is necessary to measure the mass concentration of a specific pollutant dividing the value obtained by the LCI pollutant related value.

	Devices used are VOCs detectors and tester pollutant absorbing material.
Comparability of results	Concerning the R value measurement, comparability relies on the reference standard to be used for data assessment and the typology of instrument used (calibration, resolution, etc.). Nevertheless, the R value measurement results are in general only comparable between the buildings of the same state i.e. newly built or in-use without restriction on type, use and location. Comparison of the results between a newly built building and an in-use building is not recommended
Data	• Data source (for calculation) - Not applicable. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation about the relative R value devices (CMR VOCs detectors located on tripod and tester pollutant absorbing material) used to perform the measurement and its sensitivity and accuracy. - Documentation about the duration of the measurement and the external conditions. - Documentation concerning the materials used in indoor environments. - Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if present). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the R value. - Information on the ventilation system (if available in the building).

	- Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the R value: CO1.1.1 – CO1.1.2 – CO1.1.3 – CO1.1.4 – CO1.1.5 – CO1.2.1 – CO1.2.2 – CO1.2.3 – CO 1.2.4 – CO1.2.5 – CO1.2.6.

2.1.16 KPI 16_Formaldehyde concentration

KPI TEMPLATE	
Name of the KPI	Formaldehyde concentration
Description	Formaldehyde was reclassified as a category 1B carcinogen and category 2 mutagen in 2015[36]. It is a commonly used resin in the surface treatment of textile fabrics, as a binder in wood-based panels and in numerous other applications. Upon contact with moisture, formaldehyde resins can break down, releasing continual small quantities of formaldehyde to the indoor air. Formaldehyde is also a VOC but is generally reported separately from other CMR VOCs because of its serious health risk (it is classified as carcinogenic)[37]. Indoor exposure to formaldehyde pollutant through inhalation is a dominant contributor to cause adverse health effects. Due to its serious health risk, as it is classified as carcinogenic, it is necessary to prevent human health from exposure to the contaminant; in that sense, it is preferable the use of low-emitting building materials and products. Preventing exposure to environmental tobacco smoke and other combustion emissions, will minimize exposure-related risk. In addition, ventilation can reduce indoor exposure to formaldehyde. The measurement of formaldehyde concentration must be in compliance with **EN**

[36] Commission Regulation (EU) No 605/2014 of 5 June 2014 amending, for the purposes of introducing hazard and precautionary statements in the Croatian language and its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures. OJ L 167, 6.6.2014, p.36-49.

[37] https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-02/UM3_Indicator_4.1_v1.1_37pp.pdf

	16516: *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*[38]. This European Standard specifies a horizontal reference method for the determination of emissions of regulated dangerous substances from construction products into indoor air. Another key reference standard explaining the methods to be followed for determining the formaldehyde concentration in indoor air is the **ISO 16000-6:2021** - *Indoor air — Part 6: Determination of organic compounds (VVOC, VOC, SVOC) in indoor*[39]. **WHO guidelines**[40] for indoor air quality, is a key document to be referred to, which specifies that indoor air has a special role as a health determinant and that the management of indoor air quality requires approaches different from those used for outdoor air. Another very relevant document to which refer to for establishing limit values for formaldehyde concentration in indoor air, is the **AFSSET**[41], the French agency for health safety of the environment, which has developed a in depth analysis concerning the limit values in indoor air of formaldehyde concentration.
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the formaldehyde concentration is the building.
Unit of measure	Formaldehyde concentration is measured as: [µg/m^3]
Applicability	Certification case: • New building: Not applicable. • Renovated building: Not applicable. • Existing buildings (in use): Formaldehyde is measured according to what stated in EN 16516 and the ISO 16000-6:2021. Reference limit values for formaldehyde concentration in indoor air are indicated within the WHO Guidelines and in the AFSSET document.

[38] https://standards.iteh.ai/catalog/standards/cen/858d31b1-10ac-427b-8ac8-f3d8dcf66f58/en-16516-2017
[39] https://www.iso.org/obp/ui#iso:std:iso:16000:-6:ed-3:v1:en
[40] https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf
[41] https://www.anses.fr/fr/system/files/AIR2004etVG002Ra.pdf

	Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: - In Use
Reference Standards	Formaldehyde concentration indicator is developed in accordance with **Level(s)** (the European framework for sustainable buildings) indicator 4.1: Indoor air quality. The main reference standard for the measurement of the formaldehyde concentration is the **EN 16516** *construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air*. Another key standard to be referred to, is the **ISO 16000-6:2021** - *Indoor air — Part 6*, this document specifies a method for determination of volatile organic compounds (VOC) in indoor air and in air sampled for the determination of the emission from products or materials used in indoor environments (according to ISO 16000-1) using test chambers and test cells. Of course, the reference limit values for formaldehyde concentration in indoor air are indicated within the **WHO Guidelines** and in the **AFSSET document**.
Assessment method	• Calculation process The KPI is only metered. • Measurement process For the **measurement of the formaldehyde concentration** during the occupation of the building (in-use phase), the verification of the formaldehyde concentration must be performed in all the main rooms of the building, in order to be able to ensure the health of the occupants. The measurement could be performed both in case of only natural ventilation and in case of

mechanical ventilation. Since the building is in use, all the variants that may affect the measure must be noticed, as for example: number of occupants, smoking habit, typology of the furniture, etc.
The measures must be performed within the longer permanence rooms and in the main areas of the building. At least 3 measures must be performed in the selected rooms, for a minimum duration of 30 minutes.
To properly conduct the measurement, the absorbing material tester for formaldehyde is located on a tripod, at a height of 1.5 metres. To assess the level of formaldehyde concentration, it must be evaluated the average concentration based on the sum of the individual measurements carried out.
The reference values for the formaldehyde concentration in indoor air are highlighted in the WHO guidelines and in the AFSSET document.

Detailed measurement description.

STEP 1: Calculate the Zm value referred to the building as a whole as the weighted average of the Zi indices by the number of Ni measures that fall within the single Z category index, as follow:

$$Zm = \frac{\sum (Zi \cdot N\,i)}{\sum Ni}$$

Where:
Zi = dimensionless category index of the i-th measure
Ni = number of measurements that fall within each of the Zi category indices

STEP 2: . Compare the average value of the Zm category index with the performance scale benchmarks and assign the score based on the following table:

Average concentration of formaldehyde	Category index of the area Z_{ia}
< 0,010	5
0,010 and 0,030	3
0,030 – 0,050	0
0,050 – 0,100	-1

Comparability of results	Concerning the formaldehyde concentration measurement in indoor air, comparability relies on the reference standard to be used for data assessment and the typology of instrument used (calibration, resolution, etc.).
Data	• Data source (for calculation) - Not applicable. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation about the formaldehyde devices (absorbing material tester for formaldehyde) used to perform the measurement and its sensitivity and accuracy. - Documentation about the duration of the measurement and the external conditions. - Documentation concerning the materials used in indoor environments. - Justification of the used measurement systems, rooms, occupancy and measurement duration. - Documentation about ventilation system (if present). • Data quality (for calculation) - Not applicable. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the formaldehyde concentration. - Information on the ventilation system (if available in the building). - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the formaldehyde concentration: CO1.1.1 – CO1.1.2 – CO1.1.3 – CO1.1.4 – CO1.1.5 – CO1.2.1 – CO1.2.2 – CO1.2.3 – CO 1.2.4 – CO1.2.5 – CO1.2.6.

2.1.17 KPI 17_Operational energy costs

KPI TEMPLATE	
Name of the KPI	Operational energy cost
Description	The indicator measures the economic performance of a building in relation to its energy performance. The operational energy cost equates to the total cost of energy during the operational stage of the building. Operational energy is the energy that is used during the in-use stage of building life cycle for space and water heating, space cooling, lighting, running the equipment and appliances, etc. The aspects of primary energy conversion to final energy are excluded. The starting point to calculate this is based on the actual or simulated amount of the building final energy demand for each usage and fuel type as per the methodology used in the KPI 02 (delivered final energy demand).
Scope	KPI addresses both residential and non-residential buildings
System boundary	The assessment boundary of this is constrained to the total cost of energy occurring during the operational stage of the building as per the definition of Building life cycle stage B6 in the and CEN—EN 15804. This includes thermal and electrical energy for space cooling, heating, lighting, ventilation and auxiliary systems. For new building and under renovation buildings the cost of electrical plug load or any other load that is not included in the calculation of the final energy demand as per the KPI 02 delivered final energy demand are excluded from this calculation
Unit of measure	euros per square metre of useable floor area per year (€/m^2/a)
Applicability	Certification case: • New building: Calculated based on the projected final energy use. The energy use performance assessment must be identical with the one used to assess KPI 02 • Renovated building: Calculated based on the projected energy use. The energy use performance assessment must be identical with the one used to assess KPI 02 • Existing buildings (in use):

	Measured based on the actual final energy use. The energy use performance assessment must be identical with the one used to assess KPI 02 Building use: · Residential · Single house · Multi-apartment · Non residential · Office · School · Retail · Etc. Project stage: · Design · Construction / As Built · In Use
Reference Standards	International Performance Measurement and Verification Protocol (IPMVP), Level(s) indicator 6.1: Life cycle costs
Assessment method	**Calculation method (For new building and under renovation buildings):** 1. Determine the delivered energy demand as described in the KPI 02. The simulated/ calculated total final energy demand of the building will include the final energy end use with a breakdown for each fuel type. 2. Calculate the yearly operational energy costs by multiplying the final energy demand for each fuel type by a representative energy price. 3. Calculate the energy that is locally generated and sold to the grid and subtract the revenue made from the cost 4. Calculate the resulting operational energy costs (normalised) for the building based on the reference floor area by dividing the Annual operational energy costs on the reference floor area. 5. The resulting operational energy cost will be presented in €/(m²·a).

	Measurement approach (Existing buildings (in use)): 1. Determine the delivered final energy for the buildings based on actual or recent (not older than 2 years) metered energy bills. 2. Calculate the yearly operational energy costs by multiplying the final energy demand for each fuel type by the actual energy price. 3. Calculate the energy that is locally generated and sold to the grid based on actual bills that cover the identical time period as the ones used in step 1 and subtract the revenue made from the cost 4. Calculate the operational energy costs (normalised) for the building based on the reference floor area by dividing the Annual operational energy costs (inferred from recent energy bills) on the reference floor area 5. The resulting operational energy cost will be presented in €/(m²·a).
Comparability of results	The comparability of the indicator results is not possible due to the dynamics of fuel prices in each MS , and within each region. The specifics of final energy usage of buildings as per their type and fuel carriers and user behavior. Nevertheless, the results of the indicator can be used to optimize the design decisions and to reduce the building performance gap and indirectly to reduce the building environmental footprint and resources consumption.
Data	• Annual delivered energy by fuel type in kWh.a (projected or measured) • Annual generated energy in kWh.a (projected or measured) • Revenue generated from sold energy in € • Reference floor area in m2 (usable floor area) • Energy prices by fuel type in € (projected or measured) – Eurostat data can be used to estimate the energy price in case the energy prices are not accessible ,

	http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_price_statistics
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the operational energy cost: EQ4.1.2 - EQ4.1.3 - EQ4.1.4 - EQ4.1.5 - EQ4.1.6 - EQ4.1.7 - EQ4.2.2 - EQ4.2.3- EQ4.2.4- EN3.2.5

2.1.18 KPI 18_Smart Readiness Indicator

KPI TEMPLATE	
Name of the KPI	Smart Readiness Indicator (SRI)
Description	The Smart Readiness Indicator for buildings is a composite indicator that intended to measure the technological readiness of the buildings in three main functionalities: 1. **Building:** which refer to the building systems ability to maintain energy efficiency performance and operation of the building through the adaptation of energy consumption 2. **User:** Which describe the systems ability to adapt its operation mode in response to the needs of the occupant, paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and ability to report on energy use. 3. **Grid:** which measure the flexibility of the building systems to participate in active and passive as well as implicit and explicit demand-response, in relation to the grid.
Scope	KPI addresses both residential and non-residential buildings
System boundary	The assessment boundary is the building or the part of a building. The assessed smart-ready services* that the building has or could use are grouped in 9 technical domains: • Heating • Cooling • Domestic Hot water

	• Ventilation • Lighting • Dynamic building envelope • Electricity • Electric vehicle charging • Monitoring and control *Depending on actual availability of the service
Unit of measure	% . the smart readiness score of a building or building unit is expressed as a percentage which represents the ratio between the smart readiness of the building or building unit compared to the maximum smart readiness that it could reach
Applicability	Certification case: · New building: Calculation approach based on the SRI3_calculation-sheet_v4_5 · Renovated building: Calculation approach based on the SRI3_calculation-sheet_v4_5 · Existing buildings (in use): Calculation approach based on the SRI3_calculation-sheet_v4_5 Building use: · Residential · Single house · Multi-apartment · Non residential · Office · School · Retail · Etc. Project stage: · Design · Construction / As Built · In Use
Reference Standards	The method for calculating the SRI is based on the multi-criteria assessment method defined in Commission Delegated Regulation (EU) 2020/2155 .
Assessment method	The Auditor uses Method B with default weighing as defined in the Calculation sheet for SRI assessment method A/B (V4.5). The Auditor assigns the correct functionality level in each smart ready service of the 9 domains based on

	the installed and working systems in the building. The Auditor indicates which systems are actually present in the building based on on-site or virtual inspection of the buildings. The allocation of other user defined domains and systems beyond the ones included by default Method B in is not permitted.
Comparability of results	The comparability of SRI between buildings has several limitations: • The default weighting factors are different depending on the type of building (residential or non-residential) and on the location (climate zone**) • The smart readiness score of a building is a percentage that expresses how close (or far) the building is from maximal smart readiness. But the maximum nominal impact score is not simply the sum of all the impacts of the services listed in the SRI catalogue. It is very likely that due to local and site-specific context some domains and services are not relevant, not applicable or not desirable. The SRI methodology accommodates this by performing a triage process to identify the relevant services for a specific building.
Data	• Building type, building location (climate zone), construction year and useful floor area • Technical building systems that are present in the building • Smart ready services available in the building • Functionality level and surface share/coverage for each smart ready service
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the Smart Readiness Indicator (SRI): EN2.2.3, EN2.1.5, EN2.3.4, EN2.4.5, ID5.2.4, ID5.1.4, MN1.1.5

2.1.19 KPI 19_Summer thermal discomfort in 2030 and 2050

KPI TEMPLATE

Name of the KPI	Summer thermal discomfort in 2030 and 2050
Description	This indicator measures the percentage of the year in which building occupants are not satisfied with the summer thermal conditions within a building based on the climate condition projections for the years 2030 and 2050. Thermal comfort in summer months is guaranteed when the indoor temperature in those spaces or zones that account for >10% of the total useful floor area of a building does not exceed 27°C. In conjunction with this, it is also intended to measure the ability of a building (with and without building services) to meet predefined thermal comfort conditions during the cooling season. The climate is set to change in the future and the heat waves, as well as tropical nights, are expected to become more frequent and sever in the years 2030 and 2050, which can pose a significant health risk to vulnerable groups. Given the longevity of buildings, this indicator is intended to help identify and implement climate adaptation measures that can minimize the risk of overheating and maintain an acceptable degree of thermal comfort in the summer. The indicator follows basically the same methodology as Indicator 9 (Time outside of thermal comfort range), except that it uses projections for future climate in 2030 and 2050 to measure the thermal performance of the building instead of past weather data.
Scope	Both residential and non-residential buildings
System boundary	The performance of the building to keep the indoor temperature below the 27 °C thresholds should be evaluated with or without mechanical cooling. For buildings with full or mixed mechanical cooling, the performance of the building envelope without the operation of these mechanical systems shall be evaluated. This is to evaluate the inherent thermal resistance of the building envelope. The indicator must include the internal operating temperature and the comfort conditions of the users.

	within the building. The specified performance must apply to the rooms or zones that account for more than 10% of the total floor area of the building.
Unit of measure	The percentage of time in which the indoor temperature exceeds 27 °C during the cooling season (summer months).
Applicability	Both residential and non-residential buildings. Project stage: · Design · Construction / As Built · In Use
Reference Standards	• The calculation of the reported performance shall be based on a dynamic energy simulation complying with the ISO EN 52000-1 series. • Overheating assessment that is part of a national calculation method shall be accepted if it is based on a dynamic simulation method similar to one above mentioned standard. • Dynamic simulations shall be performed using weather files for the site or region based on reliable climate projections for 2030 and 2050. • The climate projection modeling must be based on the UN IPCC Mitigation emissions scenario (SRES E1 or RCP 6.0). In all cases, the source of the climate projections and associated weather files for 2030 and 2050 must be clearly stated. ISO 52016-1:2017 Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads
Assessment method	The indicator's objective is to measure the percentage of time in the years 2030 and 2050 in which the indoor temperature exceeds 27 °C during the cooling season (summer months) for every zone in the building that occupies 10% or of the total floor area. The assessor shall be able to: • Document the weather file used • Document the climate projection year, weather file. • Document the evaluated zones in the building. • Document the Mitigation emissions scenario used (SRES E1 or RCP 6.0).

	• Document the used building thermal and physical values. • Document the performance characteristics and operating regimes of the actual or simulated cooling systems. • Document the building the use and occupancy profile used. • Document the length of the cooling period for the years 2030 and 2050 Document the dynamic simulation method used. **Calculation method:** • Select reliable climate projections for 2030 and 2050 based on the UN IPCC mitigation emissions scenario SRES E1 or RCP 6.0, that are intended for the site or region. • Identify whether the national/regional calculation method is dynamic and whether an overheating assessment is also required in order to obtain a building permit. • If the national/regional calculation method is dynamic, this may be used to calculate the time out of range. If not, a dynamic simulation method and the software tool will need to be selected for use. • Determine if default values for the building occupancy and conditions of use patterns are stipulated in a national calculation method, or whether real-life assumptions can be made. • Run the simulation in order to obtain the internal temperatures per hour for a year for each thermal space or zone that accounts for >10% of the total useful floor area of a building. • Calculate the average value of the global building indoor temperature, weighted on the surface areas and the occupancy intensity of the different thermal spaces or zones. • If the simulation does not automatically calculate the time out of range, the result shall be analyzed in order to derive the percentages for the upper and lower temperature bands.

Comparability of results	The results of the indicator are comparable between the buildings that share the same usage, cooling period, and climatic location as long as the same dynamic simulation method and climatic projection weather file are used.
Data	The input data collected by the assessors shall be compliant with the input data required in the ISO EN 52000-1 series. Examples of requested input data are listed below: • Details about building envelope and windows U values and construction method (can be substituted by data from construction year class for existing buildings) • Building openings and orientation • Weather files for the years 2030 and 2050 • Building usage and occupancy profiles as per national definitions for the building type and use • Characteristics of the building cooling and technical systems • External and internal thermal loads • Cooling period as per national definitions Dynamic simulations shall be performed using weather files for the site or region based on reliable climate projections for 2030 and 2050. The climate projection modeling must be based on the UN IPCC Mitigation emissions scenario (SRES E1 or RCP 6.0).
Assessors and auditor' required competences	Listed below the learning outcomes belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the **percentage of time outside of thermal comfort range:** • EN1.1 – Energy Simulation (EN1.1.4, EN1.1.5) • EN3.1 Heating and cooling systems (EN3.1.1, EN3.1.2, EN3.1.3, EN3.1.4, EN3.1.5, EN3.1.7, EN3.1.10, EN3.1.11,) • EN3.2 Ventilation systems (EN3.2.1, EN3.2.2, EN3.2.3, EN3.2.4, EN3.2.5, EN3.2.7, EN3.2.10, EN3.2.11) • EN3.3 Hot water systems (DHW) (EN3.3.1, EN3.3.2, EN3.3.3, EN3.3.4, EN3.3.5, EN3.3.7, EN3.3.10, EN3.3.11) • EN3.4 Electric heating systems (EN3.4.1, EN3.4.2, EN3.4.3, EN3.4.4, EN3.4.5, EN3.4.7, EN3.4.10, EN3.4.11) • EN3.5 Heat pump systems and geothermal energy systems (EN3.5.1, EN3.5.2, EN3.5.3, EN3.5.4, EN3.5.5, EN3.5.7, EN3.5.10, EN3.5.11)

	• EN3.6 Solar thermal energy systems for heating, cooling and DHW (EN3.6.1, EN3.6.2, EN3.6.3, EN3.6.4, EN3.6.5, EN3.6.7, EN3.6.10, EN3.6.11) • EN3.7 Solar power systems for electric generation (EN3.7.1, EN3.7.2, EN3.7.3, EN3.7.4, EN3.7.5, EN3.7.7, EN3.7.10, EN3.7.11) • EN3.8 Combined Heat and Power (CHP) generation (EN3.8.1, EN3.8.2, EN3.8.3, EN3.8.4, EN3.8.5, EN3.8.7, EN3.8.10, EN3.8.11) • EN3.9 Mini wind power generation (EN3.9.1, EN3.9.2, EN3.9.3, EN3.9.4, EN3.9.5, EN3.9.7, EN3.9.10, EN3.9.11) • EN3.10 Energy storage systems (EN3.10.1, EN3.10.2, EN3.10.3, EN3.10.4, EN3.10.5) • EN4.1 Thermal insulation (EN4.1.1, EN4.1.2, EN4.1.3, EN4.1.4, EN4.1.5, EN4.1.9) • EN4.2 Building air tightness (EN4.2.1, EN4.2.2, EN4.2.3, EN4.2.4, EN4.2.5, EN4.2.9) • EN4.3 Window and glazing systems (EN4.3.1, EN4.3.2, EN4.3.3, EN4.3.4, EN4.3.5, EN4.3.9) • EN4.4 Solar shading systems (EN4.4.1, EN4.4.2, EN4.4.3, EN4.4.4, EN4.4.5, EN4.4.9) • EN4.5 Passive systems for cooling and heating (EN4.5.1, EN4.5.2, EN4.5.3, EN4.5.4, EN4.5.5, EN4.5.9) • EN4.6 Energy savings strategies for lighting (EN4.6.1, EN4.6.2, EN4.6.3, EN4.6.4, EN4.6.5) • CO3.2 Indoor lighting (CO3.2.1, CO3.2.2, CO3.2.3, CO3.2.4, CO3.2.5, CO3.2.9) ID5.1 Smart meters (ID5.1.1, ID5.1.2, ID5.1.3, ID5.1.4, ID5.1.7, ID5.1.8)

2.1.20 KPI 20_Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces

KPI TEMPLATE	
Name of the KPI	Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces
Description	This indicator measures the building's readiness for sustainable transport, smart energy management and grid flexibility.
Scope	Both residential and non-residential buildings.

System boundary	The system boundary is set at the building's parking lot respectively the area where the building's users park their vehicles as defined by the building construction permit.
Unit of measure	Percentage of purpose built recharging points in relation to the number of parking spaces in %.
Applicability	Electric vehicles combined with an increased share of renewable electricity production play a crucial role for reducing greenhouse gas emissions and for increasing the efficiency and thus the decarbonisation of the electricity system by providing flexibility, balancing and storage services. The number of available purpose built recharging points is crucial for the establishment of electric vehicles. Electric vehicles park regularly and for long periods, giving the opportunity to recharge. Buildings, especially those where people park for reasons of residence or employment, therefore play a crucial role in providing the necessary infrastructure for re-charging. Moreover, the installation of recharging points at building's parking lots is not only a useful service to the users but can also provide energy storage to the related building.
Reference Standards	Proposal for the EPBD recast: Article 12 defines the amount of recharging points that have to be installed and pre-cabled in new buildings, existing non-residential buildings or buildings undergoing major renovation, depending on the amount of parking spaces and the usage of the building (residential, non-residential, offices,...).
Assessment method	The assessor is to determine the percentage of the parking space that are fitted with purpose built electric recharging spaces to the total amount of parking spaces.
Comparability of results	The ratio of e-car parking spaces to can be compared between the buildings that share the same use and construction status (newly built- in use – major renovation)
Data	Number of parking spaces Number of purpose built electrical recharging spaces

Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces: MO1.1.1 – MO1.1.2 – MO1.1.3 – SE2.2.8

2.1.21 KPI 21_Daylight Provision

KPI TEMPLATE	
Name of the KPI	Daylight Provision

Description	Daylight is strongly favoured by building occupants as a way to adequately illuminate the indoor surfaces, and to save energy for electrical lighting. Daylight can provide significant quantities of light indoors, views and connection to the outside and exposure to sunlight indoors. The daylighting provision is intended as the ratio of time a target illuminance level is achieved across a fraction of the reference plane compared to the duration of daylight time. The main reference standard for daylight provision calculation is the **EN 17037 CEN European Daylight Standard**. This document specifies elements for achieving an impression of lightness indoors and for providing an adequate view out. In addition, recommendations for the duration of sunshine exposure within occupied rooms are given, as well as how to limit glare. It applies to all spaces that may be regularly occupied by people. Concerning the metering of indoor daylight, the reference standard to be taken into account for the measurement in as built and in in use phase is the **UNI 10840** - *Light and lighting*. A specific standard for working places is the **EN 12464-1:2021** - *Light and lighting - Lighting of work places*. Another important reference standard providing key information regarding the devices to be used during the measurement is the **UNI 11142:2004** - *Light and lighting - Portable photometers - Performance characteristics*. Daylight can contribute significantly to the lighting needs of any type of building and accordingly, in improving the energy performance of buildings. This means that daylight openings should have appropriate areas to provide sufficient daylight throughout the year. Moreover, it is not to overlook the fact that light impacts human health and performance by enabling performance of visual tasks, controlling the body's circadian system, affecting mood and perception, and by enabling critical chemical reactions in the body.
Scope	KPI addresses both residential and non-residential buildings.
System boundary	The assessment boundary of the daylight provision is the building (and its exterior

	geometry) and the external environment close to the building.
Unit of measure	Daylight provision is measured as: [%]
Applicability	Certification case: • New building: The daylight provision is calculated in new buildings accordingly to EN 17037. Paragraph 5.1.3 and Annex B, fully describe the two possible calculation methods (method 2 to be preferred). • Renovated building: The daylight provision is calculated in under major renovation buildings accordingly to EN 17037. Paragraph 5.1.3 and Annex B, fully describe the two possible calculation methods (method 2 to be preferred). • Existing buildings (in use): Daylight provision in-situ measurement is measured according to what stated in UNI 10840, EN 12464-1 and UNI 11142. Building use: • Residential · Single house · Multi-apartment • Non residential · Office · School · Retail · Etc. Project stage: · Design · Construction / As Built · In Use
Reference Standards	Daylight provision indicator is developed in accordance with what stated in EN 17037. Indeed, the main reference standard for the calculation of the daylight provision is, actually, the EN 17037 – Daylighting in buildings. The main reference standards for the measurement of the daylight provision are the UNI 10840 and the EN 12464-1 which describe the measurement method for the average daylight factor. Furthermore, the standard UNI

	11142 provides relevant information concerning the instruments to be used for the measurement.
Assessment method	• Calculation process The daylight provision is calculated in new buildings and under major renovation buildings accordingly to EN 17037. Paragraph 5.1.3 fully describes the two possible calculation methods: Method 1) Calculation method using daylight factors on the reference plane. Annex A gives values for target daylight factors (DT) and minimum target daylight factors (DTM) to be achieved depending on the given site. Method 2) Calculation method of illuminance levels on the reference plane using climatic data for the given site and an adequate time step. Annex A gives values for target illuminances and minimum target illuminances to be achieved. Annex B describes recommendations for the daylight calculations using the two methods. • Measurement process During the occupation of the building (in-use phase), the verification of the daylight is fundamental to ensure visual well-being of the occupants. For each main room of the building, it is necessary to evaluate the lighting values identifying several measuring points distributed in the space. Some adjusting must be adopted to obtain an accurate measurement (curtains drawn, obstruction resulting from the furniture, absence of occupants, etc.) At the same time of the indoor measurements, the external values are measured (better in overcast conditions with no direct solar radiation). Having these data, it will be possible to calculate the average daylight factor making a ratio between the average indoor values measured and the average outdoor values. The sensor to be used to conduct measurements is called luxmeter. For external measurement, if necessary, could be used in addition a shadow ring, to create the proper outdoor measurement conditions.

Comparability of results	Concerning the daylight provision calculation, comparability relies on the reference standard to be used for data assessment. For the measurement, comparability relies on the typology of instrument used (class, resolution, etc.) and on the correct time alignment of the indoor and outdoor measurements.
Data	• Data source (for calculation) - Building's orientation; - Internal geometry of the room (partition and surface reflectance); - External geometry of the building (balconies, obstructions, etc.); - Dimension of the vertical façade windows; - Glazing material. • Data source (for measurement) - Documentation of the rooms in which the measurement took place (geometry, exposure, etc.). - Documentation about the occupancy of the measured rooms. - Documentation about devices (luxmeter) used to perform the measurement and its sensitivity, accuracy, resolution, measure range and class. - Documentation about the duration of the measurement and the external conditions. - Documentation concerning the materials used in indoor environments. - Justification of the used measurement systems, rooms, occupancy and measurement duration. • Data quality (for calculation) - The accuracy of the description of the internal geometry of the room. - The accuracy of the external geometry of the building. - The accuracy of the description of the materials used for building construction and also the fit-out materials. • Data quality (for measurement) - The accuracy of the measurement instruments used to measure the daylight provision.

	- Information on the weather external condition. - Information about any possible issue that may affect the final result of the measurement.
Assessors and auditor' required competences	Listed below the LOs belonging to the CW 17939:2022 of TRAIN4SUSTAIN for the daylight provision: EN4.3.1 – EN4.3.2 - EN4.3.3 - EN4.3.4 - EN4.3.5 - EN4.4.1 - EN4.4.2 - EN4.4.3 - EN4.4.5 - EN4.6.1 - EN4.6.2 - EN4.6.3 - EN4.6.4 - EN4.6.5 – CO3.1.1 - CO3.1.2 - CO3.1.3 - CO3.1.4 - CO3.1.5 - CO3.1.10 – CO3.2.1 - CO3.2.2 - CO3.2.3 - CO3.2.4 - CO3.2.10.

2.2 KPIs Assessment Report

The KPI assessment report is a technical document prepared by the assessor in the EUB SuperHub certification process, it reports the value of the KPIs and contains all the supporting information for the assessment.

It is made up of two different documents:

- Building data: a document which organises and collects the necessary formal documentation to activate an EUB building certification process. Data refers to the building, to the client who requires the activation of the EUB building certification process and of the assessor in charge of the evaluation.
- KPI reporting format: it organises and collects the necessary documentation to properly perform the calculation or measurement of a specific KPI. The content of the KPI reporting format is different for each KPI.

2.2.1 Building data

The building data document organises and collects the necessary documentation to activate an EUB building certification process. Indeed, it contains the main information related to the building to be assessed, the main data both of the client and the assessor and, of course, the main key documents useful to perform the building certification.

This building information reporting format is also an easy way for data retrieval and organisation.

Much information listed in the building reporting format are available in the EUB SuperHub DBL; the interlinking with those tools is an added value to speed up building data collection and for gathering information on the actors involved in the certification processes.

BUILDING DATA	
Building code	
Building name/ project denomination	
Building address	
Type of intervention	
CLIENT DATA	
Name of the client	
Contact person	
Phone number and e-mail address	
ASSESSOR DATA	
Name of the technical expert	
Contact person	
Phone number and e-mail address	

Table 19: Building data

2.2.2 KPI reporting format

The KPI reporting format is contained in the KPI assessment report, it organises and collects the necessary documentation to properly perform the calculation or measurement of a specific KPI. Indeed, it contains the main information and the key documents required to proceed in the assessment of the KPI.

It's important to underline the fact that the KPI reporting format is specific to each KPI because each indicator requires different data and documentation to be calculated. For each KPI a specific reporting format is provided.

Below, an example of the content included in the KPI reporting format of the KPI 1_Total annual primary energy demand per useful floor area.

KPI 1

KPI REPORTING FORMAT	
KPI 1_Delivered annual final energy demand per useful floor area	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting).

	➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation.
Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh, - list of all services (EPB and non-EPB services) that each measured energy carrier covers.

KPI 2

KPI REPORTING FORMAT	
KPI 2_Total annual primary energy demand per useful floor area	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation. ➢ Total primary energy factors at national level.
Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh,

	- list of all services (EPB and non-EPB services) that each measured energy carrier covers.

KPI 3

KPI REPORTING FORMAT	
KPI 3_Non-renewable annual primary energy demand per useful floor area	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation. ➢ Non-renewable primary energy factors at national level.
Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh, - list of all services (EPB and non-EPB services) that each measured energy carrier covers.

KPI 4

KPI REPORTING FORMAT	
KPI 4_Embodied energy	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation ➢ List of building elements, services and phases considered ➢ Reference Study Period (RSP is usually 50 years) ➢ Lifespan of each product or element ➢ Bill of Quantities for building elements

	➢ Bill of Materials (if method 1 is used) ➢ % of completeness of building description (in mass) ➢ Name of database used for EPDs or embodied energy coefficient (+ URL) ➢ Data quality characteristics of the database ➢ Embodied energy coefficient per building element, family of products or per material ➢ Embodied energy of the building per life cycle module, per m^2 of useful floor area ➢ Aggregated embodied energy for the whole building on its RSP, per m^2 of useful floor area.
Measured values	N/A

KPI 5

KPI REPORTING FORMAT	
KPI 5_Renewable annual primary energy demand per useful floor area	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation. ➢ Renewable primary energy factors at national level.
Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh, - list of all services (EPB and non-EPB services) that each measured energy carrier covers.

KPI 6

KPI REPORTING FORMAT	
KPI 6_Renewable energy ratio	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation. ➢ Total primary energy factors at national level. ➢ Renewable primary energy factors at national level. ➢ Perimeter choice (on-site, nearby, distant).
Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh, - list of all services (EPB and non-EPB services) that each measured energy carrier covers.

KPI 7

KPI REPORTING FORMAT	
KPI 7_Annual use stage energy-related Global Warming Potential (GWP)	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). ➢ Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation. ➢ Emission factors for energy carriers

Measured values	➢ Technical specification of the meters (electricity meter, gas flow meter, fuel flow meter, calorimeter, etc.) used to measure delivered energy to the building site for each energy carrier. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising: - values of each measured energy carrier expressed in measured units (e.g., Litres, m^3, kg, etc.), - calorific value (gross or net) of fuel used for calculating delivered energy expressed in kWh, - values of each energy carrier expressed in kWh, list of all services (EPB and non-EPB services) that each measured energy carrier covers. Emission factors for energy carriers

KPI 8

KPI REPORTING FORMAT	
KPI 8_Life Cycle Global Warming Potential (GWP)	
Calculated values	➢ Name of standard/s used for calculation ➢ Name of LCA software tool used for calculation ➢ List of building elements (and % of completeness of building description in mass), services and phases considered ➢ Reference Study Period (RSP is usually 50 years) ➢ Bill of quantities for building elements or materials ➢ Lifespan of each product or element ➢ EPDs corresponding to products or Generic/default data used if specific EPDs are missing (so as to avoid empty boxes) ➢ Final energy consumption per energy carrier (in use phase) ➢ Water consumption (in use phase) ➢ Emission factors for energy carriers and for water ➢ Global warming potential per building element or material ➢ Global warming potential of the building per life cycle module and per family of products, per m2 of useful floor area ➢ Aggregated Global warming potential for the whole building on its RSP (usually 50 years)
Measured values	N/A

KPI 9

KPI REPORTING FORMAT	
KPI 9_Time outside of thermal comfort range	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool or dynamic simulation method used for calculation. ➢ Indication of the evaluated zones in the building ➢ Building thermal and physical values ➢ List of building heating or cooling systems considered. ➢ Building's use and occupancy profile used
Measured values	N/A

KPI 10

KPI REPORTING FORMAT	
KPI 10_Ventilation rate	
Calculated values	➢ Reason for the eventual inapplicability of the criterion. ➢ Graphic drawings of the building with indication of the main rooms verified. The necessary documentation to be included: - plans of each floor of the building with indication of the geometric dimensions of the main rooms subject to verification (assign an identification code to each room); for each main room, report the position of the system terminals; - abacus of the system input/output terminals. ➢ Occupation schedule for each building zone. ➢ Calculation table indicating the total design ventilation air flow rate for each room and the supply air flow per person.
Measured values	➢ Technical specification of the instruments (anemometer, flow hood, fan anemometer, etc.) used to perform the measurements. ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising measured values.

KPI 11

KPI REPORTING FORMAT	
KPI 11_CO_2 concentration	
Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (carbon dioxide detector. etc.) used to perform the measurements. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising measured values.

KPI 12

KPI REPORTING FORMAT	
KPI 12_Relative Humidity	
Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (hygrometric sensors, psychrometric, dew point, capacitive type) used to perform the measurements. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Measurement report summarising measured values.

KPI 13

KPI REPORTING FORMAT
KPI 13_Total VOCs

Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (VOCs detectors and tester pollutant absorbing material) used to perform the measurements. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Indication concerning the occupation of the building. ➢ Duration of the measurements. ➢ Measurement report summarising measured values.

KPI 14

KPI REPORTING FORMAT	
KPI 14_CMR VOCs concentration	
Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (VOCs detectors and tester pollutant absorbing material) used to perform the measurements. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Indication concerning the occupation of the building. ➢ Information about smoking habit of the occupants, typology of the furniture, materials used in indoor area, etc. ➢ Duration of the measurements. ➢ Measurement report summarising measured values.

KPI 15

KPI REPORTING FORMAT

KPI 15_R value	
Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (VOCs detectors and tester pollutant absorbing material) used to perform the measurements. Check their calibration, resolution, etc. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Indication concerning the occupation of the building. ➢ Measurement report summarising measured values.

KPI 16

KPI REPORTING FORMAT	
KPI 16_Formaldehyde concentration	
Calculated values	➢ The KPI is only measured.
Measured values	➢ Technical specification of the instruments (absorbing material tester for formaldehyde) used to perform the measurements. ➢ Information about the mechanical ventilation installed in the building (if present) ➢ Boundary conditions that may have affected the measurements. ➢ Indication concerning the occupation of the building. ➢ Information about smoking habit of the occupants, typology of the furniture, materials used in indoor area, etc. ➢ Duration of the measurements. ➢ Measurement report summarising measured values.

KPI 17

KPI REPORTING FORMAT	
KPI 17_Operational energy costs	
Calculated values	➢ Name of the database, source used for estimating the energy prices by fuel type in € ➢ Name of standard/s used for calculating the EPC. ➢ Name of software tool used for calculation. ➢ List of building services (EPB services) considered (e.g., heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting). ➢ Subtype of calculated (asses) assessment method used (e.g., design, as built or tailored). Boundary conditions of use (e.g., usage and operating times, internal set-point temperature for heating/cooling operation, energy need for DHW supply) used in calculation.
Measured values	➢ Invoices from energy provider of at least 12 consecutive calendar months showing the metered imported and exported energy values Or ➢ Automatic reading from smart meters, covering all imported and exported energy (thermal and electrical) ➢ Name of the database, source used for estimating the energy prices by fuel type in €

KPI 18

KPI REPORTING FORMAT	
KPI 18_Smart Readiness Indicator	
Calculated values	➢ Technical information about all the relevant Building Automation and Control Systems (BACS) and other smart systems installed in the building that are declared in the SRI3 calculation-sheet v4_5. ➢ Building EU climate zone and use type based on the EPC. ➢ A filled out SRI3 calculation-sheet v4_5.
Measured values	➢ The KPI is only calculated.

KPI 19

KPI REPORTING FORMAT	
KPI 19_Summer thermal discomfort in 2030 and 2050	
Calculated values	➢ Name of standard/s used for calculation. ➢ Name of software tool or dynamic simulation method used for calculation. ➢ Indication of the evaluated zones in the building ➢ Indication of the climate projection year, Mitigation emission scenario and weather file used ➢ Building thermal and physical values ➢ Building cooling systems considered Building's use and occupancy profile used, and the length of the cooling period.
Measured values	N/A

KPI 20

KPI REPORTING FORMAT	
KPI 20_Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces	
Calculated values	➢ Number of parking spaces at the design stage ➢ Number of purpose built electrical recharging spaces at the design stage
Measured values	➢ Number of existing parking spaces ➢ Number of existing purpose built electrical recharging spaces

KPI 21

KPI REPORTING FORMAT	
KPI 21_Daylight Provision	
Calculated values	➢ Climatic data used to perform the calculation. ➢ Name of software tool used for calculation. ➢ Geometry of the building and the information about the geometry of the windows. ➢ Presence of mobile or fixed solar screens. ➢ Calculation table.

Measured values	➢ Technical specification of the instruments (luxmeter) used to perform the indoor measurements. ➢ Technical specification of the instruments (shadow ring, to create the proper outdoor measurement conditions) used to perform the outdoor measurements. ➢ Outdoor climate conditions. ➢ Indicate the measuring points distributed in the space. ➢ Indicate all the elements that may affect the accuracy of the measurement (curtains drawn, obstruction resulting from the furniture, presence of occupants, etc.) ➢ Boundary conditions that may have affected the measurements. ➢ Indication concerning the occupation of the building. ➢ Measurement report summarising measured values.

3 ROADMAP for the implementation of EUB SuperHub certification scheme

In chapter 1 the EUB SuperHub building certification process has been deeply detailed by defining all the elements useful to assure the quality and reliability of the EUB e-Passport (representing the final output of the certification process). Then, in chapter 2 a guideline on the EUB SuperHub Key Performance Indicators, the assessment methodologies and the reporting format are described, in order to ensure the highest comparability of certification results across Europe. Chapter 3 represents the conjunction element for the implementation of the EUB SuperHub building certification scheme across EU. Indeed, this section describes the roadmap for the implementation, managing, testing, verification and monitoring of the EUB SuperHub certification scheme within the European Union.

The approach adopted by EUB SuperHub project is based on the "Market study for a voluntary common European Union certification scheme for the energy performance of non-residential buildings[42]" report, produced by the DG Energy (ENER) of the EC.

Of course, the process has been adapted to the specificities of the EUB SuperHub project and contextualised to the specific requirements.

3.1 ROADMAP towards Next Gen EPCs

The roadmap for the implementation of EUB SuperHub certification scheme followed by the project consortium, is **articulated into four main group of tasks**, listed below:

- Ownership and management
- EUB SuperHub scheme management
- Implementation of the EUB SuperHub certification
- Verification, monitoring and surveillance.

In the following subparagraphs the sub tasks of each of the four group of tasks are detailed, including the description of the activity and the related task owner.

3.1.1 Ownership and management

The first groups of tasks concern:

- the establishment of the EUB SuperHub scheme owner at EU level;
- the organisation of a framework to manage the activities performed by the scheme owner.

[42] https://energy.ec.europa.eu/system/files/2014-12/Final%2520report%2520-%2520Building%2520Certification%2520Schemes%2520-%2520FINAL%252026112014_0.pdf

Initially the role of **EUB SuperHub scheme manager** will be taken by the EUB SuperHub consortium. Later this role could be taken by national/regional authorities in charge of EPCs.

SUB-TASK	DESCRIPTION	TASK OWNER
Set up of the EUB SuperHub scheme manager	The interested partners of the EUB SuperHub consortium will sign an MOU establishing the subject that will assume the role of scheme manager at EU level. At the same time a EUB SuperHub Management Board will be set up.	EUB SuperHub Consortium
Areas of activity, staffing and assignment of roles	The Management Board will organise the main areas of activities appointing a responsible for each of them: - *Technical area*: in charge of maintaining/updating the EUB SuperHub Platform, e-Passport and EUB SuperHub KPIs, organisation of training activities for assessors and auditors. - *Marketing and Communication area*: in charge of the promotion of the EUB SuperHub certification and label, development of communication strategies, positioning of the scheme within the market. - *Finance and administration area*: in charge of contracts and other administrative tasks. - *Certification and labelling area:* in charge of: ✓ implementation, verification, quality assurance of the certification process. ✓ management of the e-Passports registry. ✓ accreditation of certification bodies and auditors.	Management Board

Table 20: ROADMAP: Ownership and management

3.1.2 EUB SuperHub scheme management

Text This group of tasks deals with the set-up of a light physical centre supported by the online EUB SuperHub Platform to perform the tasks of the 4 areas of activities defined above.

SUB-TASK	DESCRIPTION	TASK OWNER
Set up of a Light Physical Centre and staffing	Set-up of a light physical centre to support the tasks of the 4 Areas of Activity. The contact point will be hosted by one of the EUB SuperHub PPs. Appointment of a Director and technical secretariat by the Management Board.	Management Board
Organisation of different parties	The light physical centre will act as general communication contact point for the public, professionals, auditors, certification bodies, public authorities, private clients.	Light physical centre
Link to other physical centres of mandatory EPC	The physical centre will contact similar centres in EU dealing with the mandatory EPC scheme. This will allow the creation of synergies with governing structures of existing national and internationally operating schemes.	Light physical centre
Link to other online platforms and databases	The physical centre will explore ways to connect the EUB SuperHub online platform to other certification platforms and databases.	Light physical centre
Technical area	The light physical centre will support the responsible of the technical area in performing its tasks and will organise working groups if and when necessary (e.g., update of KPIs, etc.). The light physical centre will be the focal point for the maintenance of the EUB SuperHub online platform and data management.	Light physical centre

Marketing and Communication area	The light physical centre will support the responsible of the marketing and communication area and will be the focal point for distribution and communication of strategies.	Light physical centre
Certification and labelling area	The light physical centre will support the responsible of the certification and labelling area. The light physical centre will be the focal point for the quality assurance of the certification process and will manage the e-Passport registry.	Light physical centre
Finance and administration area	The light physical centre will support the responsible for finance and administration in performing the day-by-day tasks.	Light physical centre

Table 21: ROADMAP: EUB SuperHub scheme management

3.1.3 Implementation of the EUB SuperHub certification

These tasks concern the implementation of the EUB SuperHub certification process.

SUB-TASK	DESCRIPTION	TASK OWNER
Design of accreditation process for certification bodies	The process to accredit certification bodies to issue e-Passports will be designed in accordance with relevant existing standards (e.g., ISO).	Light physical centre - Certification and labelling area
Establish link to certification bodies	The Light physical centre will establish a link to certification bodies to identify suitable institutions to carry out the EUB SuperHub certification.	Light physical centre - Certification and labelling area
Accreditation of certification bodies	Certification bodies will be accredited to issue the EUB SuperHub e-Passport.	Light physical centre - Certification and labelling area

Training design and accreditation of assessors and auditors	Design of the qualification and accreditation process for assessors and auditors.	Light physical centre - Certification and labelling area
Set up of Registries	The Registers for e-Passports, accredited certification bodies, accredited auditors and qualified assessors are set up on the EUB SuperHub Platform.	Light physical centre - Certification and labelling area
Training of assessors and auditors	Within the implementation phase the previously designed training will need to be carried out. Courses, trainers and training facilities will also need to be identified.	Light physical centre - Technical area
Accreditation of auditors	Auditors will be accredited to issue the EUB SuperHub e-Passport and inserted in the Auditors' Registry.	Light physical centre - Certification and labelling area
Qualification of assessors	Assessors will be qualified and integrated in the Assessors' Registry.	Light physical centre - Certification and labelling area
Raise awareness	The carrying out of marketing campaigns and informing the public and stakeholders of the existence of the EUB SuperHub certification process.	Light physical centre – Marketing and Communication
Collect, review and disseminate data	In order to understand and improve the scheme during and after the starting phase, data will need to be collected, reviewed and disseminated.	Light physical centre - Certification and labelling area

Table 22: ROADMAP: Implementation of the EUB SuperHub certification

3.1.4 Verification, monitoring and surveillance

After the start phase, a verification, monitoring and surveillance process will be maintained over time.

SUB-TASK	DESCRIPTION	TASK OWNER

Verification and surveillance	The setting up of a verification and surveillance system to ensure quality of the process	Light physical centre
Electronic screening	Statistical screening of the data in the Registry of e-Passports to locate and assess the statistical outliers	Light physical centre - Certification and labelling area
Desktop control	A small percentage (e.g., 5%) of the e-Passports are taken randomly from the Registry and checked to assess whether general information is correct. Defective labels can be selected for technical auditing	Light physical centre - Certification and labelling area
Technical auditing	Field control of a small percentage (e.g., 0.5%) of the reported e-Passports. This is done on the premises by a technical auditor. The auditor carries out a new assessment and compares it to the audited one.	Light physical centre - Certification and labelling area
Periodic review of technical standards	Regular updates of the EUB SuperHub technical standards (e.g., assessment methods of KPIs) related to the issue of new documents and regulations.	Light physical centre - Technical area

Table 23: ROADMAP: Verification, monitoring and surveillance

4 Conclusion

Throughout the development of the EUB SuperHub project, the activity of Task 2.5 experienced an synergic progress moment together with the activity of the CWA on the KPIs, starting from the kick-off meeting of the CEN workshop hosted in Brussels, on April 28th. With a synergistic effort for the achievement of the qualitative excellence of the KPIs description, Task 2.5 has been nourished by the CWA progresses on KPIs extensive analysis which has improved the final result quality. The activity of the CWA will last still many months and the results achieved in D2.5 can be considered, somehow, the starting point for the qualitative improvement of the KPIs description, related to the next generation EPCs.

With the same rationale of improving final quality results of D2.5, LAT meetings helped a lot in adopting a bottom-up approach for the definition of many key aspects included in the deliverable, above all the certification processes. Feedbacks, emerged from the stakeholders involved during the local meetings, have been taken into account for the elaboration of this document.

The deliverable D2.5 inherited the result of Task 2.2 (D2.2) and provide, to the CWA activity, a complete and accurate document which can be further improved thanks to CWA meetings with qualified stakeholders.

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