WP5
Task 5.2
Training the user groups and professional

Training Material

Date: Jan 2024

Ahmed Khoja
Hochschule München University of Applied Sciences

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

The EUB Super Hub Training and E-Passport

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T5.2 Training the user groups and professional

Objective

- To deepen technical aspects related to building performance indicators, focusing on a set of key performance indicators (KPIs) developed in the EUB SuperHub project.

- These indicators are intended to become a recognized pre-standard at the European level (CEN Workshop Agreement) to standardize and compare building certification processes across Europe

- The training is meant to enable the professionals implementing the EUB certification process in their country and to familiarize them on how to issue the new E-Passport

- To provide a common training curriculum, to facilitate the transition toward a standardize building certification processes across Europe.

- To enable the participants to apply the EUB SuperHUB system of indicators and to updating their skills in relation to new European requirements for energy, sustainability and smart building certification

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T5.2 Training the user groups and professional

EUB SuperHub

Target Audience

- The courses is aimed at professionals and other active actors and multipliers in the field of energy performance and sustainability assessment of buildings

Participation Certificate

- In accordance with CWA 17939/2022 (CEN Workshop Agreement) of CEN (European Committee for Standardization), the skills acquired will be certified through the European competence qualification system TRAIN4SUSTAIN
- Participants will be able to register on the ESR (European Skill Registry) portal and map their skills through the European Skills Passport

Participation Cost

- The course is free of charge

Information and Registration

- For more information and to register, contact the local Training Secretariat (Peter Gyuris - Geonardo Ltd.)

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T5.2 Training the user groups and professional

Structure, Duration, and Methodology

- The training program is structured in 5 module. The trainee will get access to other supplementary materials via the E-training platform
- Participants will be provided with localized explanatory sheets, calculation tools for EUB SuperHub indicators, and access to the IT platform
- The training session are meant to be interactive and held in person or online, recorded session might be available subject to PPs requirement

Module 1	Module 2	Module 3	Module 4	Module 5
Intro to the EUB SuperHub project and Next Generation Energy Certification	EUB SuperHub platform and EUB SuperHub digital building logbook	Thermal Comfort, Indoor Air Quality, Resilience to overheating and Daylight Sufficiency	Energy consumption, Renewable energy, GHG emissions and Costs	Smart buildings and E-mobility

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EUB SuperHub

Module 1
Introduction to the EUB SuperHub, E-Passport and Next Generation Energy Certification

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Contents

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1 – The EUB Super HuB Project

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EUB SuperHub: **Eu**ropean **B**uilding **Su**stainability **P**erformance and **E**nergy Cert**i**fication **Hub**

- **Duration:** 1 June 2021 - 31 May 2024 (36 Month)
- **Overall budget:** € 1 982 750
- **EU contribution** € 1 982 750
- **Coordinated by:** GEONARDO ENVIRONMENTAL TECHNOLOGIES LTD
- **Funding scheme:** Coordination and support actions (CSA)
- **Topic(s):** LC SC3 B4E 4 2020 – Topic on next Generation of Energy Performance and Certification

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We contribute to a sustainable world while addressing the EU market needs

By concentrating all factual information on buildings in one place, the user can easily track their carbon footprint and close the performance gap.

Energy Performance Certificates (EPC), Sustainability and SRI Ratings

We will create holistic, interoperable and transparent EPCs which will directly feed into the e-Passports.

E-Passports

Supported by the information located on the Digital Building Logbook, e-Passports will allow people to check the status of buildings in no time.

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Objectives of the EuB SuperHub project

Energy Performance Assessments and Certificates should integrate the increasing availability of data during the operation of buildings, new technologies (smart buildings), life cycle thinking (LCA, whole life costing...), carbon footprint management, societal needs, all of which interact with energy efficiency and associated investments.

The objective is to harmonize, improve, extend and make reliable the Energy Performance Certificates in Europe (EPC), and to create tools such as a database and a "one-stop shop" web platform to federate, promote and facilitate the development of these new EPCs among the different types of actors. Application to buildings and neighborhoods (planning scale). Training and communication complete this project.

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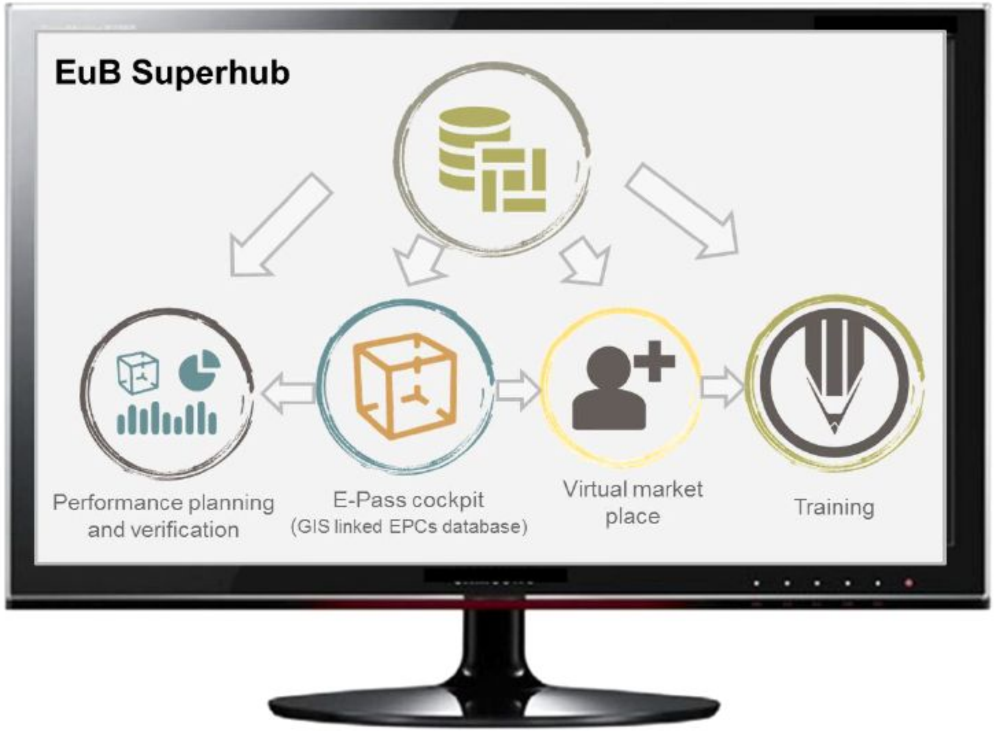
OBJECTIVES

- Development of a **common European framework** based on the European Voluntary Certification Scheme (EVCS), and the Smart Readiness Indicator (SRI)
- Creation of a **database of information and characteristics of buildings (digital logbook)** for market players, after identifying a methodology for collecting heterogeneous data
- Establishment of a **digital one-stop shop** where it is possible to find assessment systems, local databases and guides that will improve the confidence and transparency of EPC
- Production and presentation of **case studies** in the different countries, considering different building types, climatic conditions and field practices



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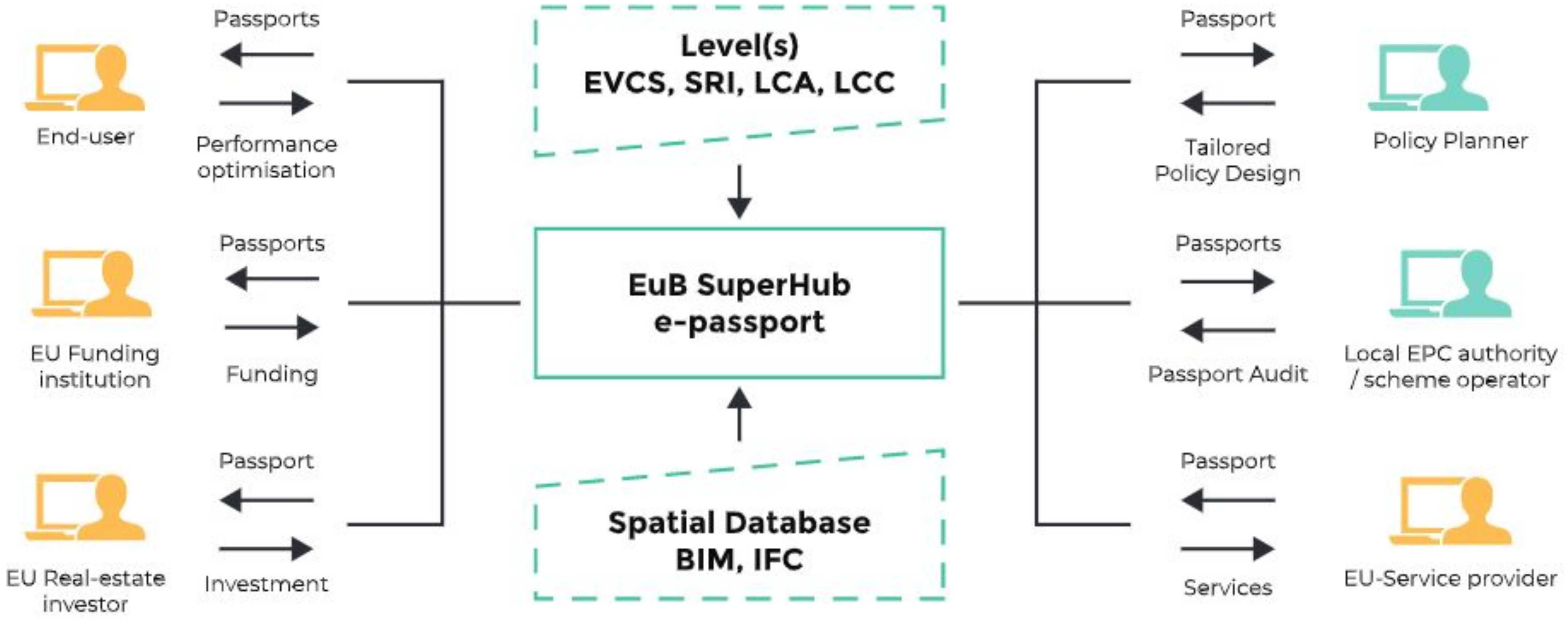
Key aspects of EUB SuperHub and role of actors



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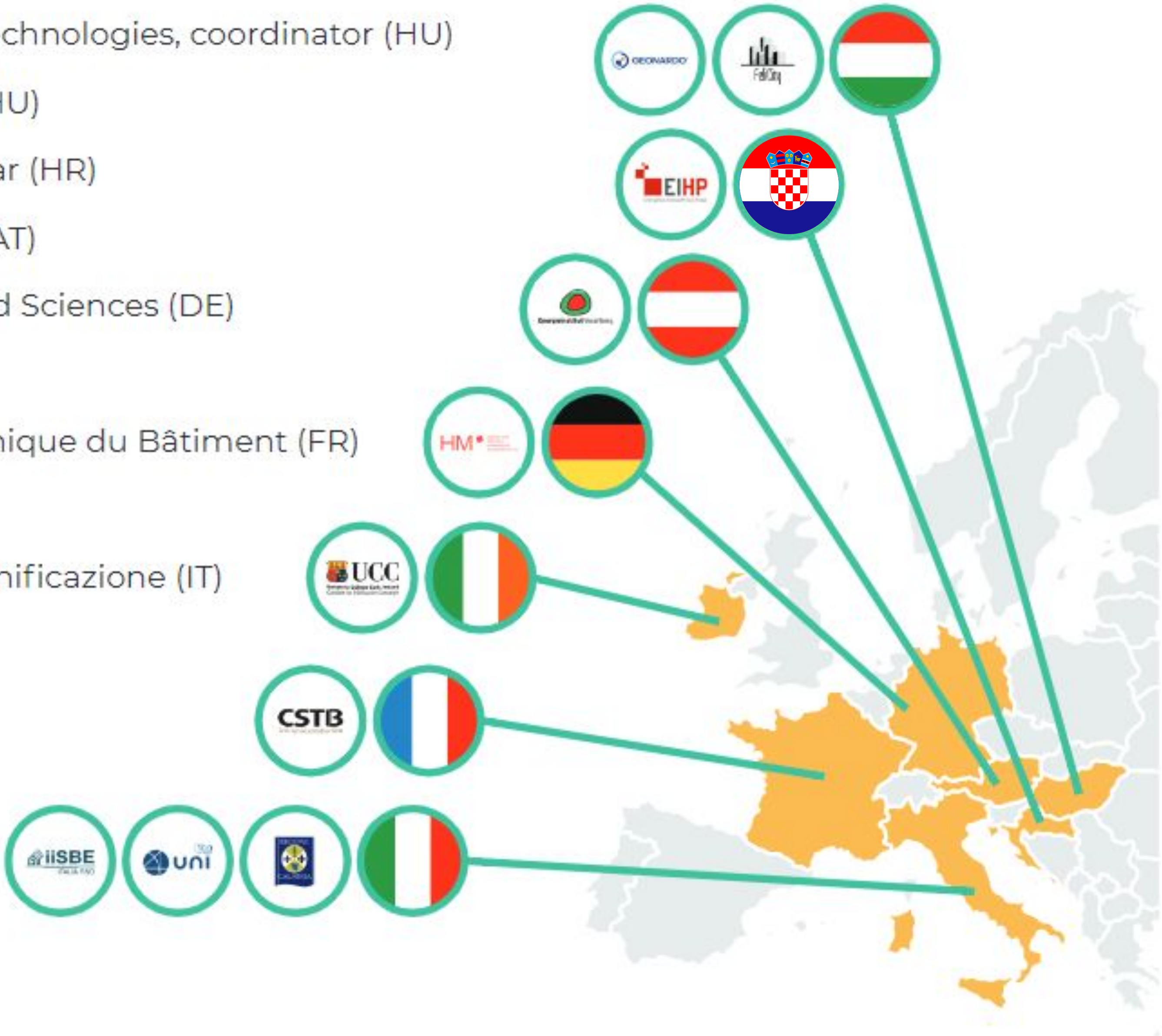
EUB SUPERHUB IDENTITY CARD

10 partners covering 7 countries

EUB SuperHub

- Geonardo Environmental Technologies, coordinator (HU)
- Felicity Tools Engineering (HU)
- Energy Institute Hrvoje Pozar (HR)
- Energieinstitut Vorarlberg (AT)
- Munich University of Applied Sciences (DE)
- University College Cork (IE)
- Centre Scientifique et Technique du Bâtiment (FR)
- iiSBE Italia R&D (IT)
- Ente Nazionale Italiano di Unificazione (IT)
- Regione Calabria (IT)



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2 - EUB SuperHub web platform

One-stop shop features and Virtual Market place

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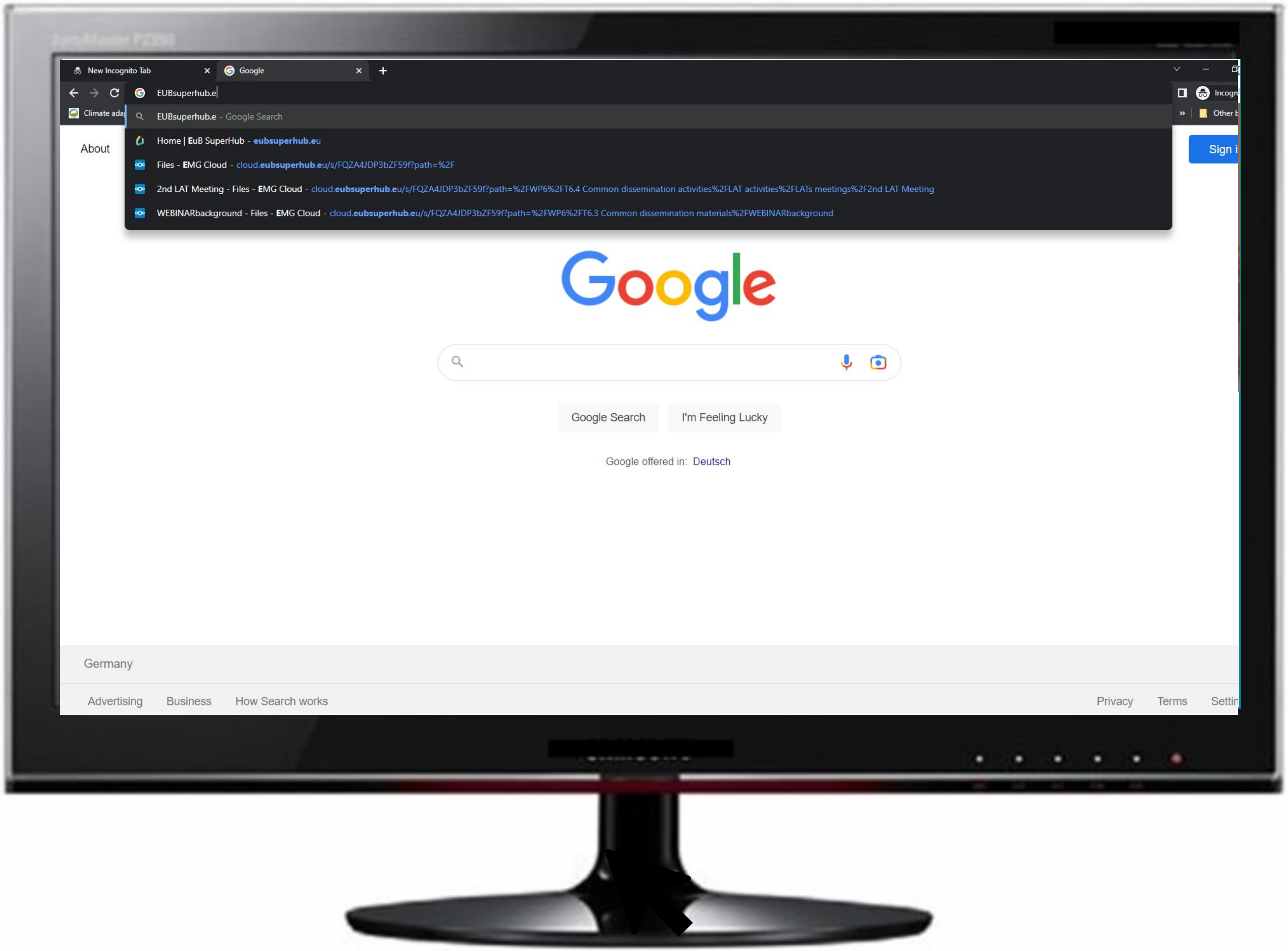

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E-Cockpit

The E-cockpit module is a multi-scale cloud- based geo referenced interactive database that will tie the EPCs information, sustainability and smartness rating with the building geometry and BIM model in the geo referenced database that :

A. Link the local EPCs (where possible)
B. All users can access and view the published information
C. Allow to share and publish building certificates (LCA, SRI, LCC, IAQ, ratings) from the PVT
D. Common harmonized KPIs (EU-Passport)
E. E-cockpit outputs can be aggregated for portfolio of buildings or district for city wide assessment (energy heat maps, urban mining maps, renovation maps, smartness maps, etc).

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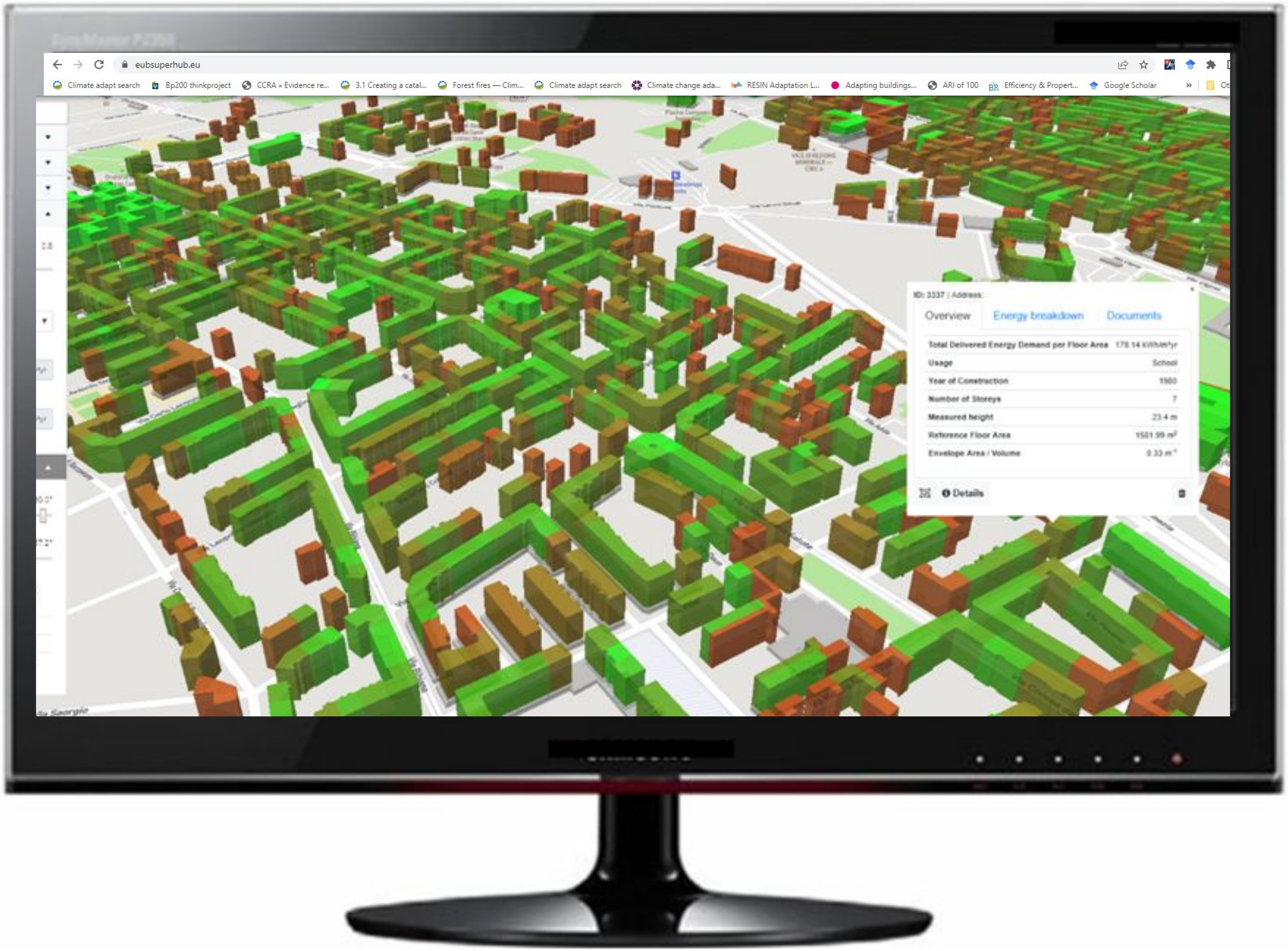
E-cockpit

EUB SuperHub



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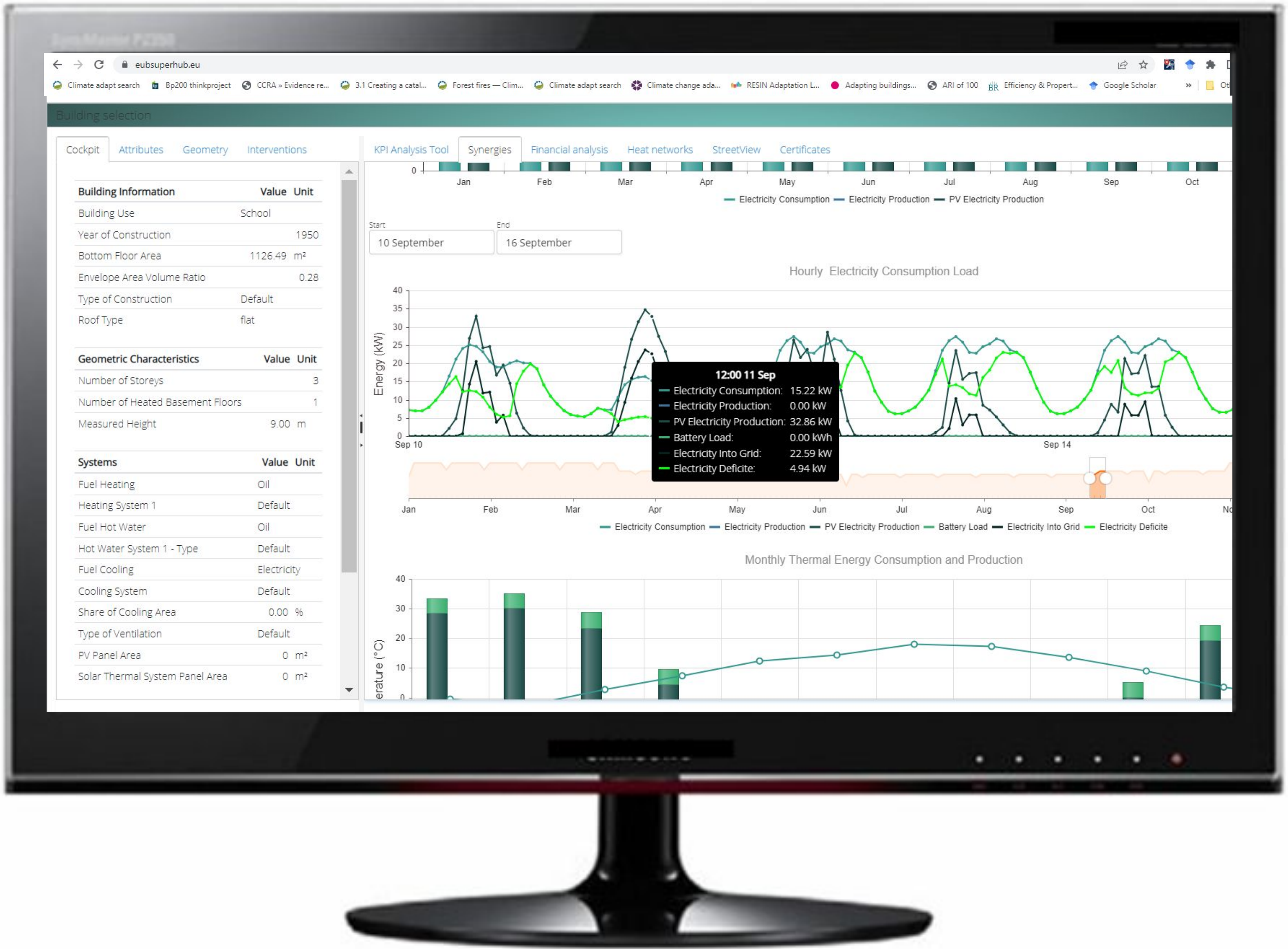
E-cockpit

EUB SuperHub



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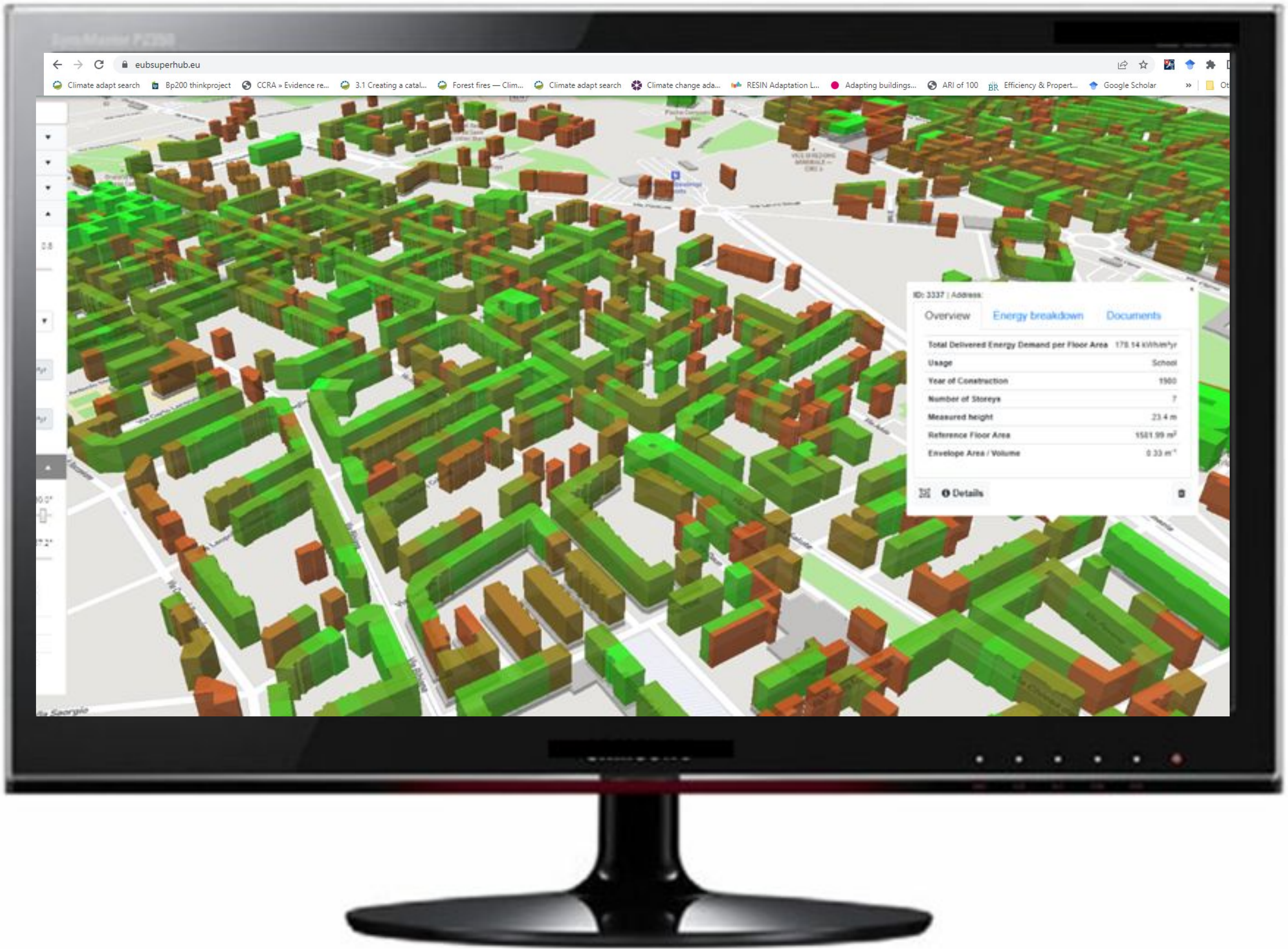
E-cockpit

EUB SuperHub



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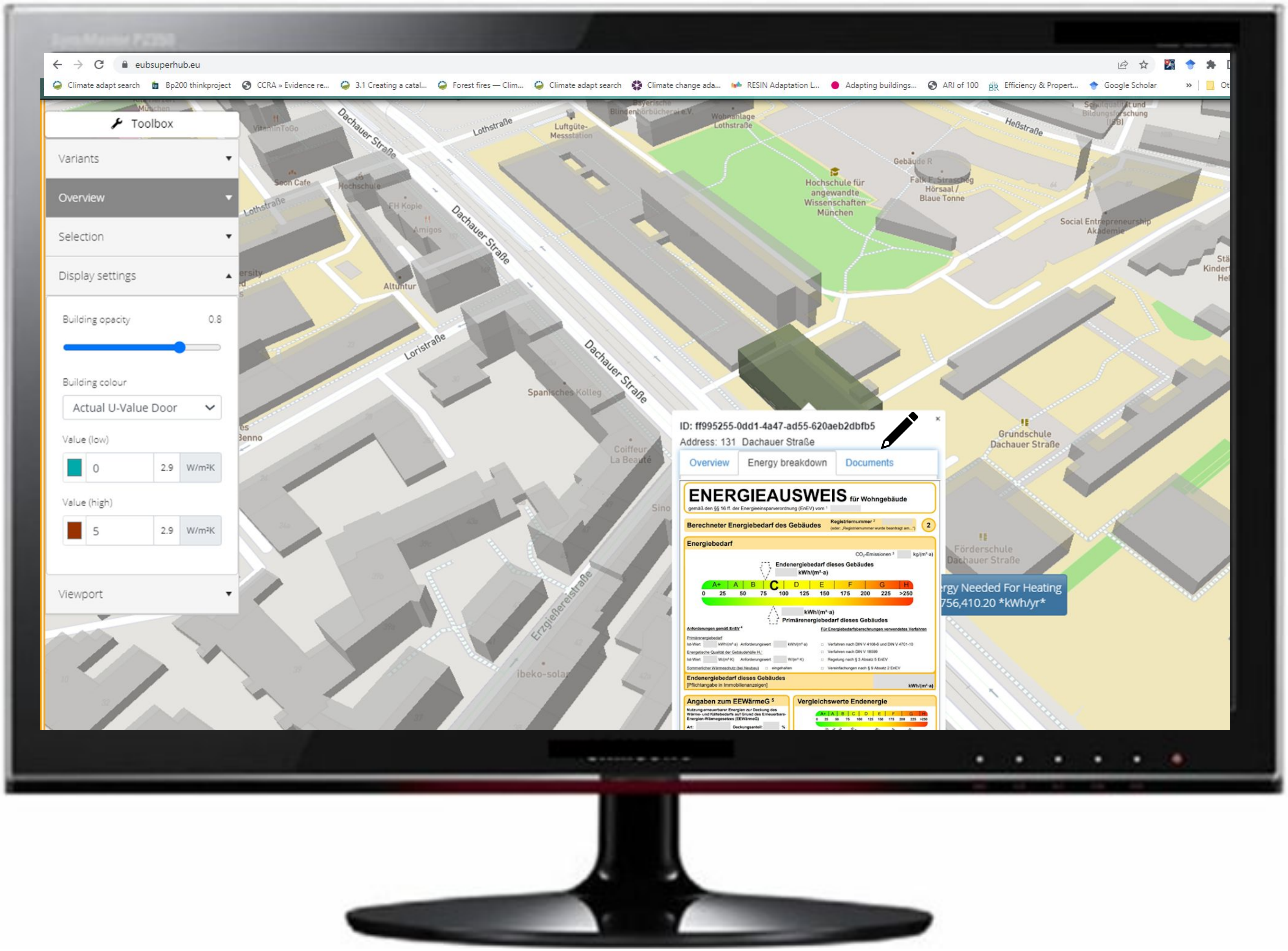
E-cockpit

EUB SuperHub



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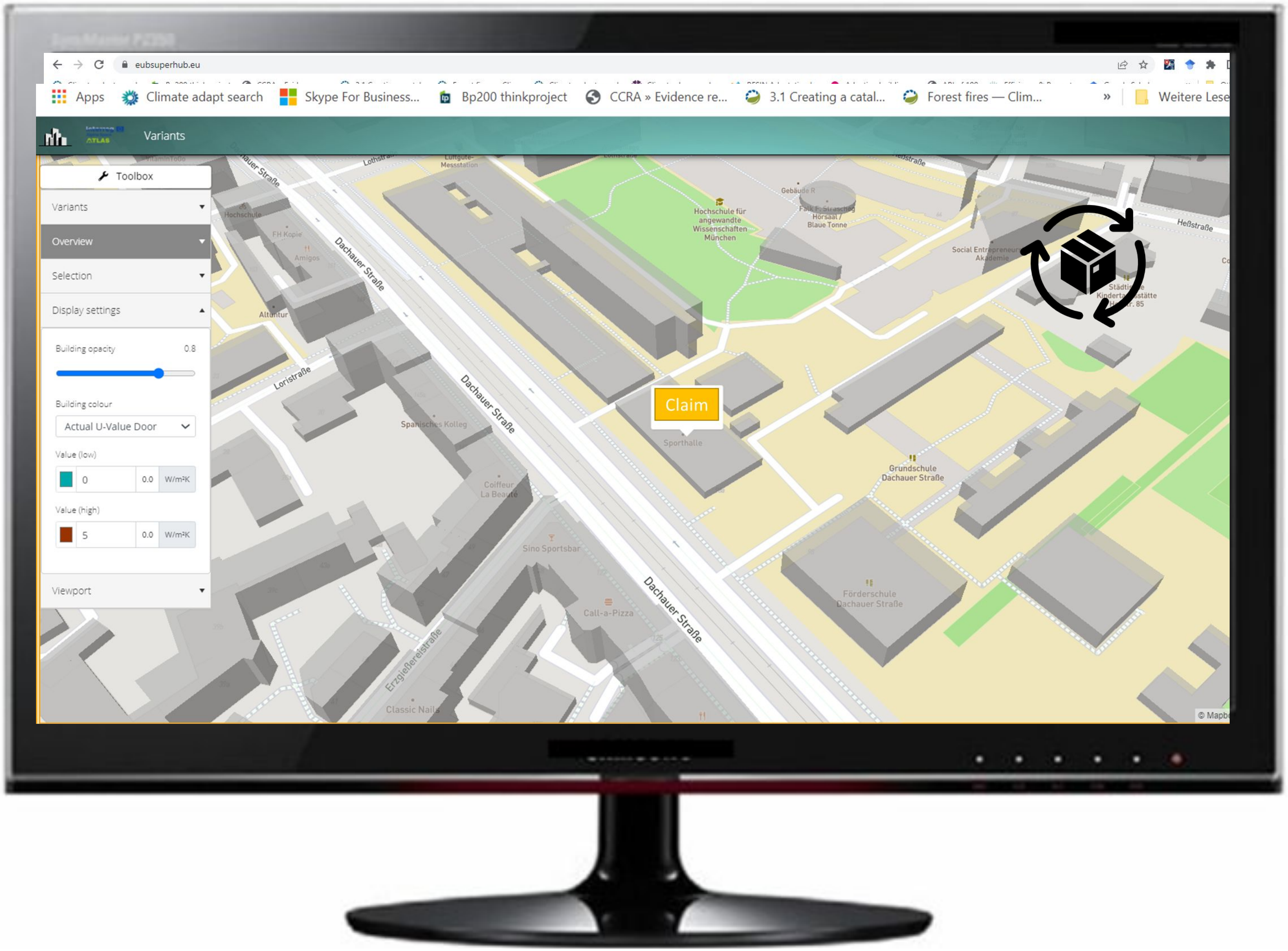
E-cockpit

EUB SuperHub



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Planning and Verification tool (PVT)

The module (PVT) is a multi scale planning and verification tool that uses the information collected by the user and other databases to enable the evaluation of building performance three domains (energy, sustainability and smartness) and help the user plan possible interventions via simulating of what-if scenarios.

A. Each user can use the tool to get a first assessment of the building performance

B. Uses a Plain language data entry interface to populate the building Information and connect it to the building logbook

C. All the rating results will remain hidden from public until the user decides to publish it in the E-cockpit

D. The personal beta-version of the EPC can be shared with VM either to an accredited auditor to verify and or to find a service providers

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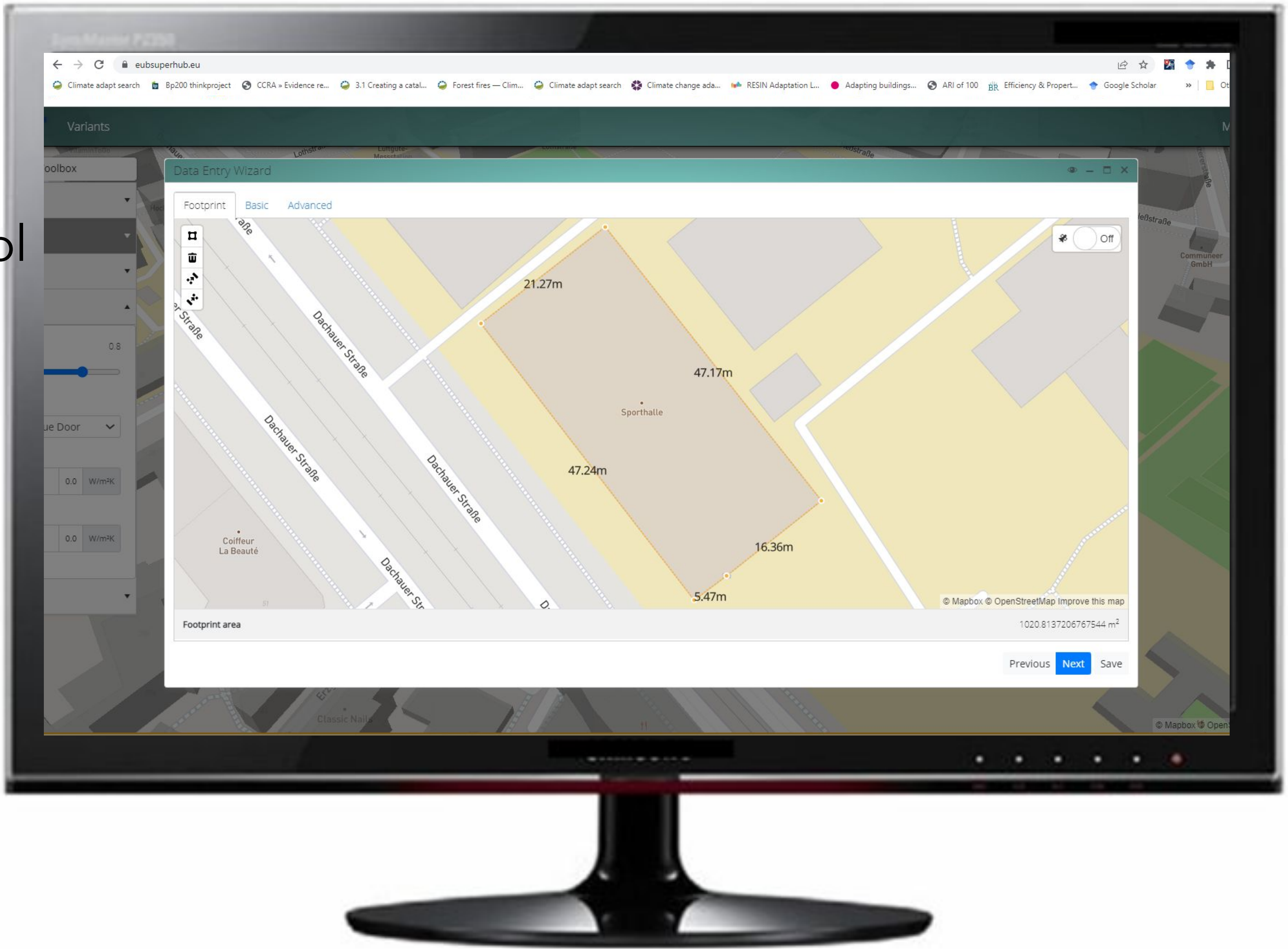
Planning and Verification tool (PVT)



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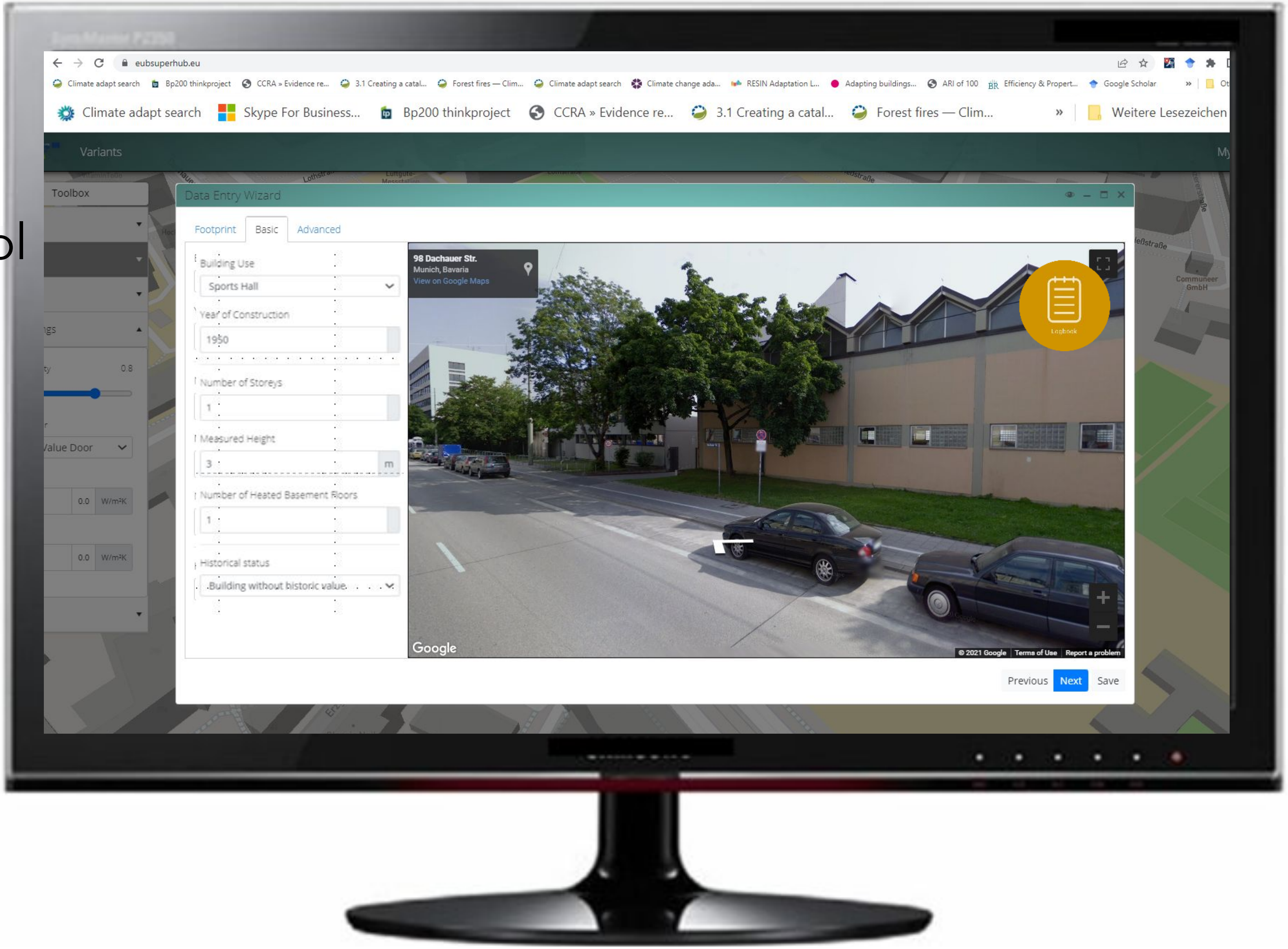
Planning and Verification tool (PVT)



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Planning and Verification tool (PVT)

EUB SuperHub

"Digital building logbook is a dynamic tool that allows a variety of data, information and documents to be recorded, accessed, enriched and organized under specific categories. It represents a record of major events and changes over a building's lifecycle"

Definition of the digital building logbook. Report 1 of the study on the development of a European Union framework for buildings' digital logbook. Jonathan Volt et al, 2020

ISBN 978-92-9460-144-5
DOI 10.2826/480977

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Planning and Verification tool (PVT)

EUB SuperHub

Level 0 - Data category	Level 1	Level 2	Value- 1	Unit
2-GENERAL BUILDING INFORMATION	**Basic building data**	Year of construction		–
2-GENERAL BUILDING INFORMATION	Basic building data	Year of renovation		–
2-GENERAL BUILDING INFORMATION	Basic building data	Brief description of renovation		–
2-GENERAL BUILDING INFORMATION	Basic building data	Remaining useful physical life span after the last building renovation (expected lifetime)		yr
2-GENERAL BUILDING INFORMATION	Basic building data	Base height		m
2-GENERAL BUILDING INFORMATION	Basic building data	Number of Storeys (floors)		–
2-GENERAL BUILDING INFORMATION	Basic building data	Floor height		m
2-GENERAL BUILDING INFORMATION	Basic building data	Measured Height		m
2-GENERAL BUILDING INFORMATION	Basic building data	Number of Heated Basement Floors		–
2-GENERAL BUILDING INFORMATION	Basic building data	District heating access	XXX	–
2-GENERAL BUILDING INFORMATION	Basic building data	Physical accessibility (design for all)	XXX	–
2-GENERAL BUILDING INFORMATION	Basic building data	Vertical transport - Lift (elevator)	Select from drop down list	–
2-GENERAL BUILDING INFORMATION	Basic building data	Lift position	Select from drop down list	–
2-GENERAL BUILDING INFORMATION	Basic building data	Historical status	Select from drop down list	–
2-GENERAL BUILDING INFORMATION	Basic building data	Building surroundings		–
2-GENERAL BUILDING INFORMATION	**Building geometry**	Footprint area		m^2
2-GENERAL BUILDING INFORMATION	Building geometry	Bottom floor area		m^2
2-GENERAL BUILDING INFORMATION	Building geometry	Floor area (unheated and heated area)		m^2
2-GENERAL BUILDING INFORMATION	Building geometry	**Useful floor area (heated area)**		m^2
2-GENERAL BUILDING INFORMATION	Building geometry	Building's envelope area *A* (sum of areas of external faces of the building, e.g. walls, roofs, floors)		m^2

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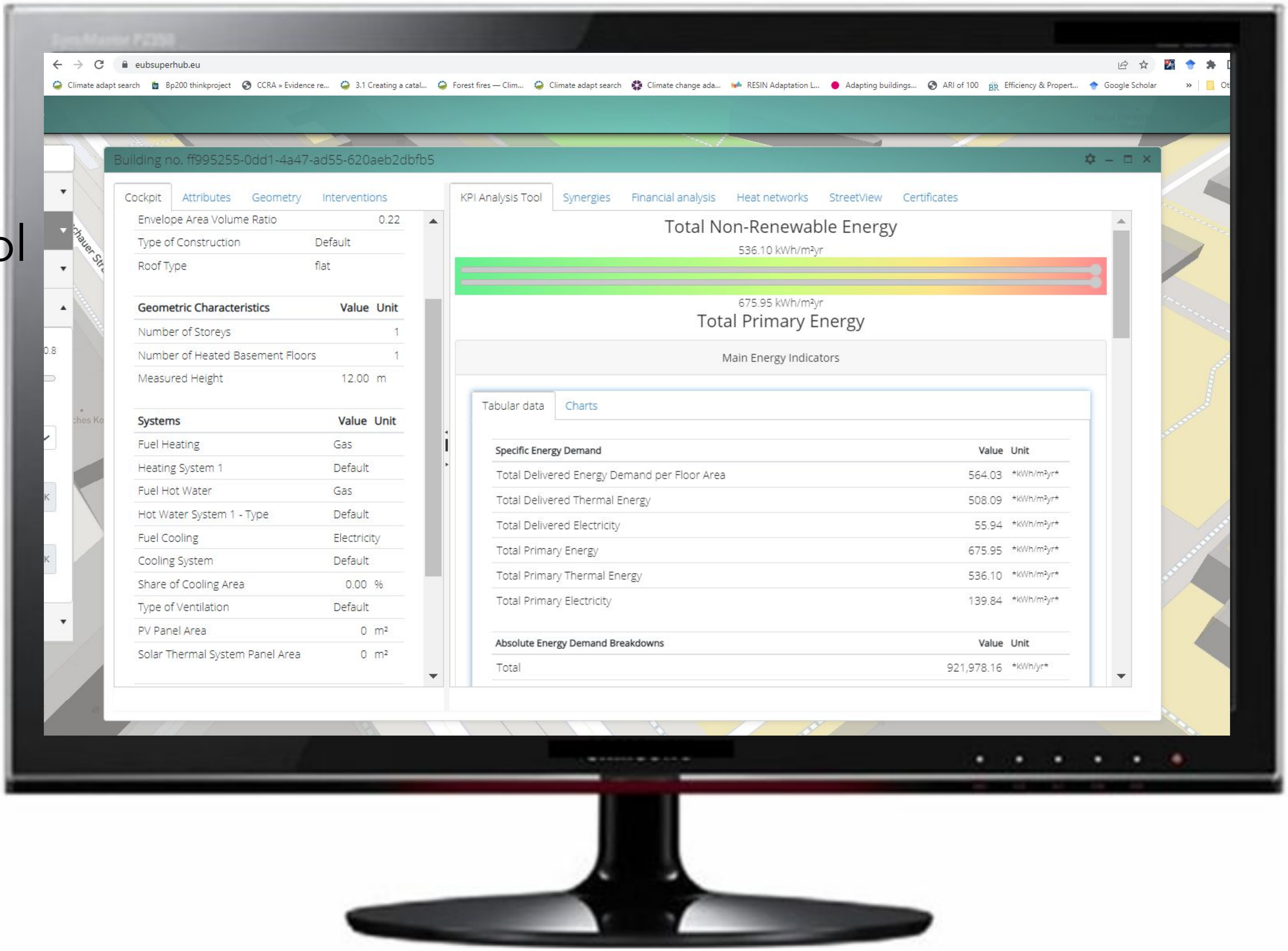
Planning and Verification tool (PVT)



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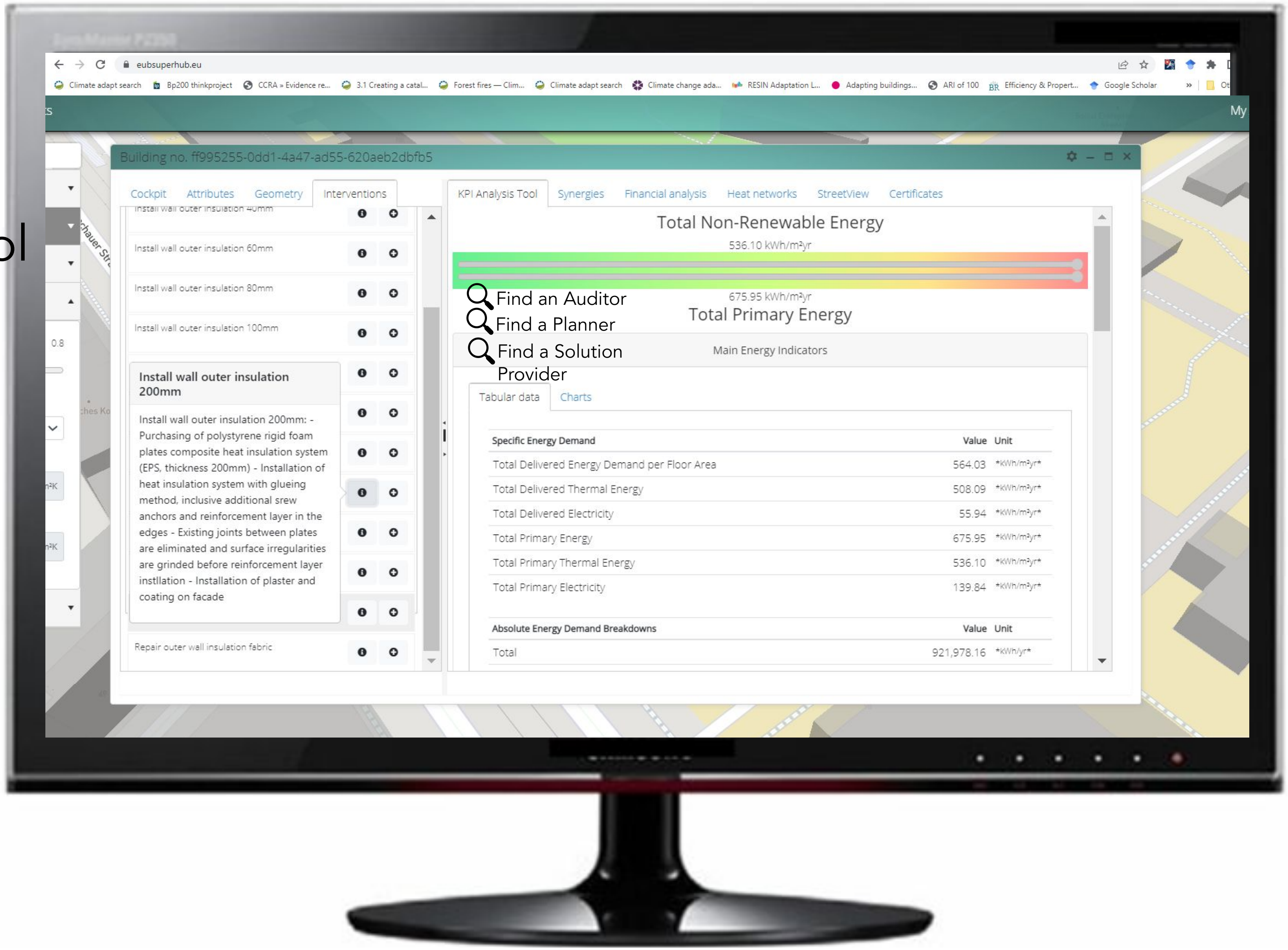
Planning and Verification tool (PVT)



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Virtual marketplace

The VM will facilitate the match making connection between the **building users, auditors and solution providers.** When the PVT user create a renovation scenario in the PVT module, the EuB Superhub platform can suggest to the user several matching solution providers through the virtual marketplace (VM) for the elaboration of service quotation:

A. Service providers can register for free in the VM to offer their solutions and technologies

B. The VM will work out qualification criteria and required training for service providers to be the registered in the VM

C. VM works as **yellow pages** and is to be connected to the PVT

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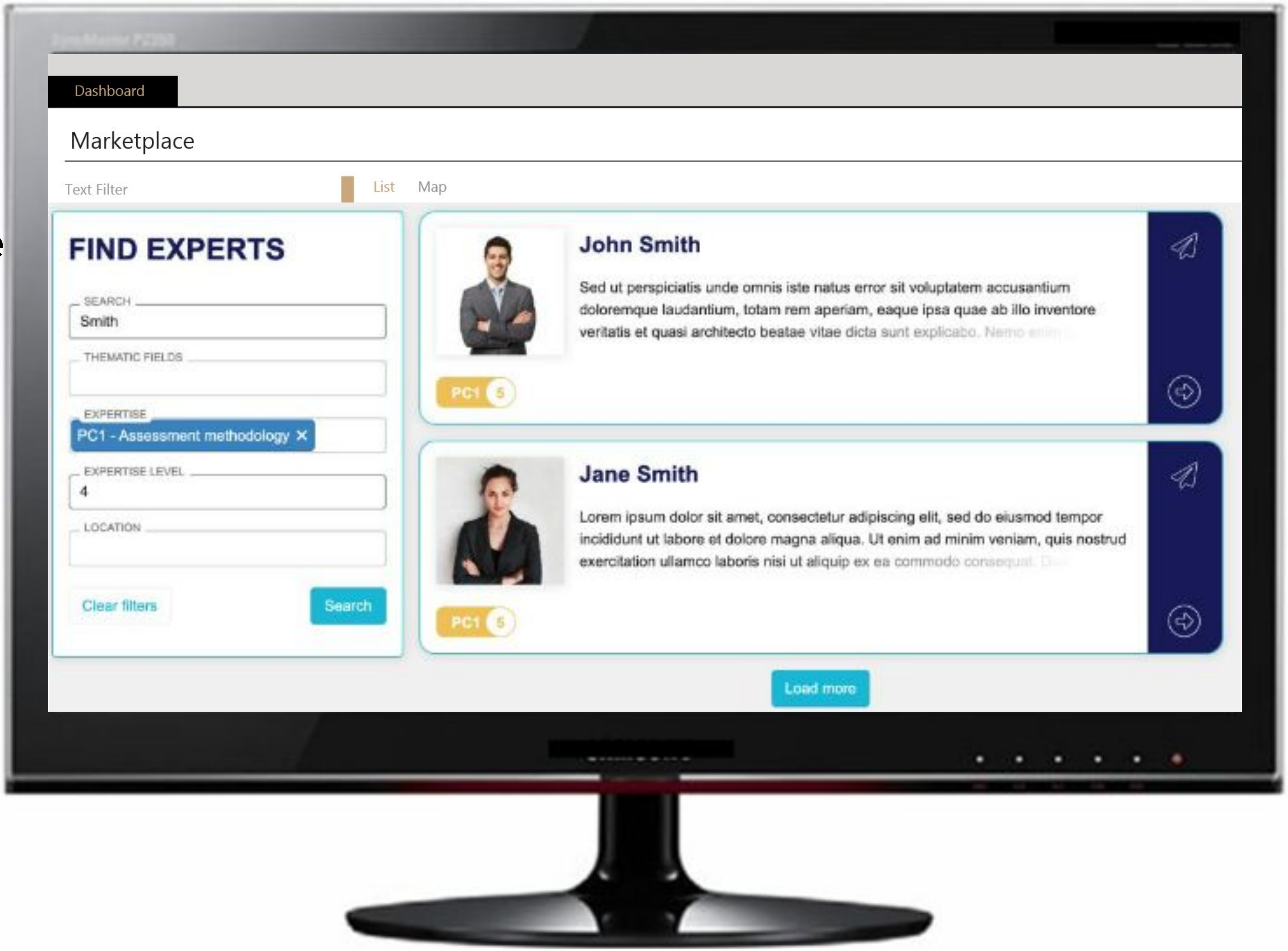
Virtual marketplace



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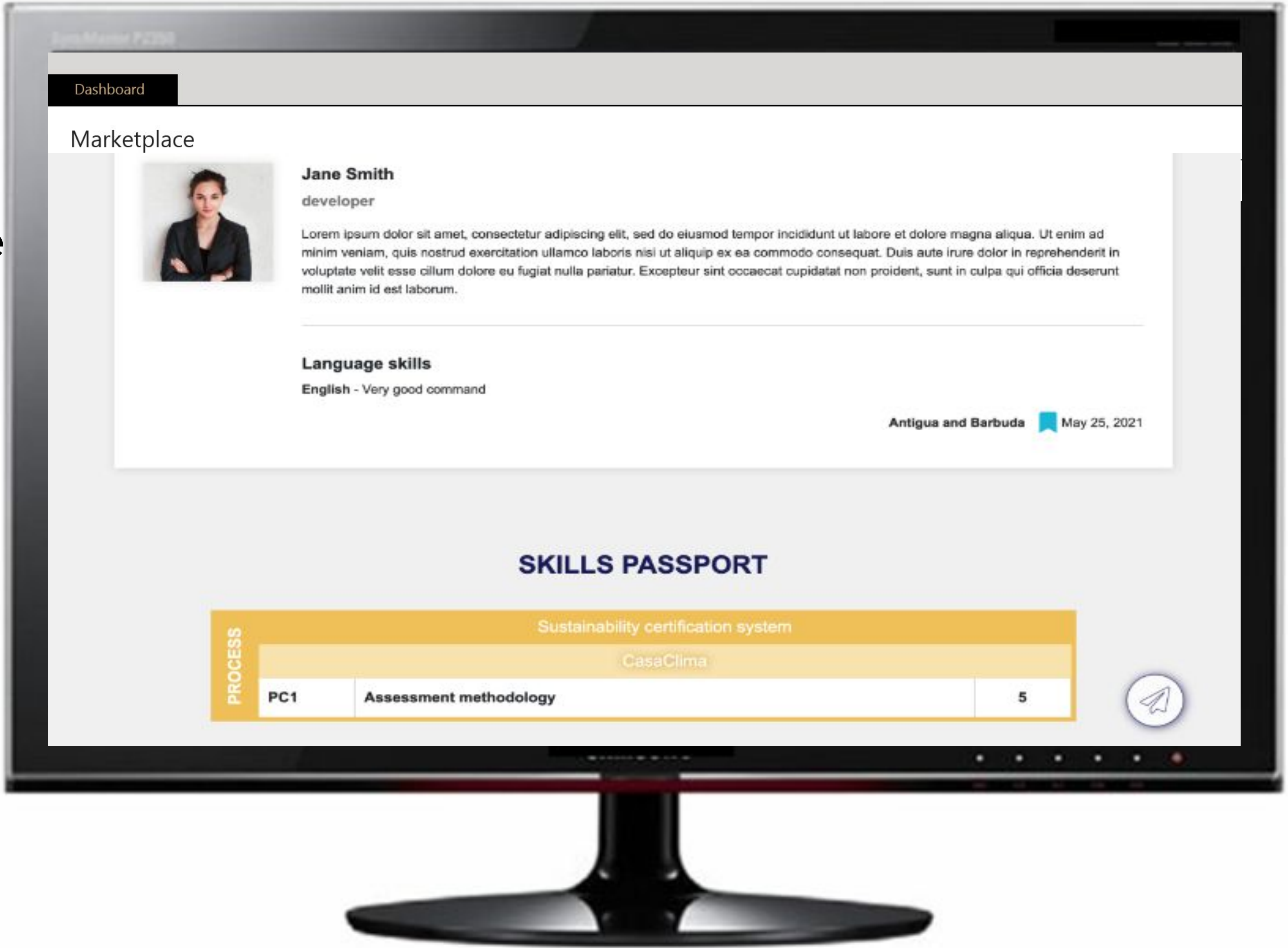
Virtual marketplace



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Training

The E- training module will support the training of the new generation of energy, sustainability, smart solution experts and assessors in using the EUB SuperHub certification/passport processes and the platform E-cockpit, VM and PVT modules:

A. It will incorporate e-learning methods like wikipages, video-tutorials, webinars and podcasts

B. will allow working in a multi-language environment

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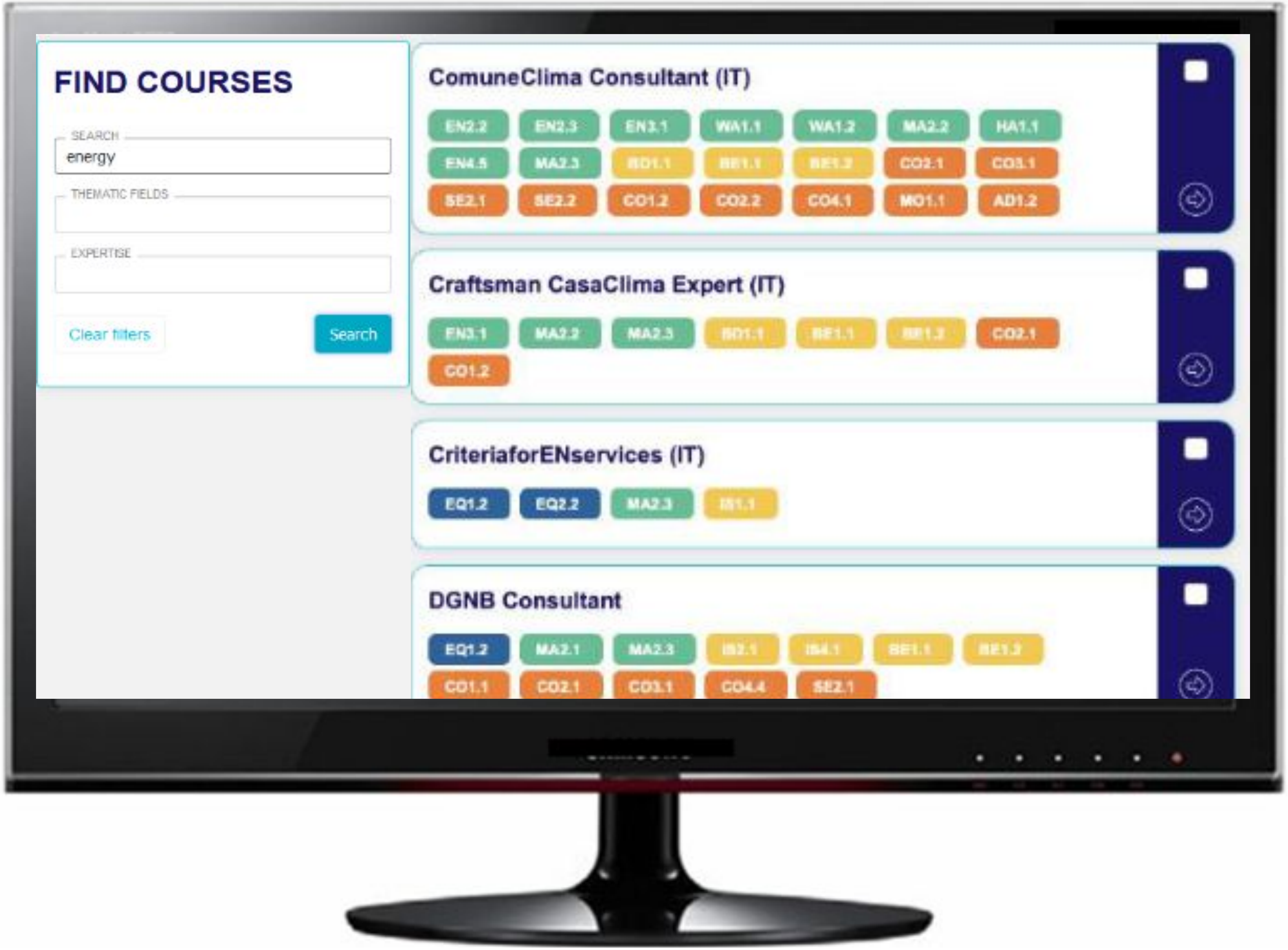
Training



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3 - The EUB-E Passport and next generation of energy certification

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EUB SuperHub certification process

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 and restated within the amendments adopted by the European Parliament on 14 March 2023.

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

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EUB SuperHub certification process

The EUB SuperHub certification process can take place in **two versions**:

Basic **Advanced**

The **Advanced** version foresees two levels of control (auditor + certification body) and 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 foresees one level of control (auditor) and is applied to:

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

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EUB SuperHub certification process

EUB SuperHub

The EUB SuperHub certification process (both Basic and Advanced) is **articulated in three phases** corresponding to the main project's stages:

DESIGN: phase where the design is refined and plans, specifications and estimates are created . All design information required to manufacture and construct the project are completed. The final output of this phase in the ***"EUB e-Passport Design".***

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".***

IN USE: phase where the building is used, operated and maintained. The final output of this phase in the ***"EUB e-Passport In Use".***

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EUB SuperHub certification process

<u>**ACTORS**</u> involved in the certification process are:

- **CLIENT:** His/her activities concerns the registration of the building and the appointment of the assessor for the evaluation of the building.

- **CERTIFICATION BODY**: His/her activities concern the appointment of the auditor and the issue of the final certificate, the EUB e-Passport for the technical design phase.

- **ASSESSOR:** His/her activities address the indicators' characterisation and the drafting of assessment report.

- **AUDITOR:** His/her activity is to revise the content of the technical reports produced by the Assessors in the different certification phases.

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TRAIN4SUSTAIN Competence Quality Standard

EUB SuperHub

TRAIN4 SUSTAIN

CEN WORKSHOP AGREEMENT

CWA 17939

October 2022

ICS 03.100.30

English version

TRAIN4SUSTAIN Competence Quality Standard

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

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

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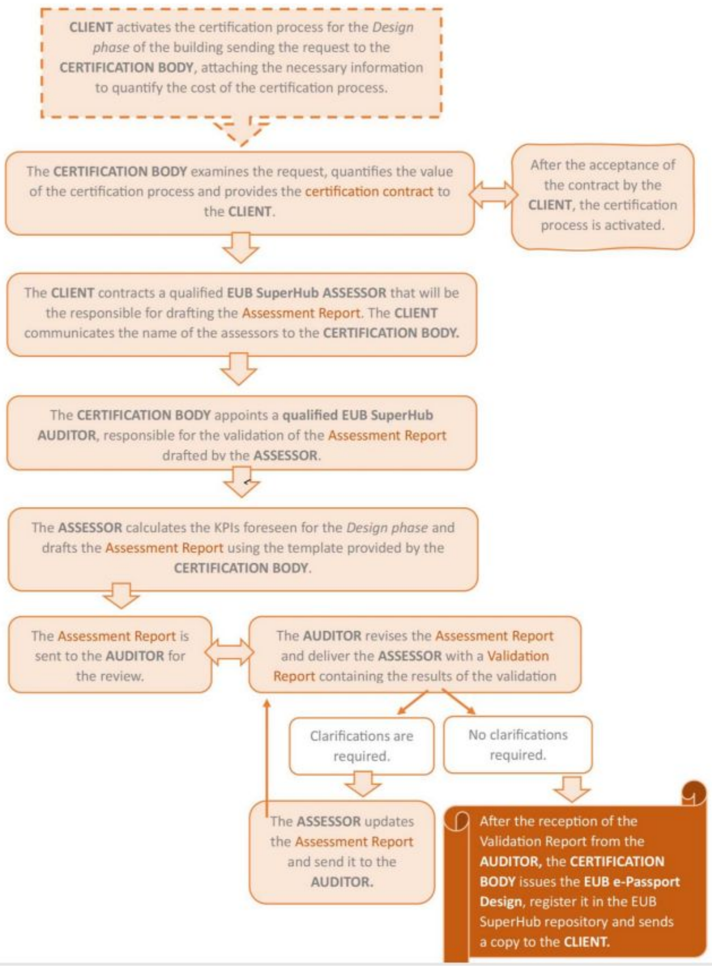
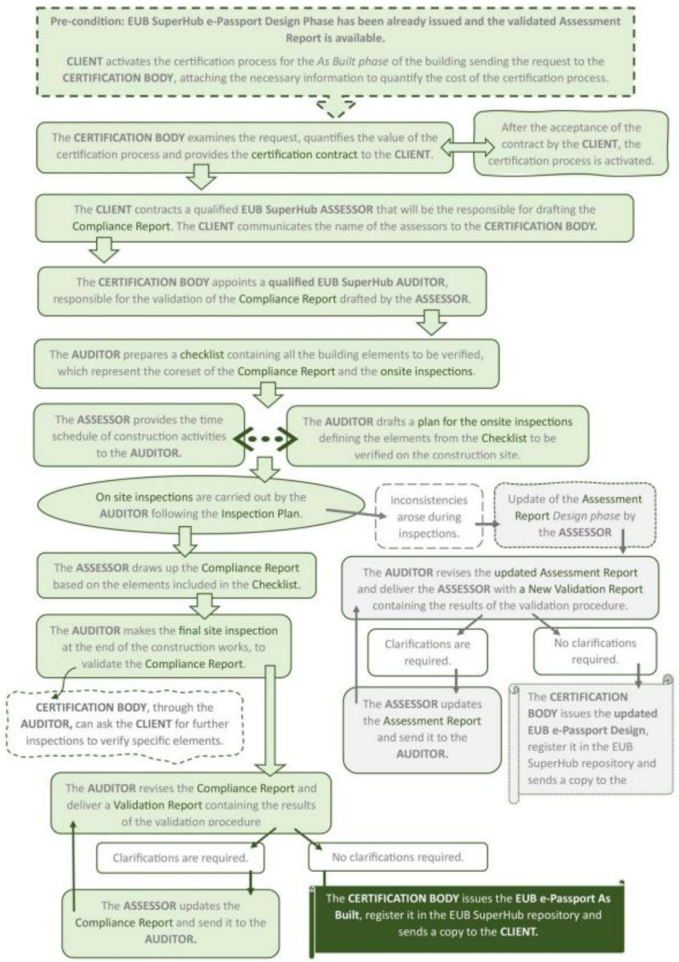
EUB SuperHub certification process

EUB SuperHub

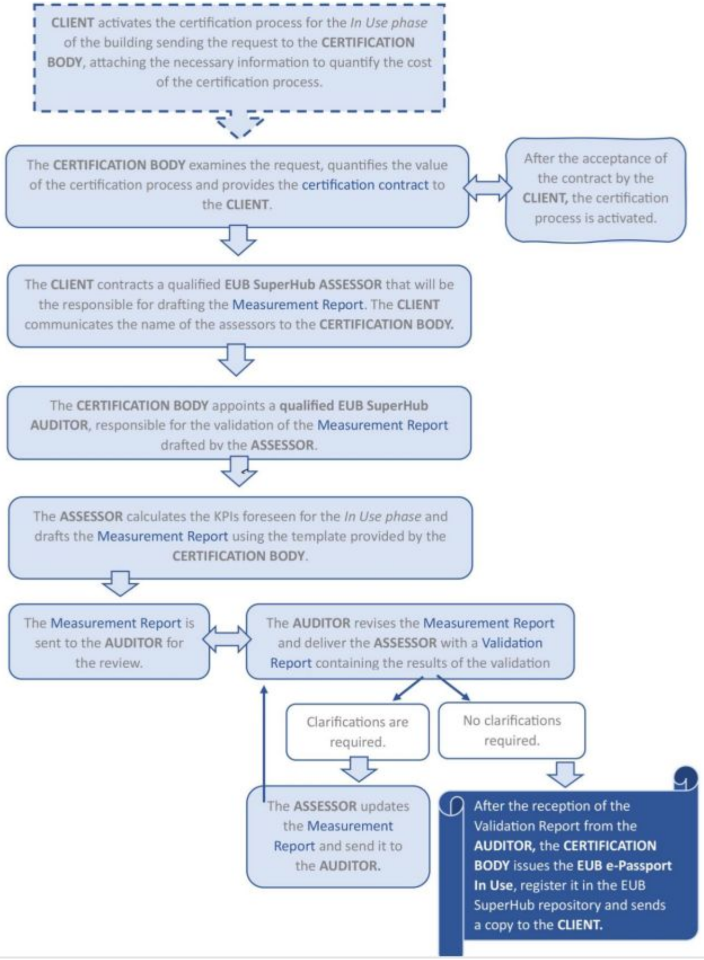
Certification process for the *Design phase*



Certification process for the *Construction / As Built phase*



Certification process for the *In Use phase*



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EUB SuperHub certification process

Certification process for the *Design phase*

CLIENT activates the certification process for the *Design phase* of the building sending the request to the **CERTIFICATION BODY**, attaching the necessary information to quantify the cost of the certification process.

The **CERTIFICATION BODY** 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** 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.**

The **CERTIFICATION BODY** appoints a **qualified EUB SuperHub AUDITOR**, responsible for the validation of the Assessment Report drafted by the **ASSESSOR**.

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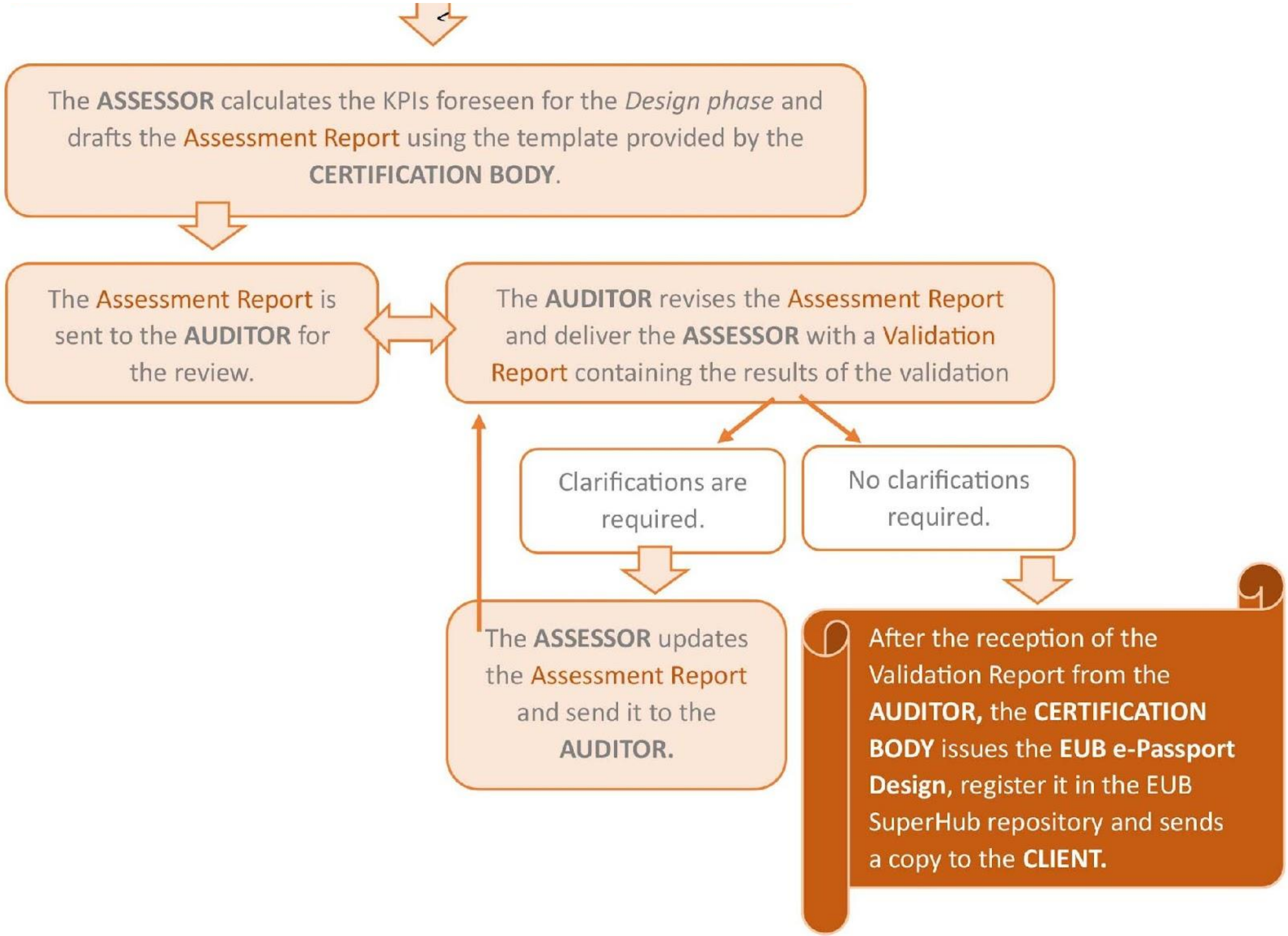
EUB SuperHub certification process

Certification process for the *Design phase*



This project is

EUB SuperHub certification process

Certification process for the *Construction / As Built phase*

Pre-condition: EUB SuperHub e-Passport Design Phase has been already issued and the validated Assessment Report is available.

CLIENT activates the certification process for the *As Built phase* of the building sending the request to the **CERTIFICATION BODY**, attaching the necessary information to quantify the cost of the certification process.

The **CERTIFICATION BODY** 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** 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 **CERTIFICATION BODY** appoints a **qualified EUB SuperHub AUDITOR**, responsible for the validation of the **Compliance Report** drafted by the **ASSESSOR**.

The **AUDITOR** prepares a **checklist** containing all the building elements to be verified, which represent the coreset of the **Compliance Report** and the **onsite inspections**.

The **ASSESSOR** provides the time schedule of construction activities to the **AUDITOR.**

The **AUDITOR** drafts a **plan for the onsite inspections** defining the elements from the **Checklist** to be verified on the construction site.

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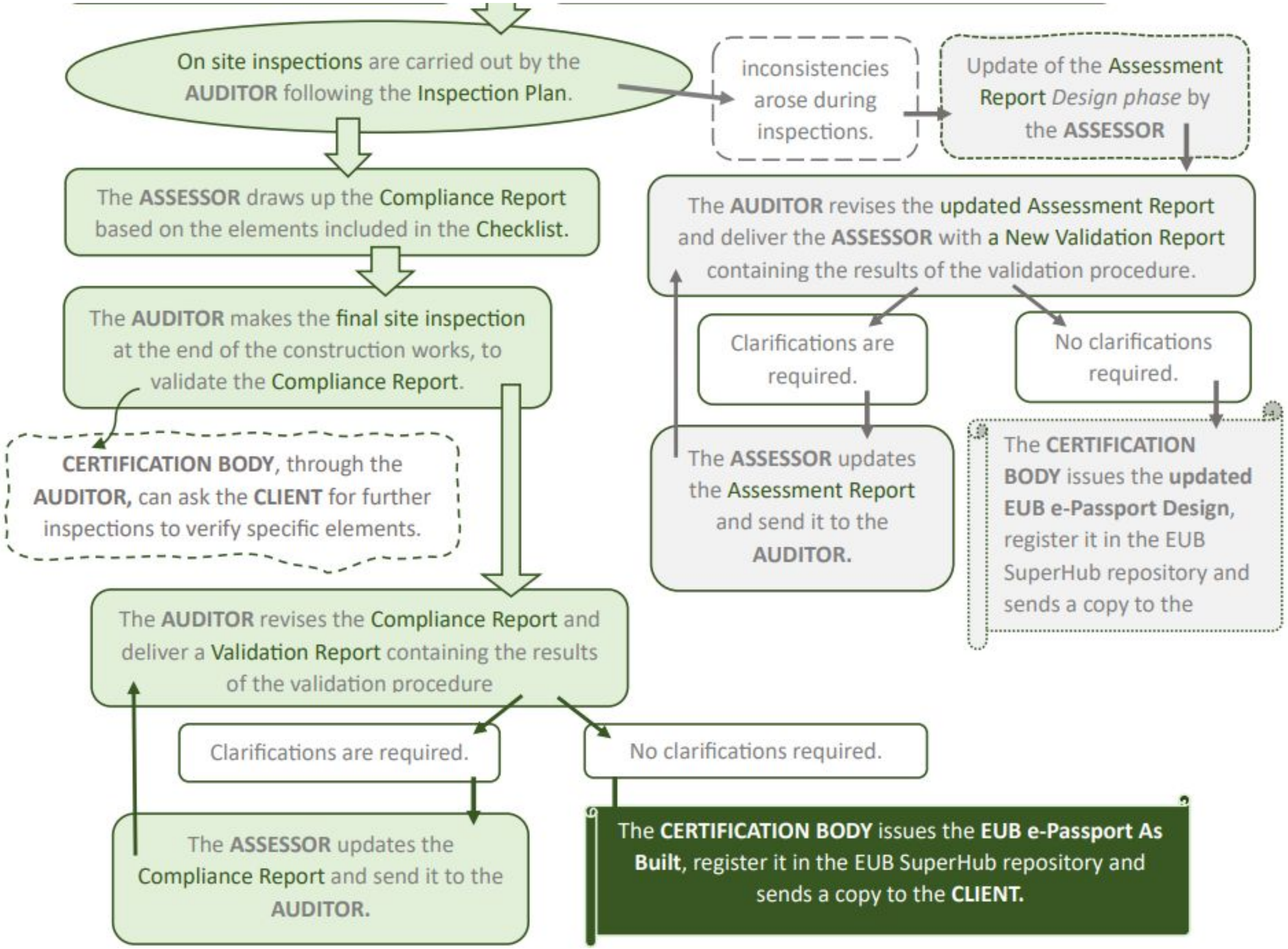
EUB SuperHub certification process

Certification process for the *Construction / As Built phase*



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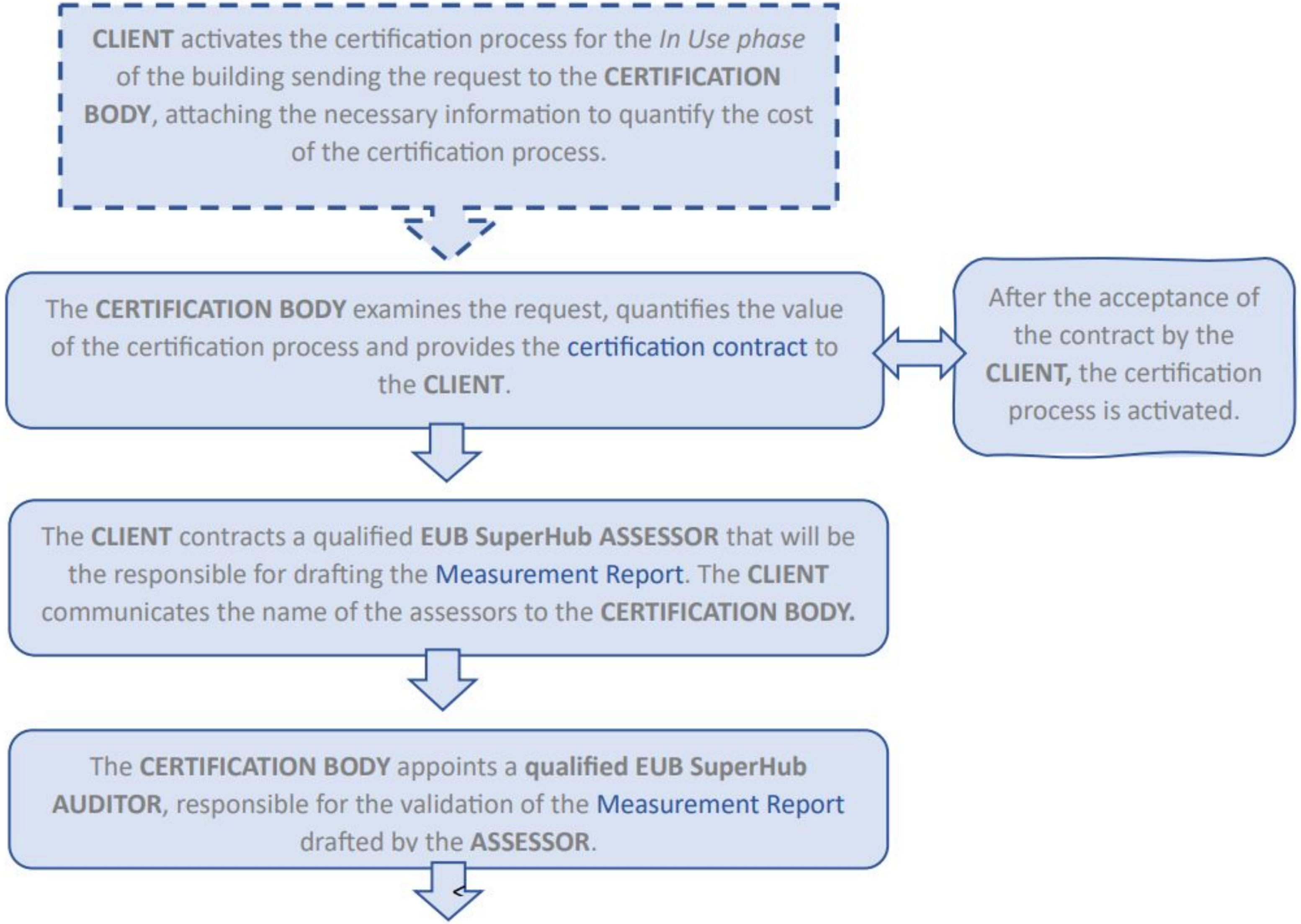
EUB SuperHub certification process

Certification process for the *In Use phase*



EUB SuperHub certification process

Certification process for the *In Use phase*

The **ASSESSOR** calculates 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.

The **AUDITOR** revises the Measurement Report and deliver the **ASSESSOR** with a Validation Report containing the results of the validation

Clarifications are required.

No clarifications required.

The **ASSESSOR** updates the Measurement Report and send it to the **AUDITOR.**

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 sends a copy to the **CLIENT.**

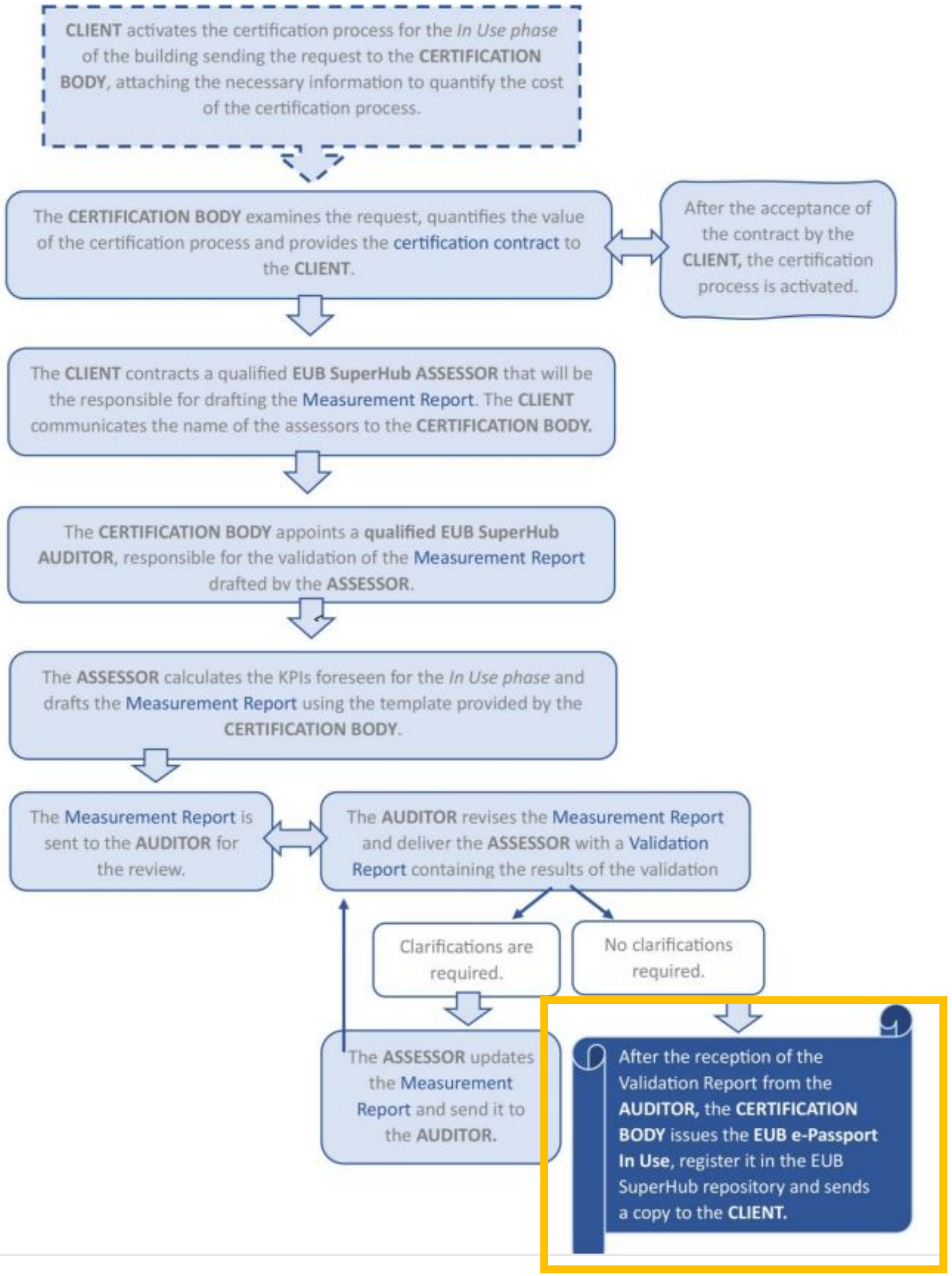
This project is co

EUB SuperHub certification process

Ensuring quality assurance to the certification process through:

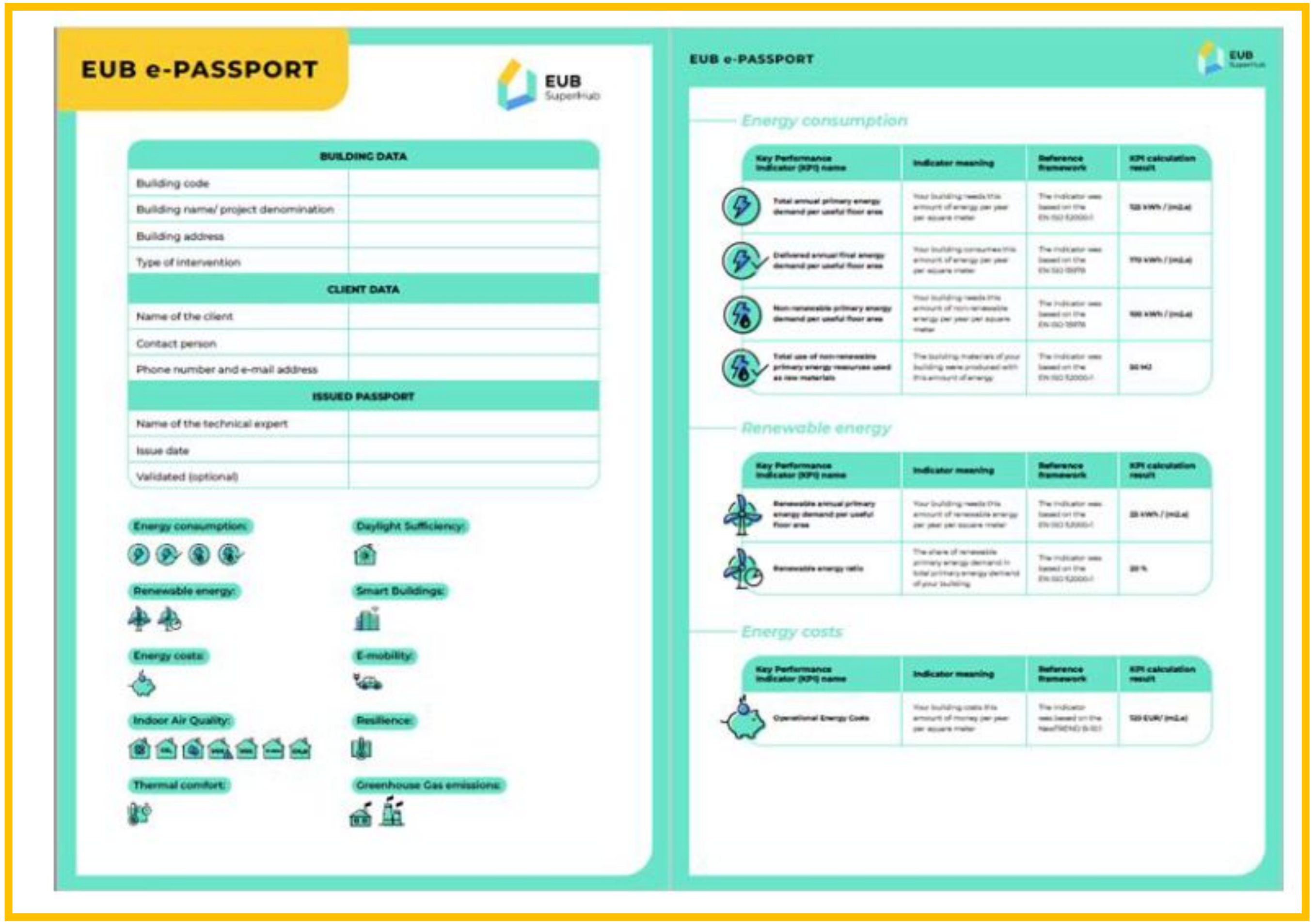
- ✔ **Third-party verification**
- ✔ **Monitoring** of the certification procedures
- ✔ **Standards for conformity** assessment
- ✔ Measurement of **KPIs affordability and operativity**
- ✔ **Collecting feedback** from users involved in all the process phases

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.



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

EUB SuperHub



This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

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Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 1	Delivered annual energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)
	KPI 2	Total annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)
	KPI 3	Non-renewable annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)
	KPI 4	Embodied energy	[kWh/m^2] or [MJ]	EN 15978
Renewable energy	KPI 5	Renewable annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)
	KPI 6	Renewable energy ratio (on-site, nearby)	[%]	B1.4 CESBA MED
GHG emissions	KPI 7	Annual use stage energy-related Global Warming Potential (GWP)	[kg CO_2 eq./ m²] for a reference study period of 50 years or [kg CO_2 eq. / (m²a)]	C1.3 CESBA MED
	KPI 8	Life Cycle Global Warming Potential (GWP)	[kg CO_2 eq./ m²] for a reference study period of 50 years	1.2 Level(s)
Thermal comfort	KPI 9	Percentage of time outside of thermal comfort range	[%]	4.2 Level(s)
Indoor air quality	KPI 10	Ventilation rate	[l/(sm^2)]	4.1 Level(s)
	KPI 11	CO_2 concentration	[ppm]	
	KPI 12	Relative humidity	[%]	
	KPI 13	Total VOCs	[µg/m^3]	
	KPI 14	CMR VOCs concentration	[µg/m^3]	
	KPI 15	R value	[decimal ratio]	
	KPI 16	Formaldehyde concentration	[µg/m^3]	
Costs	KPI 17	Operational energy cost	[€/(m^{2}a)]	10.1 NewTREND
Smart buildings	KPI 18	Smart Readiness Indicator (SRI)	[%]	SRI
Resilience to climate change	KPI 19	Summer thermal discomfort in 2050	[%] of time in which the indoor temperature exceeds 27 °C during the cooling season	5.1 Level(s)
E-mobility	KPI 20	Percentage of recharging points and installed pre-cabling in relation to the number of parking spaces	[%]	EPBD recast (Article 12)
Daylight sufficiency	KPI 21	Daylight provision	[%]	EN 17037

EUB SuperHub

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

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Module 2
EUB SuperHub platform the EUB Digital building Logbook

Training Material
Date: Jan 2024
Ahmed Khoja
Hochschule München University of Applied Sciences

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

Contents

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – The EUB Platform

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

2 – The EUB SuperHub Digital Building Logbook (DBL)

Lack of information? – one of many barriers that prevent the renovation rate from growing

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub

EU legislation – EU renovation wave strategy (October 2020)

EU RENOVATION WAVE STRATEGY (October 2020)

EUROPEAN COMMISSION

Brussels, 14.10.2020
COM(2020) 662 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives

{SWD(2020) 550 final}

„Deep renovation is not always achievable in one go. It is therefore important to create better conditions for staged renovation. The Commission will introduce **Digital Building Logbooks**[27] that will **integrate all building related data** provided by the upcoming **Building Renovation Passports**[28], **Smart Readiness Indicators**, **Level(s)**[29] and **EPCs** to ensure compatibility and integration of data throughout the renovation journey."

[27] Digital Building Logbooks will serve as repositories for data on individual buildings and facilitate information sharing within the construction sector, and between building owners and tenants, financial institutions and public authorities.

[28] As foreseen by the EPBD, Building Renovation Passports will provide a clear roadmap for staged renovation over the lifetime of a building, helping owners and investors plan the best timing and scope for interventions.

[29] The Commission's recent Level(s) framework covers energy, material and water use, quality and value of buildings, health, comfort, resilience to climate change and life-cycle cost.

https://ec.europa.eu/environment/eussd/buildings.htm

The EUB SuperHub Digital Building Logb

EU legislation – the proposed recast EPBD

EUROPEAN COMMISSION

15.12.2021

Brussels, 15.12.2021
COM(2021) 802 final

2021/0426 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the energy performance of buildings (recast)

European Parliament
2019-2024

TEXTS ADOPTED

14.03.2023

P9_TA(2023)0068

Energy performance of buildings (recast)

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 (recast) (COM(2021)0802 – C9-0469/2021 – 2021/0426(COD))[1]

(Ordinary legislative procedure – recast)

Council of the European Union

14.12.2023

Brussels, 14 December 2023
(OR. en)

16655/23

LIMITE

ENER 691
ENV 1479
TRANS 594
ECOFIN 1356
RECH 555
CODEC 2462

Interinstitutional File:
2021/0426(COD)

PUBLIC

NOTE

From:	General Secretariat of the Council
To:	Permanent Representatives Committee
No. Cion doc.:	15088/21 + ADD 1
Subject:	Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast) - Analysis of the final compromise text with a view to agreement

15.12.2021	14.03.2023	14.12.2023
37. ‘**digital building logbook**’ means a common repository for all relevant building data, including data related to energy performance such as energy performance certificates, renovation passports and smart readiness indicators, which facilitates informed decision making and information sharing within the construction sector, among building owners and occupants, financial institutions and public authorities;	37. ‘**digital building logbook**’ means a common repository for all relevant building data, including data related to energy performance such as energy performance certificates, renovation passports and smart readiness indicators, as well as on the life-cycle GWP and indoor environmental quality, which facilitates informed decision making and information sharing within the construction sector, among building owners and occupants, financial institutions and public authorities;	37. ‘**digital building logbook**’ means a common repository for all relevant building data, including data related to energy performance such as energy performance certificates, renovation passports and smart readiness indicators, as well as on the life-cycle GWP, which facilitates informed decision making and information sharing within the construction sector, among building owners and occupants, financial institutions and public bodies;

24. ‘Life-cycle Global Warming Potential (GWP)’ means an indicator which quantifies the global warming potential contributions of a building along its full life-cycle;
57c. ‘indoor environmental quality’ means the result of an assessment inside a building based upon parameters such as relating to the temperature, humidity, ventilation rate and presence of contaminants, influencing the health and wellbeing of its occupants;

The EUB SuperHub Digital Building Logbook

16. 'building element' means a technical building system or an element of the building envelope;

Article number		14.12.2023
Article 10	Renovation passport	8. Member States shall ensure that the building renovation passport is stored in, or can be accessed via, **the digital building logbook**, when established.
Article 14	Data exchange	For the purpose of this Directive, building systems data shall include at least all readily available data related to the energy performance of building elements, the energy performance of building services, the projected lifespan of the heating systems, where available, building automation and control systems, meters, measuring and control devices and charging points for e-mobility and be linked, where available, to the **digital building logbook**.
Article 19	Databases for energy performance of buildings	6. For the purpose of ensuring coherence and consistency of information, Member States shall ensure that the national database for energy performance of buildings is interoperable and integrated with other administrative databases containing information on buildings, such as the national building cadastre or land registry and **digital building logbooks**.
Annex V	TEMPLATE FOR ENERGY PERFORMANCE CERTIFICATES	The energy performance certificate may include the following links with other initiatives if these apply in the relevant Member State: (a) a yes/no indication whether an smart readiness assessment has been carried out for the building; (b) the value of the smart readiness assessment (if available); (c) a yes/no indication whether a **Digital Building Logbook** is available for the building.

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub

15.12.2021	14.03.2023	14.12.2023
6. ‘technical building system’ means technical equipment for • space heating, • space cooling, • ventilation, • domestic hot water, • 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;	6. ‘technical building system’ means technical equipment for • space heating, • space cooling, • ventilation, • domestic hot water, • built-in lighting, • building automation and control, • electrically operated solar shading, • electrical installations, • electric-vehicles charging stations, • 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;	6. ‘technical building system’ means technical equipment for • space heating, • space cooling, • ventilation, • domestic hot water, • built-in lighting, • building automation and control, • on-site renewable energy generation and energy storage, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit;

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EUB SuperHub - Task 1.4 Impact of energy efficiency improvements and certifications on the value of buildings

Overview of national property price registers

NO LINK between the building value and the EPC class!

Country	Germany	Italy	Austria	France	Ireland	Croatia
PROPERTY PRICE REGISTER or REAL ESTATE INFORMATION SYSTEM (register containing transaction values of sold properties)						
Does a national property price register exist? (yes/no)	no Individual one exists for each federal state	yes	no	yes	yes	yes
Name of property price register	**Database of real estate prices**	**Database of real estate prices**	–	**Land property and real estate transactions prices**	**Residential Property Price Register**	**Real estate information system eNekretnine**
Name of property price register in original language	Kaufpreissammlung	Banca dati quotazioni immobiliari	–	Demande de valeurs foncières (fichier DVF)	Residential Property Price Register	Informacijski sustav tržišta nekretnina eNekretnine
Home page of property price register	See example:https://redaktion-akoga.niedersachsen.de/gutachterausschuesse/kaufpreissammlung/kaufpreissammlung-72286.html	https://www1.agenziaentrate.gov.it/servizi/Consultazione/ricerca.htm	–	https://app.dvf.etalab.gouv.fr/	https://www.propertypriceregister.ie	https://nekretnine.mgipu.hr
Name of organisation / ministry/ company responsible	Obere Gutachterausschüsse (OGA) - Higher Valuation Board	Revenue Agency - Ministry of Economy and Finance	–	French General Directorate of Public Finances (DGFiP) of the Ministry of Finances, in partnership with Etalab	Property Services Regulatory Authority	Ministry of physical planning, construction, and state assets
Type of buildings covered	Residential and non-residential buildings	Residential, commercial, offices	–	Residential and non-residential buildings, plots of land	Residential buildings	Residential and non-residential buildings
Does register contain EPC label class of a building/building unit being sold? (yes/no)	NO (but contain information about the final and primary energy values)	NO	–	NO	NO	NO

Source: EUB SuperHub Project. D1.4. EPCs, Sustainability Certifications and Buildings' Green Value. Available online: https://eubsuperhub.eu/assets/content/EUB%20SuperHub_deliverable_D14.pdf

The EUB SuperHub Digital Building Logbook (DBL)

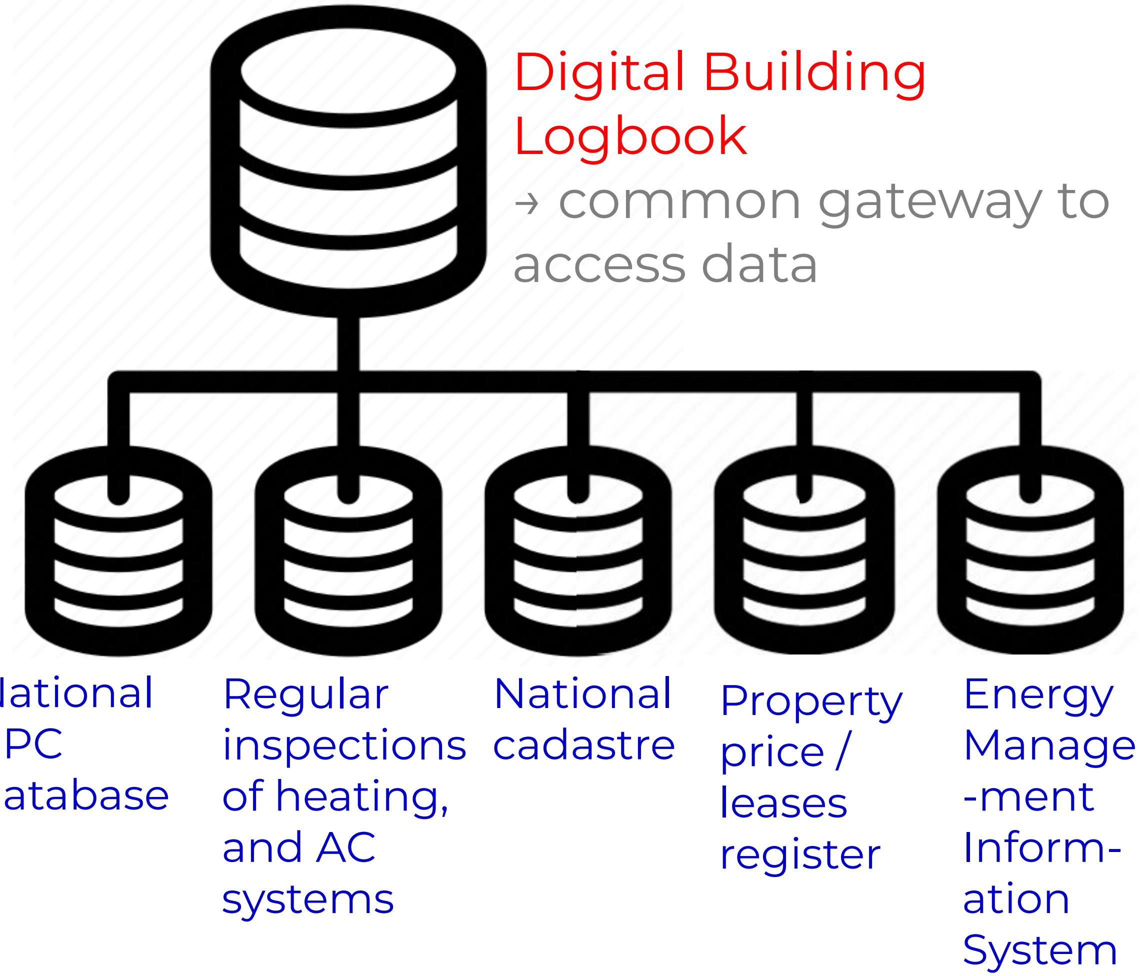
A database is interoperable if it can exchange, interpret, and present shared data in a way that is understood by other databases.

EU legislation – the proposed recast EPBD (December 2023)

Article 19

Databases for energy performance of buildings

6. For the purpose of ensuring coherence and consistency of information, Member States shall ensure that the national database for energy performance of buildings is **interoperable** and integrated with other administrative databases containing information on buildings, such as the national building cadastre or land registry and **digital building logbooks**.



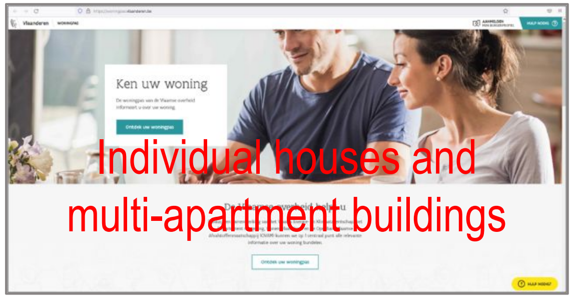
"DBL should link different data instead of building everything from scratch"
DBL should not be a self-contained library, but it should link to existing databases and connect them."

Source: European Commissions – Meeting report – Announcement Webinar Digital Building Logbook Study, June 2022

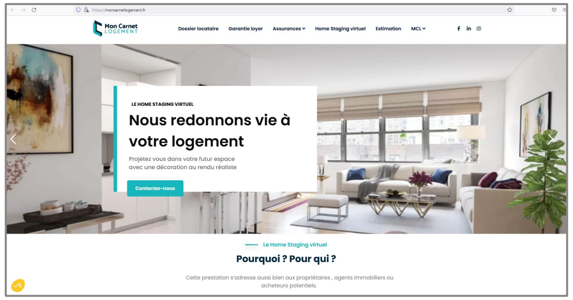
This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

The EUB SuperHub Digital Building Logbook (DBL)

Overview of building logbooks and initiatives across the EU

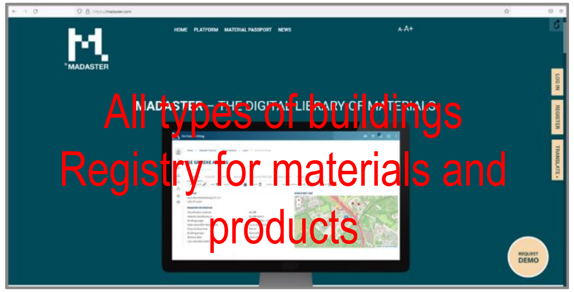


Belgium (Flanders) – Woningpas
https://woningpas.vlaanderen.be/



France - Mon carnet logement
https://moncarnetlogement.fr/

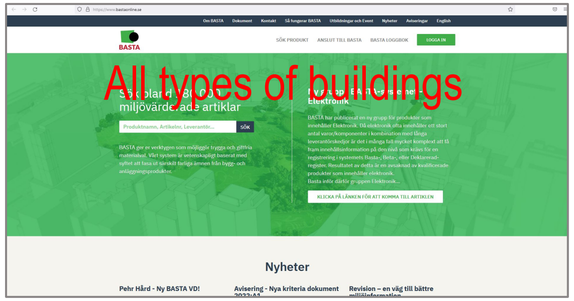
Germany – Eigenheim Manager
https://eigenheim-manager.de/



Netherlands – Madaster
https://madaster.com/

Portugal – casA+
https://portalcasamais.pt/

Spain – PAS-E
http://pas-e.es/#/

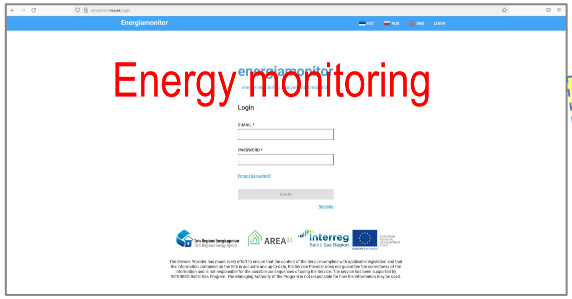


Sweden – BASTA Loggbok
https://www.bastaonline.se/

Sweden – MinVilla
https://minvilla.villaagarna.se/

Sweden – Produktkolen
https://www.produktkollen.se/

Croatia – Energy Management Information System
https://www.isge.hr/login.xhtml



Estonia – Energiamonitor
http://emonitor.trea.ee/login

38 registered logbooks and initiatives across EU at different maturity level

The EUB SuperHub Digital Building Logbook (DBL)

Benefits of DBL

Introducing the concept of digital building logbooks, to overcome the main challenge of a lack of access to sufficient building-related data, is of the utmost importance and can contribute to:

- ✔ Access to information;
- ✔ Information sharing within the construction sector, among building owners and occupants, financial institutions, and public authorities;
- ✔ A higher renovation rate of existing buildings - promoting energy renovation by providing the necessary information;
- ✔ Better informed decision making throughout the whole building life-cycle;
- ✔ Simplification of the construction process;
- ✔ Improved market information and transparency;
- ✔ Better management of inspections and better operation, use, and maintenance of a building;
- ✔ A better overview of the building stock at all levels;
- ✔ Better monitoring progress towards climate goals - better assessment of the progress of decarbonisation;
- ✔ More effective policy making, etc.

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The EUB SuperHub Digital Building Logbook (DBL)

Comparison of different existing DBL data structures

16. 'building element' means a technical building system or an element of the building envelope;

	IBRoad-Log July 2018	ALDREN BuildLog April 2019	BIM4EEB Building Log-Book June 2019	Study EU DBL July 2020	X-Tendo Logbook November 2020
1	General and administrative information	Building picture	General and administrative information	Administrative information	Administrative information
2	Building construction information	Energy rating & target	Building construction information	General information	General information
3	Building energy performance	Energy verification	Building energy performance	Building descriptions and characteristics	Building descriptions and characteristics
4	Building operation and use	Comfort & well-being	Building operation and use	Building operation and use	Building operation and use
5	Smart information	Cost value risk	IoT information	Building performance	Building performance
6	–	Documentation—BIM	–	Building material inventory	Building material inventory
7	–	–	–	Smart readiness	Smart readiness
8	–	–	–	Finance	Finance

EUB SuperHub

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

Source: Malinovec Puček, M.; Khoja, A.; Bazzan, E.; Gyuris, P. A Data Structure for Digital Building Logbooks: Achieving Energy Efficiency, Sustainability, and Smartness in Buildings across the EU. Buildings 2023, 13, 1082. https://doi.org/10.3390/buildings13041082

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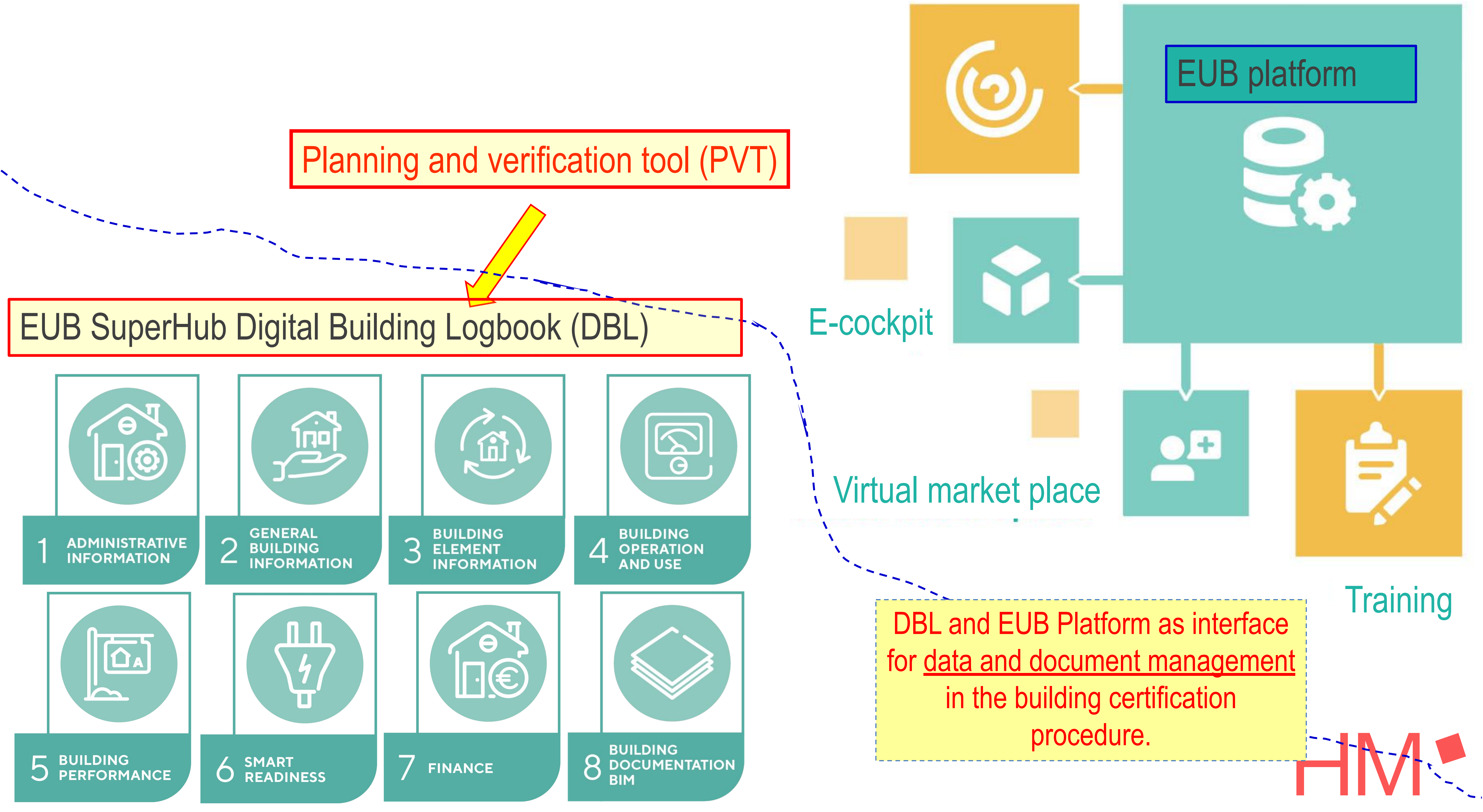

EUB platform
Planning and verification tool (PVT)
E-cockpit
EUB SuperHub Digital Building Logbook (DBL)
Virtual market place
1 ADMINISTRATIVE INFORMATION
2 GENERAL BUILDING INFORMATION
3 BUILDING ELEMENT INFORMATION
4 BUILDING OPERATION AND USE
5 BUILDING PERFORMANCE
6 SMART READINESS
7 FINANCE
8 BUILDING DOCUMENTATION BIM
Training
DBL and EUB Platform as interface for data and document management in the building certification procedure.
HM

EUB SuperHub DBL data structure

8 MODULES

EUB SuperHub

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

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

BUILDING RELATED DATA

DOCUMENTS

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub DBL data structure

EUB SuperHub

6 levels

1
2
3
4
5
6
7
8

Level 0 - Data category	Level 1	Level 2	Level 3	Level 4	Level 5
1-ADMINISTRATIVE INFORMATION	**Building name** (if any; building name in case of non-residential buildings)				
1-ADMINISTRATIVE INFORMATION	**Unique building identifier**				
1-ADMINISTRATIVE INFORMATION	**Building type**	**Building state**			
1-ADMINISTRATIVE INFORMATION	Building type	**Building use** (residential, non-residential)			
1-ADMINISTRATIVE INFORMATION	Building type	Residential building type			
1-ADMINISTRATIVE INFORMATION	Building type	Non-residential building type			
1-ADMINISTRATIVE INFORMATION	**Building address**	Street			
1-ADMINISTRATIVE INFORMATION	Building address	Street number			
1-ADMINISTRATIVE INFORMATION	Building address	Postal code			
1-ADMINISTRATIVE INFORMATION	Building address	City			
1-ADMINISTRATIVE INFORMATION	Building address	Country			
1-ADMINISTRATIVE INFORMATION	Building address	Geo coordinates - Latitude			
1-ADMINISTRATIVE INFORMATION	Building address	Geo coordinate - Longitude			
1-ADMINISTRATIVE INFORMATION	Building address	Land parcel number			
1-ADMINISTRATIVE INFORMATION	**Building location**	Climate zone			
1-ADMINISTRATIVE INFORMATION	Building location	Climate Data Station			
1-ADMINISTRATIVE INFORMATION	**Ownership**	Ownership type 1			
1-ADMINISTRATIVE INFORMATION	Ownership	Ownership type 2			
1-ADMINISTRATIVE INFORMATION	Ownership	**Building owner**	**Private person**	Name and surname	
1-ADMINISTRATIVE INFORMATION	Ownership	Building owner	Private person	E-mail adress	
1-ADMINISTRATIVE INFORMATION	Ownership	Building owner	Private person	Mobile phone	

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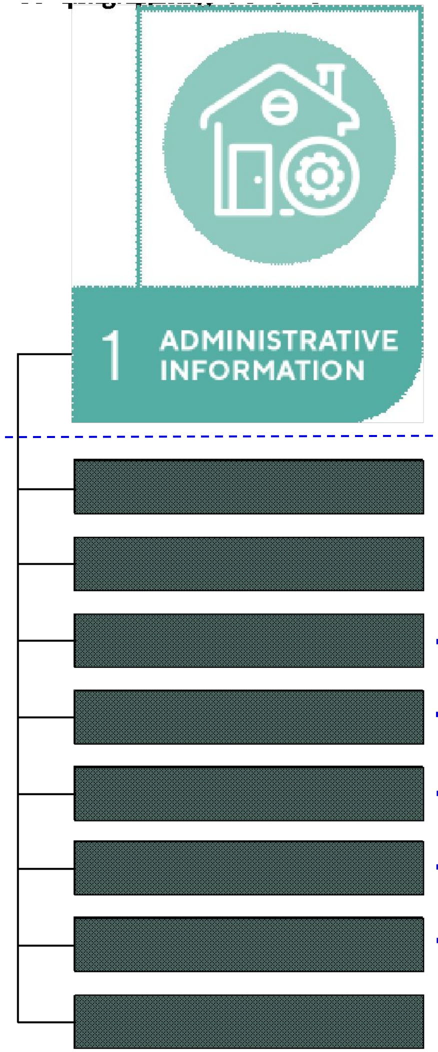
The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub DBL data structure – 1 ADMINISTRATIVE INFORMATION

Level 0



Building state

Select from drop down list
New building in the design phase
New building in the construction phase
New building in the 'as built' phase
Existing building in the use phase
Renovated building in the design phase
Renovated building in the construction phase
Renovated building in the 'as built' phase

Building state

- New building in the design phase
- New building in the construction phase
- New building in the 'as built' phase
- Existing building in the use phase
- Renovated building in the design phase
- Renovated building in the construction phase
- Renovated building in the 'as built' phase

Level 1

→ Building state, Building use, Residential building type, Non-residential building type

→ Street, Street number, Postal code, City, Country, Geo coordinates – latitude, longitude, Land parcel number

→ Climate zone, Climate data station

→ Ownership type, Building owner

→ DBL author, DBL last update

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub DBL data structure – 2 GENERAL BUILDING INFORMATION

EUB SuperHub

The EUB SuperHub DBL will document and store … the history of any major renovation or replacements…”

Building renovation	Renovated building envelope	Walls, Floor, Roof, Windows, Skylights, Door/s, Other
	Renovated Technical Building System (TBS)	Space heating system, Domestic Hot Water (DHW) preparation system, Space cooling system, Ventilation system, Lighting system, Building Automation and Control system (BACS), ON-SITE Renewable energy generation and o…

Physical accessibility (design for all)

- Ramp - access routes to the entrance door/s
- Access routes to lift, if installed
- Barrier-free WC/s
- Operating information with at least two senses principle
- Other

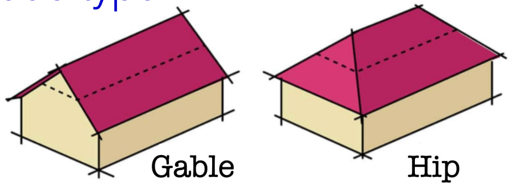
Level 0

Level 1

- Basic building data → Year of construction, Building renovation, Building pictures, Base height, Number of storeys, Floor height …
- District heating access, Vertical transport- Lift, Lift position, Historical status, Fire safety, Seismic resilience, Physical accessibility (design for all), Building surroundings
- Building geometry → Footprint area, Bottom floor area, Total floor area, Useful floor area, Shape factor
- Building contruction basics → Type of construction, Roof (Roof type, Roof inclination), Façade type

Roof type

- flat
- gabled
- hipped



This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub

EUB SuperHub DBL data structure – 3 BUILDING ELEMENT INFORMATION

The EUB SuperHub DBL will document and store … the use of material (material passport)…

The EUB SuperHub DBL will hold records about… expected end of life …

EPBD

Directive on the energy performance of buildings (EPBD) 2010/31/EU
Recast EPBD (December 2021)

9. 'building element' means a technical building system or an element of the building envelope;

Level 0

Walls	Layers	Material type – name, Layer thickness
		Layer thermal conductivity, Layer density, Layer thermal capacity, Layer vapour permeability
		Material location
		Material weight (mass of each building element), Material volume (layer volume)
		Global Warming Potential (GWP) - embodied carbon
		Total Renewable Primary Energy (PERT), Total non-Renewable Primary Energy (PENRT)
		Embodied energy coefficient

Level 1

- Building envelope → Infiltration rate, Internal heat capacity, Thermal bridging, Walls, Floor, Roof, Windows, Skylights, Door/s
- Technical Building System (TBS) → Space heating system, Domestic Hot Water (DHW) preparation system, Space cooling system, Ventilation system, Lighting system, Blinds, Technical home and building management, Building Automation and Control system (BACS), ON-SITE Renewable energy generation and storage, Battery energy storage system

Space heating system DHW preparation system Space cooling system	Production year
	Life span - max (DIN EN 15459)
	Remaining useful physical life span

Technical Building System (TBS)	Building Automation and Control system (BACS)	BACS efficiency class (EN 15232-1)	C

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub DBL data structure – 4 BUILDING OPERATION AND USE

EUB SuperHub

Level 0

Level 1

- Building use → Reference year, Number of occupants, Daily usage time, Annual usage days, Daily HVAC system op. hours, Setting room temperature (heating period, cooling period), User behaviour
- Climate data actual → Locality - name (JRC, Eurostat), Locality – latitude, Locality – longitude, Locality – altitude, Annual average outside air temperature, Annual average solar radiation, Annual average wind speed, Heating degree days (HDD), Cooling degree days (CDD)
- Metered data → Energy consumption, On-site renewable energy generation, Exported renewable energy generated on-site, Auto-consumed renewable energy generated on-site, Water consumption, Domestic hot water consumption
- Inspection of heating and air-conditioning systems (EPBD) → Inspection type, Inspection of heating system, Inspection of air-conditioning system, Inspection of heating and air-conditioning systems
- Building maintenance → Date, ID of the maintenance, Building element, Maintenance log - brief description, Validity or future maintenance data, Maintenance service contact, Maintenance certificate/report

The EUB SuperHub DBL will hold records about… maintenance history …

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub DBL data structure – 5 BUILDING PERFORMANCE

The EUB SuperHub DBL will hold records about… the results of older EPCs and assessment certificates…

The EUB SuperHub DBL will act as the digital container containing all input parameters to calculate the passport rating in three domains:

- **EPC**
- **Sustainability**
- **Smartness**

Level 0

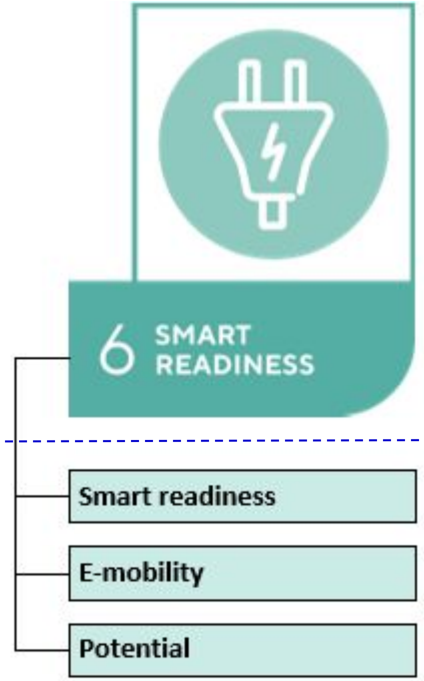
Level 1

- Energy Performance Certification (EPBD) → Energy Performance Certificate (EPC), EPC number, Issue date, Validity date, EPC type, EPC rating, EPC support documentation, Tailored renovation recommendations, Climate resilience potential, Energy performance calculation, Energy assessor
- EUB SuperHub certification → EUB SuperHub Certificate, EUB SuperHub Certificate number, Issue date, EUB SuperHub rating, …, Assessor (auditor)
- Sustainability certification → DGNB, BREEAM, LEED, Protocollo ITACA certification system, …
- Key Performance Indicators (KPIs) → 21 selected KPIs

EUB SuperHub DBL data structure – 6 SMART READINESS

Level 0

Level 1



Smart readiness → Smart Readiness Indicator (SRI)

E-mobility → Charging infrastructure for E-mobility, Total number of available parking spaces, Number of purpose-built electrical recharging spaces, Number of pre-cabled recharging stations, EV charging station types, EV charging capacity, Total charging capacity, Maximum charging capacity per E-parking space, EV grid balancing, EV charging information and connectivity

Potential → Smart district potential, Demand response potential

The EUB SuperHub Digital Building Logbook (DBL)

EUB SuperHub

7 FINANCE

The EUB SuperHub DBL will document and store … operational costs

Level 0

7 FINANCE

Level 1

- **Annual rent** → Annual rent, Annual rent per useful floor area
- **Annual property tax** → Annual property tax, Annual property tax per useful floor area
- **Building valuation** → Market value, Rent value, Valuation cost
- **Property selling** → Property price paid, Property price paid per useful floor area
- **Renewal costs** → Renewal costs, Renewal costs per useful floor area, Brief description of renewal, Total renewal cost - LIFE CYCLE COSTS
- **Property yields**
- **Certificate costs** → EPC cost, DGNB certificate cost, BREEAM certificate cost, LEED certificate cost, Protocollo ITACA certificate cost
- **Cost of reports on the inspection of heating and/or air-conditioning systems**
- **Operational costs** → Annual energy costs for each energy carrier (cr), Energy price with VAT included for each energy carrier (cr), TOTAL annual ENERGY costs, Annual water costs
- **Energy revenues** → Annual energy revenues, Annual energy revenues per useful floor area

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Digital Building Logbook (DBL)

8 BUILDING DOCUMENTATION BIM

EUB SuperHub

Level (

8 BUILDING DOCUMENTATION BIM

Level

- **Permits** → Location (planning) permit, Building/construction permit, Use permit
- **Fire safety report**
- **Seismic resilience report**
- **Manuals** → Safety manual, User manual
- **Fire safety plan**
- **Design and plans of the building** → Architectural plans, 3D model, Technical Building System (TBS) plan 1..X, As built plans
- **Tenancy agreement/s**
- **Building utilities** → Utility contracts and bills for electricity, water, thermal energy (natural gas, district heating system, …)
- **Building construction bills**
- **Building maintenance** → Maintenance service contact, Maintenance bills, Maintenance certificate/report
- **Building certification system** → Energy Performance Certification (EPBD), EUB SuperHub certification, Sustainability certification
- **Inspection of heating and air conditioning systems (EPBD)** → Report on the inspection of heating system, Report on the inspection of air-conditioning system
- **Building valuation**
- **Building insurance** → Insurance document
- **Weather data** → Weather file, Weather file for year 2030, Weather file for year 2050
- **Building Information Model - BIM**
- **Building pictures**
- **Thermal image building pictures**

North façade, South façade, East façade, West façade, North-East façade, North-West façade, South-East façade, South-West façade, Top view, Others

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Document Management System (DMS)

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 − Certification contract, Assessment report, Validation report).

8 BUILDING DOCUMENTATION BIM

INPUT from all stakeholders

- Permits
- Fire safety report
- Seismic resilience report
- Manuals
- Fire safety plan
- Design and plans of the building
- Tenancy agreement/s
- Building utilities
- Building construction bills
- Building maintenance
- Building certification system
- Inspection of heating and air conditioning systems (EPBD)
- Building valuation
- Building insurance
- Weather data
- Building Information Model - BIM
- Building pictures
- Thermal image building pictures

Stored EPCs

- Energy Performance Certification (EPBD)
- EUB SuperHub certification
- Sustainability certification

DGNB, BREEAM, LEED, Protocollo ITACA, KGA, HQE, HPI, …

KGA - Kommunalgebäudeausweis - AUSTRIA (Vorarlberg)
HQE - Haute Qualité Environnementale – FRANCE
BNK - Bewertungssystem Nachhaltiger Kleinwohnhausbau - GERMANY
HPI - Home Performance Index - IRELAND

- Design phase
- Construction / As Built phase
- In Use phase

EUB e-Passport
EUB certification documents

- EUB e-Passport Design
- EUB certification documents
- EUB e-Passport As Built
- EUB certification documents
- EUB e-Passport In Use
- EUB certification documents

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Data and Document Management

EUB SuperHub

For all the three phases of the certification process, tables describing the direct connection between the **data/documents input/output required to perform the certification process** have been produced.

Table 2: Actors, data/documents input/output in the EUB certification process for the Design phase

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

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

Stage	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)	–		

Module 3
Indoor Air, Thermal and Daylight Quality

Training Material
Date: Jan 2024

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Contents

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Quality

KPI 10 Ventilation rate

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Qutaliy

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 10	Ventilation rate	[l/(sm2)]	4.1 Level(s)

Objective

- The rate of ventilation is one of the most effective strategies for controlling the exchange of air, CO2, and humidity. It includes the provision of a minimum rate of air exchange to avoid levels of CO2 that are not suitable for health, humidity, and pollutant substances derived from materials inside the environment

Applicability (applicable only to buildings equipped with a mechanical ventilation)

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 10 Ventilation Rate

Description

- This indicator measures the ventilation rate in each main room of the building, in relation to the expected use patterns.
- The assessment boundary of the ventilation rate is the building equipped with a mechanical ventilation
- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

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KPI 10 Ventilation Rate

Scope

- The 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

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KPI 10 Ventilation Rate

Unit of measure

- The Ventilation rate (air flow) is measured as: [l /s/m2]

$$q_{tot} = n \cdot q_p + A_R \cdot q_B$$

where

q_{tot}	= total ventilation rate for the breathing zone, l/s
n	= design value for the number of the persons in the room,
q_p	= ventilation rate for occupancy per person, l/(s person)
A_R	= floor area, m^2
q_B	= ventilation rate for emissions from building, l/(s·m^2)

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KPI 10 Ventilation Rate

Assessment method

The method of calculating the ventilation rate in the design execution phase is provided by EN 16798-1 which defines three different methods for the evaluation of air quality.

Method 1: based on the perceived air quality

Method 2: based on limit values of pollutant concentration

Method 3: based on predefined ventilation rates.

In terms of the accuracy of the final result, method 1 is the preferred one

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

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KPI 10 Ventilation Rate

Detailed description of calculation-based assessment - Method 1

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/m2.

Category	Total design ventilation air flow rate for the room	
	l/(s per person)	l/(s.m²)
I	20	2
II	14	1,4
III	8	0,8
IV	5,5	0,55

$$q_{tot} = n \cdot q_p + A_R \cdot q_B$$

Category	Explanation
I	High level of expectation and is recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons, to increase accessibility
II	Normal level of expectation
III	An acceptable, moderate level of expectation
IV	Low level of expectation. This category should only be accepted for a limited part of the year

air quality categories according to EN 16798-1.

where

q_{tot} = total ventilation rate for the breathing zone, l/s

n = design value for the number of the persons in the room,

q_p = ventilation rate for occupancy per person, l/(s person)

A_R = floor area, m^2

q_B = ventilation rate for emissions from building, l/(s·m²)

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KPI 10 Ventilation Rate

Detailed description of calculation-based assessment - Method 1

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

Table 8. Guideline and limit values for dust and pollutants of indoor relevance in outdoor air.

Parameter	Concentration	Time weighting	Source
Fine particulate matter ($PM_{2.5}$)	10 μg/m³	Annual average	WHO, 2006.
	20 μg/m³	Annual average	Directive 2008/50/EC
	25 μg/m³	24 hour average	WHO, 2006.
Coarse particulate matter (PM_{10})	50 μg/m³	24 hour average	Directive 2008/50/EC
	50 μg/m³	24 hour average	WHO, 2006.
	40 μg/m³	Annual average	Directive 2008/50/EC
	20 μg/m³	Annual average	WHO, 2006.
Benzene	5 μg/m³	Annual average	Directive 2008/50/EC

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/m2).

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KPI 10 Ventilation Rate

Detailed description of calculation-based assessment - Method 2

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- **Method based on limit values for substance concentration:** aims to reduce or dilute a particular substance.

$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \cdot \frac{1}{\varepsilon_v}$$

where

Q_h	is the ventilation rate required for dilution, in m^3 per second;
G_h	is the generation rate of the substance, in micrograms per second;
$C_{h,i}$	is the guideline value of the substance, in micrograms per m^3;
$C_{h,o}$	is the concentration of the substance of the supply air, in micrograms per m^3;
ε_v	is the ventilation effectiveness.

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KPI 10 Ventilation Rate

Detailed description of calculation-based assessment - Method 3

uses a pre-defined minimum ventilation airflow rate estimated to meet needs for perceived air quality and health of occupants

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.m²)	Ach	l/(s per person) [a]	q_p l/(s per person)	q_B l/(s.m²)
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

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KPI 10 Ventilation Rate

Detailed description of measurement-based assessment

- 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.


https://www.ikz.de/sanitaertechnik/news/detail/pruef-und-messverfahren-fuer-raumlufttechnische-anlagen-din-en-125992013-inhalte-und-wesentlich/

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KPI 10 Ventilation Rate

Data For Calculation Method

-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 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

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KPI 10 Ventilation Rate

Data For Measurement Method

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 evaluate the selected parameters (anemometer, flow hood, fan anemometer, etc.)

- 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.

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KPI 10 Ventilation Rate

Reference Standards

- Ventilation rate 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 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 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).

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KPI 10 Ventilation Rate

Helpful links

https://www.youtube.com/watch?v=bEyOnYPDY0U

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1 – Indoor Air Quality

KPI 11 CO2 Concentration

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1 – Indoor Air Qutaliy

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Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 11	CO_2 concentration	[PPM]	4.1 Level(s)

Objective

- To ensure an adequate level of indoor air quality (IAQ), it is necessary to ensure that the concentration of CO2 falls within safety limits. Moreover, the measurement of CO2 concentration is an indirect measure that allows us to understand if the mechanical ventilation is functioning correctly and if there are any anomalies

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

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KPI 11 CO2 concentration

Description

- This indicator measures the CO2 concentration in the use stage of the building.
- 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 indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

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KPI 11 CO2 concentration

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings

400ppm 0.04%	Normal outdoor air
400-1,000ppm 0.04-0.1%	Typical CO2 levels found indoors
1,000-2,000ppm 0.1-0.2%	Common complaints of drowsiness or poor air quality
2,000-5,000ppm 0.2-0.5%	Headaches, fatigue, stagnant, stuffiness, poor concentration, loss of focus, increased heart rate, nausea
>50,000ppm >5%	Toxicity due to oxygen deprivation occurs
>100,000ppm >10%	Oxygen deprivation in seconds: convulsions, coma, and death

https://www.co2meter.com/en-de/blogs/news/carbon-dioxide-indoor-levels-chart

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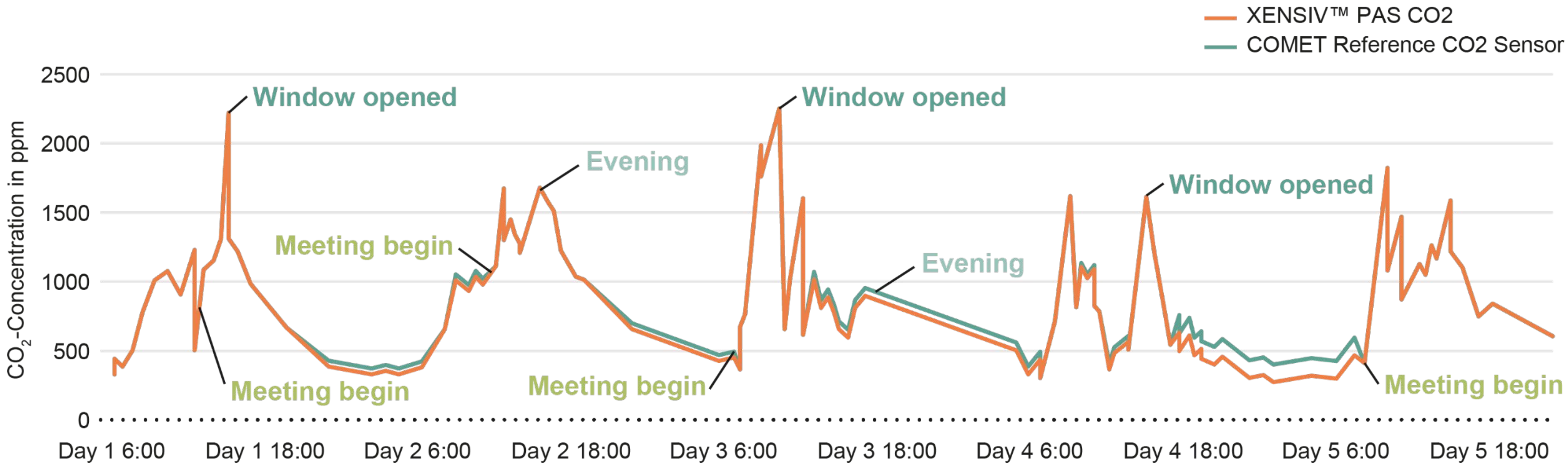
KPI 11 CO2 concentration

Unit of measure

- CO2 concentration is measured as: particle per million [ppm].



https://assonina.it/2021

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KPI 11 CO2 concentration

Assessment method

For the measurement of the CO2 concentration in in-use phase, it is necessary to measure the CO2 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.

Category	CO_2 concentration above outdoors for non-adapted persons (ppm)
I	550
II	800
III	1350
IV	1350

IAQ: indoor air quality.

EN 16798-1 b9

Table B.12 — Design CO_2 concentrations in occupied living rooms and bedrooms

Category	Design ΔCO_2 concentration for living rooms (ppm above outdoors)	Design ΔCO_2 concentration for bedrooms (ppm above outdoors)
I	550	380
II	800	550
III	1 350	950
IV	1 350	950

NOTE 1 The above values in Table B.12 correspond to the equilibrium concentration when the air flow rate is 4, 7, 10 l/s per person for cat. I, II, III respectively and the CO_2 emission is 20 l /h per person and 13,6 l/h per person for living rooms and bedrooms respectively.

NOTE 2 For a 10 m^2 room (room height 2,5 m, 25 m^3) 4; 7 and 10 l/s per person correspond, with two persons in the room, to an air change rate of 1,2; 2,0 and 2,9 ACH.

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KPI 11 CO_2 concentration

Detailed description of measurement-based assessment

Placement of measurement points

Identify at least one measurement point for each environment at a height from the floor between 1.1 m and 1.7 m (breathing zone; 1.5 m according to UNI EN ISO 16000-26:2012) and at a distance greater than 1 m from doors, windows, ventilation grills, or from the air expulsion of any occupant present during the test.

The external measurement point of the building should be close to the real estate unit under examination; avoid external areas that can have a high concentration of CO_2 (e.g., exhaust air grills, garages)

Requirements of measurement instruments

The use of non-dispersive infrared (NDIR) CO_2 sensors, equipped with a data acquisition and recording system (data logger) for continuous monitoring over time, is required, with the following minimum requirements:

range: 0 to 5000 ppm
uncertainty: 50 ppm + 3% of the read value
resolution: 1 ppm

The monitoring of CO_2 must be accompanied by monitoring of the internal thermohydrometric conditions (data logger with relative humidity and air temperature sensors) for a better understanding of the CO_2 trends in relation to user behavior (e.g., opening of windows).

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KPI 11 CO2 concentration

Detailed description of measurement-based assessment

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]

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KPI 11 CO2 concentration

Detailed description of measurement-based assessment

STEP 4: Assign the score to the rooms evaluated. Compare the increasing of the CO2 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

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KPI 11 CO_2 concentration

Detailed description of measurement-based assessment

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

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KPI 11 CO_2 concentration

Data For Measurement Method

- 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 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

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KPI 11 CO_2 concentration

Data For Measurement Method

Floor area (m2)	Method applied	Outdoor air quality (particulates)	Outdoor air quality (gaseous pollutants)	Supply air quality	Filter specification		
					1st	2nd	3rd
2500	Method 3 - predefined airflow rates	ODA (P) 2 - high contamination (<50% above limits)	ODA (G) 1 - clean (below limits)	SUP 2 - rooms for permanent occupation	ePM10: 85%		

Design indoor air quality conditions - specific information for defined building zones

Building zone/room	Floor area (m2)	Method applied	Ventilation performance category	Ventilation rate	Units	Design occupation rate (person/m2)	Upper CO2 limit (ppm above outdoor air)	Control range of relative humidity (%)

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KPI 11 CO_2 concentration

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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 11 CO2 concentration

Helpful links

https://www.youtube.com/watch?v=_hMOKDxOyEo

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Quality

KPI 12 Relative Humidity

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Qutaliy

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 12	Relative humidity	[%]	4.1 Level(s)

Objective

- Relative humidity level is an important factor that influences the comfort of occupants. High relative humidity (> 90%) increases the perception of the intensity of hot or cold temperatures, while excessively low humidity (<20%) can cause irritation to the eyes, nose, and throat. Poor control of the humidity of can create ideal conditions for mold growth.

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

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KPI 12 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 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 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 mold growth, which in turn can provoke respiratory or allergenic health issues

- 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

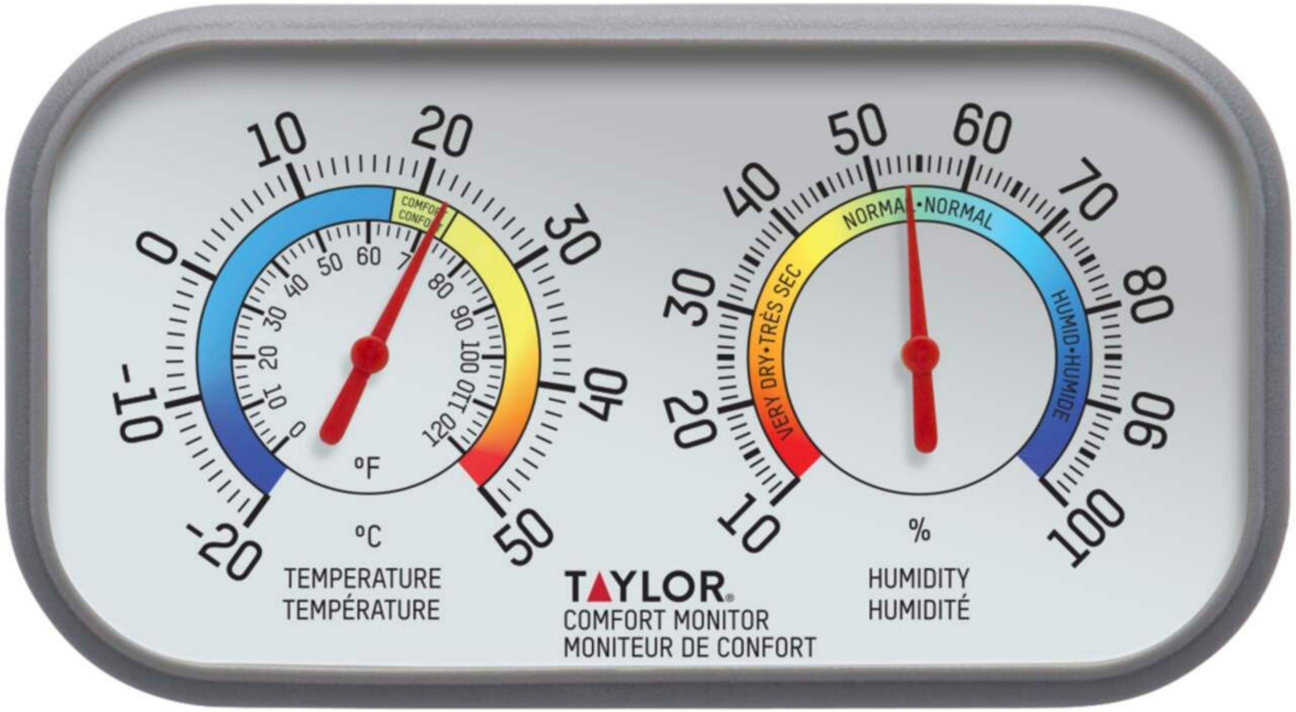
- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings

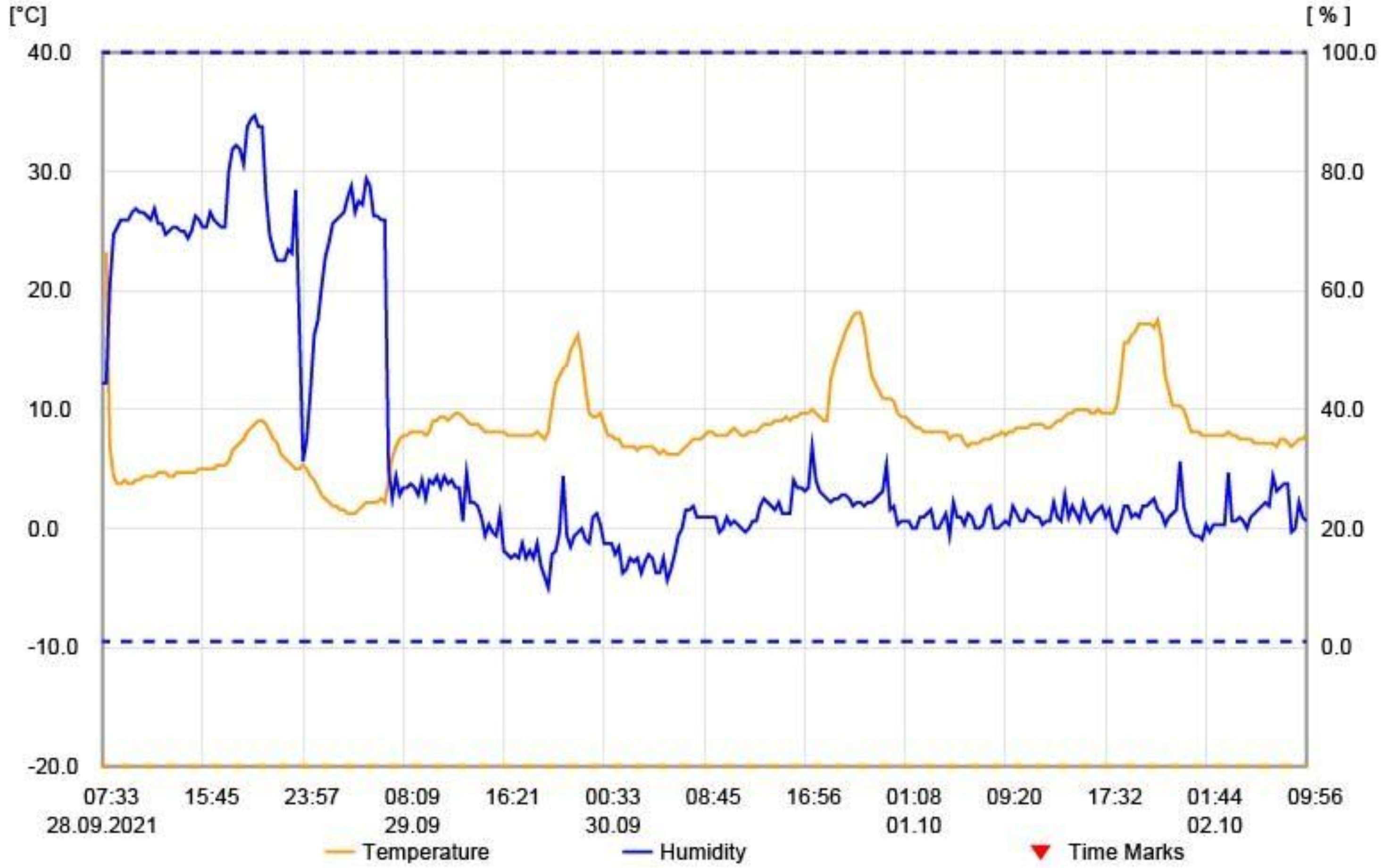


This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Unit of measure

- Relative humidity is measured as: [%].



https://atuncampos.com.ec/room-relative-humidity-an-overview-sciencedirect-topics-ee-6Lo7x9cl

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Assessment method

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).

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Detailed description of measurement-based assessment

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%

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Data For Measurement Method

- Data source (for measurement)

- 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 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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

Data For Measurement Method

Design indoor air quality conditions - general building level information

Floor area (m2)	Method applied	Outdoor air quality (particulates)	Outdoor air quality (gaseous pollutants)	Supply air quality	Filter specification		
					1st	2nd	3rd
2500	Method 3 - predefined airflow rates	ODA (P) 2 - high contamination (<50% above limits)	ODA (G) 1 - clean (below limits)	SUP 2 - rooms for permanent occupation	ePM10: 85%		

Design indoor air quality conditions - specific information for defined building zones

Building zone/room	Floor area (m2)	Method applied	Ventilation performance category	Ventilation rate	Units	Design occupation rate (person/m2)	Upper CO2 limit (ppm above outdoor air)	Control range of relative humidity (%)

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 12 Relative Humidity

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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

EUB SuperHub

1 – Indoor Air Quality

KPI 13 Total VOCs

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

1 – Indoor Air Qutaliy

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 13	Total VOCs	[µg/m3]	4.1 Level(s)

Objective

- To ensure an adequate level of indoor air quality (IAQ), it is necessary to reduce exposure to Volatile Organic Compounds (VOCs) as they have adverse impact on human health, VOCs emissions can be limited through the careful selection of products and construction materials.

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

Description

- This indicator measures the VOCs concentration in the use stage of the building.
- 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.
- Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs 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. VOCs are emitted by a wide array of products numbering in the thousands
- Organic chemicals are widely used as ingredients in household products. Paints, varnishes and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored
- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings.

- 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.

- The reference limit values for TVOCs concentration in indoor air are indicated within the WHO Guidelines.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

Unit of measure

- Total VOCs is measured as: [µg/m3].

Table B.17 —Criteria for the different building types

SOURCE	Low emitting products for low polluted buildings	Very low emitting products for very low polluted buildings
Total VOCs TVOC (as in EN 16516)	< 1 000 µg/m^3	< 300 µg/m^3
Formaldehyde	< 100 µg/m^3	< 30 µg/m^3
Any C1A or C1B classified carcinogenic VOC	< 5 µg/m^3	< 5 µg/m^3
R value (as in EN 16516)	< 1,0	< 1,0

The R value includes the pollutants with limit values that have been identified.

B.7 WHO health-based criteria for indoor air

Table B.21, 2nd column gives suggested guideline values for indoor and outdoor air pollutants as formulated by the WHO. For some pollutants no indoor air requirements have been defined yet by WHO. For those values only WHO outdoor requirements are presented, see the 3rd column.

Table B.21 — WHO guideline values for indoor and outdoor air pollutants

Pollutant	WHO Indoor Air Quality guidelines 2010	WHO Air Quality guidelines 2005
Benzene	No safe level can be determined	-
Carbon monoxide	15 min. mean: 100 mg/m^3 1 h mean: 35 mg/m^3 8h mean: 10 mg/m^3 24 h mean: 7 mg/m^3	-
Formaldehyde	30 min. mean: 100 µg/m^3	-
Naphthalene	Annual mean: 10 µg/m^3	-
Nitrogen dioxide	1 h mean: 200 µg/m^3 Annual mean: 20 µg/m^3	-
Polyaromatic Hydrocarbons (e.g. Benzo Pyrene A B[a]P)	No safe level can be determined	-
Radon	100 Bq/m^3 (sometimes 300 mg/m^3, country-specific)	-
Trichlorethylene	No safe level can be determined	-
Tetrachloroethylene	Annual mean: 250 µg/m^3	
Sulfure dioxide	-	10 min. mean: 500 µg/m^3 24 h mean: 20 µg/m^3
Ozone	-	8 h mean: 100 µg/m^3
Particulate Matter PM 2,5	-	24 h mean: 25 µg/m^3 Annual mean: 10 µg/m^3

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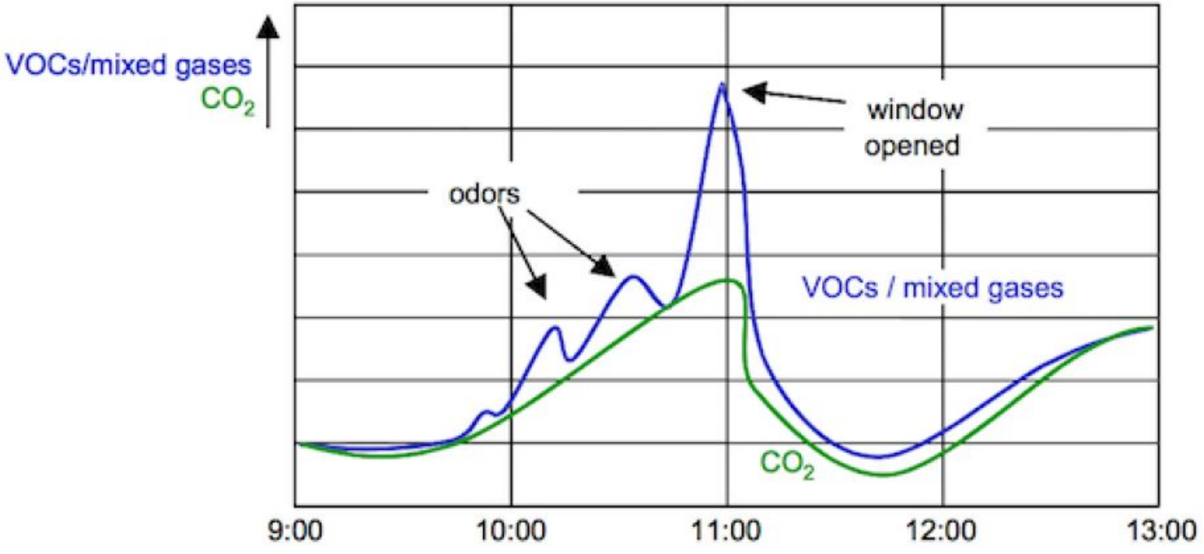
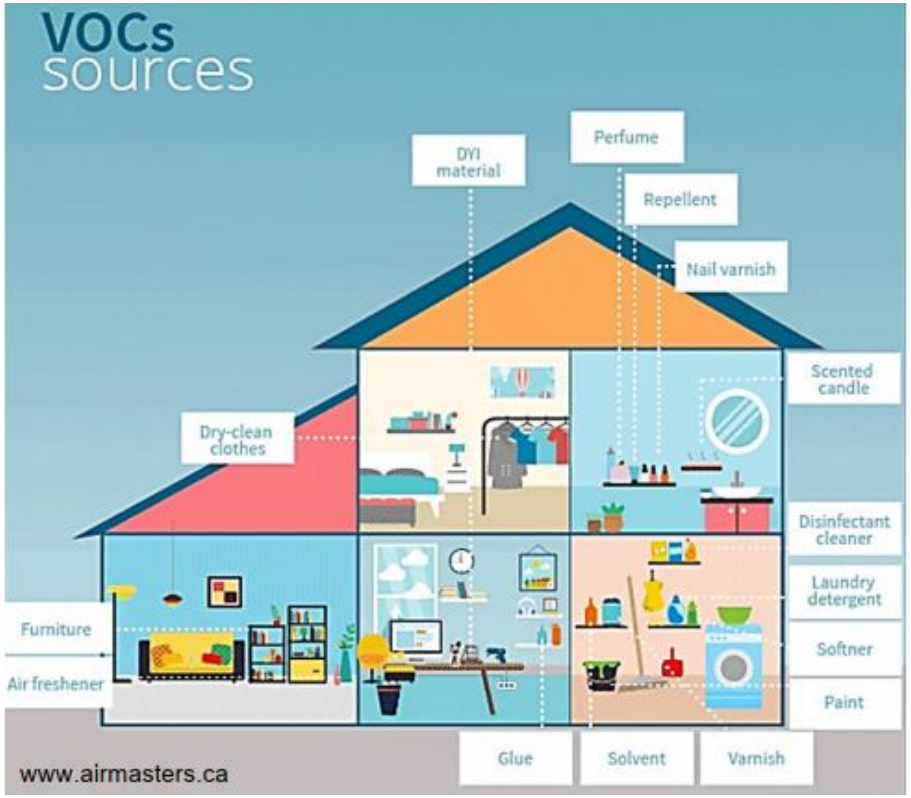
KPI 13 Total VOCs

Assessment method

For the measurement of TVOCs in the as-built and usage phases of the building, it is necessary to measure the concentration of TVOCs in the internal air and the external air, near the building, by using VOC detectors placed on tripods at a height of 1.5 meters





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KPI 13 Total VOCs

Assessment method (as built phase):

After the completion of a building, it is important to assess the level of TVOC concentration in the internal air for the health of future occupants. The measurement of TVOCs can be carried out both in the presence of mechanical ventilation and in the case of natural ventilation.

The verification of the TVOC concentration level must be carried out in all the main rooms of the building and, at the same time, in the external area adjacent to the building. For each pollutant measured, it is necessary to verify the quantitative increase in the value of the internal air relative to the external air value.

The reference values for TVOCs in the internal air are highlighted in the World Health Organization (WHO) guidelines.

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KPI 13 Total VOCs

Assessment method (in use phase):

An additional consideration is the fact that, since the building is in use, all the variants that can influence the measurement must be noted, such as the number of occupants, smoking habits, types of furnishings, etc.

The instruments to be used for the measurement can vary depending on which pollutant needs to be assessed; in most cases, VOC detectors placed on tripods at a height of 1.5 meters are used.

It is advisable to carry out the measurement over a period sufficient to establish the trend of the TVOC concentration level (not less than one week)

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

Detailed description of measurement-based assessment

STEP 1: Measure the indoor concentration of each pollutant (Benzene - Toluene - Styrene - Tetrachlorethylene - Trichlorethylene) within the selected main rooms.

STEP 2: Measure the absolute 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 absolute concentration (Ci) of the indoor air compared to the external one, using the following formula:

$$C_i = | C_{out} - C_{ext} | \ [\mu g/m3]$$

where:

C_{out} = value of the individual indoor VOC [μg/m3];

C_{ext} = value of the individual external VOC [μg/m3]

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KPI 13 Total VOCs

Detailed description of measurement-based assessment

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:

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

where: Σni = 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:

$$Ki = \Delta Cmi/VGi$$

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KPI 13 Total VOCs

Detailed description of measurement-based assessment

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

Ka = Σ Ki

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

Building Kb index* Performance scale

Building K_b index*	Performance scale
< 0,1	5
0,1 and 0,3	3
0,3 and 0,5	0
0,5 and 1	-1

*Kb index is equal to the main index building

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KPI 13 Total VOCs

Data For Measurement Method

- 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 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 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.

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KPI 13 Total VOCs

Data For Measurement Method

Level 3 - 4.1.2 Target indoor air pollutants		Representative area tested			Representative area tested		
Nature of IAQ parameter	IAQ parameter	Design stage	Post completion (prior to occupation)	During occupation	Design stage	Post completion (prior to occupation)	During occupation
Pollutants predominantly from outdoor sources	Radon (Bq/m^3)						
	$PM_{2.5}$ ($\mu g/m^3$)						
	PM_{10} ($\mu g/m^3$)						
	Ozone ($\mu g/m^3$)						
	Benzene ($\mu g/m^3$)						
Air quality aspects (from outdoor & indoor sources)	Relative humidity (%)						
	CO2 (ppm indoors)						
	CO2 (ppm outdoors)						
Pollutants predominantly from indoor sources	Total VOC ($\mu g/m^3$)	n/a			n/a		
	Total CMR VOCs ($\mu g/m^3$)	n/a			n/a		
	R-value	n/a			n/a		
	Formaldehyde ($\mu g/m^3$)	n/a			n/a		

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

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).

- The reference limit values for TVOCs concentration in indoor air are indicated within the WHO Guidelines.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 13 Total VOCs

Helpful links

https://www.youtube.com/watch?v=u6W_06qbFPI&list=PL3EGWMSHI12Yp64Snr36_x2168tTqui3N&index=7

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EUB SuperHub

1 – Indoor Air Quality

KPI 14 CMR VOCs concentration

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

1 – Indoor Air Qutaliy

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 14	CMR VOCs concentration	[µg/m3]	4.1 Level(s)

Objective

- To ensure an adequate level of indoor air quality (IAQ), it is necessary to reduce exposure to (CMR VOCs) Carcinogen, Mutagen, Reprotoxic. CMR VOCs refers to substances which are chronically toxic and have very serious impacts on health are classified as Carcinogenic, Mutagenic or toxic for Reproduction according to Regulation (EC) No 1272/2008 as they have adverse impact on human health.

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Description

- This indicator measures the CMR VOCs concentration in the use stage of the building.

- CMR VOCs is measured according to what stated in EN 16516 and in the ISO 16000-6:2021. In addition to Total VOCs estimation, a value for total CMR VOCs is necessary to separately identify the more hazardous substances that may be emitted.

- 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

- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings.

- 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..

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KPI 14 CMR VOCs concentration

Unit of measure

- CMR VOCs is measured as: [μg/m3].

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KPI 14 CMR VOCs concentration

Assessment method

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).

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Detailed description of measurement-based assessment

STEP 1: Measure the indoor concentration Carcinogenic, Mutagenic, Reprotoxic pollutants within the selected main rooms.

STEP 2: Measure the absolute 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 absolute concentration (Ci) of the indoor air compared to the external one, using the following formula:

$$C_i = | C_{out} - C_{ext} | \ [\mu g/m3]$$

where:
C_{out} = value of the individual indoor CMR VOCs [μg/m3];
C_{ext} = value of the individual external CMR

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Detailed description of measurement-based assessment

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:

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

where: Σni = 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.

$$K_a = \Sigma Ki$$

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Data For Measurement Method

- 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 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.
-

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 14 CMR VOCs concentration

Data For Measurement Method

EUB SuperHub

Level 3 - 4.1.2 Target indoor air pollutants		Representative area tested			Representative area tested		
Nature of IAQ parameter	IAQ parameter	Design stage	Post completion (prior to occupation)	During occupation	Design stage	Post completion (prior to occupation)	During occupation
Pollutants predominantly from outdoor sources	Radon (Bq/m^3)						
	$PM_{2.5}$ ($\mu g/m^3$)						
	PM_{10} ($\mu g/m^3$)						
	Ozone ($\mu g/m^3$)						
	Benzene ($\mu g/m^3$)						
Air quality aspects (from outdoor & indoor sources)	Relative humidity (%)						
	CO2 (ppm indoors)						
	CO2 (ppm outdoors)						
Pollutants predominantly from indoor sources	Total VOC ($\mu g/m^3$)	n/a			n/a		
	Total CMR VOCs ($\mu g/m^3$)	n/a			n/a		
	R-value	n/a			n/a		
	Formaldehyde ($\mu g/m^3$)	n/a			n/a		

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 14 CMR VOCs concentration

Reference Standards

- CMR VOCs 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 CMR 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).
- The reference limit values for CMR VOCs concentration in indoor air are indicated within the WHO Guidelines.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Quality

KPI 15 R value

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Qutaliy

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 15	R value	[decimal ratio]	4.1 Level(s)

Objective

- To ensure an adequate level of indoor air quality (IAQ), it is necessary to reduce exposure to toxic substance . the R value normalizes each individual VOC concentration with respect to the "lowest concentration of interest" LCI value specific for that single VOC. This creates a coefficient for each VOC and, when the coefficients for VOCs identified individually in the same sample are summed together, it is possible to generate the composite R value

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 15 R value

Description

- This indicator measures the R value. The R value normalizes each individual VOC concentration with respect to the "lowest concentration of interest“ LCI value specific for that single VOC.

- Since each individual VOC has the potential toxicity in case of human exposure, the value R has been developed, trying to translate data from total VOC measurements into potential health risks.

- An R value >1 means that the content of VOCs in the indoor air can be a risk to human health.

- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 15 R value

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings.

- The R value is a metered indicator, it can be measured during the in-use phase.

- Concerning the LCI values, the main document to which refer to is the Agreed EU-LCI values , developed by the European Commission, released in December 2021

- 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 air . This European Standard specifies a horizontal reference method for the determination of emissions of regulated dangerous substances from construction products into indoor

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 15 R value

Unit of measure

- R value is measured as: [decimal ratio].
- R value is measured according to what stated in EN 16516 and in ISO 16000-6.
- 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. When more than one substance with an EU-LCI value is measured, the R values of each substance are added together.

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 15 R value

Assessment method

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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 15 R value

Detailed description of measurement-based assessment

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.

- 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. When more than one substance with an EU-LCI value is measured, the R values of each substance are added together.

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KPI 15 R value

Data For Measurement Method

- 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 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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 15 R value

Data For Measurement Method

Level 3 - 4.1.2 Target indoor air pollutants		Representative area tested			Representative area tested		
Nature of IAQ parameter	IAQ parameter	Design stage	Post completion (prior to occupation)	During occupation	Design stage	Post completion (prior to occupation)	During occupation
Pollutants predominantly from outdoor sources	Radon (Bq/m^3)						
	$PM_{2.5}$ ($\mu g/m^3$)						
	PM_{10} ($\mu g/m^3$)						
	Ozone ($\mu g/m^3$)						
	Benzene ($\mu g/m^3$)						
Air quality aspects (from outdoor & indoor sources)	Relative humidity (%)						
	CO2 (ppm indoors)						
	CO2 (ppm outdoors)						
Pollutants predominantly from indoor sources	Total VOC ($\mu g/m^3$)	n/a			n/a		
	Total CMR VOCs ($\mu g/m^3$)	n/a			n/a		
	R-value	n/a			n/a		
	Formaldehyde ($\mu g/m^3$)	n/a			n/a		

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Quality

KPI 16 Formaldehyde concentration

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Indoor Air Qutaliy

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Indoor air quality	KPI 16	Formaldehyde concentration	[decimal ratio]	4.1 Level(s)

Objective

- 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. Ventilation can reduce indoor exposure to formaldehyde

Applicability (applicable only to In-use Buildings)

Building use:

- Residential
- Non-residential

Project stage:

- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 16 Formaldehyde concentration

Description

- This indicator measures the Formaldehyde concentration in 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.

- Formaldehyde 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.

- Reference limit values for formaldehyde concentration in indoor air are indicated within the WHO Guidelines and in the AFSSET document.

- The AFSSET , 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..

- The indicator is alighted with the Level(s) indicator 4.1: Indoor air quality

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 16 Formaldehyde concentration

Scope

- The KPI addresses both residential and non-residential buildings, but it is important to point out that this KPI is only applicable to in-use buildings.

- The Formaldehyde concentration is a metered indicator, it can be measured during the in-use phase.

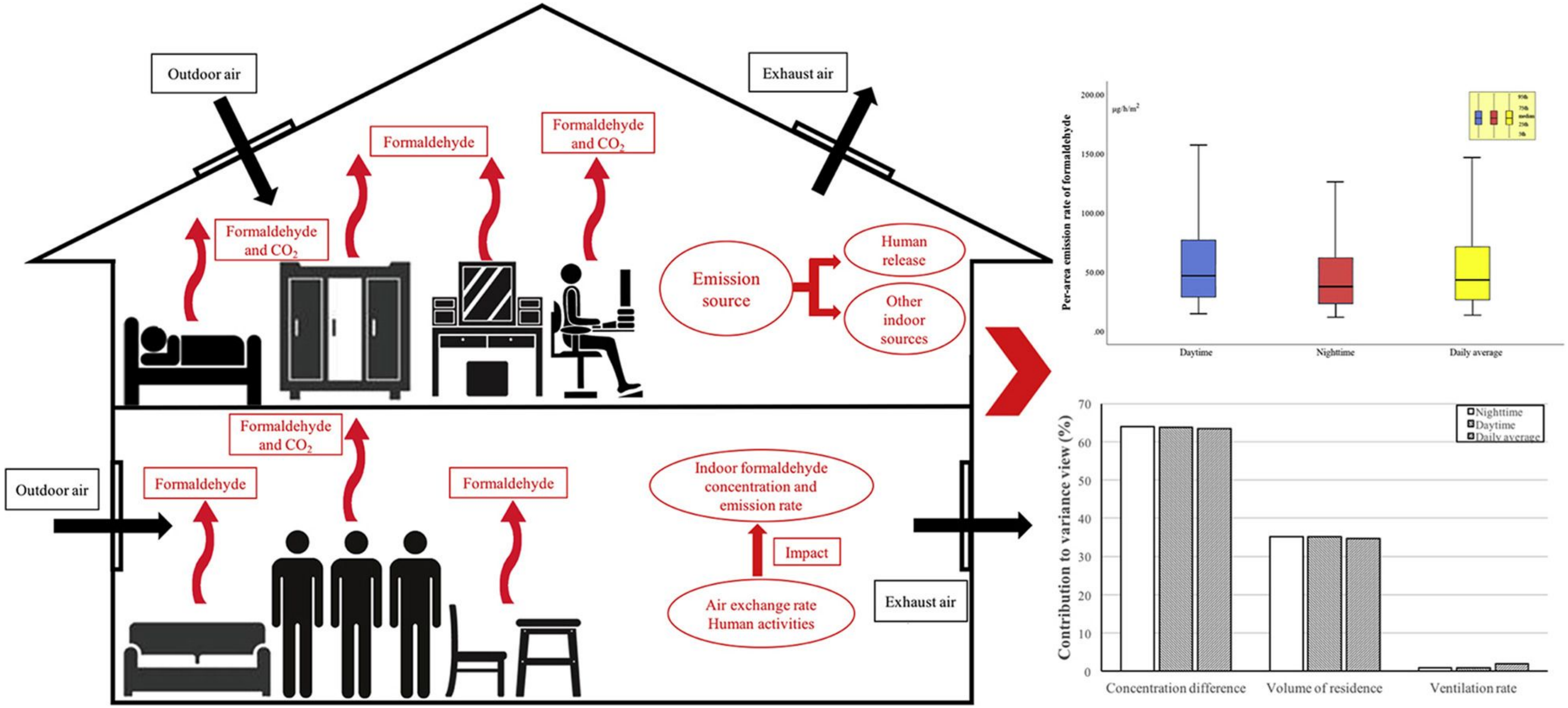
- Formaldehyde is measured according to what stated in EN 16516 and the ISO 16000-6:2021. Reference limit values for formaldehyde concentration in indoor air are indicated within the WHO Guidelines and in the AFSSET document.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 16 Formaldehyde concentration

Unit of measure

- Formaldehyde concentration is measured as: [µg/m3]



Li, Baizhan, et al. "An investigation of formaldehyde concentration in residences and the development of a model for the prediction of its emission rates." Building and environment 147 (2019): 540-550.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 16 Formaldehyde concentration

Assessment method

- 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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 16 Formaldehyde concentration

Detailed description of measurement-based assessment

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

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 16 Formaldehyde concentration

Detailed description of measurement-based assessment

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

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KPI 16 Formaldehyde concentration

Data For Measurement Method

- 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 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.

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KPI 16 Formaldehyde concentration

Data For Measurement Method

Level 3 - 4.1.2 Target indoor air pollutants		Representative area tested			Representative area tested		
Nature of IAQ parameter	IAQ parameter	Design stage	Post completion (prior to occupation)	During occupation	Design stage	Post completion (prior to occupation)	During occupation
Pollutants predominantly from outdoor sources	Radon (Bq/m^3)						
	$PM_{2.5}$ ($\mu g/m^3$)						
	PM_{10} ($\mu g/m^3$)						
	Ozone ($\mu g/m^3$)						
	Benzene ($\mu g/m^3$)						
Air quality aspects (from outdoor & indoor sources)	Relative humidity (%)						
	CO2 (ppm indoors)						
	CO2 (ppm outdoors)						
Pollutants predominantly from indoor sources	Total VOC ($\mu g/m^3$)	n/a			n/a		
	Total CMR VOCs ($\mu g/m^3$)	n/a			n/a		
	R-value	n/a			n/a		
	Formaldehyde ($\mu g/m^3$)	n/a			n/a		

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2 – Thermal Comfort

KPI 9 Percentage of time outside of thermal comfort range

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2 – Thermal Comfort

KPI 9 Percentage of time outside of thermal comfort range

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2 – Thermal comfort

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Thermal comfort	KPI 9	Percentage of time outside of thermal comfort range	[%]	4.2 Level(s)

Objective

- 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

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 9 Percentage of time outside of thermal comfort range

Description

- This indicator measures the percentage of time of the year, during occupation periods, when building occupiers are not comfortable with the thermal conditions inside a building.

- 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

- Thermal comfort is supposed to be guaranteed when the indoor temperature in each space or zone that accounts for >10% of the reference area of a building is within a range of 18°C to 27°C. (Category III EN 16798-1 Table B.5/ Category C EN ISO 7730)

- The control of overheating is specifically addressed by the Energy Performance of Buildings Directive (EPBD) 2018/844

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 9 Percentage of time outside of thermal comfort range

Scope

- The indicator's scope encompasses the assessment of both the internal operating temperature and the comfort levels of the building's occupants. For buildings equipped with full or mixed-mode mechanical cooling systems, the assessment is to be done twice: with and without the use mechanical systems.

- The assessment of performance shall apply to the conditioned spaces or zones that account for >10% of the total area unit of the building.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 9 Percentage of time outside of thermal comfort range

Unit of measure

- The percentage of time [%] in which the indoor operative temperature (to) is out of a range of 18°C to 27°C, (Category III EN 16798-1 Table B.5 / Category C EN ISO 7730) during the occupation periods of the year (heating and cooling seasons), with and without building services.

Cate-gory	Thermal state of the body as a whole		Operative temperature °C		Max. mean air velocity m/s	
	PPD %	PMV	Summer (0,5 clo) Cooling	Winter(1 clo) Heating	Summer(0,5 clo) Cooling	Winter(1 clo) Heating
A	< 6	-0.2 < PMV < + 0.2	23,5 – 25,5	21,0 – 23,0	0,18	0,15
B	< 10	-0.5 < PMV < + 0.5	23,0 – 26,0	20,0 – 24,0	0,22	0,18
C	< 15	0.7 < PMV < + 0.7	22,0 – 27,0	19,0 – 25,0	0,25	0,21

Table B.5 — Temperature ranges for hourly calculation of cooling and heating energy in four categories of indoor environment

Type of building or space	Category	Temperature range for heating seasons, °C Clothing approximately 1,0 clo	Temperature range for cooling seasons, °C Clothing approximately 0,5 clo
Residential buildings, living spaces (bed room's, kitchens, living rooms etc.) Sedentary activity ~1,2 met	I	21,0 –25,0	23,5 - 25,5
	II	**20,0–25,0**	**23,0 - 26,0**
	III	18,0- 25,0	22,0 - 27,0
	IV	17,0–25,0	21,0 – 28,0
Residential buildings, other spaces (utility rooms, storages etc.) Standing-walking activity ~1,5 met	I	18,0–25,0	
	II	**16,0–25,0**	
	III	14,0–25,0	
Offices and spaces with similar activity (single offices, open plan offices, conference rooms, auditoria, cafeteria, restaurants, class rooms) Sedentary activity ~1,2 met	I	21,0 – 23,0	23,5 - 25,5
	II	**20,0 – 24,0**	**23,0 - 26,0**
	III	19,0 – 25,0	22,0 - 27,0
	IV	17,0–25,0	21,0 – 28,0
During the between heating and cooling seasons (with Θ_{rm} between 10 and 15°C) temperature limits that lie in between the winter and summer values may be used. Air velocity is assumed < 0,1 m/s and RH~40% for heating season and 60% for cooling season.			

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KPI 9 Percentage of time outside of thermal comfort range

Terms and Definitions

Operative temperature(to):

is defined as the uniform temperature of an enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the existing non-uniform environment.

$$t_o = \frac{h_c \, . t_a + h_r \, . \bar{t}_r}{h_c + h_r}$$

Where: ta–air temperature
tr–mean radiant temperature
hc–heat-transfer coefficient by convection
hc–heat-transfer coefficient by radiation.

In general: hr= 4,9 w/m2k hc= 2,9 w/m2k
If :
-surfaces with very different temperatures -hr= *tr*;
-high air velocities (var>0.2 m/s) -hc= (10. var) 1/2.

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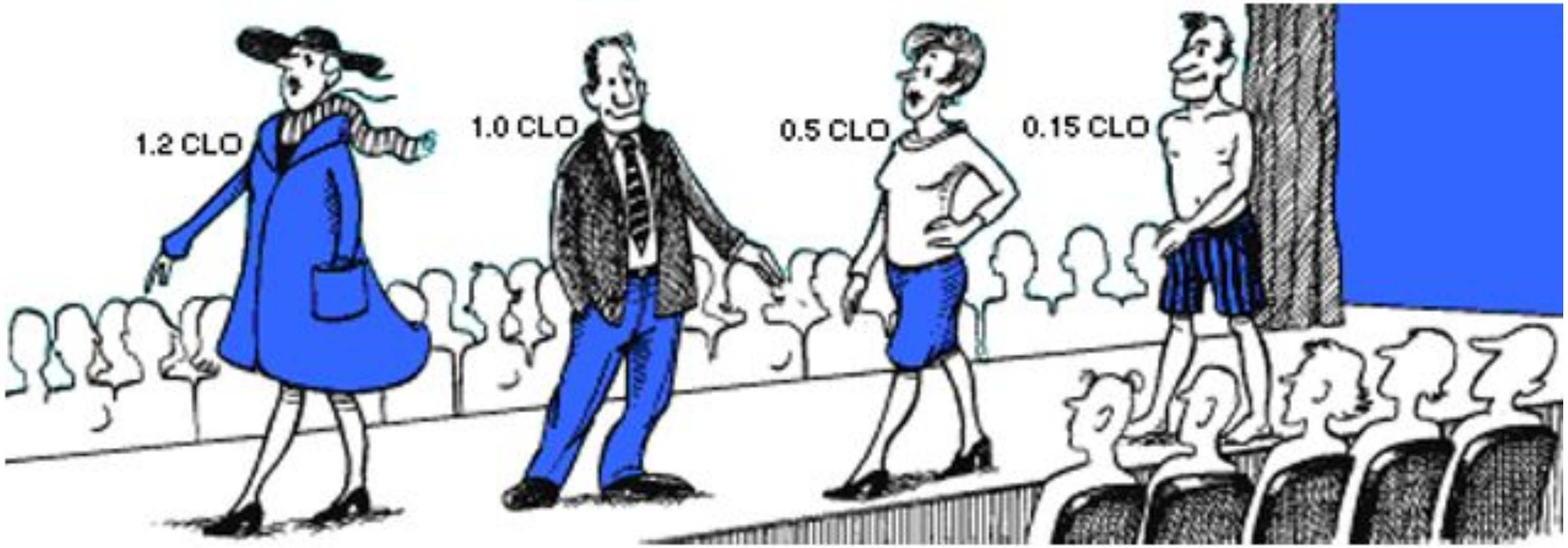
KPI 9 Percentage of time outside of thermal comfort range

Terms and Definitions

The unit normally used for measuring clothing's insulation is the Clo unit, but the more technical unit m2° C/W is also seen frequently (1 Clo = 0.155 m2°C/W).

The Clo scale is designed so that a naked person has a Clo value of 0.0 and someone wearing a typical business suit has a Clo value of 1.0. Some normal Clo values are shown in the figure



This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.
https://stem.elearning.unipd.it/pluginfile.php/462049/mod_resource/content/1/Thermal%20Booklet.pdf

KPI 9 Percentage of time outside of thermal comfort range

Terms and Definitions

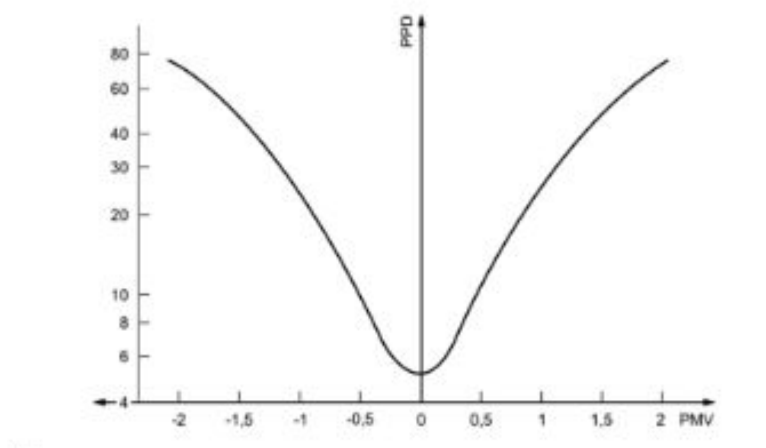
PPD and PMV

The PMV predicts the mean value of the thermal votes of a large group of people exposed to the same environment. But individual votes are scattered around this mean value and it is useful to be able to predict the number of people likely to feel uncomfortably warm or cool. The PPD is an index that establishes a quantitative prediction of the percentage of thermally dissatisfied people who feel too cool or too warm. For the purposes of this International Standard, thermally dissatisfied people are those who will vote hot, warm, cool or cold on the

PMV

+ 3	Hot
+ 2	Warm
+ 1	Slightly warm
0	Neutral
– 1	Slightly cool
–2	Cool
– 3	Cold

PPD



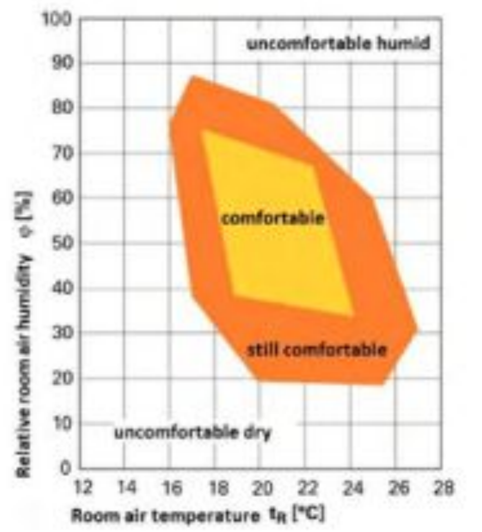
Key
PMV predicted mean vote
PPD predicted percentage dissatisfied, %

ISO 7730

Local thermal discomfort

Thermal dissatisfaction can also be caused by unwanted cooling or heating of one particular part of the body. This is known as local thermal discomfort. Key inputs are:

- Draught
- Vertical Air temperature difference
- Warm and cold floors
- Radiant asymmetry



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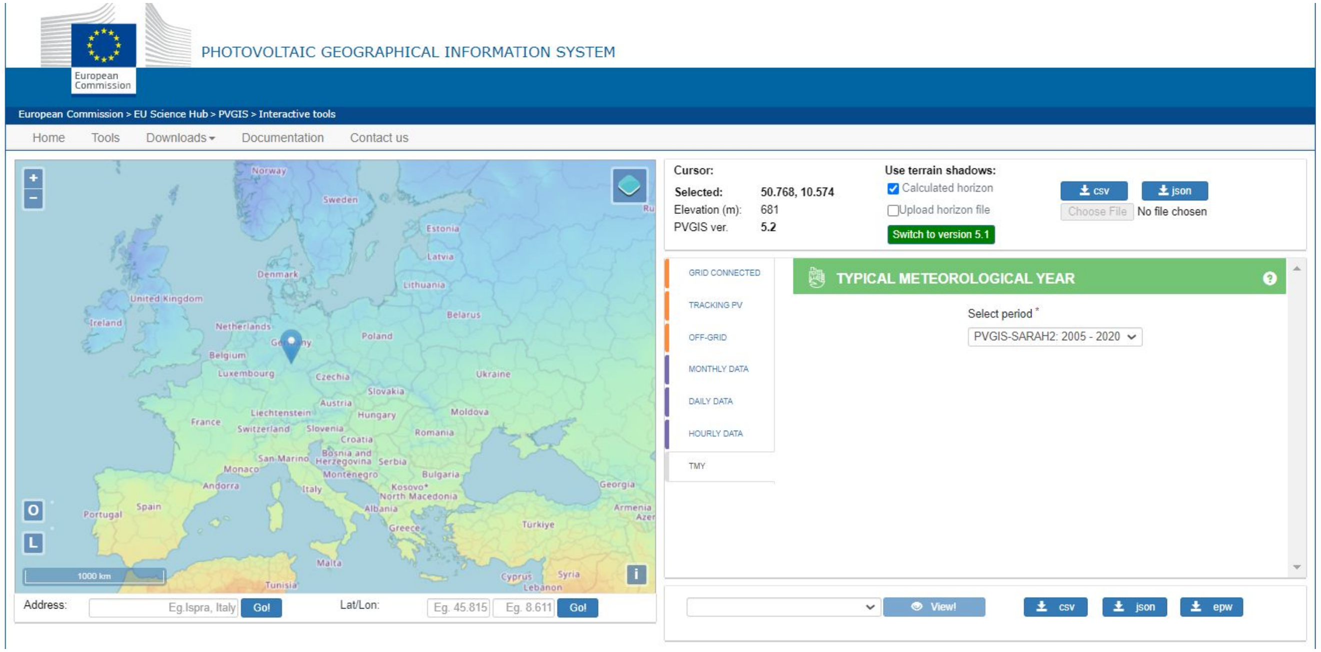
https://oculusltd.co.nz/thecomfortstandards/

KPI 9 Percentage of time outside of thermal comfort range

Terms and Definitions

Typical meteorological year (TMY)

A typical meteorological year (TMY) is a set of meteorological data with data values for every hour in a year for a given geographical location. The data are selected from hourly data for the full time period available, currently 2005-2020 in PVGIS 5.2 and 2005-2016 in PVGIS 5.1. If it is not possible to access local meteorological data on an hourly basis, the freely accessible meteorological data bank of the Joint Research Centre, Photovoltaic Geographical Information System (PVGIS) – TMY



https://re.jrc.ec.europa.eu/pvg_tools/en/#TMY

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https://oculusltd.co.nz/thecomfortstandards/

KPI 9 Percentage of time outside of thermal comfort range

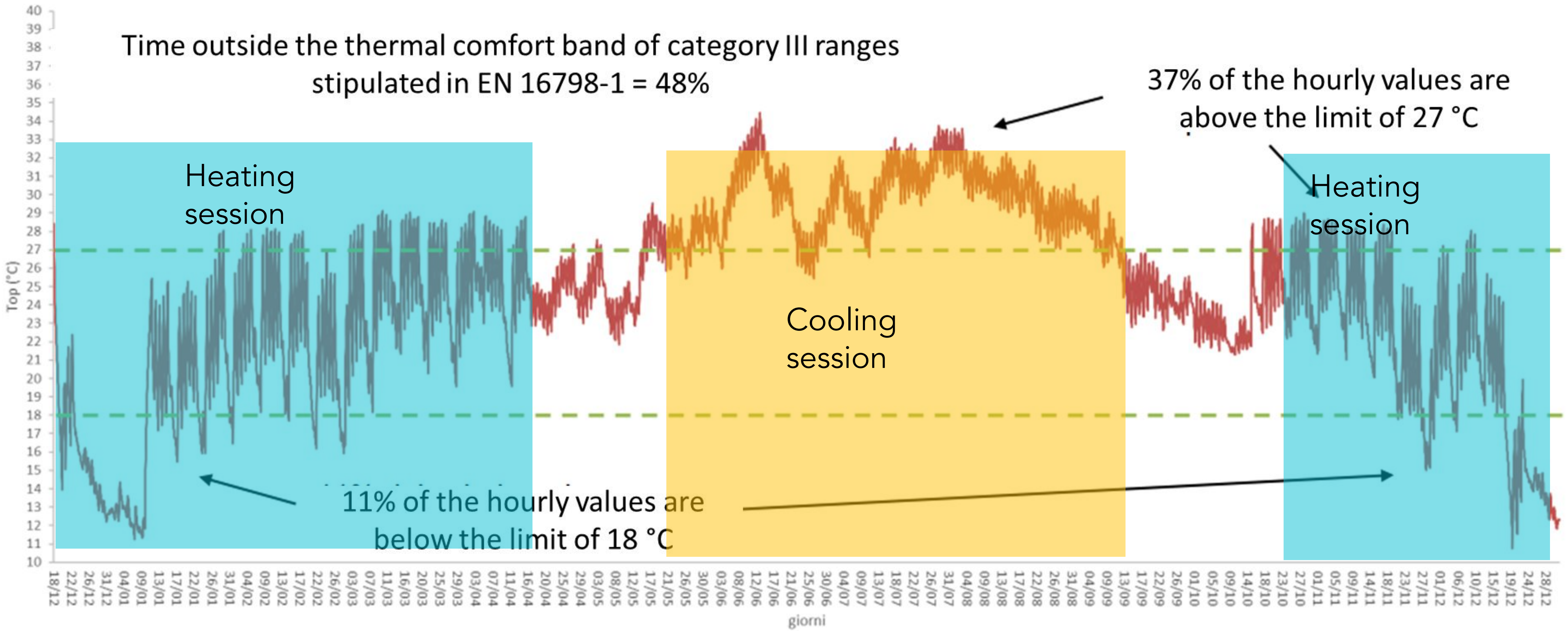
Assessment method

Nr	
1	The indicator is calculated with a dynamic simulation tool / onsite measurement based on EN ISO 7730
2	The assessment is made based on time outside the category III temperatures ranges stipulated in EN 16798-1/ EN ISO 7730 for conditioned spaces or zones that account for >10% of the total area unit of the building
3	Establish two models for each building or property typology, one with mechanical heating/cooling systems and one without
4	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. If not use the values from the 16798-1
5	Determine also whether the weather files are stipulated or not in a national method. In any case the weather files must be in line with the EN 16798-1definition of typical meteorological year (TMY) and PVGIS 5.2.
6	Define the the reference area of a building and the duration of the heating and cooling season based on national definitions
7	Calculate the average value of the global building indoor temperature, weighted by the surface areas and the occupancy intensity of the different thermal spaces or zones.
8	If the simulation does not automatically calculate the time outside the interval, identify the result of the calculation routine that can be used to query the internal hourly temperature and analyze the result to obtain the percentages for the higher and lower temperature bands.
9	Use a reporting format for assessment results, and document assumptions, method, weather data, etc. so as to facilitate interpretation and comparison.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 9 Percentage of time outside of thermal comfort range

Assessment method



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KPI 9 Percentage of time outside of thermal comfort range

Reporting format

Project Stage	Design / Construction	As Built/ In Use
Assessment method	Simulation	Onsite-measurement
Assessment reference	Category III EN 16798-1 Table B.5 (18°C to 27° C)	Category C EN ISO 7730 (18°C to 27°C)
Reference area	m² of the area unit	m² of the area unit
% Time outside comfort range during the heating session with mechanical system	%	%
% Time outside comfort range during the heating session without mechanical system	%	%
% Time outside comfort range during the Cooling session with mechanical system	%	%
Time outside comfort range during the Cooling session without mechanical system	%	%
Cumulative % Time outside comfort range with a mechanical system	%	%
Cumulative % Time outside comfort range without mechanical system	%	%

KPI 9 Percentage of time outside of thermal comfort range

Data

The input data collected by the assessors shall be compliant with the input data required in the ISO EN 52000-1 series, EN ISO 52016-1, EN 16798-1:2019 and if applicable the EN ISO 7730:2005 (under revision)

Examples of requested input data are listed below:

- Details about building envelope and windows: U values and construction method (for building without an EPC or detailed drawing this can be substituted by data from construction year class for existing buildings)
- Building materials and related thermal mass
- Building openings and orientation
- Building usage and occupancy profiles
- Building heating systems
- Building cooling systems
- Weather data

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KPI 9 Percentage of time outside of thermal comfort range

Reference Standards

- EN ISO 52000 series: The calculation of the reported performance shall be based on a dynamic energy simulation complying with the EN ISO 52000-1 series.
- EN ISO 52016-1: Energy performance of buildings - Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads
- 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 (it replaces EN 15251:2007).
- CEN/TR 16798-2:2019 - Energy performance of buildings - Ventilation for buildings - Part 2: Interpretation of the requirements in EN 16798-1.
- EN ISO 7730:2005 - Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (under revision)

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KPI 9 Percentage of time outside of thermal comfort range

Helpful links

https://www.youtube.com/watch?v=PPqATKgAoW4&t=1919s

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2 – Thermal Comfort

KPI 19 - Summer thermal discomfort in 2050

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2 – Thermal comfort

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Resilience to Overheating	KPI 19	Summer thermal discomfort in 2050	[%] of time in 2050 in which the indoor temperature exceeds 27 °C during the cooling season	5.1 Level(s)

Objective

- 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 severe 2050. 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

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 19 - Summer thermal discomfort in 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 year 2050.
- 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 cooling seasons in 2050.
- 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
- Thermal comfort is supposed to be guaranteed when the indoor temperature in each space or zone that accounts for >10% of the reference area of a building does not exceed 27°C during the cooling season.
- The indicator follows basically the same methodology as KPI 9 (Time outside of thermal comfort range), except that it uses projections for future climate in 2050 to measure the thermal performance of the building instead of past weather data

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 - Summer thermal discomfort in 2050

Scope

- The indicator's scope encompasses the assessment of both the internal operating temperature and the comfort levels of the building's occupants based on climate projection for the year 2050. For buildings equipped with full or mixed-mode mechanical cooling systems, the assessment is to be done twice: with and without the use mechanical systems.

- The assessment of performance shall apply to the conditioned spaces or zones that account for >10% of the total area unit of 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.

- The assessment of performance shall apply to the conditioned spaces or zones that account for >10% of the total area unit of the building.

- The assessment of performance shall be done for using an hourly Dynamic simulations model

- The climate projection modeling must be based on the UN IPCC Mitigation emissions scenario (SRES A2 or RCP 6.0).

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KPI 19 - Summer thermal discomfort in 2050

Unit of measure

- The percentage of time [%] in which the indoor operative temperature (to) is above 27°C, during the occupation periods for the year 2050 (based on IPCC Mitigation scenario (SRES A1B or RCP 6.0), with and without cooling system building services.

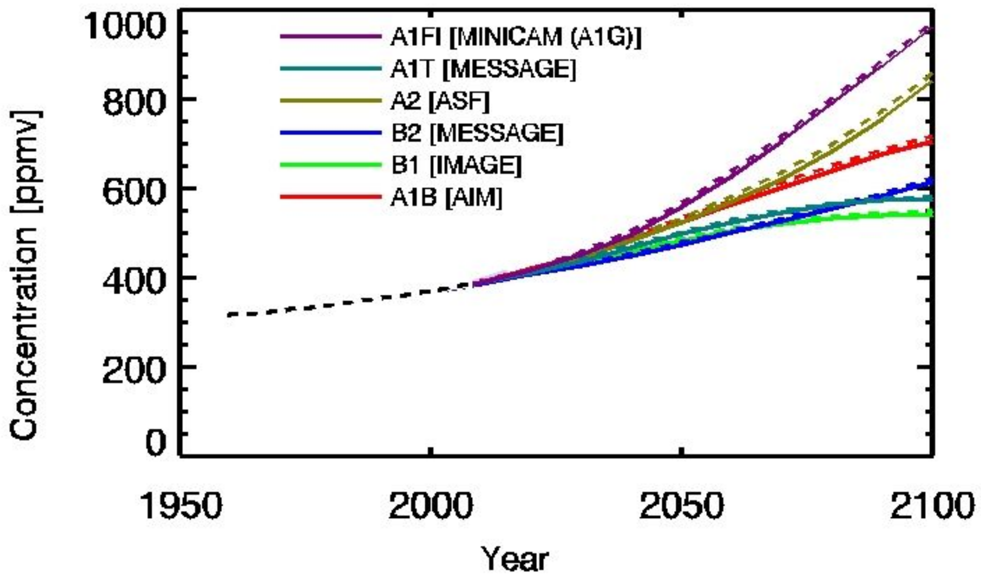
This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 - Summer thermal discomfort in 2050

Terms and Definitions

- The SRES (Special Report on Emissions Scenarios) Scenarios are climate change scenarios that were developed by the Intergovernmental Panel on Climate Change (IPCC) for use in assessing the possible impacts of climate change. These scenarios were created to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions.

- They are broadly divided into four narrative storylines labeled A1, A2, B1, and B2, which are designed to cover a wide range of the main demographic, economic, and technological driving forces of future greenhouse gas and sulfur emissions



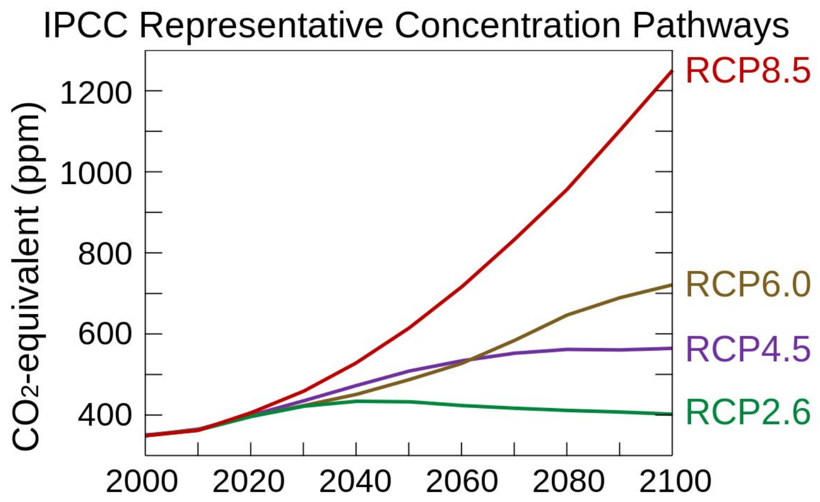
This project is co-funded by the Europ

KPI 19 - Summer thermal discomfort in 2050

Terms and Definitions

- The Representative Concentration Pathways (RCPs) are climate projections developed for the Intergovernmental Panel on Climate Change (IPCC) to be used in the Fifth Assessment Report (AR5) and beyond. They are scenarios that include possible future climate outcomes based on different concentrations of greenhouse gases and other forcings. Here's what each RCP represents

- RCP 6.0: is stabilization scenario, but the path to stabilization is less aggressive than in RCP 4.5. Radiative forcing in this scenario reaches 6.0 W/m² by the end of the century. It assumes that some mitigation policies will be implemented but does not involve as rapid a shift away from fossil fuels as the lower RCP



This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 - Summer thermal discomfort in 2050

Assessment method

Nr	
1	The indicator is calculated with a dynamic simulation tool to estimate the % time in which the building operative temperature exceed 27°C during the cooling season (summer) in the year 2050
2	Define the spaces or zones that account for >10% of the total area unit of the building
3	Establish two models for each building or property typology, one with mechanical heating/cooling systems and one without
4	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. If not use the values from the 16798-1
5	Select reliable climate projections 2050 based on the UN IPCC mitigation emissions scenario SRES A2 or RCP 6.0, that are intended for the site or region
6	Define the the reference area of a building and the duration of the heating and cooling season based on national definitions
7	Calculate the average value of the global building indoor temperature, weighted by the surface areas and the occupancy intensity of the different thermal spaces or zones.
8	If the simulation does not automatically calculate the time outside the interval, identify the result of the calculation routine that can be used to query the internal hourly temperature and analyze the result to obtain the percentages for the higher and lower temperature bands.
9	Use a reporting format for assessment results, and document assumptions, method, weather data, etc. so as to facilitate interpretation and comparison.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 - Summer thermal discomfort in 2050

Reporting format

Project Stage	**Design / Construction / In use**
Assessment method	Simulation
Assessment reference	[%] of time in 2050 in which the indoor temperature exceeds 27 °C during the cooling season
Reference area	m^2 of the area unit
Weather file used and RPC or SRES	
% of time in which the indoor temperature exceeds 27 °C during the cooling season without mechanical system	%
% of time in which the indoor temperature exceeds 27 °C during the cooling season with mechanical system	%

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KPI 19 - Summer thermal discomfort in 2050

Data

The input data collected by the assessors shall be compliant with the input data required in the ISO EN 52000-1 series, EN ISO 52016-1, EN 16798-1:2019 and EN ISO 52010-1

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 year 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

Posslibe sources of 2050 Data files:

https://www.ipcc-data.org/sim/gcm_clim/SRES_TAR/hadcm3_download.html

https://www.iesve.com/support/weatherfiles/weathershift

https://meteonorm.com/en/meteonorm-version-8

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KPI 19 - Summer thermal discomfort in 2050

Reference Standards

EUB SuperHub

- EN ISO 52000 series: The calculation of the reported performance shall be based on a dynamic energy simulation complying with the EN ISO 52000-1 series.

- EN ISO 52016-1: Energy performance of buildings - Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads

- 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 (it replaces EN 15251:2007).

- EN ISO 52010-1:2018 Energy performance of buildings, External climatic conditionsPart 1: Conversion of climatic data for energy calculations

- EN ISO 7730:2005 - Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (under revision)

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KPI 19 - Summer thermal discomfort in 2050

Helpful links

https://www.youtube.com/watch?v=YLx8sZZLxtc

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

3 – Daylight sufficiency

KPI 21 - Daylight Provision

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

3 – Daylight sufficiency

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Daylight sufficiency	KPI 21	Daylight Provision	[%]	EN 17037

Objective

- Daylight can contribute significantly to the lighting needs of any type of building and accordingly, in improving the energy performance of buildings and user health and comfort

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 21 Daylight Provision

Description

- This indicator measures the ratio of time in which a target illuminance level is achieved across a fraction of the reference plane compared to the duration of daylight time.
- The indicator is aligned with the EN 17037 CEN European Daylight Standard.

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KPI 21 Daylight Provision

Scope

- The indicator's scope encompasses the assessment of ratio of time a target illuminance level is achieved across a fraction of the reference plane compared to the duration of daylight time.

- For new and renovated buildings, The daylight provision is calculated according to EN 17037. Paragraph 5.1.3 and Annex B (Method2) - (The standard requires a minimum daylighting provision of 300 lx of natural light illuminance over 50 % of the space and 100 lx minimum over 95 % of the space, both for more than half of the daylight hours in the year)

- For in-use budlings, the daylight provision is measured according to UNI 10840, EN 12464-1 and UNI 11142.

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KPI 21 Daylight Provision

Unit of measure

- [%] natural light illuminance .
- EN 17037:2018 states ''that a space is considered to provide adequate daylight if a target and minimum illuminance level is achieved across a fraction of the reference plane within a space for at least half of the daylight hours

Table A.1 — Recommendations of daylight provision by daylight openings in vertical and inclined surface

Level of recommendation for vertical and inclined daylight opening	Target illuminance E_T lx	Fraction of space for target level $F_{plane,\%}$	Minimum target illuminance E_{TM} lx	Fraction of space for minimum target level $F_{plane,\%}$	Fraction of daylight hours $F_{time,\%}$
Minimum	300	50 %	100	95 %	50 %
Medium	500	50 %	300	95 %	50 %
High	750	50 %	500	95 %	50 %
NOTE Table A.3 gives target daylight factor (D_T) and minimum target daylight factor (D_{TM}) corresponding to target illuminance level and minimum target illuminance, respectively, for the CEN capital cities.					

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KPI 21 Daylight Provision

Assessment method for new and renovated b...

EUB SuperHub

Nr	
1	The indicator is calculated with a dynamic simulation tool
2	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
3	Method 1) Calculation method using daylight factors on the reference plane.
4	Method 2) Calculation method of illuminance levels on the reference plane using climatic data for the given site and an adequate time step
5	Annex A of EN 17037 gives values for target illuminances and minimum target illuminances to be achieved.
6	Annex B of EN 17037 describes recommendations for the daylight calculations using the two methods

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KPI 21 Daylight Provision

Assessment method for in-use buildings

Nr	
1	Daylight provision in-situ measurement is measured according to what is stated in UNI 10840, EN 12464-1 and UNI 11142.
2	For each main room of the building, it is necessary to evaluate the lighting values identifying several measuring points distributed in the space.
3	Some adjusting must be adopted to obtain an accurate measurement (curtains drawn, obstruction resulting from the furniture, absence of occupants, etc.)
4	At the same time of the indoor measurements, the external values are measured (better in overcast conditions with no direct solar radiation).
5	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.
6	Annex A of EN 17037 gives values for target illuminances and minimum target illuminances to be achieved.

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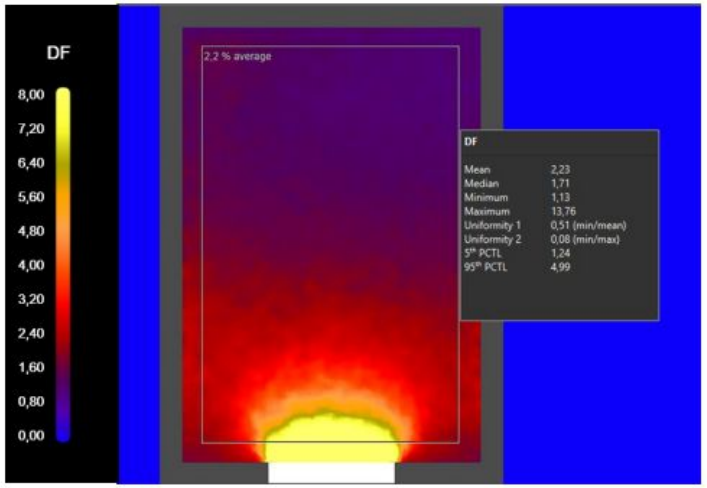
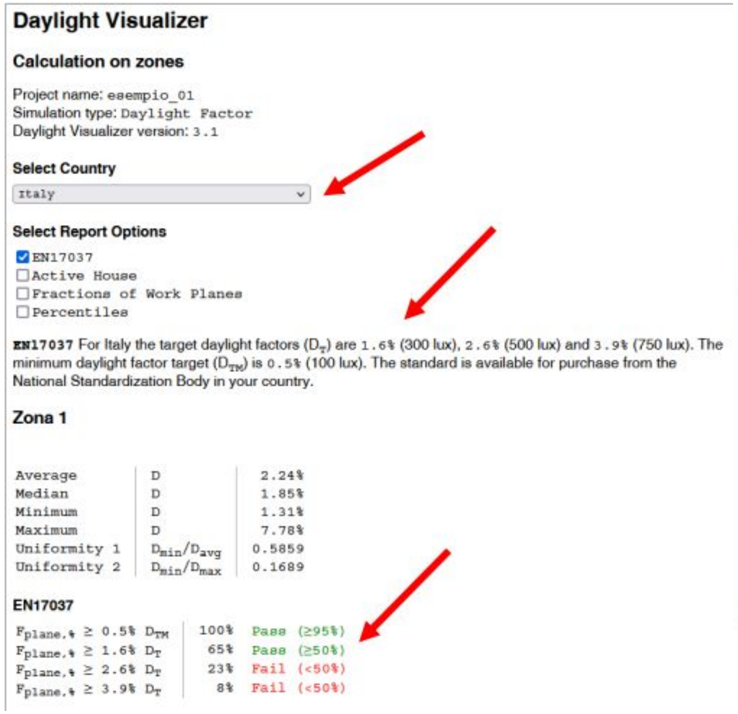
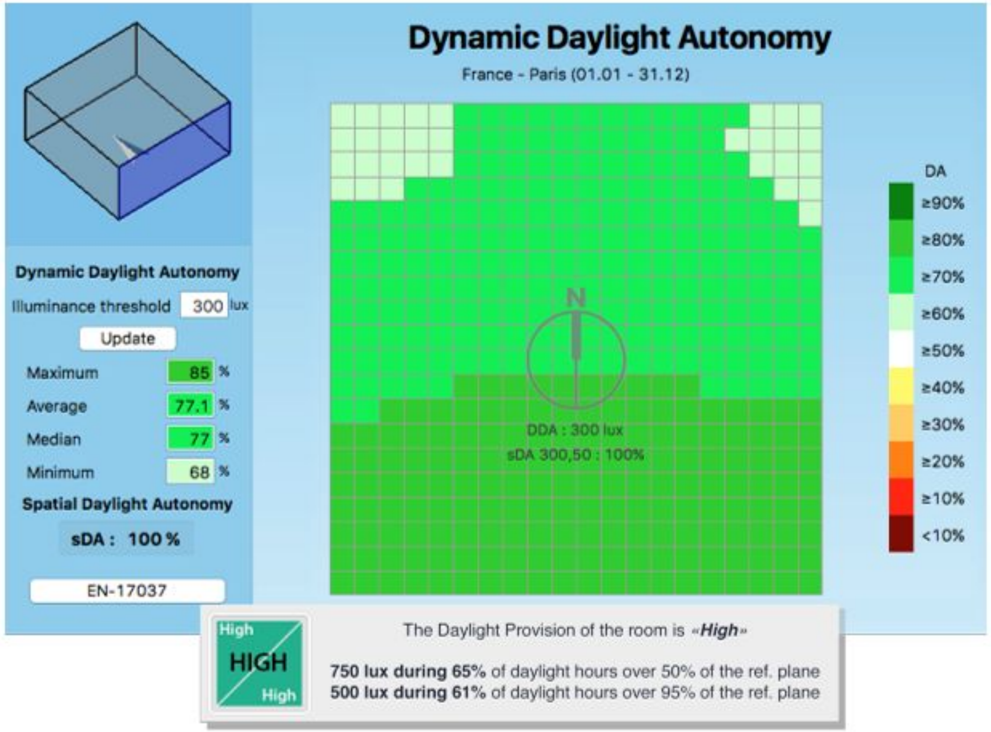
KPI 21 Daylight Provision

Assessment method







Display of the Daylight Provision calculated with the dynamic approach Method B EN 17037 - Paule, B., Boutillier, J., Pantet, S., Sutter, Y., & Sa, E. (2018). A lighting simulation tool for the new European daylighting standard. Proceedings of BSO, 2018, 4th.

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KPI 21 Daylight Provision

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 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.

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KPI 21 Daylight Provision

Data

- 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 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

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KPI 21 Daylight Provision

Reference Standards

- 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.

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KPI 21 Daylight Provision

Helpful links

https://www.youtube.com/watch?v=CwLgjjeMYKs

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Module 4
Indoor Energy, Renewables, GHG emission and Operational energy cost

Training Material
Date: Jan 2024
Ahmed Khoja
Hochschule München University of Applied Sciences

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

Contents

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

1 – Energy consumption

KPI 1 - Delivered annual energy demand per area unit

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1 – Energy consomption

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 1	Delivered annual energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)

Objective

- The Net delivered energy demand, is the energy required to meet the demand of buildings (EPB) services of the assessed building only. It represents delivered minus exported energy, both expressed per energy carrier

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 1 Delivered annual energy demand per area unit

Description

- Energy can be delivered to the building and exported from the building through the system boundary.

It is important to differentiate between:

- Delivered energy demand and
- Net delivered energy demand.

- The delivered energy demand is used for satisfying the uses taken into account or to produce the exported energy.

- The Net delivered energy demand, is the energy required to meet the energy demand of considered energy performance of buildings (EPB) services of the assessed building only, represents delivered minus exported energy, both expressed per energy carrier

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KPI 1 Delivered annual energy demand per area unit

Scope

- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- 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

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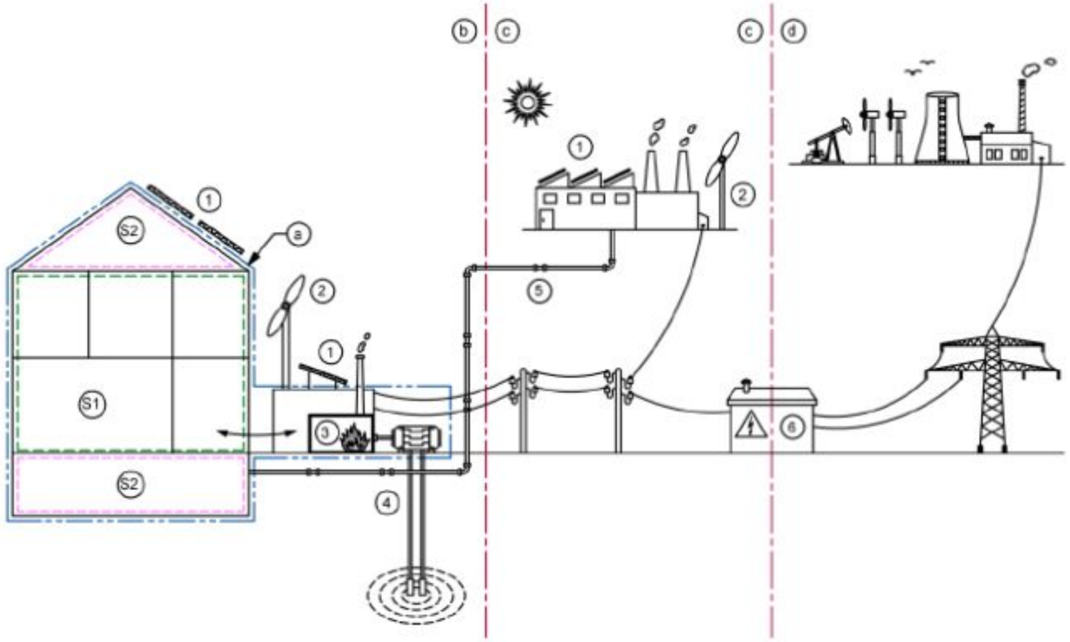
KPI 1 Delivered annual energy demand per area unit

Unit of measure

- Delivered annual energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{del}}$ in [kWh/(m2a)]



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
		S2,	Space outside thermal envelope	2	Wind
b	On-site			3	Boiler room
c	Nearby			4	Heat pump
d	Distant			5	District heating / cooling
				6	Substation (low voltage and possible storage)

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KPI 1 Delivered annual energy demand per area unit

The Assessment method

EUB SuperHub

According to EN ISO 52000 (Table 3), there are two types/methods of the energy performance of building assessment:

- calculated (asset) assessment method,
- measured (operational) assessment method – only applicable to existing buildings in the use phase.

Subtypes of calculated (asset) assessment method: design, as built, actual, and <u>tailored</u>.

Subtypes of measured (operational) assessment method: actual, climate corrected, use corrected, and <u>standard</u>.

The assessment type and subtype used should be reported in all cases for the purposes of comparability.

To compare calculated and measured delivered energy:

- either the calculation shall be tailored to reflect the same conditions of climate and use of the building as the measured energy performance (subtype of calculated (asset) assessment method → <u>tailored</u>),

or the measured energy performance to be compared shall be standardized for climate and use to reflect the same conditions as the calculated energy performance (subtype of measured (operational) assessment method → <u>standard</u>).

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KPI 1 Delivered annual energy demand per area unit

Detailed description of calculation-based assessment method

The calculation direction goes from the needs (e.g. for space heating/cooling, domestic hot water preparation) to the delivered energy and calculations are based on the boundary conditions of use (e.g., internal set-point temperature, usage times)

Calculated delivered annual energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{del,calc}}$ in **kWh/(m²a)** through the system boundary required to meet the energy demand of considered uses and to generate the exported energy:

$$E_{\mathrm{del,calc}} = \frac{\sum E_{\mathrm{del},cr,\mathrm{calc}}}{A}$$

where:

$E_{\mathrm{del},cr,\mathrm{calc}}$ is the calculated annual delivered energy for energy carrier (cr) [kWh/a]

A – is the area unit [m^2]

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KPI 1 Delivered annual energy demand per area unit

Detailed description of calculation-based assessment method

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Calculated (asset) assessment method for calculating the delivered annual energy demand per area unit:

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 energy demand per area unit** $\boldsymbol{E_{\mathrm{del,calc}}}$ in **kWh/(m^{2}a)** to the building site by summing up the calculated annual delivered energy for each energy carrier (cr) (from step 2) and then dividing by area unit.

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KPI 1 Delivered annual energy demand per area unit

Detailed description of calculation-based assessment method

Calculated net delivered annual energy demand per area unit for EPB services $\boldsymbol{E_{\text{del,net,calc}}}$ in $\mathbf{kWh/(m^2a)}$ through the assessment boundary:

$$E_{\text{del,net,calc}} = \frac{\sum E_{\text{del},cr,\text{calc}} - \sum E_{\text{exp},cr,\text{calc}}}{A}$$

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 – is the area unit [m^2]

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KPI 1 Delivered annual energy demand per area unit

Detailed description of calculation-based assessment method

EUB SuperHub

Calculated (asset) assessment method for calculating the net delivered annual energy demand per area unit:

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 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 energy demand** per area unit $E_{\mathrm{del,net,calc}}$ in kWh/(m^{2}a) by subtracting the total annual exported energy from the total annual delivered energy and then dividing by area unit.

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KPI 1 Delivered annual energy demand per area unit

Detailed description of measurement-based assessment method

The measured delivered annual energy demand per area unit to meet the energy demand of considered EPB services $\boldsymbol{E}_{\mathbf{del,meas}}$ 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 energy demand per area unit $E_{\mathrm{del,calc}}$ in kWh/(m²a) using the measured delivered energy amount $E_{\mathrm{del};cr,\mathrm{meas}}$ instead of the corresponding calculated amounts $E_{\mathrm{del};cr,\mathrm{calc.}}$:

$$E_{\mathrm{del,meas}} = \frac{\sum E_{\mathrm{del},cr,\mathrm{meas}}}{A}$$

where:

$E_{\mathrm{del},cr,\mathrm{meas}}$ is the measured annual delivered energy for energy carrier (cr) corrected to standard use and climate data set [kWh/a]

A – is the area unit [m²]

NOTE: The actual measured annual delivered energy for energy carrier (cr) under actual conditions needs to be corrected to standard use (correction from actual to standard occupancy pattern and conditions of use) and climate data set (correction from the actual to the standard weather). Also, only desired EPB services should be considered excluding for example appliances and lighting in the case of residential buildings.

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KPI 1 Delivered annual energy demand per area unit

Detailed description of measurement-based assessment method

Measured (operational) assessment method - delivered annual energy demand per area unit:

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. if non-EPB services are included in the raw measured data, perform separation procedures to get measured annual delivered energy for EPB services only,
3. to get the measured annual delivered energy for energy carrier (*cr*) corrected to standard use and climate data set perform the following corrections:

- correction from actual to standard occupancy pattern and conditions of use,
- correction from the actual to the standard weather,

4. calculate the **delivered annual energy demand per area unit** $\boldsymbol{E_{\mathrm{del,meas}}}$ in **kWh/(m^{2}a)** to the building site by summing up measured annual delivered energy for each energy carrier (*cr*) corrected to standard use and climate data set (from step 3) and then dividing by area unit.

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KPI 1 Delivered annual energy demand per area unit

Detailed description of measurement-based assessment method

The measured net delivered annual energy demand per area unit $\boldsymbol{E_{\mathrm{del,net.meas}}}$ 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 energy demand per area unit $E_{\mathrm{del,net,calc}}$ in kWh/(m²a) using the measured delivered and exported energy amounts $E_{\mathrm{del};cr,\mathrm{meas}}$ and $E_{\mathrm{exp};cr,\mathrm{meas}}$ instead of the corresponding calculated amounts $E_{\mathrm{del};cr,\mathrm{calc}}$ and $E_{\mathrm{exp};cr,\mathrm{calc.}}$:

$$E_{\mathrm{del,net,meas}} = \frac{\sum E_{\mathrm{del},cr,\mathrm{meas}} - \sum E_{\mathrm{exp},cr,\mathrm{meas}}}{A}$$

where:

$E_{\mathrm{del},cr,\mathrm{meas}}$ is the measured annual delivered energy for energy carrier (cr) corrected to standard use and climate data set [kWh/a]

$E_{\mathrm{exp},cr,\mathrm{meas}}$ is the measured annual exported energy for energy carrier (cr) [kWh/a]

A – is the area unit [m²]

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KPI 1 Delivered annual energy demand per area unit

Detailed description of measurement-based assessment method

Measured (operational) assessment method – net delivered annual energy demand per area unit:

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. if non-EPB services are included in the raw measured data, perform separation procedures to get measured annual delivered energy for EPB services only,
3. to get the measured annual delivered energy for energy carrier (*cr*) corrected to standard use and climate data set perform the following corrections for each energy carrier (*cr*):

- correction from actual to standard occupancy pattern and conditions of use,
- correction from the actual to the standard weather,

1. calculate the total annual delivered energy to the building site corrected to standard use and climate data set by summing up measured annual delivered energy for each energy carrier (*cr*) corrected to standard use and climate data set (from step 3),
2. measure annual exported energy from the building site through the assessment boundary for each energy carrier (*cr*),
3. calculate the total annual exported energy from the building site by summing up measured annual exported energy for each energy carrier (*cr*) (from step 5),

calculate the **net delivered annual energy demand per area unit** $E_{\mathbf{del,net,meas}}$ in **kWh/(m²a)** by subtracting the total annual exported energy from the total annual delivered energy and then dividing by area unit.

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KPI 1 Delivered annual energy demand per area unit

Data

- **Data source (for calculation)**

For the calculation of the **calculated delivered annual energy demand per area unit $\boldsymbol{E}_{\mathbf{del,calc}}$** in **kWh/(m²a)**, the following values are required:

- $\Sigma E_{\mathrm{del},cr,\mathrm{calc}}$ is the sum of all calculated 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 is area unit in [m²]

For the calculation of the **calculated net delivered annual energy demand per area unit $\boldsymbol{E}_{\mathbf{del,net,calc}}$** in **kWh/(m²a)**, the following values are required:

- $\Sigma E_{\mathrm{del},cr,\mathrm{calc}}$ is the sum of all calculated 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]
- $\Sigma E_{\mathrm{exp},cr,\mathrm{calc}}$ is the sum of all calculated annual exported energy from the building site for energy carrier (cr) in [kWh/a]
- A is area unit in [m²]

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KPI 1 Delivered annual energy demand per area unit

Data

- **<u>Data source (for measurement)</u>**

For the calculation of the **measured delivered annual energy demand per area unit $\boldsymbol{E_{\mathrm{del,meas}}}$** in **kWh/(m^{2}a)**, the following values are required:

- $\Sigma E_{\mathrm{del},cr,\mathrm{meas}}$ is the sum of all <u>measured</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 is area unit in [m^2]

For the calculation of the **measured net delivered annual energy demand per area unit $\boldsymbol{E_{\mathrm{del,net,meas}}}$** in **kWh/(m^{2}a)**, the following values are required:

- $\Sigma E_{\mathrm{del},cr,\mathrm{meas}}$ is the sum of all <u>measured</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]
- $\Sigma E_{\mathrm{exp},cr,\mathrm{meas}}$ is the sum of all <u>measured</u> annual exported energy from the building site for energy carrier (*cr*) in [kWh/a]

A is area unit in [m^2]

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KPI 1 Delivered annual energy demand per area unit

Reference Standards

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 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.

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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Energy consumption

KPI 2 - Total annual primary energy demand per area unit

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Energy consumption

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Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 2	Total annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)

Objective

- 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 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

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 2 Total annual primary energy demand per area unit

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 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

- 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.

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KPI 2 Total annual primary energy demand per area unit

Scope

- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- 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.
- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.

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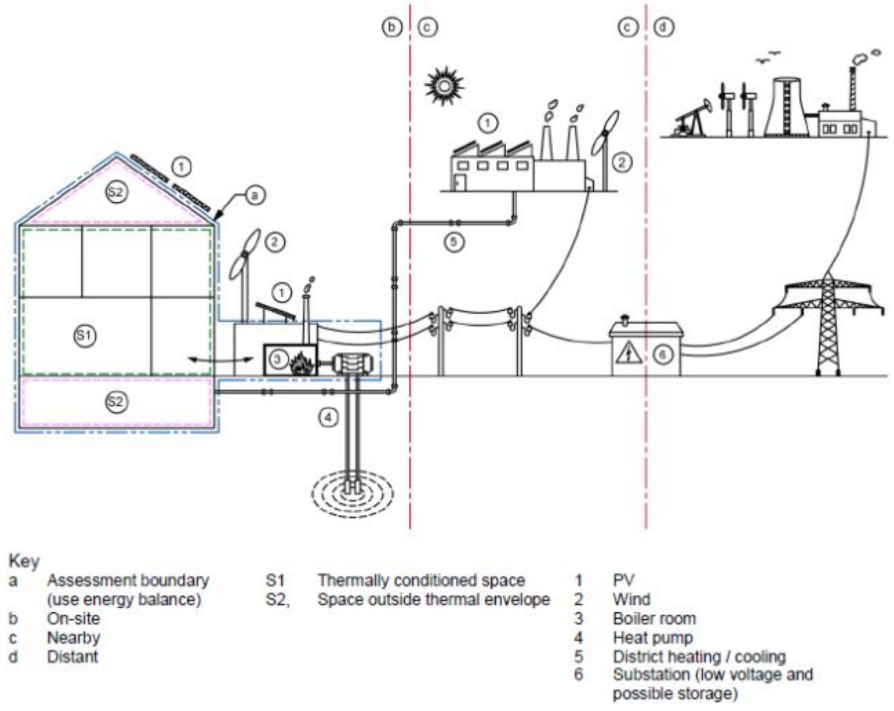
KPI 2 Total annual primary energy demand per area unit

Unit of measure

- Total annual primary energy demand per area unit E_{Ptot} in [kWh/(m^{2}a)] to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy

- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.



This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 2 Total annual primary energy demand per area unit

The Assessment method

According to EN ISO 52000 (Table 3), there are two types/methods of the energy performance of building assessment:

- calculated (asset) assessment method,
- measured (operational) assessment method – only applicable to existing buildings in the use phase.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 2 Total annual primary energy demand per area unit

Detailed description of the 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 area unit $\boldsymbol{E_{\mathrm{Ptot}}}$ 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:

$$\boldsymbol{E_{\mathrm{Ptot}} = E_{\mathrm{Pnren}} + E_{\mathrm{Pren}}}$$

where:

E_{Pnren} – is non-renewable annual primary energy demand per area unit for EPB services [kWh/(m²a)] → see indicator named *Non-renewable annual primary energy demand per area unit*

E_{Pren} – is renewable annual primary energy demand per area unit for EPB services [kWh/(m²a)] → see indicator named *Renewable annual primary energy demand per area unit*

The net annual primary energy demand per area unit for EPB services $\boldsymbol{E_{\mathrm{Ptot,net}}}$, in **kWh/(m²a)**, represents the total primary energy demand subtracted by the exported renewable primary energy demand:

$$E_{\mathrm{Ptot,net}} = E_{\mathrm{Ptot}} - E_{\mathrm{Pren,exp}}$$

E_{Ptot} – is the total annual primary energy demand per area unit to satisfy the EPB services or to produce the exported energy [kWh/(m²a)] - $E_{\mathrm{Pren,exp}}$ – is the exported renewable annual primary energy demand per area unit [kWh/(m²a)]

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 2 Total annual primary energy demand per area unit

Data

Data required for the calculation of **the total annual primary energy demand per area unit $\boldsymbol{E_{\mathrm{Ptot}}}$** in **kWh/(m²a)** to satisfy the EPB services or to produce the exported energy:

- E_{Pnren} – is non-renewable primary energy demand per area unit per year for EPB services [kWh/(m²a)] → see indicator (03) named *Non-renewable annual primary energy demand per area unit for EPB services* $\boldsymbol{E_{\mathrm{Pnren}}}$ in kWh/(m²a)
- E_{Pren} – is renewable primary energy demand (on-site, nearby) per area unit per year for EPB services [kWh/(m²a)] → see indicator (5) named *Renewable annual primary energy demand (on-site, nearby) per area unit for EPB services* $\boldsymbol{E_{\mathrm{Pren}}}$*, in kWh/(m²a)*

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This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 2 Total annual primary energy demand per area unit

Data

Data required for the calculation of **net primary energy demand per area unit per year** for EPB services $\boldsymbol{E}_{\mathbf{Ptot,net}}$, in **kWh/(m^{2}a)**,:

- E_{Ptot} – is the total annual primary energy demand per area unit to satisfy the EPB services or to produce the exported energy [kWh/(m^{2}a)]
- $E_{\mathrm{Pren,exp}}$ – is the exported renewable annual primary energy demand per area unit [kWh/(m^{2}a)]

Primary energy factors (total, non-renewable, renewable) are defined at a national level.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 2 Total annual primary energy demand per area unit

Reference Standards

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 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.

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

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1 – Energy consumption

KPI 3 - Non-renewable annual primary energy demand per area unit

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Energy consomption

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 3	Non-renewable annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)

Objective

- The indicator uses non-renewable primary energy factors defined for different fuels to calculate the non-renewable primary energy demand based on the delivered energy demand, which is obtained either through a calculation or from metered data

Applicability

Building use:
- Residential
- Non-residential

Project stage:
- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 3 Non-renewable annual primary energy demand per area unit

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 energy demand, which is obtained either through a calculation or from metered data

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KPI 3 Non-renewable annual primary energy demand per area unit

Scope

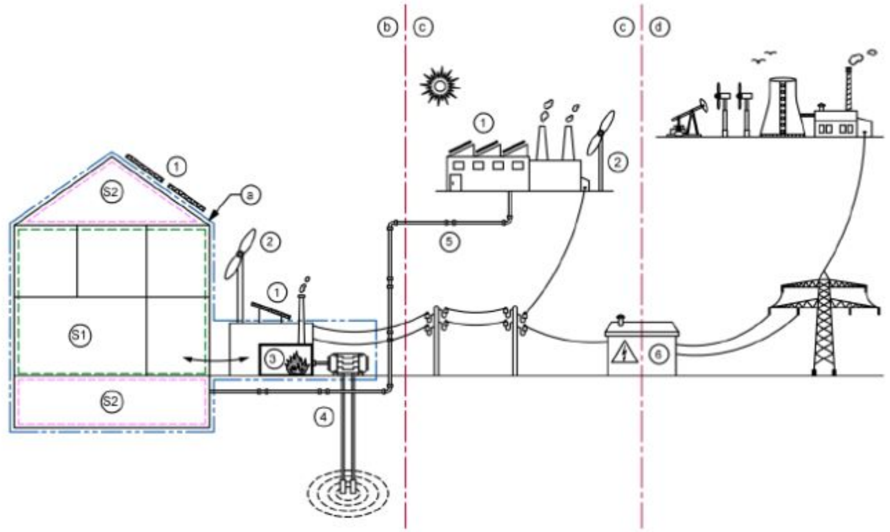
- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- Multiplying non-renewable primary energy factors with the delivered/exported energy to calculate non-renewable primary energy demand follows outside the assessment boundary.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 3 Non-renewable annual primary energy demand per area unit

Unit of measure

- Non-renewable annual primary energy demand per area unit for EPB services E_{Pnren} in [kWh/(m^{2}a)]
- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
b	On-site	S2,	Space outside thermal envelope	2	Wind
c	Nearby			3	Boiler room
d	Distant			4	Heat pump
				5	District heating / cooling
				6	Substation (low voltage and possible storage)

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KPI 3 Non-renewable annual primary energy demand per area unit

The Assessment method

According to EN ISO 52000 (Table 3), there are two types/methods of the energy performance of building assessment:

- calculated (asset) assessment method,
- measured (operational) assessment method – only applicable to existing buildings in the use phase.

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

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KPI 3 Non-renewable annual primary energy demand per area unit

Detailed description of the assessment method

- **Calculation process**

Non-renewable annual primary energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{Pnren}}$ 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 area unit:

$$\boldsymbol{E}_{\mathbf{Pnren}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{calc}} \cdot f_{\mathrm{Pnren,del},cr}\right)}{A_{\mathrm{use}}}$$

where:

$E_{\mathrm{del};cr,\mathrm{calc}}$ – is the calculated annual delivered energy for energy carrier (*cr*) [kWh/y]

$f_{\mathrm{Pnren:del};cr}$ – non-renewable primary energy factor for the delivered energy carrier (*cr*) [–]

A – area unit [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.

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KPI 3 Non-renewable annual primary energy demand per area unit

Detailed description of the assessment method

- <u>**Measurement process**</u>

Non-renewable annual primary energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{Pnren}}$ in **kWh/(m²a)** is calculated by multiplying <u>measured delivered energy</u> for each energy carrier (cr) with the <u>non-renewable primary energy factors</u> corresponding to each energy carrier and then dividing by area unit:

$$\boldsymbol{E}_{\mathbf{Pnren}} = \frac{\sum \left(E_{\mathrm{del},cr,\mathrm{meas}} \cdot f_{\mathrm{Pnren,del},cr}\right)}{A_{\mathrm{use}}}$$

where:

$E_{\mathrm{del},cr,\mathrm{meas}}$ – is the measured annual delivered energy for energy carrier (cr) [kWh/y]

$f_{\mathrm{Pnren,del};cr}$ – non-renewable primary energy factor for the delivered energy carrier (cr) [–]

A – area unit [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

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KPI 3 Non-renewable annual primary energy demand per area unit

Data

- **Data source (for calculation)**

For the calculation of the **non-renewable annual primary energy demand per area unit** for EPB services $\boldsymbol{E}_{\mathbf{Pnren}}$ 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]
- $f_{\mathrm{Pnren,del},cr}$ – non-renewable primary energy factor for the delivered energy carrier (cr) [–]
- A – area unit [m^2]

- **Data source (for measurement)**

For the calculation of the **non-renewable annual primary energy demand per area unit** for EPB services $\boldsymbol{E}_{\mathbf{Pnren}}$ in **kWh/(m²a)** the following values are required:

- $E_{\mathrm{del},cr,\mathrm{meas}}$ – is the measured annual delivered energy for energy carrier (cr) [kWh/a]
- $f_{\mathrm{Pnren,del},cr}$ – non-renewable primary energy factor for the delivered energy carrier (cr) [–]
- A – area unit [m^2]

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KPI 3 Non-renewable annual primary energy demand per area unit

Reference Standards

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The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 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.

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

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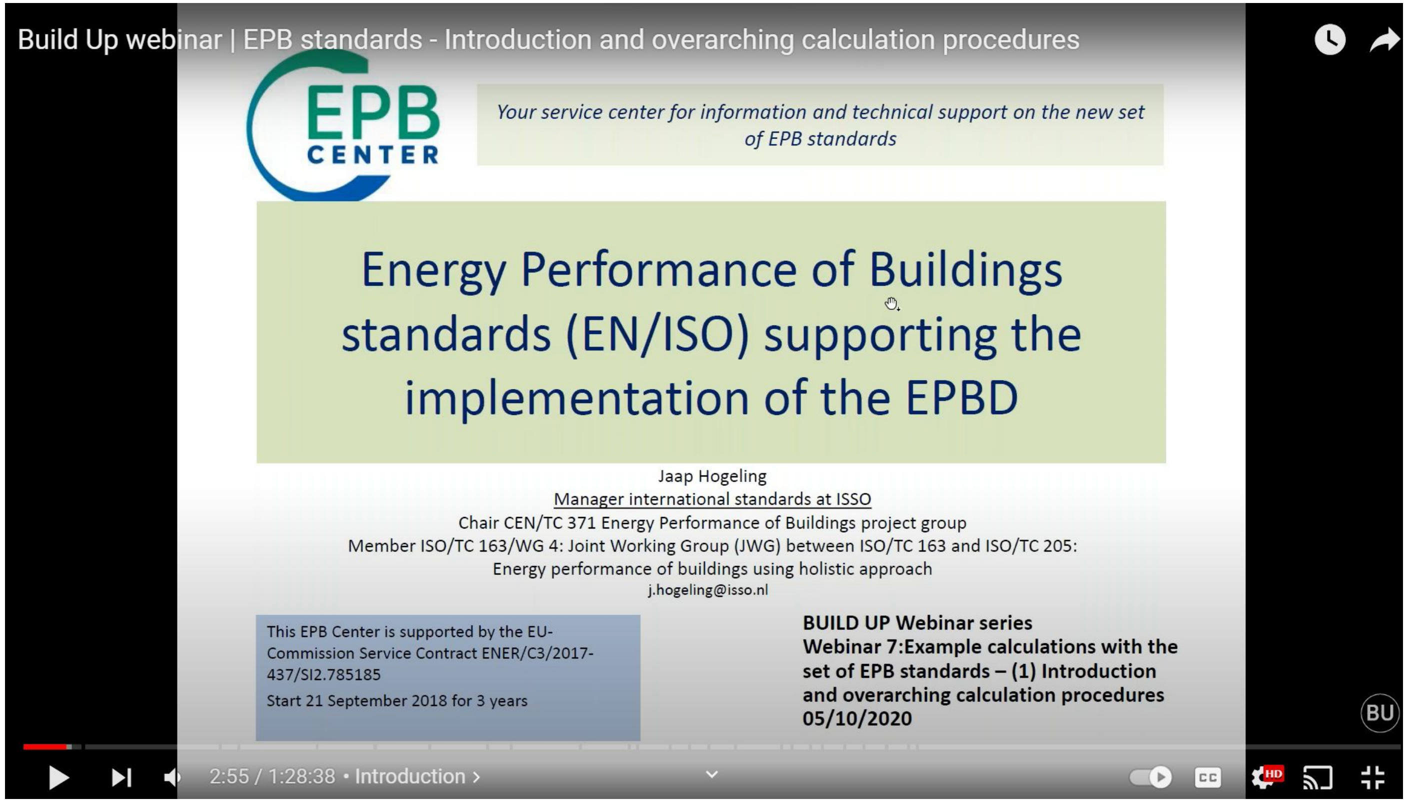
HM

Helpful links



https://www.youtube.com/watch?v=uqnRkUMtOGA

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1 – Energy consumption

KPI 4 - Embodied energy

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1 – Energy consomption

EUB SuperHub

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 4	Embodied energy	[[kWh/m2] or [MJ]]	EN 15978

Objective

- 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. This indicator is not among the EN 15978 tables of indicators, it may be considered as a sub-indicator.

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

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KPI 4 Embodied energy

Description

- 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.

- It includes non-renewable primary energy uses and non-renewable primary energy resources used as raw materials.

- 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**".

- 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.

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KPI 4 Embodied energy

Scope

- This KPI addresses both residential and non-residential buildings.

- This indicator supposes a good knowledge of construction products and services (technical equipment) attached to the building. So, it is adapted to new construction and to renovated buildings.

- 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 (50 years by default) and end-of-life.
- The rules for determining their impacts and aspects are defined in EN 15804 and EN 15978.

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 assessment boundary description and in results presentation. This enables results understanding and comparability.

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KPI 4 Embodied energy

Scope

All the construction elements are considered: from foundations to finishings.
The minimum scope/perimeter of the indicator includes the following building parts and elements:
The elements defined in Level(s) European framework, including also fittings, furnishings, technical services / systems and external works on the plot of land, should be included, and if not, replaced by default values.
Notes:

- Detailed tables are available in Level(s) Indicator 1.2 Manual and in User Manual 2 document, chapter on building description,
- Furniture and equipment brought by the building occupants are not included.

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

Table drawn from Level(s) framework, 2021

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KPI 4 Embodied energy

Unit of measure

Embodied energy is measured as:

[kWh/m^2] or [MJ] (net calorific value)

Note: The EN 15978 standard mentions MJ unit for all energy indicators, but for ensuring homogeneity with the other energy KPIs, it is preferable to use kWh / m^2 (per area unit and for building RSP = 50 years).

RSP = reference study period

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KPI 4 Embodied energy

The Assessment method

Certification case:

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.

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.

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KPI 4 Embodied energy

The Assessment method

Certification case:

3. **Renovated buildings** (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.

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KPI 4 Embodied energy

The 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).

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KPI 4 Embodied energy

Detailed description of method 1 : The Bill of Materials (BoM)

The following steps should be followed to compile the BoM:

- Compile the Bill of Quantities (BoQ): 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).
- Consider the non-renewable primary energy.
- The results are then aggregated at the building scale.
- A reporting format with sufficient detailed interim figures is recommended.

method specified in Level(s) (*Level(s) indicator 1.1: Use stage energy performance*) could be used.

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KPI 4 Embodied energy

Detailed description of method 2 : Use of a database of EPDs compliant with EN 15804)

- Compile the Bill of Quantities (BoQ): A BoQ comprises the building elements accounting for at least 99% of the mass of the building.
- Identify in the database the EPDs (from cradle to grave) 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 non-renewable primary energy indicator.
- Multiply the quantities and the value of the primary non-renewable energy for each product.
- If some EPDs are not available, use realistic default values instead of "zero" (and precise their number and source).
- Aggregate at the scale of the building, keeping available interim results (e.g. per life cycle module and per family of products).

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KPI 4 Embodied energy

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** Sustainability of construction works - Data quality for environmental assessment of products and construction work - Selection and use of data (formal vote in autumn 2023).

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KPI 4 Embodied energy

Helpful Links

https://www.youtube.com/watch?v=fa25pcgkqEw

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KPI 4 Embodied energy

Reference Standards

- **EN 15978**:2011, Sustainability of construction works - Assessment of environmental performance of buildings – Calculation method (under revision in 2022-2023, to be published in 2024).
- **EN 15804**:2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
- **ISO 14067**:2018, Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification.

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2 – Renewable energy

KPI 5 - Renewable annual primary energy demand per area unit

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2 – Renewable energy

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Renewable Energy	KPI 5	Renewable annual primary energy demand per area unit	[kWh/(m^{2}a)]	1.1 Level(s)

Objective

- 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.

Applicability

Building use:
- Residential
- Non-residential

Project stage:
- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 5 Renewable annual primary energy demand per area unit

Description

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:

$E_{\mathrm{Pren,onst}}$ – renewable primary energy demand produced on-site

$E_{\mathrm{Pren,nrby}}$ – renewable primary energy demand produced nearby

$E_{\mathrm{Pren,dist}}$ – renewable primary energy demand produced distant

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KPI 5 Renewable annual primary energy demand per area unit

Scope

- KPI addresses residential and non-residential buildings with the default energy performance of buildings (EPB) services (see 3 Terms and definitions).

- KPI addresses the following module of the building life-cycle:B6 : Operational energy use

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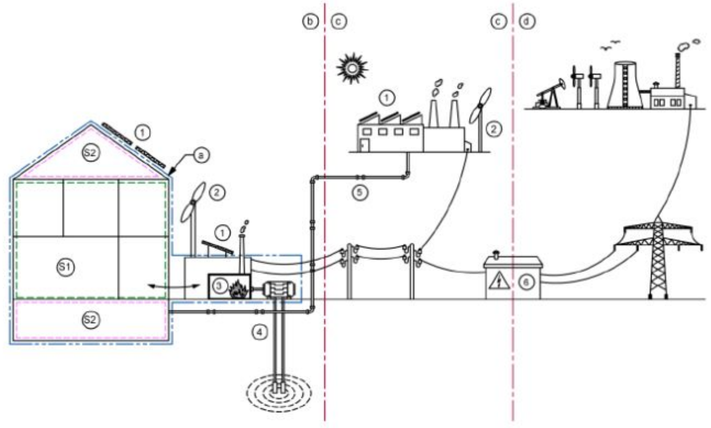
KPI 5 Renewable annual primary energy demand per area unit

EUB SuperHub

Unit of measure

- Renewable annual primary energy demand per area unit for energy performance of buildings services (EPB services) E_{Pren} in [kWh/(m^{2}a)]
- 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.
-



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
b	On-site	S2,	Space outside thermal envelope	2	Wind
c	Nearby			3	Boiler room
d	Distant			4	Heat pump
				5	District heating / cooling
				6	Substation (low voltage and possible storage)

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 5 Renewable annual primary energy demand per area unit

The Assessment method

According to EN ISO 52000 (Table 3), there are two types/methods of the energy performance of building assessment:

- calculated (asset) assessment method,
- measured (operational) assessment method – only applicable to existing buildings in the use phase.

The formula for calculating renewable annual primary energy demand per area unit 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.

To avoid double-counting of renewable energy it is important to denote renewable primary energy demand with subscript following the chosen perimeters:

$E_{\mathrm{Pren,onst}}$ – renewable primary energy demand produced on-site

$E_{\mathrm{Pren,nrby}}$ – renewable primary energy demand produced nearby

$E_{\mathrm{Pren,dist}}$ – renewable primary energy demand produced distant

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 5 Renewable annual primary energy demand per area unit

Detailed description of the assessment method

- <u>**Calculation process**</u>

Renewable annual primary energy demand per unit for EPB services $\boldsymbol{E}_{\mathbf{Pren}}$ in **kWh/(m²a)** is calculated by multiplying the <u>calculated annual delivered energy</u> for each energy carrier (*cr*) with the <u>renewable primary energy factors</u> corresponding to each energy carrier and then dividing by area unit:

$$\boldsymbol{E}_{\mathbf{Pren}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{calc}} \cdot f_{\mathrm{Pren,del},cr}\right)}{A}$$

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 – area unit [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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 5 Renewable annual primary energy demand per area unit

Detailed description of the assessment method

EUB SuperHub

- <u>**Measurement process**</u>

Renewable annual primary energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{Pren}}$ in **kWh/(m²a)** is calculated b multiplying <u>measured annual delivered energy</u> for each energy carrier (*cr*) with the <u>renewable primary energy factor</u> corresponding to each energy carrier and then dividing by area unit:

$$\boldsymbol{E}_{\mathbf{Pren}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{meas}} \cdot f_{\mathrm{Pren,del},cr}\right)}{A}$$

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 – area unit [m²]

Format for reporting the results of an assessment using the measured (operational) assessment method specified i 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

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KPI 5 Renewable annual primary energy demand per area unit

Data

EUB SuperHub

- **Data source (for calculation)**

For the calculation of the **renewable annual primary energy demand per area unit** 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 – area unit [m^2]

- **Data source (for measurement)**

For the calculation of the **renewable annual primary energy demand per area unit** for EPB services $\boldsymbol{E_{\mathrm{Pren}}}$ in **kWh/(m²a)** the following values are required:

- $E_{\mathrm{del},cr,\mathrm{meas}}$ – 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 – area unit [m^2]

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HM

KPI 5 Renewable annual primary energy demand per area unit

Reference Standards

EUB SuperHub

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 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.

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

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

HM

2 – Renewable energy

KPI 6 - Renewable energy ratio (on-site, nearby)

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

2 – Renewable energy

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Renewable Energy	KPI 6	Renewable energy ratio (on-site, nearby)	[%]	B1.4 CESBA MED

Objective

- 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

Applicability

Building use:
- Residential
- Non-residential

Project stage:
- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 6 Renewable energy ratio (on-site, nearby)

Description

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.

Perimeter choice	Choice – **RER calculation** (renewable energy)	Choice – RER calculation (total energy)
On-site	**Yes**	Yes
Nearby	**Yes**	Yes
Distant	No	Yes

NOTE: When calculating this indicator, the perimeter choices must always be clearly declared if they differ from default choices.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

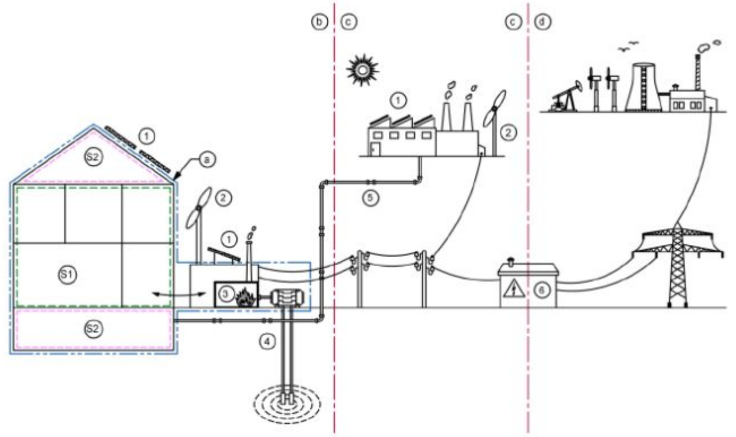
KPI 6 Renewable energy ratio (on-site, nearby)

Scope

- KPI addresses residential and non-residential buildings with the default energy performance of buildings (EPB) services (see 3 Terms and definitions).

- KPI addresses the following module of the building life-cycle:B6 : Operational energy use

- Dividing the renewable primary energy demand with the total primary energy demand follows outside the assessment boundary



Key
a Assessment boundary (use energy balance)
b On-site
c Nearby
d Distant

S1 Thermally conditioned space
S2, Space outside thermal envelope

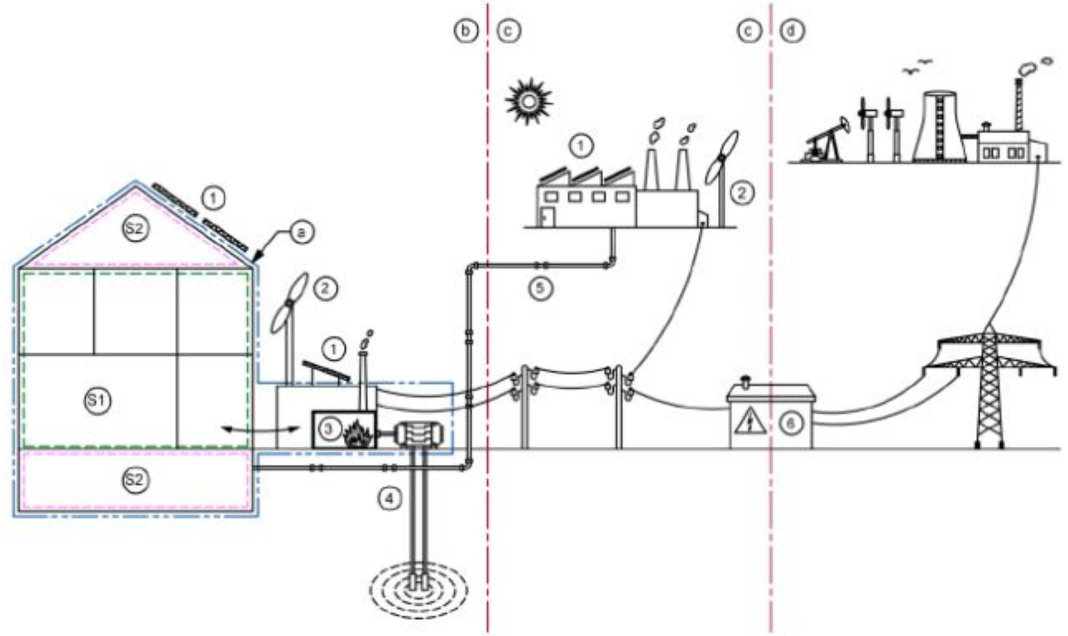
1 PV
2 Wind
3 Boiler room
4 Heat pump
5 District heating / cooling
6 Substation (low voltage and possible storage)

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 6 Renewable energy ratio (on-site, nearby)

Unit of measure

- Renewable energy ratio (on-site, nearby) $RER_{\text{onst,nrby}}$ in [%]



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
b	On-site	S2,	Space outside thermal envelope	2	Wind
c	Nearby			3	Boiler room
d	Distant			4	Heat pump
				5	District heating / cooling
				6	Substation (low voltage and possible storage)

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 6 Renewable energy ratio (on-site, nearby)

The Assessment method

EUB SuperHub

According to EN ISO 52000 (Table 3), there are two types/methods of the energy performance of building assessment:

- calculated (asset) assessment method,
- measured (operational) assessment method – only applicable to existing buildings in the use phase.

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

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) [%]

$\boldsymbol{RER}_{\mathbf{onst,\ nrby}}$ – renewable energy ratio (on-site, nearby) [%] – default choices according to EN ISO 52000-1

$RER_{\mathrm{onst,\ nrby,\ dist}}$ – renewable energy ratio (on-site, nearby, and distant) [%]

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

HM

KPI 6 Renewable energy ratio (on-site, nearby)

Detailed description of the assessment method

- **Calculation process**

The renewable energy ratio (onsite, nearby) $RER_{\mathrm{onst,nrby}}$ in % is calculated by formula:

$$\boldsymbol{RER_{\mathrm{onst,nrby}} = \frac{E_{\mathrm{Pren,onst,nrby}}}{E_{\mathrm{Ptot}}} \cdot 100}$$

where:

E_{Ptot} – is the total annual primary energy demand per area unit based on the calculated delivered energy [kWh/(m^{2}a)]

$E_{\mathrm{Pren,onst,nrby}}$ – is the renewable annual primary energy demand per area unit in [kWh/(m^{2}a)] for the purpose of *RER* calculation, including the on-site and the nearby produced renewable primary energy demand based on the calculated renewable energy.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 6 Renewable energy ratio (on-site, nearby)

Detailed description of the assessment method

- **<u>Measurement process</u>**

The renewable energy ratio (onsite, nearby) $RER_{\mathrm{onst,nrby}}$ in % is calculated by formula:

$$\boldsymbol{RER}_{\mathbf{onst,nrby}} = \frac{\boldsymbol{E}_{\mathbf{Pren,onst,nrby}}}{\boldsymbol{E}_{\mathbf{Ptot}}} \cdot \mathbf{100}$$

where:

E_{Ptot} – is the total primary annual energy demand per area unit <u>based on the measured delivered energy</u> [kWh/(m^{2}a)]

$E_{\mathrm{Pren,onst,nrby}}$ – is the renewable annual primary energy demand per area unit in [kWh/(m^{2}a)]for the purpose of RER calculation, including the on-site and the nearby produced renewable primary energy demand <u>based on the measured renewable energy</u>.

NOTE: The renewable energy ratio $RER_{\mathrm{onst,nrby}}$ 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 $RER_{\mathrm{onst,nrby}}$ can be calculated using the same above given formula based on measured value only in case all contributions of renewable sources are measured!

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 6 Renewable energy ratio (on-site, nearby)

Detailed description of the assessment method

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- **Measurement process**

Renewable annual primary energy demand per area unit for EPB services $\boldsymbol{E}_{\mathbf{Pren}}$ in **kWh/(m²a)** is calculated by multiplying measured annual delivered energy for each energy carrier (*cr*) with the renewable primary energy factor corresponding to each energy carrier and then dividing by area unit:

$$\boldsymbol{E}_{\mathbf{Pren}} = \frac{\sum\left(E_{\mathrm{del},cr,\mathrm{meas}} \cdot f_{\mathrm{Pren,del},cr}\right)}{A}$$

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 – area unit [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

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HM

KPI 6 Renewable energy ratio (on-site, nearby)

Data

- **Data source (for calculation)**

For the calculation of the **renewable energy ratio (onsite, nearby)** $\boldsymbol{RER}_{\mathbf{onst,nrby}}$ in **%** the following values are required:

- E_{Ptot} – the total annual primary energy demand per area unit based on the calculated delivered energy [kWh/(m^{2}a)]
- $E_{\mathrm{Pren,onst,nrby}}$ – the renewable annual primary energy demand per area unit 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/(m^{2}a)]

For the calculation of the renewable annual primary energy demand per area unit $\boldsymbol{E}_{\mathbf{Pren,onst,nrby}}$ in [kWh/(m^{2}a)] the following values are required:

- $E_{\mathrm{del},cr,\mathrm{calc,onsite}}$ – the calculated annual on-site delivered energy for energy carrier (cr) [kWh/(m^{2}a)]
- $E_{\mathrm{del},cr,\mathrm{calc,nrby}}$ – the calculated annual nearby delivered energy for energy carrier (cr) [kWh/(m^{2}a)]
- $f_{\mathrm{Pren,del},cr}$ – renewable primary energy factor for the delivered energy carrier (cr) [–]

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KPI 6 Renewable energy ratio (on-site, nearby)

Data

- **<u>Data source (for measurement)</u>**

For the calculation of the **renewable energy ratio (onsite, nearby)** $\boldsymbol{RER}_{\mathbf{onst,nrby}}$ in **%** the following values are required:

- E_{Ptot} – is the total annual primary energy demand per useful internal floor area based on the <u>measured</u> delivered energy [kWh/(m^{2}a)]
- $E_{\mathrm{Pren,onst,nrby}}$ – the renewable annual primary energy demand per area unit for the purpose of *RER* calculation, including the on-site and the nearby produced renewable primary energy demand based on the <u>measured</u> renewable energy [kWh/(m^{2}a)]

For the calculation of the renewable annual primary energy demand per area unit $\boldsymbol{E}_{\mathbf{Pren,onst,nrby}}$ in [kWh/(m^{2}a)] the following values are required:

- $E_{\mathrm{del},cr,\mathrm{meas,onsite}}$ is the <u>measured</u> annual on-site delivered energy for energy carrier (*cr*) [kWh/(m^{2}a)]
- $E_{\mathrm{del},cr,\mathrm{meas,nrby}}$ is the <u>measured</u> annual nearby delivered energy for energy carrier (*cr*) [kWh/(m^{2}a)]

$f_{\mathrm{Pren,del},cr}$ – renewable primary energy factor for the delivered energy carrier *cr* [–]

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KPI 6 Renewable energy ratio (on-site, nearby)

Reference Standards

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 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.

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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

3 – GHG emissions

KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

3 – GHG emissions

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Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
GHG emissions	KPI 7	Annual use stage energy-related Global Warming Potential (GWP)	[kg CO2 eq./ m^2] for a reference study period of 50 years or [kg CO2 eq. / (m^2a)]	B1.4 CESBA MED

Objective

- The variety of GHG are represented by the Global Warming Potential (GWP). GWP represent the potential contribution of a system to the earth's global warming and the associated effects on the climate.

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

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KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

Description

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 (called EPB services), knowing the energy sources / carriers involved

(GWP) 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 CO2, over a given period of time (100 years in general).

The indicator is an extension of indicator "Delivered annual energy demand per area unit" (KPI 1) in terms of GHG emissions. The knowledge of the energy sources/carriers linked to the flows of delivered energy is necessary. Note that the GWP indicator is based on delivered energy, not on primary energy.

Regarding the description form of KPI 1, attention is drawn on the following points:

- only "delivered energy" is considered here, without reduction due to exported energy,
- delivered energy can be calculated or measured.

The present indicator is obtained through a calculation process, not a measurement process. It can be based on calculated or measured energy input data, according to the application case.

The present indicator is obtained through a calculation process, not a measurement process. It can be based on calculated or measured energy input data, according to the application case.

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KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

Scope

- The scope includes both residential and non-residential buildings.
- The building services considered (also called EPB services) are mentioned in the table:
- NOTE: When calculating this indicator, the building services considered must always be clearly declared if they differ from default choices.
- The system boundary is the same as for indicator "KPI 1 - Delivered annual energy demand per area unit, 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 excluded from the assessment boundary

Building service (or EPB service)	Building service considered in the calculation of indicator (Yes/No)	
	Residential buildings	Non-residential buildings
Heating	Yes	Yes
Cooling	Yes	Yes
Ventilation	Yes	Yes
Humidification	Yes	Yes
Dehumidification	Yes	Yes
Domestic hot water	Yes	Yes
Lighting	**No**	**Yes**
External lighting	No	No
People transport (e.g., elevators)	No	No
Appliances	No	No
Others	No	No

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

Unit of measure

2 possibilities:

- kg CO_2 eq. / m^2 area unit, for a reference study period (RSP) of 50 years,
- kg CO_2 eq. / (m^2.y) (per area unit and per year

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KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

The Assessment method

- **New building** in the design/construction/’as built’ phase (without long-term use data) – The indicator is based on calculated delivered energy demand per carrier.
- **Existing building** in the use phase (with long-term use data of at least three years) - The indicator is based on calculated or measured delivered energy demand per carrier.
- **Renovated building** in the design/construction/’as built’ phase (without long-term use data) - The indicator is based on calculated delivered energy demand per carrier.

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

The Assessment method

EUB SuperHub

Calculation method:

GWP linked to annual energy consumption: each type of energy flow is multiplied by an emission factor drawn from an official national 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.

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KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

Data

The necessary data are:

- Delivered energy consumption per use and per energy carrier (from indicator KPI 1)
- Emission factors for energy carriers

For electricity consumptions, it is important to distinguish use by use, because the emission factors generally differ according to the use. For instance, they may be specific for 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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 7 - Annual use stage energy-related Global Warming Potential (GWP)

Reference Standards

- **ISO 16745-1**:2017 - Sustainability in buildings and civil engineering works - Carbon metric of an existing building during use stage - Part 1: Calculation, reporting and communication
- **EN 15978:**2011 - Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method (under revision in 2022-2023)
- **ISO 14067**:2018 - Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification (note: a product may be a good or a service)
- **ISO 52000-3**:2023 - Energy performance of buildings - Overarching EPB assessment - Part 3: General principles for determination and reporting of primary energy factors (PEF) and CO_2 emission coefficients.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

3 – GHG emissions

KPI 8 - Life Cycle Global Warming Potential (GWP)

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

3 – GHG emissions

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
GHG emissions	KPI 8	Life Cycle Global Warming Potential (GWP)	[kg CO2 eq./ m^2] for a reference study period of 50 years	1.2 Level(s)

Objective

- GWP represent the potential contribution of a system to the earth's global warming and the associated effects on the climate. This indicator measures the building’s potential contribution to the earth's global warming and the associated effects on climate change throughout its life cycle.

Applicability

Building use:
- Residential
- Non-residential

Project stage:
- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

Description

This indicator measures the building's potential 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 elements (materials, construction products, technical systems, often simply called 'products') to the end of the building's service life, and the subsequent building demolition and end-of-life of its elements, are summed up:

In this indicator, GHG emissions embodied in building products life cycles are brought together with direct and indirect GHG emissions from use stage performance (linked to operational energy and water consumption).

Global Warming Potential indicator (GWP) 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).

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

Scope

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- The scope includes both residential and non-residential buildings.

- Regarding building products, this KPI considers the life cycle of 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. It is similar to KPI 4 (embodied energy).

- Regarding building operation, direct and indirect GHG emitted from energy-related services (called EPB services) are considered, like for **KPI 7** (use stage energy-related GWP), but also GHG emissions from processes linked to water provision and sewage. So the use-stage part of this indicator is broader than for KPI

- The life cycle of the building is considered, together with the life cycle of the construction products it is made of.

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KPI 8 - Life Cycle Global Warming Potential (GWP)

System boundary

The assessment boundary is set at the building and its site (plot of land) including:

- **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

Notes:

- Detailed tables are available in Level(s) Indicator 1.2 Manual and in User Manual 2 document, chapter on building description,
- Furniture and equipment brought by the building occupants are not included.

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KPI 8 - Life Cycle Global Warming Potential (GWP)

System boundary

The full life cycle is considered, “from cradle to grave” as defined in EN 15978. The results are 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.

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

System boundary

- 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).

- The assessment boundary shall be specified in the assessment report, because it may differ from one case to another, from one country to another, depending on available data and tools, and possible national regulation. If there exists, a national method may be used, provided it is compliant with the reference standards hereafter listed.
-
- The assessment boundary of this KPI includes those of KPI 4 (embodied energy) and KPI 7 (use stage GWP), but includes more processes, as water-related ones, upstream and downstream of the building use phase. For the calculation of the use stage water consumption, it is recommended to follow the methodology and practical tool of Level(s) indicator 3.1 (2021).

- In order to enable a correct interpretation of results and valid comparisons, the assessment boundary shall be described

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Unit of measure

- kg CO2 eq. / m^2 area unit, for a reference study period (RSP) of 50 years.

(same unit as Level(s) indicator 1.2)

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

- **New building** in the design/construction/'as built' phase (without long-term use data) – The indicator is based on calculated delivered energy demand per carrier.
- **Existing building** in the use phase (with long-term use data of at least three years) - The indicator is based on calculated or measured delivered energy demand per carrier.
- **Renovated building** in the design/construction/'as built' phase (without long-term use data) **-** The indicator is based on calculated delivered energy demand per carrier.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

Certification case:

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 products, equipment and materials used for the building construction, and potential replacements of products in the future (during RSP), following EN 15978.
- Regarding operational energy and water use, the indicator is based on calculated delivered energy demand per carrier, and calculated water consumption.

Existing buildings in the use phase (<u>with long-term use data of at least three years</u>)

In the case of existing buildings in the use phase, this indicator is generally <u>not</u> 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.

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

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Certification case:

3. Renovated buildings <u>(without long-term use data)</u>

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.

Regarding operational energy and water use, the indicator is based on calculated delivered energy demand per carrier, and calculated water consumption.

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KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

The present indicator is obtained through a calculation process, not a measurement process. The main reference for the calculation method is EN 15978.

The protocol is defined step by step (according to Level(s) methodology for indicator 1.2):

1. Compiling detailed and complete information about the building description (shell, core, etc.)
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

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

Calculation method:

GWP is calculated as follows:

- Life cycle of products: linear combinations based on the bill of quantities (BoQ) for initial construction, the number of replacements, and the corresponding EPDs. Data gaps should be filled by conservative assumptions with average, generic or default data.
- GWP linked to energy and water consumption: each type of flow is multiplied by an GHG emission factor drawn from an official national database and multiplied by the RSP (50 years).

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 8 - Life Cycle Global Warming Potential (GWP)

The Assessment method

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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 and EN 15978 shall be followed.

In case this approach is not feasible, 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)

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Reporting

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Results: The results are to be reported separately for each life cycle stage (from A to D), as presented in the following table 1 (extract from Level(s) user manual for indicator 1.2).

Table 1 – Reporting format for Life Cycle GWP, according to Level(s)

Indicator	Unit	Product (A1-3)	Construction process (A4-5)	Use stage (B1-7)	End of life (C1-4)	Benefits and loads beyond the system boundary (D)
(1) GWP - fossil	kg CO_2 eq					
(2) GWP - biogenic	kg CO_2 eq					
GWP – GHGs (1+2)	kg CO_2 eq					
(3) GWP – land use and land use change	kg CO_2 eq					
GWP – overall (1+2+3)	kg CO_2 eq					
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].

In recent EPDs, GWP is divided into 3 components according to the origin of the GHG: fossil, biogenic or land use and land use change (luluc). The total GWP is the sum of these 3 components. Some EPDs databases are not yet so detailed, including only a single figure for GWP indicator.

Regarding use stage results, it is advised to display separately B1-B5 (linked to products life cycle), B6 (linked to operational energy use) and B7 (linked to operational water use), for analysis and comparison purpose.

This detailed reporting table may accept, if LCA practice is not mature enough, only a part of results.

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Data

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Data source

- Bill of quantities (complete and detailed)
- Lifespan of each product or element
- EPDs database aligned with EN 15804+A2
- Generic or default data if specific EPDs are missing (so as to avoid empty boxes)
- delivered energy consumption per use and energy carrier
- Water consumption
- Emission factors for energy carriers and for water (including pre- and post-use treatment)

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Data

EUB SuperHub

Data quality

- Software calculation tool aligned with EN 15978 and approved/validated by national authorities
- Completeness of building description, with respect of cut-off rules
- Database with recent (5 years maximum) and third-party verified/reviewed EPDs
- Official/national/actual emission factors for energy and water
- Relevant use and good quality of generic or default data (representative, not older than 10 years)
- Correct correspondence between the products put in place or installed in the building and EPDs
- Quality requirements of Level(s) for indicator 1.2 (life cycle GWP), dealing with software tools and environmental data
- Quality requirements of (pr)EN 15941 (to be published)

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Reference Standards

- •**EN 15804:2012+A2:2019,** Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products
- •**EN 15978:2011,** Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method (under revision in 2022-2023, to be published in 2024)
- •**ISO 14040 and ISO 1404**
- **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**

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KPI 8 - Life Cycle Global Warming Potential (GWP)

Reference Standards

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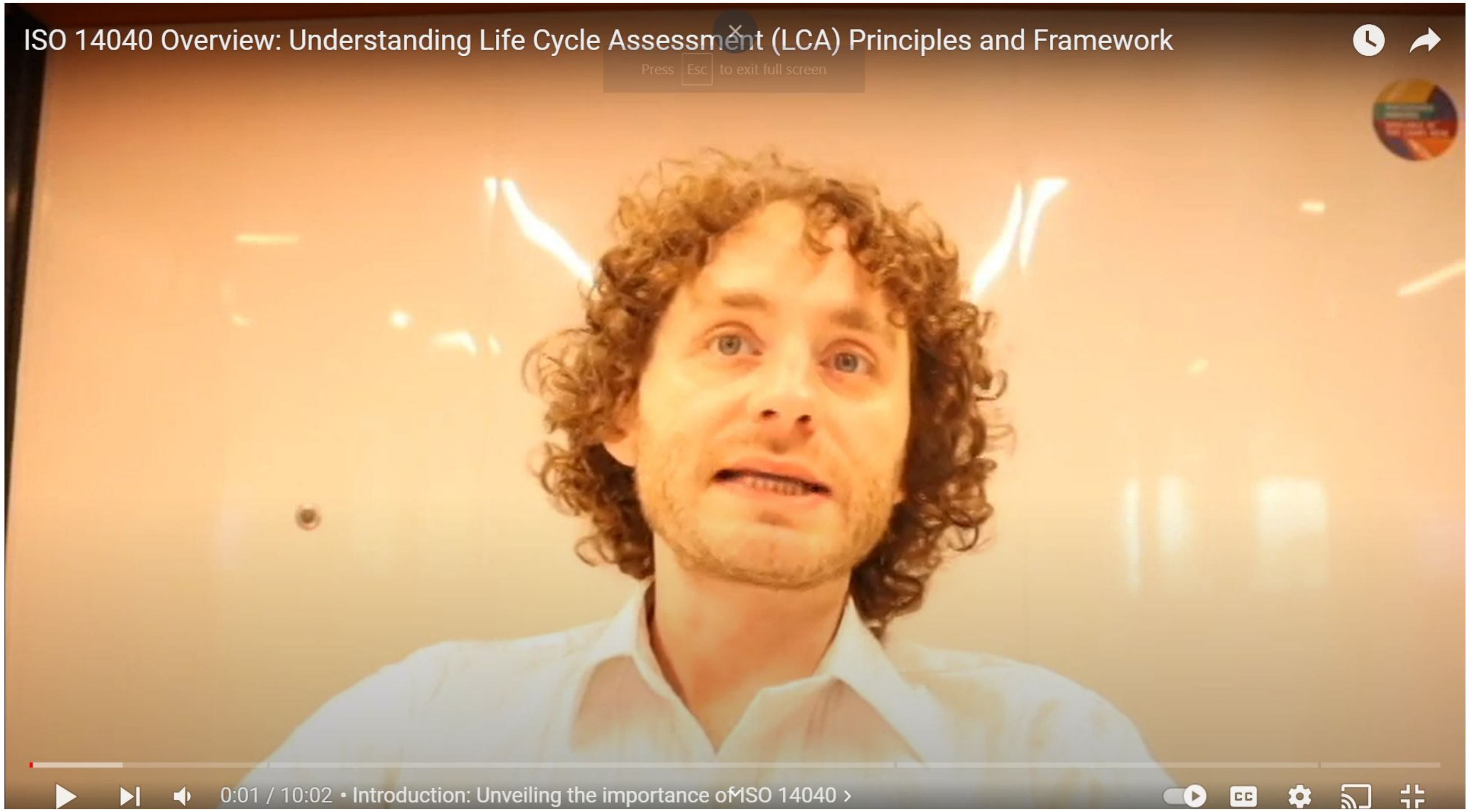

https://www.youtube.com/watch?v=clOkpDnSeak

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4 – Costs

KPI 17 - Operational energy cost

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4 – Costs

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Costs	KPI 17	Operational energy cost	[€/(m2a)]	10.1 NewTREND

Objective

- The indicator measures the economic performance of a building in relation to its energy performance

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 17 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.
- The Operational energy is the energy that is used during the in-use stage of building life cycle for space heating, domestic hot water, space cooling, ventilation, built-in lighting, running the equipment and appliances, etc.
- The aspects of primary energy conversion to delivered energy are excluded
- The starting point to calculate this KPI is based on the actual or simulated amount of the building delivered energy demand for each usage and including each fuel type as per the methodology used in the KPI 1 Delivered annual energy demand per area unit.

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KPI 17 Operational energy cost

Scope

- The indicator addresses both residential and non-residential buildings. The aspects of primary energy conversion to delivered energy are excluded.

- KPI addresses the following module of the building life-cycle: B6 (Operational energy use)

- The assessment boundary of this indicator 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 heating, space cooling, domestic hot water, built-in lighting, ventilation and auxiliary systems.

- The calculation of the delivered energy demand is made according the methodology outline in the **KPI 1_Delivered annual energy demand per area unit**

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KPI 17 Operational energy cost

Unit of measure

- Euro per square metre of area unit per year [€/(m2a)]

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KPI 17 Operational energy cost

Assessment method for new and renovated buildings

Nr	
1	The indicator is calculated with a simulation tool
2	Determine the delivered energy demand as described in the KPI 1. The simulated/ calculated total delivered energy demand of the building will include the delivered energy end use with a breakdown by use and fuel type
3	Calculate the yearly operational energy costs by multiplying the delivered energy demand for each fuel type by a representative energy price
4	Calculate the energy that is locally generated and sold to the grid and subtract the revenue made from the cost
5	Calculate the resulting operational energy costs (normalised) for the building based on the reference area unit by dividing the annual operational energy costs on the reference area unit.
6	The resulting operational energy cost will be presented in €/(m²·a).

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KPI 17 Operational energy cost

Assessment method for in-use buildings

Nr	
1	the indicator is based on metered values and energy bills not older than 2 Calander years
2	Determine the delivered energy for the buildings based on actual or recent metered data
3	Calculate the yearly operational energy costs by multiplying the delivered energy demand for each fuel type by the actual energy price
4	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
5	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
6	The resulting operational energy cost will be presented in €/(m²·a).

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KPI 17 Operational energy cost

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 (area unit)
- 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

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KPI 17 Operational energy cost

Reference Standards

- International Performance Measurement and Verification Protocol (IPMVP), Level(s) indicator 6.1: Life cycle costs

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KPI 17 Operational energy cost

Helpful links

https://www.youtube.com/watch?v=WAUdT3dVWeU

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Module 5
Smart Budlings and E-mobility

Training Material
Date: Jan 2024
Ahmed Khoja
Hochschule München University of Applied Sciences

This project is co-funded by the European Union’s Horizon 2020 programme under grant agreement no. 101033916.

Contents

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

1 – Smart Building

KPI 18 - Smart Readiness Indicator (SRI)

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1 – Smart Buildings

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Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Smart buildings	KPI 18	Smart Readiness Indicator (SRI)	[%]	Commission Delegated Regulation (EU) 2020/2155 of 14 October 2020SRI and Commission Implementing Regulation (EU) 2020/2156 of 14 October 2020 detailing the technical modalities for the effective implementation of an optional common Union scheme for rating the smart readiness of buildings

Objective

- The potential of smart technologies in the building sector was heavily emphasised in the 2018 revision of the European Energy Performance of Buildings Directive (EPBD) and the concept of a Smart Readiness Indicator (SRI) was introduced. The Smart Readiness indicator in intended to raise awareness of the benefits promised by smart building technologies.

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 19 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 system's 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.

The 'smartness' of a building refers to its ability to sense, interpret, communicate and actively respond in an efficient manner to changing conditions in relation to

- the operation of technical building systems,
- the external environment (including energy grids)
- demands from building occupants

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 Smart Readiness Indicator (SRI)

Scope

- The indicator addresses both residential and non-residential buildings.

- KPI addresses the following module of the building life-cycle: B1-B6 (Operational energy use)

- 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

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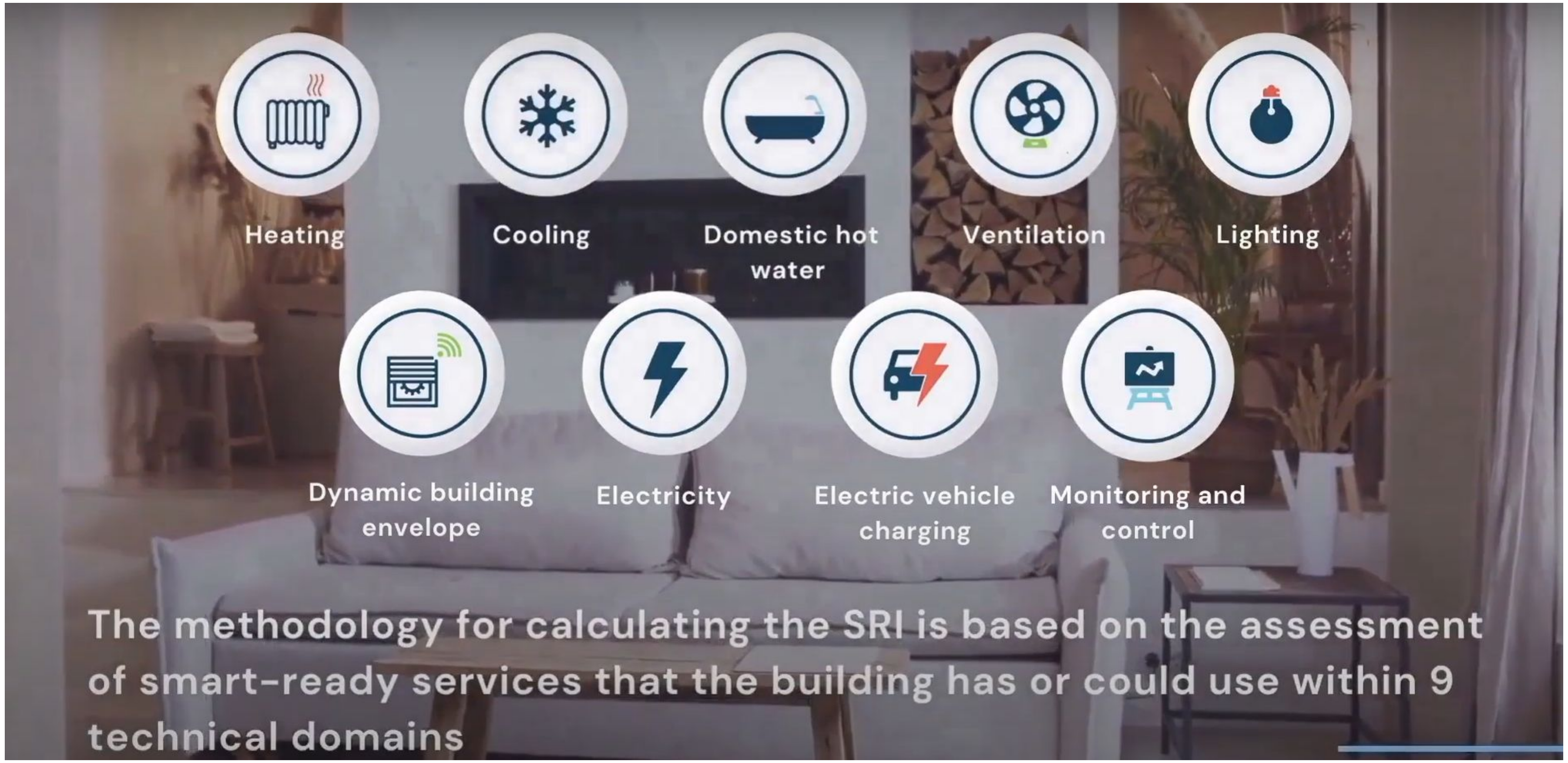
KPI 19 Smart Readiness Indicator (SRI)

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



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KPI 19 Smart Readiness Indicator (SRI)

Assessment method

From the SRI calculation sheet, use Method B with default weighing as defined in the Calculation sheet for SRI assessment method A/B (V4.5).

Assign the correct functionality level in each smart ready service of the 9 domains based on the installed and working systems in the building.

Indicate 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.

SRI assessment package comprising a calculation sheet and a practical guide can be provided upon request by filling this form.

https://ec.europa.eu/eusurvey/runner/SRI-assessment-package

This project is co-funded by the European Union's Horizon 2020 programme under grant agreement no. 101033916.

KPI 19 Smart Readiness Indicator (SRI)

Detailed description of the assessment

https://www.youtube.com/watch?v=GV6dY8rrn4w&list=PLst-Hb6W0Mn9QZ3q3DBv1_5qVTOlh5bca&index=3

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KPI 19 Smart Readiness Indicator (SRI)

Detailed description of the assessment

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https://energy.ec.europa.eu/system/files/2022-06/SRI%20training%20slide%20deck%20-%20Version%202%20-%20Jan%202022%20-%20updated.pdf

https://energy.ec.europa.eu/system/files/2023-01/SRI%20training%20slide%20deck%20-%20Version%202%20-%20Jan%202022%20GERMAN.pdf

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KPI 19 Smart Readiness Indicator (SRI)

Data

- Building type, building location (climate zone), construction year and area unit
- 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

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KPI 19 Smart Readiness Indicator (SRI)

Reference Standards

- The method for calculating the SRI is based on the multi-criteria assessment method defined in Commission Delegated Regulation (EU) 2020/2155.

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KPI 19 Smart Readiness Indicator (SRI)

Helpful links

19 January 2023, SRI training session for LIFE and HORIZON projects. Presentation and recording.

21 September 2022, SRI awareness session in Italian | Sessione informativa sullo Smart Readiness Indicator (SRI) | Presentation and recording.

8 September 2022, Sustainable Places conference, Workshop Innovations for Upgrading the Smartness of Buildings. The recording of the workshop is available here.

30 June 2022, SRI awareness session in Spanish | Sesión informativa sobre el indicador smart readiness | Presentation and recording.

1 April 2022, SRI awareness session in French | Session d'information sur l'Indicateur de Potentiel d'Intelligence des bâtiments | Presentation and recording.

7 December 2021, SRI Training webinar (in English). The recording of the webinar is available here.

https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator/sri-implementation-tools_en#for-sri-assessors

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2 – E-mobility

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

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2 – E-mobility

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
E-mobility	KPI 20	recharging points and installed pre-cabling in relation to the number of parking spaces	[%]	EPBD recast (Article 12)

Objective

- Electric vehicles combined with an increased share of renewable electricity production play a crucial role for reducing GHG and 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.

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 20 Recharging points in relation to the number of parking spaces

Description

- This indicator measures the building's readiness for electrical transport, smart energy management and grid flexibility.

- The two types of charging station installation are either free-standing as a charging pole or wall mounted as a "wall box". Depending on the installation location and type of use, the charging station must fulfil requirements with regard to environmental factors: mechanical strength (impact protection, vandalism, graffiti), weather resistance (suitable protection class, operating temperature range), UV light resistance, corrosion resistance, vibrations

- The location must be selected in such a way that all loading operations can always be carried out safely. It must be possible to connect the vehicle without the use of extension cables or cable reels

- A supply line, designed for a continuous current carrying capacity of 32 A, from the main distribution board or the meter cabinet to the charging point is provided for a charging facility. In order to avoid considerable follow-up costs, it is recommended to provide a corresponding empty conduit to accommodate such a cable when planning the new building

- Furthermore, a separate empty conduit for a communication line, for example a network line, should be laid to the charging station in order to connect the charging station for future applications.

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KPI 20 Recharging points in relation to the number of parking spaces

Scope

- The indicator addresses both residential and non-residential buildings.
- 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.
- KPI addresses the following module of the building life-cycle: B1-B7

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KPI 20 Recharging points in relation to the number of parking spaces

Unit of measure

- % . Percentage of purpose-built recharging points in relation to the number of parking spaces in %.

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KPI 20 Recharging points in relation to the number of parking spaces

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

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KPI 20 Recharging points in relation to the number of parking spaces

Data

- Number of parking spaces
- Number of purpose-built electrical recharging spaces

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KPI 20 Recharging points in relation to the number of parking spaces

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,…).

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KPI 20 Recharging points in relation to the number of parking spaces

Helpful links

19 January 2023, SRI training session for LIFE and HORIZON projects. Presentation and recording.

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Thank you

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