EUB SuperHub

European Building Sustainability performance and energy certification Hub

D1.2 - Transnational indicators for the next generation energy certification

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1. table

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Dissemination level		
PU	Public	x
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

3. table

History			
Version	Date	Reason	Revised by

01	18/03/2022	Draft	iiSBE
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Executive Summary

Glossary

EPC	Energy performance certificate
SC	Sustainability certificate
KPI	Key performance indicators
MS	Member State
EPBD	Energy Performance of Buildings Directive
NZEB	nearly zero-energy buildings
LCA	Life cycle assessment
LCC	Life cycle cost
BER	Building Energy Rating
PPs	Project Partners
ISO	International Organization for Standardization
CEN	European Committee for Standardization
SBTool	Sustainable Building Tool
SBA	Sustainable Building Alliance
SRI	Smart Readiness Indicator
AF	Affordability Rating

1 Introduction

The crucial end-result of Task 1.2 activity is **an accurate list of selected indicators for evaluating the energy performance, sustainability and smartness of buildings in the next generation of Energy Performance Certificates (EPCs).**

Indicators selected **result from a recognition of the existing transnational set of indicators.** The final list of indicators produced in Task 1.2 consists of **indicators which have the prerogatives and the potential to become Key Performance Indicators (KPIs) and they represent the starting point of Task 2.2**, precisely related to the definition of common transnational indicators and assessment metrics for the E-Passport.

To be able to get this selected list of indicators, several activities have been carried out, usually in conjunction with Task 1.3, which is mainly focused on the identification of needs and expectations of public institutions and market actors.

The conclusion of Task 1.2 highlights the relevant aspects to be highly considered for the next generation EPC in relation to the policies of the European Commission and hence, **the need for introducing additional related indicators**, not existing in the transnational set of indicators analysed.

The starting point of Task 1.2 activity has been the investigation and the subsequent **analysis of the relevant transnational sets of indicators**, considering the initiatives of the European Community (SBA, Level(s)), the outputs of European Projects already concluded (CESBA MED, FASUDIR, NewTREND, etc.), standardisation process (CEN), etc. Several indicators have been collected thanks to this reconnaissance and properly catalogued according to a fixed template.

Next step of Task 1.2 activity concerned **the identification, through a "*bottom-up*" approach, of the thematic areas considered the most relevant for the next generation of EPCs**. To do that in a proper way, the activity followed two different approaches, including desk research and field activity with relevant stakeholders.

The selection has been built on:

- Results arising from a **concise user-friendly Survey**, prepared and distributed in Task 1.3, with the aim to get feedback from the stakeholders, whose suggestions about next generation of EPC are considered very relevant for the activity, about the priority of each of the thematic areas identified; and
- An in-depth analysis related to the proposal included in the document released from the European Commission about the **revision of the Energy Performance of Buildings Directive (EPBD)** in December 2021.

Results achieved through this "*bottom-up*" approach have been discussed internally, among technical partners mainly involved in the activity. The **internal consortium consultation** has contributed to the final selection of the thematic areas of interest and the key aspects to be included in the EUB SuperHub Passport for the next generation of EPCs.

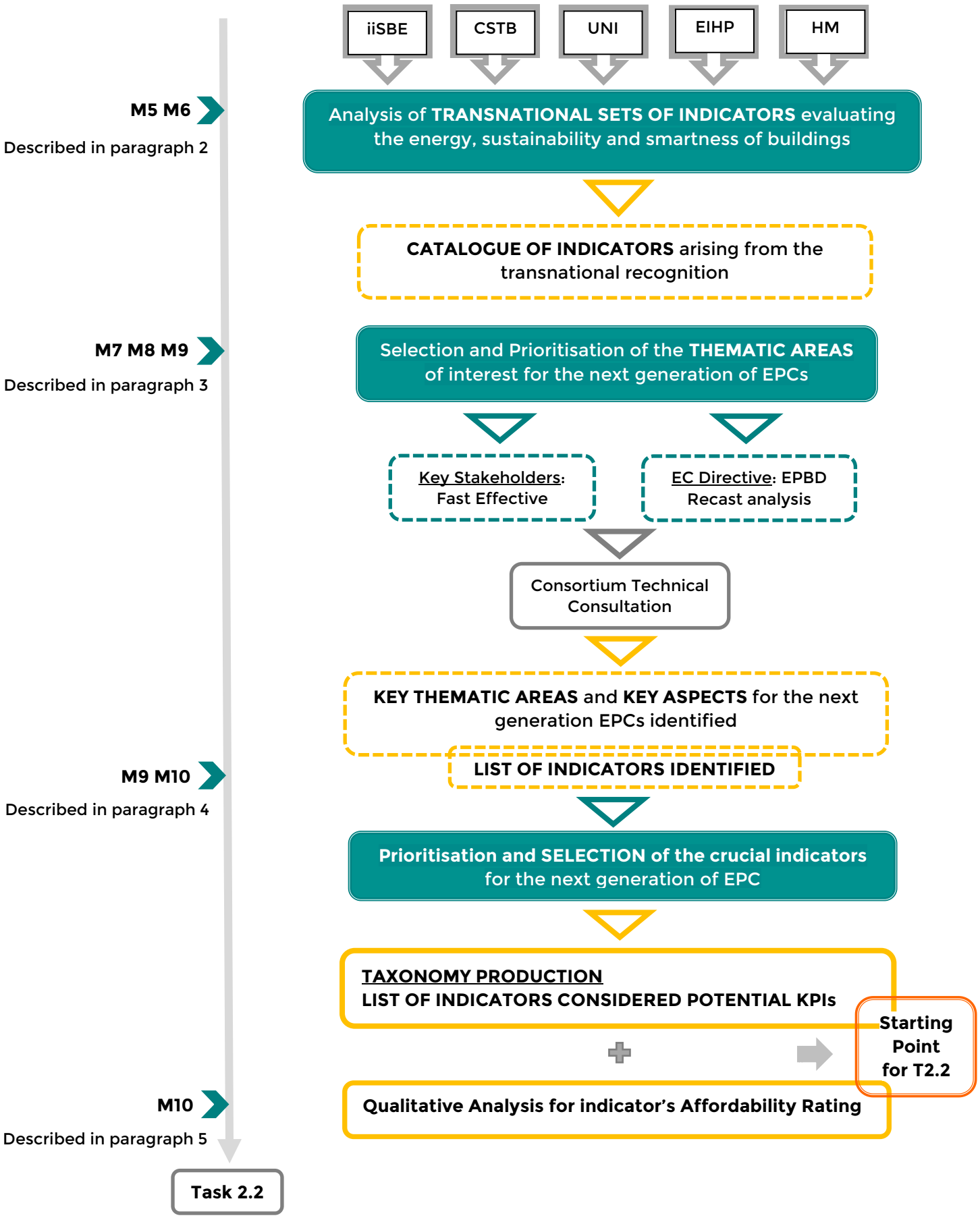
Once **detected the key thematic areas of interest**, **indicators belonging to them have been identified**, starting from the transnational frameworks analysed at the beginning.

According to a prioritisation activity, based on an approach focused on the rank of importance of priority elements considered for the selection (standard, European strategies, compliance with the EPBD recast, etc.), **in an objective way Task 1.2 has been able to define the list of indicators which have the characteristics to become KPIs.** The list of potential KPIs is made up of indicators relevant according to the objectives established by the European Commission in relation to the next generation of EPCs and coherent with the sustainability strategies defined for buildings. **This procedure has highlighted the indicators which have the prerogatives and the potential to become Key Performance Indicators (KPIs)** and they will be further investigated in Task 2.2.

Finally, **to further detail the potential KPIs identified, a qualitative analysis has been carried out with the aim to define**, for each of them, **the indicator's affordability rating**. This activity has enabled to give, to each indicator selected, an affordability score classifying them depending on their characteristics, areas of application, availability of data, cost and other parameters extensively described in the deliverable. The final objective of Task 1.2 was, indeed, **to establish a taxonomy classification of the fundamental indicators for the next generation of EPCs to be included in the EUB SuperHub Passport,** returning a catalogue of indicators very closed to the needs of market actors.

Of course, at the end of the work process carried out in Task 1.2, it has been fundamental to **perform a direct comparison among the suggestions for the next generation of EPCs expressed by the European Commission in the EPBD recast and how the potential KPIs identified can fulfil them**, highlighting the aspects still uncovered by the indicators selected.

To follow, a schematic summary of the key steps developed for Task 1.2 with some indication about the implementation timeline and the reference paragraphs for the activity description.


iiSBE
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Task 2.2

2 Analysis of relevant transnational sets of indicators

To achieve the objectives established in Task 1.2, the very early activity carried out by the consortium is the investigation and analysis of the available transnational set of indicators, related to the evaluation of the energy performance, sustainability and smartness of buildings.

Transnational frameworks analysed by PPs are listed below, catalogued according to the belonging field.

Standardisation process	▪ UNI EN 15643:2021 ▪ UNI EN 15978:2011 ▪ UNI EN 16309:2014+A1:2014 ▪ UNI EN 16627:2015
EC initiatives	▪ Smart Readiness Indicators ▪ SBTool ▪ Level(s) ▪ SBA Common metrics
EU project	▪ NewTREND (H2020) ▪ FASUDIR (FP7) ▪ OpenHouse (FP7) ▪ SuPerBuilding (FP7) ▪ CESBA MED (Interreg MED)

Table 1: Transnational frameworks analysed in the first part in the activity of Task 1.2.

The capitalisation of the results achieved by the European projects mentioned above, in parallel with the investigation of the direction taken by the European Commission in the proposal[1] for the Directive of the European Parliament and of the Council on the energy performance of buildings (recast), are the main aspects deepened in the context of Task 1.2.

Furthermore, it has been strongly taken into account the analysis of the current needs of the market actors, a crucial aspect that guarantees the alignment of project outputs with market demands.

All the PPs contributing to this in-depth investigation. Below the Template elaborated by iiSBE Italia for the analysis of the frameworks assigned to each consortium partner; specific provisions on the content of each paragraph are provided, using Level(s) initiative as example.

1-BASIC INFORMATION

[1] https://ec.europa.eu/energy/sites/default/files/proposal-recast-energy-performance-buildings-directive.pdf

1.1 Name of the framework: (e.g. Level(s))

1.2 Name of the framework developer: (e.g. JRC – European Commission)

1.3 Webpage: (e.g. https://ec.europa.eu/environment/levels_en - Please indicate one or more webpages where it is possible to find information on)

1.4 Countries where the framework is used: (e.g. European Union)

1.5 Brief summary (max 2.000 characters)

e.g. Level(s) is the common EU framework of core sustainability indicators for buildings. Level(s) is designed to enable professionals that play a role in the planning, design, financing and execution of building projects to make a clear contribution to broader environmental improvements at European level. It aims to establish a common language of sustainability for buildings by defining core indicators for the sustainability of office and residential buildings. The Level(s) framework provides a set of indicators and common metrics for measuring the sustainability performance of buildings along their life cycle, assessing the following aspects: environmental performance, health and comfort, life cycle cost and value, and potential risks to future performance, etc.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: (e.g. offices, residential buildings, schools, etc.)

2.2 Building types applicability: (e.g. new, existing/refurbishment, in use)

2.3 Users and purpose

Example:

User	Purpose
Project design teams, including architects, engineers, quantity surveyors and specialist Consultants	It provides a simple structure that can be presented to clients in order to prioritise attention on sustainability aspects. It supports the user at each stage in a project, with guidance notes on how to make accurate performance assessments.
Clients and investors, including property owners, developers, managers and investors	It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals. It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions

2.4 Physical boundaries of the assessment: *(The object of the assessment. e.g. building, building + site, building + site + location)*

2.5 Time boundaries *(At what stages of the project's the framework can be used. e.g. concept, detailed design, construction, as built, in use)*

3-STRUCTURE OF THE FRAMEWORK

(List the criteria as they are organised in the framework, including indicators and unit of measure.). For instance (Level(s)):

Macro-objective 1: Greenhouse gas emissions along a building life cycle

Criterion	Indicator	Unit of measure
1.1 Use stage energy performance	Primary energy demand per useful internal floor area	kWh/m2/yr
1.2 Life cycle Global Warming Potential	Greenhouse gases emitted per useful internal floor area	Kg CO_2 eq/m^2/yr

Macro-objective 2: Resource efficient and circular material life cycles

Criterion	Indicator	Unit of measure
....		
....		

Macro-objective 3: Efficient use of water resources

Criterion	Indicator	Unit of measure
....		
....		

Etc.

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

List the criteria of the framework in relation to the 3 sustainability dimensions: environment, society, economy. In the case more than one dimension is applicable, insert the criterion under the prevalent.

For instance (Level(s)):

Environment
1.1 Use stage energy performance
1.2 Life cycle Global Warming Potential
.....

Society
4.1 Indoor air quality
4.2 Time outside of the thermal comfort range
.....

Economy
6.1 Life cycle cost

6.2 Value creation and risk exposure
.....

5-DATA REQUIREMENTS

Please describe (if any) the quality requirements for the data necessary for the calculation.

6-REPORTING

Please describe (if any) the information about the requirements for the presentation of the results in reporting and communication.

7-LEGISLATION

Please describe the possible linkages to the legislation.

8-NOTES

Please insert here any additional information useful to describe the framework not included in the previous paragraphs.

In the next subparagraphs are individually described the transnational frameworks analysed by the PPs, according to the template presented above.

2.1 Level(s)

1-BASIC INFORMATION

1.1 Name of the framework:

Level(s)

1.2 Name of the framework developer:

Joint Research Centre (JRC) – European Commission (DG ENV & DG GROW)

1.3 Webpage:

https://ec.europa.eu/environment/levels_en

https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/412/documents

1.4 Countries where the framework is used:

European Union

1.5 Brief summary

Level(s) is the common EU framework of core sustainability indicators for office and residential buildings. Level(s) is designed to enable professionals who play a role in the planning, design, financing and execution of building projects to make a clear contribution to broader environmental improvements at European level. It aims to establish a common language of sustainability for buildings by defining core indicators for the sustainability of office and residential buildings.

The Level(s) framework provides a set of indicators and common metrics for measuring the sustainability performance of buildings along their life cycle, assessing the following aspects: environmental performance, health and comfort, life cycle cost and value, and potential risks to future performance.

The Level(s) common framework encourages users to think about the whole life cycle of a building, providing a basis for quantifying, analysing and understanding the life cycle.

Linked to this, it seeks to address several aspects of circularity by providing indicators that can help in understanding how to extend the utility of the building - not just in terms of its service life and value in the property market, but also in terms of the future potential for recovery, reuse and recycling of the materials it is composed of.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability:

Offices and residential buildings

2.2 Building types applicability:

New, existing / refurbishment and in use

2.3 Users and purpose

User	Purpose
Project design teams, including project managers, architects, engineers and quantity surveyors	• It provides a simple structure that can be presented to clients in order to prioritise attention on sustainability aspects. • It supports the user at each stage in a project, with guidance notes on how to make accurate performance assessments. • It has a focus on the performance of the completed building, and the steps to be taken at design stage to ensure high performance. • It provides flexibility in the level of detail at which sustainability aspects can be addressed in the design process.
Clients and investors, including property owners, developers, managers and investors	• It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals. • It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions. • It focusses on minimising the gap between design and occupied performance. • It identifies how the costs and risks associated with a building's performance can be future proofed and managed to deliver long-term value. • It provides tools to identify opportunities to extend the lifespan, improve the internal environmental quality and enhance the long-term value of building assets.
Public policy makers and procurers at local, regional and national level	• It provides a clear set of prioritised aspects of performance to focus attention on, together with a standardised basis for setting requirements for new and renovated buildings to meet. • It provides the basis for actions and requirements that can contribute to Member State, regional and local government carbon reduction targets as well as broader sustainability objectives. • It focusses on performance aspects that are of direct ongoing financial interest to public authorities and agencies, such as operating and maintenance costs;

	• It includes indicators that measure comfort and wellbeing aspects of a building and its internal environment, e.g. indoor air quality, thermal comfort. • It provides recommendations on how the performance of an occupied building can be monitored and surveyed

2.4 Physical boundaries of the assessment:

Building + Site (for the analysis of demolition and construction waste) + Location (for the analysis of risks linked to climate change).

2.5 Time boundaries

From the very earliest stages of conceptual design through to the projected end of life of the building. The framework is organised into three levels. The levels provide a choice as to how advanced the reporting on sustainability for the project will be. The three levels represent the following stages in the execution of a building project:

Level 1. Conceptual design: early-stage qualitative assessments and reporting on the concepts that the chosen indicators will cover. It provides a simple structure that can be presented to clients to prioritise attention on sustainability aspects).

Level 2. Detailed design and construction: quantitative assessment of the designed performance. Allowing comparison between different design options and monitoring of the construction according to standardized units and methods.

Level 3. As-built and in-use: monitoring and surveying of activity both on the construction site and of the completed building and its first occupants. Level 3 helps the entire team understand actual building performance and identify lessons learned from the design to inform and improve future projects.

3-STRUCTURE OF THE FRAMEWORK

Level(s) framework is structured as follows:

1. Macro-objectives: A set of 6 macro-objectives that contribute to EU and Member State policy objectives in areas such as energy, material use, waste management, water and indoor air quality.

2. Core Indicators: A set of 16 common indicators, together with a simplified Life Cycle Assessment (LCA) methodology, that can be used to measure the performance of buildings and their contribution to each macro-objective.

Macro-objective 1: Greenhouse gas and air pollutant emissions along a building life cycle

Criterion	Indicator	Unit of measure
1.1 Use stage energy performance	Primary energy demand per useful internal floor area	kWh/m²/yr kWh

1.1 Use stage energy performance	Delivered final energy demand	kWh/m²/yr kWh
1.1 Use stage energy performance	Non-renewable primary energy demand	kWh/m²/yr
1.1 Use stage energy performance	Renewable primary energy demand	kWh/m²/yr
1.2 Life cycle Global Warming Potential	Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area.	kg CO_2 equivalents per square metre per year [kg CO_2 eq/m²/yr]*

Macro-objective 2: Resource efficient and circular material life cycles

Criterion	Indicator	Unit of measure
2.1 Bill of quantities, materials and lifespans	Mass of construction products and materials necessary to complete defined parts of the building. For each entry, the mass is disaggregated into different material fractions. If optional lifespans are entered for each entry, the masses and costs of materials over the building lifetime can be measured.	Unit quantities, mass and years***
2.2 Construction & demolition waste and materials	Overall quantity of waste generated by construction, renovation and demolition activities (in kg)	kg of waste and materials per m2 total useful floor area*
2.3 Design for adaptability and renovation	Semi-quantitative assessment of the extent to which the design of a building could facilitate future adaptation to changing occupier needs and market conditions	Adaptability score
2.4 Design for deconstruction, reuse, and recycling	Quantitative assessment of the extent to which the design of a building could facilitate the future reuse, recycling or	Deconstruction score

	recovery of building elements, components and constituent parts and materials	

Macro-objective 3: Efficient use of water resources

Criterion	Indicator	Unit of measure
3.1 Use stage water consumption	The total consumption of water is measured for an average building occupant, with the option to split this value into potable and non-potable water	m^3/yr of water per occupant

Macro-objective 4: Healthy and comfortable spaces

Criterion	Indicator	Unit of measure
4.1 Indoor air quality conditions	Ventilation rate	L/s/m^2
4.1 Indoor air quality conditions	CO2 concentration	ppm
4.1 Indoor air quality conditions	Relative humidity	%
4.1 Target pollutants indoor sources	Total VOCs	mg/m^3
4.1 Target pollutants indoor sources	CMR VOCs concentration	mg/m^3
4.1 Target pollutants indoor sources	R value	Decimal ratio
4.1 Target pollutants indoor sources	Formaldehyde concentration	mg/m^3
4.1 Target pollutants indoor sources	Benzene	mg/m^3
4.1 Target pollutants indoor sources	Radon concentration	Bq/m^3
4.1 Target pollutants indoor sources	Particulate matter<2,5 mm	mg/m^3
4.1 Target pollutants indoor sources	Particulate matter<10 mm	mg/m^3
4.2 Time outside of thermal comfort range	The proportion of the year when building occupiers are not comfortable with the thermal conditions inside a building.	% of the time out of range during the heating and cooling seasons
4.3 Lighting and visual comfort	Analysis of availability and quality of light. This can be understood in	Level 1 checklist**

	terms of a combination of installed electric lighting systems and the penetration of natural light into a building. A further aspect relates to the degree of control that end-users have over their living or working environment, including the extent to which automatic systems can be overridden to allow for a reaction to a change in conditions and the personalisation of comfort conditions	
4.4 Acoustics and protection against noise	Measurement of environmental noise, impact and airborne transmission of sound, reverberation of sound inside spaces	Level 1 checklist**

Macro-objective 5: Adaptation and resilience to climate change

Criterion	Indicator	Unit of measure
5.1 Protection of occupier health and thermal comfort	Proportion of the year when building occupiers are comfortable with the summer thermal conditions inside a building.	Projected % time out of range in the years 2030 and 2050
5.2 Increased risk of extreme weather events	Study of the increased risk of extreme weather events in the conceptual design of the building	Level 1 checklist**
5.3 Increased risk of flood events	Quantities of stormwater that will fall on the plot area, where it will be directed, how quickly it will leave the drainage system and reach the natural watercourse, and what exactly are the different components of the drainage system.	Level 1 checklist**

Macro-objective 6: Optimised life cycle cost and value

Criterion	Indicator	Unit of measure

6.1 Life cycle costs	All building element costs incurred at each life cycle stage of a project for the reference study period and, if defined by the client, the intended service life	Euros per square metre per year [€/m²/yr]
6.2 Value creation and risk exposure	Measure of the positive influence of improved sustainability performance on a property financial valuation and/or a financial risk rating.	Level 1 checklist**

**Composite indicators: These indicators are more complex and difficult to reduce to a single unit of measurement. Instead, they consist of several related units of measurement that must be read together to understand a building's performance.*

***Qualitative assessments: These indicators do not currently have an agreed quantitative unit or units of measurement, so instead the results of a qualitative assessment can be reported.*

****Information reporting: This indicator is designed to encourage users to handle and process specific items of data about their building as an aid to life cycle thinking*

NB: The core indicators of macro-objectives 1, 2 and 3 are complemented by a holistic assessment of a building's environmental impact - a full Life Cycle Assessment (LCA) of a building. By making a LCA, the environmental impacts associated with a building can be quantified and the most significant areas – commonly referred to as "hot spots" – can be identified and used as the starting point for improving performance.

Technical terms and definitions used

- R value: According to EN 16516, the R value is the sum of all Ri values obtained during a given test. The Ri value is the ratio of Ci / LCIi, where Ci is the mass concentration in the air of the reference room and LCIi is the LCI value of compound i.

- LCI: According to EN 16516, LCI is the Lowest Concentration of Interest, which is a substance-specific value and is quoted in terms of mass concentration in the air of the reference room, for health-related evaluation of emission levels from construction products.

- TVOC: According to EN 16516, 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 of every individual compound (target and non-target, identified and unidentified) eluting between n-hexane and n-hexadecane inclusively using the specified column, and

calculated using the TIC response factor for toluene after subtracting the blank values and after excluding compounds calculated to be below 5 μg/m3 in the air of the reference room using the TIC response factor for toluene, additionally all compounds listed in Annex G (of EN 16516) are included even if they elute after n-hexadecane or before n-hexane under the specific test conditions.

- **CMR VOC:** Carcinogenic, mutagenic, reprotoxic (CMR) substances.

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
1.1 Use stage energy performance
1.2 Life cycle Global Warming Potential
2.1 Bill of quantities, materials and lifespans
2.2 Construction & demolition waste and materials
2.3 Design for adaptability and renovation
2.4 Design for deconstruction, reuse and recycling
3.1 Use stage water consumption
5.2 Increased risk of extreme weather events
5.3 Increased risk of flood events

Society
4.1 Indoor air quality
4.2 Time outside of the thermal comfort range
4.3 Lighting and visual comfort
4.4 Acoustics and protection against noise
5.1 Protection of occupier health and thermal comfort

Economy
6.1 Life cycle cost
6.2 Value creation and risk exposure

5-DATA REQUIREMENTS

Main data requirements and potential sources for thermal simulation. The table below summarises the main data items and potential sources for the realisation of thermal simulation. Each method will provide guidance on where real values can substitute default values. For a tailored assessment, real values shall be used as far as possible.

Data item	Potential source	
	Default EU values	National, regional or locally specific values
Conditions of use and occupancy	EN ISO 13790 (Annex G8) EN ISO 52000-1 ISO/TR 52000-2 EN ISO 52016-1	National or regional calculation method
Thermal envelope description	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method: certified products and details
Building services description	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method: certified products
Reference year climate file	Three climate zones (EN 15265 test cases)	National or regional calculation method Member State Meteorological Offices
Primary energy factors	EN 15603 (Annex E) EN 52000-1 (Annex B.10)	National or regional calculation method
Internal temperature set points	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method
Ventilation and infiltration rates	EN 15241 EN 15242	National or regional calculation method
Internal gains as heat flows	EN ISO 13790 (Annex J) EN ISO 52016-1	National or regional calculation method
Heating/cooling system characteristics and capacity	-	National or regional calculation method: certified products [13]

The source of the table above is "Level(s) indicator 1.1: use stage energy performance, user manual: introductory briefing, instruction and guidance", the table describes the specification of the main data requirements and potential sources.

Third party input data

It is recommended that where third party input data is used, special attention be paid to its quality and compliance. For example, input data may also be available that has been checked and certified for use – for example, performance data for architectural details that can minimise thermal bridging.

Weather data

It is recommended to use a test reference year derived from the medium term (20 or 30 year) time series of a standard local weather station. If it is difficult to access hourly local weather files, the Joint Research Centre's open access weather file database may be used for sites across the EU Real values shall be used as far as possible.

Where possible, it is important to take into account the Urban Heat Island (UHI) effect, as this can have a significant effect on localised external temperatures. In some EU towns and cities, work has been done to interpolate weather datasets to take into account the UHI effect. This is particularly important in major cities and

locations where the urban design, commuting patterns and topography can exacerbate winter or summer conditions.

Thermal comfort analysis

The Predicted Percentage Dissatisfied (PPD) design stage estimate requires input data for six thermal parameters - clothing, activity, air and mean radiant temperature, air velocity and humidity.

Data item	Potential source	
	Default EU values	National, regional or locally specific values
Thermal simulation	*See indicator 1.1*	*See indicator 1.1*
PPD thermal parameters	ISO 8996, ISO 9920 EN ISO 7730 Annexes B/C EN ISO 7730 Annex E (overall estimate of PPD)	National or regional calculation method (overheating assessment) Building permitting requirements
Weather data	Three climate zones (EN 15265 test cases)	National or regional calculation method Member State Meteorological Offices

The source of the table above is "Level(s) indicator 4.2: time outside of thermal comfort range, user manual: introductory briefing, instruction and guidance", the table describes data requirements and sources for indicator 4.2.

Whilst an estimation of the time out of a thermal comfort range will provide a broad indication of the tolerance of the building, it will not provide information on persistent periods of temperature stress that may reduce occupants' tolerance to 'out of range' conditions.

As a result, their willingness to adapt to higher temperatures may progressively reduce during these events, thereby affecting discomfort levels and cooling energy use.

Data on the duration and intensity of heat waves in a locality or region can provide the basis for a more detailed risk assessment.

6-REPORTING

In order to make the link between design, as-built and occupied performance, the Level(s) framework makes it possible to report on building performance by using the indicators at the following project stages along the life cycle of a building:

1. Design stage (based on calculations, simulations, and scenarios)
2. Implementation stage (based on as-built drawings, specifications, and tracking)
3. Completion stage (based on commissioning and testing)
4. Operation stage (based on measured performance and occupant satisfaction)

Spreadsheet tools have been pre-designed and are available at the project website. They enable users to easily report on assessment results for selected indicators and life cycle tools, at different project stages, and at different Levels.

7-LEGISLATION

By defining core indicators for the sustainability of office and residential buildings, Level(s) clarifies and concretizes the EU policy objectives on sustainability performance of buildings along their life cycle and enables professionals that play a role in the planning, design, financing, and execution of building projects to apply more effectively the EU policies and legislation (EED, EPBD, etc.) contents, making a clear contribution to broader environmental improvements at European level.

8-NOTES

Calculation methods

Criterion 1.1 - The calculation method should be the national or regional calculation method for energy performance laid down in the Member State where the building is located. If other calculation methods are used, they must be compliant with the EN ISO 52000 series and standards developed under mandate 480.

Criterion 1.2 – The main reference standard providing the calculation method is EN 15978. Reference is also made to ISO 14040/44, EN 15804 and the European Commission's Product Environmental Footprint (PEF) method.

Criterion 2.1 - When considering the optional service life data for each entry, the user is recommended to follow the rules in section 9.3.3 of EN 15978, ISO 15686-8, tools such as BCIS, DGNB or ETool, specific standards for specific elements (e.g. EN 15459 for heating systems) know-how gained from experience with such elements in similar buildings and circumstances.

Criterion 2.3 - The method refers to the principles and design aspects that are included in EN 15643-3, EN 16309 and ISO 20887.

Criterion 2.4 - This calculation method has been developed for Level(s) and is broadly related to the principles of the German Green Building Council's (DGNB) ease of recovery and recycling criterion TEC1.6.

Criterion 4.1 - Each of the different parameters listed above that relate to IAQ have their own calculation method and reference standards. Measuring one aspect in isolation is not recommended, due to the interdependence between ventilation performance and emission rates from materials/building activities and any parameters measured to assess IAQ.

- Specifications for ventilation systems and target CO2 and relative humidity levels follow EN 15251 and EN 16798.
- The main standard for running simulations of building ventilation is EN 16798-7.
- The choice of filter specification for air intakes (based on outdoor air quality and target IAQ) should be in line with EN 13779.

- Regarding construction products/materials as potential sources of indoor air pollutants (i.e. VOCs), EN 16516 is the main standard for reporting emission data.
- Risk assessments for mould and radon shall be carried out as and when deemed necessary by relevant experts. Standardised semi-quantitative risk assessments methods may be used.
- The main reference standards for post occupancy surveys of indoor environments and user perceptions of comfort and wellbeing are ISO 10551 and ISO 28802

Criterion 4.2 - Calculation of the reported performance shall be based on a dynamic energy simulation and in accordance with the method described in Annex A.2 of EN 16798-1. An overheating assessment that forms part of a National Calculation Method shall be accepted if it is based on a dynamic simulation method. If a more advanced calculation method is used, it shall be compliant with the ISO EN 52000-1 series. If there is the intention to carry out post-occupancy evaluation of satisfaction/dissatisfaction with the thermal environment, the Predicted Percentage Dissatisfied (PPD) shall be estimated based on EN ISO 7730 (for mechanically cooled buildings) or the acceptable summer indoor temperature range (for buildings without mechanical cooling). The estimate PPD can then be compared with the results from an occupier survey.

Criterion 4.3 - The calculations carried out when assessing the provision of electric light in a space are mostly defined in EN 12464-1 (Light and lighting. Lighting of workplaces. Indoor workplaces) and EN 17037 (Daylight in buildings). These standards are complemented by the design requirements for the indoor environment in EN 16798-1.

Criterion 4.4 - Noise levels at the facade of a building, due to environmental noise, are predicted as a yearly average (often with a daily penalty distribution) or a maximum level. Predictions can be made according to the calculation method described in Annex II of Directive 2002/49/EC. Commercial software programs perform three-dimensional calculations and provide estimates of the health burden. The models vary with the frequency range of concern, being adjustable according to the noise source type and the potential for noise annoyance. Input data for noise models should include data similar to the level of vehicle counts/estimations and sound power measurements of noise sources made according to the standard series ISO 3744 and ISO 9614 series. Data is also available from the NOISE database provided by the EU in support of Directive 2000/14/EC. To predict indoor noise levels from environmental noise, either calculators included in acoustic software models can be used, or predictions may be based on the sound insulation properties of the facades and reverberation times of the receiving rooms using a building element approach.

Calculations of apparent sound insulation can be made using ISO 12354 parts 1 to 4 using laboratory measurements from ISO 10140 series or table values.

The reverberation time (T), and the equivalent sound absorption area (Aeq), can be estimated using EN ISO 12354-6, based on volume and sound absorption data obtained using ISO 354, ISO 12354-6 Annex B, EN 16487, ASTM 423 and/or ISO

20189. Speech intelligibility (STI), Strength (G), Definition (D50), and Clarity (C80), can be estimated using numerical simulation or ray-tracing models for acoustic prediction. The reverberation time (T), and the equivalent sound absorption area (Aeq), can also be more precisely estimated using these calculation tools. Input data for the tools shall be sound absorption data obtained using ISO 354, ISO 12354-6 Annex B, EN 16487, ASTM 423 and/or ISO 21089.Measurements of the relevant descriptors shall be performed according to the ISO 3382 series of standards.

Criterion 5.1 - Calculation of the reported performance shall be based on a dynamic energy simulation and in accordance with the method described in Annex A.2 of EN 16798-1. An overheating assessment that forms part of a National Calculation Method shall be accepted if it is based on a dynamic simulation method. If a more advanced calculation method is used, it shall be compliant with the ISO EN 52000-1 series.

Dynamic simulations shall be carried out using weather files for the location or region that are based on authoritative climatic projections for 2030 and 2050. The modelling shall, as a minimum, be based on the UN IPCC 'mitigation' (SRES E1 or RCP 6.0) emissions scenario. A second worst case scenario 'medium-high' (SRES A1B or RCP 2.6) emissions scenario may also be considered. The source of the climatic projections and associated weather files for 2030 and 2050 shall be clearly reported.

Criterion 6.1 - The reference standard for calculating the life cycle costs of each life cycle stage shall be EN 15459, ISO 15686-5 and EN 16627. The reference standard ISO 15686-8 provides a methodology for calculating and estimating the design life of elements and components.

For each indicator it is necessary to identify: (i) what level of expertise is required; (ii) who will be responsible for the assessment and (iii) How, and by whom, will the information and data be managed.

An important part of working at level 2 and 3 is the completion of the building description. Its role is to provide a transparent basis for comparing the performance of different buildings. The information in the building description will also be used to normalise and obtain the results for several of the indicators.

2.2 SBA - Sustainable Building Alliance

1-BASIC INFORMATION

1.1 Name of the framework:

Sustainable Building Alliance Framework for Common Metrics of Buildings

1.2 Name of the framework developer:

A group of institutes, among the partners of Sustainable Building Alliance :

- CSTB (France)
- BRE (UK)
- DGNB (Germany)
- VTT (Finland)

- Qualitel Association (France)

The Sustainable Building Alliance (SBA) was initiated in 2008 and officially established in 2009 by BRE (United Kingdom), CSTB (France), DGNB (Germany), FCAV (Brazil), ITC CNR (Italy), QUALITEL (France) and VTT (Finland). In the following years, the membership expanded to 34 members of 14 countries.

A first report on sustainable building Core Metrics was presented in 2009 and published in 2010 under the title" A **Framework for Common Metrics of Buildings 2010**".

Other R&D reports were produced, dealing with the test of 4 Common Metrics, integration to BIM and IFC, impact on green value.

In 2022 this SB Alliance does not exist anymore (dissolved in 2021), nor the initial website (www.sballiance.org).

1.3 Webpage:

Information on SBA works is available in a group hosted by Construction 21 International:

https://www.construction21.org/community/pg/groups/5626/

Contact at CSTB: Anne-Claire Gislard, AnneClaire.GISLARD@cstb.fr

1.4 Countries where the framework is used:

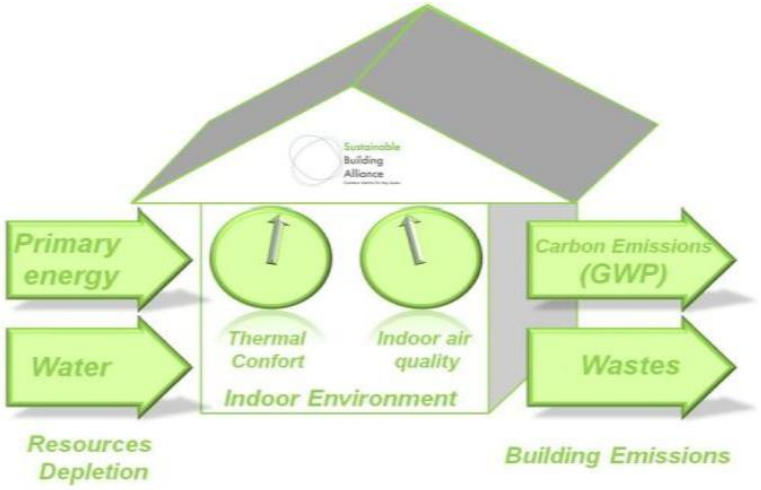
The SBA Common Metrics Framework is not used as such in Europe, but this work inspired subsequent R&D works.

1.5 Brief summary

The Sustainable Building Alliance was an international non-profit organization bringing together operators of building rating tools and certification, standard setting organizations, national building research centres and key property industry stakeholders. The purpose of SB Alliance was accelerating the adoption of sustainable building practices through the promotion of shared and harmonised indicators for building performance assessment and rating. It relied on the fact that the existing certification schemes in Europe and other regions of the world did not share the same indicators, the consequence being that a building may have 3 environmental certificates in order to speak the language of each framework. This is still a reality today, but in a lesser extent.

The SBA framework includes six criteria / metrics, four of them relate to environmental aspects and impacts considering the building life cycle, the two others relate to the indoor environment:

- Carbon emissions (GWP)
- Primary energy
- Water
- Wastes
- Indoor Environment Quality:
  o Thermal comfort
  o Indoor air quality



The 6 criteria of the SBA framework

This framework was supposed to motivate the certification bodies of SBA to adopt harmonised core indicators in their respective assessment schemes, but finally in 2012 some of them were not ready yet to adopt the SBA Common Metrics.

The R&D work done by SBA, as well as some other works on the same topic, paved the way for subsequent works, as CEN TC350 standardisation (e.g. EN 15978) and the construction of Level(s).

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability:

Residential buildings, offices, schools and possibly other building types.

2.2 Building types applicability:

- New buildings: all indicators can be applied
- In-use buildings: only indicators dealing with operation phase can be applied

2.3 Users and purpose

User	Purpose
Developer, investor, owner, designer, property or facility manager, tenant/user, etc.	Assess, estimate value, benchmark, check, improve, optimise, etc.

2.4 Physical boundaries of the assessment:

Building + site

The life cycle of the building is considered (before use stage, use stage, end-of-life stage), but some unit stages are mandatory and other optional. For LCA indicators, they differ slightly according to the indicator.

Regarding construction products and equipment, the mandatory ones are:

• Roof
• Load-bearing structure
• Exterior and basement walls including windows
• Internal Walls
• Floor Slabs
• Foundation
• Floor Finishes/Coverings

Regarding services, for operational energy-related impacts, the mandatory scope is limited to the 5 regulated energy uses.

2.5 Time boundaries

The SBA framework can be used during:

- design (provided input data are available, if no, use of generic data)

- as built

- in use.

3-STRUCTURE OF THE FRAMEWORK

1 - Resource depletion

Criterion	Indicator	Unit of measure
1.1 - Primary energy	Use of non-renewable primary energy *(on the building life cycle)*	kWh / m^2 *(the basis for area measurement shall be stated)*
1.2 - Water	Water consumption *(on the building life cycle)*	m^3 / time period / <functional equivalent>

2 - Building emissions

Criterion	Indicator	Unit of measure
2.1 - Carbon emissions	Global Warming Potential (GWP_{100}) *(on the building life cycle)*	kg CO_2eq / <unit>
2.2 - Waste	Solid wastes production *(on the building life cycle)* - Hazardous waste - Non-hazardous waste - Inert waste - Nuclear waste *(in-use)*	For each one: Tonne / <functional equivalent> For nuclear waste: kg / <functional equivalent>

3 - Indoor Environment Quality

Criterion	Indicator	Unit of measure

3.1 - Thermal comfort	For summer and winter settings: % time out of range of minimum and maximum temperature *(by calculation or measurement or NCM)*	% time
3.2 - Indoor Air Quality	CO_2 concentration during the occupied period *(by calculation or measurement or NCM)*	CO_2 ppm
	Formaldehyde concentration *(measurement)*	µg / m^3

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
1.1 - Primary energy
1.2 - Water
2.1 - Carbon emissions
2.2 - Waste

Society
3.1 - Thermal comfort
3.2 - Indoor Air Quality

Economy
..... *(none)*

5-DATA REQUIREMENTS

The SBA framework draws attention on data quality criteria:

- Data quality should be documented
- Specific data: no more than 5-year-old
- Generic data: no more than 10-year-old
- Period of data collection
- Technology representativeness
- Geographical representativeness
- Completeness
- Consistency
- Uncertainty

In addition, the SBA framework includes requirements for scenarios at the different stages of the building or product life cycle. The scenarios used shall be documented.

6-REPORTING

The presentation of the results for the indicators shall be documented separately for the different life cycle stages. The following format/template must be respected. For each indicator a summation is possible only if data for all modules (and sub-components) are available. This table is a part of the assessment report including useful information and all justifications asked in the framework document.

Functional Equivalent														
Type of Building		<Office, house , school etc.>												
Occupancy (Pattern of Use)		<number of occupants, hours of use>												
Required Service Life		<for the building in years>												
Regulations and Standards		<Country/Region for the building regulations or standards for the construction or use of the building>												
Climate Type		<e.g. Mediterranean.>												
Indicator		Before use stage					Use Stage				End of Life Stage			
		Product Stage			Construction Stage							Disposal Stage		
		Raw Material Process	Transport	Manufacturing	Transport	Construction Installation Process	Operation of building-incorporated services	Operation of non building-incorporated appliances	Maintenance, repair and refurbishment	Transport (of people)	Deconstruction	Transport	Recycling, reuse and energy recovery	Waste Disposal
GWP	CO_2 eq													
Energy	kWh													
Water	m^3													
Waste	Tonnes Hazardous													
	Tonnes Non-hazardous													
	Tonnes Inert													
	kg - Nuclear													

		Design	In-use	
IEQ	Thermal Comfort %TOR			
	Thermal Comfort Dev			
	IAQ [CO_2] ppm			
	IAQ [Formaldehyde] µg/m^3			

Key:

Stages included for each indicator		Required in 2009 version		Optional in 2009 version
		Not included in 2009 version		Not relevant

7-LEGISLATION

If a national calculation method (NCM) is used to make a calculation, it must be specified in the assessment report. At least, energy consumption is calculated by the national regulation.

8-NOTES

The LCA indicators of SBA Common Metrics were tested on pilot projects in 2011-2012 by R&D institutes of several countries in order to verify their applicability.

Reference: "Sustainable Building Alliance, Piloting SBA Common Metrics, Phase 1, Final report, October 2012".

2.3 SBTool – Sustainable Building Tool

1-BASIC INFORMATION

1.1 Name of the framework: Sustainable Building Tool (SBTool).

1.2 Name of the framework developer: iiSBE International

1.3 Webpage: https://www.iisbe.org/sbmethod

1.4 Countries where the framework is used: Worldwide.

1.5 Brief summary

The SBTool is a generic framework for rating the sustainable performance of buildings and projects and it is the result of a research process, known as Green Building Challenge, dating back to 1998. Twenty-five nations have contributed to its development, coordinated by iiSBE (international initiative for a Sustainable Built Environment).

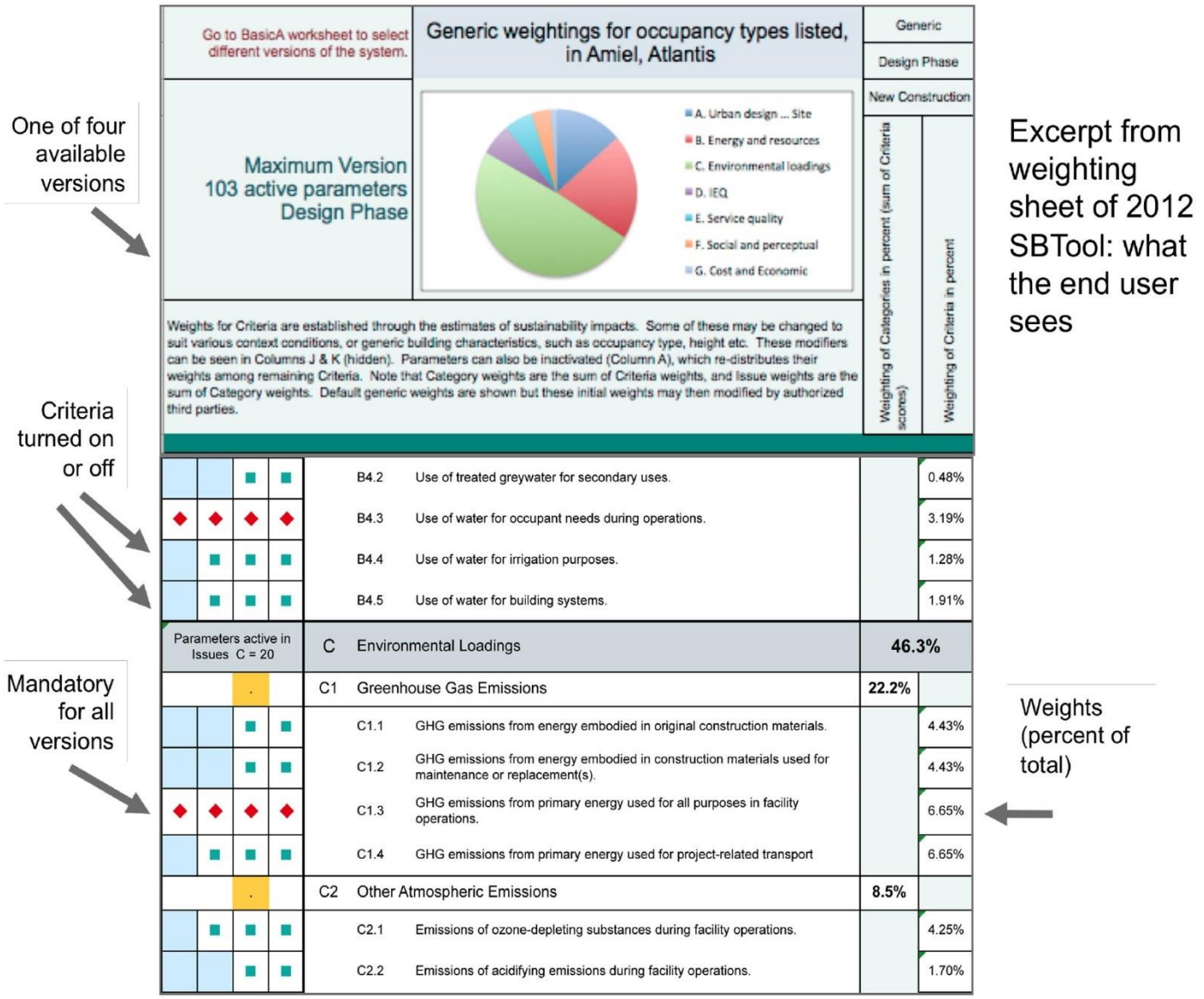
The SBTool has been conceived as an international tool able to be adapted to the characteristics of any geographical area. The SBTool is indeed, a "Generic Framework", which means that is a generic multicriteria system that needs a regional contextualization to be applied and used. It may also be thought of as a toolkit that assists local organizations to develop local SBTool rating systems; it can be used by authorized third parties to establish adapted versions as rating systems to suit their own regions and building types.

In relation to the regional characteristics, the contextualization consists in the choice of the most relevant criteria to be applied, in assigning weights to criteria in order to reflect local priorities and in the definition of the performance scale (benchmark) based on local conditions. By this way, it is possible to obtain an operational framework able to measure the sustainability level of a building in relation to the context in which it is located. Indeed, the SBTool considers region-specific and site-specific context factors.

SBTool can also be used by owners and managers of large building portfolios, to express in a very detailed way their own sustainability requirements to their internal staff or as briefing material for competitions.

The system covers a wide range of sustainable building issues, not just green building concerns, but the scope of the system can be modified to be as narrow or as broad as desired, ranging from 100+ criteria to half a dozen. The system is set up to allow easy insertion of local criteria and/or language and includes IDP process steps.

Below an example of the weight calculation of the in SBTool taken from https://www.iisbe.org/system/files/SBTool%20System%20as%20a%20platform%20for%20education%20in%20SBE.pdf



The figure above, taken from the paper "Using the SBTool System as a platform for education in sustainable built environment" wrote by Nils Larsson and Luis Braagança, displays an example of the weight calculation of the in SBTool.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: Residential buildings and non-residential buildings (commercial, offices, etc.)

2.2 Building types applicability: new building, existing building, renovation project.

2.3 Users and purpose

User	Purpose

Project design teams, including architects, engineers, quantity surveyors and specialist Consultants	It can be contextualised to each regional context. It ensures transparency in the reporting of performance assessment and the associated data, calculation methods and assumptions.
Clients and investors	It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals.
Owners and managers of large building portfolios	To express in a very detailed way their own sustainability requirements to their internal staff or as briefing material for competitions.

2.4 Physical boundaries of the assessment: The SBTool provides separate modules for Site and Building assessments, with Site assessments carried out in the Pre-design phase and Building assessments carried out in Design, Construction or Operations phases.

2.5 Time boundaries: SBTool is able to carry out assessments at four distinct stages of the life-cycle and the systems provides default benchmarks suited to each phase (Pre-design, Design, Construction and Operations).

3-STRUCTURE OF THE FRAMEWORK

SBTool is a flexible and comprehensive framework that provides coverage of almost all issues related to the sustainability of building; it provides a cross-disciplinary / multi-criteria view of sustainability, showing the importance and constituting the basis for a broad comprehension.

A	Site and Infrastructure			
A1	Site Planning, Development and Maintenance			
	code	Criterion	indicator	Unit of measure
	A1.1	Protection and restoration of wetlands.	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of the wetlands.	Qual
	A1.2	Protection and restoration of coastal environments.	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of the coastal environment.	Qual

	A1.3	Reforestation for carbon sequestration, soil stability and biodiversity.	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of forested areas on the site.	Qual
	A1.4	Development or maintenance of wildlife corridors.	The long-term presence of urban fauna.	-
	A1.5	Remediation of contaminated soil, groundwater or surface water.	Status of soil, groundwater, or surface water after treatment.	
	A1.6	Shading of building(s) by deciduous trees.	Native trees retained or planted, according to landscaping plans and specifications; measured as percent of building frontage facing the equator, at a height of 5 m. that will be covered by foliage during the warm season within 5 years.	Qual
	A1.7	Use of vegetation to provide ambient outdoor cooling.	Ratio of total vegetated surface area (on ground and on roofs, and including trees), divided by total site area. The result is known as or Leaf Area Index.	n
	A1.8	Use of native plant types.	The extent of vegetated landscaped area that is planted with native plants.	%
	A1.9	Provision of public open space(s).	The provision of land within the site suitable as public open space because of its location, area or other characteristics.	Qual
	A1.10	Provision and quality of children's play area(s).	In projects with residential accommodation for families, the existence and type of facilities for children's play and	Qual

			the quality of service provided.	
	A1.11	Facilities for small-scale food production for residential occupants.	Location, dimensions, access to sun and water.	Qual
	A1.12	Provision and quality of bicycle pathways and parking.	Type and extent of bicycle paths in the project, connectivity with off-site bicycle paths, amount of sheltered and unsheltered bicycle parking, location of bicycle parking facilities relative to building entrances.	Qual
	A1.13	Provision and quality of walkways for pedestrian use.	Type and extent of walkways in the project, extent of walkways sheltered from rain, snow or excess sunshine.	Qual
A2	Site Characteristics and Functionality			
	A2.1	Maximizing efficiency of land use through development density.	Development density of the project, expressed as the ratio of gross floor area above grade of the Design relative to the maximum permitted gross floor area on the site.	n
	A2.2	Impact of mixed uses on demand for commuting transport.	Number of major uses within the project, related to a threshold area.	Qual
	A2.3	Impact of orientation on the passive solar potential of building(s).	Deviation, in degrees (°) of main building axis from East-West (to ensure a maximum possible insolation).	Qual
	A2.4	Building morphology, aggregate measure.	-	-
	A2.5	Impact of site and building orientation on natural ventilation of building(s) during warm season(s).	Predicted differential wind pressures in Pascals (Pa) during warm season(s) at key points of the building envelope where windows or other	Pa

			openings exist or are likely to be provided.	
	A2.6	Impact of site and building orientation on natural ventilation of building(s) during cold season(s).	Predicted differential wind pressures in Pascals (Pa) during cold season(s) at key points of the building envelope where windows or other openings exist or are likely to be provided.	Pa
A3	Project Infrastructure and Services			
	A3.1	Supply, storage and distribution of surplus thermal energy amongst groups of buildings.	Total thermal energy capacity from solar and conventional sources, total storage capacity, total thermal energy demand from all buildings, and percent utilisation of surplus thermal energy.	%
	A3.2	Supply, storage and distribution of surplus photovoltaic energy amongst groups of buildings.	Total DC and AC electrical generating capacity from photovoltaic sources, total storage capacity, total electrical energy demand from all buildings, and percent utilisation.	%
	A3.3	Supply, storage and distribution of surplus hot water amongst groups of buildings.	Total hot water capacity from solar and conventional sources, total storage capacity, total hot water demand from all buildings, and percent utilisation.	%
	A3.4	Supply, storage and distribution of surplus rainwater and greywater amongst groups of buildings.	Total hot water capacity from solar and conventional sources, total storage capacity, total hot water demand from all buildings, and percent utilisation.	%
	A3.5	Provision of facility to produce energy from solid waste.	Presence of the facility, its output, energy effectiveness and minimization of harmful emissions.	-

	A3.6	Provision of solid waste collection and sorting services.	Solid non-organic waste generation during operations, excluding amounts used for energy production, capacity and location of communal (multi-building) non-organic solid waste and sorting facilities, and provision of appropriate management and staffing.	Qua
	A3.7	Composting and re-use of organic sludge.	Presence of the service and suitable facilities, estimated output of organic waste and sludge produced, level of service.	Qual
	A3.8	Provision of split grey / potable water services.	Presence of a split supply system and percent of individual building occupancies serviced.	%
	A3.9	Provision of surface water management system.	Predicted or actual capacity of the surface water management system to successfully cope with 100-year precipitation and flood events so that disruption to activities on the site or physical damage to structures or contents is avoided.	Qual
	A3.10	On-site treatment of rainwater, stormwater and greywater.	Existence of an on-site wastewater treatment system and the percent of total rain, storm and greywater waste treated.	%
	A3.11	On-site treatment of liquid sanitary waste.	Existence of an on-site sewage treatment system and the percent of sewage treated.	%
	A3.12	Provision of on-site communal transportation system(s).	Existence and type of an on-site public or communal transportation system	Qual

			in a large project, percentage of buildings that have access to the system, and frequency of service.	
	A3.13	Provision of on-site parking facilities for private vehicles.	The ratio of parking spaces for private vehicles per dwelling unit, plus the ratio of parking spaces for private vehicles per 100 m2 of usable area (ua) of non-residential occupancies.	%
	A3.14	Connectivity of roadways.	Mean distance between intersections of roadways or streets.	m
	A3.15	Provision of access roads and facilities for freight or delivery.	The degree to which building(s) in the project are serviced by access roads and facilities for freight or delivery.	Qual
	A3.16	Provision and quality of exterior lighting.	Provision of exterior lighting systems, coverage of roadways, walkways and building entries, and directional efficiency to limit light pollution.	Qual

B	Energy and Resource Consumption			
B1	Total Life Cycle Non-Renewable Energy			
	B1.1	Embodied non-renewable energy in original construction materials.	Estimate of embodied primary energy used for structure, envelope (excl. glazing), and major interior components	kWh/ m^2 per yr.
	B1.2	Embodied non-renewable energy in construction materials for maintenance or replacement(s).	Estimate of embodied primary energy annualized over the entire lifespan of the building used for structure, envelope (excl. glazing), and major interior components for periodic maintenance or replacement	kWh/ m^2 per yr.

	B1.3	Consumption of non-renewable energy for all building operations.	Annual kWh of delivered energy per m2 of net area, including fuel and electrical use	Total kWh/ m^2 per yr.
	B1.4	Consumption of renewable energy for all building operations.	Average annual kWh of renewable energy, including power produced by photovoltaics or wind turbines, per m2 of net area as predicted by means of an acceptable method or tool.	Total kWh/ m^2*yr
	B1.5	Consumption of non-renewable energy for project-related transport.	Estimated annual primary energy use per unit area, kWh/m2 per year.	kWh/ m^2 per yr.
	B1.6	Consumption of non-renewable energy for demolition or dismantling process.	Estimated non-renewable energy, in kWh/m2, required to disassemble or demolish the building and to prepare materials for shipment off the site.	kWh/ m^2 per yr.
B2	Electrical peak demand			
	B2.1	Electrical peak demand for building operations.	Average of peak monthly electrical demand for one year	W/ m^2
	B2.2	Scheduling of building operations to reduce peak loads on generating facilities.	Average predicted reduction of weekly electrical demand for one year	W/ m^2
B3	Use of Materials			
	B3.1	Degree of re-use of suitable existing structure(s) where available.	The development of an inventory and the percent, by area, of an existing structure that is re-used or recycled, where the structures are in usable condition.	%
	B3.2	Protection of materials during construction phase.	Measures taken to protect materials on site.	Qual
	B3.3	Material efficiency of structural and building envelope components.	The combined weight in kg. of building structural and building envelope components relative to the gross volume of the structure.	kg / m^3
	B3.4	Use of virgin non-renewable materials.	The estimated percentage of total mass of the building that consists of	%

			virgin non-renewable materials.	
	B3.5	Efficient use of finishing materials.	The percent of above-grade interior floor, wall or ceiling surface areas in which structural elements are left exposed.	%
	B3.6	Ease of disassembly, re-use or recycling.	Measures taken to facilitate future disassembly and re-use or recycling.	%
B4	Use of potable water, stormwater and greywater			
	B4.1	Embodied water in original construction materials.	Potable water used in the production of original materials and products, in m3/m3 of gross area. This criterion is not applicable to the Operations phase, due to the difficulty in obtaining valid historical data.	L / m^3
	B4.2	Use of water for occupant needs during operations.	Estimates made during the design phase focus on use of water-efficient sanitary fixtures equipment, to predict the gross water volume needed; and also plans for the use of stored rainwater or recycled (grey) water, to estimate what the net water consumption may be.	m^3 / m^2*yr
	B4.3	Use of water for irrigation purposes.	Estimates made during the design phase focus on use of amount of landscaped area, plans for the use of drought-resistant planting and the use of stored rainwater or recycled (grey) water, to estimate what the net water consumption may be.	m^3 / m^2 * yr
	B4.4	Use of water for building systems.	Use of water-efficient building equipment and the use of stored rainwater or recycled (grey) water where possible.	m^3 / m^2 * yr

C	Environmental Loadings		
C1	Greenhouse Gas Emissions		

	C1.1	GHG emissions from energy embodied in original construction materials.	CO2-equivalent emissions per Kg. per m2 of gross area, as determined by calculations based on design documents and fuel emission values plus process-related emissions related to the region of production, and annualized according to the predicted lifespan of the building.	kg/m^2 * year
	C1.2	GHG emissions from energy embodied in construction materials used for maintenance or replacement(s).	Estimate of GHG emissions due to embodied primary energy annualized over the entire lifespan of the building (see F12) used for structure, envelope (excl. glazing), and major interior components for periodic maintenance or replacement, as determined by a program designed to estimate embodied energy and emissions through Life Cycle Analysis; also, estimate of replacement cycles.	kg/m^2 * year
	C1.3	GHG emissions from primary energy used for all purposes in facility operations.	Annual CO2-equivalent emissions per Kg. per m2 of net area, as determined by an hour-by-hour simulation program and calculations based on regional fuel emission values.	kg / m^2 per yr.
	C1.4	GHG emissions from primary energy used for project-related transport	Measures taken during the Design phase to provide incentives for using shared or public transport and disincentives for using private automobiles.	Qual
C2	Other Atmospheric Emissions			
	C2.1	Emissions of ozone-depleting substances during facility operations.	CFC-11 equivalent, in gm per m2 per yr.	gm / m^2 per yr.
	C2.2	Emissions of acidifying emissions during facility operations.	SO2 Equiv. per year in kg. per unit net area	Kg. / m^2 per yr.

	C2.3	Emissions leading to photo-oxidants during facility operations.	Ethene equiv. per year in gm per net unit area	gm / m^2 per yr.
C3	Solid and Liquid Wastes			
	C3.1	Solid waste from the construction and demolition process retained on the site.	The development of a credible construction waste management plan and the percentage, by weight, of construction waste to be re-used (on or off the site) or re-cycled, as predicted in the plan.	%
	C3.2	Solid non-hazardous waste from facility operations sent off the site.	Facilities provided in the design for the storage and sorting of solid wastes in both dispersed and central locations.	%
	C3.3	Risk of non-radioactive hazardous waste resulting from facility operations.	The level of risk identified in a credible hazardous waste storage and disposal plan.	kg
	C3.4	Radioactive waste resulting from facility operations.	-	-
	C3.5	Liquid effluents from building operations that are sent off the site.	The volume of liquid waste per m2 of gross area that is sent off the site for treatment. Note that units for residential occupancies are M3 / pp*yr, and M3 / m2*yr for non-residential.	m^3 / m^2*yr
C4	Impacts on Project Site			
	C4.1	Impact of construction process on natural features of the site.	The existence and quality of contents of a plan to minimize ecological damage to the site due to the construction process.	Qual
	C4.2	Impact of construction process or landscaping on soil stability or erosion.	-	-
	C4.3	Recharge of groundwater through permeable paving or landscaping.	The predicted percentage of precipitation that is able to recharge groundwater through permeable paving or landscaping.	%
	C4.4	Changes in biodiversity on the site.	Changes in biodiversity from pre-project to post-project conditions	Qual
	C4.5	Adverse wind conditions at grade around tall buildings.	Number of floors above grade.	Qual
C5	Other Local and Regional Impacts			

	C5.1	Impact on access to daylight or solar energy potential of adjacent property	Percentage of nearest face of an existing building or a future building designed on an adjacent site in accordance with existing regulations, that will be shaded by the Design.	%
	C5.2	Impact of construction process on local residents and commercial facility users.	During design phase, expert prediction of likely disruption levels; during and after construction phase, results of local random surveys.	Qual
	C5.3	Impact of building user population on peak load capacity of public transport system.	Projected impact of building population on public transport capacity during morning and evening rush hours.	%
	C5.4	Impact of private vehicles used by building population on peak load capacity of local road system.	Projected impact of building population on local road capacity during morning and evening rush hours.	%
	C5.5	Potential for project operations to contaminate nearby bodies of water.	Distance of the building from water body or wetland as defined in official documentation or assessment by competent authorities.	m
	C5.6	Cumulative (annual) thermal changes to lake water or sub-surface aquifers.	Predictions of changes in the average annual temperature of sub-surface aquifers, determined by simulation studies.	Deg. C
	C5.7	Contribution to Heat Island Effect from roofing, landscaping and paved areas.	Reflectance and area of paved and landscaped areas, as indicated by drawings and specifications.	%
	C5.8	Degree of atmospheric light pollution caused by project exterior lighting systems.	Percentage of total exterior light output that lies outside a vertical 120 degree cone, as indicated by drawings and specifications.	%

D	Indoor Environmental Quality		
D1	Indoor Air Quality and Ventilation		

	D1.1	Pollutant migration between occupancies.	Ensure that areas that contain equipment or activities generating chemical pollutants, are separately ventilated and isolated from other occupied spaces. Examples include copier rooms, waste storage areas and janitorial rooms.	Qual
	D1.2	Pollutants generated by facility maintenance.	-	-
	D1.3	Mould concentration in indoor air.	-	-
	D1.4	Volatile organic compounds concentration in indoor air.	Measures taken to screen finishing materials used in construction, and to ensure that maintenance procedures generate a minimum of VOCs.	Qual
	D1.5	CO2 concentrations in indoor air.	Designs for HVAC systems that conform to ASHRAE, CIBSE or other acceptable protocol.	ach
	D1.6	Effectiveness of ventilation in naturally ventilated occupancies during cooling seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	D1.7	Effectiveness of ventilation in naturally ventilated occupancies during intermediate seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	D1.8	Effectiveness of ventilation in naturally ventilated occupancies during heating seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	D1.9	Air movement in mechanically ventilated occupancies.	Predicted air speed in m/s, as indicated by an analysis of proposed HVAC system characteristics or by post-occupancy monitoring.	m/s
	D1.10	Effectiveness of ventilation in mechanically ventilated occupancies.	Percent of ventilation air reaching work surfaces, as indicated by an analysis of proposed HVAC system and room characteristics.	Eac
D2	Air Temperature and Relative Humidity			
	D2.1	Appropriate air temperature and relative humidity in	Compliance of mechanical ventilation systems with recognized design	Qual

		mechanically cooled occupancies.	standards such as ASHRAE or CIBSE.	
	D2.2	Appropriate air temperature in naturally ventilated occupancies.	Predicted ability of natural ventilation systems to maintain temperatures within an acceptable range, as indicated by drawings and specifications.	Qual
D3	Daylighting and Illumination			
	D3.1	Appropriate daylighting in primary occupancy areas.	The predicted Daylight Factor in a typical occupancy area located on the ground floor of the building, as indicated by drawings and specifications.	DF
	D3.2	Control of glare from daylighting.	The predicted maximum ratio of contrast in illuminance between windows and adjacent wall areas in a typical occupancy area, as indicated by design	ratio
	D3.3	Appropriate illumination levels and quality of lighting in non-residential occupancies.	Appropriateness of illumination levels and lighting quality to planned tasks, in Lux, as indicated by design characteristics.	Qual
D4	Noise and Acoustics			
	D4.1	Noise attenuation through the exterior envelope.	The predicted noise attenuation performance of the exterior wall most exposed to potential sources of noise, as indicated by design characteristics.	STC
	D4.2	Transmission of facility equipment noise to primary occupancies.	Noise Reduction Criteria ratings of mechanical equipment and equipment rooms, as indicated by design characteristics.	NRC
	D4.3	Noise attenuation between primary occupancy areas.	Minimum Sound Transmission Class of partitions between primary occupancy areas, as indicated by design characteristics.	STC
	D4.4	Appropriate acoustic performance within primary occupancy areas.	Predicted reverberation time in seconds, as	Qual

			indicated by design characteristics.	
D5	Control of electromagnetic emissions			
	D5.1	Electromagnetic emissions	-	-

E	Service Quality			
E1	Safety and Security			
	E1.1	Construction safety.	-	-
	E1.2	Risk to occupants and facilities from fire.	Risk level for occupants in the most vulnerable part of the building.	-
	E1.3	Risk to occupants and facilities from flooding.	Probability of injury or death or major property damage in case of 100-year flood event or other foreseeable flood risk.	Qual
	E1.4	Risk to occupants and facilities from windstorms.	Probability of injury or death or major property damage in case of 100-year windstorm events.	Qual
	E1.5	Risk to occupants and facilities from earthquake.	Probability of injury or death or major property damage in case of earthquake event foreseeable within a 100-year time frame.	-
	E1.6	Risk to occupants and facilities from use of explosive devices.	Probability of injury or death or major property damage in case of an accidental or wilful explosion in or near the building.	-
	E1.7	Risk to occupants from incidents involving biological or chemical substances.	Probability of injury or death or major property damage in case of an accidental or wilful biological or chemical release in or near the building.	-
	E1.8	Occupant egress from tall buildings under emergency conditions.	Time required for a person located in the most remote and vulnerable location in the building to reach a safe refuge area outside the building.	Qual
	E1.9	Maintenance of core building functions during power outages.	Predictions of the number of days that ventilation, temperature, lighting, sanitation and internal	Days

			transportation systems continue to provide minimally acceptable service, under conditions of temperature, rainfall, power and fuel supply that fall outside of anticipated design conditions.	
	E1.10	Personal security for building users during normal operations.	Measures that are likely to assure adequate levels of actual and perceived personal security, according to design documentation.	Qual
E2	Functionality and efficiency			
	E2.1	Appropriateness of type of facilities provided for tenant or occupant needs.	Factors include location, distance to relevant support facilities, surrounding environment (noise, traffic etc.),	Qual
	E2.2	Functionality of layout(s) for required functions.	Goodness of fit of provided layouts (shape, ease of access) with functional requirements.	-
	E2.3	Appropriateness of space provided for required functions.	Goodness of fit of provided area with functional requirements.	-
	E2.4	Appropriateness of fixed equipment for required functions.	Appropriateness of provided fixed equipment with functional requirements.	-
	E2.5	Provision of exterior access and unloading facilities for freight or delivery.	Adequacy of the facility unloading and temporary storage capacity and measures to prevent excessive noise and visual pollution from disturbing occupants.	-
	E2.6	Efficiency of vertical or horizontal transportation systems in building.	For lifts, the time required to travel from the ground floor to the top floor (or vice versa) during peak periods.	Min
	E2.7	Spatial efficiency.	The ratio of directly functional net areas to total net area in each occupancy. Total Net Areas exclude only structure and building envelope areas; Net Functional Areas (NFA)	%

			exclude interior garages, vertical circulation and building mechanical rooms.	
	E2.8	Volumetric efficiency.	The ratio of directly functional net volumes to total net volume in each occupancy. Total Net Volumes exclude only vertical and horizontal structure and building envelope areas; Net Functional Volumes (NFV) exclude interior garages, vertical circulation, building mechanical rooms, parts of interior atria not directly supporting functional performance. In the case of residential, office and other utilitarian occupancies, room heights above 3.5 m. are also excluded.	%
E3	Controllability			
	E3.1	Effectiveness of facility management control system.	The presence of a computerized building management control system whose capability is consistent with the complexity of building systems.	Qual
	E3.2	Capability for partial operation of facility technical systems.	The predicted ability of building systems to provide partial heating, ventilation, cooling or lighting services, according to design documentation.	Qual
	E3.3	Degree of local control of lighting systems.	The area of typical lighting control zones in perimeter areas in m2, as shown in design documentation.	m2
	E3.4	Degree of personal control of technical systems by occupants.	The degree of control over key indoor environment systems that can be exercised by occupants, according to design documentation.	Qual
E4	Flexibility and Adaptability			

	E4.1	Ability for building operator or tenant to modify facility technical systems.	The level of renovation work necessary to alter technical systems to suit new requirements.	Qual
	E4.2	Potential for horizontal or vertical extension of structure.	Degree of technical and design difficulty and capital cost requirements linked to expansion possibilities.	Qual
	E4.3	Adaptability constraints imposed by structure or floor-to-floor heights.	Structural load capacity and layout.	Qual
	E4.4	Adaptability constraints imposed by building envelope and technical systems.	The ease or difficulty in altering the building envelope or technical systems to suit a new occupancy type.	Qual
	E4.5	Adaptability to future changes in type of energy supply.	The ease or difficulty in installing heating or cooling equipment that require a different fuel, or to install photovoltaic systems.	Qual
E5	Optimization and Maintenance of Operating Performance			
	E5.1	Operating functionality and efficiency of key facility systems.	Commissioning plans developed and/or implemented and commissioning staff assigned.	Qual
	E5.2	Adequacy of the building envelope for maintenance of long-term performance.	In areas where applicable, the existence of a report that describes and details the measures taken to ensure long-term integrity of the building envelope.	Qual
	E5.3	Durability of key materials	Materials and components conforming to accepted standards for durability.	-
	E5.4	Existence and implementation of a maintenance management plan.	The availability of a comprehensive and long-term plan at the end of Design phase, and evidence of its implementation during Operations phase.	Qual
	E5.5	On-going monitoring and verification of performance.	The provision of energy sub-metering systems and water consumption monitoring systems,	Qual

			according to design documentation.	
	E5.6	Retention of as-built documentation.	The maintenance of a building log, of varying degrees of comprehensiveness.	Qual
	E5.7	Provision and maintenance of a building log.	The presence of sales agreements or leases that will encourage owners or tenants to operate the facilities efficiently.	Qual
	E5.8	Provision of performance incentives in leases or sales agreements.	The presence of sales agreements or leases that will encourage owners or tenants to operate the facilities efficiently.	Qual
	E5.9	Level of skills and knowledge of operating staff.	The scope and depth of training provided to building operators, including contracted staff.	Qual

F	Social, Cultural and Perceptual Aspects			
F1	Social Aspects			
	F1.1	Universal access on site and within the building.	The scope and quality of design measures planned to facilitate access and use of building facilities by persons with disabilities.	Qual
	F1.2	Access to direct sunlight from living areas of dwelling units.	The percentage of dwelling units whose principal daytime living areas have direct sunlight. for at least 2 hours per day at 12 noon on Winter Solstice, according to design documentation.	%
	F1.3	Visual privacy in principal areas of dwelling units.	The percentage of dwelling units whose bedroom and living areas are open to horizontal or downward views from a point within 20 m of the exterior windows.	%
	F1.4	Access to private open space from dwelling units.	Minimum area and dimensions, in m2 and m. and adequate protection from excessive solar exposure.	%

	F1.5	Involvement of residents in project management.	Extent and quality of plans for participation, or survey of residents.	-
F2	Culture and Heritage			
	F2.1	Compatibility of urban design with local cultural values.	Expert assessment of the degree to which new features, systems and materials are consistent with local cultural values related to urban design and architecture, including both functional and aesthetic aspects.	Qual
	F2.2	Provision of public open space compatible with local cultural values.	Expert assessment of the degree to which public open space provided in the project is consistent with local cultural values.	Qual
	F2.3	Impact of the design on existing streetscapes.	Expert assessment of the harmony of the Design with adjacent existing buildings, in features such as height, bulk, set-back from the street, window size and height, colour or type of materials.	Qual
	F2.4	Use of traditional local materials and techniques	Architect's estimate of the percent of the non-structural elements of the building will be constructed using traditional local materials and construction techniques.	%
	F2.5	Maintenance of the heritage value of the exterior of an existing facility.	Expert assessment of the degree to which new features, systems and materials are consistent with the character of the original design of the heritage building.	Qual
	F2.6	Maintenance of the heritage value of the interior of an existing facility.	Expert assessment of the degree to which new features, systems and materials are consistent with the character of the original design of the heritage building.	Qual
F3	Perceptual			

	F3.1	Impact of tall structure(s) on existing view corridors.	Expert or public opinion regarding impairment of existing view corridors.	Qual
	F3.2	Quality of views from tall structures.	Expert or public opinion regarding impairment of existing view corridors.	Qual
	F3.3	Sway of tall buildings in high wind conditions.	Lateral displacement from vertical under high wind conditions (to be defined further), in m.	-
	F3.4	Perceptual quality of site development.	Views of an expert panel.	-
	F3.5	Aesthetic quality of facility exterior.	-	-
	F3.6	Aesthetic quality of facility interior.	-	-
	F3.7	Access to exterior views from interior.	Visual quality of exterior artifacts or natural objects and their distance from the viewer.	Qual

G	Cost and Economic Aspects			
G1	Cost and Economics			
	G1.1	Construction cost.	Predicted construction cost per unit area, according to design documentation.	$/m^2
	G1.2	Operating and maintenance cost.	Operating cost per unit area for energy, water & maintenance, according to design documentation.	$/m^2
	G1.3	Life-cycle cost.	Predicted Life Cycle Cost over a 25-year period, with calculations carried out in accordance with recognized procedures.	$/m^2
	G1.4	Investment risk	Estimate of the financial level of risk faced by investors and other relevant parties, such as municipality or utilities.	%
	G1.5	Affordability of residential rental or cost levels.	The predicted total occupancy cost (rental cost or total carrying charges and upkeep of a purchased unit), as a percentage of modal household income in the urban region.	%

	G1.6	Impact of project on land values of adjacent properties.	Percent change in market value of properties within 200 m of the project boundaries, 12 months after the start of construction.	%
	G1.7	Impact of construction and operations on the local economy.	Prediction of the percentage of construction expenditures for goods and services going to firms with permanent offices in the urban region.	%
	G1.8	Economic viability of commercial occupancies.	Gross annual revenue per m2 of net area.	%

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment		
B	Energy and Resource Consumption	
B1	Total Life Cycle Non-Renewable Energy	
	B1.1	Embodied non-renewable energy in original construction materials.
	B1.2	Embodied non-renewable energy in construction materials for maintenance or replacement(s).
	B1.3	Consumption of non-renewable energy for all building operations.
	B1.4	Consumption of renewable energy for all building operations.
	B1.5	Consumption of non-renewable energy for project-related transport.
	B1.6	Consumption of non-renewable energy for demolition or dismantling process.
B2	Electrical peak demand	
	B2.1	Electrical peak demand for building operations.
	B2.2	Scheduling of building operations to reduce peak loads on generating facilities.
B3	Use of Materials	
	B3.1	Degree of re-use of suitable existing structure(s) where available.
	B3.2	Protection of materials during construction phase.
	B3.3	Material efficiency of structural and building envelope components.
	B3.4	Use of virgin non-renewable materials.
	B3.5	Efficient use of finishing materials.
	B3.6	Ease of disassembly, re-use or recycling.
B4	Use of potable water, stormwater and greywater	
	B4.1	Embodied water in original construction materials.
	B4.2	Use of water for occupant needs during operations.
	B4.3	Use of water for irrigation purposes.
	B4.4	Use of water for building systems.

C	Environmental Loadings	
C1	Greenhouse Gas Emissions	
	C1.1	GHG emissions from energy embodied in original construction materials.
	C1.2	GHG emissions from energy embodied in construction materials used for maintenance or replacement(s).
	C1.3	GHG emissions from primary energy used for all purposes in facility operations.
	C1.4	GHG emissions from primary energy used for project-related transport
C2	Other Atmospheric Emissions	
	C2.1	Emissions of ozone-depleting substances during facility operations.
	C2.2	Emissions of acidifying emissions during facility operations.
	C2.3	Emissions leading to photo-oxidants during facility operations.
C3	Solid and Liquid Wastes	
	C3.1	Solid waste from the construction and demolition process retained on the site.
	C3.2	Solid non-hazardous waste from facility operations sent off the site.
	C3.3	Risk of non-radioactive hazardous waste resulting from facility operations.
	C3.4	Radioactive waste resulting from facility operations.
	C3.5	Liquid effluents from building operations that are sent off the site.

D	Indoor Environmental Quality	
D1	Indoor Air Quality and Ventilation	
	D1.1	Pollutant migration between occupancies.
	D1.2	Pollutants generated by facility maintenance.
	D1.3	Mould concentration in indoor air.
	D1.4	Volatile organic compounds concentration in indoor air.
	D1.5	CO2 concentrations in indoor air.
	D1.6	Effectiveness of ventilation in naturally ventilated occupancies during cooling seasons.
	D1.7	Effectiveness of ventilation in naturally ventilated occupancies during intermediate seasons.
	D1.8	Effectiveness of ventilation in naturally ventilated occupancies during heating seasons.
	D1.9	Air movement in mechanically ventilated occupancies.
	D1.10	Effectiveness of ventilation in mechanically ventilated occupancies.
D2	Air Temperature and Relative Humidity	
	D2.1	Appropriate air temperature and relative humidity in mechanically cooled occupancies.
	D2.2	Appropriate air temperature in naturally ventilated occupancies.
D3	Daylighting and Illumination	
	D3.1	Appropriate daylighting in primary occupancy areas.
	D3.2	Control of glare from daylighting.

	D3.3	Appropriate illumination levels and quality of lighting in non-residential occupancies.
D4	Noise and Acoustics	
	D4.1	Noise attenuation through the exterior envelope.
	D4.2	Transmission of facility equipment noise to primary occupancies.
	D4.3	Noise attenuation between primary occupancy areas.
	D4.4	Appropriate acoustic performance within primary occupancy areas.
D5	Control of electromagnetic emissions	
	D5.1	Electromagnetic emissions

Society		
E1	Safety and Security	
	E1.1	Construction safety.
	E1.2	Risk to occupants and facilities from fire.
	E1.3	Risk to occupants and facilities from flooding.
	E1.4	Risk to occupants and facilities from windstorms.
	E1.5	Risk to occupants and facilities from earthquake.
	E1.6	Risk to occupants and facilities from use of explosive devices.
	E1.7	Risk to occupants from incidents involving biological or chemical substances.
	E1.8	Occupant egress from tall buildings under emergency conditions.
	E1.9	Maintenance of core building functions during power outages.
	E1.10	Personal security for building users during normal operations.

F	Social, Cultural and Perceptual Aspects	
F1	Social Aspects	
	F1.1	Universal access on site and within the building.
	F1.2	Access to direct sunlight from living areas of dwelling units.
	F1.3	Visual privacy in principal areas of dwelling units.
	F1.4	Access to private open space from dwelling units.
	F1.5	Involvement of residents in project management.

Economy		
G1	Cost and Economics	
	G1.1	Construction cost.
	G1.2	Operating and maintenance cost.
	G1.3	Life-cycle cost.
	G1.4	Investment risk
	G1.5	Affordability of residential rental or cost levels.
	G1.6	Impact of project on land values of adjacent properties.
	G1.7	Impact of construction and operations on the local economy.

	G1.8	Economic viability of commercial occupancies.

5-DATA REQUIREMENTS

Data necessary for the calculation are in detail described within the SBTool framework.

6-REPORTING

A User Guide (pdf) of the SBTool and the Master List Criteria are available on the website.

7-LEGISLATION

All standards to which indicators refer to.

8-NOTES

The SBTool is designed to permit authorised third parties to select one of four scope options, which determine the number of active generic criteria. All of these have been developed as generic defaults, and all users must review and modify or replace these as required to produce locally relevant versions. These criteria can vary from the "Minimum Scope" to the "Maximum Scope", as follows:

• SBTool Minimum Scope

The minimum scope version contains what the development team considers to be the minimum number of criteria to cover key issues. Clearly, this may be too limited for some, but it does offer a quicker and less complex route to assessment.

• SBTool Mid-size Scope

The Mid-size version is suggested as a version that covers most important performance issues, while remaining reasonably workable for those who are faced with the task of modifying the generic criteria with others that are specifically suited to their region.

• SBTool Maximum Scope

The Maximum version contains all criteria that have been fully developed with benchmarks and that could be used in assessments.

2.4 SRI - Smart Readiness Indicator

1-BASIC INFORMATION

1.1 Name of the framework: Smart Readiness Indicator for Buildings (SRI).

1.2 Name of the framework developer: the **European Commission DG Energy** and the SRI support team, comprised of **VITO**, the Flemish Institute for Technological Research NV (Belgium) and **Waide Strategic Efficiency Europe** (Ireland).

1.3 Webpage:

- https://smartreadinessindicator.eu/
- https://op.europa.eu/en/publication-detail/-/publication/f9e6d89d-fbb1-11ea-b44f-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search
- https://ec.europa.eu/energy/sites/default/files/sri_training_slide_deck_-_version_1_-_sept_2021.pdf
- https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_summary_2nd_interim_report.pdf
- https://energy.ec.europa.eu/select-language?destination=/node/1

1.4 Countries where the framework is used: European Union.

1.5 Brief summary

With the European Green Deal and the Renovation Wave, the European Union promotes the renovation of buildings, to help people cut their energy bills and energy use. The 2018 revision of the European Energy Performance of Buildings Directive (EPBD) heavily emphasised the potential of smart technologies in the building sector, to improve both energy efficiency and the well- being of people EPBD thus introduced the concept of a "Smart Readiness Indicator" (SRI): a common EU framework for rating the smart readiness of buildings.

The SRI concept has then been developed in close cooperation with Member States and relevant stakeholders of the building value chain. Member States are now officially invited to implement the SRI (with possibly a preliminary test phase).

The SRI assesses buildings (or building units), based on their capacity to satisfy three key functionalities:

- Optimise energy efficiency and overall in-use performance;

- Adapt their operation to the needs of the occupants;

- Adapt for the signals from the grid (energy flexibility).

[2]

Concerning the scoring methodology, there are two approaches on the SRI assessment method, distinguishing between a simplified approach (Method A) and a detailed approach (Method B).

Method A is mainly oriented towards small buildings with low complexity (single family homes, small multi-family homes, small non-residential buildings, etc.). The checklist method could be made accessible for non-experts (self-assessment is possible), such as individual homeowners and the assessment time is < 1 hour.

Method B, the detailed method, is oriented towards buildings with a higher complexity (typically large non-residential buildings, potentially large multi-family homes). On-site inspection / walk-through is needed and the assessment time is < 1 day. It is necessary the involvement of an expert, with support from a facility manager.

To support this approach, two separate service catalogues have been developed by the SRI study team: a simplified service catalogue A and a detailed service catalogue B.

The three key smart-readiness functionalities can be further detailed into seven impact criteria:

1. Energy efficiency
2. Maintenance and fault prediction
3. Comfort
4. Convenience
5. Health and wellbeing
6. Information to occupants
7. Energy flexibility and storage.

[2] Image taken from https://ec.europa.eu/energy/sites/default/files/sri_training_slide_deck_-_version_1_-_sept_2021.pdf

The methodology for calculating the SRI is based on the assessment of smart-ready services that the building has or could use ("service catalogue"), as mentioned before. These services are grouped into nine technical domains:

1. Heating
2. Cooling
3. Domestic hot water
4. Controlled ventilation
5. Lighting
6. Dynamic building envelope
7. Electricity
8. Electric vehicle charging
9. Monitoring and control.

Scores are calculated at different levels. Indeed, the assessment provides detailed scores:

- By domain and impact criterion (up to 57 scores) highlighted in the image below in green;
- Aggregating scores for each of the nine technical domains, highlighted in the image below in violet;
- Aggregating scores for each of the seven impact criteria, highlighted in the image below in orange;
- Aggregate scores for each of the three key functionalities, highlighted in the image below in red;
- Considering the overall SRI score together with the corresponding SRI class (seven classes, from SRI < 20% to SRI > 90%), highlighted in the image below in light blue.

	Overall SRI score (%) + SRI class							
	%		%				%	
	Optimise energy efficiency and overall in-use performance		Adapt its operation to the needs of the occupant				Adapt to signals from the grid (energy flexibility)	
	%	%	%	%	%	%	%	
	Energy efficiency	Maintenance and fault prediction	Comfort	Convenience	Health, well-being and accessibility	Information to occupants	Energy flexibility and storage	
Heating	%	%	%	%	%	%	%	%
Cooling	%	%	%	%	%	%	%	%
Domestic hot water	%	%	%	%	%	%	%	%
Ventilation	%	%	%	%	%	%	%	%
Lighting	%	%	%	%	%	%	%	%
Dynamic building envelope	%	%	%	%	%	%	%	%
Electricity	%	%				%	%	%
Electric vehicle charging		%		%		%	%	%
Monitoring and control	%	%	%	%	%	%	%	%

The image above describes the methodology used for calculating the SRI score at different levels, by providing aggregated scores or the overall result.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: residential buildings (the building stock of single-family houses, small multi-family buildings and large multi-family buildings) and **non-residential buildings** (office buildings, wholesale and retail buildings, and educational buildings).

2.2 Building types applicability: existing buildings, new buildings and operational building (in use). The SRI methodology can be applied both to:

- parts of a building (examples: a flat; a restaurant);
- the building as a whole.

2.3 Users and purpose

User	Purpose
Expert in EPC issuing (including architects, engineers, specialists, etc.)	Testing of the SRI framework. Provide suggestions at: support@smartreadinessindicator.eu
Technical study team on SRI	Testing of the SRI methodology developed at the EU level, which can be adapted to specific contexts
Members State of the Commission implementing	Define all arrangements of the national test phases including the decision on whether certificates are issued during the test phase

Regulation (2020/2156)	
Members State of the Commission Delegated Regulation (2020/2155)	Implementation of the SRI framework and detail the information to be included in the certificates

2.4 Physical boundaries of the assessment: The object of the assessment is the building.

2.5 Time boundaries: SRI framework is applicable at the detailed design, construction, as built and in use.

3-STRUCTURE OF THE FRAMEWORK

There two different structures of the SRI framework because there are two scoring methodology approaches on the SRI assessment method, distinguishing between a simplified approach (Method A) and a detailed approach (Method B).

The Framework is called a" service catalogue" and there is a" simplified service catalogue A" and a" detailed service catalogue B", both are contained in the "*Final report on the technical support to the development of a smart readiness indicator for buildings*"[3] (Annex E and F) developed by the European Commission Directorate for Renewables, Research and Innovation, Energy Efficiency, VITO and Waide, in June 2020. Level 0 corresponds to a non-smart building, Level 4 corresponds to a very smart building.

Simplified service catalogue A (table has been elaborated from the "final report on the technical support to the development of a smart readiness indicator for buildings", European Commission, June 2020)

[3] https://op.europa.eu/en/publication-detail/-/publication/bed75757-fbb4-11ea-b44f-01aa75ed71a1/language-en

Domain	Smart ready service	Functionality level 0 (as non-smart default)	Functionality level 1	Functionality level 2	Functionality level 3	Functionality level 4
Heating	Heat emission control	No automatic control	Central automatic control (e.g. central thermostat)	Individual room control (e.g. thermostatic valves, or electronic controller)	Individual room control with communication between controllers and to BACS	Individual room control with communication and presence control
Heating	Heat generator control (all except heat pumps)	Constant temperature control	Variable temperature control depending on outdoor temperature	Variable temperature control depending on the load (e.g. depending on supply water temperature set point)		
Heating	Heat generator control (heat pumps)	On/Off control of heat generator	Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)	Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	Variable control of heat generator capacity depending on the load AND external signals from grid	

Heating	Storage and shifting of thermal energy	None	HW storage vessels available	HW storage vessels controlled based on external signals (from BACS or grid)		
Heating	Report information regarding heating system performance	None	Central or remote reporting of current performance KPIs (e.g. temperatures, submetering energy usage)	Central or remote reporting of current performance KPIs and historical data	Central or remote reporting of performance evaluation including forecasting and/or benchmarking	Central or remote reporting of performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Domestic hot water	Control of DHW storage charging (with direct electric heating or integrated electric heat pump)	Automatic control on / off	Automatic control on / off and scheduled charging enable	Automatic on/off control, scheduled charging enables and demand-based supply temperature control or multi-sensor storage management		

Domestic hot water	Control of DHW storage charging	None	HW storage vessels available	Automatic charging control based on local availability of renewables or information from electricity grid (DR, DSM)		
Domestic hot water	Report information regarding domestic hot water performance	None	Indication of actual values (e.g. temperatures, submetering energy usage)	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Cooling	Cooling emission control	No automatic control	Central automatic control (e.g. central thermostat)	Individual room control (e.g. thermostatic valves, or electronic controller)	Individual room control with communication between controllers and to BACS	Individual room control with communication and occupancy detection
Cooling	Generator control for cooling	On/Off control of cooling production	Multi-stage control of cooling production capacity	Variable control of cooling production capacity	Variable control of cooling production capacity depending on	

			depending on the load or demand (e.g. on/off of several compressors)	depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	the load AND external signals from grid	
Cooling	Flexibility and grid interaction	No automatic control	Scheduled operation of cooling system	Self-learning optimal control of cooling system	Cooling system capable of flexible control through grid signals (e.g. DSM)	Optimized control of cooling system based on local predictions and grid signals (e.g. through model predictive control)
Cooling	Report information regarding cooling system performance	None	Central or remote reporting of current performance KPIs (e.g. temperatures, submetering energy usage)	Central or remote reporting of current performance KPIs and historical data	Central or remote reporting of performance evaluation including forecasting and/or benchmarking	Central or remote reporting of performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Controlled ventilation	Supply air flow control	No ventilation system or	Clock control	Occupancy detection control	Central Demand Control based	Local Demand Control based on air quality

	at the room level	manual control			on air quality sensors (CO2, VOC,...)	sensors (CO2, VOC,...) with local flow from/to the zone regulated by dampers
Controlled ventilation	Reporting information regarding IAQ	None	Air quality sensors (e.g. CO2) and real time autonomous monitoring	Real time monitoring & historical information of IAQ available to occupants	Real time monitoring & historical information of IAQ available to occupants + warning on maintenance needs or occupant actions (e.g. window opening)	
Lighting	Occupancy control for indoor lighting	Manual on/off switch	Manual on/off switch + additional sweeping extinction signal	Automatic detection (auto on / dimmed or auto off)	Automatic detection (manual on / dimmed or auto off)	
Dynamic building envelope	Window solar shading control	No sun shading or only manual operation	Motorized operation with manual control	Motorized operation with automatic control based on sensor data	Combined light/blind/HVAC control	Predictive blind control (e.g. based on weather forecast)
Dynamic building envelope	Reporting information	No reporting	Position of each product	Position of each product, fault	Position of each product, fault detection,	Position of each product, fault detection,

	regarding performance		& fault detection	detection & predictive maintenance	predictive maintenance, real- time sensor data (wind, lux, temperature…)	predictive maintenance, real-time & historical sensor data (wind, lux, temperature…)
Electricity	Storage of (locally generated) electricity	None	On site storage of electricity (e.g. electric battery)	On site storage of energy (e.g. electric battery or thermal storage) with controller based on grid signals	On site storage of energy (e.g. electric battery or thermal storage) with controller optimising the use of locally generated electricity	On site storage of energy (e.g. electric battery or thermal storage) with controller optimising the use of locally generated electricity and possibility to feed back into the grid
Electricity	Reporting information regarding electricity consumption	None	reporting on current electricity consumption on building level	real-time feedback or benchmarking on building level	real-time feedback or benchmarking on appliance level	real-time feedback or benchmarking on appliance level with automated personalized recommendation
Electricity	Reporting information regarding local electricity generation	None	Current generation data available	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking;

						also including predictive management and fault detection
Electricity	Reporting information regarding energy storage	None	Current state of charge (SOC) data available	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Electric vehicle charging	Charging capacity	not present	ducting (or simple power plug) available	0-9% of parking spaces has recharging points	10-50% or parking spaces has recharging point	>50% of parking spaces has recharging point
Electric vehicle charging	EV Charging Grid balancing	Not present (uncontrolled charging)	1-way controlled charging (e.g. including desired departure time and grid signals for optimization)	2-way controlled charging (e.g. including desired departure time and grid signals for optimization)		
Electric vehicle charging	EV charging information	No information available	Reporting information on EV	Reporting information on EV		

	and connectivity		charging status to occupant	charging status to occupant AND automatic identification and authorization of the driver to the charging station (ISO 15118 compliant)		
Monitoring and control	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	None	Single platform that allows manual control of multiple TBS	Single platform that allows automated control & coordination between TBS	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	
Monitoring and control	Smart Grid Integration	None - No harmonization between grid and TBS;	Demand side management possible for (some)	Coordinated demand side management		

		building is operated independently from the grid load	individual TBS, but not coordinated over various domains	of multiple TBS		
Monitoring and control	Central reporting of TBS performance and energy use	None	Central o remote reporting of real-time energy use per energy carrier	Central o remote reporting of real-time energy use per energy carrier, combining TBS of at least 2 domains in one interface	Central o remote reporting of real-time energy use per energy carrier, combining TBS of all domains in one interface	

Detailed service catalogue B

Domain	**Smart ready service**	**Functionality level 0 (as non-smart default)**	**Functionality level 1**	**Functionality level 2**	**Functionality level 3**	**Functionality level 4**
Heating	Heat emission control	No automatic control	Central automatic control (e.g. central thermostat)	Individual room control (e.g. thermostatic valves, or electronic controller)	Individual room control with communication between controllers and to BACS	Individual room control with communication and presence control
Heating	Emission control for TABS (heating mode)	No automatic control	Central automatic control	Advanced central automatic control	Advanced central automatic control with	

					intermittent operation and/or room temperature feedback control	
Heating	Control of distribution fluid temperature (supply or return air flow or water flow) - Similar function can be applied to the control of direct electric heating networks	No automatic control	Outside temperature compensated control	Demand based control		
Heating	Control of distribution pumps in networks	No automatic control estimations)	On off control	Multi-Stage control	Variable speed pump control (pump unit (internal)	Variable speed pump control (external demand signal)
Heating	Thermal Energy Storage (TES) for building heating (excluding TABS)	Continuous storage operation	Time-scheduled storage operation	Load prediction-based storage operation	Heat storage capable of flexible control through grid signals (e.g. DSM)	

Heating	Heat generator control (all except heat pumps)	Constant temperature control	Variable temperature control depending on outdoor temperature	Variable temperature control depending on the load (e.g. depending on supply water temperature set point)		
Heating	Heat generator control (heat pumps)	On/Off control of heat generator	Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)	Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	Variable control of heat generator capacity depending on the load AND external signals from grid	
Heating	Sequencing in case of different heat generators	Priorities only based on running time	Control according to fixed priority list: e.g. based on rated energy efficiency	Control according to dynamic priority list (based on current energy efficiency, carbon emissions and capacity of generators, e.g. solar, geothermal	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions and capacity of generators)	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions, capacity of generators AND

				heat, cogeneration plant, fossil fuels)		external signals from grid)
Heating	Storage and shifting of thermal energy	None	HW storage vessels available	HW storage vessels controlled based on external signals (from BACS or grid)		
Heating	Report information regarding heating system performance	None	Central or remote reporting of current performance KPIs (e.g. temperatures, submetering energy usage)	Central or remote reporting of current performance KPIs and historical data	Central or remote reporting of performance evaluation including forecasting and/or benchmarking	Central or remote reporting of performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Heating	Flexibility and grid interaction	No automatic control	Scheduled operation of heating system	Self-learning optimal control of heating system	Heating system capable of flexible control through grid signals (e.g. DSM)	Optimized control of heating system based on local predictions and grid signals (e.g. through model

						predictive control)
Domestic hot water	Control of DHW storage charging (with direct electric heating or integrated electric heat pump)	Automatic control on / off	Automatic control on / off and scheduled charging enable	Automatic on/off control, scheduled charging enables and demand-based supply temperature control or multi-sensor storage management		
Domestic hot water	Control of DHW storage charging	None	HW storage vessels available	Automatic charging control based on local availability of renewables or information from electricity grid (DR, DSM)		
Domestic hot water	Control of DHW storage charging (using hot water generation)	Automatic control on / off	Automatic control on / off and scheduled charging enable	Automatic on/off control, scheduled charging enable and demandbased supply temperature control or multi-sensor storage management	DHW production system capable of automatic charging control based on external signals (e.g. from district heating grid)	

Domestic hot water	Control of DHW storage charging (with solar collector and supplementary heat generation)	Manual selected control of solar energy or heat generation	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge and demandoriented supply or multi-sensor storage management	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge, demandoriented supply and return temperature control and multi-sensor storage management	
Domestic hot water	Sequencing in case of different DHW generators	Priorities only based on running time	Control according to fixed priority list: e.g. based on rated energy efficiency	Control according to dynamic priority list (based on current energy efficiency, carbon emissions and capacity of generators, e.g. solar, geothermal heat, cogeneration plant, fossil fuels)	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions and capacity of generators)	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions, capacity of generators AND external signals from grid)

Domestic hot water	Report information regarding domestic hot water performance	None	Indication of actual values (e.g. temperatures, submetering energy usage)	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Cooling	Cooling emission control	No automatic control	Central automatic control (e.g. central thermostat)	Individual room control (e.g. thermostatic valves, or electronic controller)	Individual room control with communication between controllers and to BACS	Individual room control with communication and occupancy detection
Cooling	Emission control for TABS (cooling mode)	No automatic control	Central automatic control	Advanced central automatic control	Advanced central automatic control with intermittent operation and/or room temperature feedback control	
Cooling	Control of distribution network chilled water temperature	Constant temperature control	Outside temperature compensated control	Demand based control		

	(supply or return)					
Cooling	Control of distribution pumps in networks	No automatic control	On off control	Multi-Stage control	Variable speed pump control (pump unit (internal) estimations)	Variable speed pump control (external demand signal)
Cooling	Interlock: avoiding simultaneous heating and cooling in the same room	No interlock	Partial interlock (minimising risk of simultaneous heating and cooling e.g. by sliding setpoints)	Total interlock (control system ensures no simultaneous heating and cooling can take place)		
Cooling	Control of Thermal Energy Storage (TES) operation	Continuous storage operation	Time-scheduled storage operation	Load prediction-based storage operation	Cold storage capable of flexible control through grid signals (e.g. DSM)	
Cooling	Generator control for cooling	On/Off control of cooling production	Multi-stage control of cooling production capacity depending on the load or demand (e.g. on/off of several compressors)	Variable control of cooling production capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	Variable control of cooling production capacity depending on the load AND external signals from grid	

Cooling	Sequencing of different cooling generators	Priorities only based on running times	Fixed sequencing based on loads only: e.g. depending on the generators characteristics such as absorption chiller vs. centrifugal chiller	Dynamic priorities based on generator efficiency and characteristics (e.g. availability of free cooling)	Load prediction-based sequencing: the sequence is based on e.g. COP and available power of a device and the predicted required power	Sequencing based on dynamic priority list, including external signals from grid
Cooling	Flexibility and grid interaction	No automatic control	Scheduled operation of cooling system	Self-learning optimal control of cooling system	Cooling system capable of flexible control through grid signals (e.g. DSM)	Optimized control of cooling system based on local predictions and grid signals (e.g. through model predictive control)
Cooling	Report information regarding cooling system performance	None	Central or remote reporting of current performance KPIs (e.g. temperatures, submetering energy usage)	Central or remote reporting of current performance KPIs and historical data	Central or remote reporting of performance evaluation including forecasting and/or benchmarking	Central or remote reporting of performance evaluation including forecasting and/or benchmarking; also including predictive management

						and fault detection
Controlled ventilation	Supply air flow control at the room level	No ventilation system or manual control	Clock control	Occupancy detection control	Central Demand Control based on air quality sensors (CO2, VOC,...)	Local Demand Control based on air quality sensors (CO2, VOC,...) with local flow from/to the zone regulated by dampers
Controlled ventilation	Air flow or pressure control at the air handler level	No automatic control: Continuously supplies of air flow for a maximum load of all rooms	On off time control: Continuously supplies of air flow for a maximum load of all rooms during nominal occupancy time	Multi-stage control: To reduce the auxiliary energy demand of the fan	Automatic flow or pressure control without pressure reset: Load dependent supp lies of air flow for the demand of all connected rooms.	Automatic flow or pressure control with pressure reset: Load dependent supplies of air flow for the demand of all connected rooms (for variable air volume systems with VFD).
Controlled ventilation	Heat recovery control: prevention of overheating	Without overheating control	Modulate or bypass heat recovery based on sensors in air exhaust	Modulate or bypass heat recovery based on multiple room temperature sensors or predictive control		

Controlled ventilation	Supply air temperature control at the air handling unit level	No automatic control	Constant setpoint: A control loop enables to control the supply air temperature, the setpoint is constant and can only be modified by a manual action	Variable set point with outdoor temperature compensation	Variable set point with load dependant compensation. A control loop enables to control the supply air temperature. The setpoint is defined as a function of the loads in the room	
Controlled ventilation	Free cooling with mechanical ventilation system	No automatic control	Night cooling	Free cooling: air flows modulated during all periods of time to minimize the amount of mechanical cooling	H,x- directed control: The amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures and humidity (enthalpy)	

Controlled ventilation	Reporting information regarding IAQ	None	Air quality sensors (e.g. CO2) and real time autonomous monitoring	Real time monitoring & historical information of IAQ available to occupants	Real time monitoring & historical information of IAQ available to occupants + warning on maintenance needs or occupant actions (e.g. window opening)	
Lighting	Occupancy control for indoor lighting	Manual on/off switch	Manual on/off switch + additional sweeping extinction signal	Automatic detection (auto on / dimmed or auto off)	Automatic detection (manual on / dimmed or auto off)	
Lighting	Control artificial lighting power based on daylight levels	Manual (central)	Manual (per room / zone)	Automatic switching	Automatic dimming	Automatic dimming including scene-based light control (during time intervals, dynamic and adapted lighting scenes are set, for example, in terms of illuminance level, different correlated

						colour temperature (CCT) and the possibility to change the light distribution within the space according to e. g. design, human needs, visual tasks)
Dynamic building envelope	Window solar shading control	No sun shading or only manual operation	Motorized operation with manual control	Motorized operation with automatic control based on sensor data	Combined light/blind/HV AC control	Predictive blind control (e.g. based on weather forecast)
Dynamic building envelope	Window open/closed control, combined with HVAC system	Manual operation or only fixed windows	Open/closed detection to shut down heating or cooling systems	Level 1 + Atomised mechanical window opening based on room sensor data	Level 2 + Centralized coordination of operable windows, e.g. to control free natural night cooling	
Dynamic building envelope	Reporting information regarding performance	No reporting	Position of each product & fault detection	Position of each product, fault detection & predictive maintenance	Position of each product, fault detection, predictive maintenance, real- time sensor data (wind, lux, temperature…)	Position of each product, fault detection, predictive maintenance, real-time & historical sensor data (wind, lux, temperature…)

Electricity	Reporting information regarding local electricity generation	None	Current generation data available	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Electricity	Storage of (locally generated) electricity	None	On site storage of electricity (e.g. electric battery)	On site storage of energy (e.g. electric battery or thermal storage) with controller based on grid signals	On site storage of energy (e.g. electric battery or thermal storage) with controller optimising the use of locally generated electricity	On site storage of energy (e.g. electric battery or thermal storage) with controller optimising the use of locally generated electricity and possibility to feed back into the grid
Electricity	Optimizing self-consumption of locally generated electricity	None	Scheduling electricity consumption (plug loads, white goods, etc.)	Automated management of local electricity consumption based on current renewable energy availability	Automated management of local electricity consumption based on current and predicted energy needs and renewable	

					energy availability	
Electricity	Control of combined heat and power plant (CHP)	CHP control based on scheduled runtime management and/or current heat energy demand	CHP runtime control influenced by the fluctuating availability of RES; overproduction will be fed into the grid	CHP runtime control influenced by the fluctuating availability of RES and grid signals; dynamic charging and runtime control to optimise self-consumption of renewables		
Electricity	Support of (micro)grid operation modes	None	Automated management of (building-level) electricity consumption based on grid signals	Automated management of (building-level) electricity consumption and electricity supply to neighbouring buildings (microgrid) or grid	Automated management of (building-level) electricity consumption and supply, with potential to continue limited off-grid operation (island mode)	
Electricity	Reporting information regarding electricity consumption	None	reporting on current electricity consumption on building level	real-time feedback or benchmarking on building level	real-time feedback or benchmarking on appliance level	real-time feedback or benchmarking on appliance level with automated personalized

						recommendation
Electricity	Reporting information regarding local electricity generation	None	Current generation data available	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Electricity	Reporting information regarding energy storage	None	Current state of charge (SOC) data available	Actual values and historical data	Performance evaluation including forecasting and/or benchmarking	Performance evaluation including forecasting and/or benchmarking; also including predictive management and fault detection
Electric vehicle charging	Charging capacity	not present	ducting (or simple power plug) available	0-9% of parking spaces has recharging points	10-50% or parking spaces has recharging point	>50% of parking spaces has recharging point
Electric vehicle charging	EV Charging Grid balancing	Not present (uncontrolled charging)	1-way controlled charging (e.g. including desired	2-way controlled charging (e.g. including desired		

			departure time and grid signals for optimization)	departure time and grid signals for optimization)		
Electric vehicle charging	EV charging information and connectivity	No information available	Reporting information on EV charging status to occupant	Reporting information on EV charging status to occupant AND automatic identification and authorization of the driver to the charging station (ISO 15118 compliant)		
Monitoring and control	Run time management of HVAC systems	Manual setting	Runtime setting of heating and cooling plants following a predefined time schedule	Heating and cooling plant on/off control based on building loads	Heating and cooling plant on/off control based on predictive control or grid signals	
Monitoring and control	Detecting faults of technical building systems and providing support to the diagnosis of these faults	No central indication of detected faults and alarms	With central indication of detected faults and alarms for at least 2 relevant TBS	With central indication of detected faults and alarms for all relevant TBS	With central indication of detected faults and alarms for all relevant TBS, including diagnosing functions	

Monitoring and control	Occupancy detection: connected services	None	Occupancy detection for individual functions, e.g. lighting	Centralised occupants detect ion which feeds in to several TBS such as lighting and heating		
Monitoring and control	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	None	Single platform that allows manual control of multiple TBS	Single platform that allows automated control & coordination between TBS	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	
Monitoring and control	Smart Grid Integration	None - No harmonization between grid and TBS; building is operated independently from the grid load	Demand side management possible for (some) individual TBS, but not coordinated over various domains	Coordinated demand side management of multiple TBS		
Monitoring and control	Central reporting of TBS performance	None	Central o remote reporting of real-time	Central o remote reporting of real-time	Central o remote reporting of real-time	

	and energy use		energy use per energy carrier	energy use per energy carrier, combining TBS of at least 2 domains in one interface	energy use per energy carrier, combining TBS of all domains in one interface	
Monitoring and control	Override of DSM control	No DSM control	DSM control without the possibility to override this control by the building user (occupant or facility manager)	Manual override and reactivation of DSM control by the building user	Scheduled override of DSM control (and reactivation) by the building user	Scheduled override of DSM control and reactivation with optimised control
Monitoring and control	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	None	Single platform that allows manual control of multiple TBS	Single platform that allows automated control & coordination between TBS	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Criteria of the SRI framework (service catalogue A and B) are linked at the same time with the three sustainability dimensions because they are intended to reduce energy consumption in a cost-effectiveness perspective, ensuring human well-being.

5-DATA REQUIREMENTS

In the" *Final report on the technical support to the development of a smart readiness indicator for buildings*"[4] are contained several geometry parameters for the selected reference buildings, including the building's physical and HVAC system characteristics, its thermal transmittance coefficients, solar transmittance data as a function of window U-value, etc. which are all checked during the assessment.

Furthermore, five climate zones have been defined; in the SRI calculation, weighting factors depend on the climate zone.

6-REPORTING

To enhance the testing activity of the SRI, the ˝SRI assessment package˝ is available, upon request, at support@smartreadinessindicator.eu. It's based on the generic SRI methodology developed at the EU level, and it can be adapted to specific contexts; it includes a practical guide (pdf) and a calculation sheet (excel).

7-LEGISLATION

- Energy Performance of Buildings Directive (2010/31/EU)
- Amending Energy Performance of Buildings Directive (2018/844/EU)
- Consolidated version of the Energy Performance of Buildings Directive
- Implementing regulation on optional scheme for rating smart readiness of buildings C (2020) 6929
- Delegated regulation on optional scheme for rating smart readiness of buildings C (2020) 6930.

8-NOTES

Experts in charge of issuing EPCs are also competent for issuing SRI certificates. Member States may couple the issuing of the SRI certificate with their EPC scheme.

The SRI support team is working on possible design options for the SRI certificates. For this purpose, in-depth consultations of potential end users are being carried out, in collaboration with Member States.

In this respect, to support the development of the Smart Readiness Indicator (SRI) and specifically to share professional perspective on the aspects that are most likely to help create an effective SRI certificate design, a EUSurvey is available at

[4] https://op.europa.eu/en/publication-detail/-/publication/bed75757-fbb4-11ea-b44f-01aa75ed71a1/language-en

https://ec.europa.eu/eusurvey/runner/SRIsurvey (responses deadline by 15 January 2022).

F.A.Q. section is available on the SRI webpage:

https://ec.europa.eu/smart-readiness-indicator

2.5 CESBA MED

1-BASIC INFORMATION

1.1 Name of the framework: CESBA MED Generic Framework → developed within Interreg CESBA MED – Sustainable MED Cities project → sustainability assessment framework at building and urban scales for sustainable built environment assessment

1.2 Name of the framework developer: CESBA MED project

1.3 Webpage:

https://cesba-med.interreg-med.eu/

1.4 Countries where the framework is used:

Italy, France, Spain, Malta, Greece, Croatia

1.5 Brief summary

Within the Interreg CESBA MED project a **common sustainability assessment framework for public buildings - CESBA MED Generic Framework** and 8 contextualized assessment tools (CESB SBTool and SNTool) are developed together with an application methodology to support decision makers and the managers of public building stocks in the implementation of more efficient energy retrofitting plans considering buildings at urban scale.

SNTool, urban scale → Sustainable Neighbourhood Tool

SBTool, building scale → Sustainable Building Tool

SNTool and SBTool allows the planners to compare the different retrofitting scenarios that have been created and to find the best suiting one for the local preferences.

A set of common criteria, indicators, and metrics to allow the comparison of the performance reached by public buildings and urban areas in the different MED regions and a common way to display the results are developed. These elements form the CESBA MED Passport.

CESBA MED Generic Framework (CESBA MED SNTool GF) is a transnational generic multicriteria assessment system for rating the sustainability performance of Mediterranean neighbourhoods.

Through the CESBA MED Generic Framework all regions in the Mediterranean areas can share common assessment methodologies, criteria, and indicators

whereas the transnational comparability of assessment results is guaranteed by the CESBA MED Passport and the CESBA MED KPIs.

The assessment method adopted in the CESBA MED Generic Framework multicriteria system is the "SBEMethod" (Sustainable Built Environment Method) developed by iiSBE (international initiative for a Sustainable Built Environment). In general, the SBEMethod is a generic multi-criteria analysis methodology for assessing the sustainability of the built environment. Starting from a set of criteria the SBEMethod provides a final score about a building, urban area or territory overall performance. Using this methodology, it is possible to give a sustainability rating to a neighbourhood. The main goal of the SBEMethod is to provide a final concise score, which summarizes the overall performance of the neighbourhood with respect to all criteria.

Developed tools include all stages of the life cycle and support the planning of activities of the whole urban cycle.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: public buildings

2.2 Building types applicability: applicable to both existing and new urban areas

2.3 Users and purpose

User	Purpose
TECHNICAL EXPERT - technical professionals and managers that work in the urban environment field (SMEs technicians, urban planners, public officers, etc.)	to support the public administration in the definition of the best sustainable retrofit scenarios for small urban areas and buildings in the context of their urban environment
Other target groups (academics and researchers, decision-makers, urban promoters, etc.) interested in sustainable urban development practices	to ensure the mainstreaming of sustainability in urban planning and management to regularly involve citizens and stakeholders on sustainable urban development

2.4 Physical boundaries of the assessment:

an area ranging from a small size (block, cluster) up to a large scale (neighbourhood)

The reference parameters for a block/cluster (small scale) are:

- 5 – 15 buildings
- traditional composition: few buildings (adjacent or separated), internal courtyard

The reference parameters for a neighbourhood (large scale) are:

- square with a 200-400 m size
- area that can be crossed in 10-15 min walk
- 200-1500 inhabitants

2.5 Time boundaries

At urban scale: existing urban areas, new urban developments

At buildings scale: buildings under renovation, new buildings,

3-STRUCTURE OF THE FRAMEWORK

CRITERIA LIST: URBAN SCALE

Issue A: Built Urban Systems

Category A1 – Urban structure and form		
Criterion	Indicator	Unit of measure
A1.1 Concentration of land parcels	Number of lots in the local area related to the total surface area	%
A1.2 Urban compactness	Relation between the usable space of the buildings (volume) and the urban space (area)	m^3 / m^2
A1.3 Building plot ratios	The ratio of total gross floor area above grade of all buildings, relative to the total developed land area within the local area	%
A1.4 Residential density	The ratio of total residential population relative to the total land area for all developed residential blocks within the local area	Persons / hectare
A1.5 Urban Street canyons (H/W aspect ratio)	The ratio of typical building heights compared to the distance between building facades on the other side of the street	%
A1.6 Homogeneity of the urban fabric	Percentage of the perimeter of the area directly adjacent to urbanized areas	%
A1.7 Conservation of Land	Area of undeveloped land with ecological or agricultural value / area of the neighbourhood	%
Category A2 – Transportation infrastructure		
Criterion	Indicator	Unit of measure
A2.1 Walking distance to public transport for area residents	Percent of residential buildings located within 500 m of a public transport stop	%

A2.2 Walking distance to public transport for area workers and students	Percent of workers and students who can reach a public transport stop within a 500 m distance	%
A2.3 Extent and connectivity of pedestrian streets and walkways	Aggregate area of pedestrian streets and walkways in the local area relative to the total land area	%
A2.4 Extent and connectivity of bicycle paths separated from vehicular traffic	Aggregate length of bicycle paths separated from vehicular traffic in the local area per 1000 residents	km/1000 residents
A2.5 Cyclomatic complexity of the street network	Cyclomatic number	–
A2.6 Connectivity of the street network	Number of intersections related to the overall surface area	number/km^2
A2.7 Street network connection and accessibility	Cul-de-sac roads and path ratio	%
A2.8 Scale of the street network	Average distance between the intersections of the area	m
A2.9 On-street and indoor parking spaces relative to local population	On-street and indoor parking spaces relative to local population	%
A2.10 Intermodality facilities	Proximity to intermodal platforms	

Issue B: Economy

Category B1 – Economic structure and value		
Criterion	Indicator	Unit of measure
B1.1 Affordability of housing property	Housing properties in the local area that are financially accessible to the lowest quintile of area population	%
B1.2 Affordability of housing rental	Percentage of the average salary of the lowest quintile of the population used for rental payments	%
B1.3 Long-term risk for capital investments	Aggregate average return on investment (ROI) on capital investments made in the local area over a 5-year period	%
B1.4 Impact of land values on adjacent areas	Average annual change in land values of properties immediately adjacent to the urban area, over a 5-year period	%
B1.5 Impact of construction and operations on the local economy	Estimated average annual economic impact in the local area, over a 5-year period	%

B1.6 Percent of residential units in the local area that are vacant	Percentage of vacant residential units	%
Category B2 – Economic activity		
Criterion	Indicator	Unit of measure
B2.1 Income equity for resident households	The GINI index for residents within the local area, relative to the GINI index for the urban area as a whole	0-1
B2.2 Average annual per-capita income of residents	Average per-capita income of residents in the local area relative to that of the urban region as a whole	%
B2.3 Employment rate	Percent of working age adults employed or actively looking for work	%
B2.4 Economic viability of commercial occupancies	Rate of business failures of commercial occupancies in the local relative to the total urban area, over a 5-year period	%
B2.5 Economic contribution from tourism activity	Estimate of average annual income from tourism activity (overnight stays and local purchases) on a per-resident basis	euro/resident
Category B3 – Cost and investment		
Criterion	Indicator	Unit of measure
B3.1 Provision of social housing units	Adequacy of annual funding for social housing units in relation to the total investment housing units	-
B3.2 Public contribution in residential retrofitting investments	Funds provided by governments over a 5-year period	%
B3.3 Operating energy costs for public buildings	Aggregated annual operating energy cost per aggregated indoor useful floor area	€/m²/year
B3.4 Levels of total public and private investment	The average annual aggregate amount of public and private investment, on a per-resident basis, for new construction, renovation and infrastructure projects in the local area, 00 Euro	€/resident

Issue C: Energy

Category C1 – Non-renewable energy		
Criterion	Indicator	Unit of measure

C1.1 Total final thermal energy consumption for building operations	Aggregated annual total final thermal energy consumption per aggregated indoor useful floor area	kWh/m²/year
C1.2 Total final thermal energy consumption for residential building operations	Urban thermal energy consumption of residential buildings	kWh/m²
C1.3 Total final thermal energy consumption for non-residential building operations	Urban thermal energy consumption of non-residential buildings	kWh/m²
C1.4 Total final electrical energy consumption for building operations	Aggregated annual total final electric energy consumption per aggregated internal useful floor area	kWh/m²/year
C1.5 Total final electrical energy consumption for residential building operations	Urban electrical energy consumption of residential buildings	kWh/m²
C1.6 Total final electrical energy consumption for non-residential building operations	Urban electrical energy consumption of non-residential buildings	kWh/m²
C1.7 Total primary energy demand for building operations	Aggregated annual total primary energy consumption per aggregated indoor useful floor area	kWh/m²/year
C1.8 Total primary energy demand for residential building operations	Ratio of average total primary energy consumption of residential buildings to the local minimum value	%
C1.9 Total primary energy demand for non-residential building operations	Ratio of average total primary energy consumption of residential buildings to the local minimum value	%
C1.10 Primary energy for heating for residential buildings	Ratio of average total primary energy consumption for heating of residential buildings to the local minimum value	%
C1.11 Primary energy for heating for non-residential buildings	Ratio of average total primary energy consumption for heating of non-residential buildings to the local minimum value	%
C1.12 Primary energy for cooling for residential buildings	Ratio of average total primary energy consumption for cooling of residential buildings to the local minimum value	%
C1.13 Primary energy for cooling for non-residential buildings	Ratio of average total primary energy consumption for cooling of non-residential buildings to the local minimum value	%

C1.14 Primary energy for DHW for residential buildings	Ratio of average total primary energy consumption for DHW of residential buildings to the local minimum value	%
C1.15 Primary energy for DHW for non-residential buildings	Ratio of average total primary energy consumption for DHW of non-residential buildings to the local minimum value	%
C1.16 Primary energy for indoor lighting for residential buildings	Ratio of average total primary energy consumption for indoor lighting of residential buildings to the local minimum value	%
C1.17 Primary energy for indoor lighting for non-residential buildings	Ratio of average total primary energy consumption for indoor lighting of non-residential buildings to the local minimum value	%
C1.18 Electrical peak demand for non-residential building operations	Aggregated peak demand in the local area	MW
C1.19 Scheduling of non-residential building operations to reduce peak loads on generating facilities	Annual time periods of electrical peak loads	h
C1.20 Energy consumption of public lighting	Annual electrical consumption by outdoor public lighting systems	kWh/m^2
C1.21 Energy consumption of local public transport	Energy efficiency of local public transport	pax.km/MJ
C1.22 Consumption of non-renewable energy for demolition or dismantling	Final consumption of non-renewable energy for building demolition or dismantling	kWh/m^2
Category C2 – Renewable and decarbonised energy		
Criterion	Indicator	Unit of measure
C2.1 Share of renewable energy on-site, relative to total final thermal energy consumption for building operations	Annual total thermal energy consumption from on-site renewable energy sources / annual total final thermal energy consumption	%
C2.2 Share of renewable energy on-site, relative to total final energy consumption for residential building operations	Ratio of on-site renewable energy consumption to the total final energy consumption of residential buildings	%
C2.3 Share of renewable energy on- site, relative	Ratio of on-site renewable energy consumption to the total final	%

to total final energy consumption for non-residential building operations	energy consumption of non-residential buildings	
C2.4 Share of renewable energy on-site, relative to total primary energy consumption for building operations	Aggregated total annual primary energy consumption from on-site renewable energy sources / aggregated total annual primary energy consumption	%
C2.5 Share of renewable energy on-site, relative to total primary energy consumption for residential building operations	Ratio of on-site renewable energy consumption to the total primary energy consumption of residential buildings	%
C2.6 Share of renewable energy on-site, relative to total primary energy consumption for non-residential building operations	Ratio of on-site renewable energy consumption to the total primary energy consumption of non-residential buildings	%
C2.7 Share of renewable energy on-site, relative to final electric energy consumption	Share of renewable electric energy in final electric energy consumptions	%
C2.8 Aggregated electrical energy generation from renewable sources located on public properties	Electrical energy generation from renewable sources from public properties	MWh/year
C2.9 Aggregated electrical energy generation from renewable sources located on private properties	Electrical energy generation from renewable sources located on private properties	MWh/year
C2.10 Electrical energy generated from renewable sources that is exported from the local area	Electrical energy generation from renewable sources that is exported from the local area	MWh/year
C2.11 Aggregated use of renewable electrical energy	Share of renewable electricity production	%
C2.12 Aggregated thermal energy generation from renewable sources located on public properties	Thermal energy generation from renewable sources from public properties	MWh/year

C2.13 Aggregated thermal energy generation from renewable sources located on private properties	Thermal energy generation from renewable sources located on private properties	MWh/year
C2.14 Thermal energy generated from renewable sources that is exported from the local area	Thermal energy generation from renewable sources that is exported from the local area	MWh/year
Category C3 – Energy recycling and storage		
Criterion	Indicator	Unit of measure
C3.1 Waste heat re-utilization from building operations	Percentage of waste heat from building operations	%
C3.2 Mid- and long-term storage of geothermal energy	Seasonal or annual thermal capacity of geothermal energy sinks in the local area	%
C3.3 Mid-term storage of electrical energy	Weekly or monthly electrical storage capacity of electrical storage devices in the local area, in GWh	%

Issue D: Atmospheric emissions

Category D1 – Atmospheric emissions		
Criterion	Indicator	Unit of measure
D1.1 GHG emissions from energy embodied in construction materials used for construction, maintenance, or replacement(s)	Aggregate GHG emissions from energy embodied in construction materials	tons CO_2/1000 m^2
D1.2 Total GHG Emissions from primary energy used in building operations	CO_2 equivalent emissions per useful internal floor area per year	kg CO_2 eq./m^2/yr
D1.3 Aggregate emissions of ozone-depleting substances during building operations	Aggregate emissions of ozone-depleting substances	tons CO_2/1000 m^2
D1.4 Aggregate emissions of acidifying emissions during building operations	Percentage of acidifying emissions over a 5-year period	%
D1.5 Aggregate annual GHG emissions from the use of private vehicles	Aggregate GHG emissions from private transport fuels	tons / yr

D1.6 Aggregate annual GHG emissions from the use of public transport	Aggregate GHG emissions from public transport fuels	Tons per 10,000 passengers
D1.7 Total GHG Emissions from buildings, private and public mobility	Aggregate GHG emissions from buildings, public and private transport fuels	%

Issue E: Non-Renewable Resources

Category E1 – Potable water, stormwater and greywater		
Criterion	Indicator	Unit of measure
E1.1 Availability of a public municipal water supply	Availability of a public municipal water supply to all permanent buildings in the area	%
E1.2 Provision of split grey / potable water services	Permanent buildings provided with split grey / potable water services	%
E1.3 Re-use of rainwater in residential buildings	Share of rainwater collected from roofs of residential buildings	%
E1.4 Re-use of rainwater in non-residential building	Share of rainwater collected from roofs of non-residential buildings	%
E1.5 Re-use of stormwater	Percent of annual stormwater that is re-used in the local area	%
E1.6 Consumption of potable water for residential population	Annual potable water consumption per occupant	m^3/occupant /year
E1.7 Consumption of potable water for non-residential building systems	Annual potable water consumption per m^2	m^3 /m^2
E1.8 Consumption of potable water for irrigation purposes	Potable water used for irrigation purposes	m^3/1000 m^2
E1.9 Intensity of water purification treatment	Energy intensity of purification treatment used for potable water	kWh/m^3
Category E2 – Solid and Liquid Wastes		
Criterion	Indicator	Unit of measure
E2.1 Access to solid waste and recycling collection points	Proximity of the resident population to the solid waste and recycling collection point	%
E2.2 Separate collection and disposal of solid waste and recycling	Separated collection and disposal of solid waste and recycling	%
E2.3 Solid waste from construction and demolition projects retained in the area for re-use or recycling	Volume of materials that will be re-used or recycled from the local area on the total solid waste from construction and demolition of building projects	%
E2.4 Solid waste from residents' activities and	Percentage of solid waste sent out of the area for re-use	%

facility operations sent out of the area for re-use, recycling or disposal		
E2.5 Composting and re-use of organic sludge	Percentage of organic sludge composted and re-used	%
E2.6 Public wastewater that is disposed or treated	Percent of public wastewater that is disposed or treated	%
E2.7 Liquid effluents from building operations that are sent out of the area	Percent of liquid effluents from building operations sent out of the area	%
E2.8 Potential for building operations to contaminate nearby bodies of water	Presence of hazardous effluents from building operations	Score
E2.9 Cumulative annual thermal changes to lake water or sub-surface aquifers	Thermal changes in lake water	Score
Category E3 – Resource consumption, retention and maintenance		
Criterion	Indicator	Unit of measure
E3.1 Consumption of non-renewable material resources for construction or renovation of buildings	Aggregate consumption of non-renewable material resources for construction or renovation of buildings	Tons/1000 m^2
E3.2 Efficient use of materials for construction of infrastructures	Quantity of materials from non-renewable material resources for construction or renovation of infrastructures in the local area over a 5-year period	Tons/1000 m^2
E3.3 Percent of reused or recycled materials used for construction or renovation	Reused or recycled materials for construction	%
E3.4 Adaptive re-use of existing buildings and structures	The percent of existing buildings and structures in the local area not requiring demolition that have been adapted to new uses	%
E3.5 Preservation and maintenance of existing buildings and structures	The percent of existing buildings and structures in the local area not requiring demolition, that have been preserved and maintained in full operating condition	Score
E3.6 Maintenance of the heritage value of existing buildings	Preservation of existing buildings with heritage value and key features	Score

Issue F: Environment

Category F1 – Environmental impacts		
Criterion	Indicator	Unit of measure

F1.1 Impact of construction activities on natural features	Preservation of land during and preconstruction phase	–
F1.2 Impact of construction activities or landscaping on soil stability or erosion	Impact degree of construction activities on soil stability	–
F1.3 Recharge of groundwater through permeable paving or landscaping	Area of permeable surfaces on total neighbourhood area	%
F1.4 Changes in biodiversity	Diversity of plant structures	–
F1.5 Heat Island Effect in the local area	Increasing of local atmospheric heating during summer	°C
F1.6 Impact on access to daylight or solar energy potential of contiguous buildings	Percentage of buildings negatively impacted to solar access	%
F1.7 Impact of local building user population on peak load capacity of public transport system	Peak load capacity of public transport system on user population	–
F1.8 Impact of private vehicles used by the local population on peak load capacity of the local road system	Impact degree of private vehicles on the population	–
F1.9 Degree of atmospheric light pollution caused by exterior lighting systems of buildings	Light pollution caused by exterior lighting systems of buildings	–
F1.10 Degree of atmospheric light pollution caused by exterior public lighting systems	Light pollution caused by exterior public lighting systems	–
F1.11 Albedo of building and paving surfaces	Average albedo of building and paving surfaces exposed to direct sunlight	Number
Category F2 – Outdoor environmental quality		
Criterion	Indicator	Unit of measure
F2.1 Ambient air quality with respect to particulates <2.5 mu (PM2.5) over a one-year period	Number of days exceeding the daily limits in a year	days / y
F2.2 Ambient air quality with respect to	Number of days exceeding the daily limits in a year	days / y

particulates <2.5 mu (PM2.5) over a one-week period		
F2.3 Ambient air quality with respect to particulates <10 mu (PM10) over a one-year period	Number of days exceeding the daily limits in a year	days/year
F2.4 Ambient air quality with respect to particulates <10 mu (PM10) over a one-week period	Ambient air quality	days/year
F2.5 Ambient air quality - carbon monoxide	Number of days exceeding the daily limits in a year	days / y
F2.6 Ambient air quality - ozone	Number of days exceeding the daily limits in a year	days / y
F2.7 Olfactory quality in the area	Frequency of anecdotal reports of poor olfactory conditions	Number
F2.8 Adverse wind conditions at grade around low-rise buildings	Qualitative	Number
F2.9 Adverse wind conditions at grade around tall buildings	Qualitative	Number
F2.10 Ambient Day time noise conditions	Percentage of building area over noise limit	%
F2.11 Ambient night-time noise conditions	Proportion of population exposed to not recommended levels of night noise	%
F2.12 Summer thermal comfort conditions	Factors include temperature, relative humidity and wind speeds, or Standard Effective Temperature (SET)	SET
F2.13 Winter thermal comfort conditions	Factors include temperature, relative humidity and wind speeds, or Standard Effective Temperature (SET)	SET
Category F3 – Ecosystems and landscapes		
Criterion	Indicator	Unit of measure
F3.1 Green zones & recreation areas availability	Availability of green zones & recreation areas	%
F3.2 Green zones & recreation areas accessibility	Accessibility of green spaces within the area	M
F3.3 Green zones & recreation areas density	Density of green spaces within the area	%

F3.4 Contamination status of undeveloped land	Contamination degree of soil and water courses of undeveloped land	–
F3.5 Surface water management	Actions for the protection of infrastructures or buildings from the water	–
F3.6 Tree coverage for shade and management of local ambient temperatures	Reduction of ambient temperatures through evapotranspiration	%
F3.7 Green roofs	Aggregate area of building roofs covered with vegetated material	%
F3.8 Vegetated walls and other building surfaces	Aggregate area of building walls and other building surfaces that are covered with vegetation, m^2	m^2
F3.9 Presence or potential for wildlife corridors	Continuity of green areas to support small wildlife	–
F3.10 Ecological diversity in the area	Degree of the diversity of the surrounding natural environment	–
F3.11 Ecological sensitivity classification of the area	The sensitivity of human and biological elements of the ecosystem to impacts of the built environment or natural events	–
F3.12 Walking or bicycling nature trails	Length of walking or bicycling nature trails	Km/1000 residents
F3.13 Condition of surface freshwater systems	The level of pollution of surface freshwater systems within the local area	–
F3.14 Condition of groundwater and subsurface aquifers	The capacity and purity of groundwater and subsurface aquifers	–
F3.15 Viability of adjacent wetlands and urban marine environments	Ability of wetlands and marine environments to withstand impacts of urban development or natural events	–

Issue G: Social aspects

Category G1 – Safety and accessibility		
Criterion	Indicator	Unit of measure
G1.1 Buildings that are accessible for use by physically disabled persons	Percent of key public, commercial and residential buildings that are accessible for use by physically disabled persons	%
G1.2 Sidewalks and other pedestrian paths that are accessible for use by	Percent of sidewalks and other pedestrian ways that are accessible for use by physically disabled persons	%

physically disabled persons		
G1.3 Barrier-free accessibility in local outdoor public areas	Adequacy of barrier-free accessible public outdoor areas compared to the total public area	%
G1.4 Ease of access to and use of public transport for physically disabled persons	Features of public transport to facilitate access physically disabled persons, such as kneeling buses and wide entries	%
G1.5 Objective / subjective safety measures	Adequacy of signage and traffic calming measures	–
Category G2 – Traffic and mobility services		
Criterion	Indicator	Unit of measure
G2.1 Performance of the public transport system	Percentage of inhabitants that are within 400 meters walking distance of at least one public transportation service stop	%
G2.2 Availability of car sharing services	Resident and working population using car sharing services	%
G2.3 Measures to limit traffic of cars and trucks passing through the local area	The effectiveness of regulations or financial measures designed to limit number of vehicles passing at peak hours	–
G2.4 Quality of pedestrian and bicycle network	Total walkway meters of dedicated pedestrian paths and meters of bicycle path and “shared space” per 100 inhabitants	m/100 inhabitants
G2.5 Availability of sheltered bicycle parking facilities	Sheltered bicycle parking spaces	%
Category G3 – Communication services		
Criterion	Indicator	Unit of measure
G3.1 Availability of a broadband communication network	Local area with available broadband communication network	%
G3.2 Access to a broadband communication network	Percentage of population with access to broadband communication	%
Category G4 – Public and private facilities and services		
Criterion	Indicator	Unit of measure
G4.1 Availability and proximity of key food and retail services	Percent of residential buildings located within a distance of 300m. of basic food and household goods	%

G4.2 Availability and proximity of key services	Percentage of inhabitants that are within 800 meters walking distance of at least 3 key services	%
G4.3 Availability and proximity of a primary school	Percentage of population near a primary school	%
G4.4 Availability and proximity of a secondary school	Percentage of population near a secondary school	%
G4.5 Availability and proximity of children's play facilities	Percentage of population near a children's' play facilities	%
G4.6 Availability and proximity of leisure facilities	Percent of residential buildings located within a distance of 1km. of public or commercial leisure facilities	%
G4.7 Access to indoor gymnastic facilities for winter use	Percent of residential buildings located near an indoor gymnastic facility for winter use	%
Category G5 – Local Food		
Criterion	Indicator	Unit of measure
G5.1 Local production of food	Surface of garden areas per capita	m^2 / inhabitant
G5.2 Residents' access to and use of urban agricultural plots	Percentage of the population with access to public urban agriculture plots	%
Category G6 – Management and community involvement		
Criterion	Indicator	Unit of measure
G6.1 Involvement of residents in community affairs	Percentage of resident population above 16 years having an involvement in community affairs	%
G6.2 Community management of urban facilities and urban spaces	Percentage of population playing management roles in public facilities	%
G6.3 Community involvement in urban planning activities	Percentage of residents active in public urban planning	LEVEL
G6.4 Individual access to community facilities and key services during off hours	Individual access to community facilities and key services during off-hours	%
Category G7 – Society, Culture and Heritage		
Criterion	Indicator	Unit of measure
G7.1 Compatibility of urban design with local cultural values	Compatibility with local area traditional values of street layouts and the character of urban spaces	Qualitative data

G7.2 Compatibility of public open space with local cultural values	Compatibility with local area traditional values of local public open spaces, including major uses, dimensions, and adjacent uses	Qualitative data
G7.3 Compatibility of new building designs with existing streetscapes	Compatibility of the design of new buildings with local area traditional types of building configurations, window types, materials, textures, and colours	Qualitative data
G7.4 Use of traditional local materials and techniques	Compatibility with local area traditional values of construction techniques and types of materials	Qualitative data
G7.5 Maintenance of UNESCO or other protected landscapes	Preventive maintenance and protection of UNESCO or other protected landscapes	Qualitative data
Category G8 – Perceptual		
Criterion	Indicator	Unit of measure
G8.1 Impact of tall structure(s) on existing view corridors	Preservation of the view corridors	Qualitative data
G8.2 Panoramic and scenic routes or viewpoints	Presence and quality of scenic routes and places	Qualitative data
G8.3 Perceived safety of public areas for pedestrians	Perceived safety of public places and pedestrian routes, as determined by a sample of pedestrians	Qualitative data
G8.4 Impact of commercial signage on the visual environment	Visual impact of exterior commercial signage	Qualitative data
G8.5 Impact of overhead electric distribution system on the visual environment	Visual impact of above-grade electrical distribution systems	Qualitative data
G8.6 Perceptual quality of area development	Perceived quality of the urban area and natural development	Qualitative data
G8.7 Aesthetic quality of new facility exteriors	Perceived quality of the exteriors of new buildings	Qualitative data

CRITERIA LIST: BUILDING SCALE

Issue A: Site Regeneration and Development, Urban Design and Infrastructure

Category A1 – Site Regeneration and Development		
Criterion	Indicator	Unit of measure
A1.1 Protection and restoration of wetlands	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of the wetlands	score

A1.2 Protection and restoration of coastal environments	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of the coastal environment	score
A1.3 Reforestation for carbon sequestration, soil stability and biodiversity	Expert assessment of the degree to which measures have been or are being taken to restore or maintain the full functionality of forested areas on the site	score
A1.4 Development or maintenance of wildlife corridors	The long-term presence of urban fauna	score
A1.5 Remediation of contaminated soil, groundwater or surface water	Status of soil, groundwater, or surface water after treatment	score
A1.6 Shading of building(s) by deciduous trees	Native trees retained or planted, according to landscaping plans and specifications; measured as percent of building frontage facing the equator, at a height of 5 m. that will be covered by foliage during the warm season within 5 years	%
A1.7 Use of vegetation to provide ambient outdoor cooling	Ratio of total vegetated surface area (on ground and on roofs, and including trees), divided by total site area. The result is known as or Leaf Area Index	Number
A1.8 Use of native plant types	The extent of vegetated landscaped area that is planted with native plants	%
A1.9 Provision of public open space(s)	The provision of land within the site suitable as public open space because of its location, area or other characteristics	score
A1.10 Provision and quality of children's play area(s)	In projects with residential accommodation for families, the existence and type of facilities for children's play and the quality of service provided	score
A1.11 Facilities for small-scale food production for residential occupants	Location, dimensions, access to sun and water	score
A1.12 Provision and quality of bicycle pathways and parking	Type and extent of bicycle paths in the project, connectivity with off-site bicycle paths, amount of sheltered and unsheltered bicycle parking, location of bicycle parking facilities relative to building entrances	score

A1.13 Provision and quality of walkways for pedestrian use	Type and extent of walkways in the project, extent of walkways sheltered from rain, snow or excess sunshine	score

Category A2 – Urban design		
Criterion	Indicator	Unit of measure
A2.1 Maximizing efficiency of land use through development density	Development density of the project, expressed as the ratio of gross floor area above grade of the Design relative to the maximum permitted gross floor area on the site	%
A2.2 Reducing need for commuting transport through provision of mixed uses	Number of major uses within the project, related to a threshold area	score
A2.3 Impact of orientation on the passive solar potential of building(s)	Deviation, in degrees (°) of main building axis from East-West (to ensure a maximum possible insolation)	score
A2.4 Building morphology, aggregate measure		
A2.5 Impact of site and building orientation on natural ventilation of building(s) during warm season(s)	Predicted differential wind pressures in Pascals (Pa) during warm season(s) at key points of the building envelope where windows or other openings exist or are likely to be provided	Pa
A2.6 Impact of site and building orientation on natural ventilation of building(s) during cold season(s)	Predicted differential wind pressures in Pascals (Pa) during cold season(s) at key points of the building envelope where windows or other openings exist or are likely to be provided	Pa
Category A3 – Project infrastructure and services		
Criterion	Indicator	Unit of measure
A3.1 Supply, storage and distribution of surplus thermal energy amongst groups of buildings	Total thermal energy capacity from solar and conventional sources, total storage capacity, total thermal energy demand from all buildings, and percent utilization of surplus thermal energy	%
A3.2 Supply, storage and distribution of surplus photovoltaic energy amongst groups of buildings	Total DC and AC electrical generating capacity from photovoltaic sources, total storage capacity, total electrical energy demand from all buildings, and percent utilisation	%
A3.3 Supply, storage and distribution of surplus hot water amongst groups of buildings	Total hot water capacity from solar and conventional sources, total storage capacity, total hot water demand from all buildings, and percent utilisation	%

A3.4 Supply, storage and distribution of surplus rainwater and greywater amongst groups of buildings	Total hot water capacity from solar and conventional sources, total storage capacity, total hot water demand from all buildings, and percent utilisation	%
A3.5 Provision of facility to produce energy from solid waste	Presence of the facility, its output, energy effectiveness and minimization of harmful emissions	score
A3.6 Provision of solid waste collection and sorting services	Solid non-organic waste generation during operations, excluding amounts used for energy production, capacity, and location of communal (multi-building) nonorganic solid waste and sorting facilities, and provision of appropriate management and staffing	score
A3.7 Composting and re-use of organic sludge	Presence of the service and suitable facilities, estimated output of organic waste and sludge produced, level of service	score
A3.8 Provision of split grey / potable water services	Presence of a split supply system and percent of individual building occupancies serviced	%
A3.9 Provision of surface water management system	Predicted or actual capacity of the surface water management system to successfully cope with 100-year precipitation and flood events so that disruption to activities on the site or physical damage to structures or contents is avoided	score
A3.10 On-site treatment of rainwater, stormwater and greywater	Existence of an on-site wastewater treatment system and the percent of total rain, storm and greywater waste treated	score
A3.11 On-site treatment of liquid sanitary waste	Existence of an on-site sewage treatment system and the percent of sewage treated	%
A3.12 Provision of on-site communal transportation system(s)	Existence and type of an on-site public or communal transportation system in a large project, percentage of buildings that have access to the system, and frequency of service	score
A3.13 Provision of on-site parking facilities for private vehicles	The ratio of parking spaces for private vehicles per dwelling unit, plus the ratio of parking spaces for private vehicles per 100 m^2 of usable area (ua) of non-residential occupancies	%
A3.14 Connectivity of roadways	Mean distance between intersections of roadways or streets	m

A3.15 Provision of access roads and facilities for freight or delivery	The degree to which building(s) in the project are serviced by access roads and facilities for freight or delivery	score
A3.16 Provision and quality of exterior lighting	Provision of exterior lighting systems, coverage of roadways, walkways and building entries, and directional efficiency to limit light pollution	score

Issue B: Energy and Resource Consumption

Category B1 – Total life cycle non-renewable energy		
Criterion	Indicator	Unit of measure
B1.1 Primary energy demand	Primary energy demand per internal useful floor area per year	kWh/m²/yr
B1.2 Delivered thermal energy demand	Delivered thermal energy demand per internal useful floor area per year	kWh/m²/yr
B1.3 Delivered electrical energy demand	Delivered electric energy demand per internal useful floor area per year	kWh/m²/yr
B1.4 Energy from renewable sources in total primary energy consumption	Primary energy demand of the building that is met by renewable sources on total primary energy demand	%
B1.5 Energy from renewable sources in total thermal energy consumption	Share of renewable energy in final thermal energy consumptions	%
B1.6 Energy from renewable sources in total electrical energy consumption	Share of renewable energy in final electric energy consumption	%
B1.7 Consumption of renewable energy for all building operations	Average annual kWh of renewable energy, including power produced by photovoltaics or wind turbines, per m2 of net area as predicted by means of an acceptable method or tool	Total kWh/m²*yr
B1.8 Consumption of non-renewable energy for all building operations	Annual kWh of delivered energy per m2 of net area, including fuel and electrical use, as predicted by means of an acceptable method or tool. Total is to include energy for space heating and cooling, vertical transport and all fixed equipment	kWh/m² *yr
B1.9 Consumption of non-renewable energy for project-related transport	Estimated annual primary energy use per unit area, kWh/m² per year	kWh/m² per yr

B1.10 Consumption of non-renewable energy for demolition or dismantling process		
B1.11 Embodied non-renewable primary energy	Embodied primary non-renewable energy	MJ/m²
Category B2 – Electrical peak demand		
Criterion	Indicator	Unit of measure
B2.1 Electrical peak demand for building operations	Average of peak monthly electrical demand for one year, W/m², as predicted by means of an acceptable method or tool	W/m²
B2.2 Scheduling of building operations to reduce peak loads on generating facilities	Average predicted reduction of weekly electrical demand for one year, W/m², as simulated by means of an acceptable method or tool	W/m²
Category B3 – Use of materials		
Criterion	Indicator	Unit of measure
B3.1 Degree of re-use of suitable existing structure(s) where available	The development of an inventory and the percent, by area, of an existing structure that is re-used or recycled, where the structures are in usable condition	%
B3.2 Protection of materials during construction phase	Measures taken to protect materials on site	score
B3.3 Material efficiency of structural and building envelope components	The combined weight in kg. of building structural and building envelope components relative to the gross volume of the structure	Kg/m³
B3.4 Use of virgin non-renewable materials	The estimated percentage of total mass of the building that consists of virgin non-renewable materials	%
B3.5 Recycled materials	Weight of recycled materials on total weight of materials	%
B3.6 Efficient use of finishing materials	The percent of above-grade interior floor, wall or ceiling surface areas in which structural elements are left exposed	%
B3.7 Ease of disassembly, re-use or recycling	Measures taken to facilitate future disassembly and re-use or recycling	score
Category B4 – Use of potable water, stormwater and greywater		
Criterion	Indicator	Unit of measure
B4.1 Embodied water in original construction materials	Potable water used in the production of original materials and products, in	l/m³

	m^3/m^3 of gross area. This criterion is not applicable to the Operations phase, due to the difficulty in obtaining valid historical data	
B4.2 Water consumption for indoor uses	Estimates made during the design phase focus on use of water-efficient sanitary fixtures equipment, to predict the gross water volume needed; and also plans for the use of stored rainwater or recycled (grey) water, to estimate what the net water consumption may be	m^3/m^2 yr
B4.3 Use of water for irrigation purposes	Estimates made during the design phase focus on use of amount of landscaped area, plans for the use of drought-resistant planting and the use of stored rainwater or recycled (grey) water, to estimate what the net water consumption may be	m^3/m^2 yr
B4.4 Use of water for building systems	Use of water-efficient building equipment and the use of stored rainwater or recycled (grey) water where possible	m^3/m^2 yr
B4.5 Potable water consumption for indoor uses	Potable water consumption per occupant per year	m^3/occupant/year

Issue C: Environmental Loadings

Category C1 – Greenhouse gas emissions		
Criterion	Indicator	Unit of measure
C1.1 GHG emissions from energy embodied in original construction materials	CO_2-equivalent emissions per Kg. per m^2 of gross area, as determined by calculations based on design documents and fuel emission values plus process-related emissions related to the region of production, and annualized according to the predicted lifespan of the building	GJ/m^2
C1.2 GHG emissions from energy embodied in construction materials used for maintenance or replacement(s)	Estimate of GHG emissions due to embodied primary energy annualized over the entire lifespan of the building (see F12) used for structure, envelope (excl. glazing), and major interior components for periodic maintenance or replacement, as determined by a	GJ/m^2

	program designed to estimate embodied energy and emissions through Life Cycle Analysis; also, estimate of replacement cycles	
C1.3 Global Warming Potential	CO_2 equivalent emissions per internal useful floor area per year	kg CO_2 eq./m^2/yr
Category C2 – Other atmospheric emissions		
Criterion	Indicator	Unit of measure
C2.1 Emissions of ozone-depleting substances during facility operations	CFC-11 equivalent, in gm per m^2 per yr	gm / m^2 per yr
C2.2 Emissions of acidifying emissions during facility operations	SO_2 Equiv. per year in kg. per unit net area	Kg. / m^2 per yr.
C2.3 Emissions leading to photo-oxidants during facility operations	Ethene equiv. per year in gm per net unit area	gm./m^2 per yr
Category C3 – Solid and liquid wastes		
Criterion	Indicator	Unit of measure
C3.1 Construction and demolition waste	Weight of waste and materials generated per 1 m^2 of useful floor area demolished or constructed	kg/m^2/life cycle stage
C3.2 Solid waste from building operations	Ratio of the number of collectable solid waste categories within a 100 m distance from the building's entrance to the reference solid waste categories	%
C3.3 Liquid effluents from building operations that are sent off the site	The volume of liquid waste per m^2 of gross area that is sent off the site for treatment. Note that units for residential occupancies are M^3 / pp*yr, and M^3 / m^2*yr for non-residential	m^3/yr
C3.4 Hazardous waste resulting from facility operations		
Category C4 – Impacts on project site		
Criterion	Indicator	Unit of measure
C4.1 Recharge of groundwater through permeable paving or landscaping	The predicted percentage of precipitation that is available to recharge groundwater through permeable paving or landscaping	%
C4.2 Changes in biodiversity on the site	The existence and quality of contents of a plan to minimize ecological damage to the site due to the construction process	score

C4.3 Adverse wind conditions at grade around tall buildings	Design-phase modelling predictions or results of operations-phase field measurements	score
Category C5 – Other local and regional impacts		
Criterion	Indicator	Unit of measure
C5.1 Impact of building on access to daylight or solar energy potential of adjacent property	Percentage of nearest face of an existing building, or a future building designed on an adjacent site in accordance with existing regulations that will be shaded by the subject building	%
C5.2 Impact of construction process on local residents and commercial facility users	During design phase, expert prediction of likely disruption levels; during and after construction phase, results of local random surveys	score
C5.3 Impact of building user population on peak load capacity of public transport system	Projected impact of building population and visitors on public transport capacity during morning and evening rush hours	%
C5.4 Impact of private vehicles used by building population on peak load capacity of local road system	For the design phase, the projected impact of building population on local road capacity during morning and evening rush hours. For the use phase field measurements should be used	%
C5.5 Potential for project operations to contaminate nearby bodies of water	Distance of the building from water body, aquifer or wetland as defined in official documentation or assessment by competent authorities. During use phase, field measurements of water quality should be taken	m
C5.6 Cumulative (annual) thermal changes to lake water or sub-surface aquifers	Predictions of changes in the average annual temperature of sub-surface aquifers, determined by simulation studies or, during use phase, on-site measurements of water temperatures	°C
C5.7 Contribution to Heat Island Effect from roofing, landscaping, and paved areas	During design phase, a building morphology and layout that permits free air circulation, reflectance, and area of horizontal surfaces of paved or constructed elements, and the area and type of landscaped areas, as indicated by drawings and specifications. During use phase, on-site measurements should be used	Variance in °C

C5.8 Degree of atmospheric light pollution caused by project exterior lighting systems	Percentage of total exterior light output that lies outside a vertical 120 degree cone, as indicated by drawings and specifications	%

Issue D: Indoor Environmental Quality

Category D1 – Indoor Air Quality and Ventilation		
Criterion	Indicator	Unit of measure
D1.1 Pollutant migration between occupancies	Measures taken to isolate areas or rooms where pollutants may be generated, as indicated by drawings and specifications	score
D1.2 Pollutants generated by facility maintenance		
D1.3 Formaldehyde concentration	Formaldehyde concentration in indoor air, μg/ m^3	μg/ m^3
D1.4 TVOC concentration in indoor air	TVOC concentration in indoor air	μg/ m^3
D1.5 CO_2 concentrations in indoor air	Designs for HVAC systems that conform to ASHRAE, CIBSE or other acceptable protocol during design phase; actual monitoring results during use phase	ppm
D1.6 Effectiveness of ventilation in naturally ventilated occupancies during cooling seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach
D1.7 Effectiveness of ventilation in naturally ventilated occupancies during intermediate seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach
D1.8 Effectiveness of ventilation in naturally ventilated occupancies during heating seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach
D1.9 Air movement in mechanically ventilated occupancies	Predicted air speed in m/s, as indicated by an analysis of proposed HVAC system characteristics or by post-occupancy monitoring	m/s
D1.10 Ventilation rate	Ventilation rate normalized per useful floor area	l/s/m^2
Category D2 – Air temperature and relative humidity		
Criterion	Indicator	Unit of measure
D2.1 Time outside of the thermal comfort range	Percentage of the time out of the range of defined interior maximum	%

	and minimum temperatures during the heating and cooling seasons	
D2.2 Thermal comfort index	Predicted Percentage Dissatisfied (PPD)	%
D2.3 Appropriate air temperature and relative humidity in mechanically cooled occupancies	During design phase, assessment of compliance of mechanical ventilation systems with recognized design standards such as ASHRAE or CIBSE	score
D2.4 Appropriate air temperature in naturally ventilated occupancies	Predicted ability of natural ventilation systems to maintain temperatures within an acceptable range, as indicated by drawings and specifications	score
Category D3 – Daylighting and illumination		
Criterion	Indicator	Unit of measure
D3.1 Appropriate daylighting in primary occupancy areas	The predicted Daylight Factor in a typical occupancy area located on the ground floor of the building, as indicated by drawings and specifications	Daylighting Factor (%)
D3.2 Control of glare from daylighting	The predicted maximum ratio of contrast in illuminance between windows and adjacent wall areas in a typical occupancy area, as indicated by design characteristics	Ratio
Category D4 – Noise and acoustics		
Criterion	Indicator	Unit of measure
D4.1 Noise attenuation through the exterior envelope	The predicted noise attenuation performance of the exterior wall most exposed to potential sources of noise, as indicated by design characteristics	STC
D4.2 Transmission of facility equipment noise to primary occupancies	Noise Reduction Criteria ratings of mechanical equipment and equipment rooms, as indicated by design characteristics	NRC
D4.3 Noise attenuation between primary occupancy areas	Minimum Sound Transmission Class of partitions between primary occupancy areas, as indicated by design characteristics	STC

Issue E: Service Quality

Category E1 – Safety and security		
Criterion	Indicator	Unit of measure
E1.1 Construction safety		

E1.2 Risk to occupants and facilities from fire	Risk level for occupants in the most vulnerable part of the building	score
E1.3 Risk to occupants and facilities from flooding	Probability of injury or death or major property damage in case of 100-year flood event or other foreseeable flood risk	score
E1.4 Risk to occupants and facilities from earthquake	Probability of injury or death or major property damage in case of earthquake event foreseeable within a 100-year time frame	score
E1.5 Risk to occupants from incidents involving biological or chemical substances - to be developed	Probability of injury or death in case of an accidental or wilful biological or chemical release in or near the building	score
E1.6 Maintenance of core building functions during power outages	Predictions of the number of days that ventilation, temperature, lighting, sanitation and internal transportation systems continue to provide minimally acceptable service, under conditions of temperature, rainfall, power, and fuel supply that fall outside of anticipated design conditions	days
E1.7 Personal security for building users during normal operations	Measures that are likely to assure adequate levels of actual and perceived personal security, according to design documentation	score
Category E2 – Functionality and efficiency		
Criterion	Indicator	Unit of measure
E2.1 Appropriateness of type of facilities provided for tenant or occupant needs	Factors include location, distance to relevant support facilities, surrounding environment (noise, traffic etc.)	score
E2.2 Suitability of layout(s) for required functions	Goodness of fit of provided layouts (shape, ease of access) with functional requirements	score
E2.3 Appropriateness of space provided for required functions	Goodness of fit of provided area with functional requirements	score
E2.4 Provision of exterior access and unloading facilities for freight or delivery	Adequacy of the facility unloading and temporary storage capacity and measures to prevent excessive noise and visual pollution from disturbing occupants	score
E2.5 Service quality and efficiency of vertical or horizontal transportation systems in building	Availability of lifts for occupant use, taking into account down-time for service and moving needs, and the time required to travel from the ground floor to the top floor (or vice	score

	versa) during peak periods; provision, capacity and speed of horizontal passenger conveying systems	
E2.6 Spatial efficiency	The ratio of directly functional net areas to total net area in each occupancy. Total Net Areas exclude only structure and building envelope areas; Net Functional Areas (NFA) exclude interior garages, vertical circulation and building mechanical rooms	%
E2.7 Volumetric efficiency	The ratio of directly functional net areas to total net area in each occupancy. Total Net Areas exclude only structure and building envelope areas; Net Functional Areas (NFA) exclude interior garages, vertical circulation and building mechanical rooms	%

Category E3 – Controllability		
Criterion	Indicator	Unit of measure
E3.1 Effectiveness of facility management control system	The presence of a computerized building management control system whose capability is consistent with the complexity of building systems	%
E3.2 Capability for partial operation of facility technical systems	The predicted ability of building systems to provide partial heating, ventilation, cooling or lighting services, according to design documentation	score
E3.3 Degree of local control of lighting systems	The area of typical lighting control zones in perimeter areas in m^2, as shown in design documentation	m^2
E3.4 Degree of personal control of technical systems by occupants	The degree of control over key indoor environment systems that can be exercised by occupants, according to design documentation	score
Category E4 – Flexibility and adaptability		
Criterion	Indicator	Unit of measure
E4.1 Ability for building operator or tenant to modify facility technical systems	The level of renovation work necessary to alter technical systems to suit new requirements	score
E4.2 Potential for horizontal or vertical extension of structure	Degree of technical and design difficulty and capital cost requirements linked to expansion possibilities	score
E4.3 Adaptability constraints imposed by structure or floor-to-floor heights	Structural load capacity and layout	score
E4.4 Adaptability constraints imposed by building envelope and technical systems	The ease or difficulty in altering the building envelope or technical systems to suit a new occupancy type	score
E4.5 Adaptability to future changes in type of energy supply	The ease or difficulty in installing heating or cooling equipment that require a different fuel, or to install photovoltaic systems	score
Category E5 – Optimization and maintenance of operating performance		
Criterion	Indicator	Unit of measure
E5.1 Operating functionality and efficiency of key facility systems	Commissioning plans developed and/or implemented and commissioning staff assigned	score

E5.2 Adequacy of the building envelope for maintenance of long-term performance	In areas where applicable, the existence of a report that describes and details the measures taken to ensure long-term integrity of the building envelope	score
E5.3 Durability of key materials	Materials and components conforming to accepted standards for durability	score
E5.4 Existence and implementation of a maintenance management plan	The availability of a comprehensive and long-term plan at the end of Design phase, and evidence of its implementation during Operations phase	score
E5.5 On-going monitoring and verification of performance	The provision of energy sub-metering systems and water consumption monitoring systems, according to design	score
E5.6 Retention of as-built documentation	The scope and quality of design documentation retained for use by building operators, according to design documentation	score

Issue F: Social, Cultural and Perceptual Aspects

Category F1 – Social aspects		
Criterion	Indicator	Unit of measure
F1.1 Universal access on site and within the building	The scope and quality of design measures planned to facilitate access and use of building facilities by persons with disabilities	score
F1.2 Access to direct sunlight from living areas of dwelling units	The percentage of dwelling units whose principal daytime living areas have direct sunlight. for at least 2 hours per day at 12 noon on Winter Solstice, according to design documentation	%
F1.3 Visual privacy in principal areas of dwelling units	The percentage of dwelling units whose bedroom and living areas are open to horizontal or downward views from a point within 20 m of the exterior windows	%
F1.4 Access to private open space from dwelling units	Minimum area and dimensions, in m^2 and m. and adequate protection from excessive solar exposure	%
Category F2 – Culture and heritage		
Criterion	Indicator	Unit of measure

F2.1 Compatibility of urban design with local cultural values	Expert assessment of the degree to which new features, systems and materials are consistent with local cultural values related to urban design and architecture, including both functional and aesthetic aspects	score
F2.2 Provision of public open space compatible with local cultural values	Expert assessment of the degree to which public open space provided in the project is consistent with local cultural values	score
F2.3 Impact of the design on existing streetscapes	Expert assessment of the harmony of the Design with adjacent existing buildings, in features such as height, bulk, set-back from the street, window size and height, colour or type of materials	score
F2.4 Use of traditional local materials and techniques	Architect's estimate of the percent of the non-structural elements of the building will be constructed using traditional local materials and construction techniques	%
F2.5 Maintenance of the heritage value of the exterior of an existing facility	Expert assessment of the degree to which new features, systems and materials are consistent with the character of the original design of the heritage building	score
F2.6 Maintenance of the heritage value of the interior of an existing facility	Expert assessment of the degree to which new interior features, systems and materials are consistent with the character of the original design of the heritage building	score
Category F3 – Perceptual		
Criterion	Indicator	Unit of measure
F3.1 Impact of tall structure(s) on existing view corridors	Expert or public opinion regarding impairment of existing view corridors	score
F3.2 Quality of views from tall structures	Expert or public opinion regarding impairment of existing view corridors	score
F3.3 Sway of tall buildings in high wind conditions	Lateral displacement from vertical under high wind conditions, in cm	sway in m
F3.4 Perceptual quality of site development	Views of an expert panel	score
F3.5 Aesthetic quality of facility exterior	–	score
F3.6 Aesthetic quality of facility interior	–	score

F3.7 Access to exterior views from interior	Visual quality of exterior artifacts or natural objects and their distance from the viewer	score

Issue G: Cost and Economic Aspects

Category G1 – Cost and Economics		
Criterion	Indicator	Unit of measure
G1.1 Construction cost	Predicted construction cost per unit area, according to design documentation	€/m²
G1.2 Operating and maintenance cost	Operating cost per unit area for energy, water & maintenance, according to design documentation	€/m²
G1.3 Life-cycle cost	Predicted Life Cycle Cost over a 25-year period, with calculations carried out in accordance with recognized procedures	€/m²
G1.4 Use stage energy cost	Energy annual cost per usable floor area	€/m²/yr
G1.5 Use stage water cost	Water annual cost per usable floor area	€/m²/yr
G1.6 Investment risk	Percent change in market value of properties within 200 m of the project boundaries, 12 months after the start of construction	score
G1.7 Affordability of residential rental or cost levels	The gross housing cost, including rent or financing costs plus basic utilities, as a percentage of median gross income	%

The Key Performance Indicators (KPIs) are those criteria that are mandatory or at least recommended to be assessed in order to make the results of the assessment comparable to each other. For comparability, it is important to agree on a short and operative list of criteria that is manageable for data collection, calculation and feasible to be assessed. As all project partners have to deal with a huge variety of indicators both on urban and on building scale the CESBA MED project partners agreed on a set of 16 KPIs on urban scale and on 13 KPIs on building scale.

The final KPIs selected for the URBAN SCALE

Issue	**Category**	Criterion	Indicator	Unit of measure
A: Built Urban Systems	**A1 – Urban structure and form**	A1.7 Conservation of Land	Area of undeveloped land with ecological or agricultural value / area of the neighbourhood	%

Issue	Category	Criterion	Indicator	Unit of measure
B: Economy	**B3 – Cost and investment**	B3.3 Operating energy costs for public buildings	Aggregated annual operating energy cost per aggregated indoor useful floor area	€/m²/year
C: Energy	**C1 – Non-renewable energy**	C1.1 Total final thermal energy consumption for building operations	Aggregated annual total final thermal energy consumption per aggregated indoor useful floor area	kWh/m²/year
		C1.4 Total final electrical energy consumption for building operations	Aggregated annual total final electric energy consumption per aggregated internal useful floor area	kWh/m²/year
		C1.7 Total primary energy demand for building operations	Aggregated annual total primary energy consumption per aggregated indoor useful floor area	kWh/m²/year
	C2 – Renewable and decarbonised energy	C2.1 Share of renewable energy on-site, relative to total final thermal energy consumption for building operations	Annual total thermal energy consumption from on-site renewable energy sources / annual total final thermal energy consumption	%
		C2.7 Share of renewable energy on-site, relative to final electric energy consumption	Share of renewable electric energy in final electric energy consumptions	%
D: Atmospheric emissions	**D1 – Atmospheric emissions**	D1.2 Total GHG Emissions from primary energy used in building operations	CO_2 equivalent emissions per useful internal floor area per year	kg CO_2 eq./m²/yr
E: Non-Renewable Resources	**E1 – Potable water, stormwater, and greywater**	E1.6 Consumption of potable water for residential population	Annual potable water consumption per occupant	m³/occupant/year
		E1.7 Consumption of potable water for non-residential building systems	Annual potable water consumption per m²	m³ /m²

Issue	Category	Criterion	Indicator	Unit of measure
F: Environment	**F1 – Environmental impacts**	F1.3 Recharge of groundwater through permeable paving or landscaping	Area of permeable surfaces on total neighborhood area	%
	F2 – Outdoor environmental quality	F2.3 Ambient air quality with respect to particulates <10 mu (PM10) over a one-year period	Number of days exceeding the daily limits in a year	days/year
G: Social aspects	**G2 – Traffic and mobility services**	G2.1 Performance of the public transport system	Percentage of inhabitants that are within 400 meters walking distance of at least one public transportation service stop	%
		G2.4 Quality of pedestrian and bicycle network	Total walkway meters of dedicated pedestrian paths and meters of bicycle path and "shared space" per 100 inhabitants	m/100 inhabitants
	G4 – Public and private facilities and services	G4.2 Availability and proximity of key services	Percentage of inhabitants that are within 800 meters walking distance of at least 3 key services	%
	G6 – Management and community involvement	G6.3 Community involvement in urban planning activities	Percentage of residents active in public urban planning	LEVEL

The final KPIs selected for the BUILDING SCALE

Issue	Category	Criterion	Indicator	Unit of measure
B: Energy and Resource Consumption	**B1 – Total life cycle non-renewable energy**	B1.1 Primary energy demand	Primary energy demand per internal useful floor area per year	kWh/m^2/yr
		B1.2 Delivered thermal energy demand	Delivered thermal energy demand per internal useful floor area per year	kWh/m^2/yr

Issue	Category	Criterion	Indicator	Unit of measure
		B1.3 Delivered electrical energy demand	Delivered electric energy demand per internal useful floor area per year	kWh/m^2/ yr
		B1.5 Energy from renewable sources in total thermal energy consumption	Share of renewable energy in final thermal energy consumptions	%
		B1.6 Energy from renewable sources in total electrical energy consumption	Share of renewable energy in final electric energy consumption	%
		B1.11 Embodied non-renewable primary energy	Embodied primary non-renewable energy	MJ/m^2
	B4 – Use of potable water, stormwater and greywater	B4.5 Potable water consumption for indoor uses	Potable water consumption per occupant per year	m^3/occupant/year
C: Environmental Loadings	**C1 – Greenhouse gas emissions**	C1.3 Global Warming Potential	CO_2 equivalent emissions per internal useful floor area per year	kg CO_2 eq./m^2/yr
	C3 – Solid and liquid wastes	C3.2 Solid waste from building operations	Ratio of the number of collectable solid waste categories within a 100 m distance from the building's entrance to the reference solid waste categories	%
D: Indoor Environmental Quality	**D1 – Indoor Air Quality and Ventilation**	D1.10 Ventilation rate	Ventilation rate normalized per useful floor area	l/s/m^2
	D2 – Air temperature and relative humidity	D2.2 Thermal comfort index	Predicted Percentage Dissatisfied (PPD)	%
G: Cost and Economic Aspects	**G1 – Cost and Economics**	G1.4 Use stage energy cost	Energy annual cost per usable floor area	€/m^2/yr
		G1.5 Use stage water cost	Water annual cost per usable floor area	€/m^2/yr

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

The final KPIs selected for the URBAN SCALE

Environment	
1.1	Conservation of Land
1.2	Total final thermal energy consumption for building operations

1.3	Total final electrical energy consumption for building operations
1.4	Total primary energy demand for building operations
1.5	Share of renewable energy on-site, relative to total final thermal energy consumption for building operations
1.6	Share of renewable energy on-site, relative to final electric energy consumption
1.7	Total GHG Emissions from primary energy used in building operations
1.8	Consumption of potable water for residential population
1.9	Consumption of potable water for non-residential building systems
1.10	Recharge of groundwater through permeable paving or landscaping
1.11	Ambient air quality with respect to particulates <10 mu (PM10) over a one-year period

Society	
1.1	Performance of the public transport system
1.2	Quality of pedestrian and bicycle network
1.3	Availability and proximity of key services
1.4	Community involvement in urban planning activities

Economy	
1.1	Operating energy costs for public buildings

The final KPIs selected for the BUILDING SCALE

Environment	
1.1	Primary energy demand
1.2	Delivered thermal energy demand
1.3	Delivered electrical energy demand
1.4	Energy from renewable sources in total thermal energy consumption
1.5	Energy from renewable sources in total electrical energy consumption
1.6	Embodied non-renewable primary energy
1.7	Potable water consumption for indoor uses
1.8	Global Warming Potential
1.9	Solid waste from building operations

Society	
1.1	Ventilation rate
1.2	Thermal comfort index

Economy	
1.1	Use stage energy cost
1.2	Use stage water cost

5-DATA REQUIREMENTS

All data necessary for the calculation are in detail described within deliverable D3.4.1 – CESBA MED SNT Generic Framework. Since there are in total 178 assessment criteria within the Urban scale generic framework, organized in 23 categories and 7 main issues, as already mentioned the CESBA MED project partners agreed on a set of 16 KPIs on urban scale and on 13 KPIs on building scale.

6-REPORTING

No data.

7-LEGISLATION

CESBA MED responded to the global challenges set by:

- the Sustainable Development Goals (SDGs),
- the Paris agreement on climate change 2015,

and to the European challenges set by:

- the Communication on Harmonisation of Building Assessment Systems (COM (2014) 445 final) - identified the need for a common European approach to assess the environmental performance of buildings throughout their lifecycle, taking into account the use of resources such as energy, materials and water,
- the Roadmap to a Resource Efficient Europe (COM (2011) 571 final), and
- the Urban agenda of the EU.

8-NOTES

The CESBA MED – Sustainable MED Cities project, a project of the European Interreg MED programme, started in November 2016 and was finished in October 2019.

The consortium consisted of 12 European partners from 7 countries (Italy, France, Spain, Malta, Greece, Austria, Croatia) in the Mediterranean region under the coordination of City of Torino.

CESBA MED is an assessment framework that has been specifically designed for the building scale in the context of its surrounding area, the neighbourhood. But, adequately contextualized, and with the right information and data in place, it allows the measurement of sustainability performance of districts as well as small urban areas.

CESBA MED main objective is to develop a common method for assessing the sustainable development of the built environment in the Mediterranean region.

2.6 SuperBuildings

1-BASIC INFORMATION

1.1 Name of the framework: SuPerBuildings (Sustainability and Performance Assessment and Benchmarking of Buildings – SuPerBuildings)

1.2 Name of the framework developer:

The consortium of 15 European partners under coordination of VTT Technical Research Centre of Finland

1.3 Webpage:

http://cic.vtt.fi/superbuildings/ no permission to access

https://www.oegut.at/downloads/pdf/bi_superbuildings-final-report.pdf → Sustainability and performance assessment and benchmarking of building, Final report, Espoo 2012, VTT Technology No.72

1.4 Countries where the framework is used:

Finland, France, Belgium, Germany, Czech Republic, Spain, Austria, Netherlands, UK.

1.5 Brief summary

The project SuPerBuildings developed and selected sustainability indicators for buildings, develop understanding about performance levels considering new and existing buildings, different building types and different national and local requirements, developed methods for the assessment and benchmarking of sustainable buildings and made recommendations for the effective use of benchmarking systems as instruments of steering and in different stages of building projects.

The project also studied the ability of BIM to provide the needed input information in order to calculate the indicator values.

The goal of the project was not to develop a uniform assessment system with a defined list of indicators, but the aim was to support the further development of existing systems.

SuPerBuildings also studied the effective use of sustainability indicators in different stages of building process.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability:

Different building types

2.2 Building types applicability:

New and existing buildings

2.3 Users and purpose

User	Purpose
Architects and designers, researchers, and academics	to provide information for assessment to use assessment results
Users of the building, real estate developers, national and regional authorities	to order assessments to use assessment results
Property valuers, neighbours of the site, insurers, funding providers, real estate agents, community representatives	to use assessment results
Facility managers, product manufacturers	to provide information for assessment

2.4 Physical boundaries of the assessment:

building + site + location.

2.5 Time boundaries

All life cycle phases of buildings.

3-STRUCTURE OF THE FRAMEWORK

SuPerBuildings' selected indicators

Subject	Criterion	Indicator	Unit of measure
Resources	1. Rational use of water	1.1 Embodied water use	m^3/functional unit (e.g., m^2 net floor area) calculated either per year or total amount for the whole life cycle of the building
		1.2 Operational water use	m^3/time unit (e.g., year or day)/person (e.g., per full time equivalent or per inhabitant) or m^3/time unit (e.g., year or day)/ functional unit (e.g., m^2 net floor area
		1.3 Wastewater production	m^3/functional unit (e.g., m^2 net floor area) /year or m^3/person (e.g., per full time equivalent or per inhabitant)/year
	2. Consumption of non-renewable primary energy	2.1 Embodied energy in the life cycle of construction products	kWh_{pe}/m^2/year or MJ_{pe}/m^2/year pe stands for primary energy m^2: net floor area (but this definition varies according to the countries) Energy is based on the net calorific value
		2.2 Energy consumed during the operation phase due to the building itself	
		2.3 Energy consumed during the operation phase due to activity-related equipment	
		2.4 Energy linked to transportation of persons due to the location/urban context of the building	
		2.5 Energy embodied in water-related services during the operation phase	
	3. Land use	3.1 Soil sealing	ratio of areas (percentage or m^2/m^2)
		3.2 Change of land use	qualitative description

Subject	Criterion	Indicator	Unit of measure
Ecosystems	4. Potential impact on climate change/ Global warming potential/ Carbon footprint	4.1 Greenhouse gases including at least CO_2, CH_4 and N_2O	kg (or tonnes) per m^2 (net floor area) calculated either per year or total amount during the chosen period (the chosen period may be the service life of the building)
		4.2 Greenhouse gases covered by IPCC Guidelines	
	5. Construction and demolition waste generation	5.1 Non-hazardous waste to disposal	kg/m^2 – amount of (each type of) waste per square meter of gross building area. Other possible units: kg/m^2/year – amount of (each type of) waste per square meter of gross building area annualized for planned lifespan of building % – percentage of construction and demolition waste for recycling or energy recovery (may be used as a way to evaluate waste management on site)
		5.2 Hazardous waste to disposal	
		5.3 Nuclear waste to disposal	
	6. Water pollution due to material leaching		mg /m^2 exposed surface /time unit (e.g., year) and/or mg /m^2 exposed surface /service life

Subject	Criterion	Indicator	Unit of measure
Comfort	7. Indoor thermal environment – Hygro-thermal comfort	7.1 PMV (Predicted Mean Vote)	7-point scale (-3, -2, -1, 0, 1, 2, 3) (+3 hot +2 warm +1 slightly warm 0 neutral -1 slightly cool -2 cool -3 cold)
		7.2 PPD (Percentage of People Dissatisfied)	%
		7.3 Operative temperature	°C
		7.4 Air temperature	°C
		7.5 Relative Humidity (RH)	%
		7.6 Air velocity	m/s
	8. Visual comfort	8.1 Illuminance	lux
		8.2 Daylight factor	%
Health	9. Indoor air quality	9.1 Several pollutants are considered	ppm or µg/m³ or RH (%) or cfu (colony forming unit)
Culture	10. Cultural heritage – Monument or monumental value/Historical value		non-quantitative or, very rarely, semi-quantitative
	11. Architectural quality – Aesthetic quality	11.1 Architectural quality in the design stage	qualitative description
		11.2 Architectural quality in the tender stage	
		11.3 "Educated" decision making	
		11.4 Public art in/on/around buildings	
Economic value	12. Life cycle costs	12.1 Capital cost	currency unit e.g., EUR as absolute value or discounted to present day value (net present value/ NPV)
		12.2 Costs in the operational phase	
		12.3 Maintenance costs	
		12.4 End of life costs	
Economic risks	13. Long term stability of value	13.1 Options for easy adaptation to change of use	depending on indicators chosen may or may not be quantitative units
		13.2 Ability to meet future legislative requirements	

Subject	Criterion	Indicator	Unit of measure
		13.3 Ability to adapt to climate change	
		13.4 Certain physical characteristics that have been proven to remain in demand over decades	
		13.5 Financial risk indicators	
Process quality	14. Integrated design in the planning process		The evaluation of the integrated design can be only qualitative. The sub-criteria are organised as a structured checklist. A list of credits / points may be associated to that checklist.

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment			
Resources	1. Rational use of water	1.1	Embodied water use
		1.2	Operational water use
		1.3	Wastewater production
	2. Consumption of non-renewable primary energy	2.1	Embodied energy in the life cycle of construction products
		2.2	Energy consumed during the operation phase due to the building itself
		2.3	Energy consumed during the operation phase due to activity-related equipment
		2.4	Energy linked to transportation of persons due to the location/urban context of the building
		2.5	Energy embodied in water-related services during the operation phase
	3. Land use	3.1	Soil sealing
		3.2	Change of land use
Ecosystems	4. Potential impact on climate change/ Global warming potential/ Carbon footprint	4.1	Greenhouse gases including at least CO_2, CH_4 and N_2O
		4.2	Greenhouse gases covered by IPCC Guidelines
	5. Construction and demolition waste generation	5.1	Non-hazardous waste to disposal
		5.2	Hazardous waste to disposal
		5.3	Nuclear waste to disposal
	6. Water pollution due to material leaching		

Society			
C o		7.1	PMV (Predicted Mean Vote)

	7. Indoor thermal environment – Hygro-thermal comfort	7.2	PPD (Percentage of People Dissatisfied)
		7.3	Operative temperature
		7.4	Air temperature
		7.5	Relative Humidity (RH)
		7.6	Air velocity
	8. Visual comfort	8.1	Illuminance
		8.2	Daylight factor
Health	9. Indoor air quality	9.1	Several pollutants are considered
Culture	10. Cultural heritage – Monument or monumental value/Historical value		
	11. Architectural quality – Aesthetic quality	11.1	Architectural quality in the design stage
		11.2	Architectural quality in the tender stage
		11.3	"Educated" decision making
		11.4	Public art in/on/around buildings

Economy			
Economic value	12. Life cycle costs	12.1	Capital cost
		12.2	Costs in the operational phase
		12.3	Maintenance costs
		12.4	End of life costs
Economic risks	13. Long term stability of value	13.1	Options for easy adaptation to change of use
		13.2	Ability to meet future legislative requirements
		13.3	Ability to adapt to climate change
		13.4	Certain physical characteristics that have been proven to remain in demand over decades
		13.5	Financial risk indicators

5-DATA REQUIREMENTS

All data necessary for the calculation are in detail described within the final report entitled *Sustainability and performance assessment and benchmarking of building* (Espoo 2012, VTT Technology No.72) – chapter 5.3 Description of the selected indicators and related assessment methods.

6-REPORTING

No data.

7-LEGISLATION

Subject	Criterion	Legislation
Resources	1. Rational use of water	Water use is included in important standards for the environmental or sustainability assessment of buildings and/or building products, like for example: - ISO 21929-1:2011 Sustainability indicators – Part 1 – Framework for the development of indicators and a core set of indicators for buildings - ISO 21931 Framework for methods of assessment of the environmental performance of construction works – Part 1 – Buildings - EN 15978:2011 Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method - EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products
	2. Consumption of non-renewable primary energy	- Energy Performance in Buildings Directive 2010/31/EU
	3. Land use	- ISO 21929-1:2011 Sustainability in building construction – Sustainability indicators Part 1 – Framework for the development of indicators and a core set of indicators for buildings
Ecosystems	4. Potential impact on climate change/ Global warming potential/ Carbon footprint	- COM(2011) 112 final "A Roadmap for moving to a competitive low carbon economy in 2050", Communication from the European Commission, Brussels, 8.3.2011.
	5. Construction and demolition waste generation	- The European Environment – State and Outlook 2010: Material Resources and Waste. Copenhagen: EEA, 2010. 46 p.
	6. Water pollution due to material leaching	- Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive – WFD) - Regulation no 305/2011/EU on construction products (CPR) - Regulation no 1907/2006/EC on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) - Regulation no 528/2012/EU on biocidal products

Subject	Criterion	Legislation
		- Decision no 2455/2001/EC establishing the list of priority substances in the field of water policy - Decision no 041/051 rev.12. Indicative list of regulated dangerous substances possibly associated with construction products under the CPD (2012) - Directive no 2006/118/EC on the protection of groundwater
Comfort	7. Indoor thermal environment – Hygro-thermal comfort	The indicator is included in important methods and standards that give guidelines for the sustainability assessment of buildings. These include: - ISO 21929-1 Sustainability indicators – Part 1 – Framework for the development of indicators and a core set of indicators for buildings - ISO 21931 Framework for methods of assessment of the environmental performance of construction works – Part 1 – Buildings SBA common metrics (CO_2 and formaldehyde concentration are included). - World Health Organization 2010. WHO guidelines for indoor air quality: selected pollutants. The WHO European Centre for Environment and Health, Bonn Office - EN 15251:2007 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics
	8. Visual comfort	Illuminance is generally accepted indicator described in: - EN 12464-1:2003, Light and lighting – Lighting of work places – Part 1: Indoor work places. This standard has been revised and republished in July 2011. Daylight factor is described in the standard: - EN 15251:2007, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

Subject	Criterion	Legislation
Health	9. Indoor air quality	- COM (2009) 400 final. Communication from the Commission to the European Parliament the Council, the European Economic and Social Committee and the Committee of Regions. Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development. The 7 key challenges are: Climate change and clean energy, Sustainable transport, Sustainable consumption and production, Conservation and management of natural resources, **Public health**, Social inclusion, demography and migration, Global poverty. - World Health Organization 2010. WHO guidelines for indoor air quality: selected pollutants. The WHO European Centre for Environment and Health, Bonn Office - World Health Organization 2009. WHO guidelines for indoor air quality: dampness and mould. WHO Regional Office for Europe.
Culture	10. Cultural heritage – Monument or monumental value/Historical value 11. Architectural quality – Aesthetic quality	- ISO 21929-1:2011, Sustainability in building construction – Sustainability indicators – Part 1 – Framework for the development of indicators and a core set of indicators for buildings → includes aesthetic quality
Economic value	12. Life cycle costs	- ISO 15686-5:2008 Buildings and constructed assets – Service life planning: Part 5, Whole life cycle costing - EN 15643-4:2011 Sustainability of construction works – Sustainability assessment of buildings – Part 4: Framework for the assessment of economic performance
Economic risks	13. Long term stability of value	- TEGOVA: European Property and Market Rating: A Valuer's Guide, 2003
Process quality	14. Integrated design in the planning process	- ISO 14001 on environmental management system - ISO 21392 on general principles of sustainability in the construction sector

8-NOTES

Sustainability and performance assessment and benchmarking of buildings, an FP7 project of the European Commission, started in January 2010 and was finished in December 2012.

The consortium consisted of 15 European partners from 9 countries (Finland, UK, France, Belgium, Germany, Czech Republic, Spain, Austria, Netherlands) under the coordination of VTT Technical Research Centre of Finland.

The main objective of the work was to develop sustainability indicators for buildings, methods for benchmarking of sustainable buildings and recommendations for the effective use of benchmarking systems as instruments of steering and in building processes.

2.7 FASUDIR

1-BASIC INFORMATION

1.1 Name of the framework: FASUDIR

1.2 Name of the framework developer: FASUDIR – FP7

1.3 Webpage: https://cordis.europa.eu/project/id/609222

1.4 Countries where the framework is used: Research project. KPIs tested in pilot case studies in Spain, Germany and Hungary

1.5 Brief summary

The FASUDIR project focused on energy retrofitting of buildings for sustainable urban districts. The developed key performance indicators in the FASUDIR project are intended to be used primarily to guide decision making process for energy retrofitting. The FASDUIR KPI provide quantitative and qualitative information about the building and/or district existing sustainability performance and allow to set targets for refurbishment. The indicators allow to assess the project in terms of its environmental, social, and economic performance, with focus on resource efficiency, low emissions, health, comfort, and cost efficiency. Since energy retrofitting measures can be conducted on both building (e.g., change of windows) and district level, (e.g., installation of district heating systems) the FASUIR opted to developed three main sets of indicators that can operate separately from each other. The first set of indicators are dedicated to measure the sustainability performance at the building level. The second set of Indicators function at a district level and the last set of indicators represent a set of multiscale indicators operating on building and district level simultaneously. Giving the fact the sustainability performance at district scale is beyond the EUB SuperHub scope and that the FASUDIR KPIs at building scale are basically derived from other system such as OPEN HOUSE and SuperBuildings that covered in over reviews, this overview opted to focus on the last set of indicators developed for use at the building and district level simultaneously as they provide a unique set of indicators that are not commonly used.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: No restriction on building type

2.2 Building types applicability: In use and refurbishment

2.3 Users and purpose

Example:

User	Purpose
Integrated multi scale Project design teams, including architects, engineers, specialist Consultants	The multiscale nature of the KPIs provide and quantitative or qualitative information about the impact of building scale renovation interventions on the district sustainability performance and vis versa
Clients and investors, including property owners, developers, managers, and investors	It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals. It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions
Energy Service Company (ESCO) and local government	The multiscale KPIs provide local governments with a holistic view about the sustainability performance of existing districts and allow to develop targeted renovation plans.

2.4 Physical boundaries of the assessment: *Building and District*

2.5 Time boundaries *Status quo, Concept, Detailed design, in use*

3-STRUCTURE OF THE FRAMEWORK

Macro-objective 1: Environmental Category

Criterion	Indicator	Unit of measure
1.1 Energy demand	1.1.1 calculating total primary energy demand over the building life cycle (from A1 to D) as per the EN 15978	kWh/(m²*a)
	1.1.2 Primary Energy use during the operational phase of the building (B6) as per the EN 15978	kWh/(m²*a)
	1.1.3 Primary energy demand used for the construction materials of the retrofitting and maintenance of the	kWh/(m²*a)

	building over the whole life cycle	
	1.1.4 ratio of the on-site yearly production of renewable primary energy in relation to the yearly average total primary energy demand of the building	%
1.2 Impacts on the Environment	1.2.1 Global Warming Potential (GWP) in CO2-equivalents per area and year for the whole life cycle of the building	Kg CO_2 eq/(m^2*a)
	1.2.2 Acidification Potential (AP) in SO2 - equivalents per area and year for the whole life cycle of the building	Kg SO_2 eq/(m^2*a)
	1.2.3 Ozone Depletion Potential in R11 - equivalents per area and year for the whole life cycle of the building	Kg R11 eq/(m^2*a)
	1.2.4 Eutrophication Potential in PO4 - equivalents per area and year for the whole life cycle of the building	Kg PO_4 eq/(m^2*a)
	1.2.5 Photochemical Ozone Creation Potential in C2H4 - equivalents per area and year for the whole life cycle of the building	Kg C_2H_4 eq/(m^2*a)
	1.2.6 Abiotic Depletion Potential Elements in SB-E kg of antimony equivalent based on the extraction rate of the resource used for the building over it whole life cycle in relation with earth ultimate reserves	kg SB-E eq /(m^2*a)

Macro-objective 2: Economic category

Criterion	Indicator	Unit of measure

3.1 Life Cycle Costs	3.1.1 Life cycle costs as the sum of the present value of all costs in relation to the year (i) from inception to the demolition of the building	€/(m²*a)
	3.1.2 Investment costs for retrofitting measures	€/(m²*a)
	3.1.3 Running costs energy	€/(m²*a)
	3.1.4 Running costs non-energy	€/(m²*a)
3.3 Return on Investment	Return on Investment	%

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
1.1 Energy demand
1.2 Impacts on the Environment

Economy
3.1 Life cycle cost
3.3 Return on Investment

5-DATA REQUIREMENTS

The list of indicators used by the FASUDIR are intentionally chosen so that the data gathering, accusation and processing is simple and easy across different district typologies.

6-REPORTING

n/a.

7-LEGISLATION

n/a.

8-NOTES

The List of FASUIR KPIs provided here represent the multi scale indicators that can be used to evaluate the building and later aggregated to measure the district sustainable energy performance. This choice is justified because the FASUDIR indicators are largely based on and derived from other well-developed system, thus, to avoid the reptation of indicators only the multi scale indicators are illustrated in the overview.

2.8 NewTREND

1-BASIC INFORMATION

1.1 Name of the framework: NewTREND

1.2 Name of the framework developer: NewTREND – Horizon 2020

1.3 Webpage: http://newtrend-project.eu/

1.4 Countries where the framework is used: Research project. KPIs tested in pilot case studies in Spain, Finland, and Hungary

1.5 Brief summary

The NewTREND project scope is limited to the assessment of a building energetic retrofit within the context of its neighbourhood. Therefore, the focus of the NewTREND KPI system is to represent the building performance at the interaction level, thus focusing on resources production, consumption and access aspects that can be affected by the retrofit project that change its values before and after retrofitting. As a result of the NewTREND whole life cycle approach to the building renovation, the KPIs are intentionally developed in manner that allow them to be usable throughout the project cycle from status-quo assessment to the design concept and targets setting followed by the verification of targets achievement in the detailed design phase and finally the use the KPIs to monitor the performance in the in-use phase, however, it must be noted that in each of these phases the data source for the computing the KPI value change as per the phase of the project and data availability. Giving the NewTREND project scope, the vast majority of the KPI are multiscale in nature, meaning that the results obtained from the KPI assessment at the building scale are aggregated to obtain a neighbourhood assessment. These multiscale indicators are annotated with the letter (M).

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: No restriction on building type

2.2 Building types applicability: In use and refurbishment

2.3 Users and purpose

Example:

User	Purpose
Integrated multi scale Project design teams, including architects, engineers, specialist Consultants	The multiscale nature of the KPIs provide and quantitative or qualitative information about the impact of building scale renovation interventions on the district sustainability performance and vis versa
Clients and investors, including property owners, developers, managers, and investors	It provides a clear set of priority aspects of performance to focus

	attention on, forming a basis for instructing design professionals. It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions
Project design teams, including architects, engineers, specialist Consultants	The KPIs can be used throughout the project cycle from status-que assessment to the design concept and targets setting followed by the verification of targets achievement in the detailed design phase and finally the use the KPIs to monitor the performance in the in-use phase
Facility managers/ Building owners	The KPIs can be used to monitor the building performance and guide interventions

2.4 Physical boundaries of the assessment: *(Building and neighbourhood)*

2.5 Time boundaries status quo assessment, *concept, detailed design, as built, in use*

3-STRUCTURE OF THE FRAMEWORK

Macro-objective 1: Energy

Criterion	Indicator	Unit of measure
1.1 Operational primary energy demand (M)	1.1.1 Primary Energy use during the operational phase of the building (B6) as per the EN 15978	kWh/(m²*a)
1.2 Delivered energy demand (M)	1.2.1 Delivered energy demand	kWh/(m²*a)
1.3 Renewable Energy On- Site (M)	1.3.1 Ratio of on-site renewable energy in relation to primary energy demand	%

Macro-objective 2: Impacts

2.1. Global warming potential (M)	1.2.1 Total carbon emissions during the operation stage	Kg CO_2 eq/(m²*a)

Macro-objective 3: Air Quality

Criterion	Indicator	Unit of measure
5.1 Indoor Air Quality	5.1.1 Occupied hours outside CO2 ppm range	%

Macro-objective 4: Thermal Comfort

Criterion	Indicator	Unit of measure
6.1 Summer Comfort without Cooling	6.1.1 Days outside comfort range	%
6.2 Thermal Comfort in the Heating Season	6.2.1 Occupied hours outside PMV range	%
6.3 Thermal Comfort in the Cooling Season	6.3.1 Occupied hours outside PMV range	%

Macro-objective 5: Acoustic Comfort

Criterion	Indicator	Unit of measure
8.1 Acoustic Comfort (M)	Indoor A-weighted sound pressure level	dBA

Macro-objective 6: Operational Costs

Criterion	Indicator	Unit of measure
10.1 Operational Energy Costs (M)	Operational energy costs, aggregated annually, normalised by floor area	€/m^2

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
1.1 Operational primary energy demand
1.2 Delivered energy demand
1.3 Renewable Energy On-site
2.1 Global Warming Potential

Society
5.1 Indoor Air Quality
6.1 Summer Comfort without Cooling
6.2 Thermal Comfort in the Heating Season
6.3 Thermal Comfort in the Cooling Season
8.1 Acoustic Comfort (M)

Economy
3.1 Operational Energy Costs

5-DATA REQUIREMENTS

Given the NewTREND KPIs whole life cycle approach. The data source for the computing the KPI value change as per the project phase and data availability. i.e. in the design phase simulation-based date can be used to verify the KPI results, computing the same KPI in the in-use phase is permitted with real data only such as metered or on-site measured data.

6-REPORTING

n/a.

7-LEGISLATION

n/a.

8-NOTES

The method used to compute 6.1 (Summer Comfort without Cooling) is valid only when 15 °C < Trm < 30 °C. Days with Trm values outside this range shall be excluded from the calculation, and the user is advised that the outdoor conditions for that day do not allow thermal comfort without mechanical systems

Trm= Running mean of the daily outdoor temperature

2.9 OPENHOUSE

1-BASIC INFORMATION

1.1 Name of the framework: OPENHOUSE

1.2 Name of the framework developer: OPENHOUSE – FP7

1.3 Webpage: https://cordis.europa.eu/project/id/244130

1.4 Countries where the framework is used: Research project. KPIs tested on over 100 pilot case studies buildings in more than 20 European countries

1.5 Brief summary

The overall objective of OPEN HOUSE research project (Benchmarking and mainstreaming building sustainability in the EU based on transparency and openness (open source and availability) from model to implementation) is to develop and to implement a common European transparent building assessment methodology, complementing the existing ones, for planning and constructing sustainable office buildings. The project ran from 02.2010 to 07.2013 with the participation of 20 institution from 13 EU countries. The OPEN HOUSE goal was to develop a transparent approach able to emerge collectively in an open way across the EU. This OPEN HOUSE based its KPIs on existing standards such both CEN/TC 350 and ISO TC59/SC17) and the EPBD Directive and its national transpositions as well as other well-established methodologies for assessing building sustainability at international, European, and national level. OPEN HOUSE assessment methodology is divided in two parts, the first part which is called the basic and quick sustainability assessment can be done at the design phase and it will allow carrying out the assessment (executable in a few days) using preliminary data. The second more comprehensive assessment called the complete assessment is done at the handover stage of the building and require detailed documentation. The OPEN HOUSE assessment system is composed of 56 indictors covering 6 categories: Environmental Quality, Social/Functional Quality, Economic Quality,

Technical Characteristics, Process Quality and The Location. During the project lifetime, the OPEN HOUSE assessment scheme was tested on over 100 building in over 24 countries spreading across the European content from Cyprus to Iceland and from Turkey in Ireland.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: Office buildings

2.2 Building types applicability: Newly built

2.3 Users and purpose

Example:

User	Purpose
Multinational real setae owner	The harmonized nature of the OPEN HOUSE KPIs provides and unified method that can be applied across the EU and provide quantitative and qualitative information about the building sustainability performance
Clients and investors, including property owners, developers, managers, and investors	It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals. It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions
Project design teams, including architects, engineers, specialist Consultants	The KPIs can be used throughout the project cycle from early design concept to the verification of targets achievement in the detailed design and project handover phase

2.4 Physical boundaries of the assessment: *Building*

2.5 Time boundaries *Design concept, Detailed design, As built*

3-STRUCTURE OF THE FRAMEWORK

Macro-objective 1: Environmental Quality

Criterion	Indicator	Unit of measure
1.1 Global Warming Potential (GWP)	1.1.1 Global Warming Potential (GWP) in CO2-equivalents per area and year for the whole life cycle of the building	Kg CO_2 eq/(m^2*a)

1.2 Ozone Depletion Potential (ODP)	1.2.1Ozone Depletion Potential (ODP)	Kg R11 eq/(m²*a)
1.3 Acidification Potential (AP)	1.3.1 Acidification Potential (AP)	Kg SO2 eq/(m²*a)
1.4 Eutrophication Potential (EP)	1.4.1 Eutrophication Potential (EP)	Kg PO4 eq/(m²*a)
1.5 Photochemical Ozone Creation Potential (POCP)	1.5.1 Photochemical Ozone Creation Potential (POCP)	Kg C2H4 eq/(m²*a)
1.9 Abiotic depletion of non renewable fossil fuels due to non renewable Primary Energy Demand (ADP_Enr)	1.9.1 Abiotic Depletion potential (ADP_Enr)	kg SB-E eq/(m²*a)
1.10 Total Primary Energy Demands and Share of Renewable Primary Energy	1.10.1 Total Primary Energy Demand	kWh/(m²*a)
	1.10.2 Share of renewable Primary Energy in Total Primary Energy Demand	%
1.11 Water and Wastewater	1.11.1 Operational Water Use and Waste Water	The water use value (WUV) in m3/*a
1.12 Land use	1.12.1 Site location	% Land use consumption
	1.12.2 Imperviousness change	Site imperviousness coefficient (#)
1.13 Waste	1.13.1 Recyclable Waste Storage	Qualitative
	1.13.2 Composting	Qualitative
1.15 Contribution to the depletion of abiotic resources - non fossil fuels (ADP elements)	1.15.1 Abiotic Depletion Potential (ADP elements)	Default: x* R

Macro-objective 2: Social / Functional Quality

Criterion	Indicator	Unit of measure
2.1 Barrier-free Accessibility	2.1.1 Barrier-free Accessibility	% of Net floor area
2.3 Thermal Comfort	2.3.1 Operative temperature in summer and winter and pre EN 15251/EN ISO 7730	°C
	2.3.2 Radiant temperature asymmetry and floor temperature	°C
	2.3.3 Draught, air velocity as per EN ISO 7730	air velocity in m/s
	2.3.4 Humidity in indoor air as per EN 15251	g of water per kg of dry air
2.4 Indoor Air Quality	2.4.1 Occupancy-based ventilation rates	total ventilation rate [l/s]
	2.4.2 Indoor air contamination with the most relevant indoor air pollutants (Existing buildings only)	Values of: formaldehyde, naphthalene, toluene, xylene, styrene in µg/m³
	2.4.3 CO2 concentration above outdoor level (Existing buildings only)	CO_2 concentrations (PPM) above outdoor levels
	2.4.4 Subjective reaction as classification of the indoor air quality (Existing buildings)	%
	2.4.5 Occurrence of Radon	Bq/m³
2.6 Acoustic Comfort	2.6.1 Indoor ambient noise levels in unoccupied staff/office areas	In dB

	2.6.2 Reverberation period	In Seconds
2.7 Visual Comfort	2.7.1 Availability of daylight throughout the building	Daylight factor as share of Usable Area in %
	2.7.2 Availability of daylight in regularly used work areas	Annual relative lighting percentage in %
	2.7.3 View to the outside	Qualitative
	2.7.4 Preventing glare in daylight	Qualitative
	2.7.5 Preventing glare in artificial light	compliance with EN 12464-1.
	2.7.6 Light distribution in artificial lighting conditions according to EN 12464-1	Qualitative
	2.7.7 Colour rendering	Colour rendering index
	2.7.8 Blinking and flashing lights	Qualitative
2.8 Operation Comfort	2.8.1 Ventilation	Qualitative
	2.8.2 Shading	Qualitative
	2.8.3 Glare prevention	Qualitative
	2.8.4 Temperatures during the heating period	Qualitative
	2.8.5 Temperatures outside the heating period	Qualitative
	2.8.6 Regulation of daylight and artificial light	Qualitative

	2.8.7 Ease of operation	Qualitative
2.11 Public Accessibility	2.11.1 General public access to the building	Qualitative
	2.11.2 External facilities open to the public	Qualitative
	2.11.3 Interior facilities, such as libraries or cafeteria, open to the public	Qualitative
	2.11.4 Possibility of third party to rent rooms in the building	Qualitative
	2.11.5 Variety of uses for public areas	Qualitative
2.16 Bicycle Amenities	2.16.1 Number of bicycle parking spaces available for building users	%
	2.16.2 Distance to bicycle parking system from a main building entrance	meters
	2.16.3 Existence of facilities for bicycle comfort and security	Qualitative
2.17 Material Sourcing	2.17.1 Material Sourcing Wood	FSC/PEFC certificates and corresponding CoC (Chain of Custody)

Macro-objective 3: Economic Quality

Criterion	Indicator	Unit of measure
3.1 Building-related Life Cycle Costs (LCC)	3.1.1 Life cycle costs	€/(m²*a)

Macro-objective 4: Technical Characteristics

Criterion	Indicator	Unit of measure
4.6 Quality of the building shell	4.6.1 Median thermal transmittance coefficients of building components U	W/m²K, U Value
	4.6.2 Thermal Bridges	W/m²K
	4.6.3 Air permeability class (window air-tightness)	Air permeability class as per EN 12207
	4.6.4 Amount of condensation inside the structure	Condensation determination as per EN ISO 13788
	4.6.5 Air exchange n50 and if necessary q50	Air-tightness measurements
	4.6.6 Solar heat protection	SHP= f * g * z (Solar heating protection) f: share of windows area (windows area/building envelope area) g: solar factor (g-value). It measures the percentage of heat that passes through the glass. z: reduction factor for solar protection devices.
4.7 Ease of Deconstruction, Recycling, and Dismantling	4.7.1 Effort for dismantling/disassembly - divided into 5 steps	Qualitative
	4.7.2 Effort for sorting/separation - divided into 3 steps	Qualitative

	4.7.3 Verification of the inclusion of a recycling/disposal concept with information about construction components in the certification application	Qualitative

Macro-objective 5: Process Quality

Criterion	Indicator	Unit of measure
5.1 Project Brief Strategy	5.1.1 Project Brief	Qualitative
	5.1.2 Architectural competition	Qualitative
5.5 Construction Site impact / Construction Process	5.5.1 Low-waste and recycling on construction site	Qualitative
	5.5.2 Low-noise construction site	Qualitative
	5.5.3 Low-dust construction site	Qualitative
	5.5.4 Environmental protection at the construction site	Qualitative
5.8 Commissioning	5.8.1 Commissioning process management and documentation	Qualitative

Macro-objective 6: The Location

Criterion	Indicator	Unit of measure
6.1 Risks at the Site	6.1.1 Earthquakes	Peak ground acceleration: % g
	6.1.2 Landslides	Qualitative

	6.1.3 Volcanic eruptions	Qualitative
	6.1.4 Tsunamis	Qualitative
	6.1.5 Extreme temperatures	Qualitative
	6.1.6 Forest fires	Qualitative
	6.1.7 Drought	Amount of observed precipitation deficits
	6.1.8 Floods	Qualitative
	6.1.9 Storms	3 Storm probability stages
	6.1.10 Avalanches	Avalanche potential
	6.1.11 Technological hazard/Chemical plants accidents	Share of chemical plants/km^2
	6.1.12 Technological hazard/Contaminant release and explosions	Sum of refineries, oil harbours and pipelines
	6.1.13 Technological hazard/Radioactive contamination from nuclear power plants accidents	Qualitative
6.3 Options for Transportation	6.3.1 Accessibility of the nearest railroad station	In Meters >1200m, 800-1200m, 500-800m, 300-500m, <300m

	6.3.2 Accessibility of the nearest public local transportation stop	In Meters >1000m, 500-1000m, 300-500m, 150-300m, <150m
	6.3.3 Availability of modern low emission transport options: city bike scheme, car club scheme, charging infrastructure for electric/hybrid vehicles, electric/hybrid bus lines	Qualitative
	6.3.4 Availability of Walking and Bike Path	Qualitative

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
1.1 Global Warming Potential (GWP)
1.2 Ozone Depletion Potential (ODP)
1.3 Acidification Potential (AP)
1.4.1 Eutrophication Potential (EP)
1.5.1 Photochemical Ozone Creation Potential (POCP)
1.9.1 Abiotic Depletion potential (ADP_Enr)
1.10.1 Total Primary Energy Demand
1.10.2 Share of renewable Primary Energy in Total Primary Energy Demand
1.11.1 Operational Water Use and Waste Water
1.12.1 Site location
1.12.2 Imperviousness change
1.13.1 Recyclable Waste Storage
1.13.2 Composting
1.15.1 Abiotic Depletion Potential (ADP elements)
2.17.1 Material Sourcing Wood
4.6.1 Median thermal transmittance coefficients of building components U
4.6.2 Thermal Bridges
4.6.3 Air permeability class (window air-tightness)
4.6.4 Amount of condensation inside the structure
4.7.1 Effort for dismantling/disassembly - divided into 5 steps
4.7.2 Effort for sorting/separation - divided into 3 steps
4.7.3 Verification of the inclusion of a recycling/disposal concept with information about construction components in the certification application
5.5.1 Low-waste and recycling on construction site
5.5.4 Environmental protection at the construction site

6.3.3 Availability of modern low emission transport options: city bike scheme, car club scheme, charging infrastructure for electric/hybrid vehicles, electric/hybrid bus lines

Society
2.1.1 Barrier-free Accessibility
2.3.1 Operative temperature
2.3.2 Radiant temperature asymmetry and floor temperature
2.3.3 Draught, air velocity
2.3.4 Humidity in indoor air
2.4.1 Occupancy-based ventilation rates
2.4.2 Indoor air contamination
2.4.3 CO2 concentration above outdoor level (Existing buildings)
2.4.4 Subjective reaction as classification of the indoor air quality (Existing buildings)
2.4.5 Occurrence of Radon
2.6.1 Indoor ambient noise levels in unoccupied staff/office areas
2.6.2 Reverberation period
2.7.1 Availability of daylight throughout the building
2.7.2 Availability of daylight in regularly used work areas
2.7.3 View to the outside
2.7.4 Preventing glare in daylight
2.7.5 Preventing glare in artificial light
2.7.6 Light distribution in artificial lighting conditions
2.7.7 Color rendering
2.7.8 Blinking and flashing lights
2.8.1 Ventilation
2.8.2 Shading
2.8.3 Glare prevention
2.8.4 Temperatures during the heating period
2.8.5 Temperatures outside the heating period
2.8.6 Regulation of daylight and artificial light
2.8.7 Ease of operation
2.11.1 General public access to the building
2.11.2 External facilities open to the public
2.11.3 Interior facilities, such as libraries or cafeteria, open to the public
2.11.5 Variety of uses for public areas
2.16.1 Number of bicycle parking spaces available for building users
2.16.2 Distance to bicycle parking system from a main building entrance
2.16.3 Existence of facilities for bicycle comfort and security
4.6.5 Air exchange n50 and if necessary q50
4.6.6 Solar heat protection
5.5.2 Low-noise construction site
5.5.3 Low-dust construction site
6.3.1 Accessibility of the nearest railroad station
6.3.2 Accessibility of the nearest public local transportation stop
6.3.4 Availability of Walking and Bike Path
6.1.1 Earthquakes
6.1.2 Landslides

6.1.3 Volcanic eruptions
6.1.4 Tsunamis
6.1.5 Extreme temperatures
6.1.6 Forest fires
6.1.7 Drought
6.1.8 Floods
6.1.9 Storms
6.1.10 Avalanches
6.1.11 Technological hazard/Chemical plants accidents
6.1.12 Technological hazard/Contaminant release and explosions
6.1.13 Technological hazard/Radioactive contamination from nuclear power plants accidents

Economy
2.11.4 Possibility of third party to rent rooms in the building
3.1.1 Life cycle costs
5.1.1 Project Brief
5.1.2 Architectural competition
5.8.1 Commissioning process management and documentation

5-DATA REQUIREMENTS

The OPENHOUSE assessment methodology allow for two types of assessments. The first one is Quick & Basic Assessment which can be fulfilled during the design stage through the submission of Letter of commitment or other easily and quickly accessible documentation. The second method, the Complete Assessment, is done after the completion of the project and usually require on site measurement or computer simulation verification in addition to as built drawings and complete description of the installed systems complemented with photos and technical documents.

6-REPORTING

n/a.

7-LEGISLATION

n/a.

8-NOTES

n/a.

2.10 European Standard Reference

1-BASIC INFORMATION

1.1 Name of the framework: European Standard reference UNI EN 15643, UNI EN 15978, UNI EN 16309, UNI EN 16627

1.2 Name of the framework developer:

UNI with the support of UNI/TC 033 /GL02 – Sustainability in buildings

CEN with the support of CEN/TC 350 - Sustainability of construction works

1.3 Webpage: UNI TC page (link); page of CEN/TC 350 (link).

1.4 Countries where the framework is used: European Union

1.5 Brief summary

The European standards analysed, mainly focused on building, which apply in the European Union are: EN 15643, EN 15978, EN 16309, EN 16627 developed by CEN with the support of CEN/TC 350-Sustainability of construction works.

These European Standards provide a system for the sustainability assessment of buildings and civil engineering works using a life cycle approach. The sustainability assessment quantifies aspects and impacts to assess the environmental, social and economic performance of buildings and civil engineering works using quantifiable indicators without value judgements. The series of standards gives requirements for the description of the object of assessment, the system boundary that applies at the building level, the list of indicators and procedures for the application of the indicators, the presentation of the results in reporting and communication, the data necessary for the application and their verification. The indicators include the assessment of the construction works' influence on the three sustainable dimensions, and impacts on the local area and of the local infrastructure beyond the curtilage of the building and the civil engineering works. The system proposed by the standards does not include aspect of organizations such as management systems, but the decisions or actions that influence the performance of all three sustainable dimensions of the object of assessment can be taken into account where the assessment includes management process related aspects. This framework moves on by the client's brief or regulations, that define technical and functional requirements and communicate any particular demands for, or related to, the sustainable performance. It's used functional equivalent for the assessment, that includes the type, the primary function, the technical requirements and the reference study period of construction works. Aspects and impacts are assigned and collected to the information Modules of the construction works life cycle (Modules A0 to D2) which describes the system boundary. Furthermore, the framework allows to make assessment through specific scenarios. The assessment report is the systematic and comprehensive summary of the assessment documentation supporting the communication that is regarded as provision of information from an assessment to any third party, covering both B2B and B2C communication purpose.

2-SCOPE OF THE FRAMEWORK

2.1 Building uses applicability: any use of buildings and civil engineering works.

2.2 Building types applicability: any type of new buildings and civil engineering works and any stage. This framework considers a process for the evaluation of the potential for sustainable refurbishment of existing construction works.

2.3 Users and purpose

User	Purpose
Project design teams, including architects, engineers, quantity surveyors and specialist Consultants	It provides indicators that characterize the sustainability aspects. It supports the user at each stage in a project, with guidance notes on how to make accurate sustainable performance assessments. It provides a basis to demonstrate or communicate the sustainable dimensions of building to third parties.
Clients and investors, including property owners, developers, managers and investors	It provides a clear set of aspects and impacts of performance to focus attention on, forming a basis for instructing design professionals. It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions. It enables to make decisions and choices that will help to address the need for sustainability of construction work. It provides a basis to demonstrate or communicate the sustainable dimensions of building to third parties.

2.4 Physical boundaries of the assessment: *the assessments can be undertaken for the object under consideration that is a whole building or civil engineering works, a part of the works or a combination of several buildings and/or civil engineering works. Take account also the impacts on the neighbourhood on the area of influence.*

2.5 Time boundaries *Each stage of the construction project from the concept to the end of life stage. It's suggested to start with the client's brief.*

3-STRUCTURE OF THE FRAMEWORK

Society

Macro-objective 1: Building related characteristics

Source	Criterion	Indicator	Unit of measure
EN 16309	Accessibility	Accessibility for people with additional needs	

		- approach to the building • the number and distance of dedicated drop-off and pick up points from the entrance for people with additional needs; • the number and distance of allocated car-parking; • the number of kerb ramps and their distance to the building; • distances to public transports; • the total number and proportion of electronically or mechanically operated entrance/exit systems; • the provision of appropriate tactile, visual and audio way finding systems; - entrance to and movement inside the building • minimum width of doors; • ease of opening of doors; • provisions of handrails; • provision of level access across internal and external thresholds; • provisions of electronically operated entrance/exit systems; • minimum width of corridors, lobbies and rooms; • provision, dimensions and ease of operation of lifts.	m m m m or km - - mm, cm, m - - - - mm, cm, m mm, cm, m
EN 16309		Access to building services • the provision and operability of sanitary facilities; • the provision and operability of sanitary facilities; • the accessibility for people with additional needs of electronically or mechanically operated systems; • the provision of communication systems in the building.	 - - - -
EN 16309	Adaptability	Ease of potential for adapting to other use • building's ability to accommodate individual user requirements; • building's ability to accommodate the change of user requirements; • building's ability to accommodate technical changes; • building's ability to accommodate the change of use.	 - - -

			-
EN 16309	Health and comfort	Thermal characteristics • operative temperature • humidity • air velocity and distribution • type of activities in the room • type of users	 °C or K % or g/kg m/s - -
EN 16309		Characteristics of indoor air quality - substances and particles (according to calculation or simulation) • According to EN 16515 (VOC e TVOC); • Carbon Dioxide • Ventilation rate • Mould growth • CO concentrations • Radiation from Radon	 μ g/m^3 μ g/m (ppm) l/s/m^3 °C and relative humidity (%) μ g/m (ppm) Bq/m^3
EN 16309		Acoustic characteristics • Sound isolation against impact and airborne sounds • Sound levels from service equipment • Room acoustics • Sound insulation from airborne sound from outside • Sound insulation of existing buildings	 dB dB seconds dB dB
EN 16309		Characteristics of visual comfort - artificial light • illuminance • Unified Glare Rating • Colour Rendering Index - daylight contribution • daylight factor • glare from the object of assessment	 lx - - % -
EN 16309		Spatial characteristics • number and floor area of all rooms • floor to ceiling height • number and floor area of toilets • number and floor area of bathrooms/showers • number and volume of storage compartments • outdoor space • common rooms	 m^2 m m^2 m^2 m^3 m^2 m^2 m m^2

		• number and dimensions (length, width, height) of connecting space • space for storage of waste	
EN 16309	Impacts on neighbourhood	Noise • Sound pressure level • Sound insulation • External sound barrier	 dB(A) dB -
EN 16309		Emissions • Particulates • Odour • Water • Heat • System control emissions	 - - - - Yes/No
EN 16309		Glare/overshadowing • Projection and illuminance • Presence of lighting • Glare emitted • Overshadowing with effect in the neighbourhood	 lux lux lux -
EN 16309		Shocks/vibrations	m/s^2 , rad/s^2
EN 16309	Maintenance and maintainability	Maintenance operation • Frequency and duration • Health and comfort impacts for the users • Safety for users • Usability of the building during maintenance	 - See other criterions - -
EN 16309	Safety and security	Resistance to climate change • Rain resistance • Wind resistance • Snow resistance • Flood resistance • Solar radiation resistance	 - - - - W/m^2
EN 16309		Accidental action • earthquake • explosions • fire and traffic impacts	 - - -
EN 16309		Personal safety and security against intruders and vandalism • Builiding fabric related aspects • User and control system related aspects	 - -
EN 16309		Security against interruptions of utility supply	-

Macro-objective 2: User and control system related characteristics for interaction with the building

Source	Criterion	Indicator	Unit of measure
EN 16309	Health and comfort	Thermal comfort • operative temperature at a building level can be controlled; • operative temperature in individual rooms can be controlled; • is there measurement and display of temperature in the building and/or individual rooms? • humidity at a building level can be controlled; • humidity in individual rooms can be controlled; • room air velocity and distribution at a building level can be controlled; • room air velocity and distribution in individual rooms can be controlled.	Yes/no Yes/no Yes/no Yes/no Yes/no Yes/no Yes/no
EN 16309		Indoor air quality • Is there control of ventilation at a building level? • Is there control of ventilation by users with automatic control and/or with manual override by users? • Is there measurement and display of concentration of CO_2 in individual rooms? • Is there measurement and display of humidity in the building and/or individual rooms?	Yes/no Yes/no Yes/no Yes/no
EN 16309		Visual comfort • Is there user control of the amount of daylight at the building level? • Is there user control of the amount of daylight in individual rooms? • Is there user control of the amount of artificial light at a building level? • Is there user control of the amount of artificial light in individual rooms? • Is there user controllability of glare from the neighbourhood?	Yes/no Yes/no Yes/no Yes/no Yes/no

EN 16309	Impacts on neighbourhood	Emissions • Particulates • Odour • Water • Heat • System control emissions	 - - - - Yes/No
EN 16309	Safety and security	Security against intruders and vandalism • User and control system related aspects	 -

Environment

Macro-objective 3: Indicators describing environmental impacts

Source	Criterion	Indicator	Unit of measure
EN 15978	Emission to air	Global warming potential, GWP	kg CO_2 equiv
		Depletion potential of the stratospheric ozone layer, ODP	kg CFC 11 equiv
		Formation potential of tropospheric ozone photochemical oxidants, POCP	kg Ethene equiv
EN 15978	Emission to air Discharges to soil Discharges to water	Abiotic Resource Depletion Potential for elements; ADP_elements	kg Sb equiv
		Abiotic Resource Depletion Potential of fossil fuels ADP_fossil fuels	MJ, net calorific value
EN 15978	Discharges to soil Discharges to water	Acidification potential of land and water; AP	kg SO_2-equiv
EN 15978	Discharges to water Use of water Use of land, landscape change and change in biodiversity	Eutrophication potential, EP	kg $(PO_4)^{3-}$ equiv

Macro-objective 4: Indicators describing resource use

Source	Criterion	Indicator	Unit of measure
EN 15978	Use of energy resources	Use of renewable primary energy excluding energy resources used as raw material	MJ, net calorific value

		Use of non-renewable primary energy excluding primary energy resources used as raw material	MJ, net calorific value
		Use of renewable secondary fuels	MJ
		Use of non-renewable secondary fuels	MJ
EN 15978	Embodied non-renewable primary energy	Total use of non-renewable primary energy resources energy resources used as raw materials (PENRT)	MJ
EN 15978	Use of materials	Use of renewable primary energy resources used as raw material	MJ, net calorific value
		Use of non-renewable primary energy resources used as raw material	MJ, net calorific value
		Use of secondary material	kg
EN 15978	Use of water	Net use of fresh water	m3

Macro-objective 5: Indicators describing waste categories

Source	Criterion	Indicator	Unit of measure
EN 15978	Use of materials Consequences for local ecology and biodiversity including heat, noise, vibration, glare and light) Radiation	Hazardous waste disposed	kg
EN 15978	Use of materials	Non-hazardous waste disposed	kg
EN 15978	Radiation	Radioactive waste disposed	kg

Macro-objective 6: Indicators describing the output flows leaving the system

Source	Criterion	Indicator	Unit of measure
EN 15978	Use of materials	Components for re-use	kg
		Materials for recycling	kg
EN 15978	Use of energy resources	Materials for energy recovery (not being waste incineration)	kg
		Exported energy	MJ for each energy carrier

Economy

Macro-objective 7: Quantify economic performance of the building – Before use stage (construction costs)

Source	Criterion	Indicator (to be read as cost cathegory, if not stated otherwise)	Unit of measure
EN 16627	LCC	Site costs (including purchase or rental costs)	€ (or other currency) /occurrence Date of occurrence
EN 16627		Product stage	€ (or other currency) /occurrence Date of occurrence
EN 16627		Transport to site	€ (or other currency) /occurrence Date of occurrence
EN 16627		Professional Fee (where these are not included in the construction costs)	€ (or other currency) /occurrence Date of occurrence
EN 16627		Temporary and enabling works	€ (or other currency) /occurrence Date of occurrence
EN 16627		Construction of asset	€ (or other currency) /occurrence Date of occurrence
EN 16627		Fit out	€ (or other currency) /occurrence Date of occurrence
EN 16627		Landscaping	€ (or other currency) /occurrence Date of occurrence
EN 16627	Impacts on economic value	Taxes and permission costs	€ (or other currency) /occurrence

			Date of occurrence
EN 16627	Impacts on economic value	Income – subsidies and incentives	€ (or other currency) /occurrence Date of occurrence

Macro-objective 8: Quantify economic performance of the building – Use stage (operation in use, maintenance and repair)

Source	Criterion	Indicator (to be read as cost category, if not stated otherwise)	Unit of measure
EN 16627	LCC	Building-related facility mgt costs	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Building-related insurance costs	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Leases and Rentals payable to third parties	€ (or other currency) /occurrence Date of occurrence
EN 16627	Impacts on economic value	Cyclical regulatory costs	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Energy costs (default is for usage as defined by EPBD related standards)	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Water related costs	€ (or other currency) /year
EN 16627	Impacts on economic value	Taxes (rates, local charges...)	€ (or other currency) /occurrence Date of occurrence
EN 16627	Impacts on economic value	Income - subsidies and incentives	€ (or other currency) /occurrence

			Date of occurrence
EN 16627	LCC	Income - Revenue from sale of asset or elements, but not part of a final disposal	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Income - Third party income during operation	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Other economic aspects	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Repairs and replacement of minor components/small areas	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Replacement of major systems and components	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Cleaning	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Grounds maintenance Needs defining to be consistent with the environmental assessment	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Redecoration	€ (or other currency) /occurrence Date of occurrence
EN 16627	Impacts on economic value	Taxes on maintenance	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	Disposal Inspections at end of lease period (excluding end of life final disposal)	€ (or other currency) /occurrence

			Date of occurrence
EN 16627	External cost and benefits	End of lease	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Planned Adaptation or planned refurbishment of asset in use	€ (or other currency) /occurrence Date of occurrence

Macro-objective 9: Quantify economic performance of the building – End of life stage (operation in use, maintenance and repair)

Source	Criterion	Indicator (to be read as cost category, if not stated otherwise)	Unit of measure
EN 16627	LCC	Deconstruction/ Dismantling Demolition	€ (or other currency) /occurrence Date of occurrence
EN 16627	External cost and benefits	All transport costs associated with the process of deconstruction and disposal of the built asset	€ (or other currency) /occurrence Date of occurrence
EN 16627	Impacts on economic value	Taxes on goods and services Landfill and other disposal costs	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Costs from re-use, recycling and energy recovery at end of life	€ (or other currency) /occurrence Date of occurrence
EN 16627	LCC	Income - Revenue from sale land	€ (or other currency)

4-CRITERIA SORTED PER SUSTAINABILITY DIMENSION

Environment
Use of water
Use of energy resources (includin gembodied energy, renewable and non-renewable)
Use of materials (including primary and secondary materials, renewable and non-renewable)
Wate generation

Emission to air (including effects on climate change)
Discharges to soil
Discharges to water
Radiation
Consequences for local ecology and biodiversity (including heat, noise, vibration, glare and light)
Use of land, landscape change and change in biodiversity.

Society
Accessibility
Adaptability
Health and comfort
Impacts on neighbourhood
Maintenance and maintainability
Safety and security

Economy
Life Cycle Costing (LCC)[5]
External cost and benefits[6]
Impacts on economic value and long term value stability of the asset

5-DATA REQUIREMENTS

The data used shall represent the building and scenarios at the time of the assessment (e.g., concept stage, basic design stage, detailed design stage, as built). The data and information used shall be complete in its representation of the object of assessment in terms of quantification. Data and scenarios shall be checked for plausibility. Where appropriate, the data shall take full account of any relevant cycle of change, e.g., seasonal variations, weekly and/or daily hours of operation/occupancy, and should be representative of at least one full year or full cycle of change. Information on the age and source of data used shall be included in the assessment report.

Sustainability analysis requires technical and cost information about individual products and components within the building and its services and systems, including service life data, type and frequency of inspection, replacement, cleaning, maintenance and repair, and deconstruction and disposal.

For environmental data, the approach to the assessment covers all stages of the building life cycle and is based on data obtained from Environmental Product Declarations (EPD). If data are in accordance with the requirements of EN 15804 then they are deemed to meet the requirements for data quality of EN 15978. If the environmental data are from other sources for which it has not been established

[5] Economic performance expressed in cost terms over the life cycle, taking account of negative costs related to energy exports and from re-use and recycling of parts of the building during its life cycle and at the end of life). Cash flow approach.

[6] Intended here as costs associated with an asset that are not necessarily reflected in the transaction costs between provider and consumer. ISO 15686-5:2017.

that it is in accordance with EN 15804 then some minimum data quality requirements apply [EN 15978 – point 10.3].

6-REPORTING

The assessment report shall contain any information of importance to the content of the communication. Communication is regarded as presentation of information from the assessment report to any third party.

The basis of the assessment is the transparency and traceability of information used and therefore the reporting and communication shall be accurate, verifiable, relevant and not misleading or deceptive. The assessment report describes the general information on the assessment, the general information on the object of assessment, the statement of boundaries and scenarios used in the assessment, the data sources. The results of the performance assessment of the building shall be reported and presented as structured List. Aspects that have not been determined shall be reported as INA (Indicator Not Assessed) and reasons for omitting this information shall be given. Information modules that are not included in the assessment shall be reported as MNA (Module Not Assessed) and reasons for excluding the module(s) shall be given.

7-LEGISLATION

The series of European standard is inserted as working tool into the legislation about Minimum Environment Criteria, adopted for public procurement (CAM, at Italian level).

8-NOTES

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3 Selection of relevant thematic areas and key aspects for the EUB SuperHub Passport for the next generation EPC

The recognition activity within the transnational panorama of sustainability indicators, described in the previous paragraph, has proved to be very comprehensive and quite exhaustive concerning the energy and sustainability aspects. Results achieved are ten list of indicators divided into categories and thematic areas; starting from these lists, **the identification of the thematic areas considered the most relevant for the next generation of EPCs** has been carried out.

The method used for the identification of the thematic areas, which are more relevant to be considered in the next generation of EPCs, it wasn't just one.

Two different approaches have been used for the selection, in order to guarantee greater objectivity of the selection, always using a "*bottom-up*" approach; they are the "Fast-Effective Survey" and the analysis of the EPBD Recast released by the European Commission, further detailed in the next paragraphs.

Based on the macro areas highlighted in the different transnational frameworks previously analysed, a checklist of the main ones has been drawn up, as follows:

Areas of interest of the transnational sets of indicators
Site - Location
Infrastructure - Transport - Services proximity
Resiliency (risk of extreme weather, seismic and flood events)
Energy consumption
Life-cycle Global Warming Potential
Resource Consumption
Renewable Energy
Material efficiency
Greenhouse Gas Emissions
Indoor Air Quality and Ventilation
Thermal comfort
Daylighting and visual comfort
Noise and Acoustics
Smart Readiness Indicators
Home automation systems
B.A.C.S.
Design for adaptability and renovation
Accessibility for persons with disabilities
Social, Cultural and Perceptual Aspects
Operating and maintenance cost
Life-cycle cost
Broadband communication network

These are the main areas identified by the consortium, based on the results of the analysis of the transnational frameworks. Next step focused on the **determination of the most relevant ones for the next generation of EPCs and on the identification of areas still missing**.

The two activities, mentioned above, carried out for the selection and prioritisation of the relevant thematic areas identified are widely described in the following paragraphs and summarised as follows:

- "Fast-Effective Survey in T1.3": using a very concise and user-friendly on-line survey, prepared and distributed in Task 1.3, guidance and suggestions concerning the priority level of the macro thematic areas identified have been collected from selected stakeholders, belonging to the different national contest represented by the project;
- "Analysis of the EPBD Recast released by the European Commission" in December 2021: to be perfectly aligned with the European Directive, concerning the proposal included in the document released from the European Commission about the revision of the Energy Performance of Buildings Directive (EPBD), the document has been deeply analysed.

Results achieved through these two approaches **have been discussed internally, through a consortium consultation among technical partners** mainly involved in the activity. They expressed their opinion about the thematic areas identified through the Fast-Effective Survey, about the indicators included in each thematic area and about any missing aspects to be taken into account. This internal consortium consultation has contributed to the final selection of the thematic areas of interest and the key aspects to be included in the EUB SuperHub Passport for the next generation of EPCs.

The objective of these activities is to **recognise the crucial aspects to be included in the next generation of EPCs, making an accurate selection and prioritisation of the thematic areas identified**. Each area includes a certain number of indicators, which represent the focus of the next activities which will lead to the identification of the potential Key Performance Indicators (KPIs).

The activities described above, are articulated in detail in the next paragraphs.

3.1 Results from the T1.3 Fast-Effective survey

The first activity carried out for the selection and prioritisation of the relevant thematic areas, has been the so called "Fast-Effective survey". **The survey has been organised in Task 1.3 and results have been exploited by Task 1.2.** This activity has allowed to get specific and relevant feedback from the point of view of the main stakeholders involved in the domain of the next generation of EPCs, all around Europe.

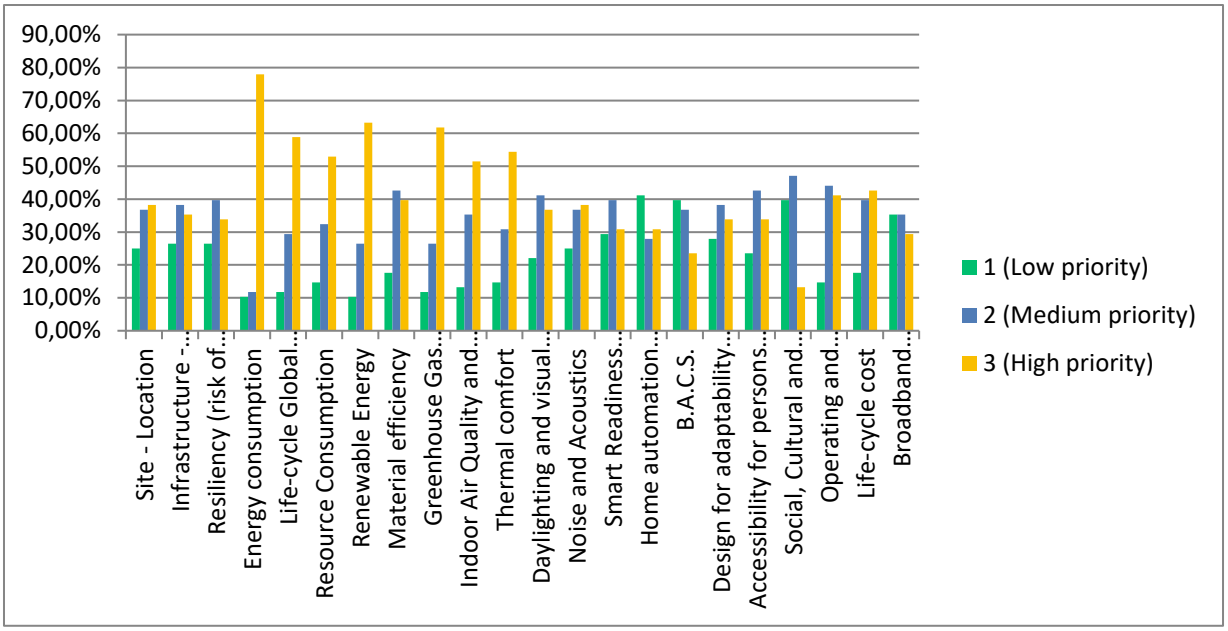
Stakeholders involved have been 83 in total but only 68 actively participated in the feedback part concerning the thematic areas to be prioritised. On the basis of the answers obtained, the thematic areas have been reclassified in the following priority order, as expressed in the following figure.

	1 (Low priority)		2 (Medium priority)		3 (High priority)	
Site - Location	25,00%	17	36,76%	25	38,24%	26
Infrastructure - Transport - Services proximity	26,47%	18	38,24%	26	35,29%	24
Resiliency (risk of extreme weather, seismic and flood events)	26,47%	18	39,71%	27	33,82%	23
Energy consumption	10,29%	7	11,76%	8	77,94%	53
Life-cycle Global Warming Potential	11,76%	8	29,41%	20	58,82%	40
Resource Consumption	14,71%	10	32,35%	22	52,94%	36
Renewable Energy	10,29%	7	26,47%	18	63,24%	43
Material efficiency	17,65%	12	42,65%	29	39,71%	27
Greenhouse Gas Emissions	11,76%	8	26,47%	18	61,76%	42
Indoor Air Quality and Ventilation	13,24%	9	35,29%	24	51,47%	35
Thermal comfort	14,71%	10	30,88%	21	54,41%	37
Daylighting and visual comfort	22,06%	15	41,18%	28	36,76%	25
Noise and Acoustics	25,00%	17	36,76%	25	38,24%	26
Smart Readiness Indicators	29,41%	20	39,71%	27	30,88%	21
Home automation systems	41,18%	28	27,94%	19	30,88%	21
B.A.C.S.	39,71%	27	36,76%	25	23,53%	16
Design for adaptability and renovation	27,94%	19	38,24%	26	33,82%	23
Accessibility for persons with disabilities	23,53%	16	42,65%	29	33,82%	23
Social, Cultural and Perceptual Aspects	39,71%	27	47,06%	32	13,24%	9
Operating and maintenance cost	14,71%	10	44,12%	30	41,18%	28
Life-cycle cost	17,65%	12	39,71%	27	42,65%	29
Broadband communication network	35,29%	24	35,29%	24	29,41%	20

As can be seen from the percentages showed in the figure above, almost 80% of the participants agree that the issue of energy consumption is of the highest priority, followed by other priority thematic areas such as:

- Renewable Energy
- Greenhouse Gas Emissions
- Life-cycle Global Warming Potential
- Thermal comfort
- Resource Consumption
- Indoor Air Quality and Ventilation
- Life cycle cost
- Noise and Acoustics
- Site – Location

The graph below gives a complete summary of all the thematic areas identified according to their level of priority (low, medium, high).



The final part of the "Fast effective survey" included a field in which respondents were asked to leave their own comments justifying the rationale behind their choice of priorities in relation to identified thematic areas.

Respondents left interesting comments; the most relevant and useful are listed within the table below.

Considerations related to the choice of priority made
It is important for us to know the environmental impact and the maintenance cost of our buildings.
Although all aspects are relevant for living standard improvement, it also needs to be taken in account which are applicable in older existing buildings and more recent existing buildings, i.e., technical readiness and optimality. Next, which level of improvement is targeted and where is the highest potential for improvement. So, in the end it is not about achieving the highest score but improving the most aspects.
The approach to sustainability must be holistic with respect to the building, its impact on the environment, on people (health and comfort) and on the value of the building.
Value creation for our customer: convenience, healthcare, energy monitoring, security improvement.
Higher importance to issues that are easier to understand and have direct impact on comfort and/or costs.
Internal comfort is a key point to sell a house and bind this info with a reliable EPC can raise its reliability on the market. In my opinion the EPC must focus on the maintenance and running cost, the effort for material and resources may worth this target: houses last for years. Low emission and high renewables are ok but very low energy consumption minimize this problem.

Simple and easily understandable information for everyone. EPC must request not too many and complex calculations because the cost must not be high for the end user.
Because green building and saving environment are more than just thermal comfort and energy saving. It's important to build on brown fields, not green unoccupied land. It's important to recycle, to renovate...but we need to have in mind that it needs to be in good price tag.

3.2 EPBD Recast analysis

The analysis of the proposed revision of the Energy Performance of Buildings Directive (published in December 2021) has been considered necessary in order to choose the potential KPIs that meet the needs and priorities of the European Union in terms of energy and sustainability performance of buildings.

Additionally, it represents one of the two activities, mentioned before, carried out for the selection and prioritisation of the relevant thematic areas for the EUB SuperHub Passport for the next generation EPC.

The Directive aims to achieve a European zero-emission and fully decarbonised building stock by 2050, upgrading the existing regulatory framework to reflect higher ambitions and more pressing needs in climate and social action.

A thorough reading of this document identified the following priorities:

- **Introduction of the minimum energy performance standards of existing buildings** to trigger the required transformation of the sector. Minimum requirements should be set with a view to achieving at least the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building.
- Requirement of **the application of the common Union scheme for rating the smart readiness of buildings, to non-residential buildings** with an effective rated output for heating systems, or systems for combined space heating and ventilation of over 290 kW (for other buildings, the scheme for rating the smart readiness of buildings should be optional for Member States).
- Member States shall address, **in relation to new buildings**, the issues of **healthy indoor climate conditions, adaptation to climate change, fire safety, risks related to intense seismic activity and accessibility for persons with disabilities**. Member States shall also address **carbon removals associated to carbon storage** in or on buildings. They shall ensure that the **life-cycle Global Warming Potential** (GWP) is calculated (in accordance with Annex III of the recast) and disclosed through the energy performance certificate of the building (as of 1 January 2030, for all new buildings).
- Member States shall address, **in relation to buildings undergoing a major renovation**, the issues of **healthy indoor climate conditions, adaptation to climate change, fire safety, and risks related to intense seismic activity, the removal of hazardous substances including asbestos, and accessibility for persons with disabilities.**

- Member States shall ensure that the energy performance certification of buildings, the establishment of renovation passports, the smart readiness assessment, and the inspection of heating systems and air-conditioning systems are **carried out in an independent manner by certified experts**.
- To promote green mobility, member States may adjust requirements for the **installation of recharging points for electric vehicles** and bicycle parking spaces.

For a better understanding of the content of the document, is provided below the "Annex V" of the proposed revision of the Energy Performance of Buildings Directive, which details point-by-point all the aspects addressed.

ANNEX V - TEMPLATE FOR ENERGY PERFORMANCE CERTIFICATES

(referred to in Article 16)

1. On its front page, the energy performance certificate shall display at least the following elements:

(a) the energy performance class;

(b) the calculated annual primary energy use in kWh/(m^2 year);

(c) the calculated annual primary energy consumption in kWh or MWh;

(d) the calculated annual final energy use in kWh/(m^2 year);

(e) the calculated annual final energy consumption in kWh or MWh;

(f) renewable energy production in kWh or MWh;

(g) renewable energy in % of energy use;

(h) operational greenhouse gas emissions (kg CO2/(m^2 year));

(i) the greenhouse gas emission class (if applicable).

2. In addition, the energy performance certificate may include the following indicators:

(a) energy use, peak load, size of generator or system, main energy carrier and main type of element for each of the uses: heating, cooling, domestic hot water, ventilation and in-built lighting;

(b) renewable energy produced on site, main energy carrier and type of renewable energy source;

(c) a yes/no indication whether a calculation of the Global Warming Potential has been carried out for the building;

(d) the value of the life-cycle Global Warming Potential (if available);

(e) information on carbon removals associated to the temporary storage of carbon in or on buildings;

(e) a yes/no indication whether a renovation passport is available for the building;

(f) the average U-value for the opaque elements of the building envelope;

(g) the average U-value for the transparent elements of the building envelope;

(h) type of most common transparent element (e.g. double glazed window);

(i) results of the analysis on overheating risk (if available);

(j) the presence of fixed sensors that monitor the levels of indoor air quality;

(k) the presence of fixed controls that respond to the levels of indoor air quality;

(l) number and type of charging points for electric vehicles;

(m) presence, type and size of energy storage systems;

(n) feasibility of adapting the heating system to operate at more efficient temperature settings;

(o) feasibility of adapting the air-conditioning system to operate at more efficient temperature settings;

p) metered energy consumption;

q) operational fine particulate matter (PM2.5) emissions.

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 a 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.

Persons with disabilities shall have equal access to the information in energy performance certificates.

3.3 Consortium Technical Consultation

The combination of the two approaches, described above, has produced an objective indication about the thematic areas considered the most relevant for the next generation EPCs and about the key sustainability and energy related aspects to be taken in account. **These important remarks have been the basis of the consortium technical consultation which has involved the technical partners mainly involved in the activity: iiSBE, CSTB and UNI**. During the comparison, some key decisions have been taken, going towards the final selection of the thematic areas of interest and the key aspects to be included in the EUB SuperHub Passport for the next generation of EPCs.

Concerning the outcomes of the Fast-Effective Survey, **to ensure the solidity of the result, the thematic areas that obtained a consensus greater than the 50% of the respondents have been selected,** in such a way to guarantee the reliability and the trust of the reply.

According to this principle, thematic areas considered are the ones highlighted in green in the table below:

	1 (Low priority)		2 (Medium priority)		3 (High priority)	
Site - Location	25,00%	17	36,76%	25	38,24%	26
Infrastructure - Transport - Services proximity	26,47%	18	38,24%	26	35,29%	24
Resiliency (risk of extreme weather, seismic and flood events)	26,47%	18	39,71%	27	33,82%	23
Energy consumption	10,29%	7	11,76%	8	77,94%	53
Life-cycle Global Warming Potential	11,76%	8	29,41%	20	58,82%	40
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Renewable Energy	10,29%	7	26,47%	18	63,24%	43
Material efficiency	17,65%	12	42,65%	29	39,71%	27
Greenhouse Gas Emissions	11,76%	8	26,47%	18	61,76%	42
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Thermal comfort	14,71%	10	30,88%	21	54,41%	37
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Broadband communication network	35,29%	24	35,29%	24	29,41%	20

The Fast-Effective Survey results face the expectations of the key stakeholders involved in the activity but, the other relevant document to consider to be able to recognise the crucial aspects to be included in the next generation of EPCs, is the **recast of the Energy Performance of Buildings Directive from the European Commission**. As widely described in chapter 3.2 of this deliverable, the Commission's proposal introduces better measures and tools to increase the rate and depth of building renovations.

Starting from the **Annex V** (template for energy performance certificates) of the EC proposal, during the internal consortium consultation many aspects have been highlighted as crucial. Some of them are simply considerations not to be missed, others are instead thematic areas to be considered.

Below the list of the aspects, extrapolated from the EPBD recast of the EC, considered by the consortium:

- Smart Readiness Indicators (including B.A.C.S.)
- Life-cycle cost
- Climate change adaptation and resilience

These three key aspects represent **three additional thematic areas to be taken into account for the identification of the potential KPIs** for the EUB Passport of the next generation of EPCs.

Other important issues are mentioned in the EPBD recast; they represent **singular aspects not belonging to specific thematic areas** but to be considered because of their relevance. The key aspects are:

- The electrical mobility and the charging points for electric vehicles
- The access for persons with disabilities to the information in energy performance certificates
- The operational fine particulate matter (PM2.5) emissions.

These important elements are not included in the transnational frameworks analysed in the first part of Task 1.2, but they are to be taken into account in relation to the next generation of EPCs, as suggested from the EC.

Furthermore, during the internal consultation a suggestion about the visual comfort has been considered since it is a crucial aspect to be strongly taken into account not only for comfort and well-being of occupants but also for energy consumption reduction. The parameter in question is the "**daylighting sufficiency**; its goal is to evaluate the amount of daylight needed to provide adequate light to perform typical tasks appropriate to each space, without electric lighting. This parameter is contained in the **EN 17037:2018**[7]; more in detail, this standard specifies elements for achieving, by means of natural light, an adequate subjective impression of lightness indoors, and for providing an adequate view out. In addition, recommendations for the duration of sunshine exposure within occupied rooms are given. The document gives information on how to use daylighting to provide lighting within interiors, and how to limit glare, defining metrics to be used for the evaluation of daylighting conditions and gives principles of calculation and verification.

To sum up, **the thematic areas selected by the consortium to be taken into account for the selection of the indicators** taken from the transnational sets are the following:

- Energy consumption
- Renewable Energy
- Greenhouse Gas Emissions
- Life-cycle Global Warming Potential
- Thermal comfort
- Resource Consumption
- Indoor Air Quality
- Life-cycle cost
- Smart Readiness Indicators
- Climate change adaptation and resilience

[7] http://store.uni.com/catalogo/en-17037-2018?josso_back_to=http://store.uni.com/josso-security-check.php&josso_cmd=login_optional&josso_partnerapp_host=store.uni.com

4 Taxonomy production: List of Potential KPIs

The last step of the work process carried out in Task 1.2, **which has as objective the identification of potential KPIs list, concerned a Taxonomy production activity**.

The Taxonomy produced, is a classification system, establishing a list of indicators which have the potential and the prerogatives to become KPIs. This taxonomy represents the final end-result of Task 1.2 activity, namely, an accurate list of selected indicators for evaluating the energy performance, sustainability and smartness of buildings in the next generation of EPCs. To reach the objective of the taxonomy production, other activities have been carried out in Task 1.2.

Once identified the thematic areas relevant for the next generation of EPCs, using the two methods described in the previous paragraph, the further activity carried out has been **the matching of the indicators coming from the transnational framework with the thematic areas selected**.

The combination between indicators and thematic areas has been carried out by iiSBE, by investigating the content of each transnational sets of indicators.

4.1 Indicators belonging to the thematic areas identified

Hereinafter, there is **the allocation of the indicators**, coming from the transnational sets of indicators analysed in the first stage of Task 1.2, **within the thematic areas selected**. The list is comprehensive of the energy, sustainability and smart readiness indicators.

THEMATIC AREAS	Framework	Code	Criterion	Indicator	Unit of m.
Energy consumption	SBTool	B1.1	Embodied non-renewable energy in original construction materials.	Estimate of embodied primary energy used for structure, envelope (excl. glazing), and major interior components	kWh/m^2 per yr.
	SBTool	B1.2	Embodied non-renewable energy in construction materials for maintenance or replacement(s).	Estimate of embodied primary energy annualized over the entire lifespan of the building used for structure, envelope (excl. glazing), and major interior components for periodic maintenance or replacement	kWh/m^2 per yr.
	SBTool	B1.3	Consumption of non-renewable energy for all building operations.	Annual kWh of delivered energy per m2 of net area, including fuel and electrical use	Total kWh/m^2 per yr.
	SBTool	B1.5	Consumption of non-renewable energy for project-related transport.	Estimated annual primary energy use per unit area, kWh/m2 per year.	kWh/m^2 per yr.
	SBTool	B1.6	Consumption of non-renewable energy for demolition or dismantling process.	Estimated non-renewable energy, in kWh/m2, required to disassemble or demolish the building and to prepare materials for shipment off the site.	kWh/m^2 per yr.

	SBTool	B2.1	Electrical peak demand for building operations.	Average of peak monthly electrical demand for one year	W/m²
	SBTool	B2.2	Scheduling of building operations to reduce peak loads on generating facilities.	Average predicted reduction of weekly electrical demand for one year, W/m2, as simulated by means of an acceptable method or tool.	W/m²
	Level(s)	1.1	Use stage energy performance	Primary energy demand per useful internal floor area	kWh/m²/yr kWh
	Level(s)	1.1	Use stage energy performance	Delivered final energy demand	kWh/m²/yr kWh
	Level(s)	1.1	Use stage energy performance	Non-renewable primary energy demand	kWh/m²/yr
	SBA	1.1	Primary energy	Use of non-renewable primary energy	kWh / m²
	CESBA MED	B1.1	Primary energy demand	Primary energy demand per internal useful floor area per year	kWh/m²/yr
	CESBA MED	B1.2	Delivered thermal energy demand	Delivered thermal energy demand per internal useful floor area per year	kWh/m²/yr
	CESBA MED	B1.3	Delivered electrical energy demand	Delivered electric energy demand per internal useful floor area per year	kWh/m²/yr
	CESBA MED	B1.8	Consumption of non-renewable energy for all building operations	Annual kWh of delivered energy per m2 of net area, including fuel and electrical use	kWh/m² *yr
	CESBA MED	B1.11	Embodied non-renewable primary energy	Embodied primary non-renewable energy	MJ/m²
	CESBA MED	C3.3	Mid-term storage of electrical energy	Weekly or monthly electrical storage capacity of electrical storage devices in the local area, in GWh	%
	CESBA MED	B2.1	Electrical peak demand for building operations	Average of peak monthly electrical demand for one year, W/m2	W/m²
	CESBA MED	B2.2	Scheduling of building operations to reduce peak loads on generating facilities	Average predicted reduction of weekly electrical demand for one year, W/m2, as simulated by means of an acceptable method or tool	W/m²
	FASUDIR	1.1.1	Total primary energy demand	Total primary energy demand over the building life cycle (from A1 to D) as per the EN 15979	kWh/(m²*a)
	FASUDIR	1.1.2	Primary Energy use during the operational phase	Primary Energy use during the operational phase of the building (B6) as per the EN 15978	kWh/(m²*a)
	FASUDIR	1.1.3	Primary energy demand used for construction materials	Primary energy demand used for the construction materials of the retrofitting and maintenance of the building over the whole life cycle	kWh/(m²*a)
	NewTREND	1.1	Operational primary energy demand	Primary Energy use during the operational phase of the building (B6) as per the EN 15978	kWh/(m²*a)

	NewTREND	1.2	Delivered energy demand	Delivered energy demand	kWh/(m²*a)
	OPENHOUSE	10.1	Total Primary Energy Demand	Total Primary Energy Demand	kWh/(m²*a)
	EN 15978		Use of non-renewable primary energy excluding primary energy resources used as raw material	Non-renewable primary energy excluding primary energy resources used as raw material	MJ, net calorific value
	EN 15978		Use of non-renewable secondary fuels	Non-renewable secondary fuels	MJ
	EN 15978		Embodied non-renewable primary energy	Total use of non-renewable primary energy resources energy resources used as raw materials (PENRT)	MJ
Renewable Energy	SBTool	B1.4	Consumption of renewable energy for all building operations.	Average annual kWh of renewable energy, including power produced by photovoltaics or wind turbines, per m2 of net area as predicted by means of an acceptable method or tool.	Total kWh/m²*yr
	Level(s)	1.1	Use stage energy performance	Renewable primary energy demand	kWh/m²/yr
	CESBA MED	B1.4	Energy from renewable sources in total primary energy consumption	Primary energy demand of the building that is met by renewable sources on total primary energy demand	%
	CESBA MED	B1.5	Energy from renewable sources in total thermal energy consumption	Share of renewable energy in final thermal energy consumptions	%
	CESBA MED	B1.6	Energy from renewable sources in total electrical energy consumption	Share of renewable energy in final electric energy consumption	%
	CESBA MED	B1.7	Consumption of renewable energy for all building operations	Average annual kWh of renewable energy, including power produced by photovoltaics or wind turbines, per m2 of net area as predicted by means of an acceptable method or tool	Tot.kWh/m²*yr
	CESBA MED	C2.10	Electrical energy generated from renewable sources that is exported from the local area	Electrical energy generation from renewable sources that is exported from the local area	MWh/year
	CESBA MED	C2.11	Aggregated use of renewable electrical energy	Share of renewable electricity production	%
	CESBA MED	C2.14	Thermal energy generated from renewable sources that is exported from the local area	Thermal energy generation from renewable sources that is exported from the local area	MWh/year
	FASUDIR	1.1.4	Production of renewable primary energy	Ratio of the on-site yearly production of renewable primary energy in relation to the yearly average total primary energy demand of the building	%

	NewTREND	1.3	Renewable Energy On- Site	Ratio of on-site renewable energy in relation to primary energy demand	%
	OPENHOUSE	1.10	Share of Renewable Primary Energy	Share of renewable Primary Energy in Total Primary Energy Demand	%
	EN 15978		Embodied renewable primary energy	Total use of renewable primary energy resources (PERT)	MJ
	EN 15978		Use of renewable secondary fuels	Renewable secondary fuels	MJ
Greenhouse Gas Emissions	SBTool	C1.1	GHG emissions from energy embodied in original construction materials.	CO2-equivalent emissions per Kg. per m2 of gross area	kg/m^2 * year
	SBTool	C1.2	GHG emissions from energy embodied in construction materials used for maintenance or replacement(s).	Estimate of GHG emissions due to embodied primary energy annualized over the entire lifespan of the building used for structure, envelope (excl. glazing), and major interior components for periodic maintenance or replacement	kg/m^2 * year
	SBTool	C1.3	GHG emissions from primary energy used for all purposes in facility operations.	Annual CO2-equivalent emissions per Kg. per m2 of net area	kg/m^2 per yr.
	SBTool	C1.4	GHG emissions from primary energy used for project-related transport	Measures taken during the Design phase to provide incentives for using shared or public transport and disincentives for using private automobiles	Qual
	SBTool	C2.1	Emissions of ozone-depleting substances during facility operations.	CFC-11 equivalent, in gm per m2 per yr.	gm / m^2 per yr.
	NewTREND	2.1	Global Warming Potential (GWP)	Total carbon emissions during the operation stage	Kg CO2 eq/(m^2*a)
	CESBA MED	D1.2	Total GHG Emissions from primary energy used in building operations	CO2 equivalent emissions per useful internal floor area per year	kg CO2 eq./m^2/yr
	CESBA MED	D1.3	Aggregate emissions of ozone-depleting substances during building operations	Aggregate emissions of ozone-depleting substances	tons CO_2/1000 m^2
	CESBA MED	C1.1	GHG emissions from energy embodied in original construction materials	CO2-equivalent emissions per Kg. per m2 of gross area	GJ/m^2
	CESBA MED	C1.2	GHG emissions from energy embodied in construction materials used for maintenance or replacement(s)	Estimate of GHG emissions due to embodied primary energy annualized over the entire lifespan of the building used for structure, envelope (excl. glazing), and major interior components for	GJ/m^2

				periodic maintenance or replacement	
	CESBA MED	C2.1	Emissions of ozone-depleting substances during facility operations.	CFC-11 equivalent, in gm per m2 per yr.	gm / m^2 per yr.
	SuPerBuildings	4.1	Emissions of GHG impacting on climate change	Greenhouse gases including at least CO2, CH4 and N2O	kg (or tonnes) per m^2 (net floor area) period
	SuPerBuildings	4.2	Emissions of GHG impacting on climate change	Greenhouse gases covered by IPCC Guidelines	kg (or tonnes) per m^2 (net floor area) period
Life-cycle Global Warming Potential	Level(s)	1.2	Life cycle Global Warming Potential	Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area	kg CO_2 eq/m^2/yr
	CESBA MED	C1.3	Global Warming Potential	CO2 equivalent emissions per internal useful floor area per year	kg CO_2 eq./m^2/yr
	SBA	2.1	Carbon emissions	Global Warming Potential (GWP100)	kg CO_2eq / <unit>
	FASUDIR	1.2.1	Global Warming Potential (GWP)	Global Warming Potential (GWP) in CO2- equivalents per area and year for the whole life cycle of the building	Kg CO_2 eq/(m^2*a)
	OPENHOUSE	1.1	Global Warming Potential (GWP)	Global Warming Potential (GWP) in CO2-equivalents per area and year for the whole life cycle of the building	Kg CO_2 eq/(m^2*a)
	EN 15978		Global warming potential, GWP	Global warming potential, GWP	kg CO_2 equiv
Thermal comfort	SBTool	D2.1	Appropriate air temperature and relative humidity in mechanically cooled occupancies.	Compliance of mechanical ventilation systems with recognized design standards such as ASHRAE or CIBSE.	Qual
	SBTool	D2.2	Appropriate air temperature in naturally ventilated occupancies.	Predicted ability of natural ventilation systems to maintain temperatures within an acceptable range, as indicated by drawings and specifications.	Qual
	Level(s)	4.2	Time outside of thermal comfort range	The proportion of the year when building occupiers are not comfortable with the thermal conditions inside a building.	% of the time out of range during the heating and cooling seasons

	SBA	3.1	Thermal comfort	For summer and winter settings: % time out of range of minimum and maximum temperature (by calculation or measurement or NCM)	% time
	CESBA MED	D2.1	Time outside of the thermal comfort range	Percentage of the time out of the range of defined interior maximum and minimum temperatures during the heating and cooling seasons	%
	CESBA MED	D2.2	Thermal comfort index	Predicted Percentage Dissatisfied (PPD)	%
	CESBA MED	D2.3	Appropriate air temperature and relative humidity in mechanically cooled occupancies	During design phase, assessment of compliance of mechanical ventilation systems with recognized design standards such as ASHRAE or CIBSE	score
	CESBA MED	D2.4	Appropriate air temperature in naturally ventilated occupancies	Predicted ability of natural ventilation systems to maintain temperatures within an acceptable range, as indicated by drawings and specifications	score
	SuPerBuildings	7.2	Thermal comfort index	PPD (Percentage of People Dissatisfied)	%
	SuPerBuildings	7.1	Thermal equilibrium index	PMV (Predicted Mean Vote)	7-point scale (-3, -2, -1, 0, 1, 2, 3) (+3 hot +2 warm +1 slightly warm 0 neutral -1 slightly cool -2 cool -3 cold)
	SuPerBuildings	7.3	Appropriate operative temperature	Operative temperature	°C
	SuPerBuildings	7.4	Appropriate air temperature	Air temperature	°C
	SuPerBuildings	7.5	Relative Humidity evaluation	Relative Humidity (RH)	%
	SuPerBuildings	7.6	Air velocity	Air velocity	m/s
	NewTREND	6.1	Summer Comfort without Cooling	Days outside comfort range	%
	NewTREND	6.2	Thermal Comfort in the Heating Season	Occupied hours outside PMV range	%
	NewTREND	6.3	Thermal Comfort in the Cooling Season	Occupied hours outside PMV range	%
	OPENHOUSE	2.3.1	Operative temperature in summer and winter	Operative temperature in summer and winter EN 15251/EN ISO 7730	°C
	OPENHOUSE	2.3.2	Thermal comfort	Radiant temperature asymmetry and floor temperature	°C
	OPENHOUSE	2.3.3	Air velocity	Draught, air velocity as per EN ISO 7730	m/s
	OPENHOUSE	2.3.4	Air humidity	Humidity in indoor air as per EN 15251	g of water per kg of dry air
	EN 16309		Thermal characteristics for health and comfort	Operative temperature	°C or K
	EN 16309		Thermal characteristics	Humidity	% or g/kg

			for health and comfort		
	EN 16309		Thermal characteristics for health and comfort	Air velocity and distribution	m/s
Resource Consumption	CESBA MED	E3.1	Consumption of non-renewable material resources for construction or renovation of buildings	Aggregate consumption of non-renewable material resources for construction or renovation of buildings	Tons/1000 m^2
	CESBA MED	E3.3	Percent of reused or recycled materials used for construction or renovation	Reused or recycled materials for construction	%
	CESBA MED	E3.5	Preservation and maintenance of existing buildings and structures	The percent of existing buildings and structures in the local area not requiring demolition, that have been preserved and maintained in full operating condition	Score
	EN 15978		Use of material	Materials for recycling	kg
Indoor Air Quality	SBTool	D1.1	Pollutant migration between occupancies.	Ensure that areas that contain equipment or activities generating chemical pollutants, are separately ventilated and isolated from other occupied spaces	Qual
	SBTool	D1.4	Volatile organic compounds concentration in indoor air.	Measures taken to screen finishing materials used in construction, and to ensure that maintenance procedures generate a minimum of VOCs.	Qual
	SBTool	D1.5	CO2 concentrations in indoor air.	Designs for HVAC systems that conform to ASHRAE, CIBSE or other acceptable protocol.	ach
	SBTool	D1.6	Effectiveness of ventilation in naturally ventilated occupancies during cooling seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	SBTool	D1.7	Effectiveness of ventilation in naturally ventilated occupancies during intermediate seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	SBTool	D1.8	Effectiveness of ventilation in naturally ventilated occupancies during heating seasons.	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site.	ach
	SBTool	D1.9	Air movement in mechanically ventilated occupancies.	Predicted air speed in m/s, as indicated by an analysis of proposed HVAC system	m/s

				characteristics or by post-occupancy monitoring.	
	SBTool	D1.10	Effectiveness of ventilation in mechanically ventilated occupancies.	Percent of ventilation air reaching work surfaces, as indicated by an analysis of proposed HVAC system and room characteristics.	Eac
	Level(s)	4.1	Indoor air quality conditions	Ventilation rate	L/s/m^2
	Level(s)	4.1	Indoor air quality conditions	CO2 concentration	ppm
	Level(s)	4.1	Indoor air quality conditions	Relative humidity	%
	Level(s)	4.1	Target pollutants indoor sources	Total VOCs	mg/m^3
	Level(s)	4.1	Target pollutants indoor sources	CMR VOCs concentration	mg/m^3
	Level(s)	4.1	Target pollutants indoor sources	R value	Decimal ratio
	Level(s)	4.1	Target pollutants indoor sources	Formaldehyde concentration	mg/m^3
	Level(s)	4.1	Target pollutants outdoor sources	Benzene	mg/m^3
	Level(s)	4.1	Target pollutants outdoor sources	Radon concentration	Bq/m^3
	Level(s)	4.1	Target pollutants outdoor sources	Particulate matter<2,5 mm	mg/m^3
	Level(s)	4.1	Target pollutants outdoor sources	Particulate matter<10 mm	mg/m^3
	SBA	3.2	Indoor Air Quality	CO2 concentration during the occupied period (by calculation or measurement or NCM)	CO_2 ppm
	SBA	3.2	Indoor Air Quality	Formaldehyde concentration	µg / m^3
	CESBA MED	D1.1	Pollutant migration between occupancies	Measures taken to isolate areas or rooms where pollutants may be generated, as indicated by drawings and specifications	score
	CESBA MED	D1.3	Formaldehyde concentration	Formaldehyde concentration in indoor air, µg/ m3	µg/ m^3
	CESBA MED	D1.4	TVOC concentration in indoor air	TVOC concentration in indoor air	µg/ m^3
	CESBA MED	D1.5	CO2 concentrations in indoor air	Designs for HVAC systems that conform to ASHRAE, CIBSE or other acceptable protocol during design phase; actual monitoring results during use phase	ppm
	CESBA MED	D1.6	Effectiveness of ventilation in naturally ventilated occupancies during cooling seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach
	CESBA MED	D1.7	Effectiveness of ventilation in naturally ventilated occupancies during intermediate seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach

	CESBA MED	D1.8	Effectiveness of ventilation in naturally ventilated occupancies during heating seasons	Air changes per hour in typical occupancy areas, predicted by modelling or measured on site	ach
	CESBA MED	D1.9	Air movement in mechanically ventilated occupancies	Predicted air speed in m/s, as indicated by an analysis of proposed HVAC system characteristics or by post-occupancy monitoring	m/s
	CESBA MED	D1.10	Ventilation rate	Ventilation rate normalized per useful floor area	l/s/m^2
	NewTREND	5.1	Indoor Air Quality	Occupied hours outside CO2 ppm range	%
	OPENHOUSE	2.4.3	CO2 concentrations above outdoor levels	CO2 concentration above outdoor level	PPM
	OPENHOUSE	2.4.5	Radon concentration	Occurrence of Radon	Bq/m^3
	EN 16309		Characteristics of indoor air quality - substances and particles	VOC e TVOC according to EN 16515	µg/m^3
	EN 16309		Characteristics of indoor air quality - substances and particles	Carbon Dioxide	µg/m (ppm)
	EN 16309		Characteristics of indoor air quality - substances and particles	Ventilation rate	l/s/m^3
	EN 16309		Characteristics of indoor air quality - substances and particles	Mould growth	°C and relative humidity (%)
	EN 16309		Characteristics of indoor air quality - substances and particles	CO concentrations	µg/m (ppm)
	EN 16309		Characteristics of indoor air quality - substances and particles	Radiation from Radon	Bq/m^3
Life-cycle cost	SBTool	G1.3	Life-cycle cost	Predicted Life Cycle Cost over a 25-year period, with calculations carried out in accordance with recognized procedures.	$/m^2
	Level(s)	6.1	Life cycle costs	All building element costs incurred at each life cycle stage of a project for the reference study period and, if defined by the client, the intended service life	€/m^2/yr
	Level(s)	6.2	Value creation and risk exposure	Measure of the positive influence of improved sustainability performance on a property financial valuation and/or a financial risk rating.	Level 1 checklist
	CESBA MED	G1.3	Life-cycle cost	Predicted Life Cycle Cost over a 25-year period, with calculations carried out in accordance with recognized procedures	€/m^2

	FASUDIR	3.1.1	Life-cycle cost	Life cycle costs as the sum of the present value of all costs in relation to the year (i) from inception to the demolition of the building	€/(m²*a)
	FASUDIR	3.1.2	Retrofitting measures Costs	Investment costs for retrofitting measures	€/(m²*a)
	NewTREND	10.1	Operational Energy Costs	Operational energy costs, aggregated annually, normalised by floor area	€/m²
	OPENHOUSE	3.1	Life-cycle cost	Building-related Life Cycle Costs (LCC)	€/(m²*a)
S.R.I.	SRI		Smart readiness indicator	SRI	%
	SRI		SRI Key Functionality	Energy saving and maintenance	%
	SRI		Smart service impact criterion	Energy savings on site	%
	SRI		Smart service impact criterion	Maintenance and fault prediction	%
	SRI		SRI Key Functionality	Comfort, ease and wellbeing	%
	SRI		Smart service impact criterion	Comfort	%
	SRI		Smart service impact criterion	Convenience	%
	SRI		Smart service impact criterion	Health and well-being	%
	SRI		Smart service impact criterion	Information to occupants	%
	CESBA MED	E3.1	Effectiveness of facility management control system	The presence of a computerized building management control system whose capability is consistent with the complexity of building systems	%
	CESBA MED	E3.2	Capability for partial operation of facility technical systems	The predicted ability of building systems to provide partial heating, ventilation, cooling or lighting services, according to design documentation	score
	CESBA MED	E3.3	Degree of local control of lighting systems	The area of typical lighting control zones in perimeter areas in m2, as shown in design documentation	m²
	CESBA MED	E3.4	Degree of personal control of technical systems by occupants	The degree of control over key indoor environment systems that can be exercised by occupants, according to design documentation	score
	CESBA MED	E3.1	Effectiveness of facility	The presence of a computerized building management control system	%

			management control system	whose capability is consistent with the complexity of building systems	
Climate Change adaptation and Resilience	CESBA MED	E1.2	Risk to occupants and facilities from fire	Risk level for occupants in the most vulnerable part of the building	score
	CESBA MED	E1.3	Risk to occupants and facilities from flooding	Probability of injury or death or major property damage in case of 100-year flood event or other foreseeable flood risk	score
	CESBA MED	E1.4	Risk to occupants and facilities from earthquake	Probability of injury or death or major property damage in case of earthquake event foreseeable within a 100-year time frame	score
	CESBA MED	E1.5	Risk to occupants from incidents involving biological or chemical substances - to be developed	Probability of injury or death in case of an accidental or wilful biological or chemical release in or near the building	score
	Level(s)	5.1	Protection of occupier health and thermal comfort	Proportion of the year when building occupiers are comfortable with the summer thermal conditions inside a building	Projected % time out of range in the years 2030 and 2050
	Level(s)	5.2	Increased risk of extreme weather events	Study of the increased risk of extreme weather events in the conceptual design of the building	Level 1 checklist
	Level(s)	5.3	Increased risk of flood events	Quantities of stormwater that will fall on the plot area, where it will be directed, how quickly it will leave the drainage system and reach the natural watercourse and what exactly are the different components of the drainage system	Level 1 checklist

4.2 Optimisation and prioritisation of the indicators list

Starting from the list of the indicators broken down according to the thematic areas identified of the previous paragraph, next activities carried out have focused on an **optimisation work of the indicators list and a subsequent prioritisation of the indicators themselves**.

Concerning the optimisation work undertaken, the main activity has been the deletion of the doubled indicators; it happened because the final set of indicators produced by some European Projects arise from the capitalisation of previous projects results or from international set of indicators, as for example the SBTool. So, duplication have been removed from the list.

Concerning **the prioritisation activity, it affected the identification of the relevant indicators through an approach based on the rank of importance**.

In order of precedence, the following priority elements have been considered for the selection:

1- The belonging of the indicator to a common European language for assessing and reporting on the sustainability performance of buildings (Level(s));
2- The presence of the indicator in a Standard (ISO, EN);
3- The compliance of the indicator with a European Commission request (the EPBD recast);
4- The relevance of the indicator in relation to the next generation of EPCs even if it comes from an assessment system accredited but not part of a standardisation process (concerning indicators coming from EU Project, the most recent have been considered).

Thanks to this objective selection, a reduced list of fundamental indicators for the next generation of EPCs has been obtained. Indicators belonging to this list are relevant according to the objectives established by the European Commission in relation to the next generation of EPCs, coherent with the sustainability strategies defined for buildings and therefore and aligned with stakeholders needs and market requests.

Based on **the simultaneous compliance with all these elements, indicators selected have the prerogatives to become the KPIs to be used in the EUB SuperHub Passport** for the next generation of EPCs.

4.3 List of Potential KPIs

Below the prioritized list of the indicators for the next generation of EPCs, which are considered potential KPIs.

	Criterion	Indicator	Unit of Measure	Reference
Energy Consumption	**1-Use stage energy performance**	Primary energy demand per useful internal floor area	kWh/m²/yr kWh	1.1 Level(s)
	2-Use stage energy performance	Delivered final energy demand	kWh/m²/yr kWh	1.1 Level(s)
	3-Use stage energy performance	Non-renewable primary energy demand	kWh/m²/yr	1.1 Level(s)
	4-Embodied non-renewable primary energy	Total use of non-renewable primary energy resources energy resources used as raw materials (PENRT)	MJ	EN 15978
	5-Electrical peak demand for building operations	Average of peak monthly electrical demand for one year	W/m²	B2.1 SBTool
Renewable Energy	**6-Use stage energy performance**	Renewable primary energy demand	kWh/m²/yr	1.1 Level(s)
	7-Energy from renewable sources in total primary energy consumption	Primary energy demand of the building that is met by renewable sources on total primary energy demand	%	B1.4 CESBA MED

	8-Embodied renewable primary energy	Total use of renewable primary energy resources (PERT)	MJ	B1.6 CESBA MED
Greenhouse Gas Emissions (in use stage)	**9-Total GHG Emissions from primary energy used in building operations**	CO2 equivalent emissions per useful internal floor area per year	kg CO_2 eq./m2/yr	D1.2 CESBA MED
Life-cycle Global Warming Potential	**10-GHG emissions from energy embodied in construction materials**	CO2-equivalent emissions per Kg. per m2 of gross area	GJ/m^2	C1.1 CESBA MED
	11-Life cycle Global Warming Potential	Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area	kg CO_2 eq/m^2/yr	1.2 Level(s)
Thermal comfort	**12-Time outside of thermal comfort range**	The proportion of the year when building occupiers are comfortable with the thermal conditions inside a building	% of time out of range during the heating and cooling seasons	4.2 Level(s)
	13-Thermal comfort index	Predicted Percentage Dissatisfied (PPD)	%	D2.2 CESBA MED
Indoor Air Quality	**14-Indoor air quality conditions**	Ventilation rate	L/s/m^2	4.1 Level(s)
	15-Indoor air quality conditions	CO2 concentration	ppm	4.1 Level(s)
	16-Indoor air quality conditions	Relative humidity	%	4.1 Level(s)
	17-Target pollutants indoor sources	Total VOCs	mg/m^3	4.1 Level(s)
	18-Target pollutants indoor sources	CMR VOCs concentration	mg/m^3	4.1 Level(s)
	19-Target pollutants indoor sources	R value	Decimal ratio	4.1 Level(s)
	20-Target pollutants indoor sources	Formaldehyde concentration	mg/m^3	4.1 Level(s)

	21-Target pollutants outdoor sources	Benzene	mg/m³	4.1 Level(s)
	22-Target pollutants outdoor sources	Radon concentration	Bq/m³	4.1 Level(s)
	23-Target pollutants outdoor sources	Particulate matter<2,5 mm	mg/m³	4.1 Level(s)
	24-Target pollutants outdoor sources	Particulate matter<10 mm	mg/m³	4.1 Level(s)
Life-cycle cost	**25-Life cycle costs**	All building element costs incurred at each life cycle stage of a project for the reference study period and, if defined by the client, the intended service life	€/m²/yr	6.1 Level(s)
	26-Operational Energy Costs	Operational energy costs, aggregated annually, normalised by floor area	€/m²	10.1 NewTREND
Smart Readiness Indicators	**27-Smart readiness indicator**	SRI	%	SRI
	28-SRI Key Functionality	Energy saving and maintenance	%	SRI
	29-SRI Key Functionality	Comfort, ease and wellbeing	%	SRI
	30-SRI Key Functionality	Grid flexibility	%	SRI
Climate Change and Resilience	**31-Protection of occupier health and thermal comfort**	Proportion of the year when building occupiers are comfortable with the summer thermal conditions inside a building	Projected % time out of range in the years 2030 and 2050	5.1 Level(s)

5 Characterisation of potential KPIs

With the aim of further characterising and detailing the potential KPIs selected, **a qualitative analysis has been carried out** by iiSBE. The objective of this characterisation is **obtaining an affordability rating for each of the indicators selected**; this final score allows us to classify them depending on their characteristics, areas of application, availability of data, cost and other parameters extensively described in the following paragraph.

Therefore, the taxonomy classification of the potential KPIs produced goes hand in hand with the qualitative analysis elaborated in the final step of Task 1.2; they both constitute the reference document for the start of Task 2.2

5.1 Qualitative analysis to define indicator's affordability rating

The qualitative analysis carried out in the final part of Task 1.2 wants to guarantee **the maximum reliability of the indicators selected**, enriching them with key information, so that they may unquestionably become KPIs.

This qualitative analysis has been carried out with the aim to define an affordability rating for each indicator and it focused on five key aspects, which represent **five crucial aspects to be considered for the reliability and robustness of an indicator**. To each of these aspects a score, ranging from 1 to 3, has been awarded with the purpose to get a final affordability rating for all the indicators selected.

The five aspects considered for the taxonomy production of the indicators are the following:

- **Data availability**: considers the easy of data retrieval and its availability to be used as it is to perform the calculation.
  (*score: 1 very difficult - 2 easy - 3 extremely easy*)
- **Complexity of the calculation or measurement**: considers the difficulty to perform the calculation necessary to get the result of the indicator.
  (*score: 1 very complicated - 2 easy - 3 extremely easy*)
- **Level of competence required for the assessor**: considers the level of knowledge and skill of the assessor, necessary to proper perform the calculation of the indicator.
  (*score: 1 high specialisation - 2 quite specialised - 3 basic*)
- **Time to perform the calculation**: considers the effort of the process of working, in terms of time, necessary to get the indicator result.
  (*score: 1 high - 2 medium - 3 low*)
- **Cost of the evaluation**: considers the real economic cost to be taken into account to get the result of the indicator. In this regard it's important to consider if any specific instrument, software, specific calculators are necessary to perform the calculation of the indicator.
  (*score: 1 high - 2 medium - 3 low*)

Below the table containing all the indicators selected as potential KPIs, on which the qualitative analysis has been performed.

Indicator	Data Availability	Complexity of the calculation	Competence required for the assessor	Time to perform the calculation	Cost of the evaluation	TOT AF
1-Primary energy demand per useful internal floor area	3	1	2	1	2	**9**
2-Delivered final energy demand	3	1	2	1	2	**9**
3-Non-renewable primary energy demand	3	1	2	1	2	**9**
4-Total use of non-renewable primary energy resources energy resources used as raw materials (PENRT)	1	1	1	1	1	**5**
5-Average of peak monthly electrical demand for one year	3	2	2	2	2	**11**
6-Renewable primary energy demand	3	1	2	1	2	**9**
7-Primary energy demand of the building that is met by renewable sources on total primary energy demand	3	1	2	1	2	**9**
8-Total use of renewable primary energy resources	3	1	2	1	2	**9**
9-Renewable primary energy demand	3	1	2	1	2	**9**
10-CO2 equivalent emissions per useful internal floor area per year	3	1	2	1	2	**9**
11-Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area	1	1	1	1	1	**5**
12-The proportion of the year when building occupiers are not comfortable with the thermal conditions inside a building.	2	1	2	1	2	**8**
13-Predicted Percentage Dissatisfied (PPD)	2	2	2	2	3	**11**
14-Ventilation rate	3	2	2	2	2	**11**
15-CO2 concentration	3	3	2	3	2	**13**
16-Relative humidity	3	3	2	3	2	**13**
17-Total VOCs	2	3	2	3	2	**12**
18-CMR VOCs concentration	2	3	2	3	2	**12**

19-R value	2	3	2	2	2	**11**
20-Formaldehyde concentration	3	3	2	3	2	**13**
21-Benzene	2	3	2	3	2	**12**
22-Radon concentration	3	3	2	3	2	**13**
23-Particulate matter<2,5 mm	3	3	2	3	2	**13**
24-Particulate matter<10 mm	3	3	2	3	2	**13**
25-All building element costs incurred at each life cycle stage of a project for the reference study period and, if defined by the client, the intended service life	1	1	1	1	1	**5**
26-Operational energy costs, aggregated annually, normalised by floor area	3	2	2	2	2	**11**
27-SRI	2	2	2	1	2	**9**
28-SRI: Energy saving and maintenance	2	2	2	1	2	**9**
29-SRI: Comfort, ease and wellbeing	2	2	2	1	2	**9**
30-SRI: Grid flexibility	2	2	2	1	2	**9**
31-Proportion of the year when building occupiers are comfortable with the summer thermal conditions inside a building	2	1	2	1	2	**8**

The affordability rating (AF), obtained by each of the potential KPIs selected, **outlines its reliability and robustness achieved through the five-parameter considered.** The total AF comes from the sum of the individual items, **the higher the score reached, the higher the usefulness of the indicator**.

Of course, it's important not only to have an overall view of the final affordability rating obtained but **evaluate also result item by item**. This approach could ensure greater transparency about the individual items which generated the final score result.

5.2 Potential KPIs and EPBD recast by side

The final review done in Task 1.2, with the aim of verifying the consistency of the list of potential KPIs elaborated, it has been a **direct comparison among the proposal contained in the EPBD recast** released by the European Commission in December 2021 **and the aspect covered by the potential KPIs** selected by EUB SuperHub.

The analysis carried out on the EPBD recast has highlighted several needs, raised by the EC, aimed at improving the quality of the EPCs for the next generation.

EPBD proposals, contained in Annex V of the document[8], are listed in the first column of the table below and directly linked with the EUB potential KPIs, which may comply with these requests.

EPBD recast – ANNEX V	**EUB potential KPIs**
On its front page, the energy performance certificate shall display at least the following elements:	
(a) the energy performance class	Indirectly covered by 1- Primary energy demand per useful internal floor area
(b) the calculated annual primary energy use in kWh/ (m^2 year)	1- Primary energy demand per useful internal floor area
(c) the calculated annual primary energy consumption in kWh or MWh	1- Primary energy demand per useful internal floor area
(d) the calculated annual final energy use in kWh/ (m^2 year)	2- Delivered final energy demand
(e) the calculated annual final energy consumption in kWh or MWh	2- Delivered final energy demand
(f) renewable energy production in kWh or MWh	Indirectly covered by 7- Primary energy demand of the building that is met by renewable sources on total primary energy demand
(g) renewable energy in % of energy use	7- Primary energy demand of the building that is met by renewable sources on total primary energy demand
(h) operational greenhouse gas emissions (kg CO_2/ (m^2 year))	9- CO_2 equivalent emissions per useful internal floor area per year
(i) the greenhouse gas emission class (if applicable)	Indirectly covered by 9- CO_2 equivalent emissions per useful internal floor area per year
In addition, the energy performance certificate may include the following indicators:	
(a) energy use, peak load, size of generator or system, main energy carrier and main type of element for each of the uses: heating, cooling, domestic hot water, ventilation and in-built lighting	Partially covered by 5- Average of peak monthly electrical demand for one year
(b) renewable energy produced on site, main energy carrier and type of renewable energy source	7- Primary energy demand of the building that is met by

[8] https://ec.europa.eu/energy/sites/default/files/proposal-recast-energy-performance-buildings-directive.pdf

	renewable sources on total primary energy demand
(c) a yes/no indication whether a calculation of the Global Warming Potential has been carried out for the building	11 - Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area
(d) the value of the life-cycle Global Warming Potential (if available)	11 - Greenhouse gases emitted from the production of building materials to the end of the building's useful life and the subsequent demolition and recovery of the building materials per useful internal floor area
(e) information on carbon removals associated to the temporary storage of carbon in or on buildings	Aspect not covered
(e) a yes/no indication whether a renovation passport is available for the building	Aspect not covered
(f) the average U-value for the opaque elements of the building envelope	Indirectly covered 1- Primary energy demand per useful internal floor area
(g) the average U-value for the transparent elements of the building envelope	1- Primary energy demand per useful internal floor area
(h) type of most common transparent element (e.g. double glazed window)	1- Primary energy demand per useful internal floor area
(i) results of the analysis on overheating risk (if available)	12- The proportion of the year when building occupiers are comfortable with the thermal conditions inside a building.
(j) the presence of fixed sensors that monitor the levels of indoor air quality	29- Comfort, ease and wellbeing
(k) the presence of fixed controls that respond to the levels of indoor air quality	29- Comfort, ease and wellbeing
(l) number and type of charging points for electric vehicles	Aspect not covered
(m) presence, type and size of energy storage systems	Aspect not covered
(n) feasibility of adapting the heating system to operate at more efficient temperature settings	Aspect not covered
(o) feasibility of adapting the air-conditioning system to operate at more efficient temperature settings	Aspect not covered
p) metered energy consumption	28- Energy saving and maintenance

q) operational fine particulate matter (PM2.5) emissions	23-Particulate matter<2,5 mm
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 a smart readiness assessment has been carried out for the building	27- SRI
(b) the value of the smart readiness assessment (if available)	27- SRI
(c) a yes/no indication whether a Digital Building Logbook is available for the building	Aspect not covered
Persons with disabilities shall have equal access to the information in energy performance certificates	Aspect not covered

As it is possible to note from the document above, **some of the requests contained in the EPBD proposal haven't found a direct correspondence with the potential KPIs selected**. Aspects not covered by the list of potential KPIs are highlighted in the document.

The reason why of these absences lies in the fact **that Task 1.2 was based mainly on a recognition activity of the existing indicators** in the transnational panorama to date and, some of the elements mentioned by the EPBD recast have not yet been investigated by these assessment systems.

Therefore, it will be necessary making an accurate survey about them in Task 2.2, which focuses precisely on KPIs selection for the next generation of EPCs. Task 2.2 will capitalise Task 1.2 results, improving the completeness of the KPIs.

6 Conclusion

In conclusion of Task 1.2 activities, it's important to stress the fact that no reconnaissance activity on the existing panorama of the next generation of EPCs, has been neglected. Many consultation activities with the key stakeholders operating in the field of the energy performance (market players, professionals, public administration employees, energy certifiers, etc.) have been carried out, capitalising their knowledge and their suggestions.

Activities of Task 1.2 have been performed synergistically and complementarily with Task 1.3, moving towards the common objective of defining an exhaustive and robust list of potential KPIs to be delivered to Task 2.2 for the continuation of the activity. Methodologies adopted in Task 1.2 have made it possible **to come to a final list of potential KPIs for the EUB Passport for the next generation of EPCs**, which is:

- **Coherent** with European Commission directives and proposals
- **Representative** of the market needs
- **Exhaustive** in relation to the stakeholders demands
- **Effective** compared to the strategies for reducing energy consumption.

Nevertheless, it's important to underline that Task 1.2 activity was mainly based on a recognition effort of the existing sets of indicators in the transnational panorama to date. In this respect, the comparison among the EPBD recast proposal of the EC and the list of the potential KPIs selected, has highlighted some "not covered" aspects, relevant in the next generation of EPCs.

Therefore, as mentioned in the previous paragraph, it will be necessary making an accurate survey about them in Task 2.2, capitalising Task 1.2 results and improving the completeness of the KPIs.

Aspects requiring a further investigation in Task 2.2, because considered relevant for the next generation of EPCs but not represented by an indicator in the list of potential KPIs, are the following:

- The electrical mobility and the charging points for electric vehicles
- The access for persons with disabilities to the information in energy performance certificates
- The daylighting sufficiency.

To conclude, Task 1.2 bequeathed to Task 2.2:

- The **taxonomy of potential KPIs** for the EUB Passport for the next generation of EPCs
- A **qualitative analysis delivering an affordability rating for each indicator**, focusing on five crucial aspects to be considered for the reliability and robustness of the metrics
- A direct **comparison among the proposal contained in the EPBD recast** released by the European Commission and the aspect covered by **the potential KPIs** selected by EUB SuperHub.

These elements all together, which have been elaborated in Task 1.2, represent the robust starting point for Task 2.2.