



2024 WINTER CONFERENCE
AND AHR EXPO

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**SMNR 31 - Zero Emission Buildings (ZEB), Rolling out the Revised
Energy Performance Buildings Directive (EPBD) in Europe**

Building Live Cycle Global Warming Potential: New Indicator Required By the Revised EPBD

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Mandate: 2022-2025

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Learning Objectives

- Describe the main indicator used in Europe to assess the Building Global Warming Potential
- Explain the main indicators used in Europe to measure energy performance of buildings
- Compare and contrast the outcomes of three common primary energy indicator calculation approach
- Explain the meaning of on-site renewable energy generation and ambient heat in the primary energy calculation
- Explain the basic requirements for zero emission buildings

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State of play of the Energy Performance Building Directive (EPBD)

- Commission proposal 15 December 2021
- Council General Approach 25 October 2022
- European Parliament plenary vote on 14 March 2023
- Trialogues ended December 7th and the compromise final text (Dec. 15th) is now publicly available.
- To be voted by Council and Parliament



**EUROPEAN
PARLIAMENT PASSES
EPBD RECAST WITH
HISTORIC EMBODIED
CARBON TEXT**

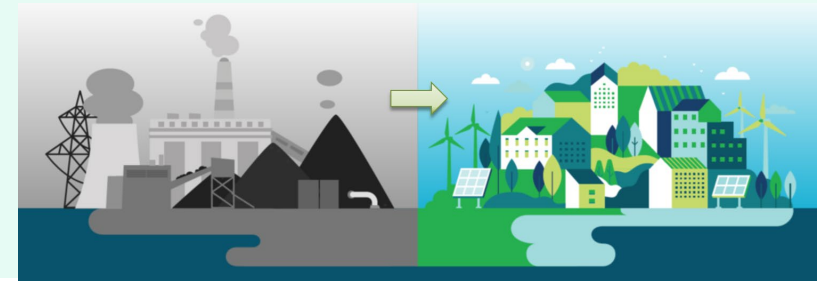
Objectives of the EPBD revision

Twofold objective

➔ Contribute to reducing buildings' GHG emissions and final energy consumption by 2030

➔ Provide a long-term vision for buildings and ensure an adequate contribution to achieving climate neutrality in 2050

➔ **EU Buildings decarbonization**

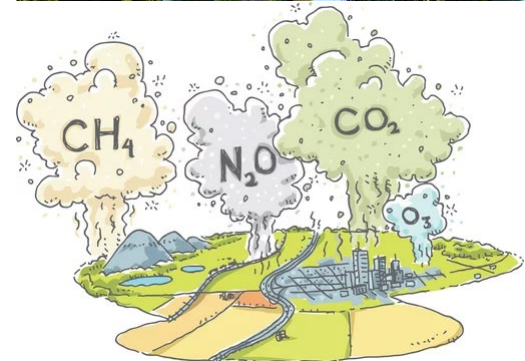


EPBD and ZEB

EPBD -Zero Emission Building

Article 2 “Definitions” – points 3

- **zero-emission building (ZEB):**
means a building with a very high energy performance,, **requiring zero or a very low amount of energy**, **producing zero on-site carbon emissions from fossil fuels** and **producing zero or a very low amount of operational greenhouse gas emissions** in accordance with the requirements set out in Article 9b.



Life-cycle Global Warming Potential of buildings

Article 2 “Definitions” – points 24 and 23

24. ‘Life-cycle Global Warming Potential (GWP)’ means an indicator which quantifies the global warming potential contributions of a building **along its full life-cycle**.
23. ‘whole life-cycle greenhouse gas emissions’ means greenhouse gas emissions that occur over the whole life cycle of the buildings, **including production of construction products, their transport, construction site activities, use of energy in the building and replacement of construction products, as well as demolition, transport and management of waste materials and their reuse, recycling and final disposal**;

GHG emissions and Global Warming Potential (GWP)

GHG emissions are measured in **CO₂ equivalent mass** determined by the **global warming potential (GWP)** of each greenhouse gas.

$$\text{CO}_{2\text{-e}} = \text{GWP} \cdot \text{greenhouse gas mass} \quad [\text{Gt}]$$

GWP is a dimensionless index that express the ratio between the infrared absorption capacity of a specific gas and CO₂ capacity.

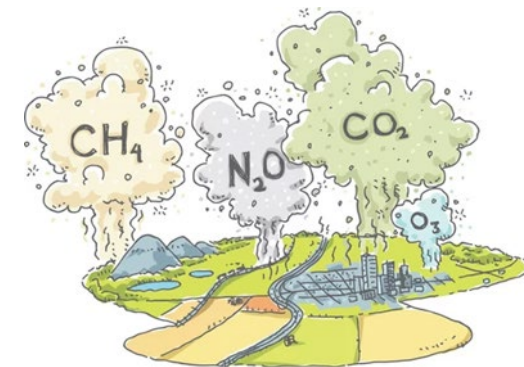
GWP depends on:

- the absorption of infrared radiation by a given gas
- the time horizon of interest (integration period: 20, 100, 500 years)
- the atmospheric lifetime of the gas

Examples:

Methane CO_{2-e} over 100 year → $\text{GWP}_{\text{CH}_4;100} = 27.9$ → $27.9 \text{ kg}_{\text{CO}_2\text{-e}} / \text{kg}_{\text{CH}_4;100}$

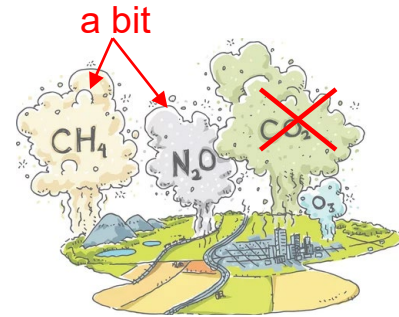
Nitrous oxide CO_{2-e} over 100 year → $\text{GWP}_{\text{N}_2\text{O};100} = 273$ → $273 \text{ kg}_{\text{CO}_2\text{-e}} / \text{kg}_{\text{N}_2\text{O};100}$



Zero Emission Building: Article 9b

1. A zero-emission building shall not cause any on-site carbon emissions from fossil fuels.

$$CO_{2;on\ site;fossil\ fuel} \equiv 0 \neq GWP_{op;on\ site} \geq 0$$



A zero-emission building shall offer the capacity to **react to external signals and adapt its energy use, generation or storage**, where economically and technically feasible.

➔ weather adaptive building



Zero Emission Building: Article 9b

5. Member States shall take the necessary measures to ensure that **the operational greenhouse gas emissions of zero-emission building comply with a maximum threshold established at the Member State level** in their building renovation plans. This maximum threshold may be set at different levels for new and renovated buildings. Member States shall notify the Commission about their maximum thresholds , including a description of the calculation methodology per building type and applied climate, in accordance with Annex I. The Commission shall review the maximum thresholds and recommend their adaptation where appropriate.

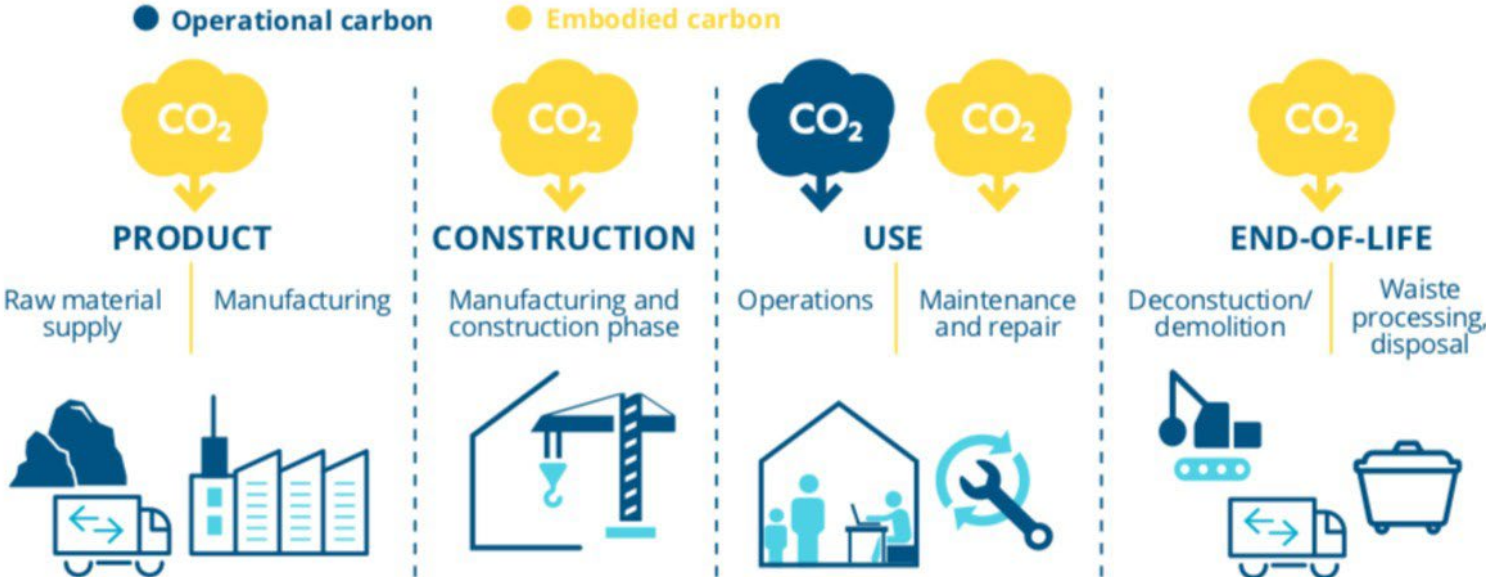
The chosen indicator is GWP

$$GWP_{operational} \leq GWP_{op;max}$$

Carbon Footprint Assessment

Energy conversion processes

Anthropomorphic carbon dioxide, CO₂, is mainly produced by **combustion processes** of carbon-based fuels, which are present in all building's life phases.



Carbon Footprint Assessment

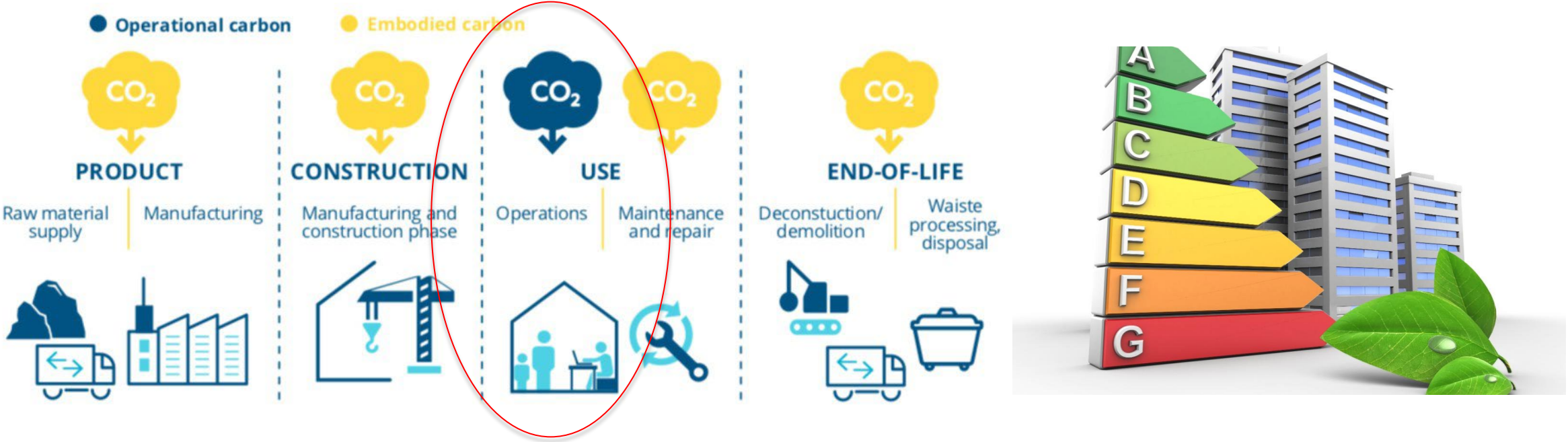
Building materials' embodied carbon is impossible to ascertain from the finished product alone and requires self-assessment and process transparency on the part of the manufacturer. ➔ **Environmental Product Declaration (EPD)**



Carbon Footprint Assessment

Building operation carbon is usually the most important emission over the lifetime

→ it depends on the Energy Performance of the Building (EPB)



EPBD and GWP

Main provisions on new buildings

The life cycle Global Warming Potential (GWP) of new buildings

- **Art. 7**

Member States shall ensure that the **life-cycle** Global Warming Potential (GWP) is calculated in accordance with Annex III and **disclosed through the energy performance certificate of the building:**

- a) as of 1 *January 2028*, for all new buildings with a useful floor area over *1000* square meters; and
- b) as of 1 *January 2030*, for all new buildings.



Just as an information, not any compliance with minimum requirements

Building Life Cycle

- **Product phase:**

obtaining and transporting raw materials to factories for manufacturing, including the manufacturing process.

- **Construction phase:**

all construction products transported or distributed and end up at the building site; all installation and other on-site work is then undertaken

- **Use phase:**

other than energy and water use for its occupants, daily life maintenance, repair, replacement and refurbishment involve periodic site activities and the replacement of components

- **End-of-life phase:**

on-site activities to demolish the building, collect/process all waste and transport it to where it will be sorted, incinerated or disposed of in a land-fill.

- **Beyond building life:**

off-site activities to potentially reuse, recycle or recover any sorted material that can avoid the use of new material in other buildings construction.



Main provisions on new buildings

The life cycle Global Warming Potential (GWP) of new buildings

... but

- By **31 December 2025** the Commission shall adopt a delegated act in accordance with Article 29 to supplement this Directive by setting out **an EU framework for the national calculation methodology** of life-cycle GWP, in accordance with Annex III.
- By **1 January 2027** Member States shall publish a roadmap detailing the **introduction of limit values on the total cumulative life-cycle GWP** of all new buildings and **set targets for new buildings from 2030**, considering a progressive downward trend, as well as maximum limit values, detailed for different climatic zones and building typologies

EPBD recast Requirements - Annex III

Calculation of life-cycle global warming potential (GWP) of new buildings pursuant to Article 7(2)

1. For the calculation of the **life-cycle global warming potential** (GWP) of new buildings pursuant to Article 7(2), the *total* GWP is communicated as a **numeric indicator for each life-cycle stage** expressed as $\text{kg}_{\text{CO}_2\text{e}}/\text{m}^2$ (of useful floor area) averaged for one year of a reference study period of 50 years.

$$GWP_{lifeCycle} = GWP_{construction} + GWP_{use} + GWP_{end-of-life}$$

Note: in CEN framework $GWP_{construction}$ includes also the production phase through EDPs

EPBD recast Requirements - Annex III

Calculation of life-cycle global warming potential (GWP) of new buildings pursuant to Article 7(2)

2. The data selection, scenario definition and calculations shall be carried out in accordance with **EN 15978** (EN 15978:2011) - *Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method*) and taking into account any subsequent standard relating to the sustainability of construction works and the calculation method for the assessment of environmental performance of buildings.

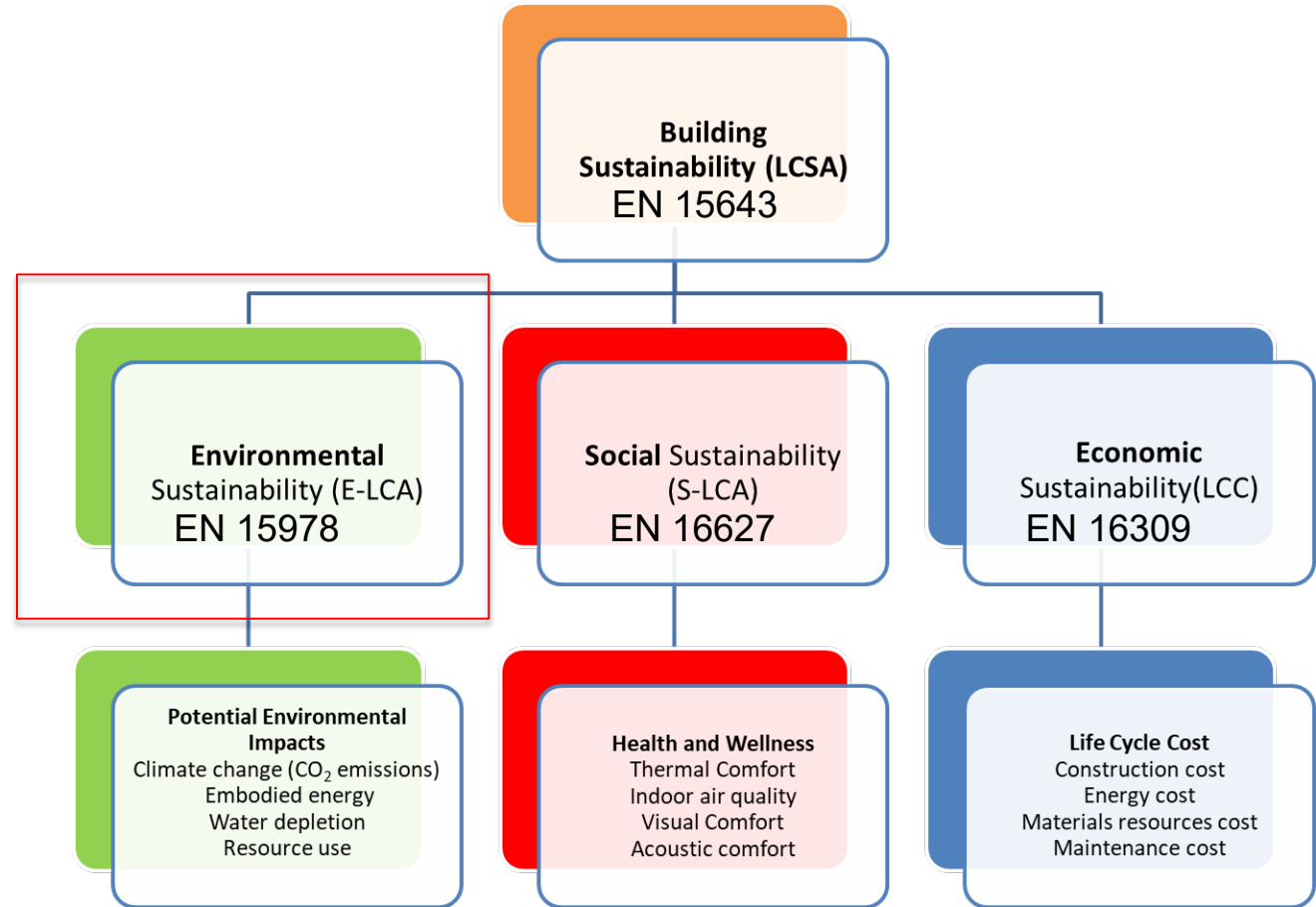


calculation methods

Buildings Sustainability Assessment: ISO/CEN Approach → Life Cycle Sustainability Assessment (LCSA)

Hierarchical scale of building sustainability with possible impact indicators, all based on Building Life Cycle.

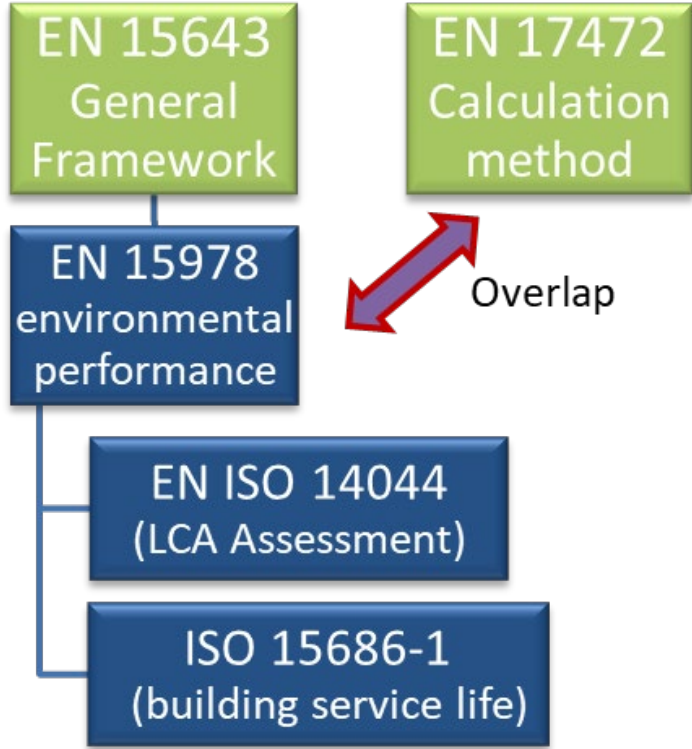
In this scheme, social sustainability has been limited to user-perceived quality, which is measured in terms of the internal comfort perceived by occupants:
i.e. IEQ .



Specific Assessment Procedures for Environmental Performance Assessment

EN 15643:2021 reports the methodology for the assessment of **environmental performance** of building:

- based on the general principles contained within **ISO 15392** (*ISO equivalent of EN 15643*)
- and on the Life Cycle Assessment, in accordance with the guidelines and requirements of **EN ISO 14044**,
- shall be in accordance with **EN 15978**, E-LCA calculation method
- based on the standardized building service life, as define in ISO 15686-1
- and shall be in accordance with **EN 17472:2022** for civil engineering works

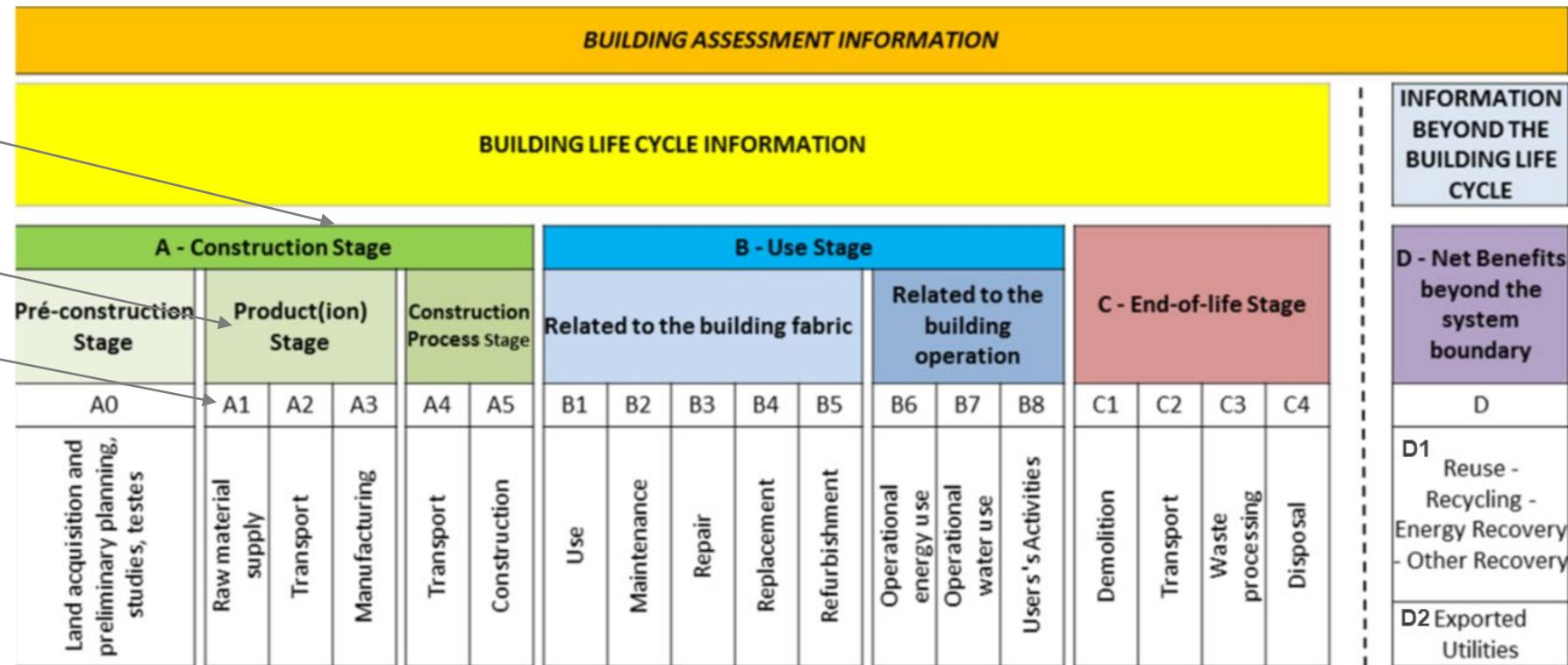


Life cycle stages

Modular approach for collecting information over the building life cycle, which is split in:

- Stages (A,B,C,D)
- sub-stages, and
- Modules (Ax, Bx ..)

EN 15643 Data Report sheet incorporates production and construction phases into the **construction stage**.



The information needed for the building assessment is not limited to those linked to the building life cycle. The net benefits (benefits and loads) resulting from reuse, recycling, energy recovery and other recovery operations of materials and substances (e.g. backfilling) and from exported utilities beyond the system boundary are assessed and reported in Module D

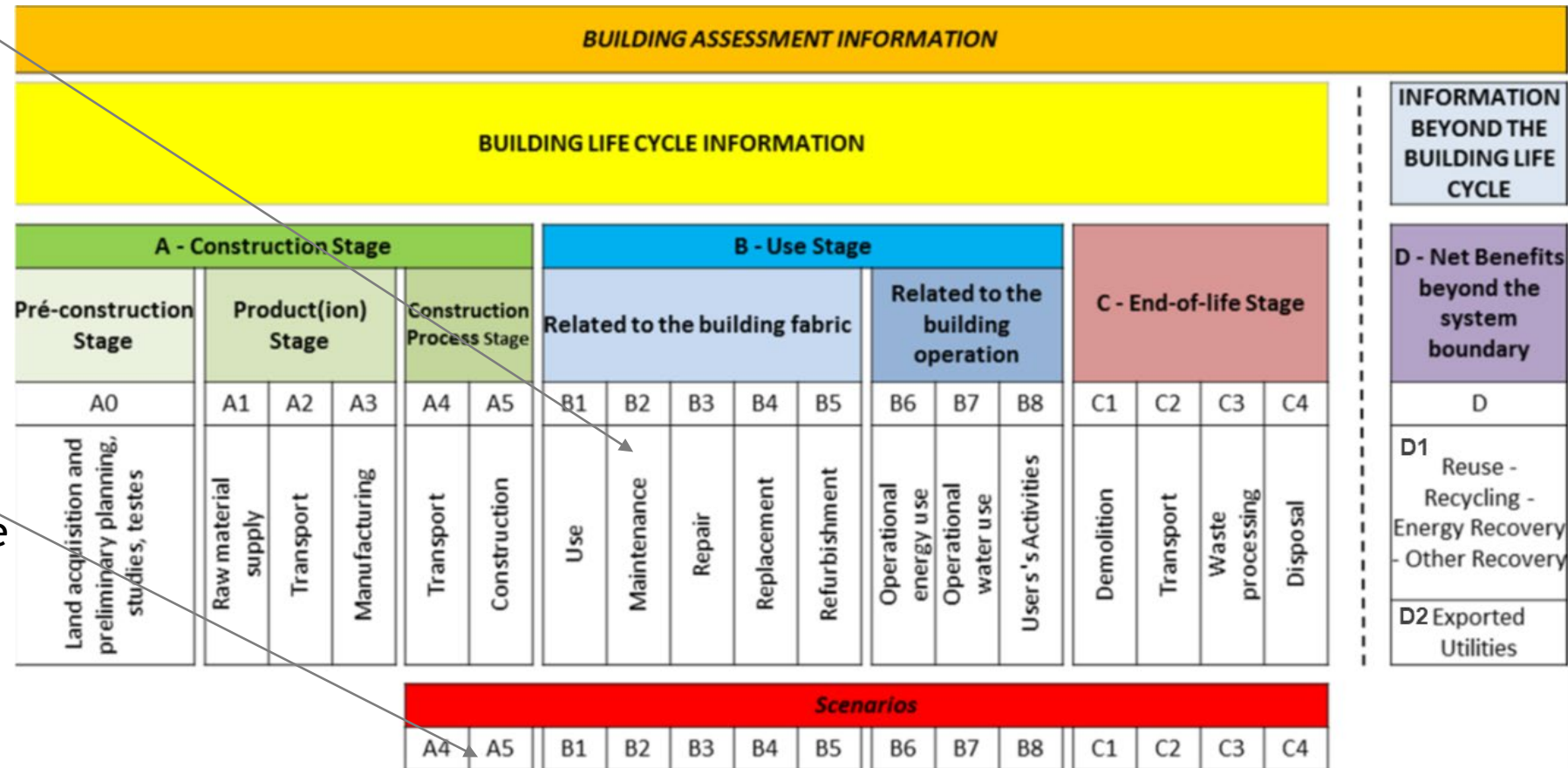
Life cycle stages

- Aspects and impacts

B1 to B5 represent the aspects and impacts that arise as a consequence of the construction works being in place

- Scenarios

Scenarios are a set of possible futures for the building life cycle that are evaluated on the basis of different criteria



EPBD recast Requirements - Annex III

Calculation of life-cycle global warming potential (GWP) of new buildings pursuant to Article 7(2)

- The scope of building elements and technical equipment is as defined [in the Level\(s\) common EU framework for indicator 1.2](#). Where a national calculation tool *or method* exists, or is required for making disclosures or for obtaining building permits, that tool *or method* may be used to provide the required disclosure. Other calculation tools or methods may be **used if they fulfil the minimum criteria laid down by the Level(s) common EU framework**. Data regarding specific construction products calculated in accordance with [revised Construction Products Regulation] shall be used when available.

The Level(s) common framework



- Level(s) is the EU initiative that joins up sustainable building thinking across the EU by offering guidance on the key areas of sustainability in the built environment and how to measure them during design and after completion.
- Level(s) framework aims to get European citizens talking the same language so they can share best practices and learn from each other using the same metrics.
- Level(s) framework is based on CEN-ISO framework and standards to achieve a consistent building sustainable assessment (BSA).

The Level(s) common framework



Environmental
Category:
emissions to air

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



Macro-objective 4:
**healthy and
comfortable
spaces**



Social
Category:
health and
comfort

Environmental
Category:
materials use

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



Macro-objective 5:
**Adaptation and
resilience to
climate change**



Environmental
Category:
resilience including
adaptation to
climate change

Environmental
Category:
water use

Macro-objective 3:
**Efficient use of
water resources**



Macro-objective 6:
**Optimised life
cycle cost and
value**



Economical
Category:
life cycle costs

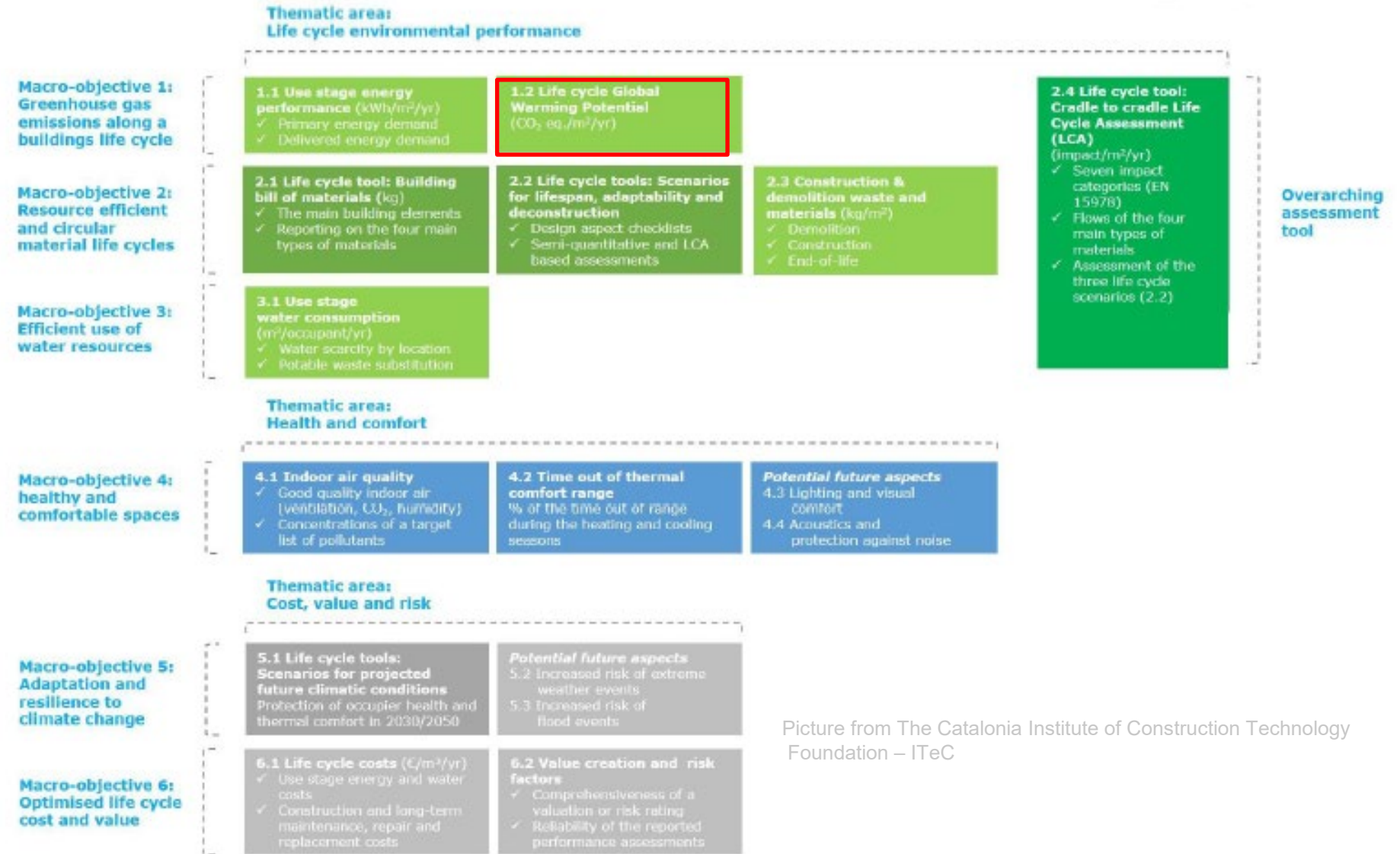
The Level(s) common framework

- Full framework

aspects

impacts

indicators

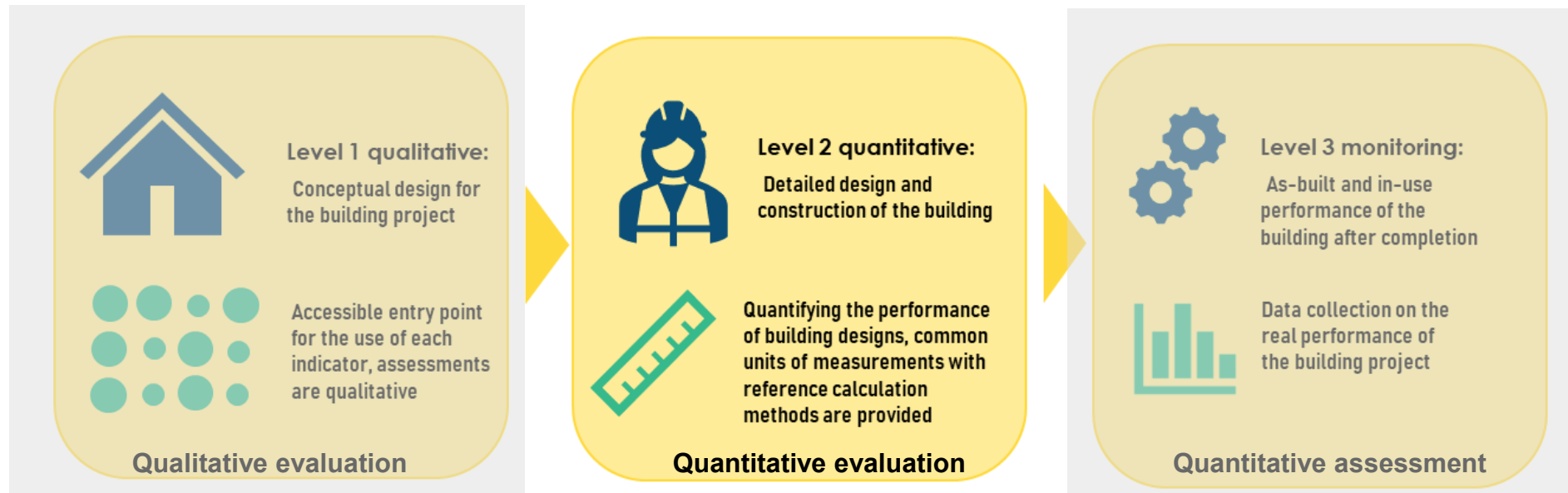


Picture from The Catalonia Institute of Construction Technology Foundation – ITeC

The Level(s) common framework: levels

- EPBD Requirement → Level 2 (new buildings)

Level(s) structure

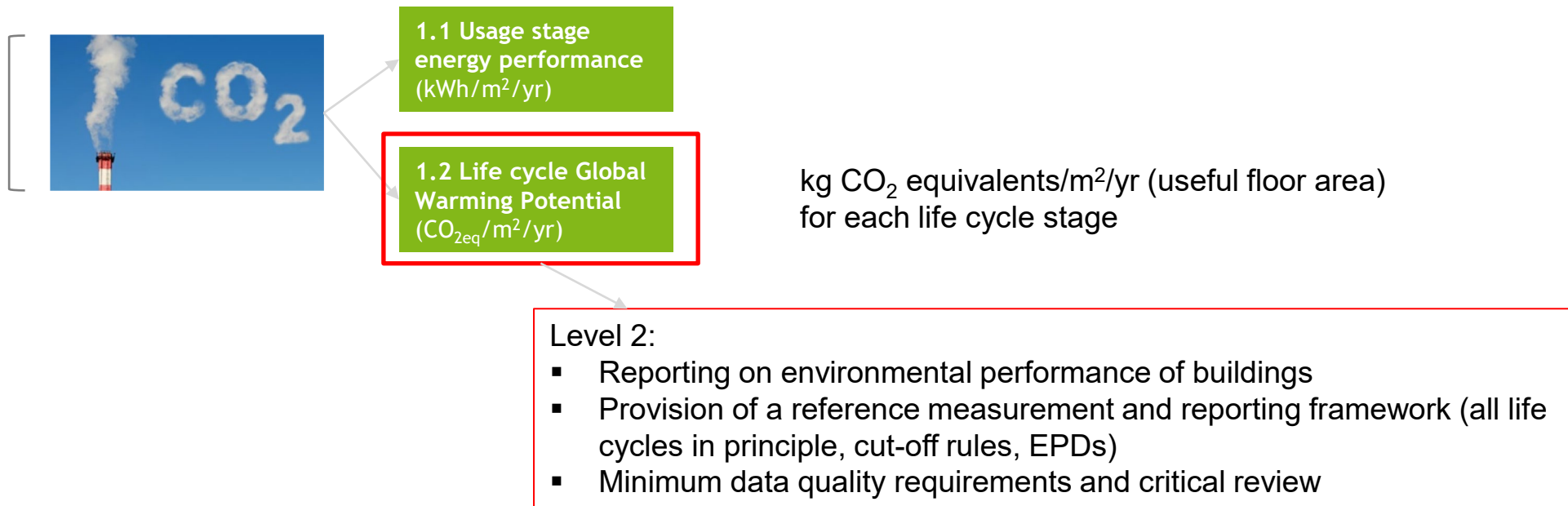


Journey from initial concept design, construction and the reality of the completed building

Picture from Irish Green Building Council

The Level(s) common framework: GWP

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



LCA focused on GWP characterization:

- Reference to functional equivalency of buildings (what, how much/long/well)
- Boundary: Evolution of the building from cradle to cradle

Level(s) common EU framework for indicator 1.2

→ Fixed by EPBD recast

The general calculation rules for carrying out the performance assessment for indicator 1.2 are set out in Table 1.2.1 and cover the following aspects of calculating life cycle Global Warming Potential (GWP):

- Objective(s) → Greenhouse gas emission → Indicator: 1.2 Life cycle Global Warming Potential
- Cut-off rules for the system boundary definition → New building over the whole life cycle
- Energy consumption modelling → According to EPBD recast rules
- Scenarios and End of Life → New building and reference study period 50 years
- LCI and LCIA datasets and software → provides a list “validated” database and software
- Data requirements → building component list and their default service lives and others
- Interpretation of the results and critical review → Classification of the data quality
- Calculations of the contribution of a building to global warming along its life cycle are standardised by ISO 14067, although the LCA standard ISO 14040/44 also provides a main general reference.

Summing up: EU Building Decarbonization means:

A building with

- zero on-site carbon emissions from fossil fuels
- a maximum thresholds on its **total** annual primary energy use
- a maximum thresholds on its **operational greenhouse gas emissions (GWP_{op})**
- designed to optimise its solar energy generation potential on the basis of the solar irradiance of the site
- total primary energy use is covered by:
 - energy from renewable sources generated onsite or nearby,
 - energy from renewable sources provided from a renewable energy community
 - energy from an efficient district heating and cooling system
 - energy from carbon free sources
- **life-cycle Global Warming Potential (GWP)** disclosed through the energy performance certificate of the building...

but

Summing up: EU Building Decarbonization means:

- By 1 January 2027 Member States shall publish and notify to the Commission a roadmap detailing the introduction of **limit values on the total cumulative life-cycle GWP** of all new buildings and **set targets for new buildings from 2030**, considering a progressive downward trend, as well as maximum limit values, detailed for different climatic zones and building typologies.

$$GWP_{lifeCycle} < GWP_{lifeCycle;max}$$

- Other than

$$E_{p;Tot;ZEB} = E_{p;nonren} + E_{p;ren} < E_{p;Tot;max}$$

2030

Questions

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