LOW CARBON BUILDING INITIATIVE

New construction scheme v 1.0 – Jan. 2024

performance

completeness

Towards consistent carbon reporting & targets:
a common European framework to decarbonize real estate

LCBI wishes to thank all European Life Cycle Analysis experts, from the private and public sector, who reviewed, commented on and challenged our methodology.

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CONTENTS

1. KEY PRINCIPLES

1. Context

Greenhouse gas (GHG) emissions are a key metric of climate change.

As the largest CO2 emitter, accounting for up to 40%[1] of global emissions, the **real-estate industry** is a key player in the fight against global warming. Thus, to achieve carbon neutrality by 2050, all European countries need to reduce the carbon footprint of new, retrofitted, and in-use buildings.

Initial efforts by the real-estate industry have focused on lowering energy use in existing buildings and transitioning to carbon-free energy. However, accurately **measuring carbon emissions at every life-cycle stage**—production, construction, operation, and demolition—is essential for a comprehensive climate impact assessment of buildings. Indeed, it allows us to consider the impact of the construction phase, which can represent, as the energy mix decarbonizes, 50% to 80% of a building's emissions over a life cycle of 50years.

To date, a **unified European methodology** allowing us to understand and compare buildings carbon footprints **has been lacking**. Addressing this, the Low Carbon Building Initiative (LCBI) has developed a unique methodology to measure the carbon footprints of buildings across their entire life cycle, with **limit values.** This methodology and its thresholds are the basis of a low-carbon performance certification for outstanding buildings. The methodology also aligns with major European standards and tools (Taxonomy, Level[s], CRREM, RICS).

Acting as a **common language,** this unified European methodology simplifies the quantification and comparison of buildings carbon footprints, and facilitates performance benchmarking for all. Such harmonization will provide a powerful signal to the market and help to unlock further private sector investment in low-carbon buildings.

For real-estate players, LCBI is a means to position life-cycle carbon footprint at the core of their strategy. It offers multiple benefits:

- For **project owners**, it functions as a low-carbon design tool, and as a means to highlight exemplary low-carbon buildings.
- For **investors,** LCBI provides access to consistent and reliable data on the whole life-cycle carbon footprint of buildings, serving as reliable indicator for investment.

LCBI was launched in 2022 by major players in the European real-estate sector alongside the Association Bâtiment Bas Carbone (BBCA[2]), established in 2015. The **LCBI first focused on newbuilt offices, residential properties, and hotels,** as considered in this document. Its broader objective is to encompass all real-estate categories, targeting new, retrofit, and in-use buildings, and foster decarbonization of the entire real-estate sector.

[1] *IEA, December 2019, Global Status Report for Buildings and Construction.*
[2] *https://www.batimentbascarbone.org/*

2. Purpose of this initiative

The aspiration of LCBI's certification initiative is to drag real-estate players into a dynamic, drastic reduction of their carbon emissions by:

- Harmonizing practices to measure how buildings affect the climate, and ensuring that these assessments are robust and complete throughout the whole life cycle (e.g. WLCA)—production, construction, in-use, and end-of-life stages.
- Setting a clear performance pathway based on quantitative targets, whilst promoting ambitious **low-carbon practices** in the building sector, compatible with both ESG reporting and design processes.
- Highlighting those buildings that have a notably low-carbon footprint.
- Covering all the main real-estate asset classes, starting with new built **office, residential, and hotel** typologies.
- Aligning with decarbonization national strategies and European low-carbon targets, and building upon compatibilities with European and international frameworks—Level(s), Taxonomy, tools (CRREM) and standards (RICS).

This document results from more than 2 years of collaborative work of benchmarking, data analysis, and expert reviews from real-estate stakeholders and LCA practitioners, including teams from the European Commission. This work was coordinated within a technical committee copiloted by ***Artelia*** and ***Elioth by Egis***, with technical support from ***OneClick LCA***.

3. Scope of application

The first version of the Low Carbon Building Initiative certification is applicable to **new build assets**, for three main building typologies within eight European countries.

Building typologies	Countries	
■ Office	■ Belgium	■ Luxemburg
■ Multi-family residential	■ France	■ Netherlands
■ Hotel[3]	■ Germany	■ United Kingdom
	■ Italy	■ Spain

Future versions may expand to other building typologies that are not yet covered by the current framework, which also encompasses future adaptability and accessible retrofitting to in-use projects. The intent is also to develop a certification that is applicable across Europe.

In the case of a construction project that reuses elements of a pre-existing building onsite, the project may still be considered as a new construction—and therefore be eligible for this certification—if the entire frame and shell is rebuilt (refer to Section 2.4 for more details).

In the case of a mixed use project, if one or more of the building uses do not fall within the three typologies listed above, LCBI advises that these areas may be included within the scope of the certification. That is if the total reference area (see 1.2) of the other uses not covered by this certification does not exceed 10% of the overall project reference area. For instance, a ground floor shop, a fitness area, a cafeteria, or a restaurant could be covered by the certification, provided that their impact is measured and reported consistently within the entire project's indicators.

Buildings with the same planning permission can be certified together, but each building must meet the performance requirements on its own.

Where works or facilities are shared between several buildings, the impact of these components on the three indicators (Embodied, Operational, and Biogenic, see 1.1) will be allocated to each building—on the basis of a ratio representative of the use of these facilities. For example, for a heat substation supplying several buildings, the impact ratio to be applied will be based on the power distributed to each building. A ratio based on the reference area (see 1.2) of each building could also be used.

It should be noted, that in order to maintain the overall consistency of the environmental assessment of the building, the scope of the assessment chosen must be identical for the calculation of the three performance indicators of this certification (Embodied Carbon, Operational Carbon, and Biogenic Carbon Storage). Evidence of this consistency shall be documented by the applicants.

For those projects that do not fall within this scope of application (e.g. other building typologies, other countries, existing buildings, etc.), the core principles of the LCBI methodology may still be used to measure, optimise, and report their carbon impacts. However dedicated thresholds will be defined in a future version for the certification to apply to those buildings.

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[3] *The thresholds for hotels are at this stage no different from those applicable to offices or residential buildings, as the studies carried out were based on a limited number of references which have not highlighted the objectives needed to adapt them. If however initial feedbacks from practitioners show such a need, these thresholds may be adapted in a later version to better reflect the characteristics of low-carbon hotels.*

4. The certification process

The certification process is based upon two distinct submissions, at two stages in the design process (shown in Figure 1):

- **Interim LCBI certificate**: A first audit from an independent certification body shall be undertaken at the end of the technical design stage and assess the final design of the project before construction work may start. Following the validation of this audit, LCBI will deliver a temporary certification. This interim LCBI certificate is optional; the applicant can apply directly for the final LCBI certificate.
- **Final LCBI certificate**: The final certification shall be delivered after practical completion, where a final audit shall be held and validated. An optional follow-up certification upgrade within 5 years is also possible to include the actual operational emissions in the assessment.

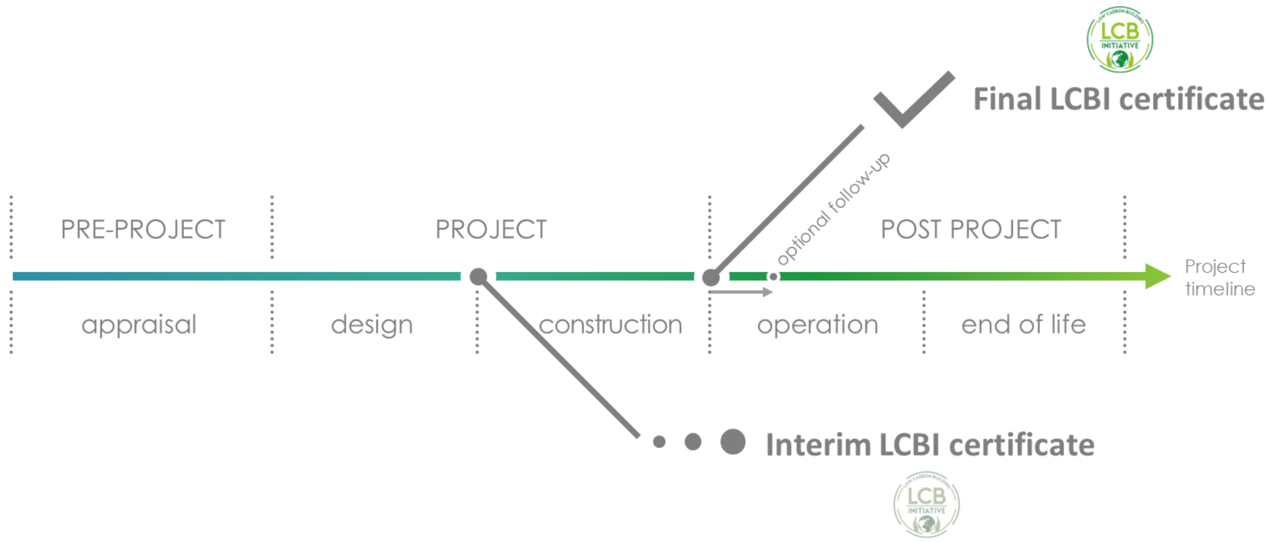


Figure 1: Application process scheme

LCBI Evaluation of carbon

EMBODIED CARBON

- LCA calculation
- Embodied emissions over 50 years
- Associated score: number of **stars** and **target** level

OPERATIONAL CARBON

- Energy consumption calculation
- Yearly operational emissions
- Associated score: number of **stars** and **target** level

BIOGENIC CARBON

- Biogenic carbon calculation through LCA
- Temporary carbon storage
- Associated score: **target** level

LCBI FINAL RATING

Depending on total number of **stars** and **target** levels, low carbon projects may achieve one of the following levels:

STANDARD | **PERFORMANCE** | **EXCELLENCE**

FINAL SCORE CARD

For a reliable comparability between LCBI projects on a consistently complete whole-building scope, lump sums may be added in accordance with the chosen LCA partial scope and energy consumption calculations.

PROJECT EXAMPLE

		Calculated + Lump sums		
EMBODIED CARBON	865 $kgCO_2e/m^2$_50yr	= 465 + 400 ★★★☆ Frame&Shell + Site&External + Partitions&Finishes	&	T_1
OPERATIONAL CARBON	7,8 $kgCO_2e/m^2.yr$	= 3,9 + 3,9 ★☆☆ Regulatory consumptions = 34 $kWhFE/m^2.yr$	&	T_2
BIOGENIC CARBON	14 $kgCO_2e/m^2$			T_1

Global performance = LCBI level

STANDARD

Figure 2 : Example of a LCBI evaluation reporting

2. METHODOLOGY

1. General methodological framework

The Low Carbon Building Initiative is built upon some of the key existing standards and frameworks that already address the environmental performance of buildings in Europe:

- EN 15978 – Assessment of environmental performance of buildings – Calculation method
- EN 15804 +A1 and +A2 – Environmental product declarations
- EN ISO 52000 – Energy performance of buildings – Set of EPB standards.
- Level(s) common framework – Macro-objective 1: Greenhouse gas and air pollutant emissions during a building's life cycle
- RICS – Whole life carbon assessment (WLCA) for the built environment, 2023

1.1. Performance indicators

The carbon performance of the building is measured through three indicators (*calculation methodologies are explained further*):

- **Embodied Carbon**: these are fossil and LULUC[4] greenhouse gas emissions over the entire life cycle of building elements (the sum of stages A1 to B5 and C1 to C4), measured in $kgCO_2e/m^2$ of reference area over 50 years.

- **Operational Carbon**: these are the annual greenhouse gas emissions related to the energy consumption of building systems (stage B6), measured in $kgCO_2e/m^2$. year. These shall include estimated refrigerant leakages.

- **Biogenic Carbon Storage**: the amount of Biogenic Carbon stored by bio-based materials in the building, in $kgCO_2e/m^2$.

[4] *Land use and land use change, EN 15804+A2.*

1.2. Reference area

The results shall be expressed per m² of **IPMS 2 without Component H** (i.e. excluding balconies, covered galleries, internal car parking, and storage rooms) as defined by the International Property Measurement Standards (IPMS) for residential buildings[5] and for offices[6]. For hotels, LCBI recommends using the same definition as for residential buildings. The different Component Areas are detailed in Table 1.

LCBI Reference Area

	IPMS 2 Component Areas		
[A]	**Vertical Penetrations**	Stairs, lift/elevator shaft and ducts but any penetration of less than 0.25m² is to be disregarded.	included
[B]	**Structural Elements**	This comprises all structural walls and columns that are to the inside of the Internal Dominant Face.	included
[C]	**Technical Services**	Plant rooms, lift/elevator motor rooms and maintenance rooms.	included
[D]	**Hygiene Areas**	Toilet facilities, cleaners' cupboard, shower rooms and changing rooms.	included
[E]	**Circulation Areas**	This comprises all horizontal circulation areas.	included
[F]	**Amenities**	Cafeterias, day-care facilities, fitness areas and prayer rooms.	included
[G]	**Workspace**	The area available for use by personnel, furniture and equipment for office purposes.	included
[H]	**Other Areas**	Balconies, covered galleries, internal car parking and storage rooms.	excluded

Table 1: Definition of the LCBI reference area based on IPMS 2 Component Areas

This definition of reference area has been selected for its similarities with RICS, SBTi, and CRREM recommended definitions. Being close to Gross Internal Floor Area allows consistent results to be expressed and benchmarked, without needing supplementary surveys to be conducted.

This reference area must be used for the calculation of each performance indicator: Embodied Carbon, Operational Carbon and Biogenic Carbon storage.

In the remainder of this document, all references to "m²" are to this reference area.

[5] *IPMS for residential: https://fastedit.files.wordpress.com/2016/09/ipms-residential-buildings-sept-2016.pdf*
[6] *IPMS for offices: https://fastedit.files.wordpress.com/2014/11/ipms-office-buildings-november-20141.pdf*

2. Embodied carbon

2.1. LCA scope: Building parts and components

The carbon assessments required for the certification process require an exhaustive bill of material quantities corresponding to the different building elements. The division of these building elements into categories is closely based to the one established by the RICS[7], and aims to cover all of a building's main components. Each is divided into smaller groups to provide a reportable breakdown and assess the completeness of the LCA (see Table 2: Minimum assessment criteria for each aspect of Embodied Carbon completeness).

The LCBI certification process therefore requires detailed and exhaustive material quantities for each of these categories. The completeness and accuracy of these quantities for each individual aspect shall be documented and audited as part of the certification process. This breakdown into categories should be compatible with other assessment frameworks. To fit within the design process, the LCBI approach is to adopt a stepped assessment that can be undertaken in four successive layers, or macro-lots, of increasing completeness as per Figure 3 below.

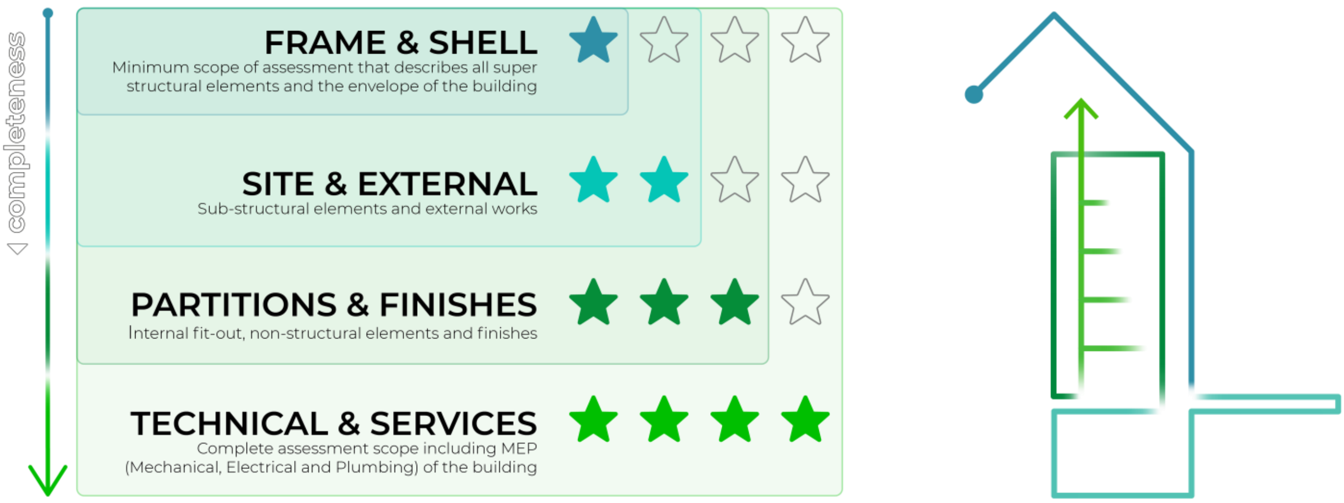


Figure 3: LCBI Embodied macro-lots

Each additional layer complements the previous one with additional building elements accounting for an increasing range of building materials. To obtain the associated star, all elements described in the Table 2 below should be modeled in the LCA.

The LCBI rating methodology relies on this increasing coverage to reward efforts of completeness whilst allowing partial assessment in response to poor data availability. This approach will incentivize better practices in reporting quantities and accurate impacts for a new build asset.

[7] *RICS, 2023, Whole life carbon assessment (WLCA) for the built environment.*

FRAME & SHELL ★☆☆☆	1.1 Frame	1.1.1	Slabs
		1.1.2	Beams
		1.1.3	Columns
		1.1.4	Walls
		1.1.5	Stairs, ramps and safety guarding
	1.2 Facade	1.2.1	Opaque facade systems
		1.2.2	Glazing systems
		1.2.3	Shading devices
	1.3 Roof	1.3.1	Structural elements
		1.3.2	Roof coverings
SITE & EXTERNAL ★★☆☆	2.1 Sub-structure	2.1.1	Foundations and piling
		2.1.2	Basement slabs
		2.1.3	Retaining walls and structural frame
	2.2 External work	2.2.1	External floor surfacing
		2.2.2	Fencing, railings and walls
		2.2.3	External networks
PARTITIONS & FINISHES ★★★☆	3.1 Internal fittings	3.1.1	Fixed partitions
		3.1.2	Interior acoustic and thermal insulation
		3.1.3	Internal doors
		3.1.4	Raised floor and screed
		3.1.5	Suspended ceilings
		3.1.6	Sanitary fittings
	3.2 Finishes	3.2.1	Floor coverings and finishes
		3.2.2	Wall and ceiling finishes
TECHNICAL & SERVICES ★★★★	4.1 Heating and hot water	4.1.1	Heating and hot water generation equipment
		4.1.2	Heating and hot water distribution network
		4.1.3	Heating emitters
	4.2 Cooling	4.2.1	Cooling generation equipment
		4.2.2	Cooling distribution network
		4.2.3	Cooling emitters
	4.3 Ventilation system	4.3.1	Air movement
		4.3.2	Air terminals
		4.3.3	Ductwork & ancillaries
	4.4 Sanitary systems	4.4.1	Cold water systems
		4.4.2	Drainage and rainwater
	4.5 Electrical installations	4.5.1	Lighting system
		4.5.2	Onsite electricity generation
		4.5.3	Electricity distribution
	4.6 Other systems	4.6.1	Lifts and escalators
		4.6.2	Firefighting installations
		4.6.3	Telecoms and data installations

Table 2: Minimum assessment criteria for each aspect of Embodied Carbon completeness

2.2. Life-cycle stages and study period

The system boundary follows the "cradle-to-grave" definition of the building life cycle as defined in EN 15978. Calculating the whole life carbon should include each module defined in this standard, corresponding to the carbon emissions associated with the various stages of the design life of the building. In its latest version, the EN 15804 +A2 standard has confirmed that future Environmental Product Data should cover all steps of the life cycle of a product as described below.

The reference study period (RSP) is set to 50 years for Embodied Carbon calculations. There are few discrepancies regarding RSP across Europe, but most methodologies[8] are using 50 years, as is the case of the Level(s) guidance.

Embodied Carbon is the carbon performance indicator for building materials and technical equipment. It focuses on stages A1 to B5 and C1 to C4 (see Table 3) of the life-cycle stages of all building components (see Table 2).

Stage B6 (Energy use) is not taken into account in Embodied Carbon calculations, as it is calculated separately in the Operational Carbon indicator. At this point, stage B7 (Water use) is not included in the LCBI scope.

The D module is **calculated and reported** but is not accounted for in the Embodied Carbon indicator of the project. Carbon emissions, thus calculated in the context of the LCBI methodology, correspond to the sum of the stages A1 to C4 (apart from B6 and B7, see Table 3 below).

LCBI Embodied Carbon

A - PRODUCT STAGE	B - USE STAGE	C - END OF LIFE
A1: Raw material supply A2: Transport A3 : Manufacturing	B1: Use B2: Maintenance B3: Repair	C1: Demolition C2: Transport C3: Waste processing C4: Disposal
A - CONSTRUCTION PROCESS STAGE A4: Transport A5: Construction installation process	B4: Replacement B5: Refurbishment	
	B6: Operational energy use B7 : Oerational water use	**D - BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY** D: Reuse, recovery, recycling, potential

Table 3: Whole Life-Cycle stages and selected LCBI embodied scope

In order to carry out the building LCA, the impacts of each individual building material and equipment must be documented by an Environmental Product Data (EPD). **Please refer to section 1.3 Prioritization of the use of EPDs for more details on standards, the Environmental Product Declaration (EPD) database, and prioritization order.**

When using incomplete environmental data on the different life-cycle stages, LCBI methodology provides a methodology for data completion in **Part 1.5 from the APPENDIX.**

[8] *Methodologies using 50 years RSP: RE2020 (France), DGNB (Germany), Danish Green Building Council, Climate Declaration (Finland), Level(s) EU framework. For more information: https://www.ramboll.com/news/embodied-carbon-and-how-to-tackle-it.*

2.3. Reference service life and replacement

The reference service life of building parts is usually estimated by the manufacturer in the EPD. In the absence of an estimation made by the manufacturer or supplier, default service lives (provided in APPENDIX, Part 1.7 Default service lives) should be used.

If these lifespans are shorter than the 50-year reference study period (RSP) of the building, a suitable number of replacements shall be considered. The number of replacements to be accounted for in the LCA is to be taken as an integer value such that the product is fully replaced at the end of each lifespan, as per Section 9.3 of EN 15978. No partial replacement on a pro-rata basis for the remaining study period shall be applied. The Embodied Carbon of each product replacement must be allocated to module B4 of the building LCA.

$$B4_{building\ LCA} = \sum_j B_{4,j} + f_i(\frac{RSP}{SL_j} - 1) * ABC_j \text{ [kg CO}_2\text{e]}$$

with $B_{4,j}$ – GHG impact of B4 stage of j product EPD (in $kgCO_2e/m^2$)
SL_j – Service Life of j product (in years)
f_i – integer part ceiling function (as opposed to floor function)
ABC_j – Total GHG impact, stages A, B and C of j product EPD, apart from B6 and B7 (in $kgCO_2e/m^2$)
RSP – Reference Study Period (50 years)

For instance, a product impact with a 20-year lifespan will be accounted for three times in the calculation to cover the 50-year building life cycle.

2.4. Circular economy

LCBI aims to promote circular practices at the end-of-life for construction materials and prevent any systematic approach to demolition, incineration, or burial. The reuse of building materials avoids the greenhouse gas emissions associated with the product and construction phases of new materials—which emit most greenhouse gases over most materials life cycles. LCBI therefore wishes to encourage these initiatives with a specific calculation rule for the LCA of reused materials. Two different cases may occur:

	Components from a deconstruction site	**Structural element from onsite pre-existing building**
Type of reused materials	Components removed from a deconstruction site (either from an in-situ or ex-situ demolished/deconstructed building) and reused instead of sourcing virgin materials for an identical use. For instance: raised floors, ceilings, carpets, structural steel beams, sanitary fittings, etc. All components of the four macro-lots (see Table 2) can theoretically be reused in a new construction project.	When a building pre-exists on the project construction site, some structural elements may be reused in place without being deconstructed, like foundations, slabs, beams, etc. **As this certification only applies to new buildings for now, LCBI considers that if any component from the first macro-lot “Frame & Shell” are reused in place from the previous super-structure without deconstruction, the project shall fall within a “renovation” typology and therefore not be subject to this first version of the LCBI scheme.** On the contrary, the reuse of any component of the second macro-lot “Site & External” (see Table 2) falls within the scope of this certification.
Embodied Carbon	The **Embodied Carbon of the product stage (modules A1 to A3) of any reused material shall be set to 0**. LCBI considers that no additional carbon emissions for the production of the component exist, which falls under the product “first life” Embodied Carbon. The carbon emissions from modules A4, A5, B and C, are calculated in the same way as if virgin materials had been used. Like new materials, the EPD prioritization method shall also apply to reused materials (*see* 1.3 Prioritization of the use of EPDs). Thus, if no specific EPD is available for the product, generic data shall be used. If the remaining lifespan of the reused material is shorter than the 50-year study period, a replacement must be taken into account in module B4 of the building LCA. It is assumed that the component to be renewed is replaced by an identical component (i.e.: by a reused material with the same lowered carbon impact). The lifespan of a reused material is defined by the EPD data, same as for new materials.	The **Embodied Carbon of the product stage (A1 to A3) and the construction process stage (A4 and A5) for these reused components of the macro-lot “Site & External” from the existing building shall be set to 0.** The carbon emissions from stages B and C, are calculated in the same way as if virgin materials had been used.

2.5. Demolition of a pre-existing building

When an existing structure pre-exists on the project site, it can either be demolished or recovered through reuse. As a reminder, if the super-structure is entirely reused the project falls within a renovation typology and should be excluded from the current scope of the LCBI certification. If the structure is partially reused, please refer to 2.4. Circular economy (*reuse of structural elements from the pre-existing building)*.

Regarding demolished sub-structures and super-structures, carbon emissions associated with the demolition of existing structural elements (from frame, shell, site, and external components) **must be assessed and reported separately from the Embodied Carbon indicator**. In this current version, and in the absence of a common methodological consensus, the carbon impact of demolition is not included in the calculation of Embodied Carbon. It should be estimated using generic environmental data only. Only **end-of-life stage C1 to C4** of all **demolished elements** should be accounted for.

The following examples illustrate the methodology of the Embodied Carbon of reuse.

Example 1: Reuse of carpets

Carpets that have already been used for 5 years in another building are removed, cleaned, and reinstalled in a new construction project. This is thus a reused material. In this case, the carbon impact of phases A1-A3 will be counted at 0 for this component. The carbon impact of the other stages (A4, A5, B and C) will be taken from the carpet manufacturer's specific up-to-date EPD, if it is available, or from generic data, if it is not. The lifespan considered for this product is the one given on the EPD (see 2.3). The 5 years of operation already carried out are not deducted from the useful life of the product.

Example 2: Construction on existing sub-structure

There is a pre-existing building with two sub-structure levels and five super-structure levels on the construction site. The super-structure is completely demolished, and the two sub-structure levels are reused to build a new super-structure above them. In this case, the carbon impact of stages A1-A3 and A4-A5 is set to 0 for the entire reused sub-structure. The carbon impact of the other stages (B and C) will be taken from the manufacturer's specifically updated EPD, if it is available, or from generic data. The carbon impact of the end-of-life (C1-C4) of the demolished super-structure should be estimated using suitable EPDs, but it is not included in the calculation of the Embodied Carbon, it should be reported separately in the Reporting Sheet (see Section 3 Reporting spreadsheet*).*

Example 3: Partial reuse of super-structure

There is a pre-existing building with two infrastructure and five super-structure levels on the construction site. The first floor of the building is reused, and four new levels are constructed above it. ***In this case, the project is considered as a renovation and this present certification does not apply.***

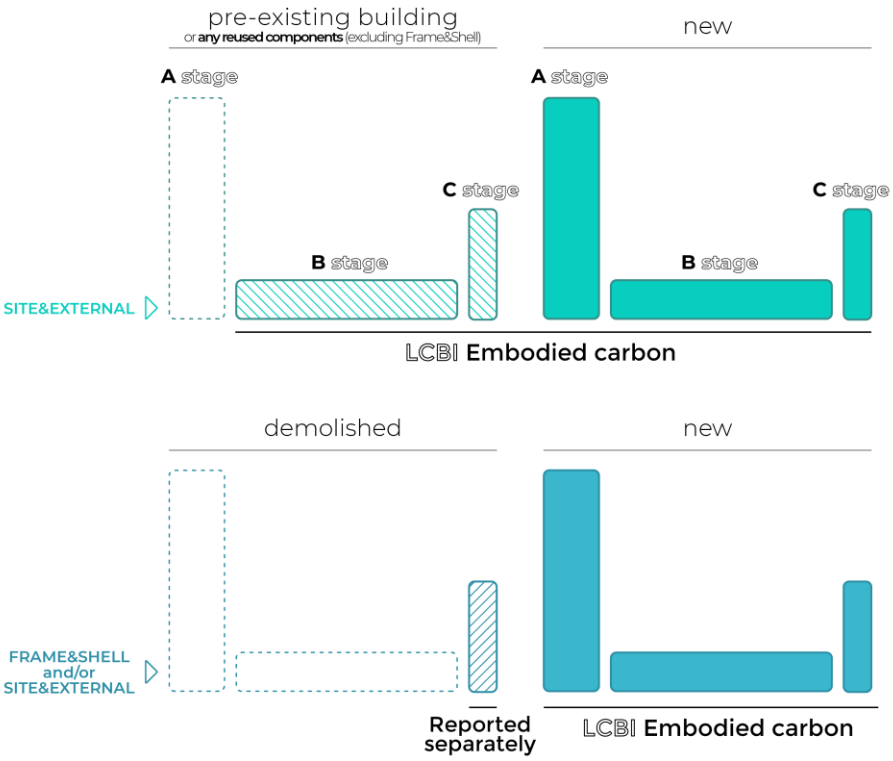


Figure 4: Reuse (2.4) and demolition (2.5) embodied emissions accounting

3. Operational carbon

3.1. Calculation process

Operational Carbon values should be the **final energy consumptions reported in $kWh_{F.E.}/m^2.yr$**. These consumptions must be estimated according to one of the three methodologies below.

To ensure the comparability of results between assessed projects, the reference area applied to the operational consumptions should be the reference area defined by the LCBI (IPMS 2, component H excluded, 1.2).

- ★☆☆ **National Calculation Methodologies** (NCM): The majority of national calculation methods are currently based on EN 15603 and its associated standards. It is anticipated that over time these methods will be updated to reflect the new EN ISO 52000 series (EPB Directives[9]). There will therefore be a transitional period during which either standard may be referred to. However, NCM are accepted, as long as they cover the five mandatory usages as per the EPB Directives & the Level(s) framework LCBI is aware of the possible discrepancies between NCM and recommends the use of complete Dynamic Energy Simulations (DES) to better estimate the energy consumption of projects.

- ★★☆ **Dynamic Energy Simulations** (DES): The DES should cover all energy usages (regulated and non-regulated) and be carried out according to the usage scenarios and assumptions for the calculation of the indicator 1.1 (use stage energy performance) of Level(s).

- ★★★ **Monitored Consumption** (MC): Alternatively, if the LCBI assessment is carried out after a full consolidated year of building occupation, real consumption (monitored and metered per usage, verified by a commissioning report) may be used.

3.2. Energy usages

The basic assessment range is the final energy consumption of the technical systems integrated in the building during its operation, as described in clause 7.4.4.7 of EN 15978. Namely, the annual energy consumed by the five following main usages:

- Heating
- Cooling
- Ventilation
- Hot water
- Lighting

A reporting template (see Section 2.2 Calculation process) should be filled for each type of energy used (electricity, gas, district network, biomass, etc.).

The energy consumption corresponding to generation, distribution and ventilation auxiliaries should be included within the reported consumption of these five usages.

The energy consumption of other technical systems integrated into the building—necessary for the technical and functional performance of the building—shall be declared to achieve the second star rating of the scope of evaluation (e.g. lifts, escalators, safety and security installations and communication systems, IT and appliances, etc.).

[9] *https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en*

The following figure describes the different assessment aspects and their corresponding stars:

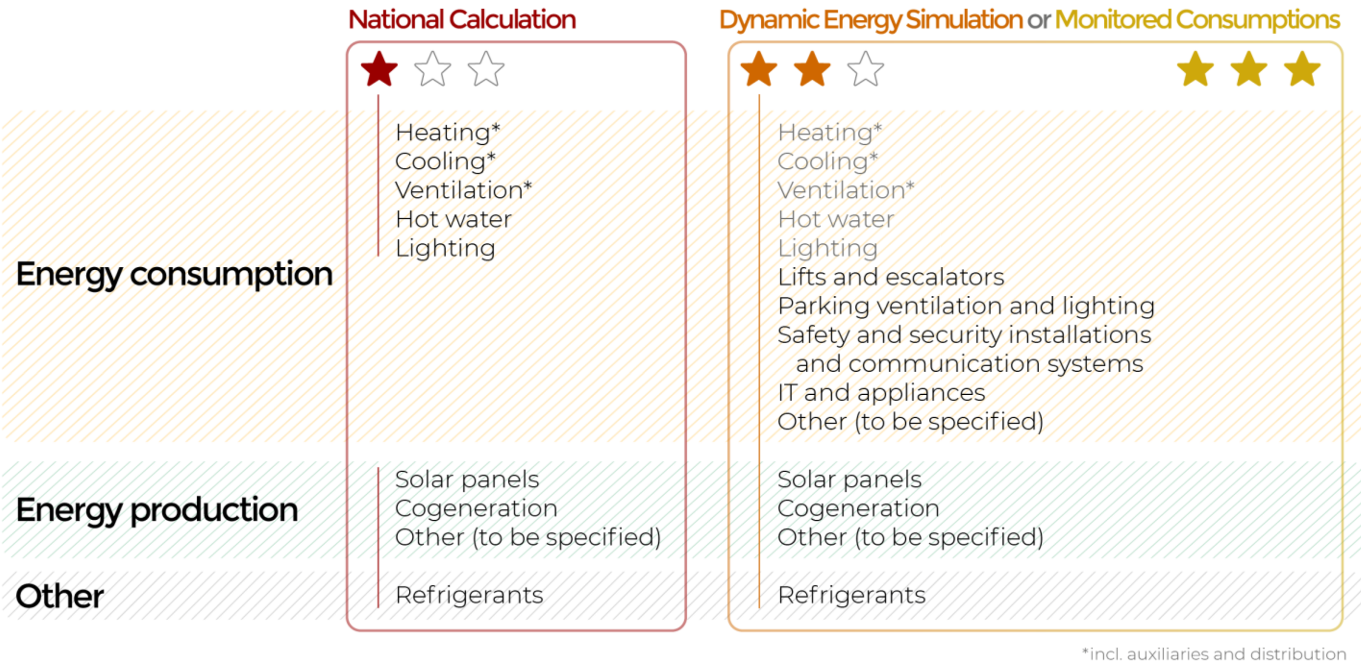


Figure 5: Minimum scope of assessment for Operational carbon

3.3. Energy emission factors

To unify the calculating method for the carbon content of energy in each country (electricity from the national grid or other local production sources), LCBI requires the use of the emission factors proposed by the CRREM[10] (Carbon Risk Real Estate Monitor, version 2) in the building's year of completion.

> To promote exemplary design and operation of the building and avoid blurring reporting with other energy procurement strategies, the methodology shall rely on location-based emission factors rather than market-based ones. LCBI certification allows the use of a justified and documented location-based emission factor for electricity, when different from the CRREM value. As per the second version of CRREM pathways[11], aligned with GHG Protocol and the SBT Initiative, transmission and distribution (T&D) losses shall be excluded from emission factor total value.

LCBI certification also allows the project to use a custom District Heating emission factor, as long as it is justified by official national documents or by official statements from district heating utility providers. Similar to electricity, if T&D losses are known, these should be excluded from the consumed district heat emission factor.

In both cases, documents should provide **justifications** on the emission factor to date. No projected value for future emission factors will be valued in this first version.

[10] *https://www.crrem.eu/tool/, exact E.F. values can be found in the reporting sheet.*
[11] *CRREM, 2023, From Global emission budgets to decarbonization pathways at property level. (A.2.3) Excluding transmission and distribution (T&D) losses.*

3.4. Local energy production

This certification proposes the following method to account for the in-situ renewable energy production:

- exported energy shall not be accounted for (e.g. not deducted from the operational use of energy),
- self-consumed renewable energy is deducted from the final energy consumption,
- The ratio of in-situ consumption shall be calculated and documented through regulatory methods, or a proposed methodology derived from the DES.

Note that the Embodied Carbon of the energy production installation should be reported in the fourth aspect of Embodied Carbon: ★★★★ Technical & Services, in proportion to the estimated share of in-situ self-consumed energy.

3.5. Fugitive emissions of refrigerants

The greenhouse gas emissions emitted by refrigerants contained in technical equipment, such as cooling units or heat pumps, can be estimated with B1 and B2 modules from those equipment EPD/PEP.

However, if the LCA is not calculated on the Technical & Service parts concerned, or if the equipment EPD/PEP does not take into account refrigerant impacts and leaks, the LCA practitioner should estimate refrigerant leaks[12] with the following formula:

$$\text{Operational Carbon}_{\text{Refrigerants}} = \text{R}_{\text{Leakage}} \times \text{Ch} \times \text{EF}_{\text{Refrigerant}}$$

- $\text{R}_{\text{Leakage}}$ is the annual leakage rate (%/year), this data must be taken from the EPD/PEP or on the equipment technical data sheet. If this data is unavailable, a conventional leakage rate of 2%/year will be set,
- Ch is the total initial refrigerant charge of the MEP equipment (kg), this data must be taken from the EPD/PEP or on the equipment technical data sheet,
- $\text{EF}_{\text{Refrigerant}}$ is the emission factor for the actual type of refrigerant used in the MEP equipment ($kgCO_2e/kg$), this data must be taken from global warming potential of cooling gases defined by the CRREM *(refer to the LCBI Reporting Sheet for exact values).* If the refrigerant used in the building is not on the list provided by CRREM, the emission factor must be taken from the GWP total life-cycle value of an EPD/PEP covering that refrigerant or documented from an auditable source.

[12] *RICS, 2023, Whole life carbon assessment (WLCA) for the built environment, 5.2.1 In-use impacts (B1).*

4. Biogenic carbon storage

The Biogenic Carbon content, which is the carbon stored as a result from photosynthesis and contained in the bio-based materials, is to be estimated for the whole building in kg CO_2e/m^2. All bio-based components of the building—independently from the scope chosen for Embodied Carbon—should be considered. This value represents the total amount of Biogenic Carbon locked/stored in the building at any time of its normal use, in this sense, no replacement should be taken into account.

Depending on the available information in the product EPD, the amount of Biogenic Carbon can be estimated in different ways. In order of priority:

- Biogenic Carbon content in **kgCO_2e**/functional unit is given by the EPD. It can directly be used for reporting.
- Biogenic Carbon content in **kgC**/functional unit is given by the EPD. The value has to be multiplied by 44/12 to be converted in kgCO_2e[13].
- No specific value is given and the EPD is in EN 15804+A2 format. The Biogenic Carbon content should be estimated by the stages **A1 (Raw material supply) from GWP - biogenic**.
- For other EPDs, **only timber products** can declare a Biogenic Carbon content. The approximation of 0.45 kgC/kg as the quantity of carbon storage in 1 kg of wood can be used as per EN 16449. For a wood product with a density of woody biomass ρ, the Biogenic Carbon content in the total volume of the product V can be approximated by the simplified formula:

$$\text{Biogenic Carbon Storage} = \frac{44}{12} \times 0.45 \times \rho \times V \quad [\text{kg } CO_2e]$$

Where:

ρ is the density of the wood product (kg/m^3)
V is the total volume of the product (m^3)

Biogenic Carbon content is usually given for the product functional unit (m^2, m^3, u…). To obtain the total biogenic storage provided to the building, the carbon content value must be multiplied by the associated quantity of material.

Note that the D module (which tends to capture the benefits of circularity and recycling, amongst other) differs from Biogenic Carbon content. Thus it cannot be directly used to calculate the Biogenic Carbon content.

[13] This conversion is due to the atomic weights: 44 kg/mol is the weight of carbon dioxide and 12 kg/mol is the weight of carbon.

3. LCBI PERFORMANCE EVALUATION

1. Embodied carbon

1.1. Key principle

In this first version of the LCBI certification, the Embodied Carbon of a project shall be evaluated against a two-dimensional framework (see below), which provides a rating of LCA completeness and Carbon performance. This framework requires two inputs: the scope of assessment (quantified by a star ★ rating) and the carbon performance (rated by Targets "T1" and Target 2 "T2").

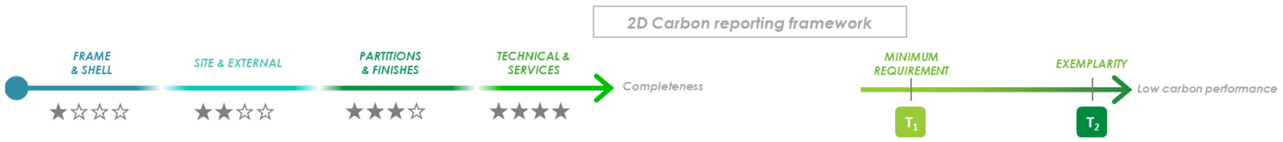


Figure 6: 2D Framework explanation on embodied

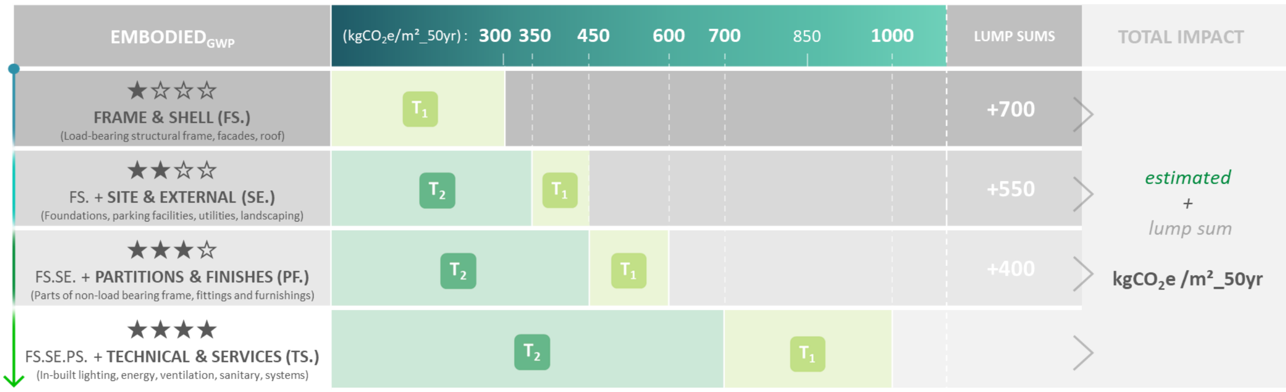


Figure 7: Embodied carbon framework assessment

1.2. Scope of assessment

As shown on Figure 7, projects are assessed for their Embodied Carbon performance for two metrics, represented by the vertical and horizontal axis of the diagram. Along the vertical axis, the project is given a rating based on its carbon assessment, as defined in the LCBI methodology. The wider the coverage of the evaluation, the more accurate the study and therefore the more "completeness" stars the project achieves.

> Tenant-related moveable partitions (for instance in office buildings) are excluded from the calculations. Retained within the Partitions & Finishes (PF) or Technical & Services (TS) sections are any other works that would be required for an open-plan layout to be handed over. If such works are unknown (undetermined tenant works), the Embodied Carbon impact of a fictional layout based on Dynamic Energy Simulation (DES) assumptions and other space-planning hypothesis is required.

The LCA of a project is deemed complete if each of its building parts is described with the appropriate environmental data and plausible quantity. For any missing elements or sub-categories where the impact is reported to zero a justification shall be provided.

1.3.Carbon performance

As represented on the horizontal axis on Figure 7, the Embodied Carbon value of a project is evaluated against different thresholds of GWP over 50 years, as calculated by a suitable LCA for the aspect being considered.

Thresholds have been tentatively calibrated to provide a universal framework, valid for all countries and all building typologies until consistent data benchmarks emerge to provide relevant differentiation. Any project can be evaluated using this table, thus obtaining a given banding for GWP and a star rating for a given LCA "completeness".

Performance metrics can then be determined at the intersection of the GWP banding and LCA completeness matrix. This position will be compared to two targets: "**Target 1**" (T1) and "**Target 2**" (T2).

T1 is the minimum requirement level to be granted the certification, it is set to 1000 kg CO_2e/m^2 for a full-scope LCA (★★★★). This level remains accessible to almost all architectural projects engaged in a low-carbon design philosophy. T2 is for exemplary projects and is set to 700 kg CO_2e/m^2 for a full-scope LCA. This level requires a focused effort throughout the design of the building.

This rating method has been designed for its flexibility. Further (more stringent) performance indicators (e.g. T3, T4) may be developed in later versions of this framework to follow the required decarbonization pathway and reflect better practices.

Low LCA results can be the result of a genuine low-carbon design; however, these results may be virtually too low as a result of an incomplete partial assessment. The framework outlined by LCBI is driven by the necessity to avoid confusing results and allow for enhanced transparency. LCBI-compliant Embodied Carbon results shall therefore be disclosed in $kgCO_2e/m^2$ along with the associated star rating.

For easy and comparable reporting to emerge from the LCBI methodology, "**lump sums**" shall be added to the calculated results when the scope of LCA is incomplete, so that final embodied results cover a complete, consistent evaluation and be used as such in ESG reports and public communications (for further details, see 1.5 Scenarios for completing cradle-to-gate EPDs).

These lump sums are purposedly designed as "upper bounds" for each macro-lot to incentivize detailed assessments to be carried out even at an earlier stage. These lump sums do not impact LCBI performance for Embodied Carbon, nor for the final evaluation. Their aim is to obtain a total single value of Embodied Carbon that can be used to fairly compare one project with another on the full LCBI extent of the LCA (★★★★).

According to the minimum requirement level values for certification access (T1) on the different scopes and their associated lump sums, all LCBI certification projects emit less than 1000 $kgCO_2e/m^2$ on the Embodied Carbon on the full LCBI extent of assessment. In other words, these lump sums are designed in such a way that any project eligible for LCBI (even with a lower level of completeness) will not exceed 1000 $kgCO_2e/m^2$ once all the lump sums are considered for the missing macro-lots.

Example

If the Embodied Carbon of a project is estimated to 400 $kgCO_2e/m^2$, ★★☆☆, the candidate shall add the associated lump sum that is equal to 550 $kgCO_2e/m^2$ in order to disclose a comparable result on the full assessment. The total impact would be 400 + 550 = 950 $kgCO_2e/m^2$, even though performance thresholds (the T1/T2 targets) are applied on the estimated Embodied Carbon of 400 $kgCO_2e/m^2$.

2. Operational carbon

2.1. Key principle

LCBI certification also addresses Operational Carbon emissions, which contribute significantly to a building's whole life-cycle carbon footprint. However, a standard framework for energy consumption in Europe is hard to establish, given the diversity of estimation and measurement methods among countries. Thus, to report and calculate operational emissions, this methodology offers from flexibility. A two-dimensional framework, similar to the one defined in the Embodied Carbon framework, is proposed to evaluate projects. Figure 9 shows how any project can assess its operational performance (Figure 8) according to two metrics: calculation process and carbon performance.

Figure 8: 2D Framework explanation for operational performance

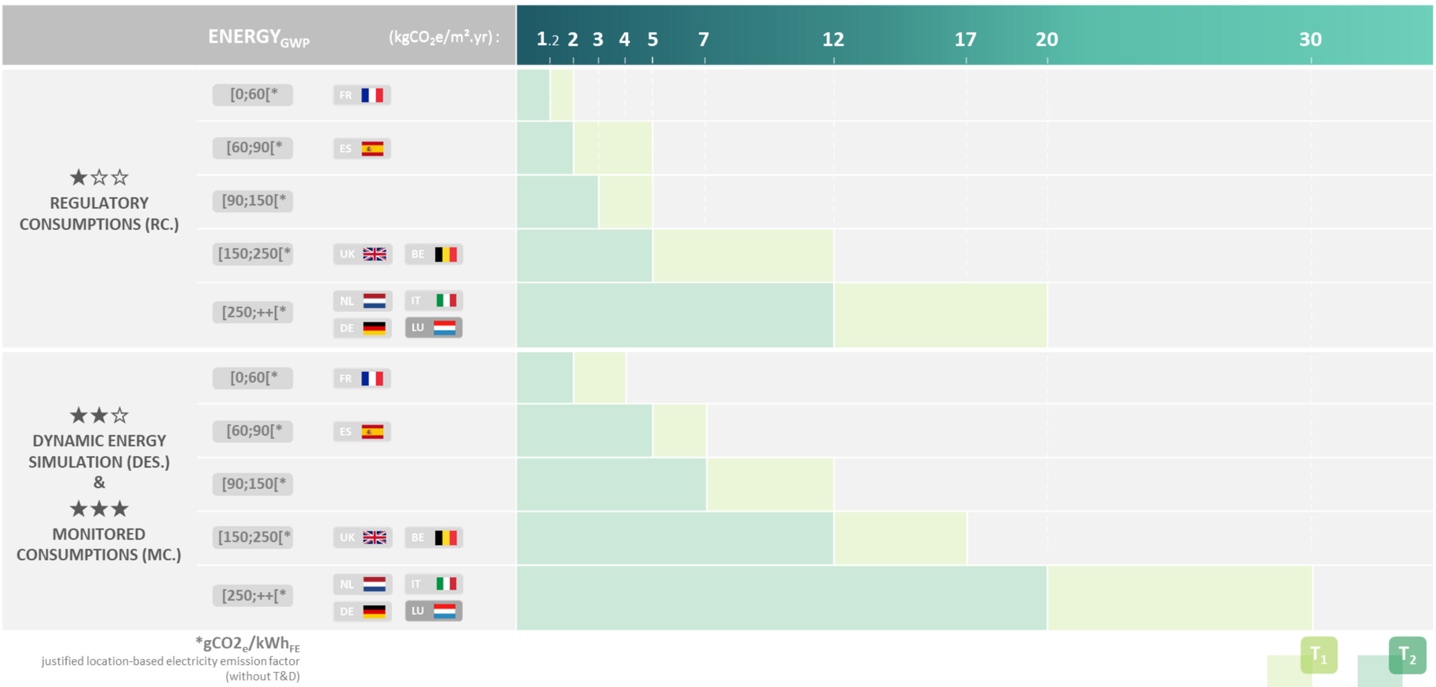


Figure 9: Operational carbon framework assessment

2.2. Calculation process

The vertical axis in Figure 9 shows the method and extent of the energy consumption assessment. To achieve one star, it is sufficient to assess the main and mandatory end-uses (heating, cooling, ventilation, hot water, lighting—see Figure 10) as per EPB Directives and the Level(s) framework. Yet this is a partial assessment as regulatory methods describe only a part of the total energy consumption measured during building operation.

Two stars can be obtained by providing a DES that thoroughly documents its assumptions and also assesses other non-regulatory uses.

The final category, relates to real energy consumption data through monitoring. For instance, in-use performance of buildings could be compared to the LCBI framework for benchmarking purposes, and a potential rating upgrade achieved at completion, or recently delivered new build projects could also request LCBI certification after 1 or 2 years of use.

2.3. Carbon performance

On Figure 9's horizontal axis, total relative **final** emissions related to operational energy (+ refrigerant gases) are reported annually. The emissions factors are based on CRREM references (default 2024 values) for each country and typology. They evolve alongside CRREM projected pathways of national grid carbon intensity to reduce the, debatable and hardly trackable, user adjustment of emission factors according to local grid decarbonization pathways. However, this principle remains open for adjustments since Level(s) supports the use of prospective emission factors from the EU Reference Scenario 2020[14]. LCBI also covers carbon intensive district heating networks. For further information, please refer to the Section 1.9 District heating.

As for the Embodied Carbon rating table, quality (from regulatory to monitored consumptions) as well as performance (banding values) are the rating criteria driving the achievement of T1 or T2. These targets are set differently from one country to another, depending on how carbon-intensive each countries current energy mix is.

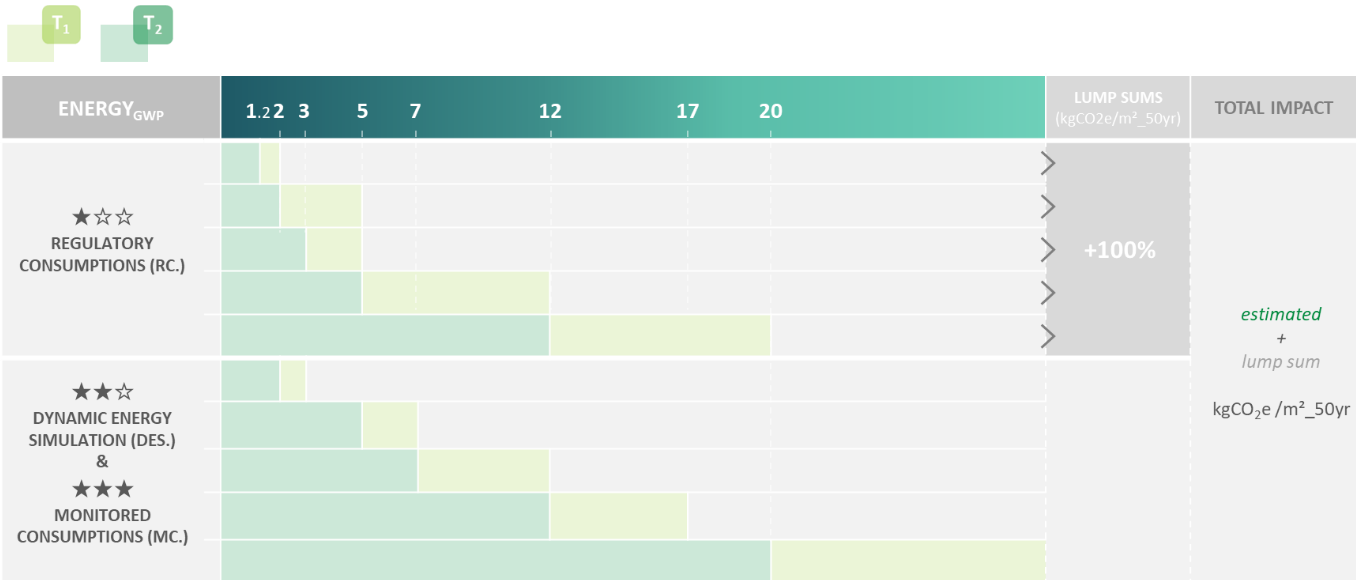


Figure 10: Operational carbon assessment with lump sums

Similar to Embodied Carbon performance, to ensure comparable results emerge on different levels, a **lump sum** shall be added to Regulatory Consumptions (if consumptions are reported on this RC scope only). This "lump sum" consists of doubling the regulatory consumptions, which reflects a building's actual energy use as well as encouraging more precise calculation.

[14] *https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en*

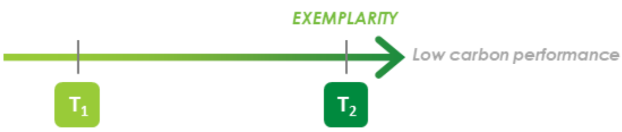
3. Biogenic carbon storage

Bio-based building materials contain carbon that has been extracted from the atmosphere as CO2 during their growth. This carbon will be re-emitted at the end of life of these materials, mainly in the form of CO2, CO, and CH4 depending on the scenario (incineration, landfill, etc.). A "biogenic carbon neutrality" approach is applied to the CO_2 stored in these materials coming from sustainable sources, as per EN15804+A2.

From a building industry perspective, provided their sustainable sourcing can be documented, bio-based materials (especially long lasting, structural ones) temporarily store a significant amount of carbon over a period of 50 years (the conventional life cycle of the building) and potentially more.

Therefore a time lag in emissions exists which is considered beneficial in the building sector's "race to urgent decarbonization", also providing a useful substitute to carbon-intensive materials whose manufacturing processes will take time to fully decarbonize.

As per the Level(s) methodology and EN 15804+A2, distinguishing itself from other methods, LCBI requests that the Biogenic Carbon content of the project is calculated and reported separately from the Embodied Carbon content (refer to Section 3 Biogenic carbon storage). Some EPDs in the 15804+A1 format do not report Biogenic Carbon separately. The targets for this criterion deliberately promote the use of bio-based materials at the construction stage, and to value the short- and long-term benefits resulting from the associated carbon storage.



	> 5 $kgCO_2e/m^2$	> 70 $kgCO_2e/m^2$
BIOGENIC CARBON	T_1	T_2

Figure 11: Biogenic carbon assessment

> In this first version of the LCBI framework **no minimum requirement is set on Biogenic Carbon Storage** in order to achieve the LCBI Standard certification.

T1 is 5 $kgCO_2e/m^2$ of Biogenic Carbon, which most projects can achieve with common finishing materials (composite wood raised floor, wooden doors, bio-based insulation, plinths, parquet, etc.).

T2 is 70 $kgCO_2e/m^2$ of Biogenic Carbon, which suits wooden or mixed structure buildings that incorporate structural timber (CLT flooring, CLT beam/columns, wooden frame facades, etc.). It reflects a strong commitment to include bio-based materials as a key low-carbon strategy for whole building design, and values the significant storage provided by those projects.

4. LCBI whole-life carbon rating

Once the project has been assessed against the three criteria of the LCBI methodology (Embodied, Operational, and Biogenic Carbon storage) and proven its compliance to different Targets (1 or 2), then the LCBI whole-life carbon rating can be delivered. This rating system is comprised on three levels of increasing exemplarity, based on its overall performance: standard, performance, excellence. This system has been designed so that T1 defines an entry level of minimum performance for low-carbon buildings, whilst T2 captures exemplarity projects—based on current data and knowledge.

> In order to grant the certification, the proposed method cautiously avoids mixing the very different flows of carbon emissions (Embodied, Operational, and Biogenic) into a single indicator. It instead defines its performance levels based on three criteria, with the following weighting:

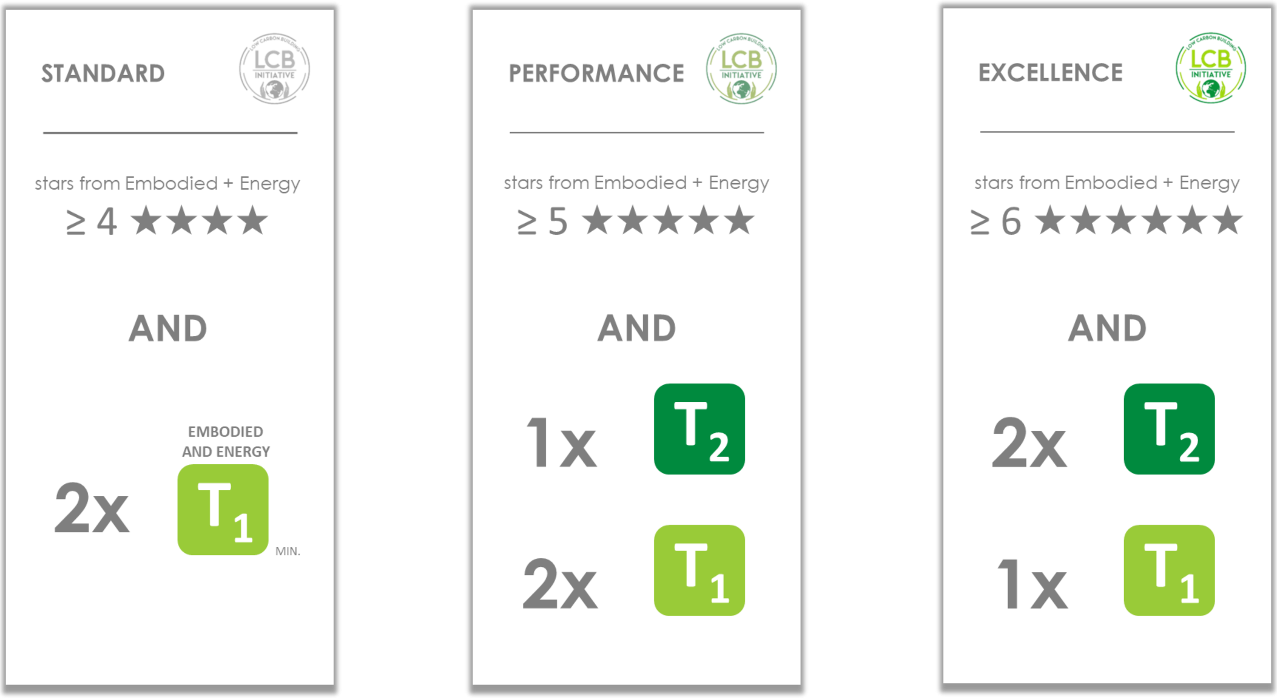


Figure 12: LCBI rating system

- **STANDARD**: *First steps towards low-carbon buildings*
  - ✓ Satisfactory assessment completeness on components + Energy indicators (at least 4★) with a minimum performance (Target 1) on Embodied and Operational Carbon,
  - ✓ Embodied Carbon does not exceed **1,000 kgCO_2e/m²**,
  - ✓ The carbon performance of the building is within the **Top 50% of benchmarked projects** carrying out a **complete and detailed LCA**, with an energy performance following **CRREM 2035** trajectories,
  - ✓ LCBI Standard certification is accessible for most specifications, but sobriety and alternative materials must be part of the design. Therefore, the **LCBI Standard certification sets a high bar for low-carbon buildings, aiming to challenge conventional practices and to exclude a business-as-usual approach.**

- **PERFORMANCE**: *Low-carbon briefs to challenge design*
  - ✓ Market best practice in terms of assessment completeness: **a wider scope is required** (at least 5★),

- ✓ Projects need at least one exemplary result within their strategy: **one T2 achieved**,
- ✓ Site-constrained projects can use biogenic materials or excellent energy performance to compensate for their infrastructure,
- ✓ Efficient and frugal projects can highlight their efforts to reduce materials whilst aiming for exemplarity design with T2,
- ✓ Project briefs can retain architectural complexity but this must be measured and balanced with other opportunities and constraints,
- ✓ Balance between operational and embodied emissions must be studied carefully, up to the MEP design, to find relevant trade-offs.

- **EXCELLENCE**: *Groundbreaking projects with exemplary reporting*
  - ✓ Projects need a complete scope of assessment (at least 6★) and two exemplary results (Target 2) for the three criteria to align with the best practices of low-carbon buildings,
  - ✓ All the carbon impacts of the building are fully assessed,
  - ✓ This level challenges building design and **incentivizes a deep practice shift to decarbonize each building part**,
  - ✓ From efficient volumes to bio-based structural materials, from façade thermal design to fossil-free heat, from alternative choices and careful sourcing for tenant works to a proper understanding of MEPs,
  - ✓ **The carbon performance** of the building is within the **Top 25%** of projects with consistent emission reporting, **having reduced their carbon emissions by more than 30% over the entire life cycle compared to business-as-usual**.

Example

For a project to attain a LCBI Standard certification (4 stars are needed). If its energy performance is estimated using National Calculation Methodology (1 star rating), it is necessary to have a comprehensive Embodied Carbon LCA, with detailed accounting of Frame & Shell + Site & External + Partitions & Finishes (3 star rating).

To reach LCBI Performance (5 stars are needed), the project must improve its study scope: either switching from NCM to DES (or Monitoring Consumption), otherwise adding Technical & Services components to the LCA scope (4 star rating).

This grading system guarantees that exemplarity low-carbon claims rely on sufficiently complete assessments (whilst acknowledging current limitations in LCA practice), transparency (a carbon result in kgCO2e/m² can no longer be disclosed without an associated number of stars), and performance (T1 and T2 representing state-of-the-art absolute carbon emissions).

Lower Embodied Carbon results coming from bio-based materials (as substituent for carbon intensive materials) are implicitly expected but setting separate targets on embodied and biogenic indicators should prevent projects from compensating poor overall design with extensive amounts of bio-based materials.

These three LCBI certification levels are developed in a flexible and resilient way so that final targets and/or star rating calibration can be tightened (or loosened) in the future. Targets may evolve in future versions and become country-based and better adapted to the three building types.

Finally, and independently of the LCBI certification process, the proposed universal 2D rating framework of *(Carbon performance) x (Completeness)* which separately addresses embodied life-cycle emissions, operational (yearly emissions) and biogenic (temporary storage) carbon, is expected to become a valuable reporting tool at a multi-asset portfolio level. It can be used as a monitoring tool to understand, track, and plan progress in the carbon performance of building stock. LCBI's position among other environmental initiatives (see Figure 13) and certifications relies upon compatibility with existing schemes, as well as its ability to bridge the gap between ESG reporting requirements and project-level management of low-carbon briefs / designs / operations, in a verified way.

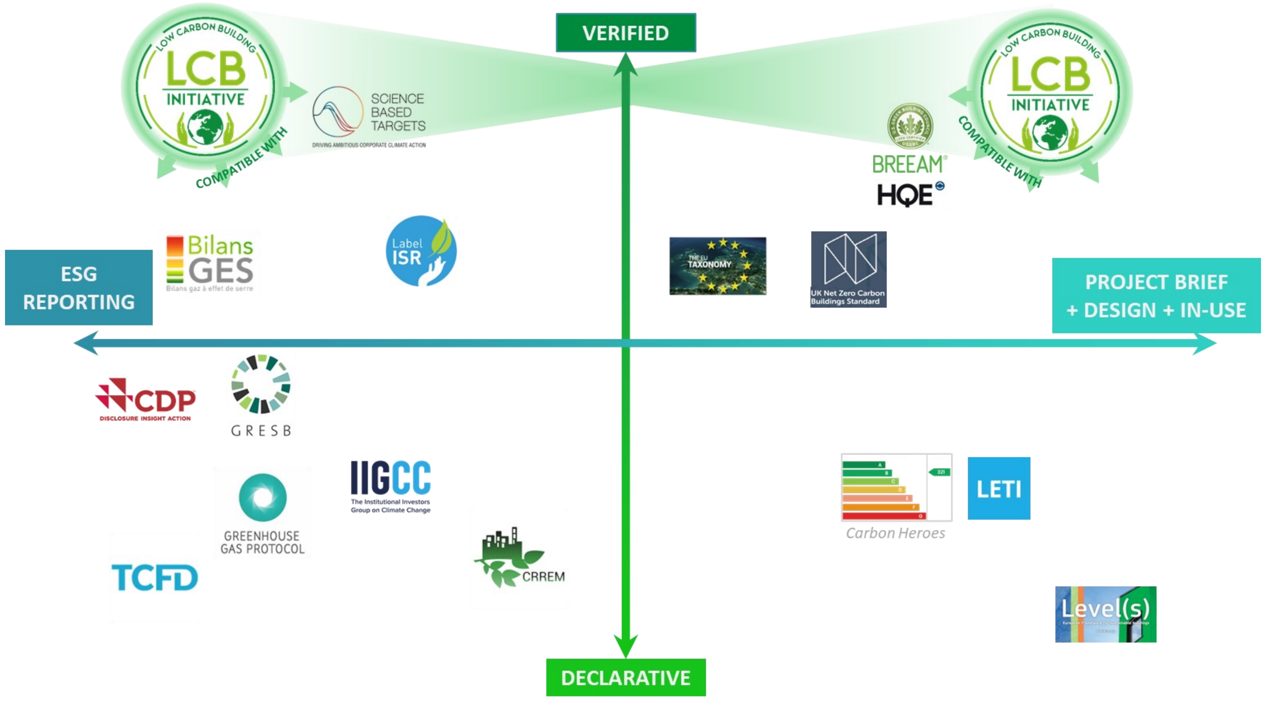


Figure 13: LCBI compliance with ESG initiatives

4. APPENDIX

1. Environmental data

1.1. EPD standard

In accordance with the EN 15978, the Low Carbon Building Initiative (LCBI) method should be based on Environmental Product Data sheets (EPDs) defined by the EN 15804+A1 standard. However, the EN 15804+A2 revision (published in July 2019) brought significant changes to EPDs, such as new indicators and a different way of accounting for Global Warming Potential. Although EPDs must comply with the +A2 amendment since July 2022, many EPD databases still contain +A1 EPDs and the transition is not complete. As this transition may take some time, LCBI accepts both +A1 and +A2 EPDs to ensure enough environmental data is available to LCA practitioners. The final switch to EN 15804+A2 will occur in a future version of LCBI.

Although full reporting on all life-cycle stages was not mandatory within the EN 15804+A1 EPD format (e.g. A4-A5 or C-D stages), LCBI requires whole life-cycle data for each construction product, which may request LCA practitioners to fill the gaps of missing stages in incomplete EPDs. Tools such as OneClickLCA are available with built-in features to ensure this is achievable during +A2 deployment in EPD databases.

1.2. Environmental databases

Various databases and programs in Europe provide EN 15804 compliant data for construction materials and equipment. All these databases can be used by the practitioner (a non-exhaustive list is available[15]). However, practitioners should be careful to use local data, as detailed in the next section.

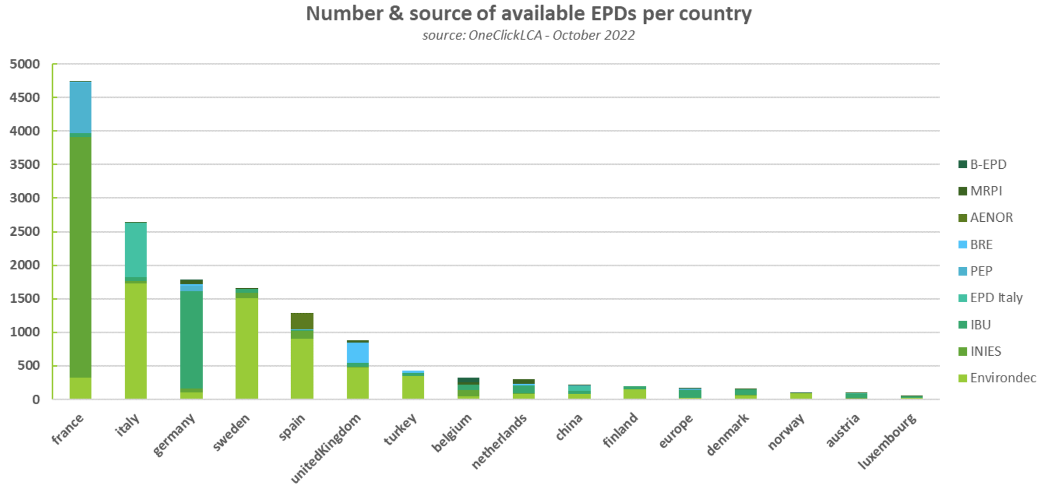


Figure 14: Database list and number of EPDs available

[15] *https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/412/documents*

1.3. Prioritization of the use of EPDs

Choosing the correct EPD to describe the environmental data of an element is important for the Embodied carbon performance of a building, as it describes the manufacturing process, the functional units, the transport and assembly assumptions, the reference service life, and other factors that affect obtaining accurate LCA results. However, most European countries lack sufficient data for LCA practice to be a reliable design tool. While this is a key hindrance to the deployment of LCA practice as a robust design tool, many manufacturers have not published EPD for their products yet.

Therefore, LCBI does not restrict the use of local EPDs but allows the use of foreign or equivalent EPDs to describe a specific product if no local or generic data is available.

The following table shows the prioritizing principle for product-specific data being used over geographic accuracy:

Priority of use	Type of data	Definition and case of use
1	Product specific EPD	Product specific EPD. The product can be manufactured at different factories but comes from one supplier. Use authorized if the commercial reference of the implemented product is covered by the specific EPD.
2	Average EPD	Represents the average of multiple products from one or more companies provided by industrial associations that cover the product. Use authorized if the commercial reference of the implemented product is covered by the list of commercial references of the average EPD.
3	Generic dataset	Environmental data in accordance with EN 15804 calculated as an average of all manufacturers of this product, representative for a country or region. This type of product data, if available, can always be used, but for more assessment accuracy, it is recommended to use a specific or average EPD when available.
4	Equivalent product EPD	This is a product specific EPD or an average EPD for an equivalent product, with the same technical characteristics and the right geographical scope of application, but it does not cover the exact product (e.g. a different brand).
5	Product specific EPD or Average EPD (other country)	A specific company product or an average EPD for a group of products from one or more companies, based on data from foreign industrial associations. Meaning the application's geographical scope of this EPD does not cover the country or region of the project. These types of data found on foreign databases can be implemented if a lack of data for the product exists on the local database. This data will be relocated by adjusting the hypothesis to the project country, including production, transport, and end-of-life scenarios.
6	Generic dataset (other country)	Environmental data in accordance with EN 15804 calculated as an average of all manufacturers of this product, based on the average of all manufacturers of this product, from another country or region that is transferred to the project's country.

Given that product environmental data may not reflect its region of use, which can lead to inaccuracies in the LCA. Therefore, in cases 5 and 6 of the table above, the product's Embodied carbon for production and transport should be adjusted to the average market of the project's country. Tools such as OneClickLCA are available with built-in features to facilitate this adjustment.

EPDs are usually valid for five years; all EPDs used for the calculation at the end of the design phase must therefore be valid. If some EPDs are updated, deleted, or expired, they remain usable for the final LCBI calculation at the end of construction.

1.4. Non-accounting of biogenic carbon

The Embodied carbon performance indicator measures the global warming impact of fossil and LULUC greenhouse gas emissions. For an EPD that follows the EN 15804+A2 standard, the LCA practitioners will add these two impact indicators:

- Climate change – fossil,
- Climate change – land use and land change (LULUC).

The impact indicator "Climate change – biogenic" will not be taken into account.

However, for EPDs made according to the EN 15804+A1 standard, fossil and Biogenic carbon emissions are not distinguished. In the case of an EPD +A1 , therefore, LCA practitioners must ensure that Biogenic carbon content is neither deducted in stage A, nor released in stage C. To do this (either through automated features in their LCA software or manually), LCA practitioners will add Biogenic carbon storage of the product to the climate change impact of phases A1-A3, and will subtract the release of Biogenic carbon contained in biomass for phases C1-C4 at the end of life. Carbon release is calculated on a case-by-case basis based on the end-of-life scenario described by the EPD. In this way, no stage of the life cycle must have a negative emission value.

1.5. Scenarios for completing cradle-to-gate EPDs

For EPDs which are in EN 15804+A1 format, only modules A1, A2 and A3 are mandatory. These EPDs are called cradle-to-gate. However, LCBI assesses performance over the entire life cycle of the building: from A1 to C4. These data will therefore be completed by the modeler in accordance with the scenarios for each stage of the life cycle described in Article 8 of EN 15978.

However, this standard leaves a great deal of freedom in the description of the end-of-life scenario, which can be impactful and depends a lot on the scenarios chosen. The main solution proposed at this stage is to rely on the combination of the LCA practitioner's experience, state-of-the-art LCA tools, and increasing partnerships between designers and manufacturers to allow for custom definition of end-of-life scenarios, rather than strictly sticking to the detailed (or missing) scenario in the available EPD. The LCA assessor should propose a realistic end-of-life scenario for the material under consideration. The end-of-life scenario chosen should be clearly explained, together with the information sources. In particular, it may be based on the end-of-life scenario assumptions described in paragraph 5.6.1 of the RICS "Whole life carbon assessment for the built environment", 2nd edition, September 2023. Module D is set to 0.

With regards to B stages for which data is lacking, it should be possible for the LCA practitioner to supplement the missing data; either by using similar complete EPDs and applying weights with respect to the impact of stages A1-A3, or by applying an average percentage of $B1\text{-}B5_{GWP}$ / $A1\text{-}A3_{GWP}$ derived from the LCA category/macro-lot and multiplying the latter by $A1\text{-}A3_{GWP}$ of the material to be completed.

1.6. Refrigerants

In the case of an LCA carried out up to the Technical & Services scope, some equipment containing refrigerants can be modelled (e.g. heat pumps or chillers). Usually, the environmental data (EPD) contains direct refrigerant emissions (generally in B1) and the impacts of refrigerant production equivalent to leaks in B2. These impacts should be included in the Operational Carbon indicator as building operating impacts. To avoid double counting, the LCA modeler will therefore ensure that these B1 and B2 modules are removed from the Embodied carbon.

1.7. Default service lives

Most EPDs provide a service life for the covered product. However, when EPDs do not give the product service life the following data can be used:

Category	Sub-category	Element	Default service lives[16] (years)
FRAME & SHELL ★☆☆☆	1.1 Frame	Slabs	
		Beams	
		Columns	≥ 50
		Walls	
		Stairs, ramps and safety guarding	
	1.2 Facade	Rain screens, timber panels	30
		Brick, stone, block and precast concrete panels	≥ 50
		Glazing systems	35
		Shading devices	30
	1.3 Roof	Structural elements	≥ 50
		Roof coverings	30
SITE & EXTERNAL ★★☆☆	2.1 Sub-structure	Foundations and piling	
		Basement slabs	≥ 50
		Retaining walls and structural frame	
	2.2 External work	Asphalt	35
		Concrete and stone paving	≥ 50
		Timber decking	15
		Fencing, railings and walls	20
		Drainage systems	30
PARTITIONS & FINISHES ★★★☆	3.1 Internal fittings	Studwork internal walls	30
		Blockwork internal walls	≥ 50
		Interior acoustic and thermal insulation	30
		Internal doors	30
		Raised access floor RAF pedestal	50
		Raised access floor tile	30
		Suspended ceilings	25
		Sanitary fittings	20
	3.2 Finishes	Carpet / Vinyl floor finishes	7
		Floor coatings	10
		Stone tiles floor finishes	25
		Cupboards, wardrobes and worktops	10
		Sockets and switches	30
		Skirting and trimming	30
		Wall render finishes	30
		Wall paint finishes	5
		Ceiling paint finishes	10
TECHNICAL & SERVICES ★★★★	4.1 Heating and hot water	Heat source (boilers, calorifiers…)	20
		Heat pumps	15
		Heating and hot water distribution network	25
		Heating emitters	20
	4.2 Cooling	Cooling generation equipment	15
		Cooling distribution network	15
		Cooling emitters	15
	4.3 Ventilation system	Air movement (fan coil systems…)	15
		Air terminals	20
		Ductwork galvanised	40
		Ductwork plastic or flexible	15
	4.4 Sanitary systems	Cold water systems	25
		Sanitaryware	20
		Drainage and rainwater	25
	4.5 Electrical installations	Lighting systems and light fittings	15
		Onsite electricity generation	15
		Electricity distribution	30
	4.6 Other systems	Lifts, escalators and conveyor installations	20
		Firefighting installations	30
		Telecoms and data installations	15

[16] *Sources: Level(s) indicator 1.2: Life cycle Global Warming Potential (GWP), Table 4. Default service lives for the minimum scope of building parts and elements. Whole life carbon assessment (WLCA) for the built environment, RICS, 2023. Table 20: Indicative component lifespans.*

1.8. Target setting methodology for operational carbon

As mentioned in Section 2.3, Operational carbon thresholds are coherent with performant energy consumptions and are aligned with CRREM pathways. These thresholds are based on a dedicated target setting method that uses energy consumption scenarios and compares them with the GHGe stranding years from the CRREM tools.

Firstly, two sets of energy consumption scenarios were simulated, representing two degrees of ambition in their thermal and usage modelling assumptions (namely base and best in the charts below). These simulated offices and housing relied on the following energy supply: all electric (heat pump) systems, no renewable energy production, and no fugitive emissions. These simulations, representative of the thermal characteristics of current new built practices, were ran using twenty-one weather files from an equal number of cities spread across eight countries. Analysis showed that there were no major discrepancies between offices and housing for their overall annual energy consumption, assuming both were heated and cooled.

Energy use and Operational carbon for these simulations (blue curves) are shown in the Figure 15 below shows the energy results for fictional offices (left), translated (right) into yearly Operational carbon emission pathways, with CRREM comparison and LCBI targets. CRREM 2024 GHGe emission factors were applied. T1 and T2 energy consumptions are expressed in kWhFE/m².yr (hatched green)—represented for indicative purposes only as they aren't subject to thresholds in the LCBI method.

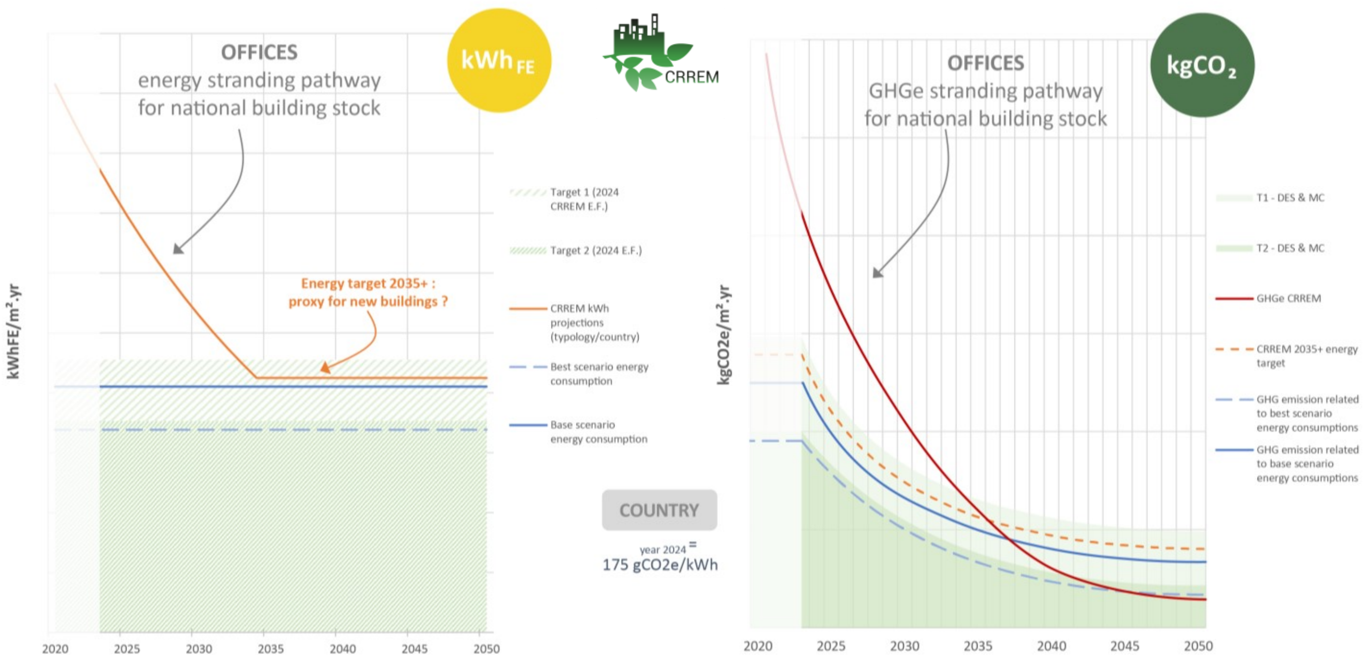


Figure 15: Energy target setting – Fictional office example

For instance, in a country with an emission factor of 175 grCO_2/kWh, the current LCBI version sets a T1 of 17 kgCO_2e/m².yr and a T2 of 12 kgCO_2e/m².yr. Energy efficient buildings (the best scenario shown by the dotted blue line), can expect a stranding year after 2035, as they achieve the second and third star energy scope for T2.

Figure 16 reiterates the same information, with the CRREM pathways and LCBI thresholds for each country where the LCBI certification applies. It can be observed that the most countries have T1 targets (which differ according to country emission factor) that match a low stranding event happening around 2035.

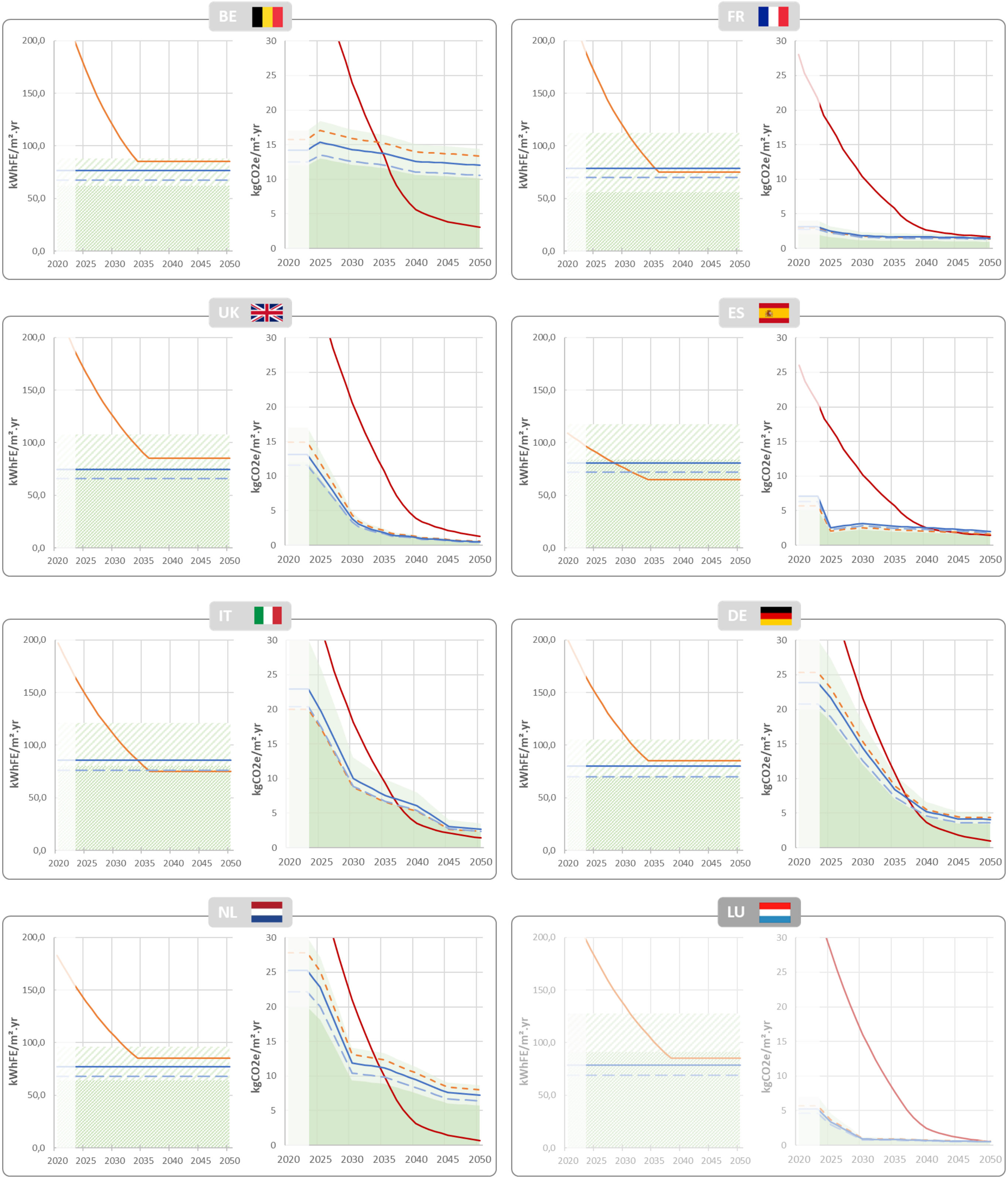


Figure 16: Energy and carbon pathways for each country

1.9. District heating

For a building that fails to meet Operational carbon targets due to using a carbon-intensive heating network supplying more than 50% of its heating needs (heating + DHW), the applicant can ask the auditor for an adaptation. The auditor will then refer the matter to the LCBI Technical Commission to verify that the building meets the minimum thermal performance requirements, and has an energy supply strategy in line with the certification's original intent.

This request will be based on a technical file comprising the following documents:

- A narrative about the choice of connection to the selected district heating network and discarded alternative options, and a demonstration that it is this choice that causes the threshold to be exceeded,
- An assessment of the project's energy consumption and its positioning in relation to CRREM energy pathways,
- Documentation sourced from the district heating utility provider on the carbon content of the energy delivered, and its 2030 decarbonization roadmap,
- An explanatory diagram of the energy supply systems installed on the project, with a description of their installed capacity and estimated coverage rates per use for the various energy sources.

On the basis of this complete file and a consistency check from the auditor, the technical commission shall be able to deliver a validation notice regarding an adapted value of T1, and make recommendations on the associated reporting requirements.

2. LCA tools

LCBI requires detailed LCA reporting which ensures comparability and transparent verifiability, as well as consistency in data formatting and completeness. To ensure accurate calculations, the **LCA tools** must meet these requirements:

- Filling gaps in EPD to cover missing life-cycle stages of cradle-to-gate EPDs
- Reporting LCA results in a format that allows them to be independently read:
    - Global warming potential for stages A1 to C4
    - Global warming potential for the D stages
    - Biogenic carbon storage

The global warming potential for the A1 to C4 stages should thus not include Biogenic carbon.

As of now, OneClickLCA software seems to comply with these necessary procedural requirements. Other in-house or commercial LCA tools may emerge over time.

3. Reporting spreadsheet

Projects applying for the certification must complete the attached Excel Reporting Sheet. It summarizes all the input data needed for calculating the three indicators (Embodied carbon, Operational carbon, and Biogenic carbon storage), as well as the results of the life-cycle assessment. Its purpose is to standardize LCBI studies and facilitate their audit. In addition to this reporting sheet, the applicant must provide the following information:

- General information about the project,
- Embodied carbon and Biogenic carbon storage: a detailed LCA component by component (quantities of materials, the name of the EPD and the database, carbon impact phase by phase, etc.),
- Operational carbon: a detailed report of regulatory consumptions or thermal simulation, and documentation on their associated assumptions.

The certifying body will provide a detailed list of the documents required when the project is registered.

Low Carbon Building Initiative – LCBI, January 2024