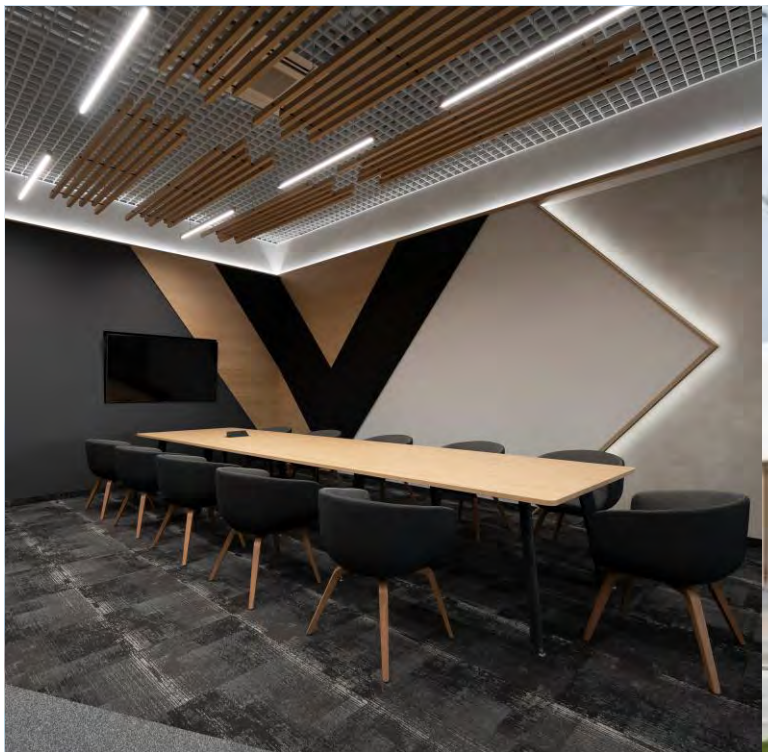
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Simplification of GWP assessment for lighting and daylighting components

A market-based perspective





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IEA SHC TASK 70 | EBC Annex 90: LOW CARBON, HIGH COMFORT INTEGRATED LIGHTING

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Our mission is *"Through multi-disciplinary international collaborative research and knowledge exchange, as well as market and policy recommendations, the IEA SHC will work to increase the deployment rate of solar heating and cooling systems by breaking down the technical and non-technical barriers."*

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SOLAR HEATING & COOLING PROGRAMME
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Simplification of GWP assessment for electric lighting and daylight components

A market-based perspective

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PREFACE

Lighting accounts for 15% of the global electrical energy consumption and 5% of global CO_2 emissions. Thus, widening the rating perspective of lighting solutions to a more holistic view of its impact on CO_2 emissions, encompassing the whole life cycle chain also in the context of regional energy markets aspects, interaction with other building trades, etc. is urgently deemed necessary. This goes far beyond the pure LED lamp-driven energy efficiency gains.

The aim of IEA SHC Task 70 / EBC Annex 90 “Low Carbon, High Comfort Integrated Lighting” is to identify and support implementing the potentials of lighting (electric, façade: daylighting and passive solar) in the decarbonization on a global perspective while aligning the new integrative understanding of humans’ light needs with digitized lighting on a building and a building related urban scale. This includes the following activities:

- Actively support broadening the view on lighting solutions as a whole in the context of decarbonization. Help bridge the gap between a component view (manufacturer’s focus) and design-oriented system approaches. Support the transition from a rather pure energy focused view so far to a life cycle assessment (LCA) perspective. On this basis, identify key impact factors and develop the most effective strategies and roadmaps while including regional specifics.
- Contextualize this with the fast-developing digitization of buildings / lighting installations on the technology, design and operational side. Add to selected open points in the digital chain like better design processes.
- Align this with the still growing understanding of user needs; here specially build upon results from earlier IEA projects (e.g. IEA SHC Task 61 / EBC Annex 77).
- Integrate competencies: Bring the different involved players (electric lighting, façade, industry, controls) so far not connected on low carbon solutions together in workshops and specific projects. Create added value also by transferring into standardization, regulations, and building certificates.
- Foster the broad implementation of low carbon solutions, also and especially in developing countries, by promoting tailored “Low Tech – High Impact Solutions” through demonstration, design guidelines, and workshops.

To accomplish these objectives, the work plan of IEA SHC Task 70 / EBC Annex 90 is organized according to the following four main subtasks.

Subtask A: Low Carbon Lighting and Passive Solar: Scenarios, Strategies, Roadmaps.

Subtask B: Visual and non-visual User Requirements.

Subtask C: Digitalized Lighting Solutions (Technology & Design Tools / Process).

Subtask D: Application and Case Studies.

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Appendix 18

A. Market availability of EPDs for luminaires 18

This report addresses simplification approaches to specify Global Warming Potential (GWP) for lighting fixtures and daylighting products. On the manufacturer's side, simplification will lower costs and – by this – will also lower the current burden of specifying GWP values at all. Also, this can mitigate the competitive disadvantages of SMEs compared to bigger industry by the high complexity and cost of current certification approaches. On designer's side embodied carbon estimation will – by simplification – be better integrated into existing workflows and established rating procedures – also and especially in its linkage to operational carbon calculation. It can increase acceptance and utilization by designers. Only with this, a bigger impact on the needed design decisions towards decarbonization in the building sector, here exemplarily addressed for the two sectors lighting and shading, can be expected. Overall GWP awareness across large portions of the market in the future can be improved.

1 Introduction and relevance

In daily practice effectiveness and costs count, from both a designer's and a manufacturer's perspective, Life Cycle Assessment (LCA) is added on top as one of many criteria to be met. Associated rating processes therefore must be slim and to the point. Complexity hinders application. LCA in lighting is perceived to be difficult. For instance, the level of detail is considered too high specifically in the early design stages or LCA and lighting specialists have different technical backgrounds – speaking different languages or at least different dialects. To have an impact it should be brought to a lower complexity level – ideally integrated with today's established energy rating procedures, which normally work with generic data.

This report specifically addresses the current complexity and in consequence options to facilitate rating the global warming potential of lighting and daylight related facade components in daily building design processes. With electric lighting and sun-shading products two exemplary market sectors are selected to make the case. Both addressed industry sectors have a quite similar market structure with a limited number of bigger companies and a rather longtail segment of small and medium enterprises (SMEs). "To simplify and clarify current ecodesign and labelling rules that apply to lighting products, to foster compliance by suppliers and enforcement by market surveillance authorities" is among other explicitly on the agenda of major lighting trade associations [1], [2].

While larger companies can more easily cope with generating and managing the complex declarations currently in use, like Environmental Product Declaration (EPDs) or Product Environmental Profiles (PEPs), this imposes high challenges on SMEs. The report therefore specifically focusses on SMEs' needs to facilitate procedures in light of their limited resources and especially by this, introducing GWP rating in large portions of the market at all.

From a manufacturer's perspective two specific approaches are addressed to support simplifications in practical use: (i) data regression based and (ii) role model based by using sector EPDs, to support simplifications in practical use. Alongside, as well the designer's perspective is investigated: (i) what level of detail is needed at which stage? (ii) What is the data availability? (iii) How can this be matched with already established, widely used and mostly mandatory rating methods in the closely linked field of energy efficiency?

Chapter 2 provides a short general background on LCA and lighting. The case of the electric lighting sector is then closer elaborated on in chapter 3, and that of the shading sector in chapter 4. For each, the status quo and then specific simplification approaches are discussed. Chapter 5 specifically tackles the topic of integrating LCA with established – in many regions already mandatory - energy rating procedures. Finally, chapter 6 addresses in a compact overview "challenges" and "actions needed".

2 Background on LCA and Lighting

Lighting accounts for 15% of global electricity consumption and 5% of related global greenhouse gas emissions [3]. This while the global lighting intensity still increases at a rate of around 2% per annum [4]. Big variations in decarbonization efforts and strategies between countries exist [5]. For instance, the development of grid side emission factors depends on market developments and political implementation strategies for carbon neutrality: e.g. 2045 in Germany, 2050 in Europe or 2060 in China.

Carbon impact is required to be quantified in different contexts for sustainability certificates, regulations and as basis for subsidies, this at different levels of detail and by different stakeholders. Still, this is most of the time a

voluntarily requirement. from the side of authorities. However, there is a trend towards making it more often mandatory to reach decarbonization goals.

For quantification, established Life Cycle Assessment (LCA) methodologies describe the environmental impacts over the entire life cycle of products and product systems, following ISO 14040 and ISO 14044. Climate change impacts are commonly quantified using Global Warming Potential (GWP) in accordance with ISO 14067. The life cycle stages are structured as “Product and Construction” (A1–A5), “Use” (B1–B7), “End-of-Life” (C1–C4), and “Beyond the System Boundary” (D), as defined in EN 15804. “Carbon Footprint”, GWP is one of the environmental impact indicators assessed within the LCA framework.

Operational carbon GWP_{oper} depends on the impact of the chosen lighting technology and façade design on “B6 Operational Energy Used”, i.e. the electricity demand and the other used energy carriers in an overall building perspective. Embodied carbon GWP_{emb} is dominated by stages A, C, (D) of a product or product system.

Data on climate change impacts at the component level are currently declared in third-party verified EPDs or PEPs, which are based on underlying life cycle assessments conducted in accordance with relevant Product Category Rules (PCR) and Product Specific Rules (PSR). To determine the GWP_{emb} of a product system like a façade the corresponding GWP_{emb} results from EPDs for glazing, framing, and sun-shading components are combined according to their quantities. Functional unit[1] (FU) relate products or product systems to services provided, for example the luminous flux of a fixture or the daylight provision on room level delivered by a façade system [6].

3 Case one: Electric Lighting Gear

We put LCA for lighting fixtures into the context of already existing regulations for the lighting market and discuss simplification for GWP rating, this specifically from a SMEs’ and designers’ perspectives. We focus on indoor lighting systems. However, the approaches can be transferred to other lighting sectors like outdoor and road lighting as well.

3.1 Status quo

3.1.1 Regulatory framework

3.1.1.1 Non LCA requirements

Lighting fixture production in the EU is governed by a comprehensive framework of more than a dozen standards, directives, and regulations to ensure product safety, electromagnetic compatibility, and environmental compliance. Key standards include EN IEC 60598-1:2024 for general luminaire requirements and tests, EN IEC 60598-2-1:2025 for fixed general purpose luminaires, EN 61547:2023-10 (general safety), EN IEC 61347-2-13:2025-04 (EMC immunity), EN IEC 61000-3-2:2019-04 (EMC compatibility), EN IEC 61000-6-2:2019-04 (EMC immunity), EN 62471:2010 (photobiological safety), EN IEC 63000:2019-01 (restrictions of hazardous substances), EN 62493:2015-11/A1:2023-03 (exposure to electromagnetic fields)**,** and EN IEC/IEEE 82079-1:2020 (instructions for use). Compliance with EU directives such as LVD 2014/35/UE (Low Voltage Directive), EMC 2014/30/UE (Electromagnetic Compatibility Directive), and RoHS 2011/65/UE (Restriction of Hazardous Substances) is mandatory, alongside adherence to the General Product Safety Regulation (GPSR 2023/988), Electric Waste Directive 2012/19/UE (WEEE) and other applicable regulations for electrical products, e.g. those regulating the waste of electrical and electronic equipment and “ecoproject” rules. Manufacturers are required to maintain product documentation for at least 10 years, including the Declaration of Conformity (CE), test reports supporting the CE declaration, user and maintenance instructions, and risk analysis. Altogether, these requirements represent a robust and multi-layered regulatory environment, with more than 15 distinct rules and standards that must be observed.

[1] In LCAs Functional Units (FU) are a key concept. A Functional Unit (FU) is a precisely defined reference that describes what function is being delivered and in what quantity, such that environmental impacts can be measured, compared, and interpreted consistently.

This framework results in significant costs for manufacturers. Internal tests and test reports incur expenses that depend on the type of test and the authorized body involved. Certification under ENEC or ENEC+ typically costs around 20,000 Euros per product family, with an additional annual renewal fee of approximately 2,000 Euros. For ZHAGA certification, the cost is about 2,000 Euros per fixture family, plus a 2,000 Euro annual fee. Altogether, the total cost for compliance and certification can easily exceed 25,000 Euros per product family, not including ongoing annual fees and the variable costs of internal testing[2].

3.1.1.2 LCA requirements

The EPDs and PEPs are both tools for assessing and communicating the environmental impact of products through Life Cycle Assessment (LCA), referring to Table 1. The EPD follows ISO 14025 and EN 15804 standards, mainly targeting the construction, industry, and infrastructure sectors, while the PEP uses a specific methodology tailored to the electrical and electronic industry. Both aim to provide environmental transparency. EPDs are published in recognized programs such as the “International EPD System” and “ECO Platform”, whereas PEPs are certified by the “PEP-Ecopassport Organization” following product specific rules (PSR) for luminaires [7]. Participation in both schemes is generally voluntary, though EPDs may be required in green building contexts, and PEPs are often required within the electrical industry. Although the cost may vary from case to case for luminaires, the cost of an EPD certificate typically starts at around 8,000 Euros per product family, plus 1,000 Euros for registration depending on affiliation status and an annual fee of 1,000 Euros. For a PEP certificate, costs include the preparation of the LCA, verification by an accredited body, and a registration fee of 865 Euros. A short validity period of five years adds to the cost due to regular renewals.

Thus, significant additional resources are required to generate and maintain fully LCA documented luminaire product portfolios. Following the EPD path around one third of the cost comes on top of already mandatory non-LCA requirements, which can then add up to a total of more than 33,000 Euros for a fixture family.

Table 1: Comparison of the third-party verified Environmental Product Declarations (EPDs) and Product Environmental Profiles (PEP) systems, providing data on climate change impacts (GWP) at component level.

Feature	EPD (Environmental Product Declaration)	PEP (Product Environmental Profile)
Full Name	Environmental Product Declaration	Product Environmental Profile
Standard/methodology	ISO 14025, EN 15804 (for the construction sector)	Specific methodology for the electrical and electronic sector
Scope	All industries (mainly construction, industry, infrastructure)	Electrical and electronic industry
Basis of analysis	Life Cycle Assessment (LCA)	Life Cycle Assessment (LCA)
Purpose	Environmental transparency of the product, support for green building	Environmental transparency in the electrical and electronic sector
Certification	Published in EPD programs, e.g. The International EPD System, ECO Platform	Certified by the PEP Ecopassport Organization
Obligation	Voluntary (in some cases required, e.g. in green building)	Voluntary (often required in the electrical industry)

[2] For outdoor lighting additional cost may arise, e.g. for „DarkSky Approved Luminaires Program – against light pollution, environment protection”. A DarkSky approved product amounts to ca. $ 3,500 + $ 500 annual renewal.

3.1.2 EPDs and PEPs in Practice

3.1.2.1 Market availability

Research among selected SMEs (< 1,000 employees) in Poland (11 companies) and Germany (13 companies) has shown that almost none have EPDs available at the moment, refer to annex A. In the European market significant numbers of EPDs are only available from bigger manufacturers (mainly > 1,000 employees) and are accessible either on their websites or in EPD databases such as “ecoinvent”.

Bigger companies obviously benefit from scaling effects, with bigger lots for specific products as well as advanced ERP integration going along with efficient digital sourcing processes where SME are often not even capable of tracing their sources. This on the one side provides strategic advantages compared to SME. On the other side bigger companies are more often than SME active on different international markets, with several different certification and regulatory schemes, which all must be addressed, putting specific loads on them as well. For bigger companies, numbers of published EPDs/PEPs are between dozens and thousands published certificates (EPDs / PEPs), Appendix A.

Generally, there is the threat that implementing EPDs in their current complexity together with the other requirements mentioned may worst case lead to the exclusion of smaller companies in tenders, leaving the market to the large players.

3.1.2.2 Structural aspects and practical experiences

This short discussion is based on practically coping with the EPDs in an SME in Poland, an in-depth analysis of 60 fixture certificates by the authors and as well direct informal exchanges with bigger manufacturers and trade associations.

a) Methodology

- *Lack of data-transparency in EPDs and PEPs:* EPDs and PEPs of fixtures contain the total weight and the weight of relevant material groups (5, 22 up to 44, depending on the declaration program). Nevertheless, no carbon emission factors are provided for these material groups. This makes the certificates untransparent and not adaptable in case of changes, e.g. in the sourcing of materials.

- *Mixture of GWP_{emb} and GWP_{oper}:* The functional unit definition mixes embodied (stages A, C, (D)) and operational carbon (“B6 Operational Energy Use”) perspectives, which is formally questionable. It hinders a clear integration with today’s energy rating standards. GWP_{oper} determined by the correct energy rating weighed with the grid side carbon emission factor should be used instead of the current “B6” specification based on deliberate lump-sum assumptions. This will then accurately consider the specific usage contexts of fixtures. The instruments – established energy rating standards - for this are at hand, rf. to Chapter 5.

- *Product family approach*: To reduce complexity for in parts bigger numbers of product variations (product families) using scale up / scale down adaptations is a promising mean.

b) Application

- *Level of detail:* The understanding of which level of data is needed and when in the building design process has to be improved. An existing mismatch should be solved: The actual product, with very specific data as in e.g. EPDs, is in most cases decided only late in the design process. For the early design phase generic data are needed, supporting correct general decision making. These data should match classifications of fixtures as used for their usage in energy rating procedures.

- *Different certification schemes:* Different available and used declaration programs do not yet follow one agreed procedure. This makes product selection according to LCA/GWP criteria for e.g. designers difficult. Manufacturers as well are challenged by this diversity. A closer look at four big manufacturers in Europe alone showed three different EPD certificates in use. Within one big company two differently generated fixture certification schemes at a time were found. Now, international standardization has been initiated, with the intention to propose one then accepted scheme [8].

- *Data consistency:* Problems in managing data consistency for specific products have been observed. Photometric data in EPDs and actual technical product specifications specifications e.g. on homepages manufacturer’s websites did not match.

– *Limited validity:* Another critical issue is the limited validity period of EPD data. For a typical office luminaire, the underlying dataset can easily comprise more than 100 parameters, many of which change over time due to shifts in sourcing and production processes. This raises questions about how reliable and meaningful the resulting declaration remains in practice. It also suggests that the current approach may quantify parameters that are too dynamic to be captured robustly, which questions the maturity of the approach.

– *SME impairs broader application:* The practical implication is that with SME a big part of the market is not yet ready for possible requirements coming up.

c) Perception and awareness

- Lack of general knowledge in SME, lack of attractiveness, relevance for companies: The EPD topic and the process of obtaining this certificate are little known to most companies, especially among the SMEs. A direct market observation was that design companies, for instance those creating products for the hospitality industry (e.g. lighting fixtures), often do not know that EPD may also apply to them.

- Burden of many regulations: Companies are already being subjected to many obligations related to certification and reporting of ecological activities, refer to 3.1.1. Additional certification obligations should therefore be only introduced when necessary. Mitigating parts of existing regulations to keep total loads at least constant should be considered.

- Position of trade associations: "To simplify and clarify current Ecodesign and labelling rules that apply to lighting products, to foster compliance by suppliers and enforcement by market surveillance authorities." is among other explicitly on the agenda of major lighting trade associations [1], [2].

3.2 Simplification approaches

Following Figure 1 specific approaches for beneficial simplifications for both relevant target groups, designers and manufacturers, designers and manufacturers, are considered. Where manufacturers need a simple approach to inform about GWP of their luminaires as function of key fixture construction parameters, consultancies should have GWP values directly at hand, without extensive research of EPDs, especially in early design phases – matched to established building assessment procedures. For consultancies, the approach of using average GWP100 parameters is discussed in section 3.2.1. As for manufacturers, the approach of modeling GWP as function of fitted CO2 equivalent factors is addressed in section 3.2.2.

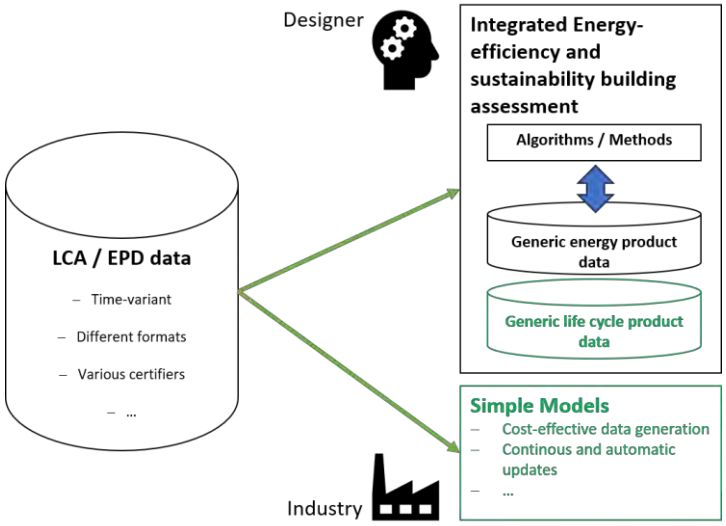


Figure 1: Illustration of simplification approaches for the target groups of industry and designers.

3.2.1 Designer's perspective

Table 2 and Figure 2 exemplarily show a set of generic GWP_{emb} values for luminaire classes in office lighting. The data aggregation is based on an analysis of EPDs and PEPs of 60 fixtures and 27 retrofit lamps conducted within IEA SHC Task 70/ Annex 90. Accordingly, representative data sets for other applications like hall lighting could be

generated. The GWP_{emb} data represent a “cradle-to-grave perspective” e.g. covering LCA stages A and C. They have been normalized to a luminous flux of 1,000 lm for the given reference service life. Table 2 as well gives an indication of the photometric distribution of the fixture as an input parameter to simple rating methods for the installed power in relevant energy rating standards. This representation allows a simple linkage to practically established energy rating procedures as discussed in Chapter 5.

In a generally comparable approach [9] a different split into luminaire classes is proposed: Downlight, cylinder, linear, troffer, post top. GWP_{emb} values are announced to be published at the end of 2026 [10].

For quality assurance, procedures comparable to the quality assurance of energy-related KPIs could be pursued, e.g. via experts in international (standardization) working groups, combined with publications of the underlying data used. Cooperation with independent certifiers in the field of LCA is an option. The introduction of AI driven data aggregation by automatically evaluating EPDs or alike (“data scraping”) in defined timesteps can as well be considered.

Table 2: Comparison of mean GWP_{emb} different luminaire classes for office lighting in $kgCO_2$/1,000lm[3]. “Cradle-to-grave perspective”; i.e. LCA stages A and C.

Fixture and its relation to the lighting scheme (photometric distribution) *		**Samples N**	**Mean GWP_{emb}****
		[-]	**[$kgCO_2$eq/1,000lm]**
Conventional, new	Ceiling mounted (**d; d-i**)	33	13,2
	Downlights (**d**)	14	9,9
	Freestanding (**d-i**)	7	11,8
	Average (**d; d-i**)	54	11,6
Desktop, new	Desktop (**d-i**)	2	7,8
	VDU on desktop (**i**)	1	2,2
	Average (**d; d-i**)	3	6,0
Fixture reuse	Light engines replacement (**all**)	3	9,2
	Retrofit lamps (**all**)	27	0,4

photometric distribution of fixture: direct **d; direct-indirect **d-i**, indirect **i**, following e.g ISO 20086*
*** GWP based on life cycle stages A and C.*

[3] In contrast to many certification schemes, no relation to “B6 Operational Energy Used” is considered.

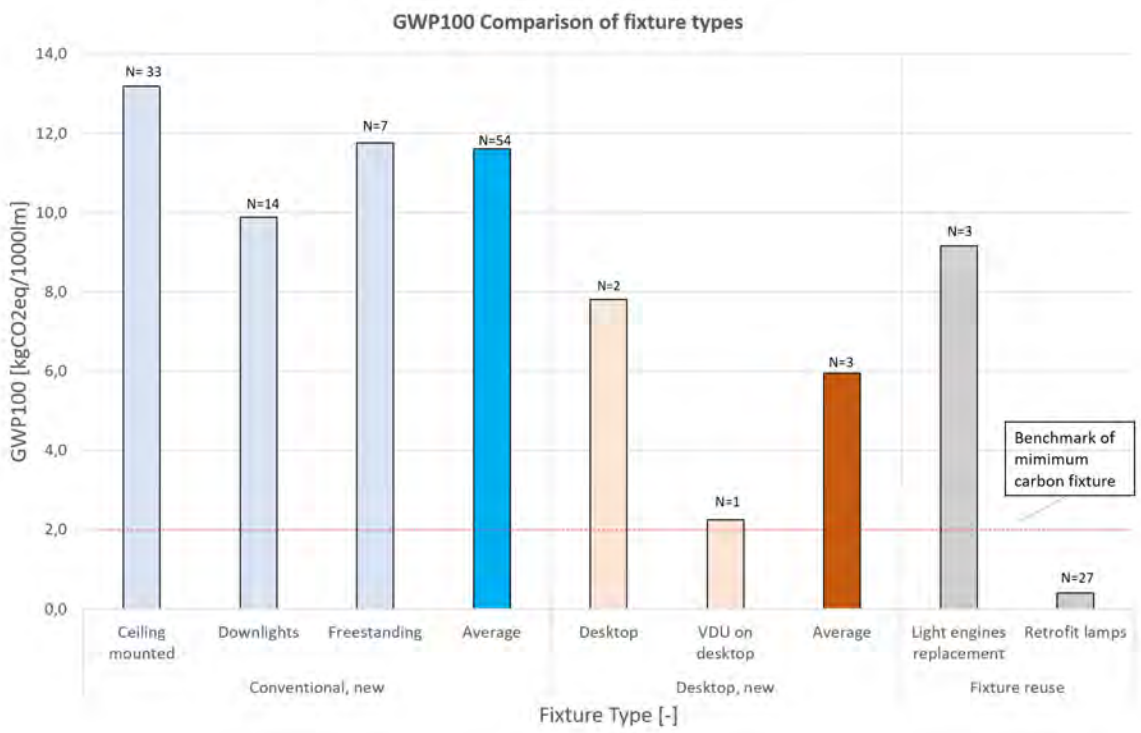


Figure 2: Comparison of new luminaires (conventional and new desktop-based concepts) and fixture reuse (light engine replacement and retrofit lamps) for LCA stages A and C.

3.2.2 Manufacturers perspective

A simplified model-based approach specifically targets manufacturers who need to rate the GWP e of their products in a simple way. The weights of key fixture components (material) classes are each multiplied by the corresponding CO_2 equivalent factors $k_{CO2,x}$. In this exemplary simple model set up in IEA SHC Task 70 / EBC Annex 90the used component classes were “steel, aluminum, plastics, electronics, packaging”. CO_2 equivalent factors $k_{CO2,x}$, listed in Table 3 for these classes were estimated using a multidimensional regression based on 31 detailed datasets of luminaire EPDs from four manufacturers for which the masses were provided. If the CO_2 equivalent factors are at hand, the estimation can be performed directly on own data. For plausibility check Table 3 as well contains material parameters from an AI supported data research. Figure 3 compares the GWP100 according to the EPD with the fitted values and shows a high coefficient of determination R2 = 0,90.

Table 3: Assumptions for CO_2 equivalent factors $k_{CO2,x}$ from multidimensional regression compared with reference values from AI based research. Fit based on a data set of 131fixtures.

	CO_2 equivalent factor for material group $k_{CO2,x}$ [$kgCO_2eq/Kg$]				
	Steel	**Aluminum**	**Plastic**	**Electronics (PCBs)**	**Packaging**
Datafit	2,2	16	7,0	25,0	2,0
Reference	0,4–2,2 6–8 (stainless)	16–18 World 6–8 Europe	1,5–2,5 5–7 (PMMA)	15–25	0,5–1,0 (cardboard)

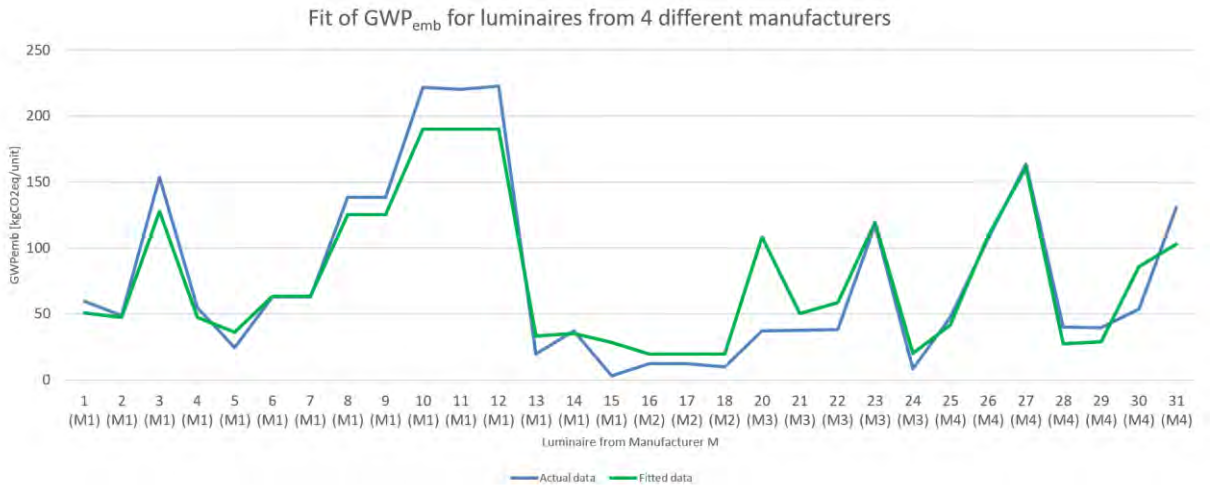


Figure 3: Simple model fit of GWPemb for LCA stages A and C for 31 fixtures from four manufacturers based on the coefficients of Table 3.

3.2.3 Other approaches

For EPDs, facilitations in the generation for specific product groups have emerged. This holds as well for fixtures, e.g.:

- "oneclicklca" [11] provides among others optimized data provision for fixtures, options to integrate better with other digital enterprise processes and tools to upload data on EPD hubs etc. The approach seems feasible rather for companies with already bigger fixtures portfolios (i.e. minimum mid-size companies) and still is associated from a manufacturer's perspective with significant efforts.
- UK based CIBSE's TM65.2 [12] targets specifically at GWP rating only, not addressing other LCA impact factors. It aims to provide a fast and cost-effective alternative to a full LCA when an official LCA is unavailable, this with an initial rather conservative embodied carbon estimation. [13] investigated on this and gives exemplary indications of the deviations compared to full EPDs / LCAs. In the UK the Lighting Industry Association (LIA) offers a "TM65.2 assured scheme". The LIA independently strips and weighs luminaires to verify manufacturer's calculation entries (into the TM65.2's mid-level scheme) to be within +/- 5% of the physical reality.

Both approaches, however, do not intrinsically solve the problem of generic data, for e.g. data sets to be used in the early design phases.

4 Case two: Sunshading Devices

We put LCA for sunshading products into the context of already existing regulations for the shading market and propose simplifications for GWP100 rating, this specifically as well from SMEs' and designer's perspective. We focus on external shading systems with reference to three representative product types for which "sector EPDs", issued by the trade association IVRSA e.V., are available.

4.1 Status quo

4.1.1 Regulatory framework

4.1.1.1 Non-LCA requirements

Sunshading products placed on the European market are already subject to a substantial non-LCA regulatory framework covering safety, performance, durability, and information duties. For external blinds and awnings, key product standards include EN 13561 for performance requirements including safety; for external shutters and venetian blinds, EN 13659 and for internal blinds, EN 13120. In addition, thermal and visual comfort classification is addressed through EN 17037 and EN 14501.

Depending on the product configuration, further requirements arise from horizontal product legislation such as the Construction Products Regulation (BAUPVO, EU No. 305/2011) and CE marking obligations under harmonized standards. Motorized systems require additional conformity under the Machinery Directive (2006/42/EC), and the Low Voltage and EMC Directives and electrical components must comply with RoHS. Fire performance, wind resistance, safe operation, installation instructions, and user information must also be documented and maintained.

4.1.1.2 LCA requirements

For sunshading systems, EPDs include data on raw material extraction, manufacturing, transport, use phase, and end-of-life, in accordance with EN 15804+A2. The applicable Product Category Rules are the PCR for Sonnenschutzsysteme [14]. The declared unit in all IVRSA sector EPDs is 1 m² of installed system, referenced to a standard window size of 1.23 m × 1.48 m (1.82 m²) per EN 14351-1.

The high degree of product customization, varying dimensions, material combinations, and motorization options and makes product-specific EPDs complex and resource-intensive for individual manufacturers. The industry has therefore adopted sector-wide EPDs, based on average production data from multiple member companies. Table 4 holds a comparison of sector EPDs vs product-specific EPDs for shading products. For the three IVRSA sector EPDs currently available (external venetian blind, roller, textile screen), rf to Figure 4, data were pooled from five manufacturers (Alulux, Beck+Heun, REFLEXA-WERKE, HELLA Sonnen- und Wetterschutztechnik, WAREMA Renkhoff SE) plus component suppliers (Somfy, VEKA), weighted by production volumes, covering the period 2020–2022.

Table 4: Comparison of sector EPDs and product-specific EPDs for sun shading products.

Feature	Sector EPD (industry-wide)	Product-specific EPD
Data basis	Averaged data from multiple manufacturers (weighted by production volume)	Data from single product or product family
Complexity for manufacturer	Lower – shared effort across industry	Higher – full individual LCA required
Typical cost for SME	Significantly reduced; shared verification and registration fees	High: data collection, third-party verification, registration
Accuracy	Representative for the sector; may not reflect best-in-class products	Precise for the specific product
Validity period	5 years; update requires industry coordination	5 years; update by manufacturer alone
Use in green building certification	Eligible for use in DGNB, LEED, BREEAM (subject to scheme-specific acceptance criteria)	Fully accepted in all schemes
Best suited for	SMEs; early design phase; broad market coverage	Large manufacturers; premium or differentiated products

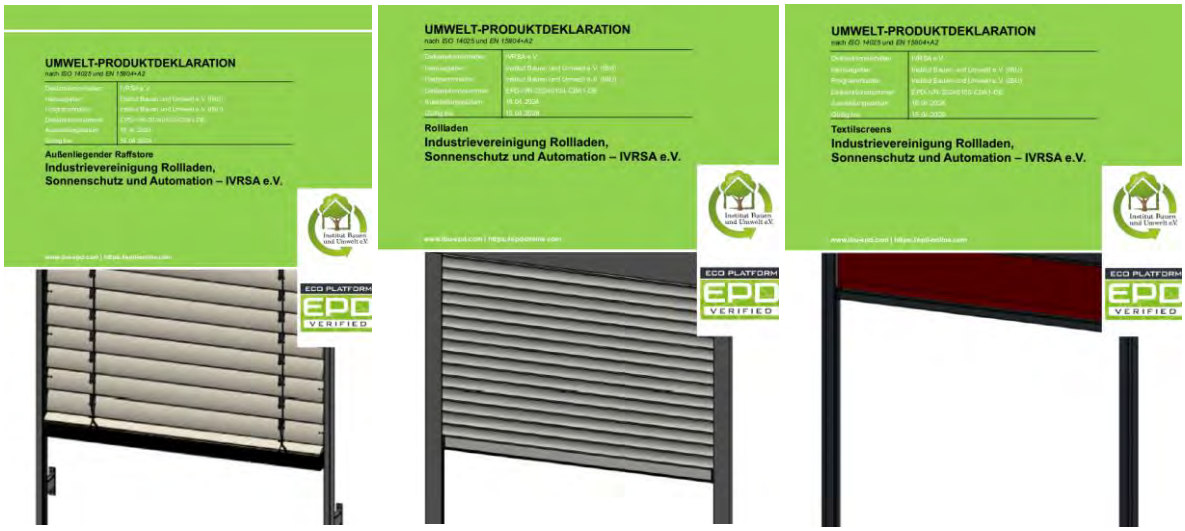


Figure 4: Examples of sector EPDs for shading products by IVRSA e.V, 2024: external venetian blind (left), roller shutter (center), textile screen (right) [15].

4.1.2 EPDs in practice

4.1.2.1 Market availability

Within the IVRSA e.V. member network, sector EPDs are available for the three product categories mentioned above (external venetian blind, roller shutter, textile screen), all issued on April 16, 2024 and valid until April 15, 2029. All three are published in the IBU EPD program, carry the ECO Platform VERIFIED mark, and have been independently verified. This makes them eligible for use in green building certification schemes such as DGNB, LEED, and BREEAM, subject to the specific acceptance criteria of each scheme.

Beyond the IVRSA network, EPDs for sunshading products remain rare, particularly among SMEs. A questionnaire conducted among IVRSA member companies, with responses from five to ten companies, confirms that EPDs currently play a limited role in day-to-day business: they are requested only sporadically and are not yet a standard requirement from architects or planners. They are viewed as “nice-to-have” today, but there is an expectation of growing regulatory importance in the future.

4.1.2.2 Structural aspects and practical experiences

Methodology

- *Preference for sector EPDs:* All three IVRSA declarations are EPDs based on averaged data from five manufacturers. This approach is driven by the high product variability in the shading sector, which makes individual product-specific EPDs disproportionately costly for SMEs. Sector EPDs allow participation with a significantly reduced financial and administrative burden.

- *Methodological consistency:* All three IVRSA EPDs follow identical system boundaries (A1–A3 with declared modules A4, A5, B6, C1–C4, D), use the same background database (Sphera MLC, CUP 2023.1), and are based on the same PCR, ensuring comparability across product types.

- *Mixture of GWP_{emb} and GWP_{oper}:* Module B6 (operational energy use) is declared in the same table as production stages A1–A3. For the external venetian blind this amounts to 6.51 $kgCO_2eq/m^2$ over 20,000 cycles, compared to 62.7 $kgCO_2eq/m^2$ for A1–A3. Here B6 does not relate to the energy balance of the space, i.e. its influence, e.g. on solar gains. This separation between embodied and operational carbon should be maintained in building assessments, as argued in Chapter 5.

- *Product family approach:* The EPDs cover the most representative product configuration per category. Variants with different dimensions or configurations can be supplied on request by the participating manufacturers.

Application

- *Effort and challenges in creation:* The development of the first sector EPDs requires substantial organizational effort. IVRSA member companies reported approximately 100 hours per product for data

collection, inter-company coordination, and engagement with external LCA consultants. Challenges included aligning data from different production sites and managing confidentiality between competing manufacturers to share production data.

- *Limited validity and update burden:* The five-year validity period creates a recurring update cycle. Given that product compositions and supply chains evolve continuously, maintaining the underlying dataset is a persistent commitment, consistent with the concern raised in Section 3.1.2 about data validity.

- *Market relevance and application:* EPDs are occasionally required in DGNB certification and in publicly funded construction projects but are not yet a widespread procurement criterion. Demand is expected to grow with the revision of the EPBD and the introduction of whole-life carbon requirements in building regulations.

- *Benefits for manufacturers:* The sector EPD model distributes LCA costs across the industry. A participating SME can reference the IVRSA declaration without generating its own full LCA, at a fraction of the individual EPD cost.

Perception and awareness

- *Low awareness in SMEs:* Outside IVRSA member companies, awareness of EPDs and the LCA certification process remains low among shading manufacturers, mirroring the pattern described for lighting SMEs in Section 3.1.2.

- *Regulatory burden context:* Companies in the shading sector already comply with more than ten product standards and directives (Section 4.1.1). Any additional environmental reporting obligation must be weighed against this existing load, reinforcing the case for simplified approaches.

- *Future outlook:* EPDs are expected to gain importance, driven by regulatory developments (EPBD, ESPR, Digital Product Passport) and the growing focus on whole-life carbon in building certifications. Integration into BIM workflows is anticipated as a key enabler for broader adoption.

4.2 Simplification approaches

Following the logic of Figure 1, specific simplification approaches for both target groups (designers and manufacturers) are proposed. Both draw on the underlying IVRSA sector EPD datasets as their primary data source.

4.2.1 Designer's perspective

From a designer's perspective, the key challenge is not the absence of EPD data for sunshading products, but the difficulty of accessing and applying that data meaningfully at the relevant stages of the design process. Sunshading decisions are typically made in early and mid-design phases, when precise product specifications are not yet fixed. At these stages, designers need sufficiently robust generic values that allow them to include embodied carbon of the façade shading layer in comparative assessments and building-level carbon budgets, without being dependent on final product selection.

Sector EPDs, as described in Section 4.1.2, already provide a practical basis for this. They represent averaged environmental performance across a range of representative products from multiple manufacturers and can serve directly as generic reference data. Compared to product-specific EPDs, sector EPDs are better suited for early design use: they are openly accessible, reflect market-typical performance rather than best-case or worst-case scenarios, and do not require prior product commitment.

Table 5 summarizes the GWP_{emb} values for the three product types currently covered by IVRSA sector EPDs. The differences between product types are instructive. The external venetian blind and roller shutter both carry higher embodied carbon than the textile screen, despite the textile screen being heavier per m². This reflects the dominant role of aluminum content in driving GWP, also refer to Figure 5: the external venetian blind is 72% aluminum by mass, the roller shutter 64%, while the textile screen contains only 44% aluminum alongside a higher proportion of steel and glass-fibre/PVC screen material. For designers, this makes sunshading embodied carbon relatively transparent and intuitive: Systems with high aluminum content in slats, guide rails, and housing will consistently show higher GWP per m² than lighter textile-based solutions. The sector EPD values capture this

relationship and allow informed system-type choices well before final product selection[4]. For the cradle-to-grave perspective differences between the three systems are in the range of 15%.

Table 5: Generic GWP_{emb} values for sunshading product classes per 1m² of installed system [$kgCO_2eq/m^2$]. Three system boundaries shown: cradle-to-gate (A1–A3), cradle-to-grave excluding operational energy (A1–A5, C1–C4), and cradle-to-grave including recycling potential (Module D). Representative type per class: motorized variant with aluminum box housing and guide rails. Source: IVRSA Verbands-EPDs, IBU, April 2024 [15].

Shading product class	Representative type (IVRSA sector EPD)	Mass [kg/m^2]	Al content [%]	GWP_{emb} A1–A3 (cradle-to-gate) [$kgCO_2eq/m^2$]	GWP_{emb} A–C excl. B6 (cradle-to-grave) [$kgCO_2eq/m^2$]	GWP_{emb} A–C incl. D [$kgCO_2eq/m^2$]	EPD reference
External venetian blind	Aluminium slats 80 mm, motorized; box housing; guide rails	7.84	72	62.7	66.3	35.9	EPD-IVR-20240103-CBA1-DE
External roller shutter	Aluminium foam-filled profiles, motorized; box housing; guide rails	7.61	64	60.8	65.0	37.8	EPD-IVR-20240104-CBA1-DE
Textile screen	Glass-fibre / PVC screen, motorized; box housing; guide rails	9.16	44	53	57.9	30.9	EPD-IVR-20240105-CBA1-DE

[4] A note on system boundaries: the cradle-to-gate values (A1–A3) are often taken as the primary reference, because they are the most widely reported and compared stage in building LCA practice, and because end-of-life scenarios depend on assumptions (collection rates, national waste treatment, future recycling technology) that vary by project and country. The full cradle-to-grave values are, however, directly available from the sector EPDs and are included in Table 5 for transparency. Two effects are worth noting. First, the life cycle stages beyond the factory gate (transport, installation, end-of-life treatment) add only about 4–5 $kgCO_2eq/m^2$, i.e. roughly 6–9% on top of the production stage — embodied carbon in sunshading products is clearly production-dominated. Second, Module D (recycling potential) reduces the total by 27–30 $kgCO_2eq/m^2$, reflecting the high recycling credit of the aluminum content. In line with EN 15804, Module D credits should be reported separately and not netted against the A–C total, as they depend on future recycling scenarios outside the system boundary. Whole-building assessments should follow the module conventions of the applicable certification scheme or national framework.

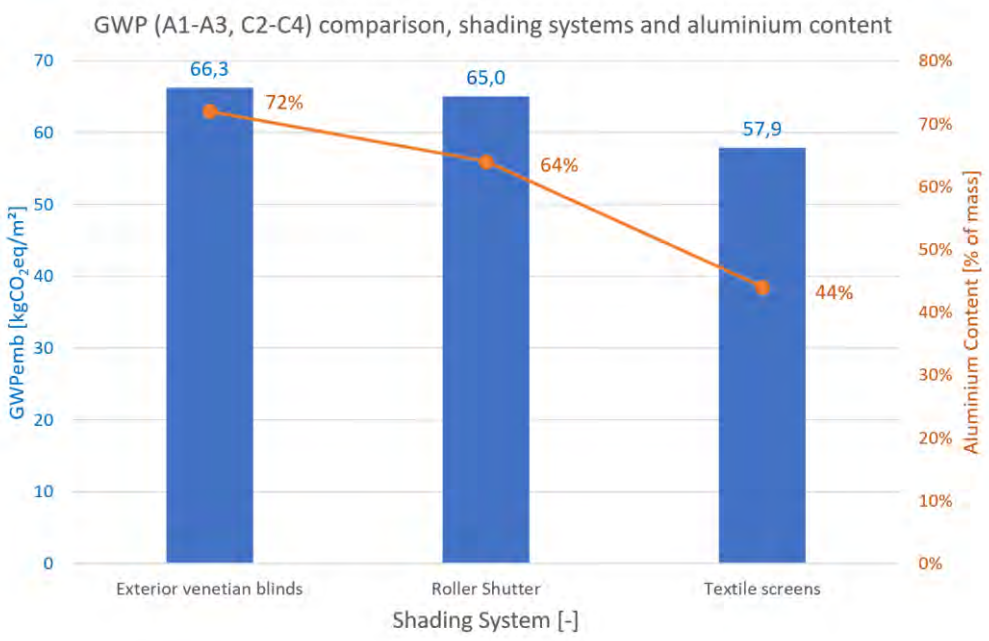


Figure 5: GWP_{emb} (A1–A3, C2-C4) per m² of installed system for the three IVRSA product types (bars, left axis), with aluminum content by mass overlaid (line, right axis). Source: IVRSA Verbands-EPDs, IBU, April 2024 [15].

The natural functional unit for designers, square metres of shading area, also aligns directly with the way sunshading is specified and quantified in building models and energy simulations, making integration into building carbon assessments straightforward. For annualising embodied carbon and for modelling replacement cycles in whole-building LCA, the product service life must also be considered. The reference service life of the declared products is governed by the durability classes of the product standards EN 13659 and EN 13561: motorized external venetian blinds, roller shutters, and screens typically fulfil the highest durability class 3, corresponding to 10,000 raising/lowering cycles and 20,000 turning cycles. In practice, at a typical usage intensity of two operating cycles per day, this corresponds to a service life of approximately 15 years. For a standard whole-building assessment period of 50 years, this implies roughly two to three replacement cycles, which should be accounted for when the per-m² values of Table 5 are scaled to the building level. As discussed in Chapter 5, linking these values to established energy rating procedures that already account for the operational impact of shading on heating, cooling, and electric lighting loads is the logical next step toward a coherent low-carbon design workflow.

For integration into building sustainability certification schemes such as DGNB, BREEAM, or LEED, and into national whole-building LCA frameworks, the IVRSA sector EPDs are eligible for use as a recognized data basis in a number of schemes. Designers should verify the acceptance criteria of the applicable certification body, in particular whether sector EPDs need to be supplemented by project-specific documentation on quantities and system boundaries.

For quality assurance of these generic values, a procedure analogous to that used for energy-related KPIs is recommended: periodic review by a technical working group (e.g. within IVRSA or a standardisation body), transparent documentation of the underlying dataset and defined update triggers.

4.2.2 Manufacturers perspective

The IVRSA sector EPDs already represent the primary simplification instrument for manufacturers: by participating in the sector EPD scheme, an SME can reference the association's declaration for its representative product without generating a full individual LCA, substantially lowering the entry barrier.

Also, a simplified manufacturer model, analogous to the regression approach of Section 3.2.2, could assign to the material compositions, given in Table 6, CO_2eq factors per material class and allow a manufacturer to estimate GWP_{emb} from the mass breakdown of their specific product. The IVRSA sector EPD data provide a natural calibration dataset for such a regression. As a next step, if individual product-level data can be obtained from the

five participating manufacturers (analogous to the 31-fixture dataset in Section 3.2.2), a validated coefficient table could be derived.

Table 6: Material composition (% by mass) of the three IVRSA product types. Source: EPD product data sheets, IVRSA/IBU, April 2024. Basis for a simplified GWP_{emb} scaling model.

Material	External venetian blind [%]	Roller shutter [%]	Textile screen [%]
Aluminum	72	64	44
Steel	16	16	34
PVC	3	3	4
Screen fabric (GF + PVC)	-	-	6
PUR/PIR foam	-	2	-
Other metals	2	5	4
PA	2	4	3
Other	5	6	5
Total mass [kg/m²]	7.84	7.61	9.16

4.2.3 Other approaches

The IVRSA sector EPD initiative demonstrates that association-led collective action can overcome the barriers that individual SMEs face. The model, pooling production data from five manufacturers, commissioning a joint LCA, and registering with a recognized EPD program is directly transferable to other shading product categories not yet covered (e.g. internal blinds and awnings) and as well other technical appliances.

Additionally, emerging tools may further reduce the effort for individual declarations. EPD platform providers are beginning to offer streamlined generator tools for specific construction product categories (cf. the luminaire EPD generator cited in Section 3.2.3). Alignment with the EU Digital Product Passport requirements under the Ecodesign for Sustainable Products Regulation (ESPR) and with the revised Construction Products Regulation will create further incentives and potentially new frameworks for simplified environmental declarations in the shading sector.

International standardization efforts, including the IEC/ISO initiatives noted for the lighting sector in Chapter 3, provide a precedent for harmonizing EPD schemes across sectors. A comparable initiative for the shading industry, potentially coordinated through ES-SO (European Solar Shading Organization) or IVRSA at European level, would help resolve the current diversity of national EPD programs and improve comparability for designers specifying products across borders.

5 Linkage to energy rating procedures

As for operational carbon, it comes down to calculating the energy balance of the space attributing the balance parts to electric lighting or to the façade / daylighting aspects and weighing this with grid specific CO_2 emission factors of the corresponding energy carriers. For electric lighting, it is linked to directly calculatable (measurable) electric power. Whereas the façade is not per se an energy consumer, it has indirect impacts on lighting energy (via daylight use) and via solar gains and transmission losses or gains on heating and cooling loads.

Methods of rating energy efficiency are (long time) established, in many countries mandatory and thereby widely used. This is also reflected by their integration into many software tools. A close linkage between LCA and energy

rating methods is virtually imperative. Figure 6 illustrates the pathway to connect lighting requirements with assessing carbon footprint of integrated lighting solutions. A main aspect is, that LCA stage “B6 Operational Energy Use” is not taken from a luminaire’s EPD or alike but from the detailed balance-based energy assessment of the specific space.

Practically this should be better integrated in the future, e.g. specifically

- provide and align generic data on energy and GWP side for lighting and sunshading components, i.e. same structure of (simplified) product classes,
- match methods and KPIs, e.g. for fixtures, scale the $kgCO_2eq/1{,}000lm$ with the flux calculated for a space in line with the methods to calculate the installed power and
- consequently leave “B6 Operational Energy Used” to the more detailed models as in ISO 10916 [16] or even detailed simulations and abstain from providing and using lump-sum values as for luminaires in EPDs for “B6 Operational Energy Used”.

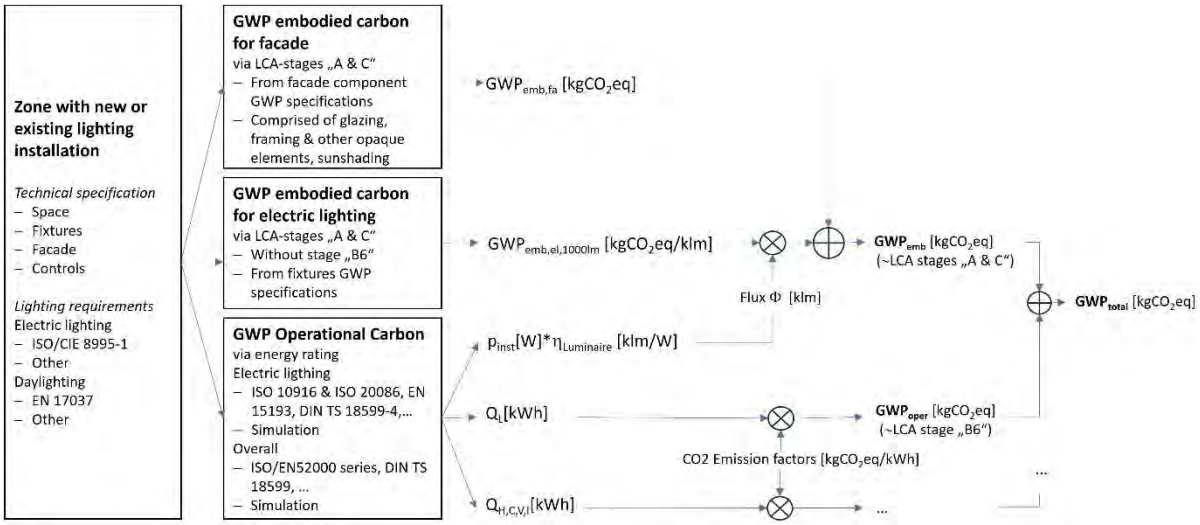


Figure 6: Pathway to connect lighting requirements with assessing carbon footprint of integrated lighting solutions.

6 Challenges and actions needed

To support the implementation of simplified approaches coping with generation and application of GWP data and procedures for lighting gear and daylighting components, the following table summarizes some of the existing challenges and actions needed to address them. The targeted stakeholders are authorities, industry, and their trade associations, designers, and building owners.

Challenge	Action needed
EPD/PEP processes are too complex and costly, especially for SMEs.	Develop **simplified assessment pathways** for SMEs, such as regression-based models, default factors, and grouped product-family methods that reduce certification effort and cost.
Very limited market penetration of EPDs among SMEs.	Support **sector-wide or association-led approaches** (e.g. sector EPDs, shared datasets, joint tools), so smaller companies can participate without having to generate full product-specific declarations individually.
Lack of generic, early-stage design data.	Create and maintain **generic aggregated GWP datasets** for common luminaire and shading classes that can be used in early design phases before exact product selection is made.
Poor alignment between embodied carbon assessment and existing energy rating workflows.	Align carbon assessment methods with **established energy rating procedures and software**, using compatible product classifications, KPIs, and data structures so embodied and operational carbon can be assessed together more effectively.
Inconsistency and low comparability across EPD/PEP schemes.	Promote **harmonization of methods, templates, and reporting rules** across schemes to improve comparability for designers and reduce confusion for manufacturers.
Data validity, maintenance burden, and weak transparency in current declarations.	Improve transparency by requiring **clearer material-group assumptions, update logic, and usable parameter disclosure**, while enabling streamlined update mechanisms for rapidly changing products and supply chains.
3rd party quality assurance.	For simplified approaches, quality assurance measures are to be developed and implemented as well. This might be covered by certifiers of detailed EPDs or delegated to standardization bodies as done for energy rating methods.

7 References

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Appendix

A. Market availability of EPDs for luminaires

A.1 Survey L&B in 2024: EPD preparation status

Company	EPD preparation status	
	In the process of preparing	**Already published**
Zumtobel	Yes, regularly, using own automated EPD generator	ca. 4,000
Signify	Yes, regularly	2,000 (covering ca. 70,000 variants)
Delta	Yes	some
XAL	Yes	2 series
Artemide	Yes	1 series
Glamox	Yes	dozens
ERCO	Yes	dozens
Filippi/Targetti	Yes	0
PRACHT	Yes	1

Data from individual survey during the Light+Building 2024 conducted by authors, updated with online info in June 2026.

A.2 EPD Status of leading Polish lighting manufacturers

Company	EPD status	Number of EPDs	Employees
LUG Light Factory	Yes	≥3	501–1,000
Lena Lighting	Yes	3	201–500
PXF Lighting	No	0	201–500
LIRA Lighting	No	0	51–200
Elmarco	No	0	11–50
Niviss	No	0	51–200
Kanlux	No	0	201–500
Pollight	No	0	11–50
Spectra Lighting	No	0	51–100
NEXT Lighting	No	0	11–50

Lumiverso	No	0	11–50
Zaho Lighting	No	0	11–50

The data presented in the table above was prepared using the Copilot tool with the Smart function in April 2026. The information sources were additionally verified manually by the authors.

Data on companies from Poland (accessed April 2026):

1. https://ensun.io/search/lighting/poland?utm_source=copilot.com [accessed …4/2026]
2. https://pzpo.pl/czlonkowie/
3. https://pollighting.pl/lista-czlonkow-zwiazku/
4. https://epd.org.pl/rejestr-epd/
5. https://www.itb.pl/itb-epds/
6. https://lenalighting.pl/o-nas/aktualnosci/3773-nasze-oprawy-z-certyfikacja-srodowiskowa-environmental-product-declarations-od-itb
7. https://www.luglightfactory.com/en/led-lighting/infrastructural-lighting/urbino/urbino-s
8. https://www.luglightfactory.com/en/led-lighting/industrial-luminaires/triton/triton-led
9. https://epd.guide/epd-newcomers/congrats-lug-light-factory-first-epd-goes-live?utm_source=copilot.com
10. https://www.lightingeurope.org/about-us/members-and-partners – Lighting Europe association in Brussels

A.3 EPD status among German SMEs in lighting industry

Company	EPD Status	Number of EPDs	Employees
Lightnet GmbH	YES	≥3	~600
RIDI Group (RIDI Leuchten GmbH)	NO	0	~450
Schuch GmbH	NO	0	~350
Hera GmbH & Co. KG	NO	0	~250
Regiolux GmbH	NO	0	~250
WILA Lichttechnik GmbH	NO	0	~200
BRUMBERG Leuchten GmbH	NO	0	~200
NORKA GmbH	NO	0	~200
Lichtwerk GmbH	NO	0	~150
BPM Lighting GmbH	NO	0	~100
Hoffmeister Leuchten GmbH	NO	0	~100
SILL Lighting GmbH	NO	0	~100
Dotlux GmbH	NO	0	~50

The data presented in the table above was prepared using the Copilot tool with the Smart function in April 2026. The information sources were additionally verified manually by the authors.

Data on companies from Germany (accessed May 2026):

1. https://build-up.ec.europa.eu/en/resources-and-tools/publications/growing-demand-environmental-product-declarations-germanys?utm_source=copilot.com
2. https://epd.guide/epd-industry-overviews/lighting-fixture-epds-in-europe-the-data-guide?utm_source=copilot.com
3. https://ibu-epd.com