SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Objectives of IEA-SHC Task 70 / EBC Annex 90

Low Carbon, High Comfort Integrated Lighting

Status of Lighting and Decarbonisation

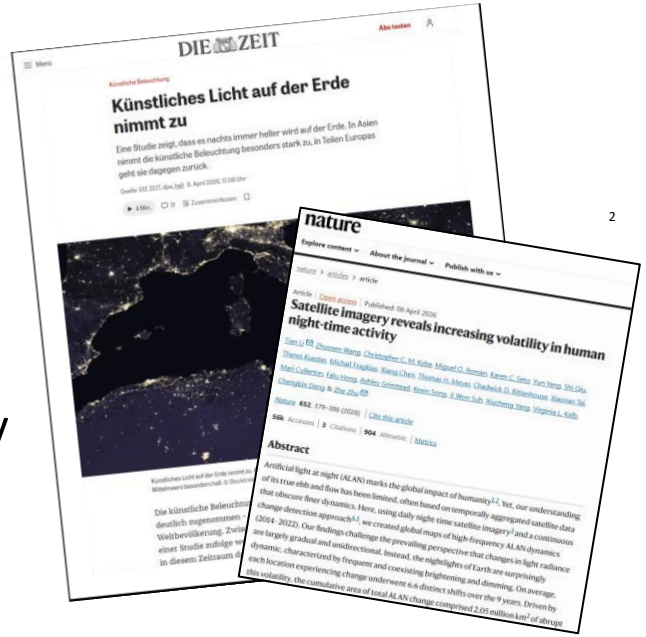
Dr. Jan de Boer
IEA SHC Solar Academy Seminar Task 70, 19th and 21st May 2026

Lighting in context of decarbonization and energy efficiency

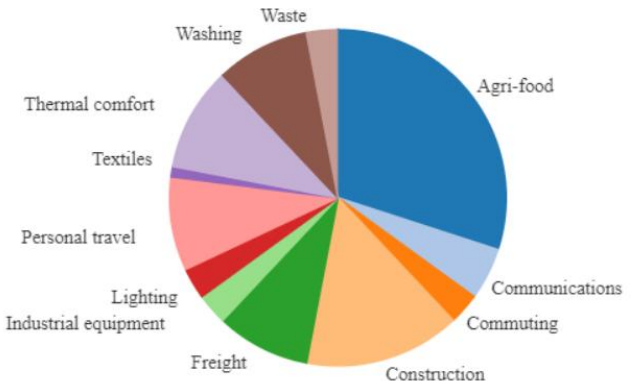
- Increase in lighting intensity worldwide by 2% each year
- Electricity for lighting accounts for 5% of the global greenhouse gas emissions and 15 % the electrical energy consumption[1]

- More and more directly taxed CO_2 emissions, higher competition for electricity

- Widening the rating perspective of lighting solutions to a more holistic view of its impact on CO_2 emissions deemed necessary, encompassing:
  - the whole life cycle (the “lighting value chain”),
  - embodied energy for electric and daylighting technology,
  - regional energy market aspects,
  - interaction with other building trades etc.



[2]



Greenhouse gas emissions by service - 50.6Gt CO2e total

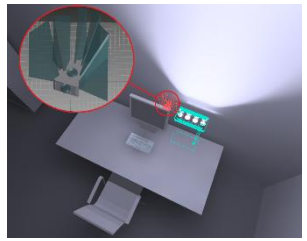
[1] UNEP Report, Accelerating the Global Adoption of ENERGY-EFFICIENT LIGHTING, 2017
[2] https://public.tableau.com/app/profile/rosamund.pearce/viz/Greenhousegasemissionsbyservice/Dashboard1

Lighting value chain

Product Stage | Planning /Design | Construction | Usage | End of Life Stage

Electric lighting

- **LED transition** on lamp level is generally **performed**, highly optimized, highly industrialized…
- **Different on luminaire level**. Potentials for decreasing the embodied energy:
  - a) **Modular luminaire architectures**: exchangeable optics, programmable lumen outputs, smart use of 3D printed parts, recyclable components
  - b) **Direct integration** into **building components** and **architecture**
  - c) **new task lighting concepts**

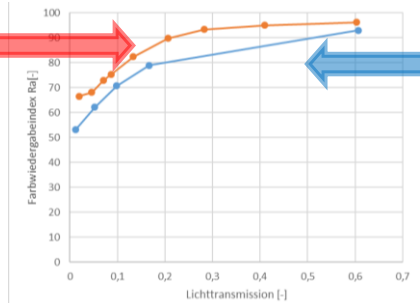


Lighting value chain

Product Stage | Planning /Design | Construction | Usage | End of Life Stage

Source: AGC

Color Rendition [-]



Source: Sage

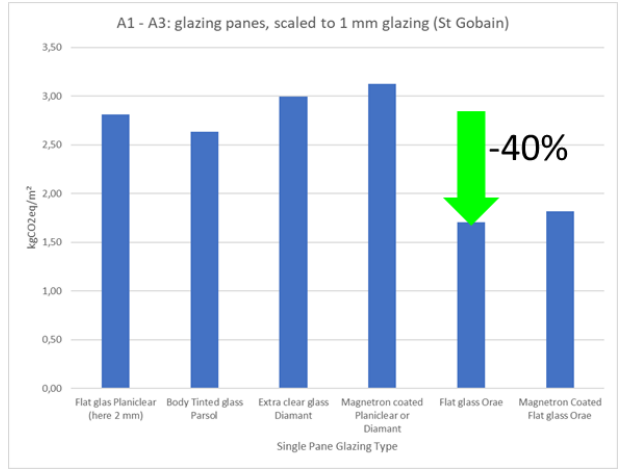
Vacuum Glazing

Source: AGC, Schüco

Same lighting and solar management with much lighter constructions

Closed Cavity Facade

Source: Dassault



Lighting value chain

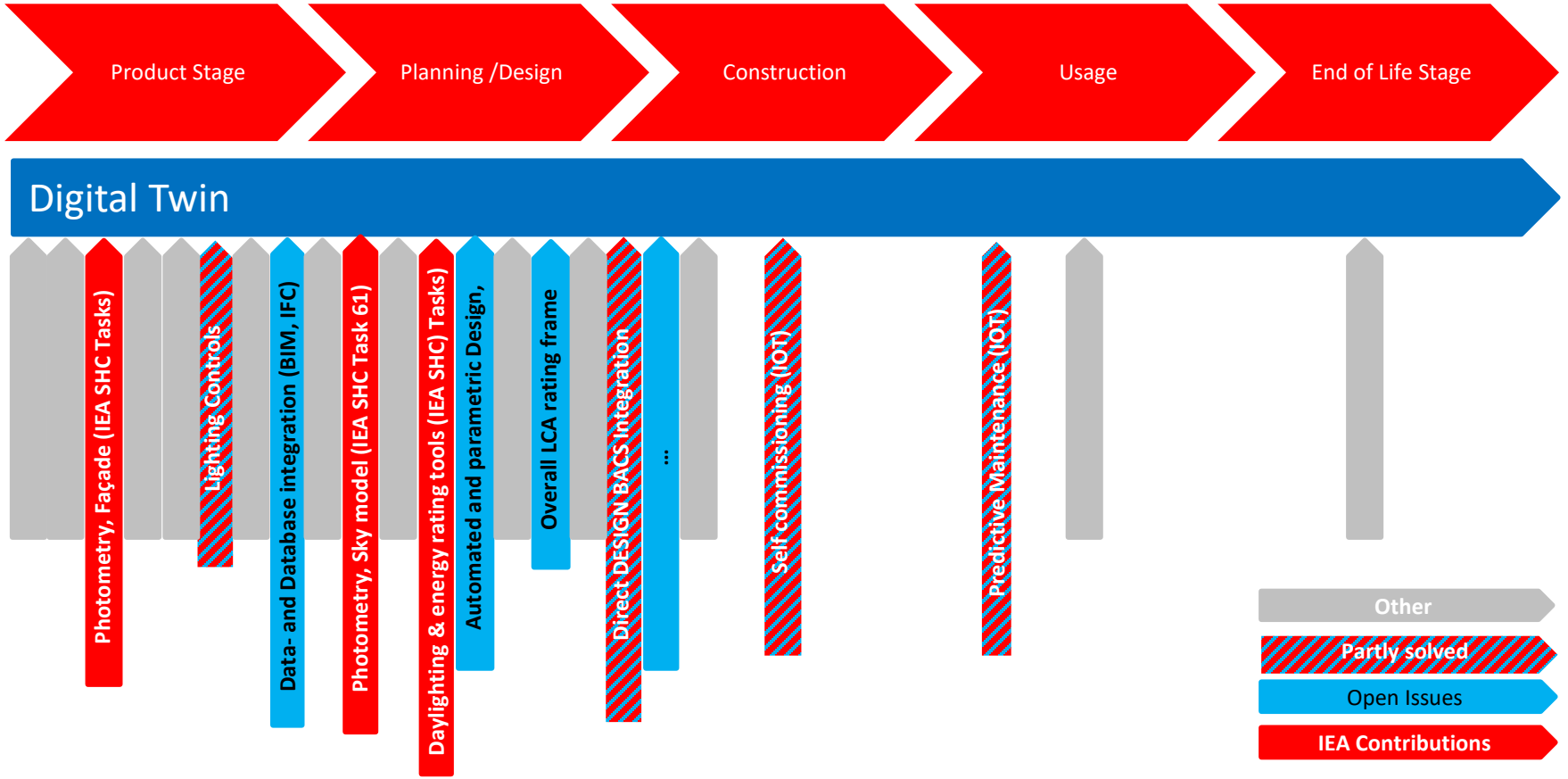
Architectural and design constraints

- Architectural and design constraints ask for answers like offering **good (day-) light supply in dense urban environments** - interior and exterior i. e. understanding façades as well from its **outside impacts on urban factors.**
- **"Competition" for optimal functionality of limited building envelope area:** daylight vs. active solar vs. facade greening, difficulties to meet the requirements as in EN 17037 or workplace regulations.

User Expectations

- Of big importance here is a further alignment with user expectations: **Integrative lighting including visual and non-visual effects is driving innovation in lighting technology.** But it comes along with a risk of energy rebounds: more delivered lumens and lower luminous efficacies, if not properly integrated with daylight as shown in IEA Task 61.
- **Daylight mimicking is a more and more discussed** approach, i. e. relying in certain situations rather on electric than on natural light and come along solar gains.

Empowering by digitalization



Lighting Carbon footprint

Scenarios, strategies, roadmaps…

Solution 1

Product, Planning, Construction → Usage → End of Life Stage

Technology and design employed

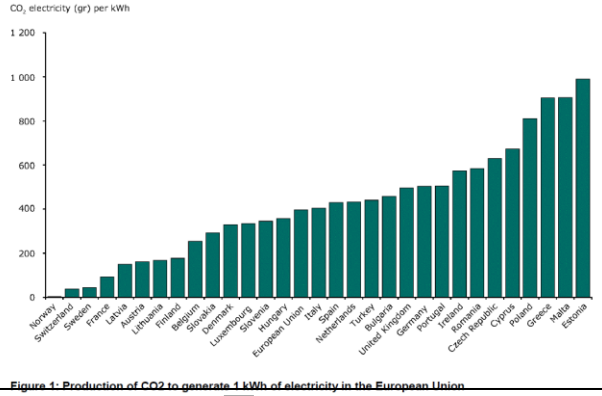
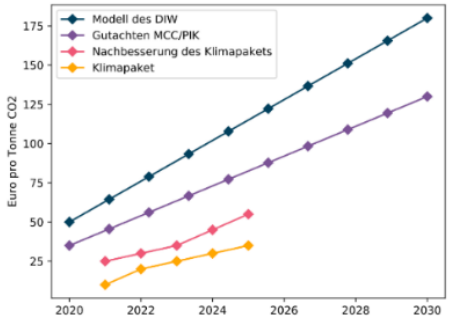


Figure 1: Production of CO2 to generate 1 kWh of electricity in the European Union



Supply side / grid context

Solution x

Product, Planning, Construction → Usage → End of Life Stage

CO_2 eq. Kg per solution

+ Link to other trades…

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Objective IEA SHC Task 70 / EBC Annex 90 “Low Carbon, high comfort integrated lighting”

The **overall objective** of the activity is to identify and support implementing the potentials of lighting (electric, façade: daylighting & passive solar) in the decarbonisation 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.

Structure

IEA SHC Task 70 / EBC Annex 90

Low Carbon, High Comfort Integrated Lighting

Task Manager: J. de Boer, Germany

Project duration: 1/2023-6/2026

Joint Work

Subtask A

Luo Tao, China
J. de Boer, Germany
(V. Ferreira, Spain)

Low Carbon Lighting and Passive Solar: Scenarios, Strategies, Roadmaps

Subtask B

B. Matusiak, Norway
M. Sarey Khanie, UK, DK

Visual and Non-Visual User Requirements

Subtask C

D. Geisler-Moroder, Austria
Eleanor Lee, USA

Digitized lighting solutions

(Technology & Design Tools / Process)

Subtask D

Niko Gentile, Sweden
Natalia Giraldo Vasquez, DK

Application and Case Studies

Joint Work

Who is behind the activity?

5th Meeting: 25th March – 28th March 2025, University of Innsbruck, Austria

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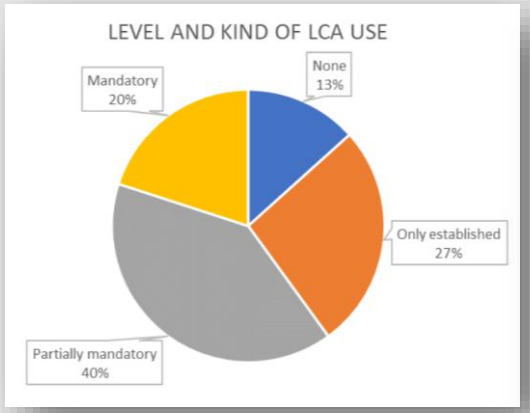
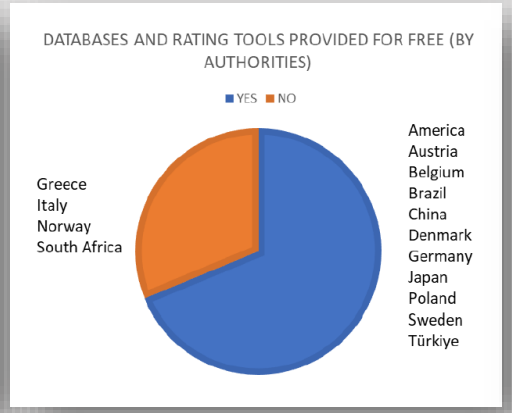
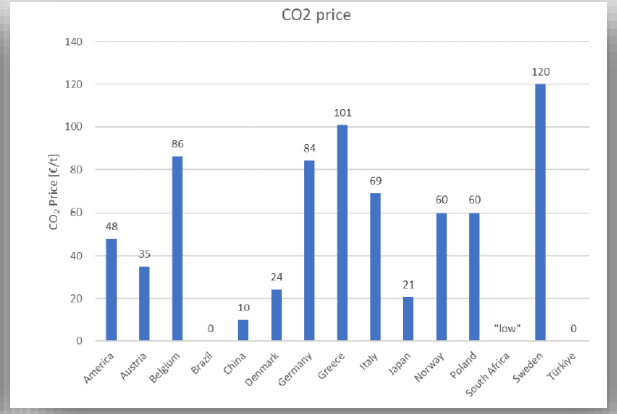
Status quo LCA in lighting: Overview on data, methods, regulations

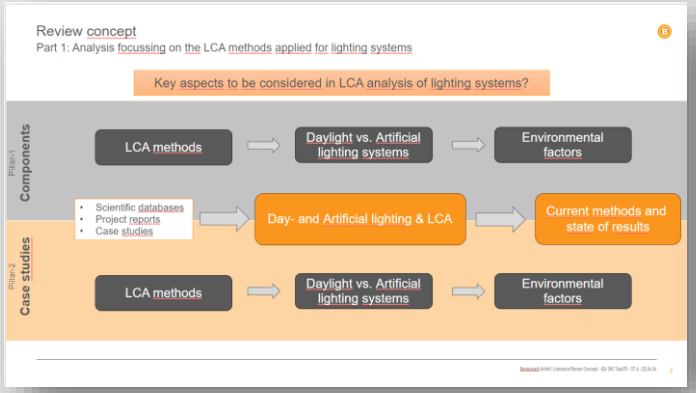
Survey in 15 countries

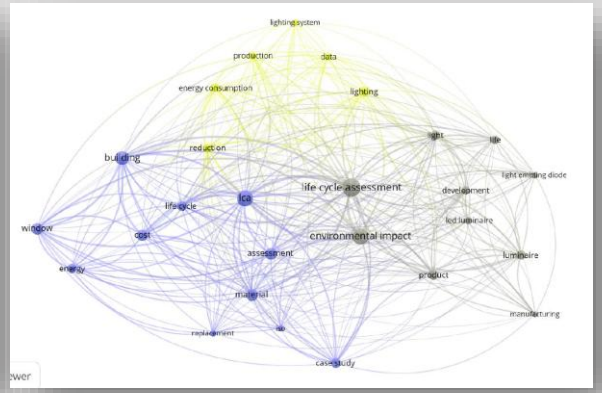


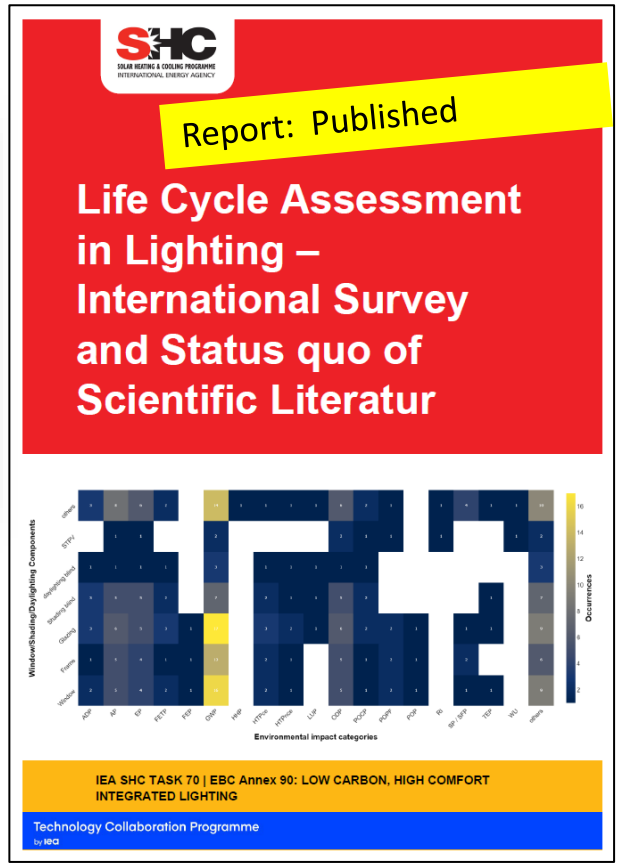




Literature survey: Det. review of 59 papers







Component Perspective: Luminaire EPDs in European Union

Order Article Reprints

Open Access Article

Environmental Impacts of Light Sources in Buildings: Analysis of Environmental Product Declarations (EPDs) in European Union

by Endrit Hoxha [1,*], Seyed Morteza Hosseini [2,*], Bernardette Soust-Verdaguer [3] and Jan de Boer [4]

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[2] Department of Architecture, Design & Media Technology, Aalborg University Copenhagen, A.C. Meyers Vænge 15, 2450 Copenhagen SV, Denmark
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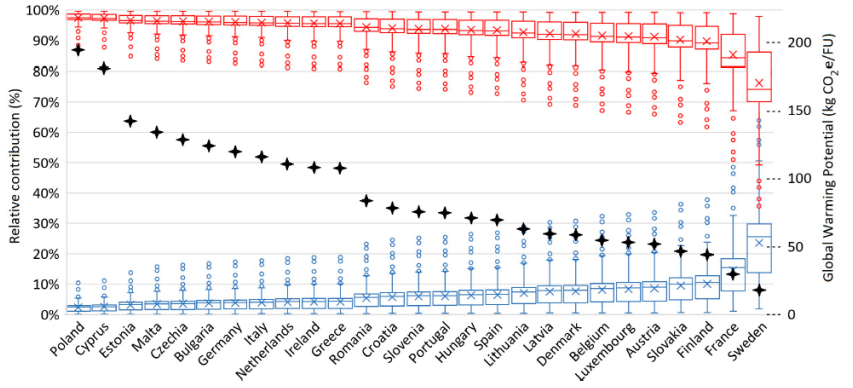


Figure 2. Average GWP score of lighting systems for EU-27 countries, and the variation of relative contributions of embodied and operational impacts. The declared functional unit (FU) is assumed to be a light providing 1000 lumens over 35,000 h. Black stars present the absolute values of GWP (kg CO_2 e/FU), red boxplots present relative operational impacts (%) and blue boxplots the relative embodied impacts (%).

Impact of Energy Mix

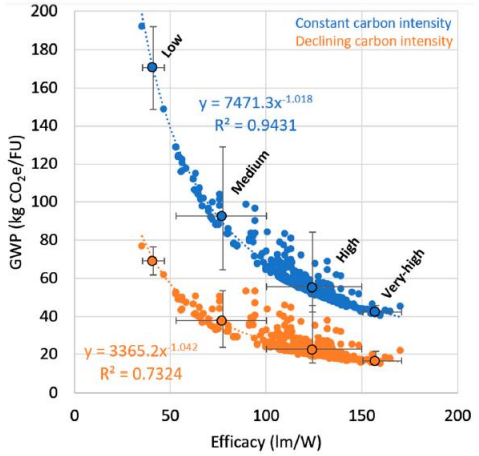
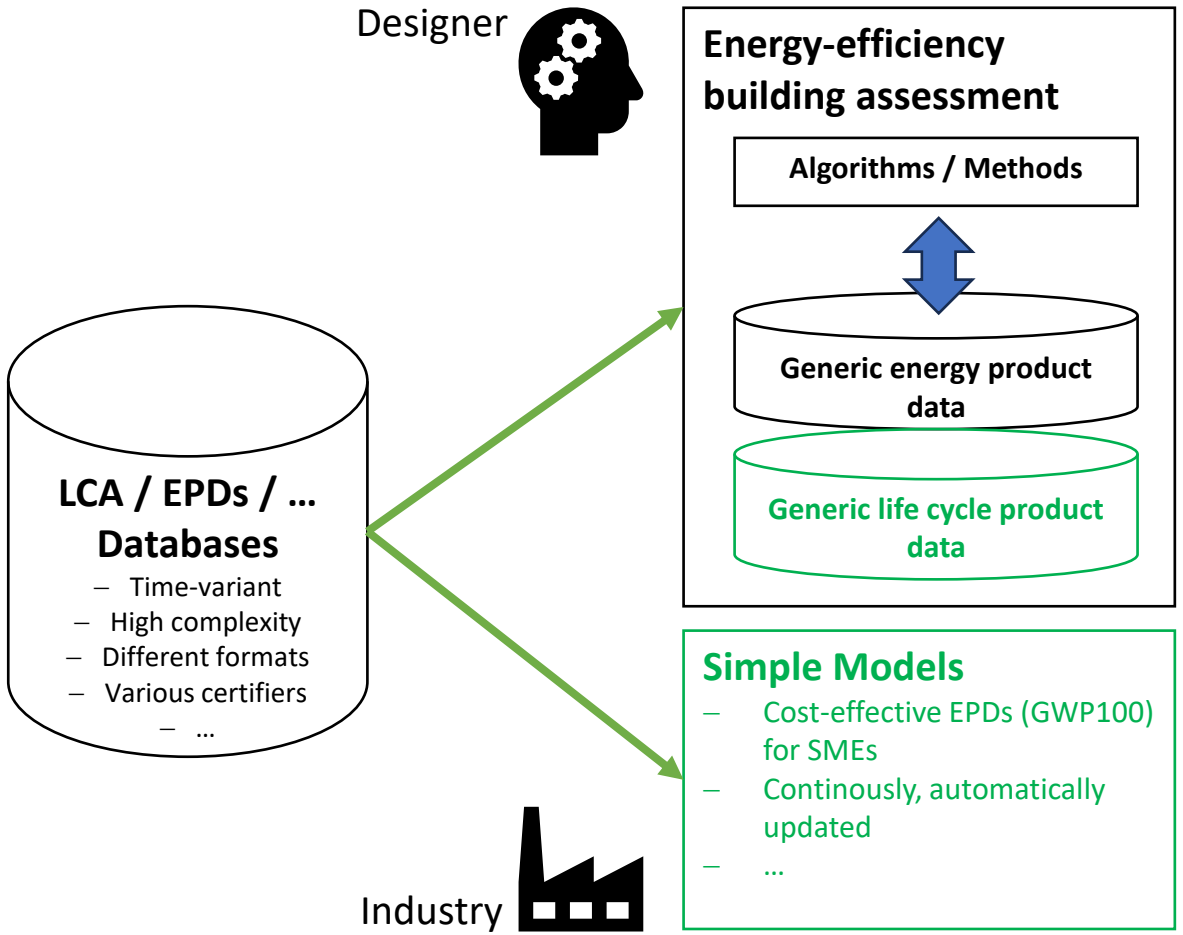
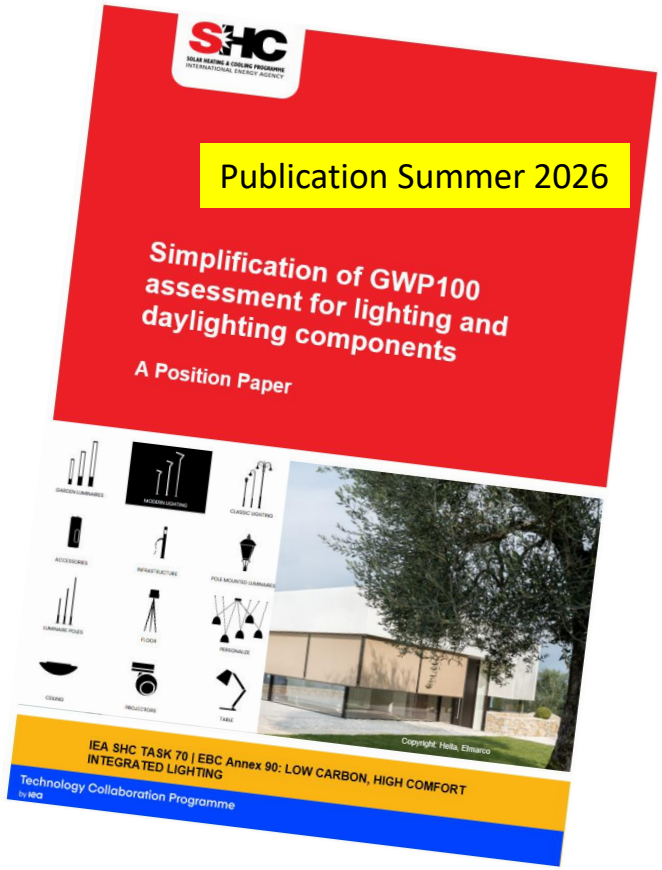


Figure 3. Relation between luminous efficacy and the environmental impacts of lighting in Denmark. Lined black circles represent the average values for each group, and the interval bars indicate the variations between the minimal and maximal values.

Impact of Luminaire Design

Component perspective: Simplification approaches





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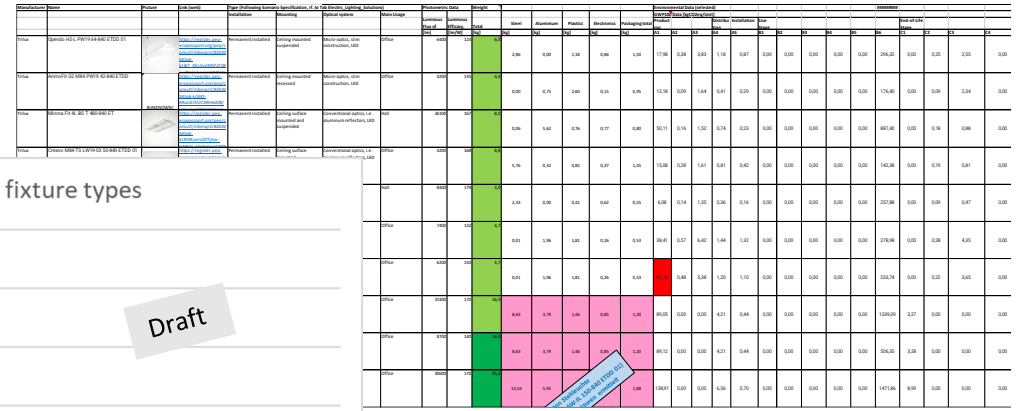
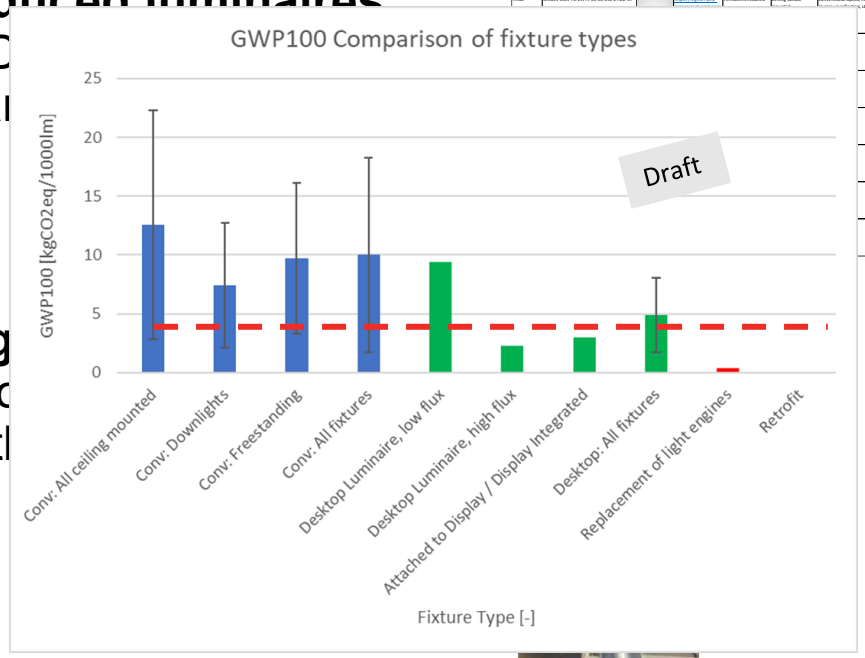
Component Perspective: GWP100 rating for fixtures

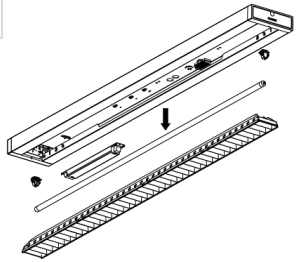
1. **Conventional mass-produced luminaires**
   Analysis of published EPD
   art from 4 bigger Europea

2. **Fixtures for new lighting**
   provide general lighting fr
   light engines attached to t

3. **Retrofit / relighting**
   a) Replacement
   b) Retrofit



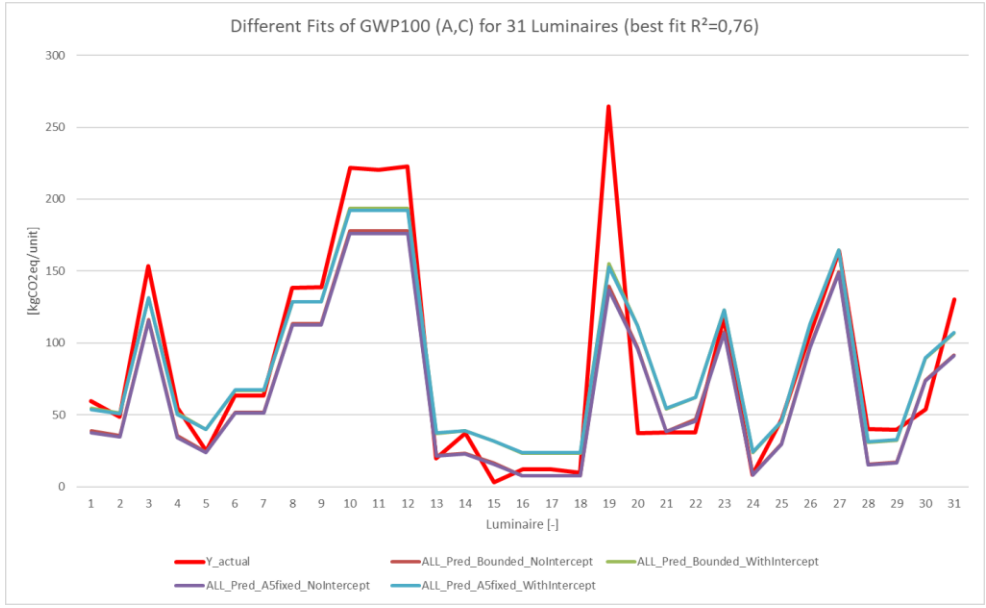




In early design phases (no specfic luminaire yet selected) for consultancies and designers.

Component Perspective: GWP100 rating for fixtures

- Estimation of GWP100
- From 5 material groups
- What‘s needed, is a ⚖



Draft

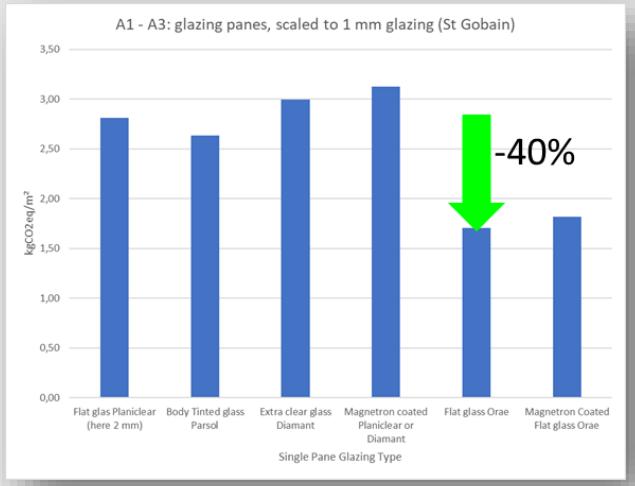
		Material(group)				
		Steel	Aluminium	Plastic	Elektronics (PCBs)	Packaging
		kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg
Datafit		2,2	15,3	2,0	25,0	2,0
Literature	Min	0,4 – 2,2 6 -8 (stainless)	6-8 Europe 16-18 World	1,5-2,5 5-7 (PMMA)	15-25	0,5-1,0 (cardboard)

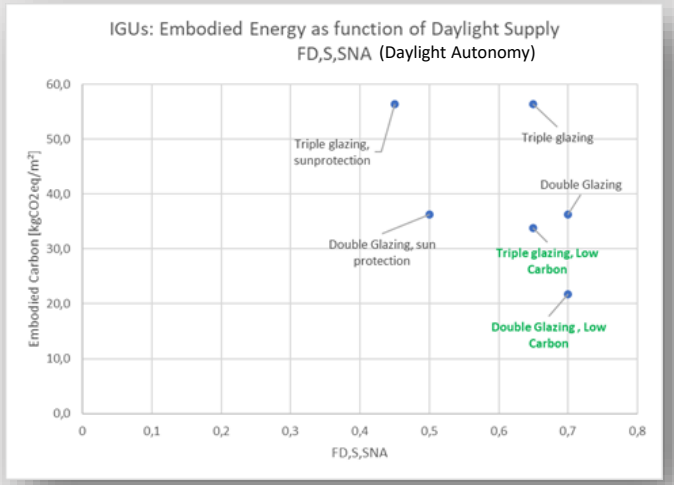
Table 5: Assumptions for CO2 equivalent factors $k_{CO2,x}$ from multidimensional regression compared with literature values

Special focus on SME

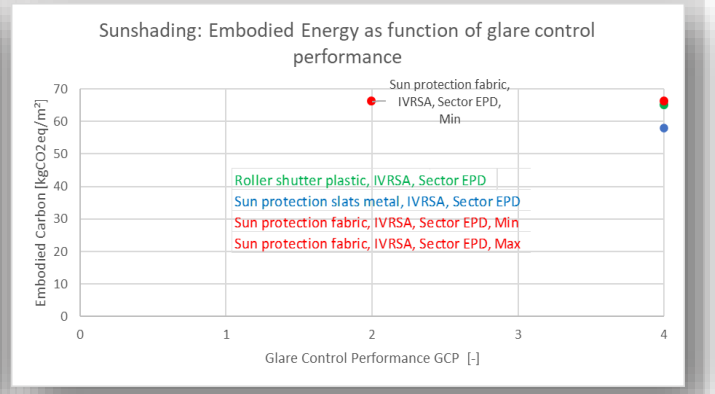
Component Perspective: GWP100 rating for façades

(Low Carbon) glazing



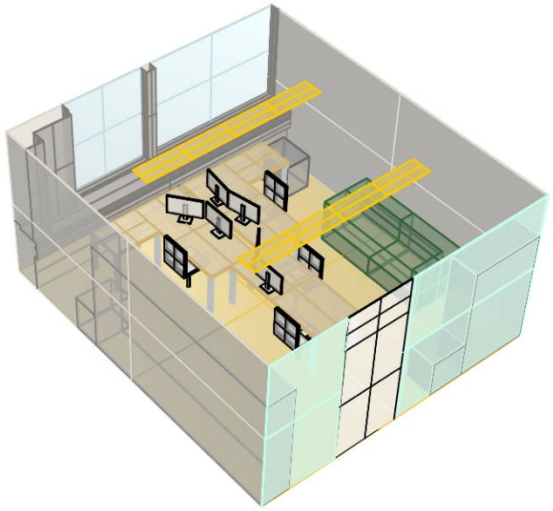


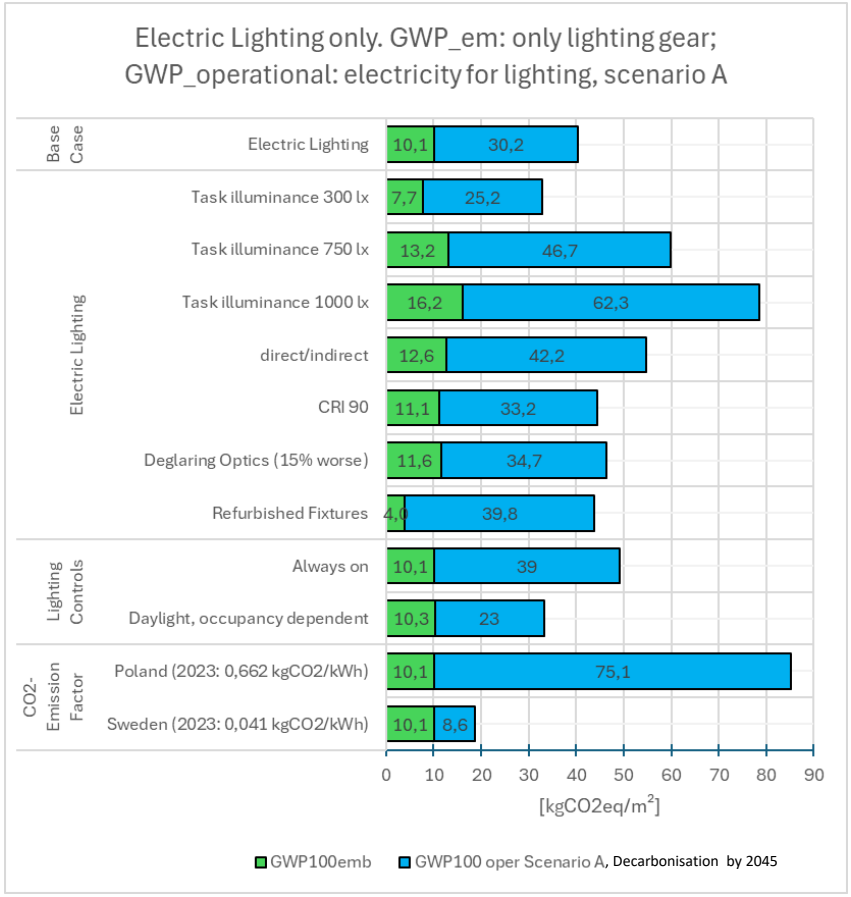
Shading systems

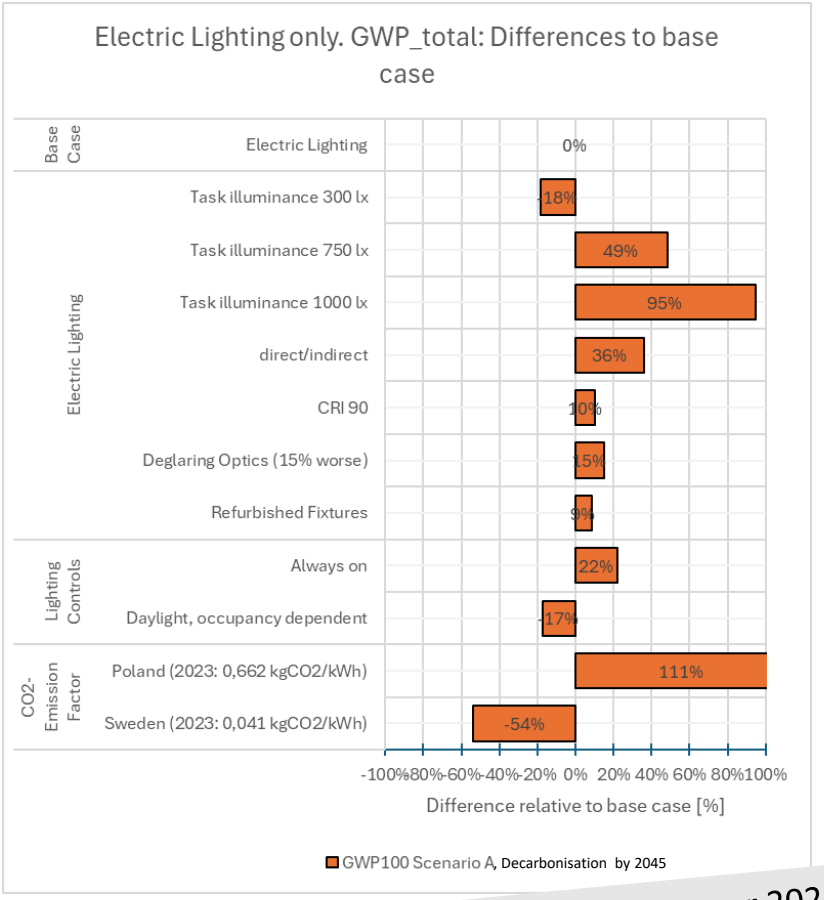


System perspective: Link with energy rating procedures / early design stages

Exemplary office space







Draft, Publication Summer 2026

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Deliverables

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