

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Objectives of IEA-SHC Task 70 / EBC Annex 90 Low Carbon, High Comfort Integrated Lighting

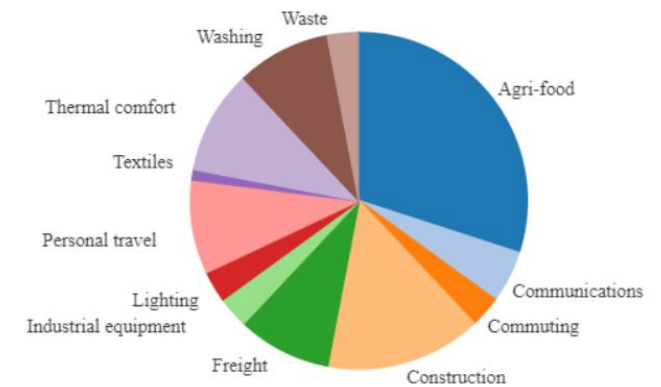
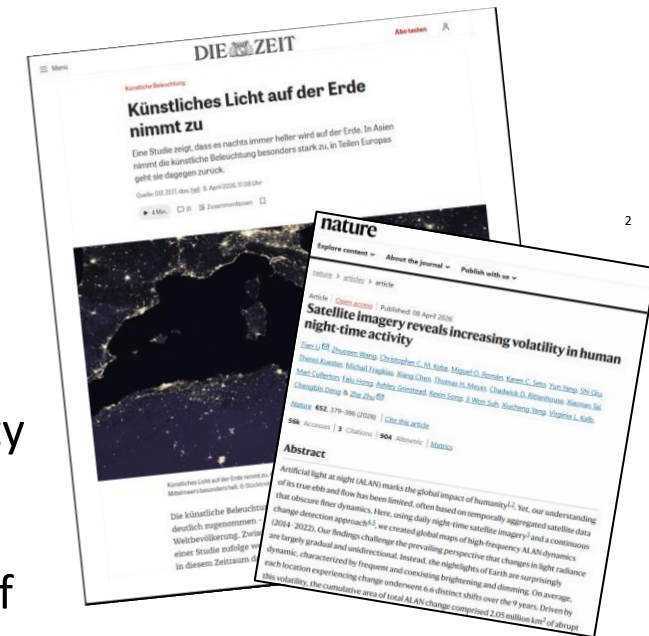
Status of Lighting and Decarbonisation

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

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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 consumption¹
- More and more directly taxed CO₂ emissions, higher competition for electricity
- Widening the rating perspective of lighting solutions to a more holistic view of its impact on CO₂ 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.



Greenhouse gas emissions by service - 50.6Gt CO₂e total

¹UNEP Report, Accelerating the Global Adoption of ENERGY-EFFICIENT LIGHTING, 2017

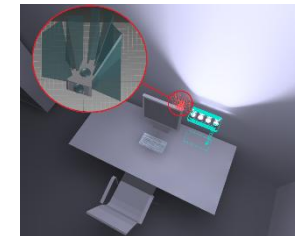
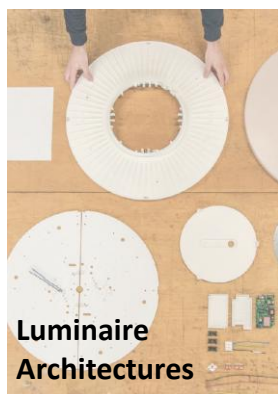
²<https://public.tableau.com/app/profile/rosamund.pearce/viz/Greenhousegasemissionsbyservice/Dashboard1>

Lighting value chain



Electric lighting

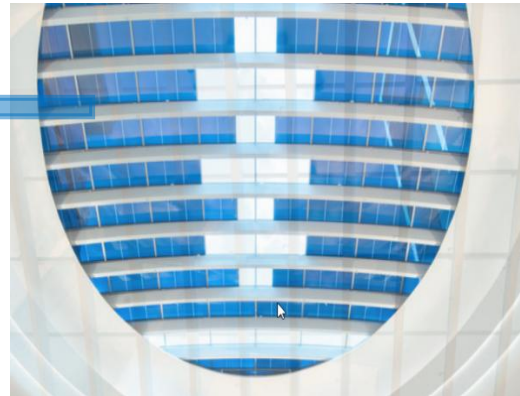
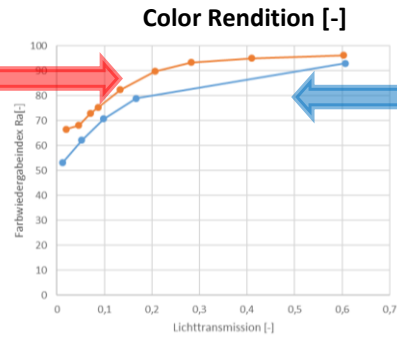
- **LED transition** on lamp level is generally **performed**, highly optimized, highly industrialized...
- **Different on luminaire level.** Potentials for decreasing the embodied energy:
 - a) **Modular luminaire architectures:** exchangeable optics, programmable lumen outputs, smart use of 3D printed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



Lighting value chain



Source: AGC



Source: Sage



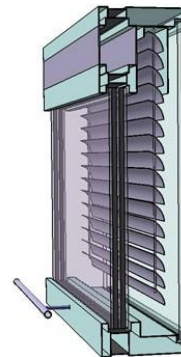
Vacuum Glazing



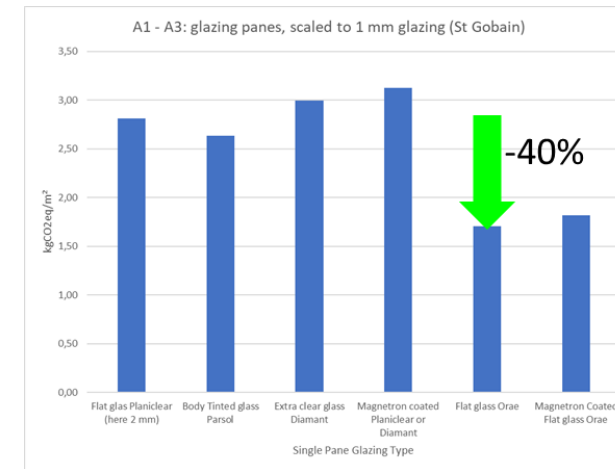
Source: AGC, Schüco

Same lighting and solar management with much lighter constructions

Closed Cavity Facade



Source: Dassault



Lighting value chain



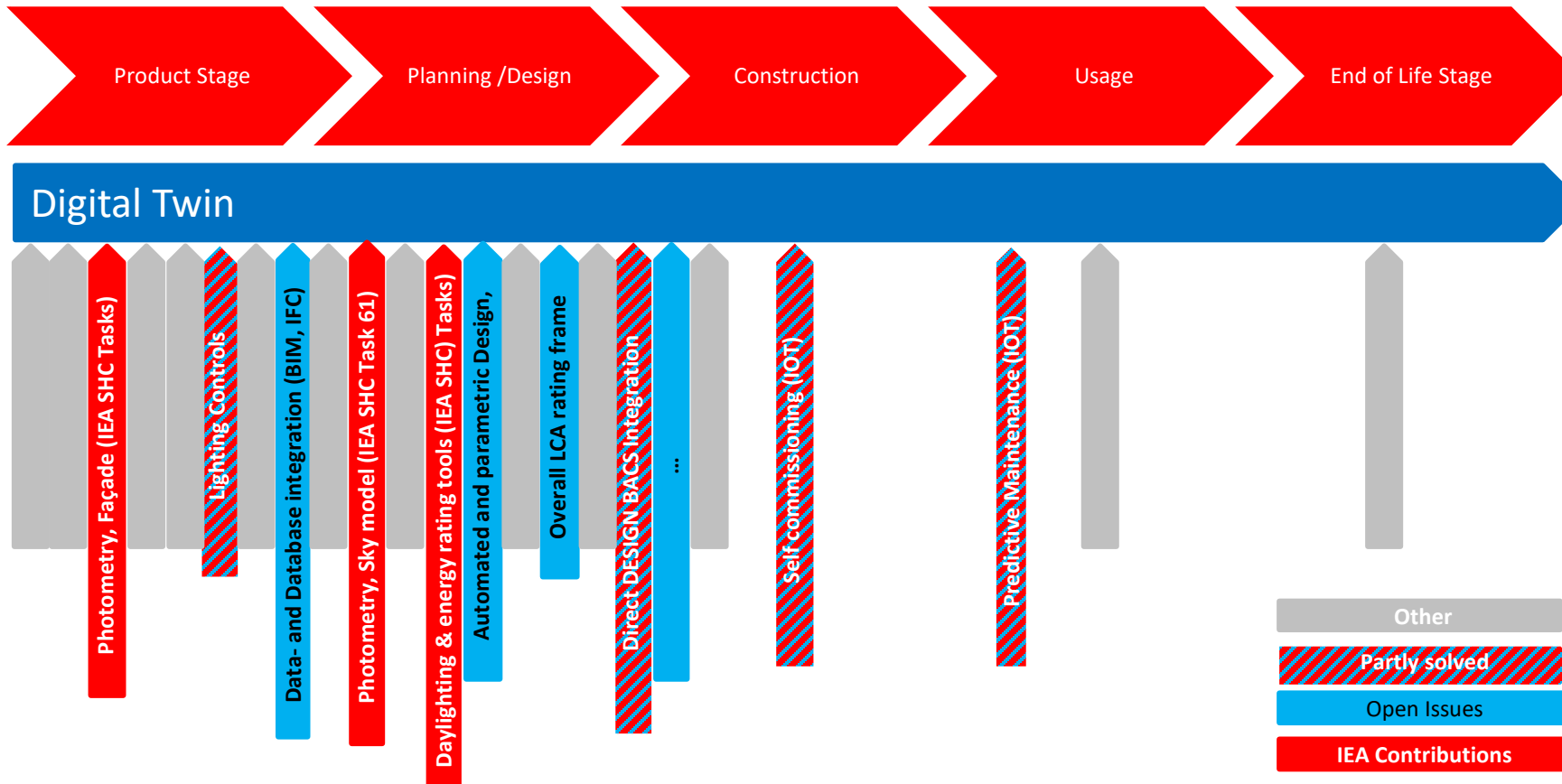
Architectural and design constraints

- 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

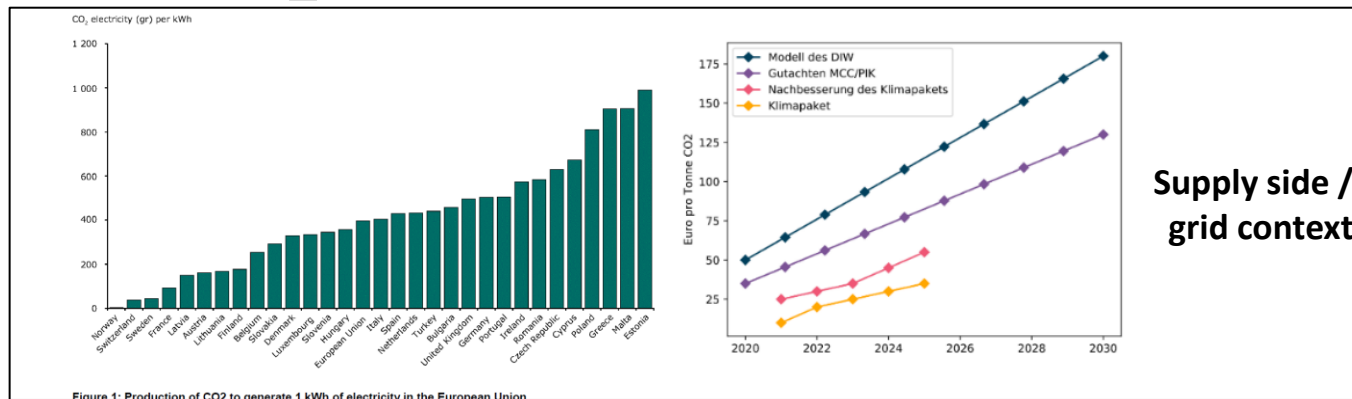


Lighting Carbon footprint

Scenarios, strategies, roadmaps...



Technology and design employed



+ Link to other trades...

CO₂ eq. Kg per solution

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?

50 participants from 15 countries 34 onsite, others online



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

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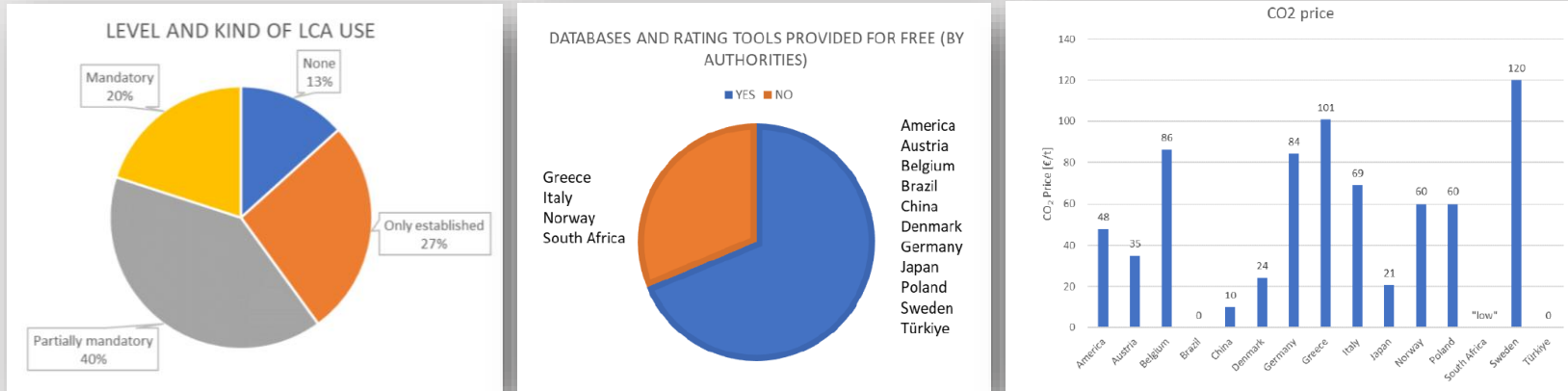
*Niko Gentile, Sweden
Natalia Giraldo Vasquez,
DK*

**Application and Case
Studies**

Joint Work

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

Survey in 15 countries



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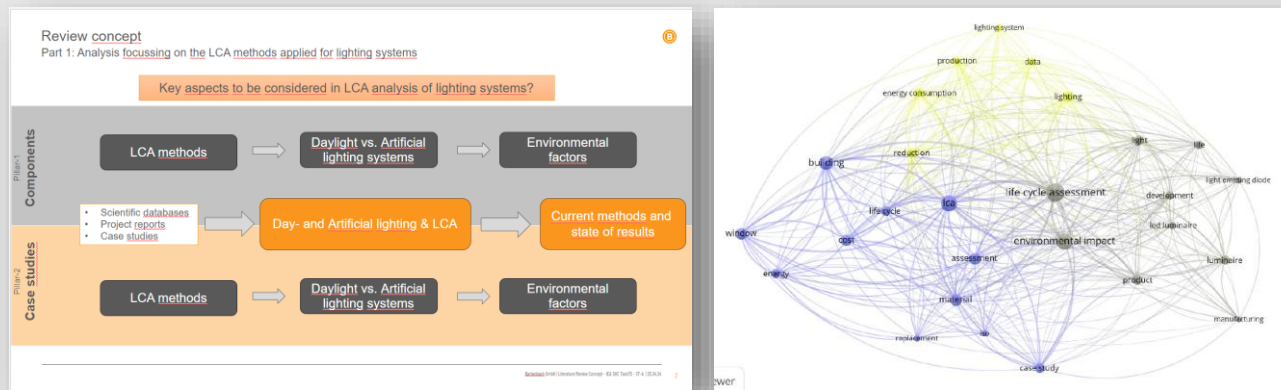
Report: Published

Life Cycle Assessment in Lighting – International Survey and Status quo of Scientific Literatur

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

Technology Collaboration Programme by IEA

Literature survey: Det. review of 59 papers



Component Perspective: Luminaire EPDs in European Union

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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-Verdaguer³ ✉ and Jan de Boer⁴ ✉

¹ Department of the Built Environment, Aalborg University Copenhagen, A.C. Meyers Vænge 15, 2450 Copenhagen SV, Denmark
² Department of Architecture, Design & Media Technology, Aalborg University Copenhagen, A.C. Meyers Vænge 15, 2450 Copenhagen SV, Denmark
³ Instituto Universitario de Arquitectura y Ciencias de La Construcción, University of Seville, 41004 Sevilla, Spain
⁴ Fraunhofer Institute of Building Physics, 70569 Stuttgart, Germany

* Authors to whom correspondence should be addressed.

Buildings 2025, 15(8), 1279; <https://doi.org/10.3390/buildings15081279>

Submission received: 7 March 2025 / Revised: 9 April 2025 / Accepted: 11 April 2025 / Published: 14 April 2025

(This article belongs to the Special Issue Lighting in Buildings—2nd Edition)

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Versions Notes

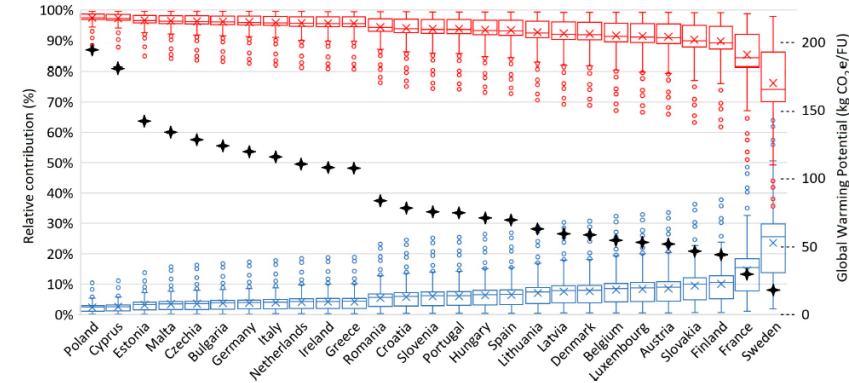


Figure 2. Average GWP score of lighting systems for EU-27 countries, and the variation of relative contributions of embodied and operational impacts. The declared functional unit (FU) is assumed to be a light providing 1000 lumens over 35,000 h. Black stars present the absolute values of GWP (kg CO₂ e/FU), red boxplots present relative operational impacts (%) and blue boxplots the relative embodied impacts (%).

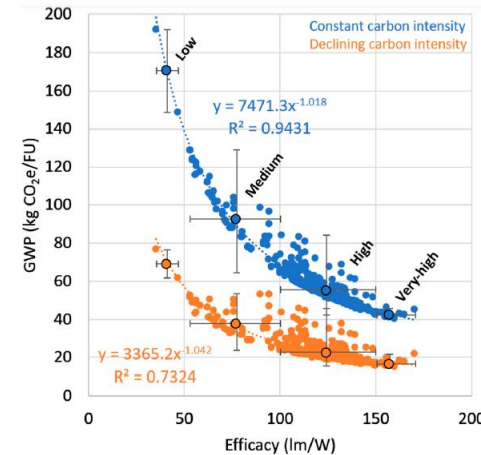
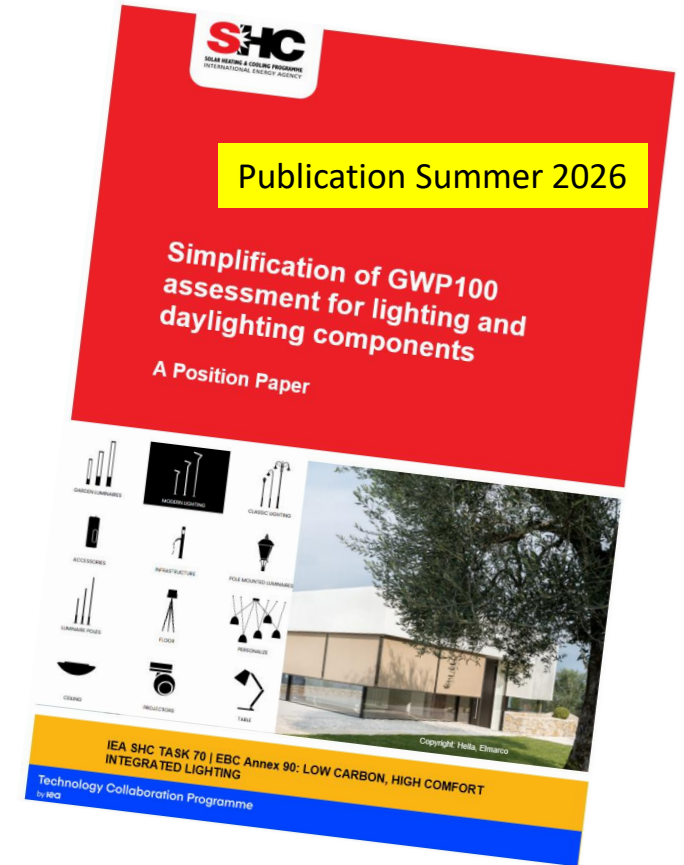
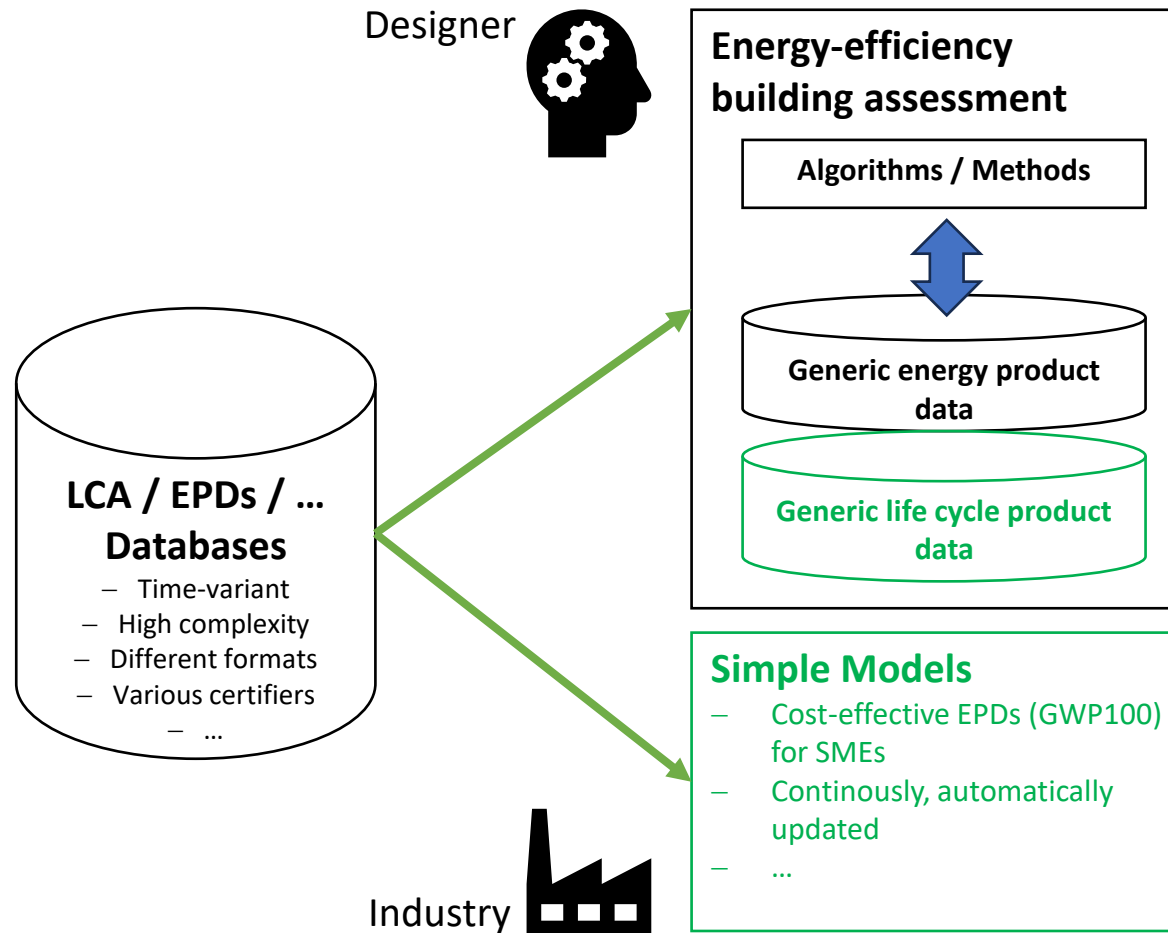


Figure 3. Relation between luminous efficacy and the environmental impacts of lighting in Denmark. Lined black circles represent the average values for each group, and the interval bars indicate the variations between the minimal and maximal values.

Impact of Energy Mix

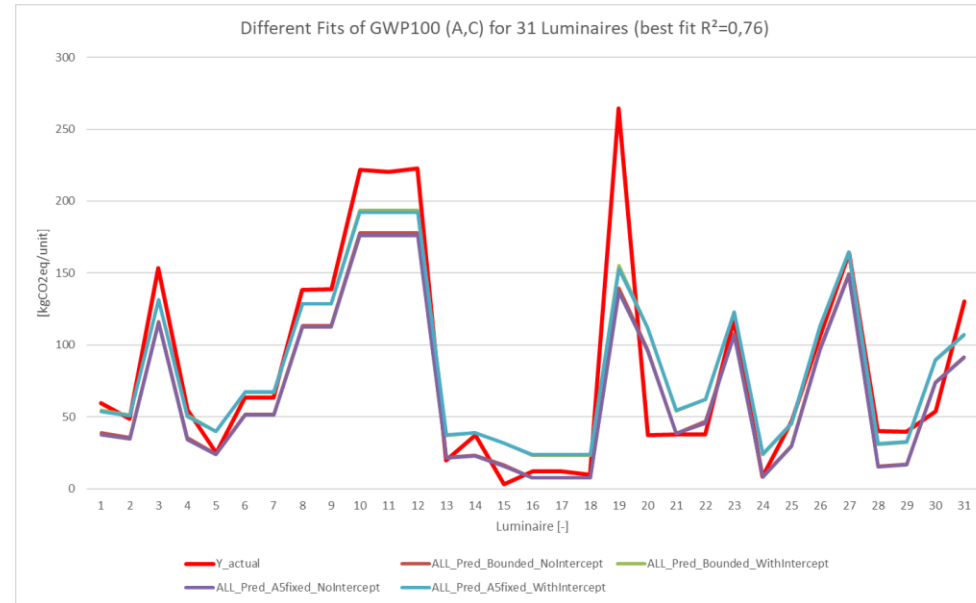
Impact of Luminaire Design

Component perspective: Simplification approaches



Component Perspective: GWP100 rating for fixtures

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



Draft

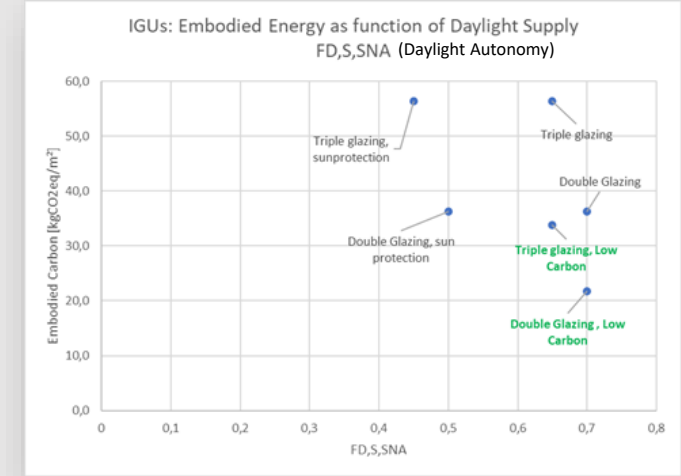
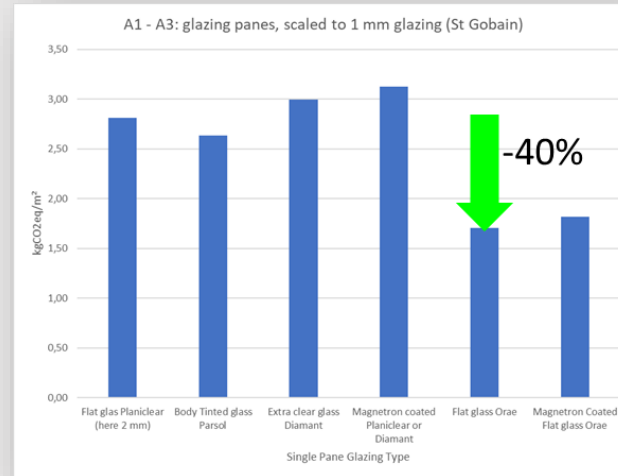
		Material(group)				
		Steel	Aluminium	Plastic	Elektronics (PCBs)	Packaging
		kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg	kgCO2eq/Kg
<u>Datafit</u>		2,2	15,3	2,0	25,0	2,0
Literature	Min	0,4 – 2,2	6-8 Europe 6-8 (stainless)	1,5-2,5 5-7 (PMMA)	15-25	0,5-1,0 (cardboard)

Table 5: Assumptions for CO2 equivalent factors k_{CO2x} from multidimensional regression compared with literature values

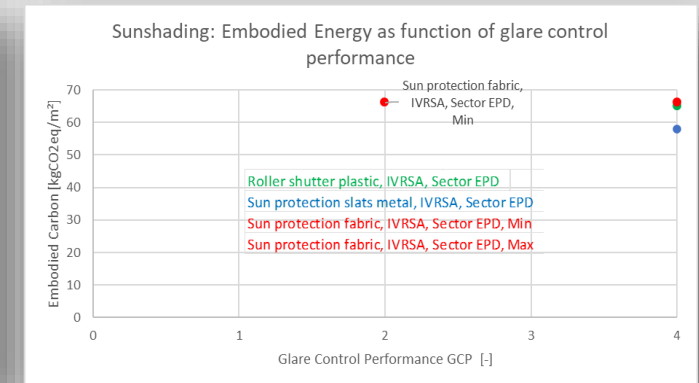
Special focus on SME

Component Perspective: GWP100 rating for façades

(Low Carbon) glazing

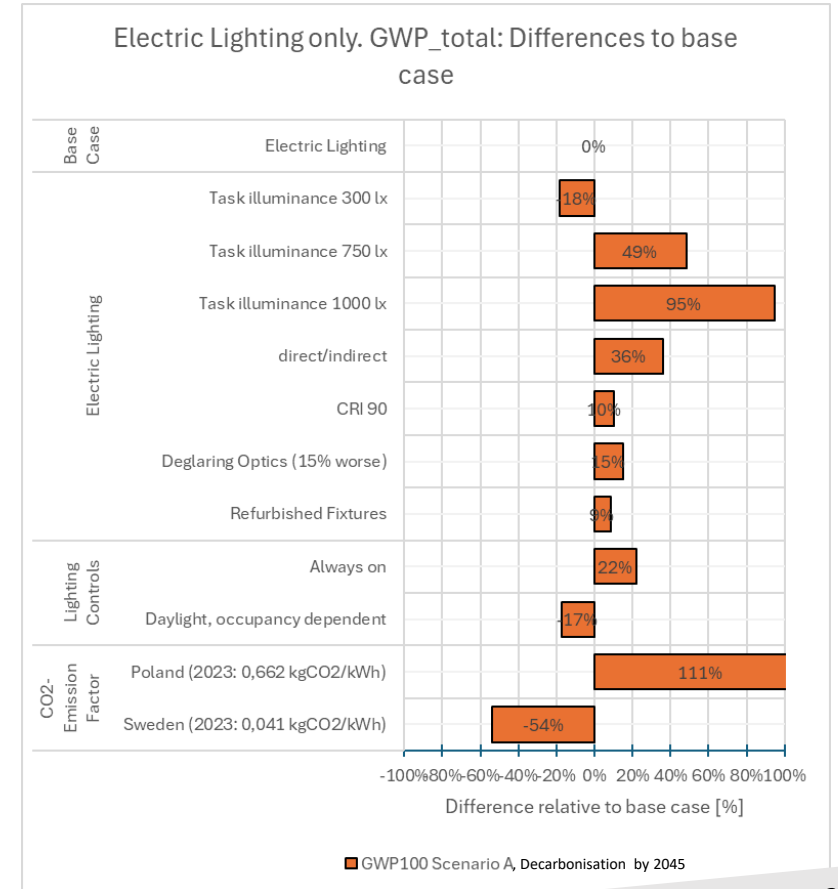
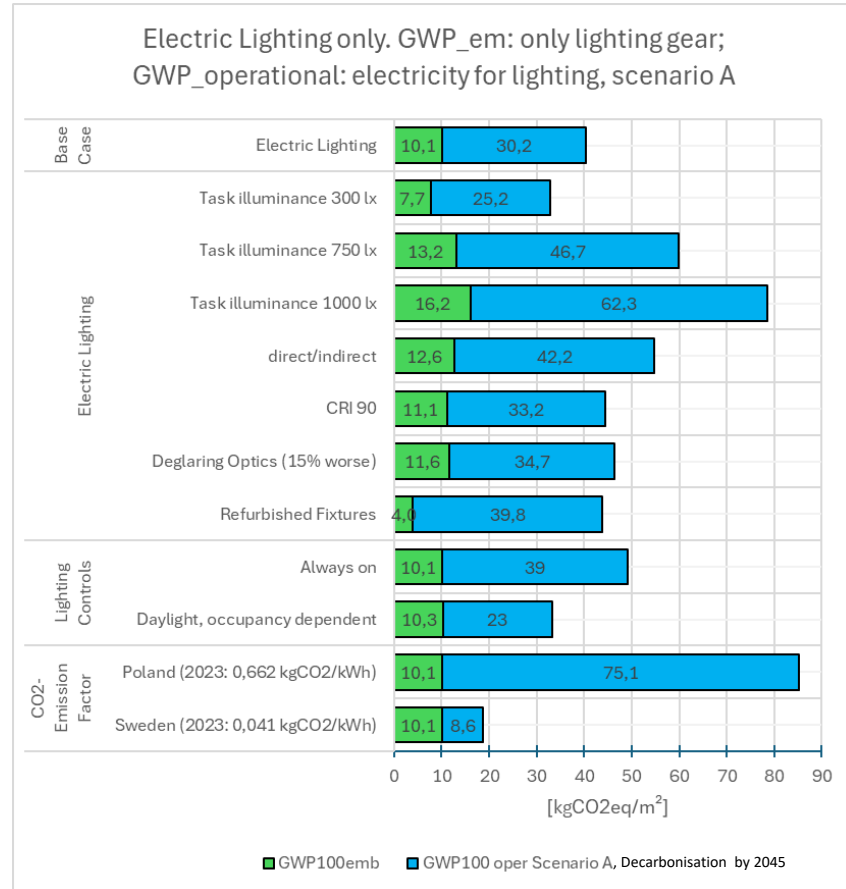
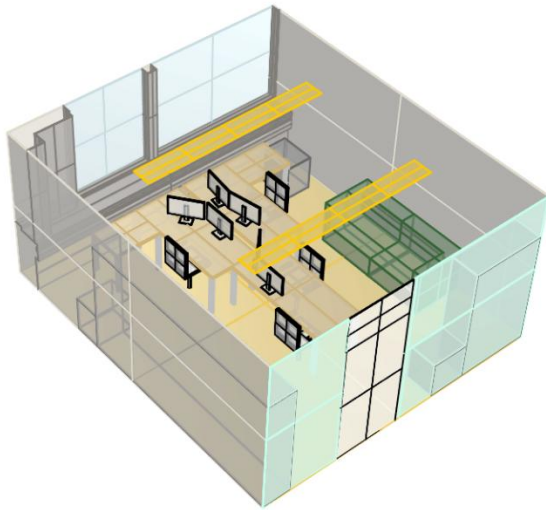


Shading systems



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

Exemplary office space



Draft, Publication Summer 2026

Structure

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Joint Work

Deliverables

ISO Standards Sectors About ISO Insights & news Taking part Store Search

ISO/CIE 10916:2024 | ISO/CIE 10916

Light and lighting — Energy

ISO Standards Sectors About ISO Insights & news Taking part

COMMITTEE DRAFT

ISO/CIE CD 25176

Light and lighting — Daylight in buildings — BSDF data generation for complex fenestration systems

Under development

A draft is being reviewed by the committee.

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LED Guideline for the Promotion of Lighting Retrofitting

2024 HIGHLIGHTS SHC Task 70 / EBC Annex 90 - Low Carbon, High Comfort Integrated Lighting

WILEY-VCH

Edited by Barbara S. Matusiak, Mandana S. Khanie

Human visual and non-visual response to the built environment – recent achievements and their practical implementation

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

ST A Report Low Carbon Lighting

Scenarios, Strategies and Roadmaps (A.1.7, A.2, A.3, A.4)

Solar Heating and Cooling

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

Technology Position Paper

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

2024 HIGHLIGHTS

SHC Task 70 / EBC Annex 90: Low Carbon, High Comfort Integrated Lighting

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

Life Cycle Assessment in Lighting – International Survey and Status quo of Scientific Literature

Building and Environment

Outdoor thermal comfort

Guest editors: Yupeng Wang; Hashem Akbari; Junqi Wang

Submission deadline: 31 July 2026

Low Carbon, High Comfort Integrated Lighting

From a global perspective, lighting systems—when designed to be energy-efficient, digitally integrated, and intelligently managed—can play a key role in reducing carbon emissions while enhancing the functional and experiential quality of both indoor and urban spaces. The International Energy Agency's SHC Task 70 / EBC Annex 90 "Low Carbon, High Comfort Integrated Lighting" is focused on implementing the full potential of lighting (electric, daylighting & passive solar) to achieve decarbonization while aligning with an integrative understanding of humans' physiological and psychological needs for light. This Special Issue provides insights into the challenges and opportunities for integrated lighting with four core thematic areas: i) Low Carbon Lighting and Passive Solar; ii) Visual and non-visual User Requirements; iii) Digitized Lighting Solutions; iv) Lab and field study performance tracking. The SI includes contributions that span case studies, simulation-based research, methodological developments, and interdisciplinary reviews.

Guest editors: Justyna Martyniuk-Peczek, Jan de Boer, David Geiser-Moroder, Natalia Giraldo Vasquez, Tao Luo, Barbara Matusiak, Eleanor Lee

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2024 HIGHLIGHTS SHC Task 70 / EBC Annex 90

KEY RESULTS IN 2024

Better (day)lighting with low environmental impact. These studies evaluate the best lighting solutions for office environments, highlighting the importance of daylighting and the role of electric lighting in meeting both visual and non-visual needs. The second example involves electric lighting. Three daylighting studies for lighting quality, one of the best performance but we were cost-effective due to its sustainability. Further research is needed.

Integrative lighting in offices: focus on the contribution of daylighting

Daylighting was analyzed in real offices with large windows obstructed seating in Torino, Italy. Daylighting was insufficient to comply with melatonin illumination recommendations at desks over 2 m from the windows.

Life Cycle Assessment in Lighting – International Survey and Status quo of Scientific Literature

Started earlier in the and lighting – EBC has now formally offers for the first calculation and it. Meanwhile a new Generation for the context of. Most of it is not For transparent dependent, it is mostly observed or performance assessment. (CFS) has been assessed.

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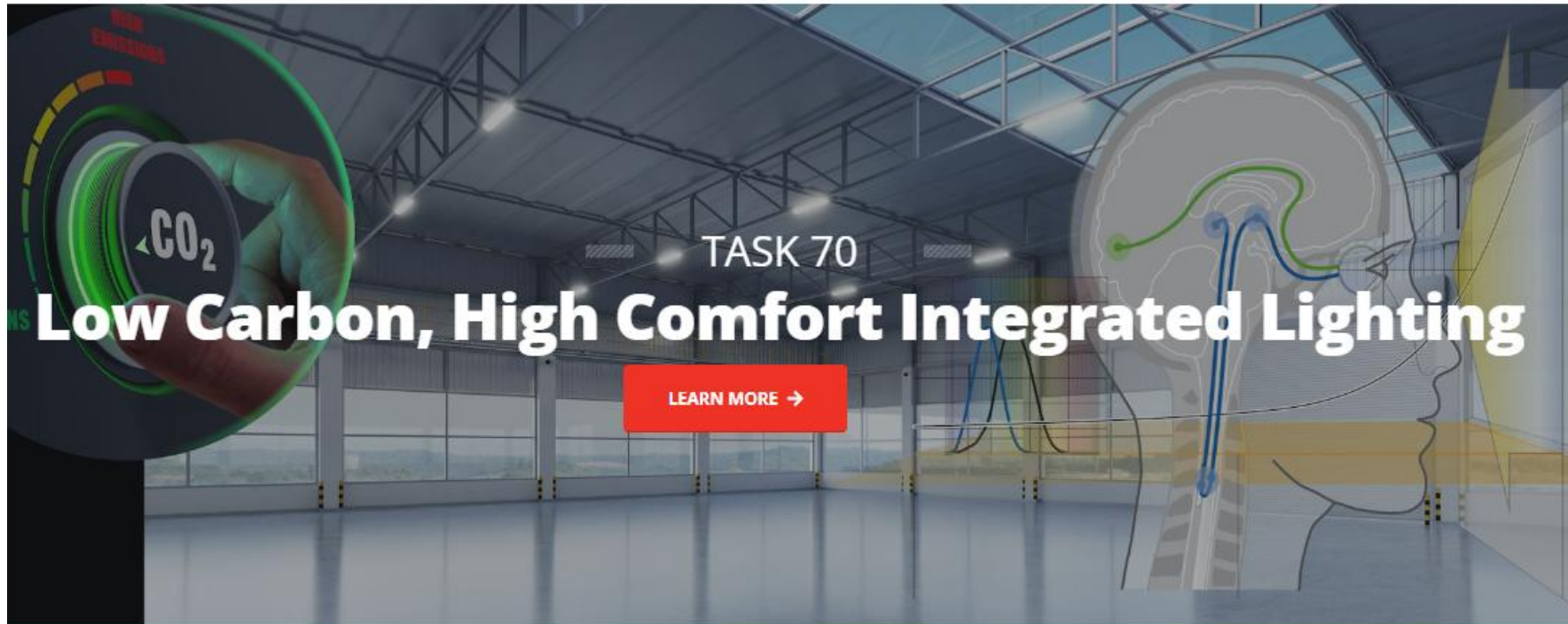
Task 70 | Low Carbon, High Comfort Integrated Lighting

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TASK 70

Low Carbon, High Comfort Integrated Lighting

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