SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2025 HIGHLIGHTS

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

THE ISSUE

Lighting accounts for 5% of the global CO2 emissions. Its carbon footprint has a significant impact on global warming. Also, in the transition to mainly electricity-based energy systems, lighting with 15% of the electrical energy consumption, is in strong competition with other existing or new consumers, e.g., e-mobility or heat pumps. With rising electricity prices and steadily higher directly taxed CO2 emissions also lighting costs increase significantly. Thus, to make todays high comfort lighting installation more efficient, the consumption of electric lighting systems must be cut further, and benefits of daylight used better. And, moreover, embodied energy for electric and daylighting - i.e., façade technology - must be taken into accounted. Thus, widening the rating perspective of lighting solutions to a more holistic view of its impact on CO2 emissions, encompassing the whole life cycle (the “lighting value chain”) also in context of regional energy markets aspects, interaction with other building trades etc. is urgently deemed necessary. This goes far beyond pure LED lamp driven efficiency gains and can allocate big additional potentials.

OUR WORK

The aim of SHC Task 70 - EBC Annex 90 is to identify and support implementing the potentials of lighting (electric, façade: daylighting & 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:

- Support broadening the view on lighting solutions as a whole in in decarbonization. Bridge the gap between a component view (manufacturer’s focus) and design-oriented system approaches. Support the transition from energy focused views to a LCA perspective. 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 especially build upon results from earlier tasks (e.g. Task 61).
- 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.

Participating Countries

Australia
Austria
Belgium
Brasil
China
Denmark
Germany
Greece
Italy
Japan
Norway
Poland
SACREE
South Africa
Spain
Sweden
Netherlands
Türkiye
U.S.A.

Task Period **2023 – 2026**
Task Leader **Dr. Jan de Boer, Fraunhofer IBP, Germany**
Email **jan.deBoer@ibp.fraunhofer.de**
Website **http:task70.iea-shc.org**

KEY RESULTS IN 2025

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

To understand the current status of LCA in lighting technology, a survey of 15 participating countries in IEA SHC Task 70 / EBC Annex 90 and a review of 59 scientific articles were conducted. The survey examined decarbonization efforts and the use of LCA in the building sector, including lighting and façade/daylighting. Key challenges include limited access to LCA tools and databases, low transparency in methodologies, insufficient LCA training for architects and engineers, and overall complexity. Simpler tools for assessing environmental performance and carbon emission limits in building regulations—similar to energy rating—are needed. The literature review shows a shift toward more integrated LCA approaches in luminaire design, emphasizing circular economy principles and modularity. Designing products for disassembly improves maintenance and reduces environmental impact, with modular LED luminaires cutting carbon footprints by about 30% through component replacement instead of full disposal. Remaining barriers include labour costs, certification gaps, and limited manufacturer data. Standardized data and stronger collaboration between manufacturers and environmental experts are essential. Façade/daylighting systems are less studied, with most research focusing on windows, frames, and glazing, while shading systems remain underexplored. Simulation studies dominate over real-world applications. Across all lighting scenarios, the use phase has the highest environmental impact, highlighting the importance of efficient planning, energy-conscious operation, and consistent maintenance. The full report is available on the Task's website.

Link into building design processes: Virtual reality in lighting design, BSDF standardization activity and new RADIANCE features

Shading or daylighting devices are of growing importance in the context of increasing overheating risks of buildings while maintaining high visual comfort for occupants. The corresponding standardization effort of a group of IEA Task 70 / Annex 90 experts on BSDF generation for complex fenestration systems is well under way. ISO/CIE CD 25176: "BSDF data generation for complex fenestration systems" committee draft was accepted and will now, in the next step, be filed as a draft international standard (DIS) by ISO TC 274.

Virtual reality is emerging as a significant yet still underutilized tool in lighting design. A study of IEA Task 70 /Annex 90 highlights how VR is explored in academic settings and how it is adopted by professionals in practice. It shows that professionals recognize the potential of VR and view it as a promising resource for evaluating lighting concepts. However, its adoption still remains limited. Participants in the study emphasized the importance of accurate representations of light distribution within virtual environments. They also expressed a strong need for intuitive, and open-source VR tools that make the technology more attractive.

Radiance is the most widely used lighting simulation engine in professional building-performance simulation and embedded in dozens of tools in building simulation. It has now undergone a major revision with the inclusion of hyperspectral rendering capabilities, an update of its general software architecture implementing a C++ class hierarchy and can now be use in Python-scripting via "pyradiance".

Exchange with Industry and Design Practice

IEA SHC Task 70 – EBC Annex 90 continued exchange with industry with two well visited industry workshops in conjunction with the experts' meetings in Innsbruck, Austria, in spring and in Changsha, China, in fall 2025. The presentations and panel discussions at the Innsbruck meeting led to an excellent exchange, especially on overarching topics such as the environmental impact of lighting and daylighting solutions towards circularity, the use of passive design strategies to reduce the operational CO2 emissions, the need for more focus on health and well-being for all populations, and the demands of all these aspects on design practices. Discussing the role of current regulations, it was stressed that LCA approaches should be simplified for a good practical application, ideally aligned with energy rating procedures. In Changsha, China, the workshop had a strong focus on façades in the context of technological developments and decarbonization as it was jointly organized with a joint Austrian-Chinese project CFS4LowCarb which is associated directly to the IEA project. Representatives from 11 companies, design offices, and external research organizations joined the task experts and were on the panels of the two workshops.