



SOLAR HEATING & COOLING PROGRAMME  
INTERNATIONAL ENERGY AGENCY

TASK 70

## Low Carbon, High Comfort Integrated Lighting

# Digitalisierung als Schlüssel für nachhaltige und Nutzer:innen-zentrierte Beleuchtungssysteme

David Geisler-Moroder  
IEA Vernetzungstreffen 2026, Wien, 19. Jänner 2026

# Beleuchtung im Kontext der Dekarbonisierung und Energieeffizienz

## Status quo

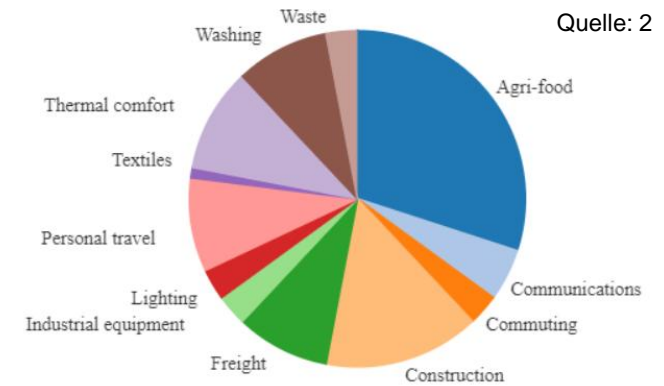
- Beleuchtung ist für 5 % der weltweiten Treibhausgasemissionen und 15 % des Stromverbrauchs verantwortlich<sup>1</sup>
- Stärkerer „Wettbewerb“ um Strom (E-Mobilität, Wärmepumpen, etc.) und Besteuerung von CO2 Emissionen

## Ziel

Erweiterung der Bewertung von integralen Beleuchtungslösungen (Tageslicht, Kunstlicht, Steuerung) auf eine ganzheitliche Sicht der Auswirkungen

- gesamter Lebenszyklus ("Beleuchtungs-Wertschöpfungskette"),
- graue Energie für elektrische Beleuchtung und Tageslichttechnologien,
- Regionale Aspekte des Energiemarktes,
- Interaktion mit anderen Gewerken am Bau, usw.

Greenhouse gas emissions by service - 50.6Gt CO<sub>2</sub>e total



<sup>1</sup>UNEP Report, Accelerating the Global Adoption of ENERGY-EFFICIENT LIGHTING, 2017

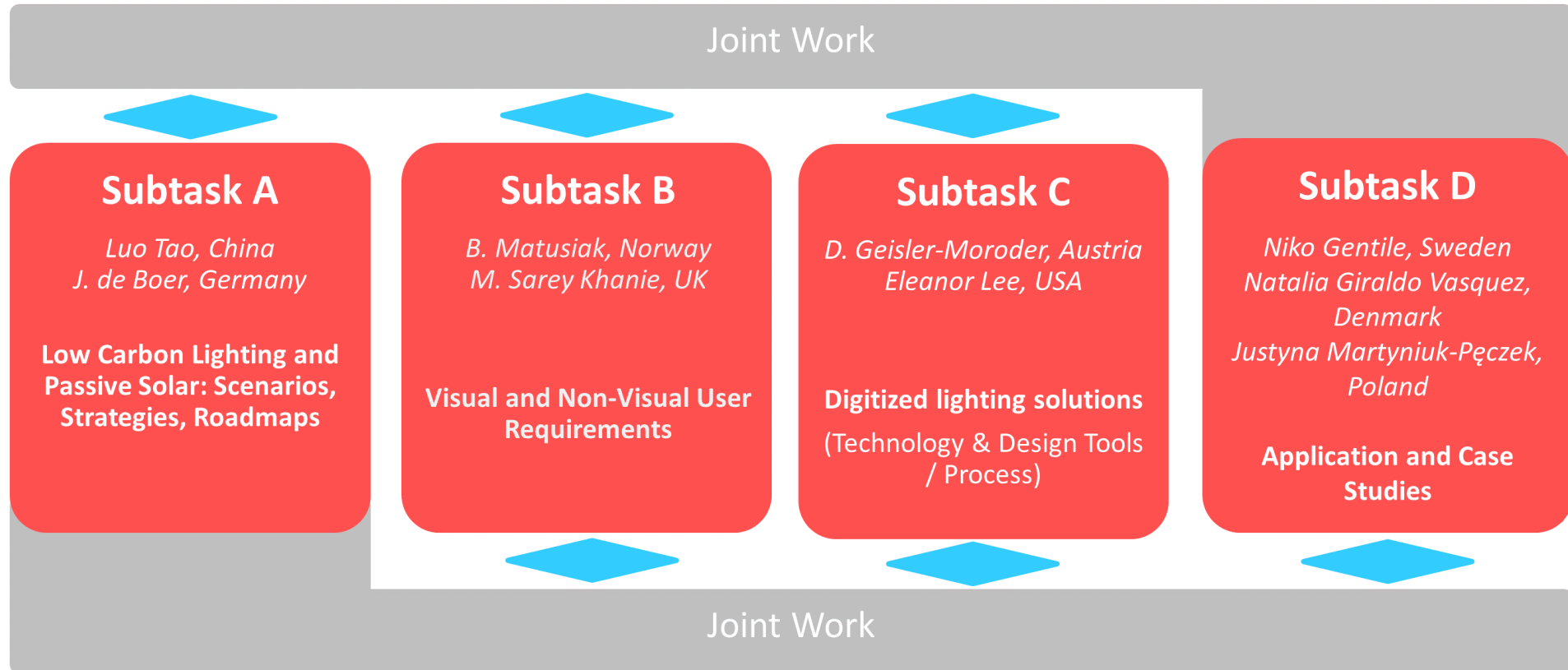
<sup>2</sup><https://public.tableau.com/app/profile/rosamund.pearce/viz/Greenhousegasemissionsbyservice/Dashboard1>

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**



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Joint Work

### Subtask A

Luo Tao, China  
J. de Boer, Germany

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

### Subtask B

B. Matusiak, Norway  
M. Sarey Khanie, UK

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,  
Denmark  
Justyna Martyniuk-Pęczek,  
Poland

Application and Case  
Studies

Joint Work

### Grundlagen

Erweiterung des LCA-  
Ansatzes auf integrale  
Beleuchtungslösungen

Daten, Methoden,  
Szenarien

### Nutzer-Perspektive

Reale Wirkung statt  
hypothetischem,  
technischem Potenzial

Visuelle/nicht-visuelle  
Anforderungen,  
Nutzerverhaltensmodelle

### Technologie & Digitalisierung

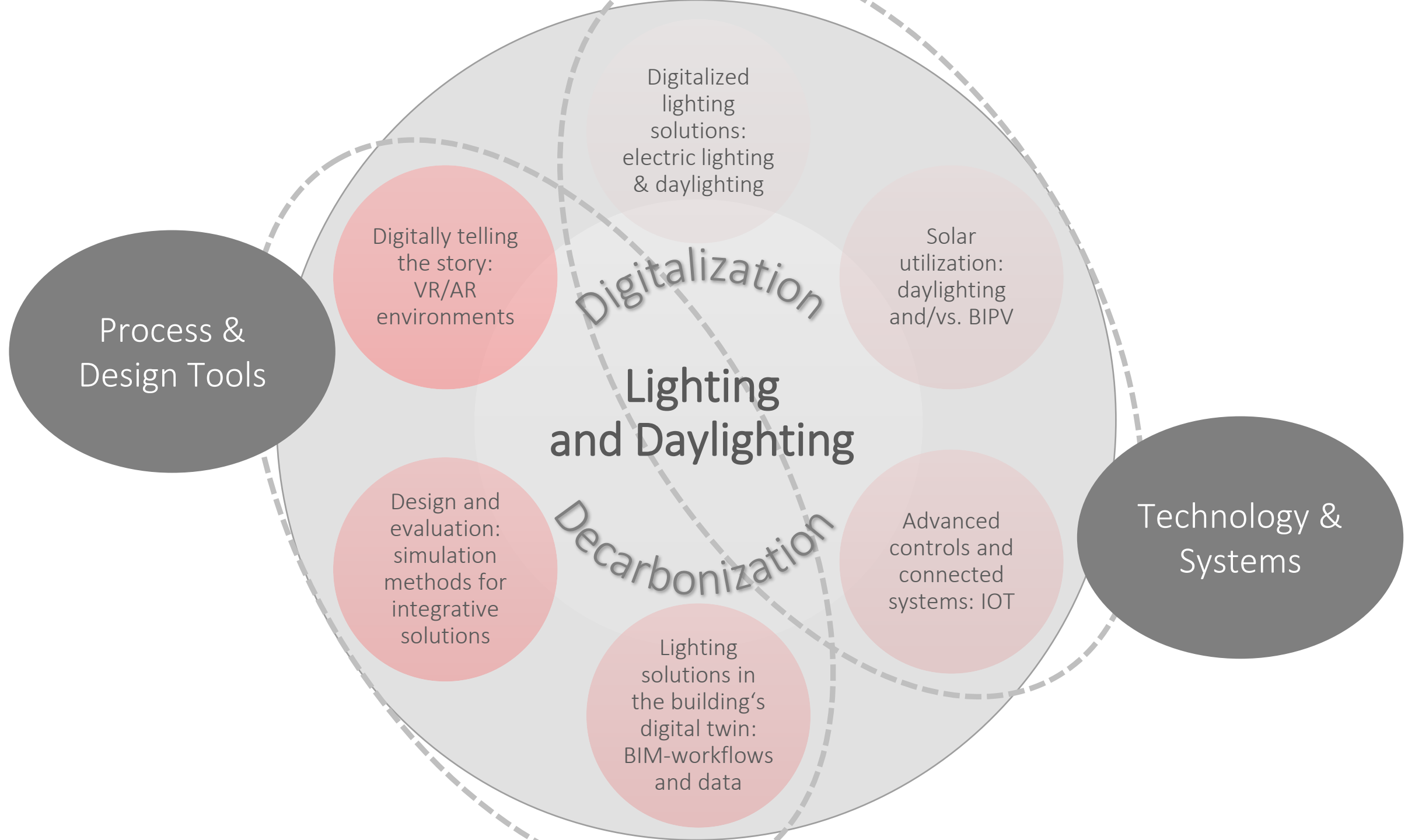
Hin zu intelligenten, ver-  
netzten und in Planungs-  
abläufen abbildbaren  
Beleuchtungssystemen

Beleuchtungssysteme,  
Workflows, Software

### Evaluierung und Validierung

Überprüfung der  
Methoden und des  
realen Impakts in  
Beispielszenarien

Fallstudien, Guidelines



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

## Technologien

- Systemkonzepte für digitalisierte Beleuchtungslösungen, Kombination Tageslicht und Solarenergie
- Beleuchtungssteuerungen und IOT

## Planungswerkzeuge / Prozesse

- BIM-Workflow für integrale Beleuchtungslösungen und zugrundeliegende Daten
- Simulationsmethoden für integrative Lichtplanung und VR-Möglichkeiten

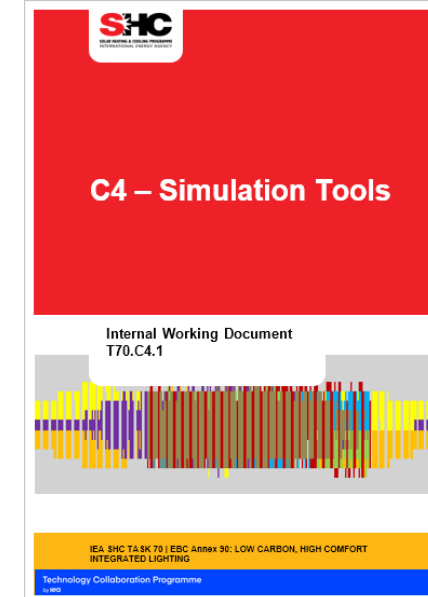


# Dissemination

## Berichte

- Literatur- und Marktübersicht zu integralen Beleuchtungslösungen (Tageslicht, Kunstlicht, Steuerung)
- BIM: Workflows, Datenspezifikation, Datenbanken
- Simulationstools
- Weitere Berichte aus Subtasks A, B, D

*(Alle zum Ende des Projekts Mitte 2026)*



# Dissemination

## Wissenschaftliche Artikel und Vorträge

- Zahlreiche Veröffentlichungen des österreichischen und des internationalen Konsortiums in internationalen Fachzeitschriften und auf Kongressen
- Special Issue „Low Carbon, High Comfort Integrated Lighting” in Building and Environment
- Buch “Human visual and non-visual response to the built environment – recent achievements and their practical implementation” (Wiley SHC Book Series)

## Industrieworkshop im Rahmen des 5. Task Meetings in Innsbruck

- Mit Vertretern aus Lichtplanung, Industrie, Normung, Land, etc.

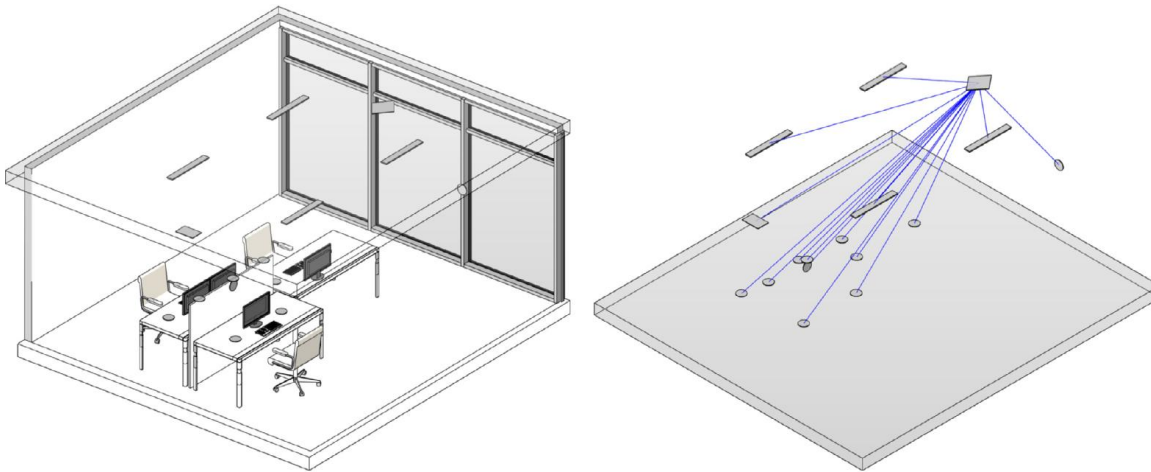




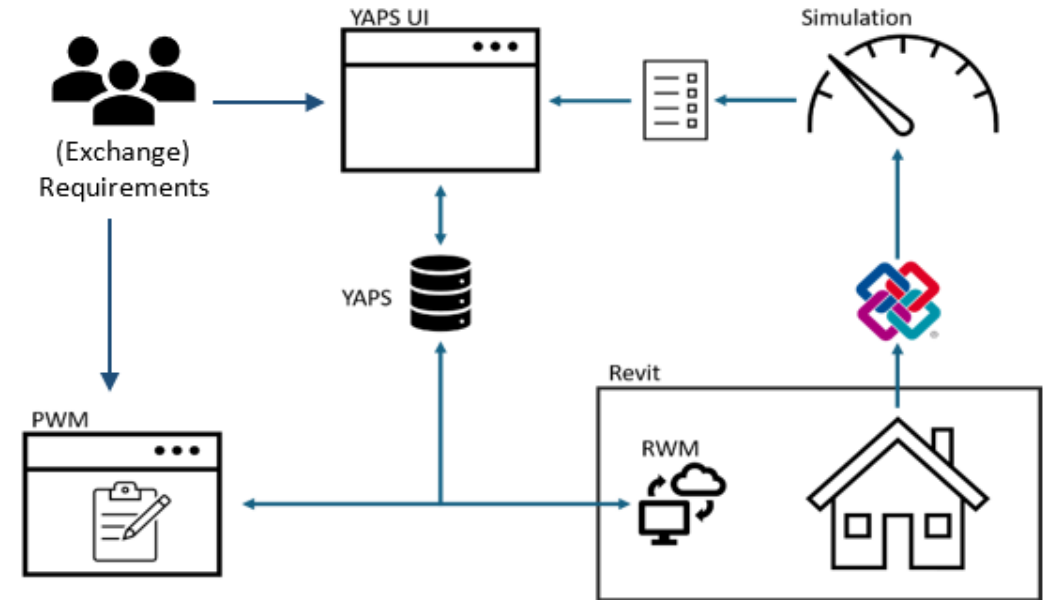
# Highlights

## BIM-Workflows

- BIM2BEM Workflow
- Steuerungsplanung in BIM



In: Philipp Zech, et al. From BIM to Digital Twin: A transformation process through advanced control modeling and automated commissioning using daylight and artificial lighting as examples, Energy and Buildings, Volume 329, 2025, 115184, <https://doi.org/10.1016/j.enbuild.2024.115184>




In: Miller, J., et al. (2025). Enhancing Interoperability Between Building Information Modeling and Building Energy Modeling: Alphanumeric Information Exchange for Energy Optimization in Early Design Stages. Applied Sciences, 15(10), 5789. <https://doi.org/10.3390/app15105789>

# Highlights

## Simulationstools


- Übersicht verfügbarer Tools
- RADIANCE Refactoring
- Spektrale Referenzräume

		AGI2	ElumTools	DALEC	DIALux	DIAL+	GB SWARE	Ladybug / Honeybee	PKPM	Radiance	RELUX	ALFA	ClimateStudio	DesignBuilder	IDA ICE	IES VE	LARK	Gerónimo	LightStanza	OpenStudio	OWL	
7	Contributor	LBNL	LBNL	UIBK	Valerio Lo Verso	UCLouvain	Zhen Tian	AAU ADMT	Zhen Tian	LBNL	Michela ngelo / Gdansk Tech	AAU ADMT + Polito + UnB	POLITO + UnB	University of Brasilia UnB	AAU BUILD	Josef (UIBK)	Barbara / NTNU	Jerome	LBNL	LBNL	UCLouvain	M
8																						
9	SOFTWARE USERS																					
10	Suited for lighting designers			+		+		+			+	+	+	0		0	0					+
11	Suited for architects			+		+		+			+	+	+	+		0	-					+
12	Suited for electric engineers			+		+		+			+	0	0	0		0	-					-
13	Suited for HVAC engineers			+		+		+			-	-	+	+		+	-					-
14	Suited for building engineers/planners			+		-		+			-	-	0	+		+	-					+
15	Suited for researchers			+		-		+			+	+	+	+		+	+					+
16																						
17	DESIGN PHASE																					
18	Suited for R&D			-		-		+			+	+	+	+		+	-					-
19	Suited for early design			+		+		+			+	+	+	+		0	-					+
20	Suited for detailed design			-		-		+			+	+	+	+		+	+					+
21																						
22	ALGORITHMS / ENGINES																					
23	Ray tracing			+		+		+			+	+	+	+		+	+					+
24	Photon mapping			-		-		-			-	-	-	-		-	+					-
25	Radiosity			-		-		-			-	-	-	-		-	-					-
26	Radiance kernel			+		+		+			-	+	+	+		+	+					+
27	3 Phase Method			+		+		+			-	-	-	+		-	-					-
28	5 Phase Method			-		-		+			-	-	-	-		-	-					-
29	Daylight Coefficient Method			-		-		+			-	-	-	+		+	+					+



**C4 – Reference Rooms**

Internal Working Document T70.C4.2



IEA SHC Task 70 IERC Annex 30: LOW CARBON, HIGH COMFORT INTEGRATED LIGHTING

Technology Collaboration Programme T70C

**3 Reference Office Space: UIBK Living Lab**

Within the internal **CoLab** at the University of Innsbruck (UIBK), an innovative concept for workplace spaces, design and energy lighting control has been implemented in a real office setting. This space has been worked out and developed as part of various research projects in recent years by researchers from the Unit for Energy Efficient Buildings. For the experimental setup of the integrated design and energy lighting environment, a test person office within the premises of the Department of Structural Engineering and Material Sciences on the 4th floor of the Faculty of Engineering Sciences was selected and transformed into a living lab (see Figure 1).



Figure 1: Office building of the Faculty of Engineering Sciences of the University of Innsbruck, Austria (left) and interior of the UIBK Living Lab (right)

In this implementation, parallel to the realistic testing and evaluation of control concepts, the aim was also to create the most cost-effective solution possible using as many existing hardware as possible in order to demonstrate effective controlling in existing buildings.



Figure 2: Control scheme implemented in the UIBK Living Lab



Figure 3: Outdoor and indoor scenes and measurement equipment for control and long-term monitoring

**3.1 Building description**

Location: Innsbruck, Austria, 47°26'00"N, 11°34'00"E, T: <https://www.openstreetmap.org/?lat=47.433333&lon=11.333333>

Climate: AUT, Tsmicro, T11200, JRC-esp, distance weather station Innsbruck report from site 0.0m

The IWEC weather data file is provided in the subfolder "TTC\_Office\_UiBk\weather".



Figure 4: 3D plot of the UIBK building outlined in white in the middle of the image. The north is up. The orientation of the building is approximately along the cardinal directions.

T70C weather data downloaded from: <https://www.openstreetmap.org/?lat=47.433333&lon=11.333333>

Report data to be kept here, following update

**3.2 Room description**

**3.2.1 Geometry**

- 3D model: <https://www.openstreetmap.org/?lat=47.433333&lon=11.333333>
- 1.50 m x 4.00 m x 2.40 m (approximate) with two windows (2.34 m x 1.00 m and 1.30 m x 1.00 m)
- Facade orientation: West (270°)
- Shading: None for and near straight specified an elevation angle per azimuth angle: **UIBK\_Living\_Lab**

The data files (3D model and shading levels) are provided in the subfolder "TTC\_Office\_UiBk\geometry".

The geometry was modeled using Rhinoceros 3D according to 2D plans as well as measurements in the real building. To increase generality, especially for LCA calculations, the concrete slabs in the southeast corner of the room, which can be seen in photos of the interior (see Figures 1 and 4) and 3D, was removed in the model.

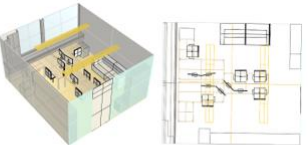


Figure 5: View and plan of the UIBK Living Lab

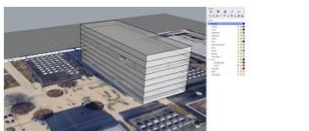


Figure 6: 3D model of the university building showing location of the UIBK Living Lab on the west facade.

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**3.2.2 Photometric characteristics**

**3.2.2.1 Materials**

Most opaque materials were measured with a handheld spectrometer in the Living Lab office. The spectral data for "Furniture" and "Concrete" were extracted from the Internal Materials database. The transparent materials were generated using IDL, a Python software based on spectral data from the RGDSP.

The geometry in the 3D model is divided into individual layers based on the different materials. The layer names are given in Table 1 and Table 2.

The spectra are provided in CSV format in the subfolder "TTC\_Office\_UiBk\materials".

**Table 1: Photometric characteristics of transparent materials in UIBK Living Lab**

Geometry layer name	Color	VIS	VIS/REF	REF	Spectral data file
Glass wall	Transparent	88.00%	88.00%	88.00%	Interface_Pink_Specs.csv
Window	Transparent	88.00%	88.00%	88.00%	Interface_Pink_Specs.csv

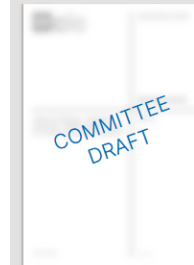
**Table 2: Photometric characteristics of opaque materials in UIBK Living Lab**

Geometry layer name	Color	VIS	VIS/REF	REF	Spectral data file
Wall	White	88.00%	88.00%	88.00%	TTC_office_wall.csv
Floor	White	88.00%	88.00%	88.00%	TTC_office_floor.csv
Roofing	White	88.00%	88.00%	88.00%	TTC_office_roofing.csv

Report data to be kept here, following update

# Highlights

## ISO/CIE 25176 “BSDF data generation for complex fenestration systems”



### 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.

- BSDF: “Photometrie eines CFS” (Complex Fenestration Systems)
- Analogon zur Lichtverteilung einer Leuchte für Tageslichtsysteme
- Grundlage für die Abbildung von Tageslicht- und Beschattungssystemen in Simulationen
  - Lichtsimulation (Sonne und Himmel)
  - Gebäudesimulation (winkelabhängige solare Gewinne)
- Bereits in verschiedenen Tools implementiert, in ISO/CIE 10916 verankert
- Draft International Standard: 27.02.2026




# Danksagung



Konsortium des IEA SHC Task 70 / EBC Annex 90



 Bundesministerium  
Innovation, Mobilität  
und Infrastruktur



**IEA Forschungskooperation**  
im Rahmen von open4innovation



Arbeitsbereich für  
Energieeffizientes Bauen





Vielen Dank!

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