Integrated Solutions for Daylight and Electric Lighting

From component to user centered system efficiency

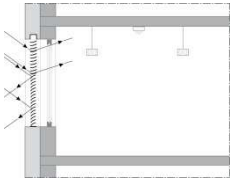
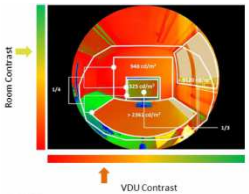
1/2018 – 6/2021

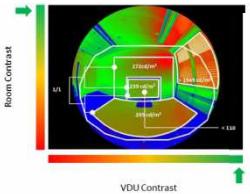
Objectives of IEA SHC Task 61 / EBC Annex 77

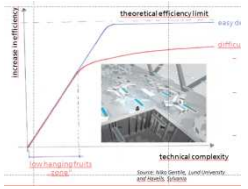
National Day Seminar, Vienna, 5th June 2019

Jan de Boer, FHG-IBP, Stuttgart, Germany

David Geisler-Moroder, Bartenbach GmbH, Aldrans, Austria



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Lichtverschmutzung

Die Welt strahlt. Leider.

„The World is shining. Unfortunatly.“

Eigentlich sollten LED-Leuchten beim Energiesparen helfen. Doch Spareffekte verpuffen, weil auch noch der letzte Fleck ausgeleuchtet wird. Neue Satellitendaten zeigen, wie die Nacht verschwindet.

Von Christoph Seidler

2 % Intensity increase of electric lighting

2% Increase of illuminated area

Each year since 2012

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Background

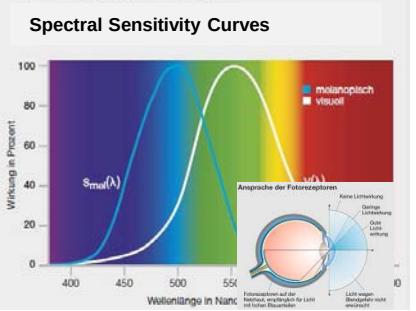
- Lighting and Energy
  - 15 % of worldwide energy consumption, absolute consumption still growing:
    - Growing economies
    - Rebound effects (“Jevons Paradoxon”): Low priced and more versatile electric lighting
- Market
  - Electric Lighting: LED Sales > 60% of market volume (Central Europe), Digitalization of light
  - Facade and daylight: 1,3 Billion m² of new facades per year (equivalent of the area of the city of London)
  - Trend: From Component to System solutions

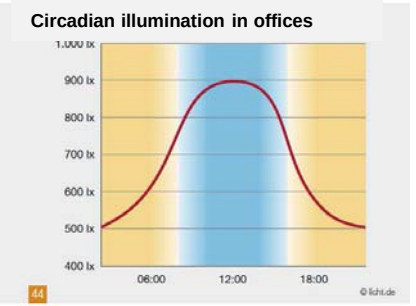
- **Open issues in the integration of day- and electric lighting**

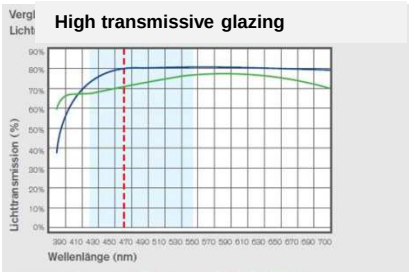
Open Issues

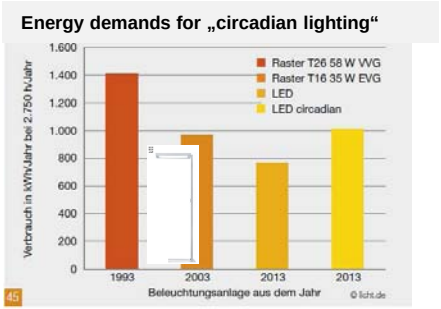
Example 1: Change in design and control parameters: *Daylight as template, …*

- Lighting solutions have to meet not only visual but non-visual effects as well
- Different needs depending on age
- Implications:
  - Different / additional targets in lighting design
  - We will see higher illuminance levels part of the time: But will that necessary mean higher energy demands?
- New products, methods, solutions coming / required
  - New daylight dependent controls
  - New luminaires (higher intensities, variable spectra)
  - New rating methods (hourly, spectral)
  - Use Cases, scenarios (different for offices, education, health care, museums, industry)









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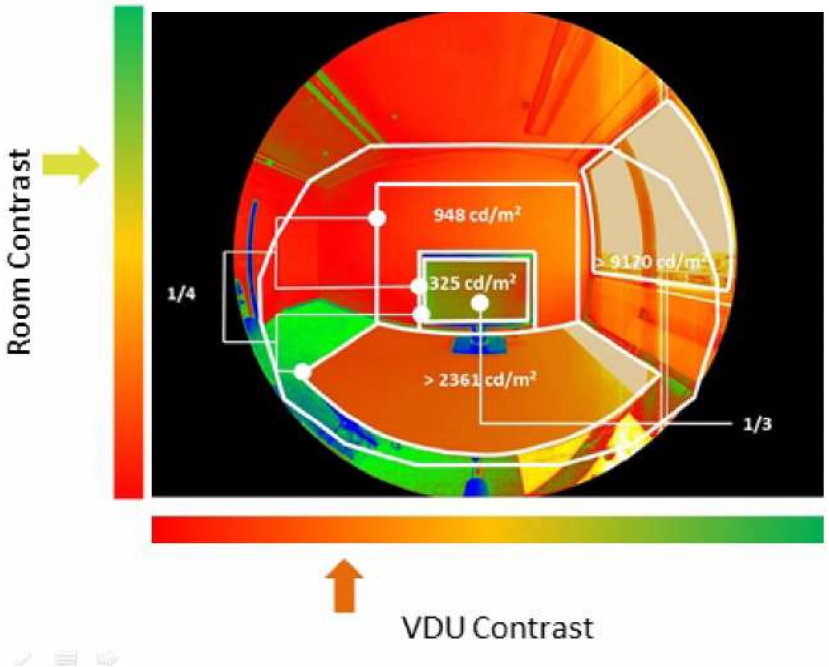
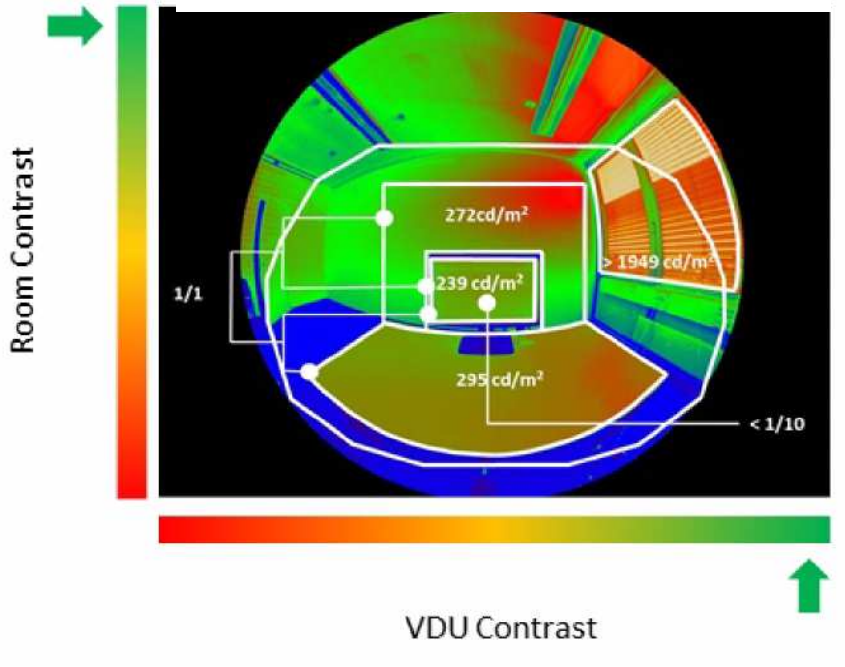
Open Issues

Example 2: Facade control is a daylighting problem

Without Glare Control

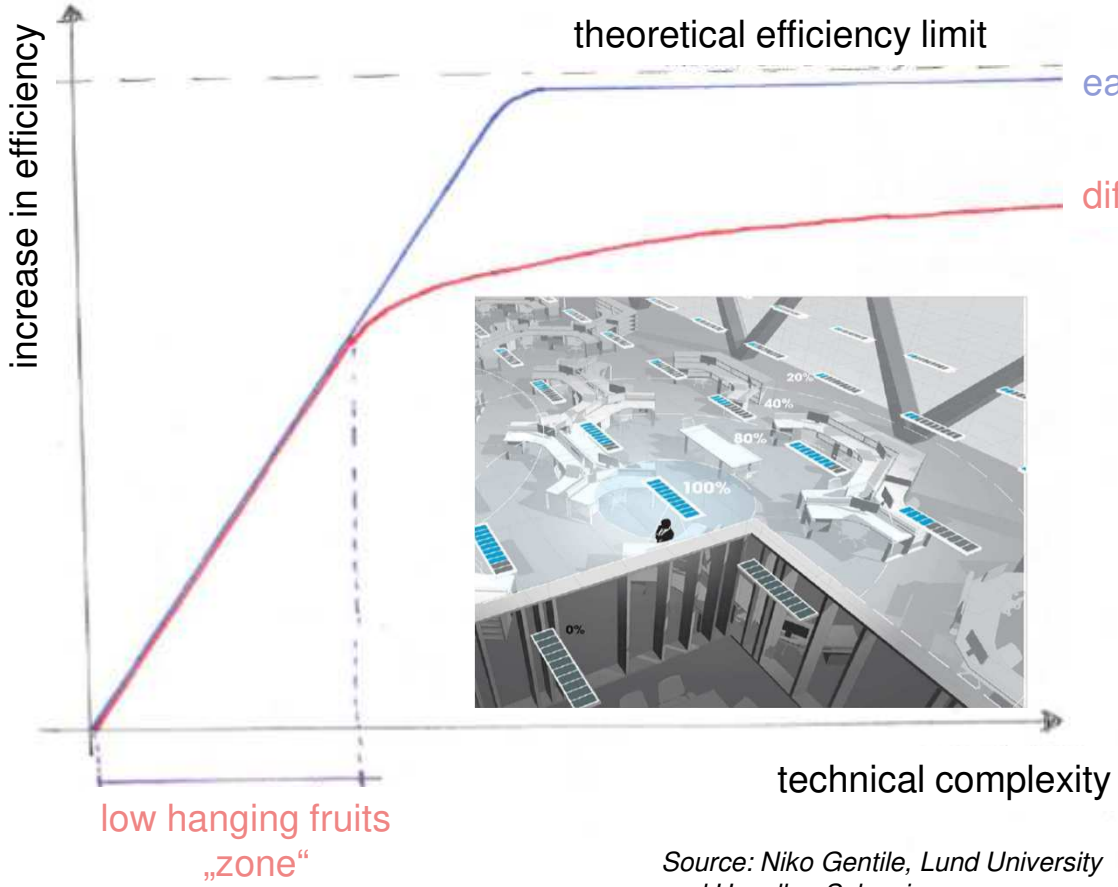


With Glare Control



Open Issues

Example 3: Complexity vs. efficiency in lighting controls

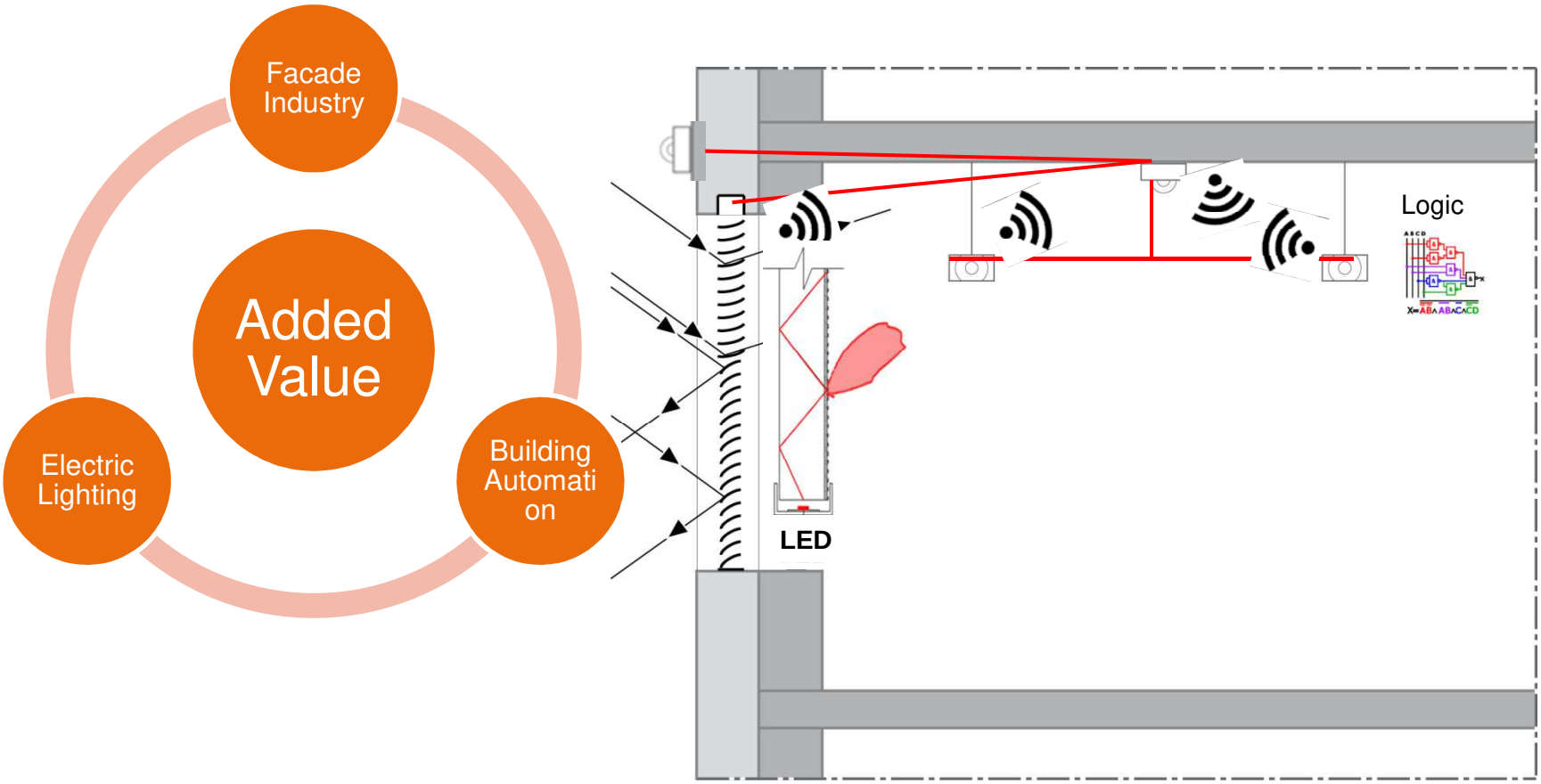


Source: Niko Gentile, Lund University and Havells - Sylvania

- What are the potentials of „Smart & Connected lighting“ („intelligent software“, Wireless networks, IOT…).
- Not everything that technically is possible, will be accepted.
- Balance between low complexity (simplicity) and high tech lighting solutions?

Open Issues

Example 4: Combine competencies: Market integration



Open Issues

Example 5: Codes / Regulations < - > Tools & Methods

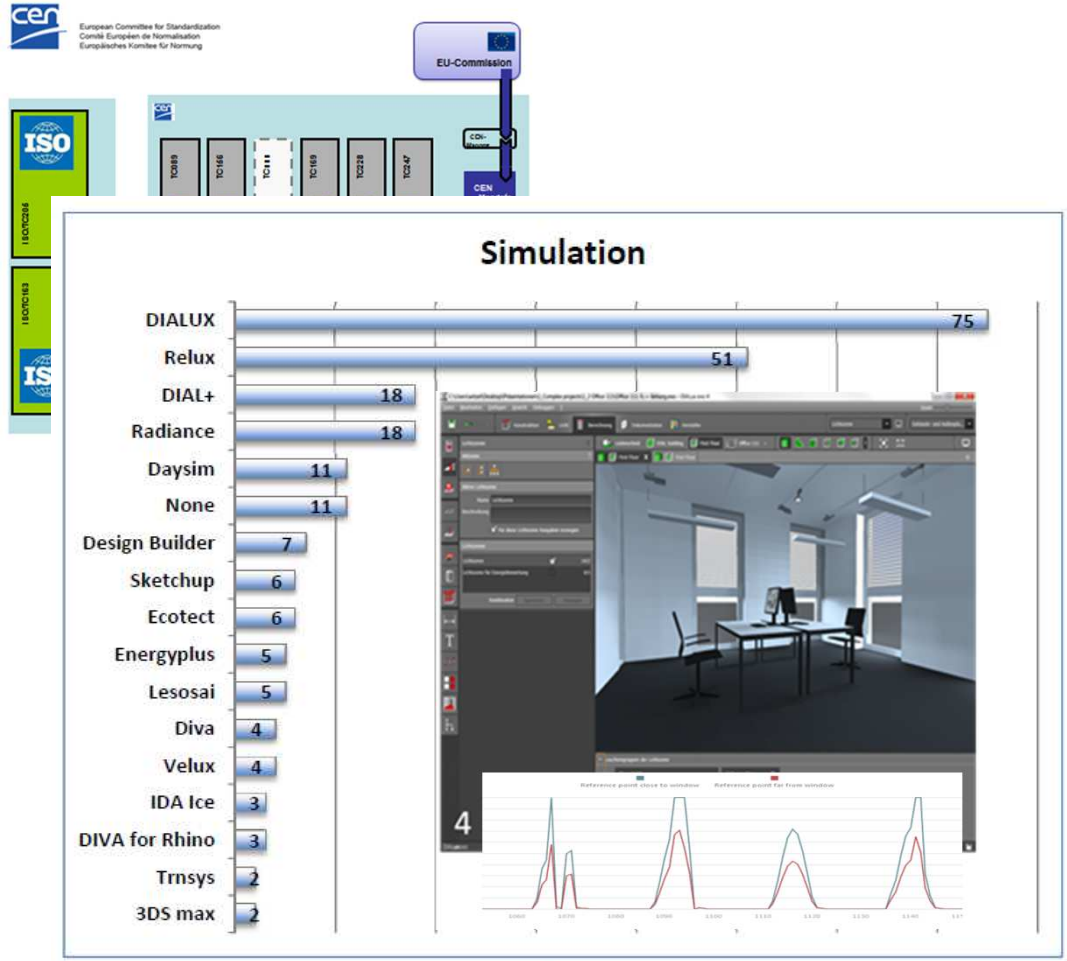
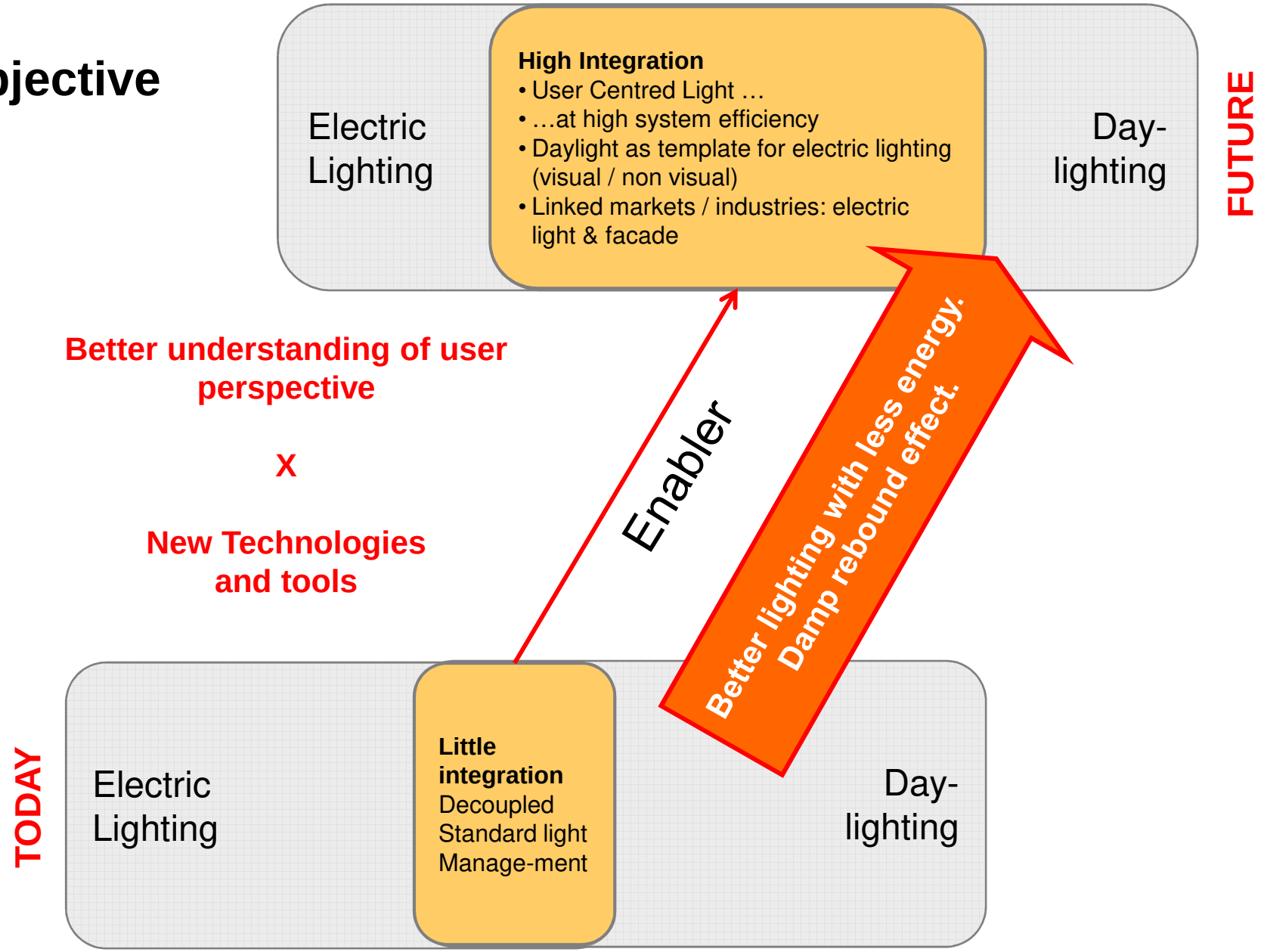


Figure 21: List of methods and tools used to handle Simulation in the retrofit process

- **System efficiency:** Triggered by energy policies (EU: „Nearly zero energy buildings“,…), cost
- Hourly and spectrally resolved methods required: for Standards (M480, CEN, ISO,…), for design tools.
- So far mainly research tools looked at
- Market leaders (**hundred thousands of users**) like Dialux, Relux are opening towards daylight and energy issues
- Basics of daylighting models developed in previous IEA work (T21, T31, T 50)

Objective


Electric Lighting
High Integration
• User Centred Light …
• …at high system efficiency
• Daylight as template for electric lighting (visual / non visual)
• Linked markets / industries: electric light & facade
Day-lighting
FUTURE
Better understanding of user perspective
X
New Technologies and tools
Enabler
Better lighting with less energy. Damp rebound effect.
TODAY
Electric Lighting
Little integration
Decoupled
Standard light
Manage-ment
Day-lighting

Task Structure

IEA SHC Task 61 / EBC Annex 77

Integrated solutions for daylight and electric lighting

From component to user centered system efficiency

Operating Agent: J. de Boer, Germany

Subtask A

B. Matusiak, Norway

User Perspective, Requirements

Subtask B

M. Fontoynont, Denmark

Integration and optimization of daylight and electric lighting

Subtask C

D. Geisler-Moroder, Austria

Design support for practioners

(Tools, Standards, Guidelines)

Subtask D

N. Gentile, Sweden

W.Osterhaus, Denmark

Lab and field study performance tracking

Joint Working Group

- Evaluation method for integrated lighting solutions
- Virtual reality (VR) based Decision Guide

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Subtask A:

User Perspective, Requirements

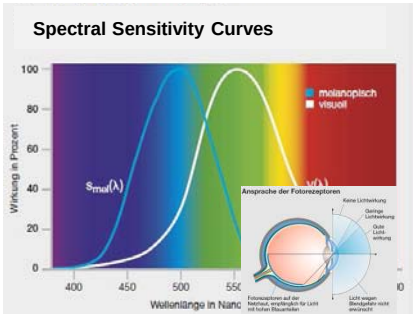
Coordination: Barbara Matusiak, NTNU, Norway

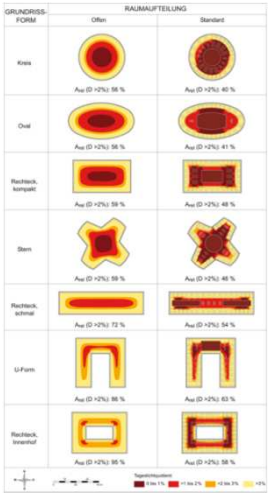
Objective: Consolidation of available knowledge on user-, activity- and time-depending visual and non-visual *requirements* including cultural and climatic dependencies. Set up *use cases* in specific applications, reflecting typical temporal changes in the usage of these interior spaces. Aggregation in so called *personas* as representations of the behaviour of a hypothesized group of users in the defined applications.

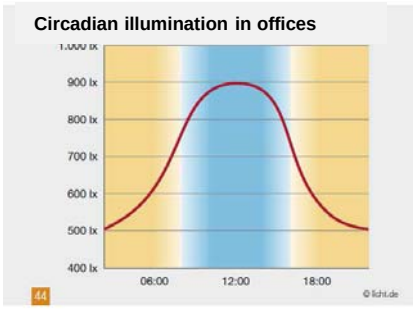
A.1 User requirements

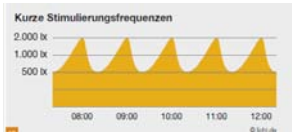
A.2 Use Cases

A.3 Representation of user behaviour - personas









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Subtask B:

Integration and optimization of day- and electric lighting

Coordination: Marc Fontoynont, SBI, Denmark

Objective: Identify the promising technical solutions to offer optimal control of lighting and daylighting components, with respect to minimum use of lighting electricity, maximum satisfaction of users, most attractive user interface (users and facility managers)

B.1 Interview of professionals: opportunities and barriers

B.2 Critical review of existing control systems and their functionalities

B.3 Critical review of new approaches under development

B.4 Review of other important aspects affecting performance of controls

B.5 Critical analysis of interfaces

B.6 Link with standardization activities

New technology	Benefits / interest
Miniaturisation of sensors, integrated sensors	Ability to read more relevant information locally, to offer a better fit with the demand of the users and facility managers
Use of LED in DC power supply	Ability to control each luminaire individually, and dim power progressively Ability to vary spectrum of light according to time of day and specific requirement of users (for example elderly, of people with specific visual handicap)
Wireless controls	Reduction of costs of installations Possibility to keep installation future proof (allowing modification of indoor space management)
Internet of Things	Link to internet can facilitate management of lighting sources with data flow upstream and downstream Management can also integrate external information (climatic conditions, variable cost of electricity, etc.) (Security issues have to be addressed)
Interface on tablets and smart phones	User friendly, mobile interface which could be used anywhere High quality graphics and possibility to ease operation: make the system fully understood.
Electrochromic glazing	Possibility to control freely daylight penetration, glare control, under various sections of the facade glazing.
Silent electric motors	Can operate blinds systems and any active daylighting systems more continuously and silently, to increase satisfaction by users
PoE (Power over Ethernet), DC-nets, driver-less/central hub solutions etc	New power technologies may call for new definitions of system components etc.
Built-in light sources	LED light sources can be integrated in other building components such as ceiling or wall modules.

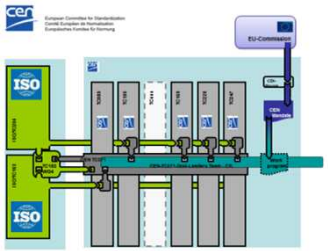
Subtask C:

Design Support for practitioners

Coordination: David Geisler-Moroder, Bartenbach, Austria

Objective: Focus on the application of technical innovations in the field of integrated lighting solutions in practitioners' workflows. Bring findings onto the desktops of designers by integration into widely used software tools, standards and codes, and design guidelines.

C.1 Review of state of the art design workflows



C.2 Standardization of BSDF daylight system characterization

C.3 Spectral sky models for advanced daylight simulations

C.4 Hourly rating method for integrated solutions

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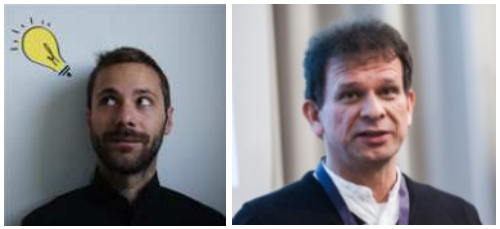
Subtask D:

Lab and Field Study Performance Tracking

Coordination**:** Niko Gentile, Lund University, Sweden;
Werner Osterhaus, Aarhus University, Denmark



Objective: Demonstrate and assess typically applied concepts for integrated daylighting and electric lighting design by medium-term experiments in live-labs, supplemented by short-term investigations in controlled research laboratory environments, as well as performance tracking in “real” field studies.

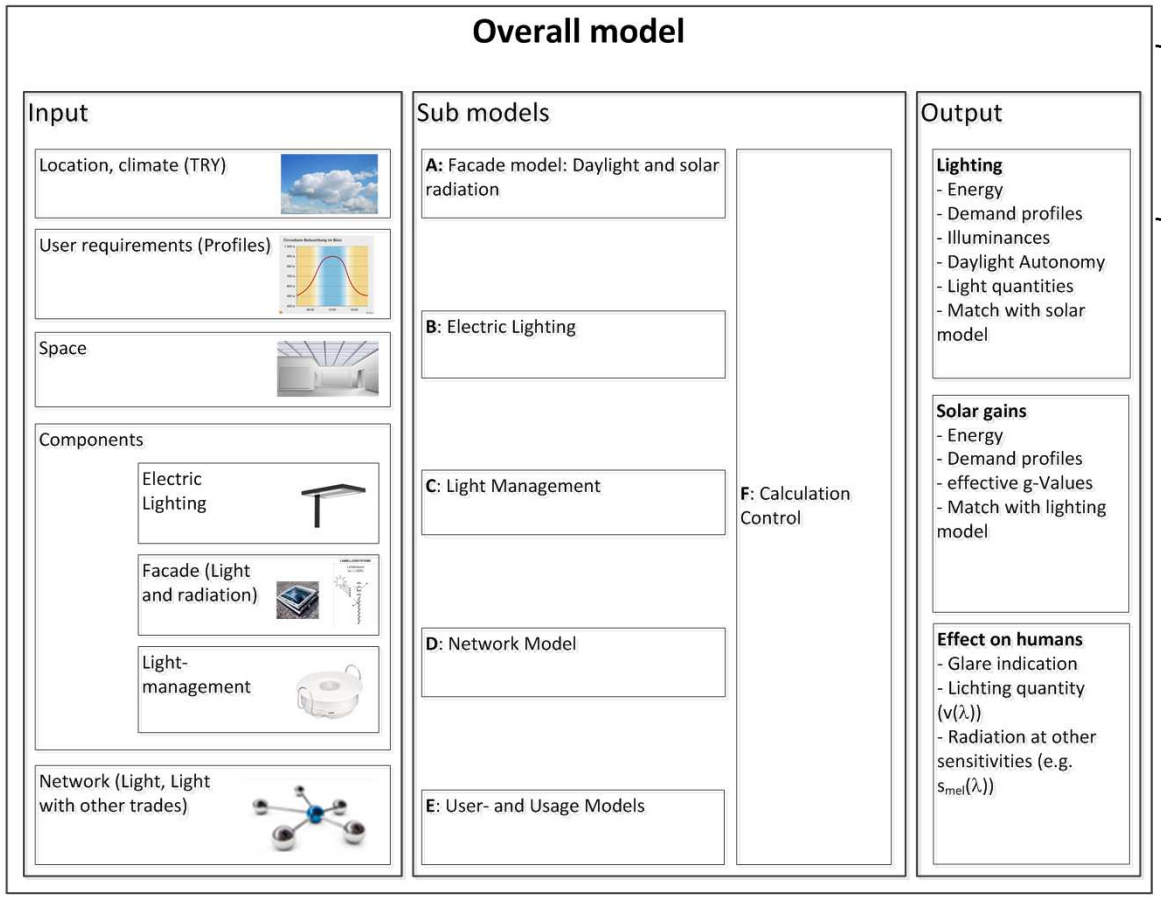
D.1 Literature Survey: Quantifying Potential Energy Savings

D.2 Monitoring protocol

D.3 Case Studies: Living Laboratories and Real Buildings

D.4 Lessons Learned – Guidance to Decision Makers

Joint Working Group:
Evaluation tool

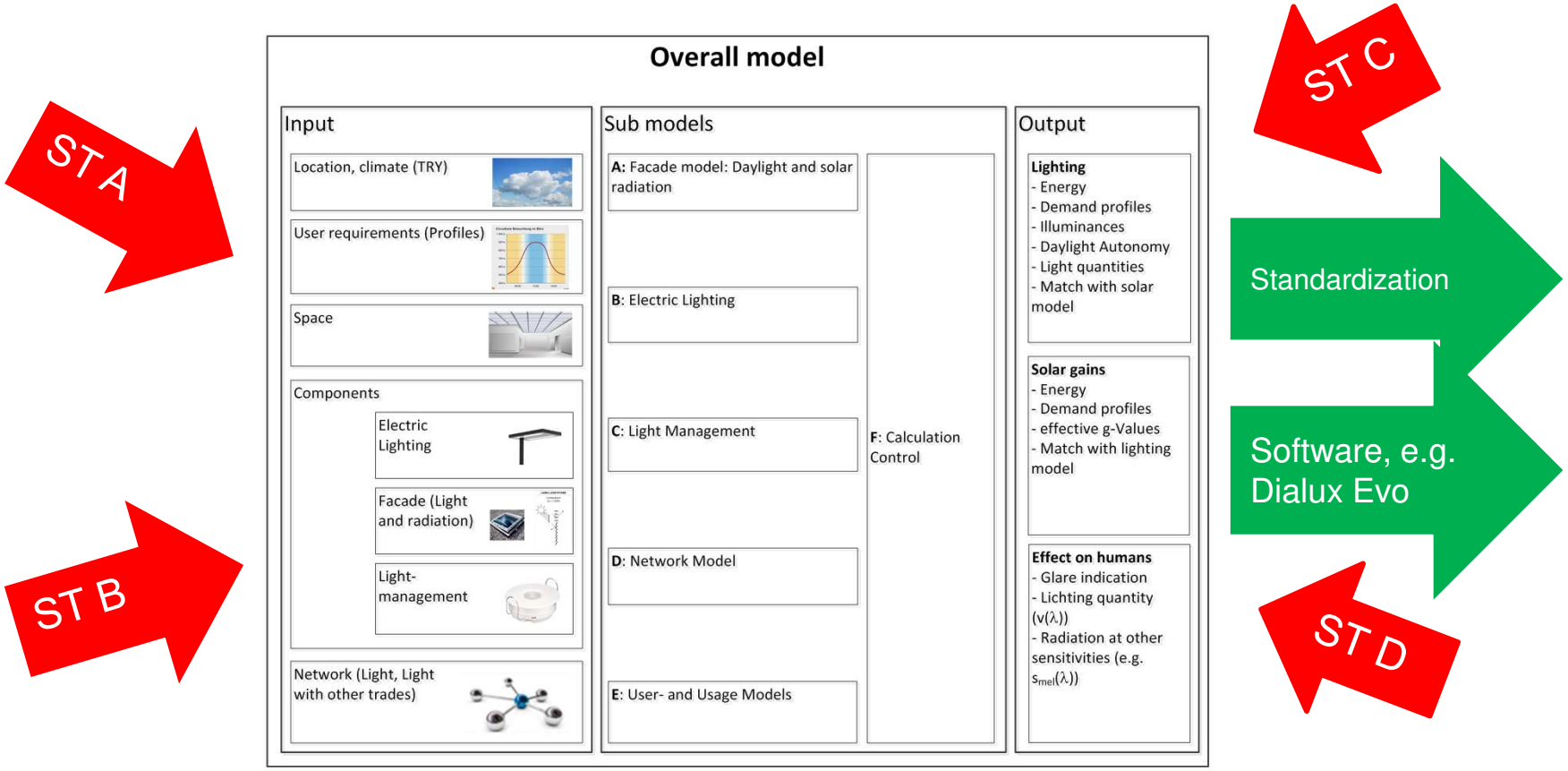


- Hourly rating method for integrated solutions
- Approach for Standardization

Joint Working Group:

Evaluation tool:

Hourly rating method for integrated solutions



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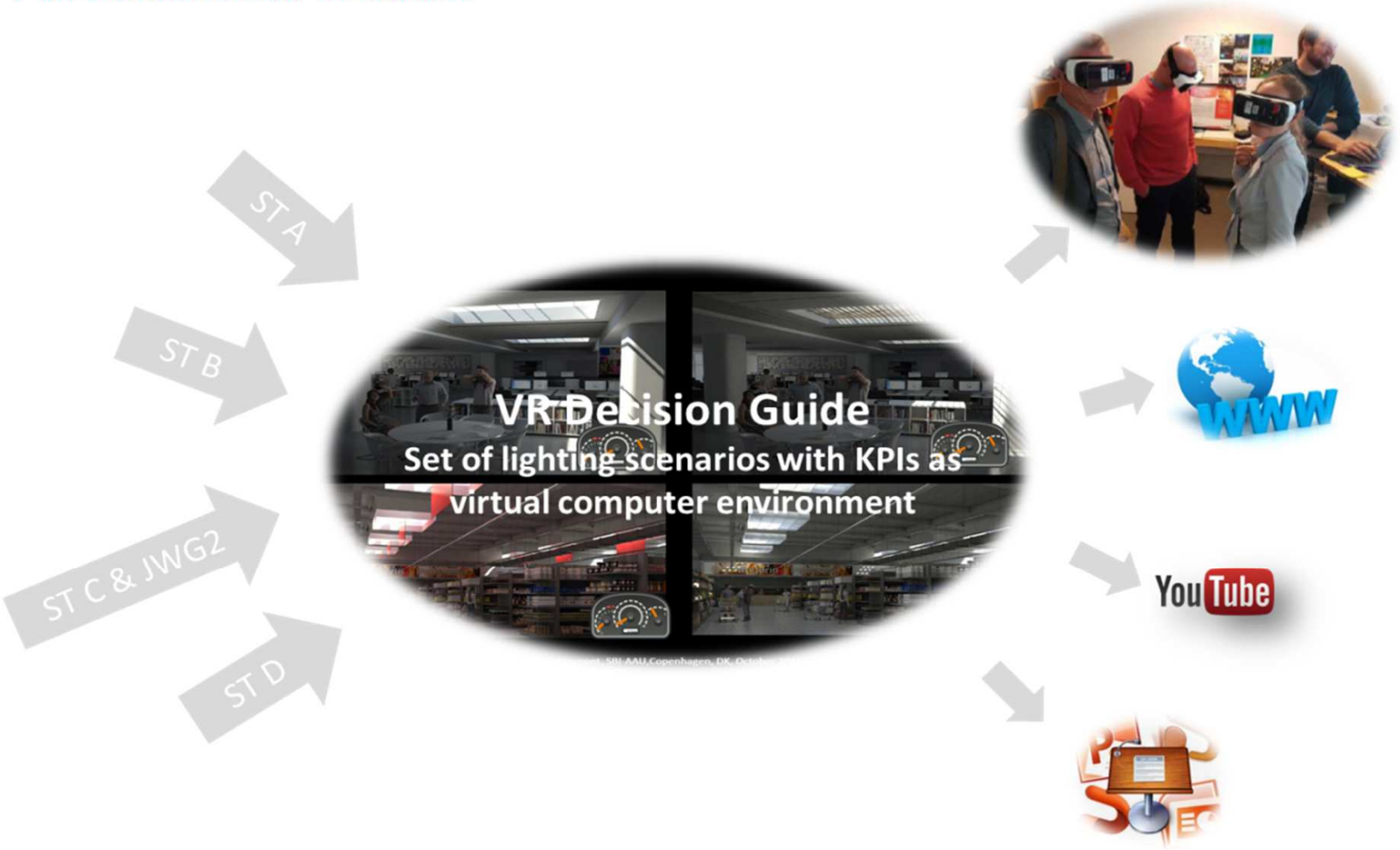
Joint Working Group:
VR Decision Guide



Who is behind the activity?

Lausanne Meeting: 33
Experts from 14 countries

Research and private companies

Research

Industry

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Outcome for different target groups

- ***Designers:*** new and better integrated tools, system overview, design guidelines and system performance information (from lab and demo testing)

- ***Standardization bodies:*** integrated daylighting and electric lighting hourly energy rating method, spectral modelling including new datasets for facades and materials.

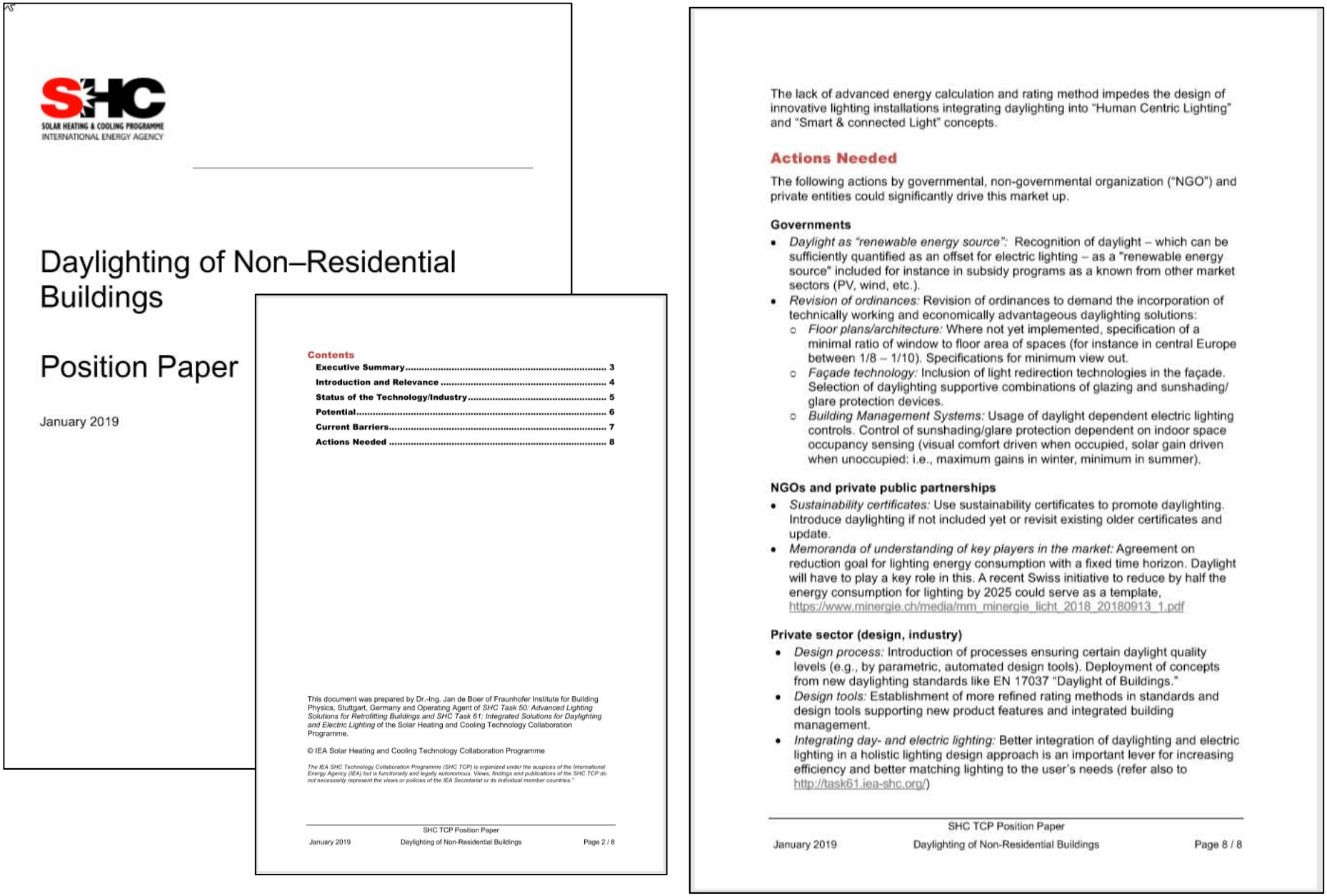
- ***Industry:*** work on the better integration of electric lighting and daylighting (façade)

- ***Software Companies:*** advanced lighting algorithms / software

- ***Building managers:*** more effective guidance on the calibration, ongoing adjustment and maintenance of integrated lighting control systems

- ***Policy makers:*** advice to stimulate deployment of successful, energy efficient lighting schemes with added benefits to the citizens.

- ***Building users:*** improved indoor conditions, to support health, comfort and energy efficiency



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Daylighting of Non–Residential Buildings

Position Paper

January 2019

Contents

This document was prepared by Dr.-Ing. Jan de Boer of Fraunhofer Institute for Building Physics, Stuttgart, Germany and Operating Agent of *SHC Task 50: Advanced Lighting Solutions for Retrofitting Buildings and SHC Task 61: Integrated Solutions for Daylighting and Electric Lighting* of the Solar Heating and Cooling Technology Collaboration Programme.

The lack of advanced energy calculation and rating method impedes the design of innovative lighting installations integrating daylighting into "Human Centric Lighting" and "Smart & connected Light" concepts.

Actions Needed

The following actions by governmental, non-governmental organization ("NGO") and private entities could significantly drive this market up.

Governments

- *Daylight as "renewable energy source":* Recognition of daylight – which can be sufficiently quantified as an offset for electric lighting – as a "renewable energy source" included for instance in subsidy programs as a known from other market sectors (PV, wind, etc.).
- *Revision of ordinances:* Revision of ordinances to demand the incorporation of technically working and economically advantageous daylighting solutions:
  - *Floor plans/architecture:* Where not yet implemented, specification of a minimal ratio of window to floor area of spaces (for instance in central Europe between 1/8 – 1/10). Specifications for minimum view out.
  - *Façade technology:* Inclusion of light redirection technologies in the façade. Selection of daylighting supportive combinations of glazing and sunshading/ glare protection devices.
  - *Building Management Systems:* Usage of daylight dependent electric lighting controls. Control of sunshading/glare protection dependent on indoor space occupancy sensing (visual comfort driven when occupied, solar gain driven when unoccupied: i.e., maximum gains in winter, minimum in summer).

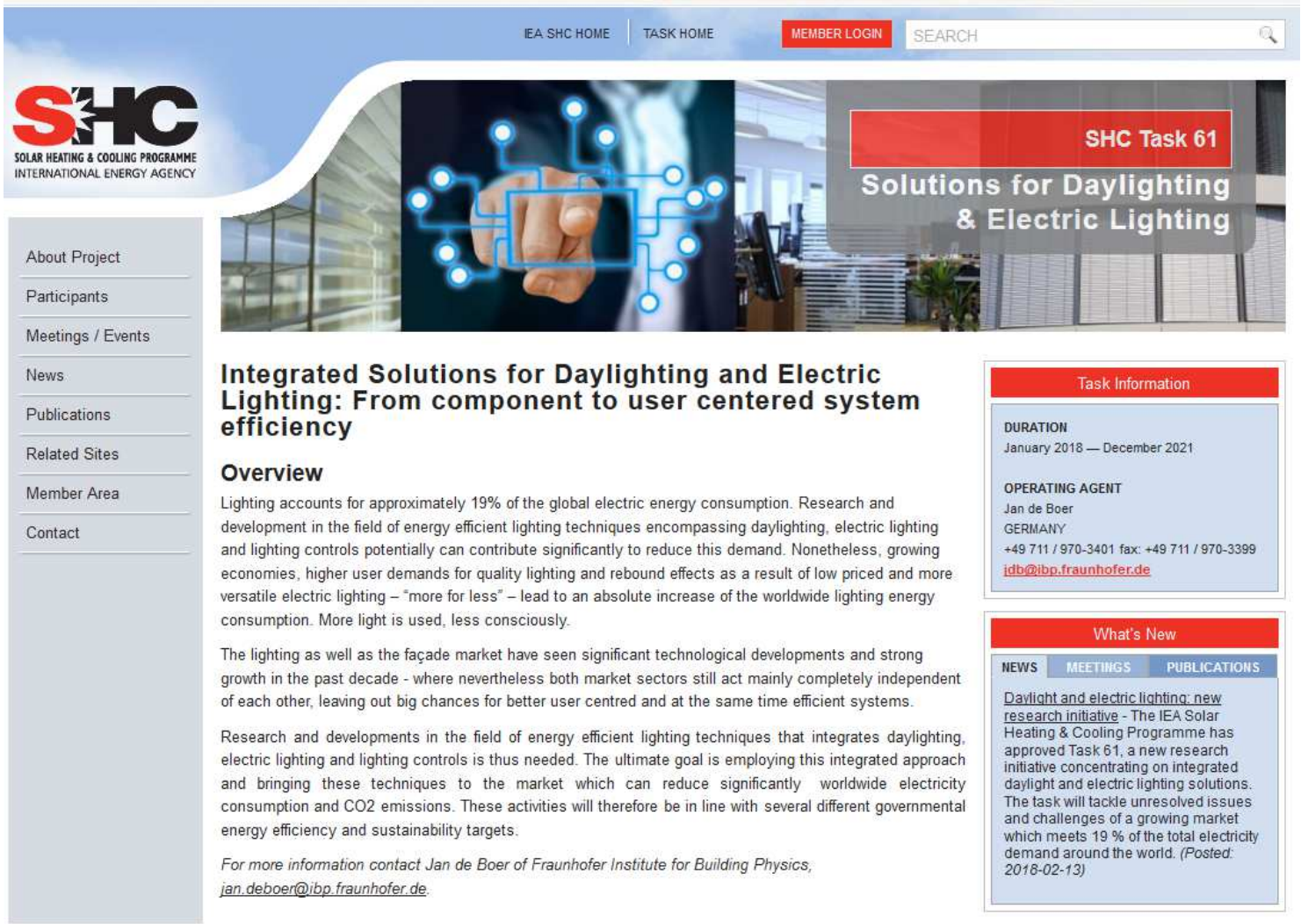
NGOs and private public partnerships

- *Sustainability certificates:* Use sustainability certificates to promote daylighting. Introduce daylighting if not included yet or revisit existing older certificates and update.
- *Memoranda of understanding of key players in the market:* Agreement on reduction goal for lighting energy consumption with a fixed time horizon. Daylight will have to play a key role in this. A recent Swiss initiative to reduce by half the energy consumption for lighting by 2025 could serve as a template, https://www.minergie.ch/media/mm_minergie_licht_2018_20180913_1.pdf

Private sector (design, industry)

- *Design process:* Introduction of processes ensuring certain daylight quality levels (e.g., by parametric, automated design tools). Deployment of concepts from new daylighting standards like EN 17037 "Daylight of Buildings."
- *Design tools:* Establishment of more refined rating methods in standards and design tools supporting new product features and integrated building management.
- *Integrating day- and electric lighting:* Better integration of daylighting and electric lighting in a holistic lighting design approach is an important lever for increasing efficiency and better matching lighting to the user's needs (refer also to http://task61.iea-shc.org/)

Follow us: http://task61.iea-shc.org/ … and of course…



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…use light intelligently.

Alexander Lervik,
Designer,
Stockholm

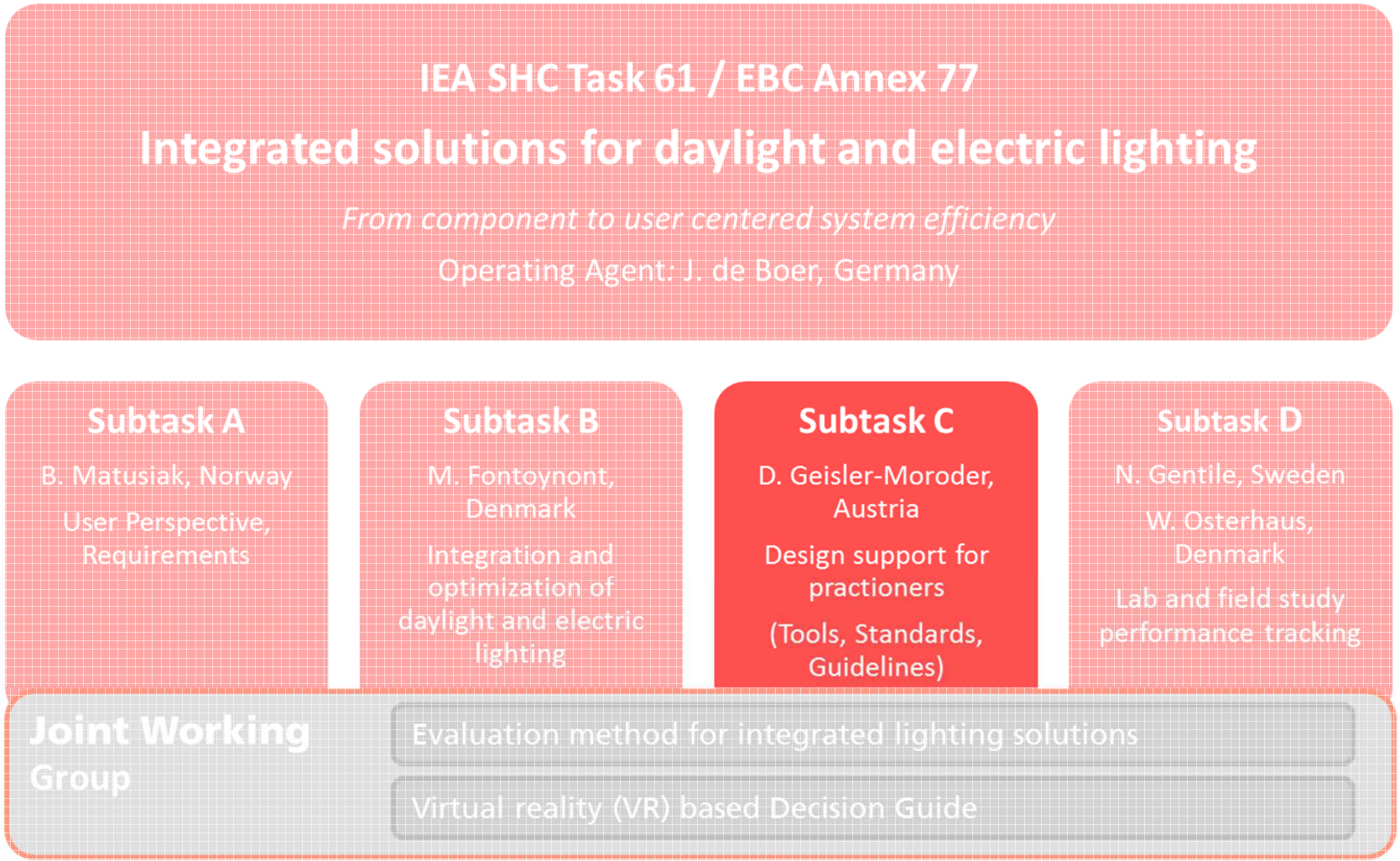
Towards standardizing daylight system characterization

or

Why does a company join an IEA SHC Task?

David Geisler-Moroder
Bartenbach GmbH

Workshop IEA SHC Research Co-operation
5 June, 2019, Vienna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Subtask C: Design Support for Practitioners

Objective:

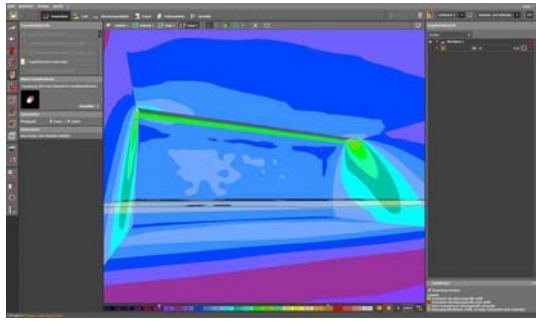
Focus on the **application of technical innovations in the field of integrated lighting solutions in practitioners' workflows**. Bring findings onto the desktops of designers by integration into widely used software tools, standards and codes, and design guidelines.

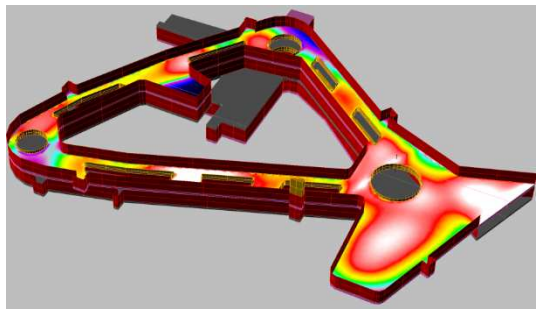
C.1
Review of state of the art design workflows

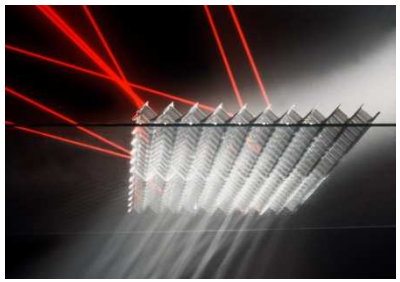
C.2
Standardization of BSDF daylight system characterization

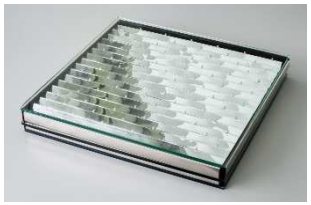
C.3
Spectral sky models for advanced daylight simulations

C.4
Hourly rating method for integrated solutions







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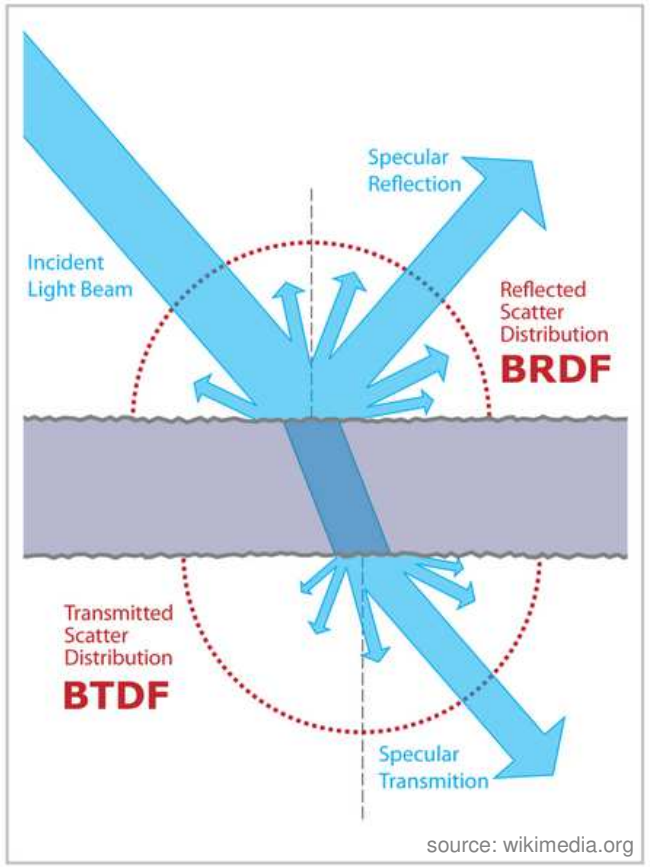
Specular
Reflection
Incident
Light Beam
Reflected
Scatter
Distribution
BRDF
Transmitted
Scatter
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BTDF
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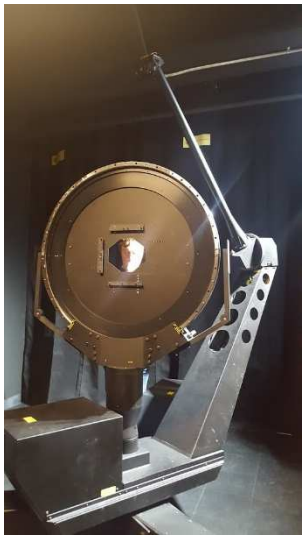
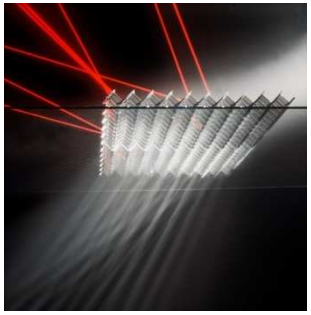
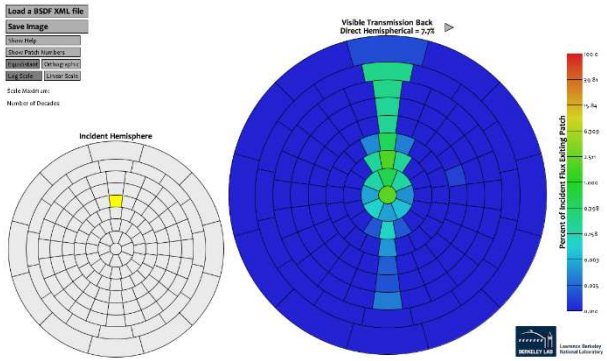




Standardization of BSDF daylight system characterization

Working items:

- Information on BSDF basics
- Specification of BSDF resolutions
- Data format(s)
- Specification of BSDF requirements for
  - Classes of daylight systems (glazing, blinds, fabrics, redirecting films,)
  - Applications / metrics (illuminance, luminance/glare, solar gain; point-in-time, annual)
- Information on BSDF generation procedures
  - Measurement devices and post-processing procedures
  - Simulation routines



IEA SHC Task 61 / EBC Annex 77

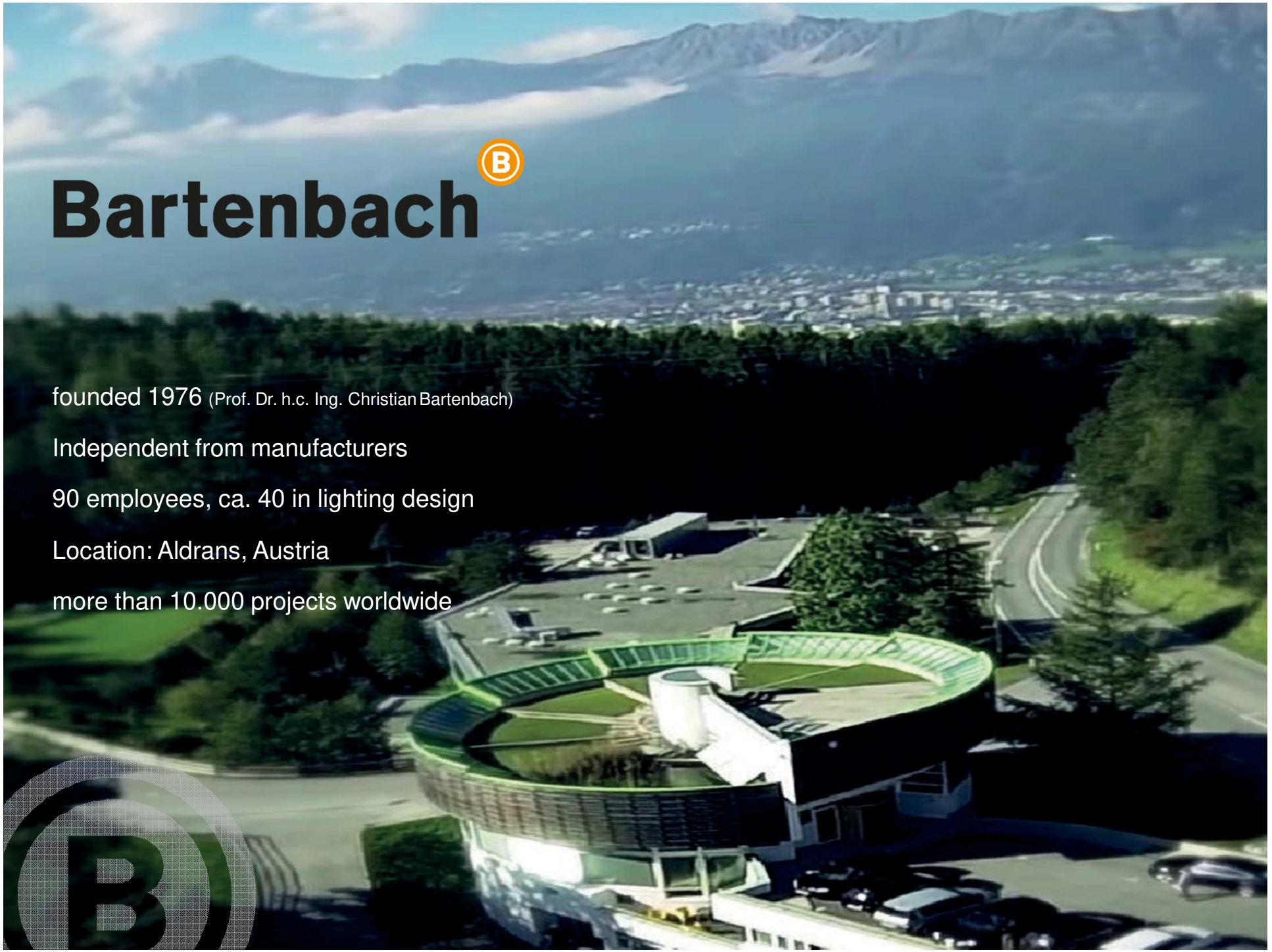
Standardization of BSDF daylight system characterization

Experts:

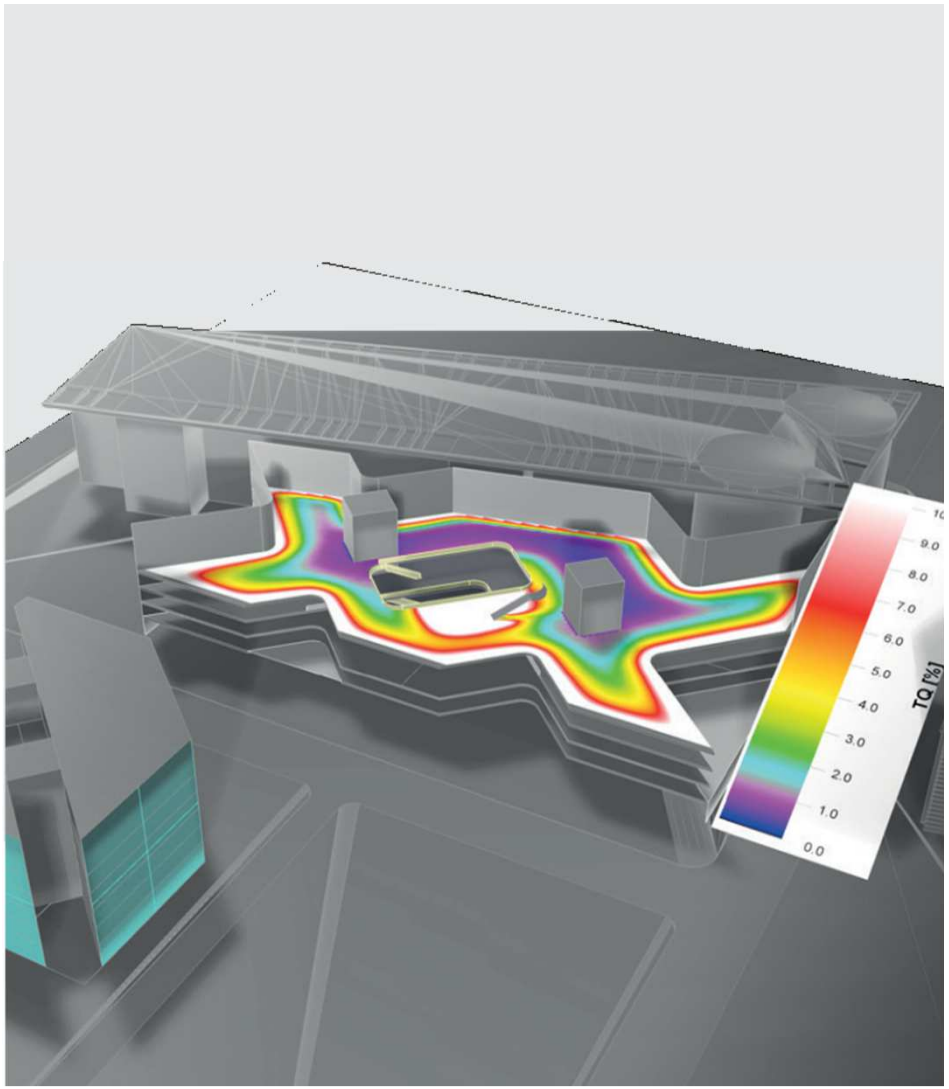
- Jan de Boer
- Bruno Bueno
- Bertrand Deroisy
- Yuan Fang
- David Geisler-Moroder
- Jacob Jonsson
- Eleanor S. Lee
- Zhen Tian
- Taoning Wang
- Gregory J. Ward
- Yujie Wu

and associated external partners:

- Peter Apian Bennewitz
- Lars Grobe
- Mandana Sarey Khanie

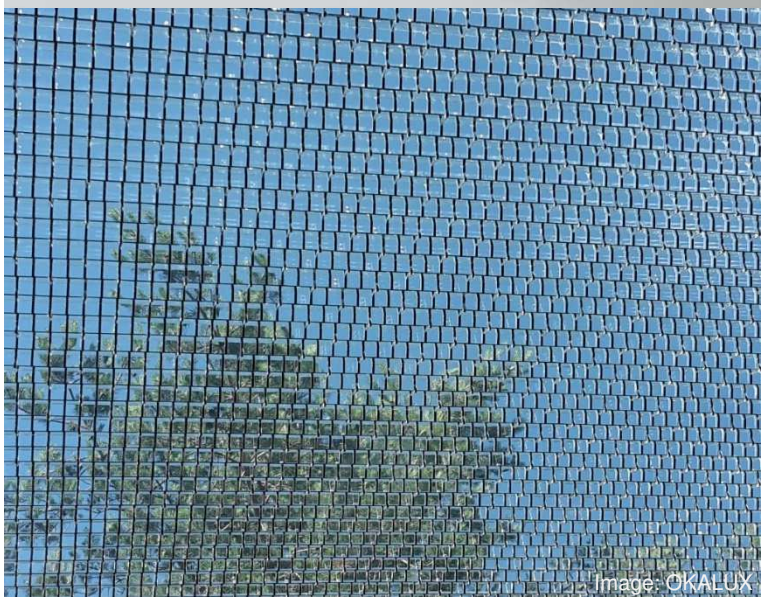

Bartenbach
founded 1976 (Prof. Dr. h.c. Ing. Christian Bartenbach)
Independent from manufacturers
90 employees, ca. 40 in lighting design
Location: Aldrans, Austria
more than 10.000 projects worldwide

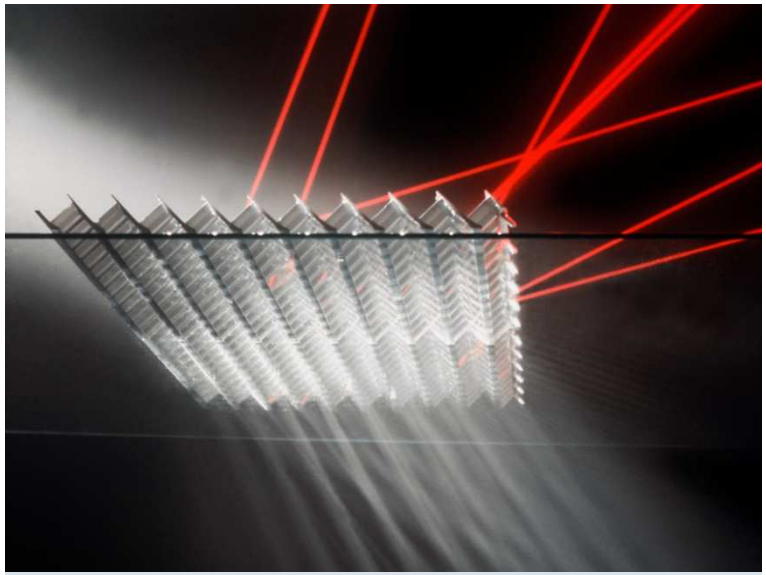
Daylighting Design

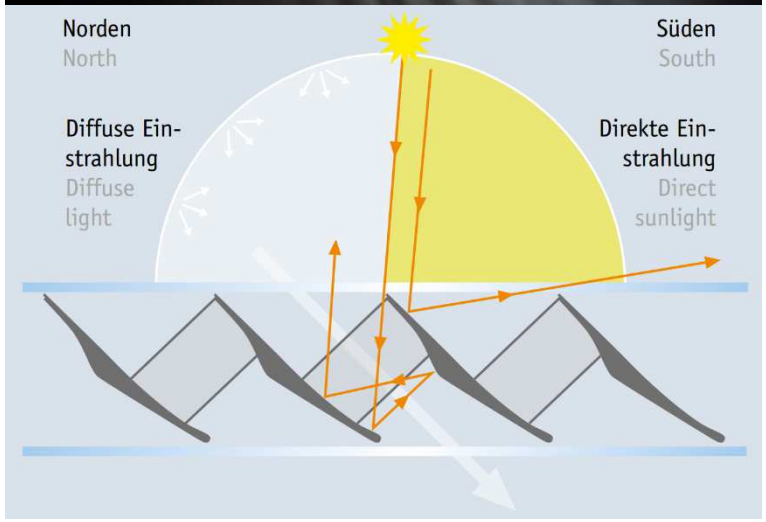


Daylighting Design

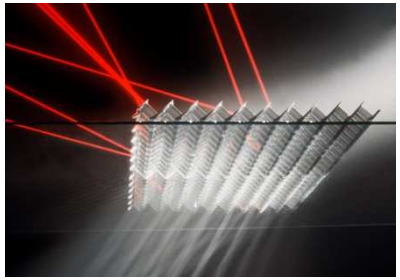
Product Development

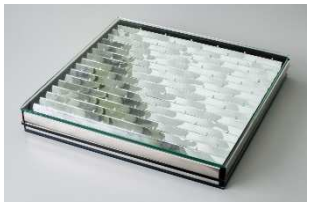














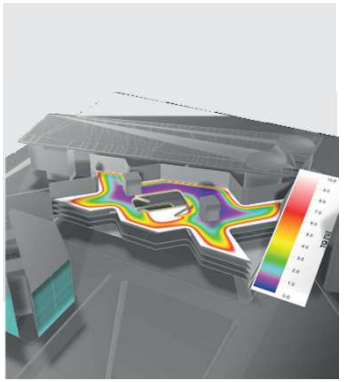
314 723 120




image: OKALUX

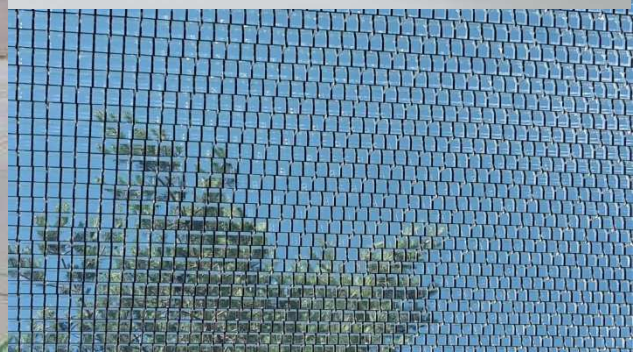
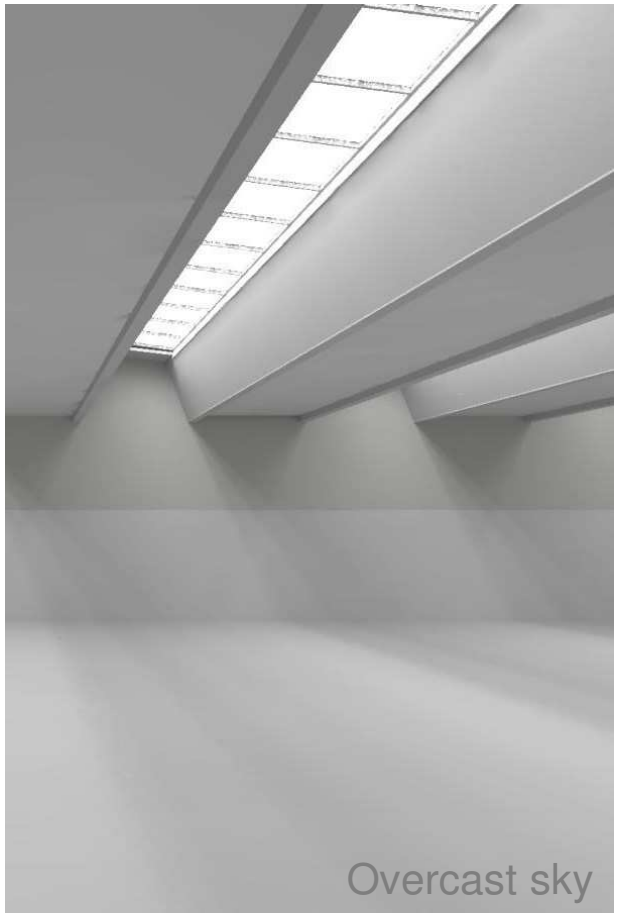
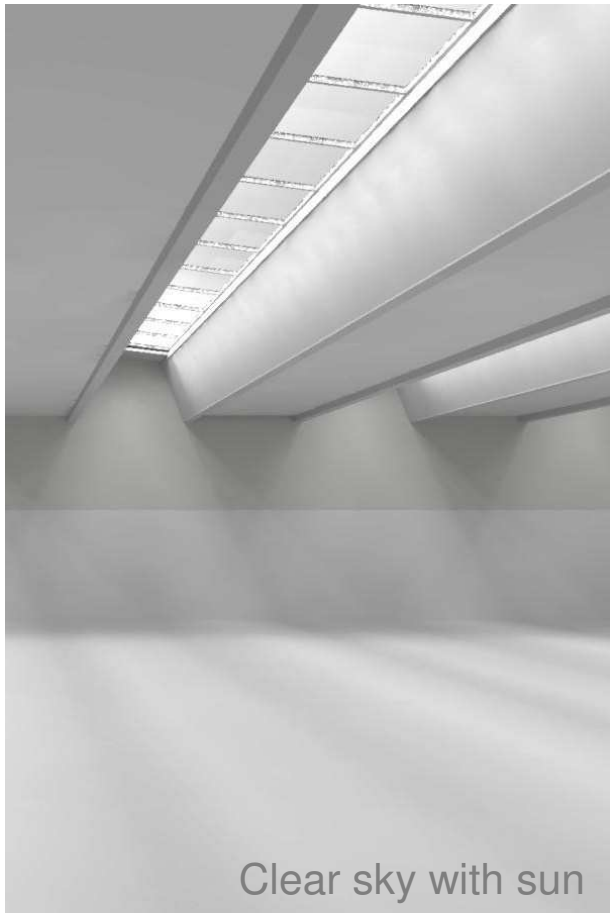




image: OKALUX


Overcast sky


Clear sky with sun

Acknowledgments

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Republic of Austria
Transport, Innovation
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FFG

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„EnOB: MEET Lichtplanung - Methoden zur effekti-ven Erschließung von Energieeinsparpotentialen in der Kunst- und Tageslichtplanungspraxis von Gebäude “

Federal Ministry
for Economic Affairs
and Energy

managed by the
Project Management Jülich PTJ
is gratefully acknowledged.

PTJ
Projektträger Jülich
Forschungszentrum Jülich