HOW TO APPROACH THE COMPARISON OF HIGHLY DIFFERENTIATED RETROFIT TECHNOLOGIES ON AN EQUAL BASIS?

Dr. Martine Knoop | Chair of Lighting Technology

Pictures: morguefile

Technische Universität Berlin

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Introduction

IEA Task 50, Subtask B

Quality assessment of **existing** and **new retrofit** solutions in the field of facade and daylighting technology, electric lighting and lighting controls

Variety of retrofit lighting solutions

Retrofit examples in retail surrounding

Examples: Retrofit solutions for retail

2008 – US DOE CALIPER study

- 10 LED retrofits for 20 W low voltage halogen
- 16 – 35 lm/W
- light output and intensity falls significantly short
- acceptable CCT and Ra (from 61 to 96)

2013 – Labayrade and Avouac

9 300 customized LED solution for a halogen retrofit (equivalent in luminous flux, Ra, CCT, beam angle)

evaluation in uncontrolled environments (restaurants, cafes and shops):

> 85% of the users:

- satisfied with the light produced
- would consider to replace halogen lamps

70 – 90 %
energy savings
Costs: €

Examples: Retrofit solutions for retail

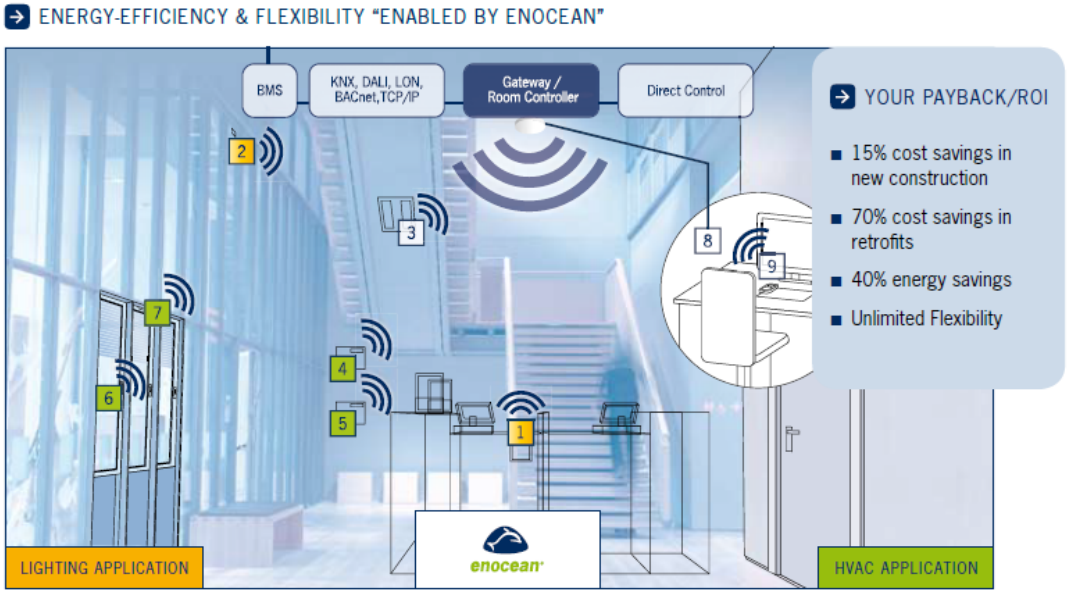
2012 – US DOE CALIPER study

- 14 LED retrofits for CFL downlights (32 W) and incandescent downlights (65 W)
- system efficacy of 39 to 69 lm/W (in situ testing)

~ 50 %
energy savings
Costs: €€

Examples: Retrofit solutions for retail

- Control of lights and shading
- Occupancy sensors in receiving areas,
  stock rooms, fitting rooms and rest rooms
- Daylight harvesting near windows and skylights



35 - 50%
energy savings
Costs: €€€

Examples: Retrofit solutions for retail

US Department of Energy:

- skylights in big-box retail → best savings opportunity
  due to high LPD, roof structure (2008)
- skylights and daylight harvesting → a deep retrofit measure with high impact (2012)

Heschong et al. 1999: presence of skylights → higher sales (31 – 49%)

It is a comparison of apples and oranges (or pears …)

Problem

Quality assessment of **existing** and **new retrofit** solutions in the field of facade and daylighting technology, electric lighting and lighting controls

Comparison of retrofit solutions?

Considerations:

- large variety of retrofit solutions for lighting
- it seems to be (too) difficult to look beyond the typical ‚easy' retrofit solution
- absence of holistic rating methods
  include non-lighting aspects (e.g. ease of installation, price, payback time)
- lack of awareness of existing and new technologies

Approach

Aim of Subtask B:

- to develop a catalogue of criteria,
  taking into consideration all aspects relevant to lighting retrofits,
- to promote new technology developments and
- *to encourage the user to look beyond the typical ‚easy' retrofit solution*

1. Develop catalogue of criteria
2. Structure variety of solutions
3. Determine benchmark

Reason to retrofit:
- Energy savings
- Reduce maintenance
- Improve lighting quality

Catalogue of Criteria

1. Energy efficiency
   component efficacy, normalized power density, energy savings potential, daylight autonomy, …
2. Environmental footprint
   primary energy consumption in manufacturing stage, with or without energy embodied in raw materials
3. Ease of use / maintenance
   control possibilities, lifetime, total lifetime light output, need for tracking
4. Visual comfort
   UGR_L, provides glare protection, …
5. Visual amenity
   spectral selectivity, effect on wall luminance, view out, privacy, colour rendering, …

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6. Retrofit process
   installation time, type of retrofit
7. Costs (initial)
8. Climate restrictions

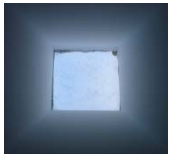
majority of characteristics in product description

lighting simulations often required

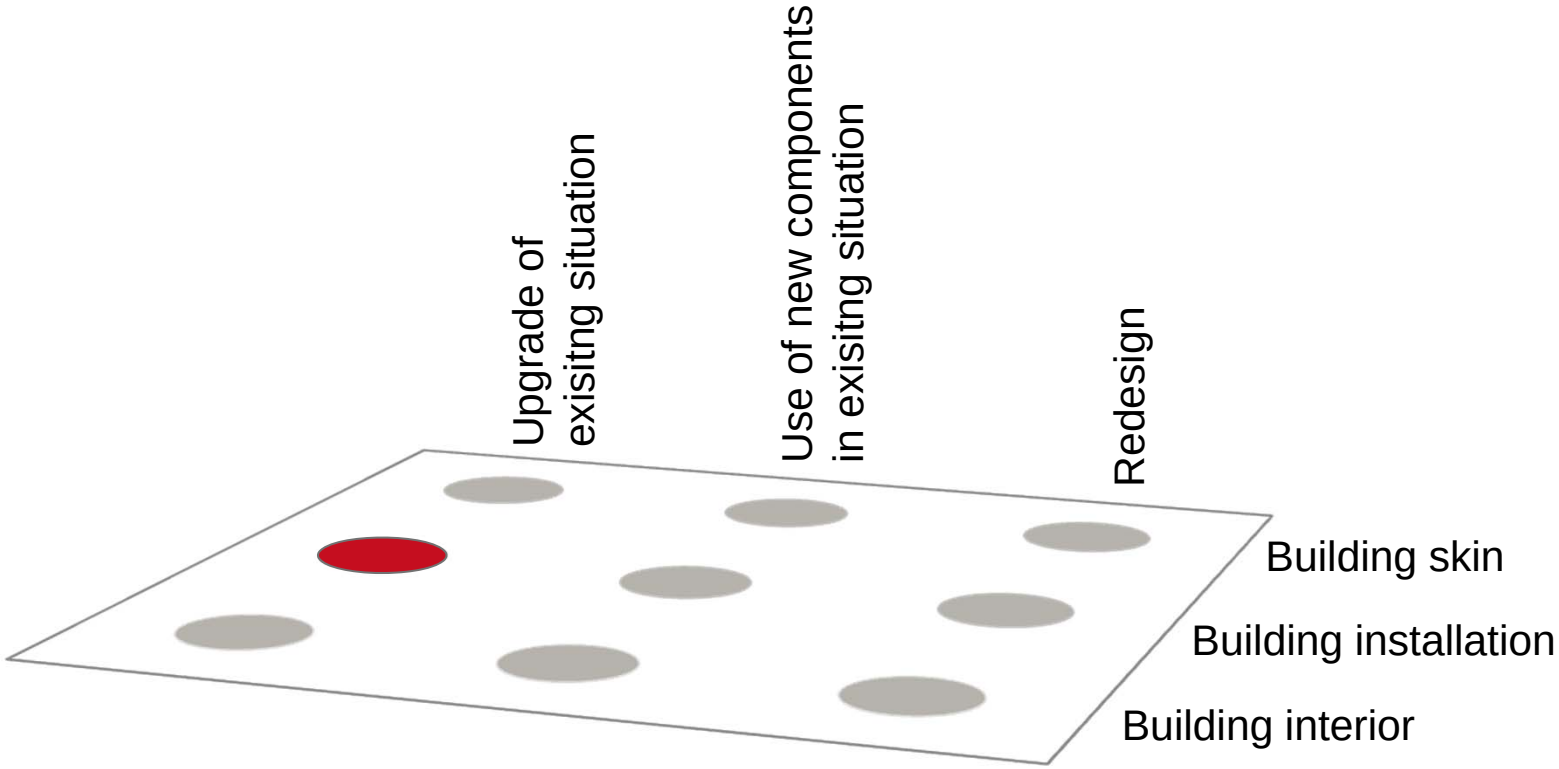
	Electric lighting	Daylighting
Energy efficiency	• energy savings potential	
Ease of use / maintenance	• lifetime • total lifetime light output • lumen depreciation • maintenance • control possibilities	• need for tracking
Environmental footprint	• primary energy consumption in manufacturing stage • with or without energy embodied in raw materials	
Visual comfort	• UGR_L • UGR for reference situation • illuminance • uniformity	• provides glare protection • Extent of Comfortable Daylight
Visual amenity	• operating frequency • percent flicker • flicker index • dimmable • dimming characteristics • reduces / increases wall illuminance • colour rendering • correlated colour temperature • impact on non visual effect of light	• spectral selectivity • visual transmittance • blockage & distortion of view, VTP • view out • privacy • effective aperture

Variety of retrofit lighting solutions

Building intervention level	Lighting component	Intervention level	Intervention type		
			Upgrade of existing situation	Use new components in existing situation	Redesign
Building Skin	Daylighting	Product			
		Control system			
Building Equipment	Electric lighting	Product			
		Control system			
Building Interior	Daylighting + Electric lighting	-			

Building intervention level	Lighting component	Intervention type		
		Upgrade of existing situation	Use new components in existing situation	Redesign
Building Skin	Daylighting			
Building Equipment	Electric lighting	  		
Building Interior	Daylighting + Electric lighting			

Retrofit solution

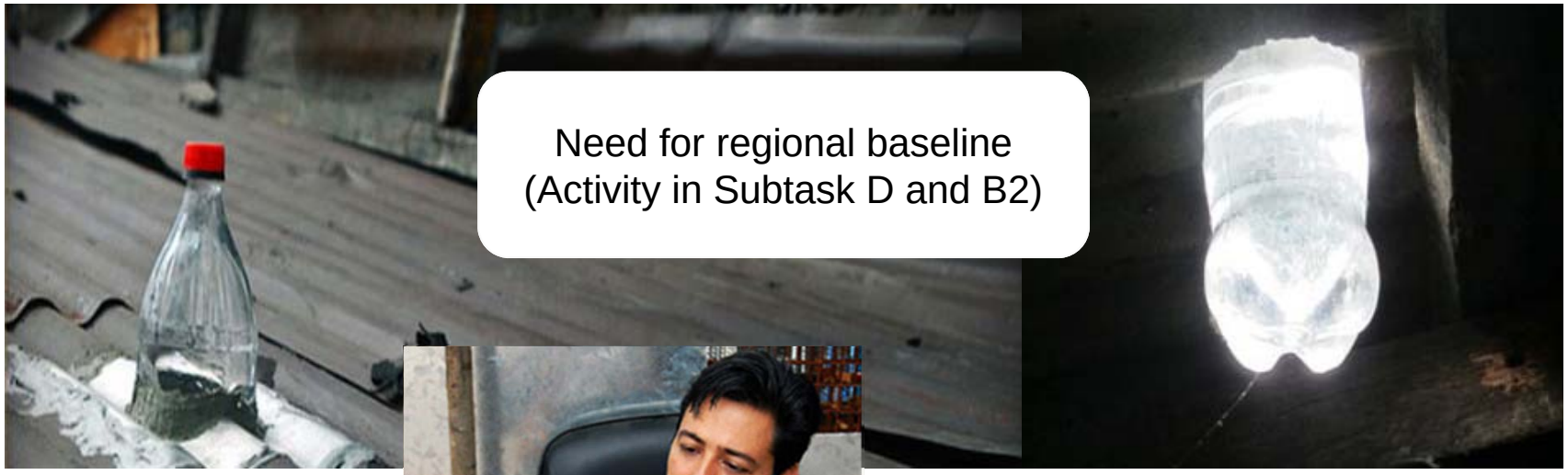


Retrofit lighting solution: Skylights

(1)

(2)

Retrofit lighting solution: Solar bottle lights



Need for regional baseline
(Activity in Subtask D and B2)

A project designed and developed by students from the Massachusetts Institute of Technology (MIT) and implemented by MyShelter Foundation

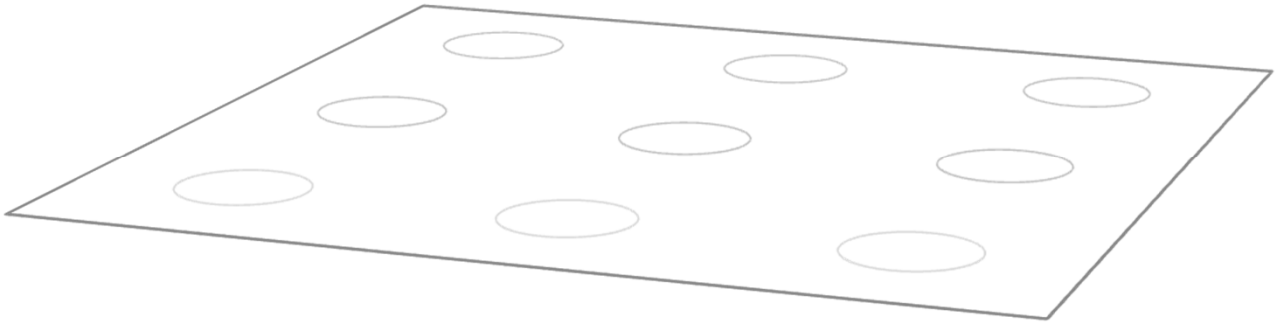
Benchmark

… describes:

- Building skin
- Building installation
- Building interior

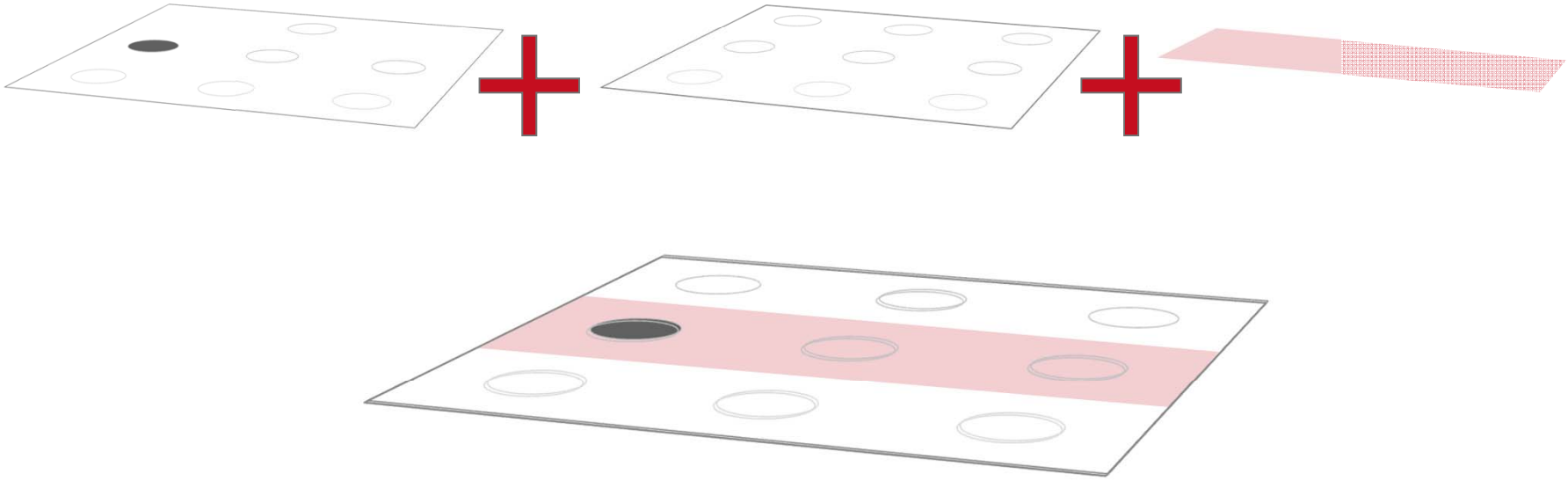
… considers:

- Level of assessment
- Application
- Location
- Climate

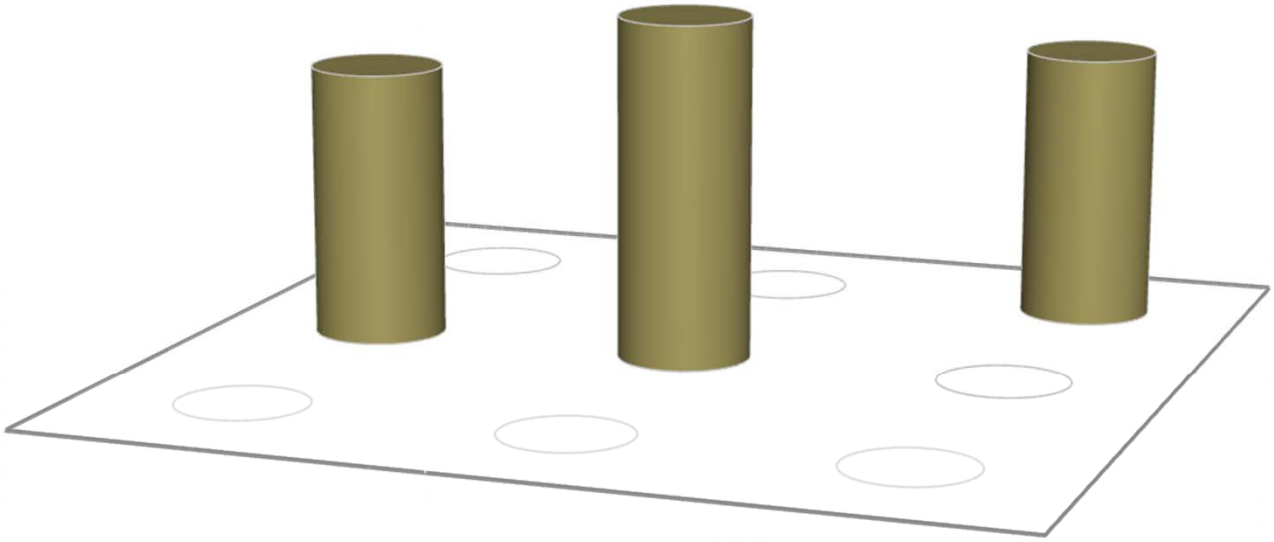


Evaluation of retrofit solutions

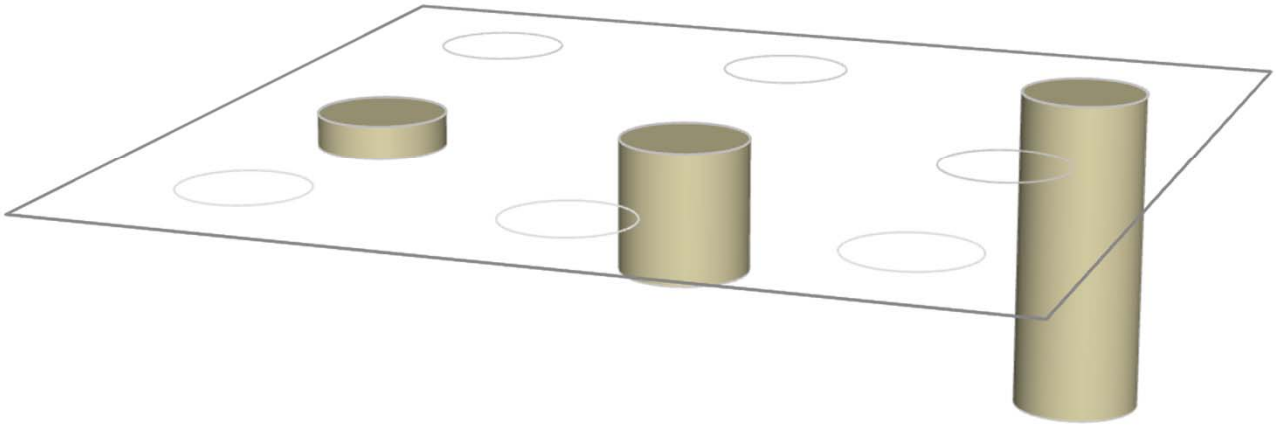
Solution + Benchmark + Catalogue of criteria



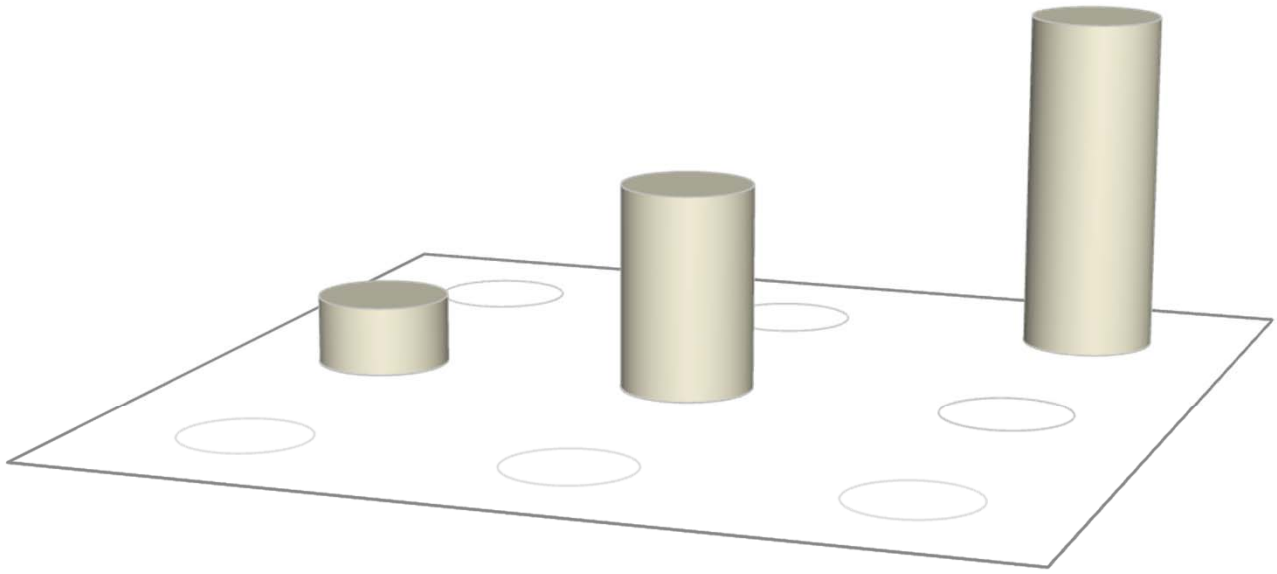
Potential energy savings in %, €, £, $, ….

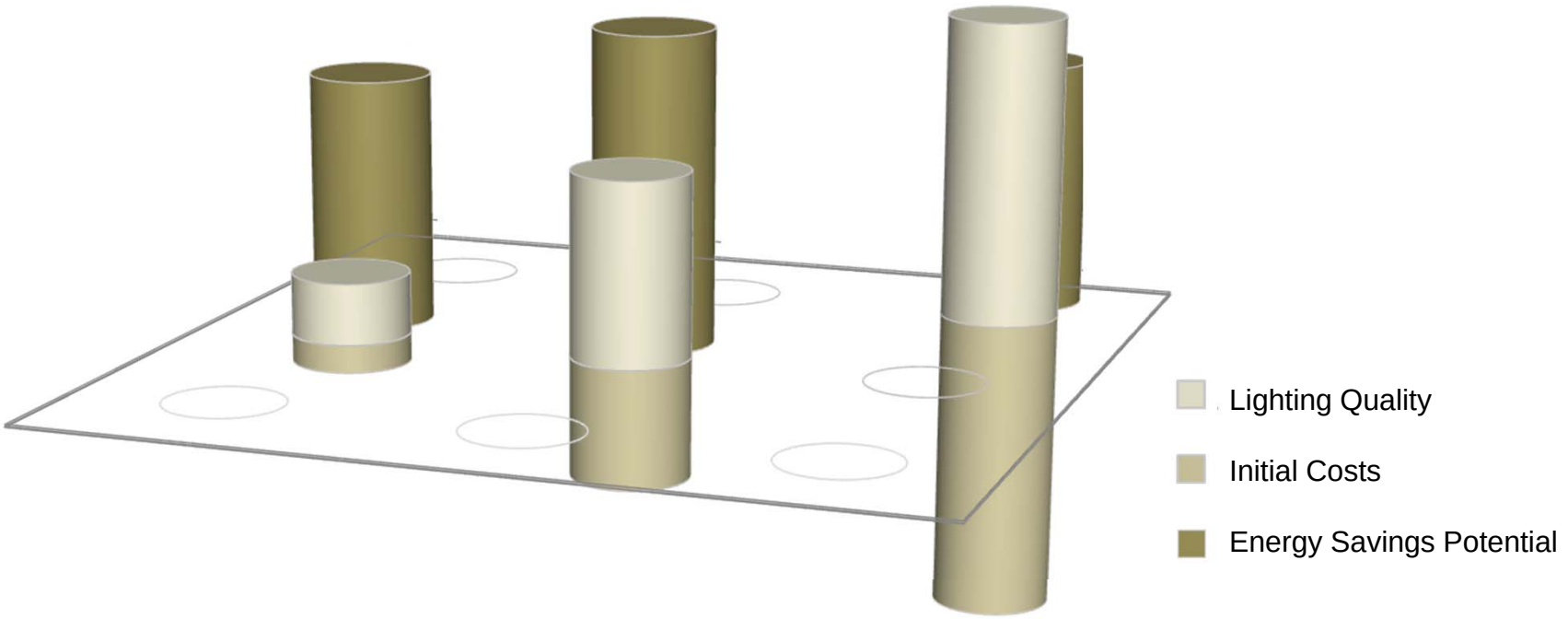


Initial Costs



Lighting quality

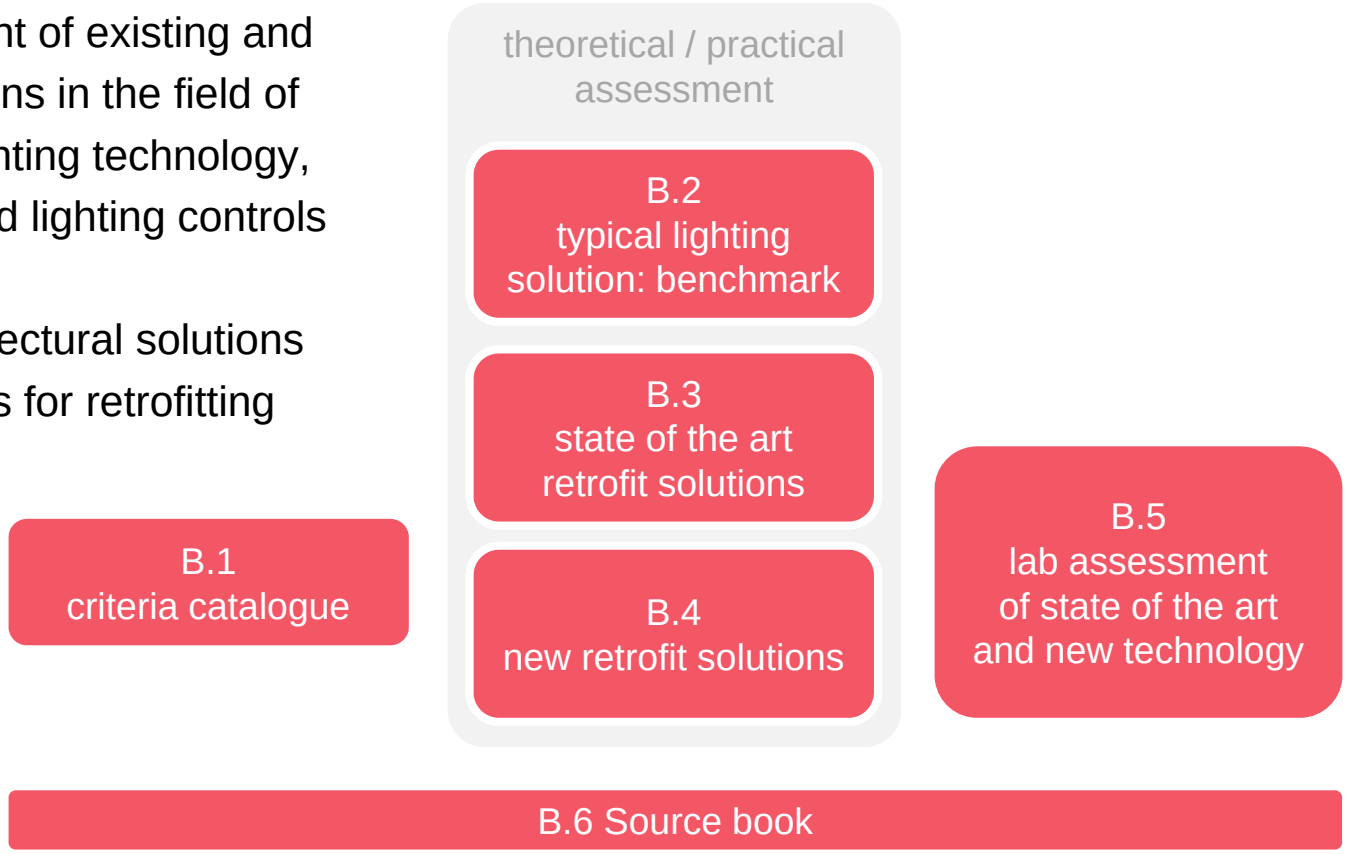


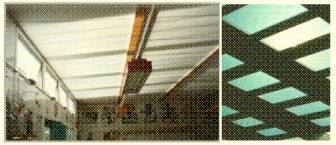
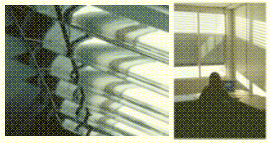
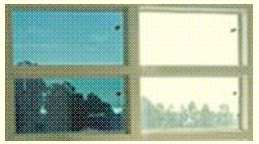
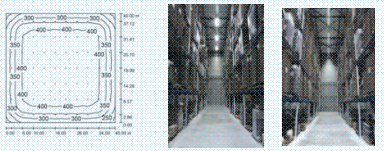

Lighting Quality
Initial Costs
Energy Savings Potential

IEA Projekt / Subtask B

Quality assessment of existing and new retrofit solutions in the field of facade and daylighting technology, electric lighting and lighting controls

Overview of architectural solutions and considerations for retrofitting



Building intervention level	Lighting component	Intervention level	Intervention type		
			Upgrade of existing situation	Use new components in existing situation	Redesign
Building Skin	Daylighting	Product			
		Control system			
Building Equipment	Electric lighting	Product			
		Control system			
Building Interior	Daylighting + Electric lighting	-			

Building intervention level	Lighting component	Intervention level	Intervention type		
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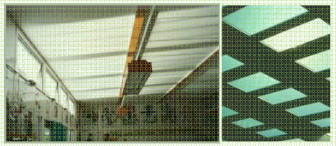
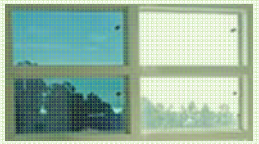
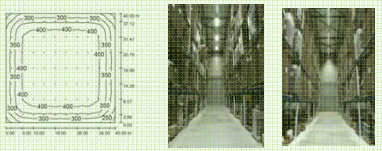
Building Skin	Daylighting	Product		 *Microstructure glazing*	 *Acrylic skylights*
		Control system		 *Electrochromic glazing*	
Building Equipment	Electric lighting	Product	 *Lab LED solutions*		 *Light adjusting ceiling*
		Control system			 *New control strategies (zoning, daylight dimming)*
Building Interior	Daylighting + Electric lighting	-			

What to expect in the coming months

- provide a set of criteria to describe lighting technologies appropriate for the retrofit process
- provide figures as baseline to classify and rate existing, built-in lighting installations against new retrofit concepts
- to be able to compare highly differentiated retrofit solutions on an equal basis …

Acknowledgement

The work presented is a result of
the cooperation with and discussion amongsts
IEA Task 50 participants.

THANK YOU