SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

SUBTASK A: LIGHTING RETROFIT COSTS MODELS FOR DECISION MAKING

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Major Contributors
WSP (Sweden), University of Kyushu University, Fraunhofer Institute-IBP (Germany), SBI-AAU (Denmark)

What are the barriers and opportunities for lighting retrofits, with super energy efficient solutions??

It depends who we talk about:

- Owners, facility managers, installers, users, authorities …(need to identify metrics, costs understood par these stakeholders?
- Identify attractive terms which could trigger decision and overcome obstacles
- Cost models (Total cost of Ownership…)
- Attractivity of lighting vs costs and energy performance

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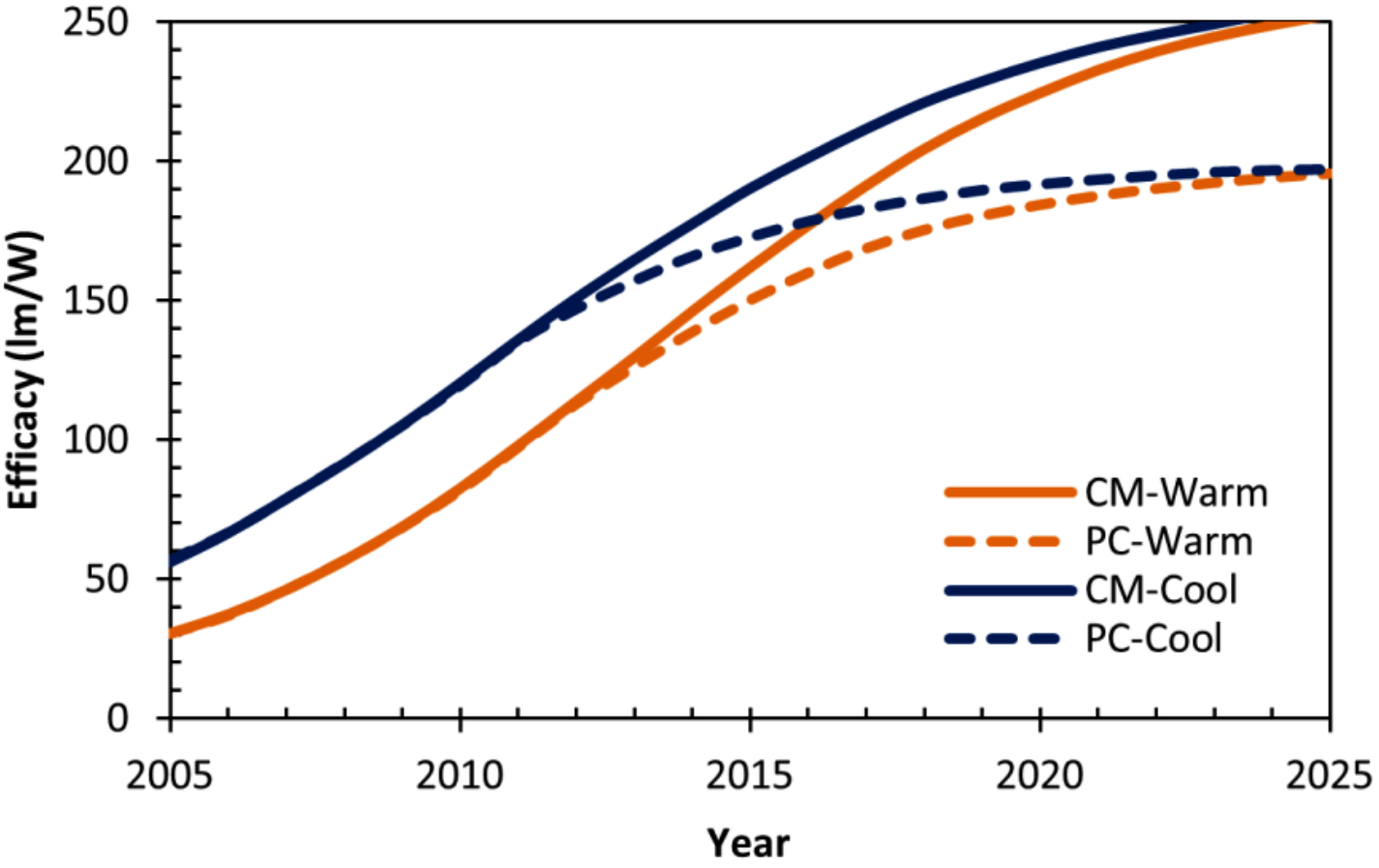
Some facts:

Stabilization of efficacy of light engines in the 160 lm/W to 200 lm/W range?



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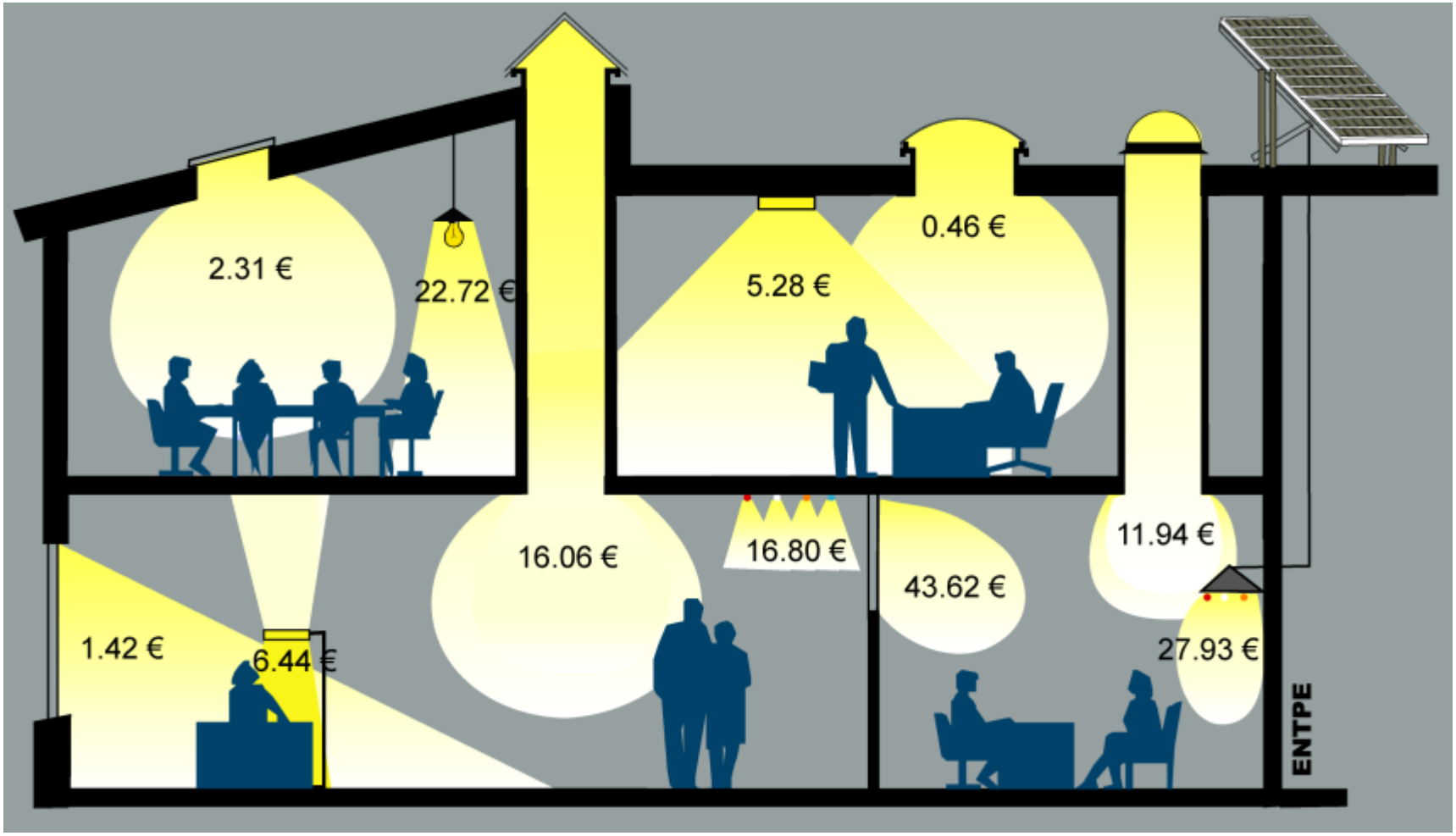
Some facts:

Stabilization of efficacy of light engines in the 160 lm/W to 200 lm/W range?

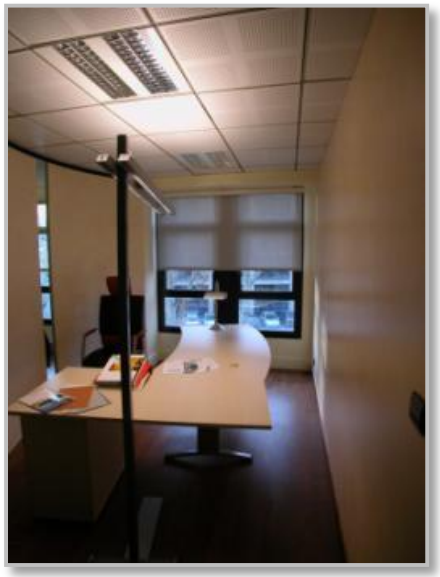
Table 1: Prediction of evolution of LED Package cost and efficacy (U.S. Department of Energy. Energy Efficiency & Renewable Energy, 2012).

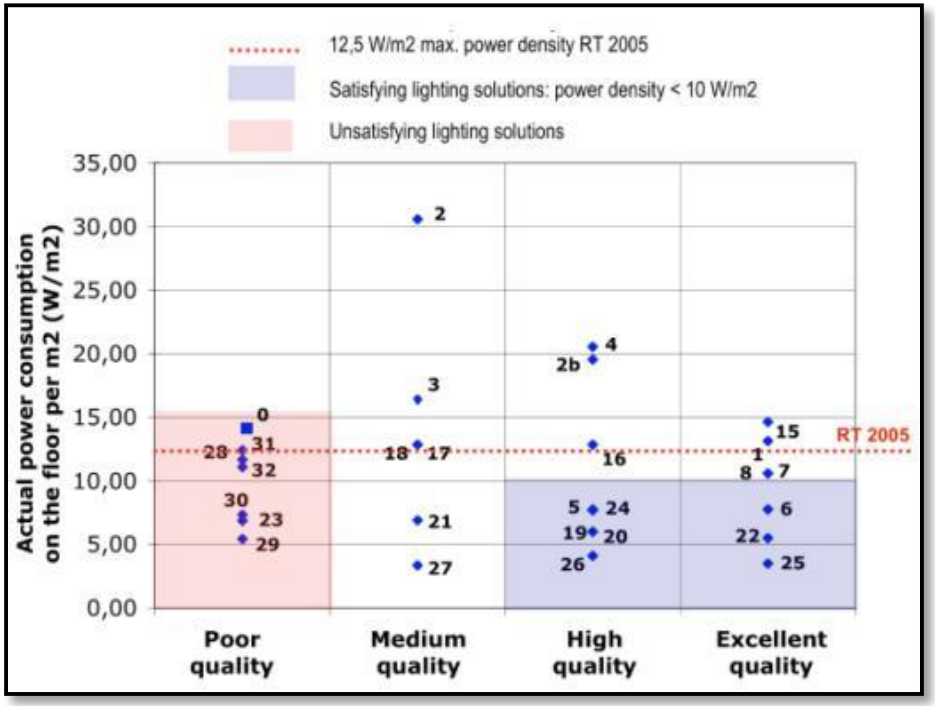
Metric	Unit	2011	2012	2013	2015	2020
LED Package Efficacy (warm white)	lm/W	97	113	129	162	224
LED Package Price (warm white)	$/klm	12.5	7.9	5.1	2.3	0.7
LED Package Efficacy (cool white)	lm/W	135	150	164	190	235
LED Package Price (cool white)	$/klm	9	6	4	2	0.7
Metric	$/klm	33	23	16.5	10	5

Notes:
Projections for cool white packages assume CCT=4746-7040K and CRI=70-80, while projections for warm white packages assume CCT=2580-3710K and CRI=80-90. All efficacy projections assume measurements at 25°C with a drive current density of 35 A/cm. Note that MYPP projections are based on price, not cost.



Total Cost Of Ownership of lighting, in **€ / Mlm.hrs** delivered on Work Plane
Source Marc Fontoynont, Light and Engineering Journal.





Quality: workplane, glare control, global luminous environment

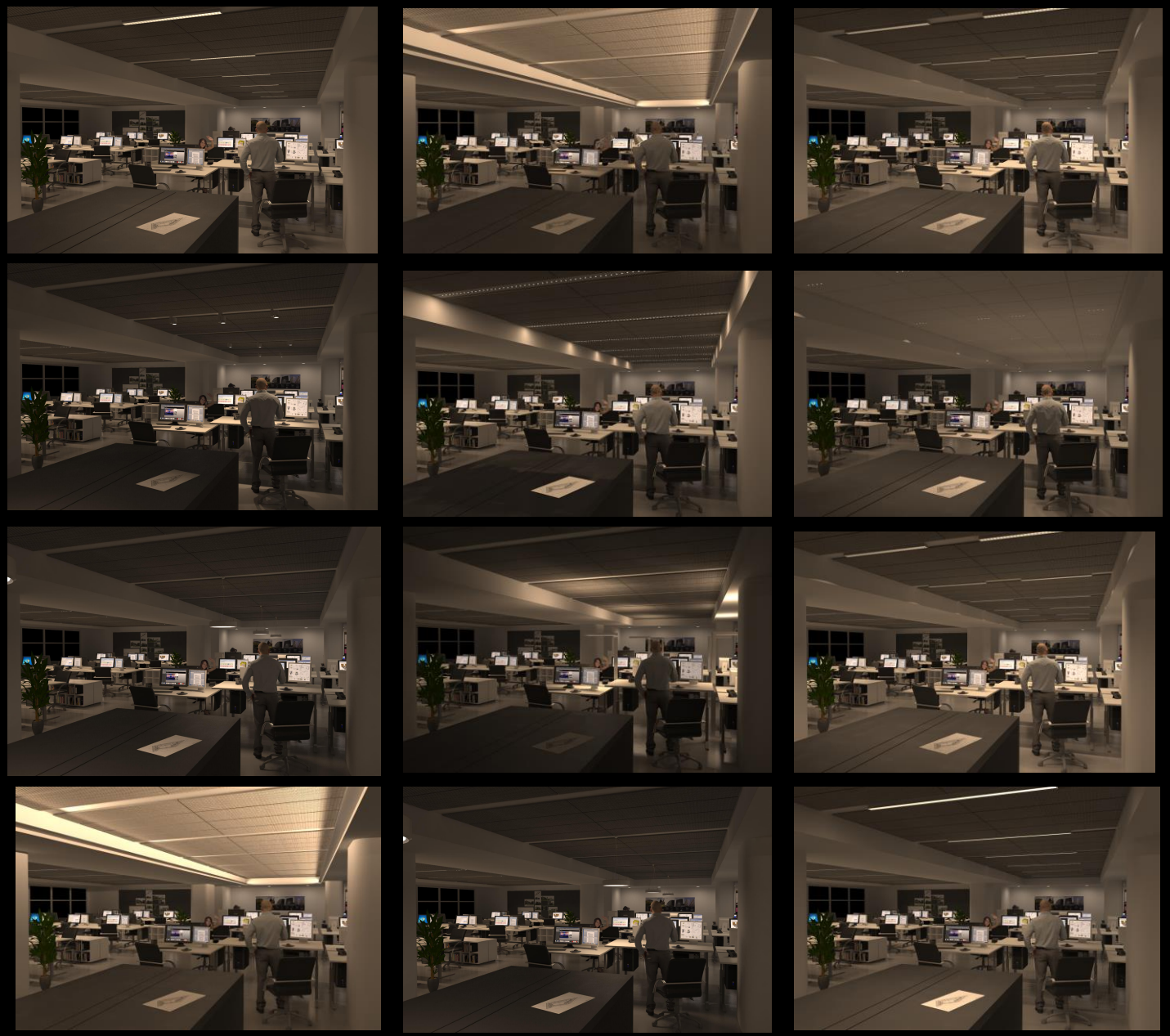
Source: ADEME PUCA, ENTPE, Ingelux, SONEPAR, 2005 ->

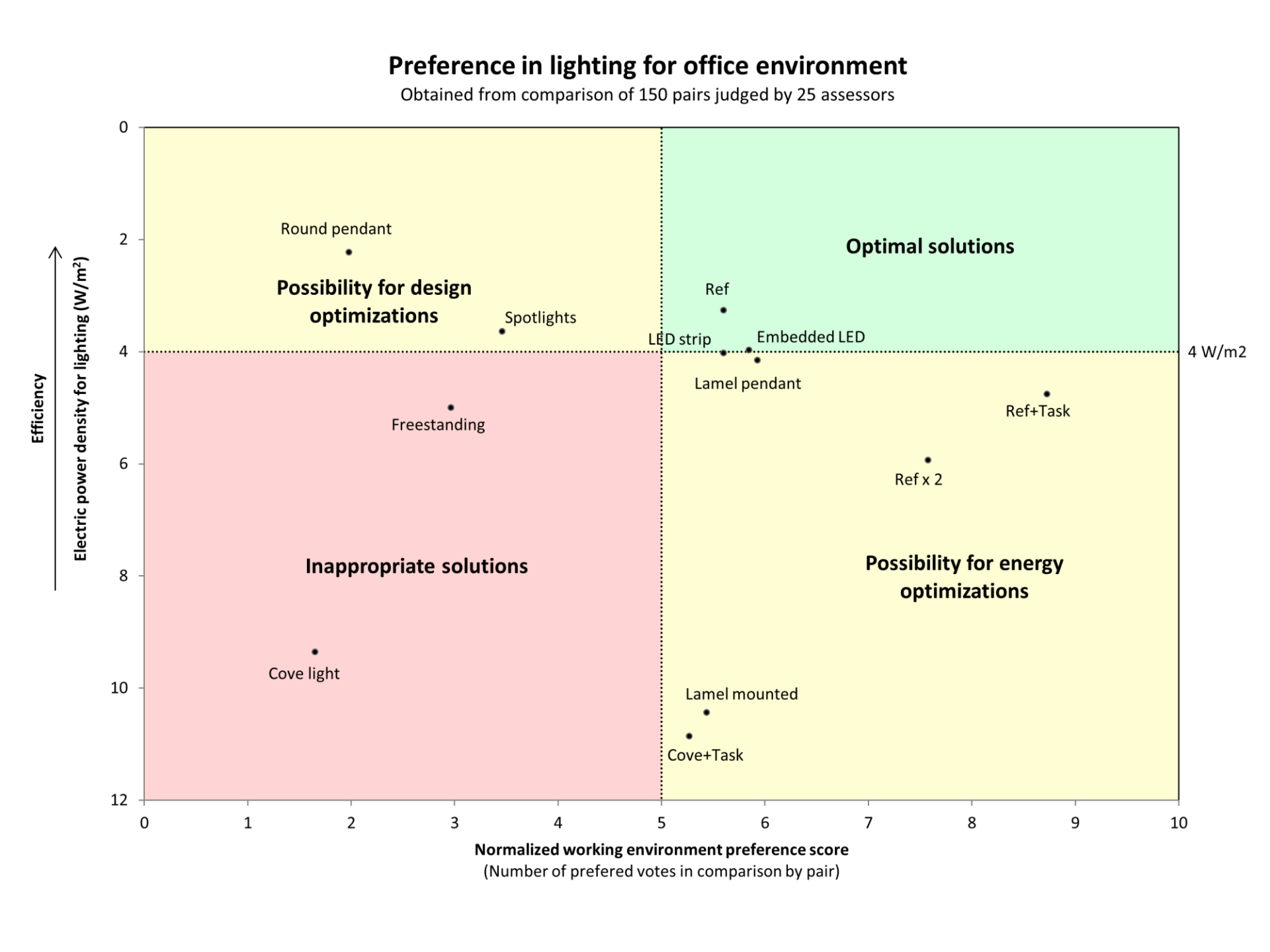
Lighting quality assessment procedures developed at SBI-AAU, Copenhagen

Present luminous schemes (stimuli) to individuals or groups of observers, **rate lighting schemes with respect to a criterion …**

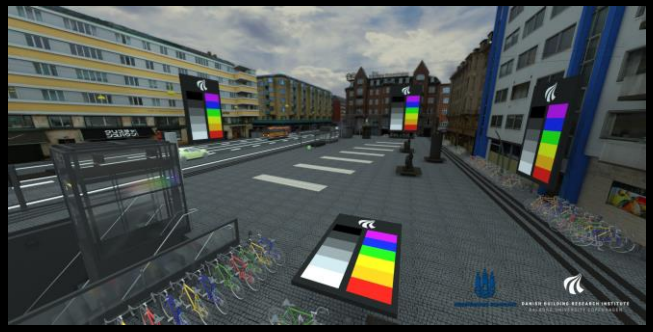
For instance, which one of the two lighting scheme is…

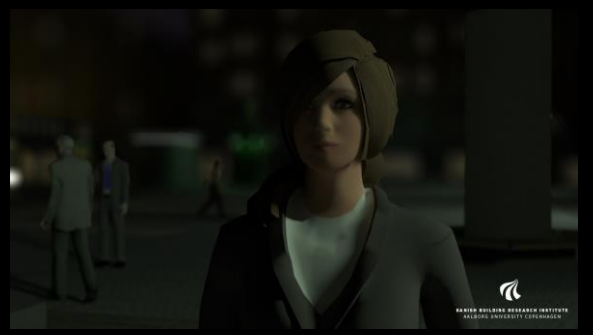
- *More suitable to a given use of the space : work, circulation, orientation?*
- *More comfortable (low glare) ?*
- *More agreeable, elegant???*
- *… and many other possible attributes*

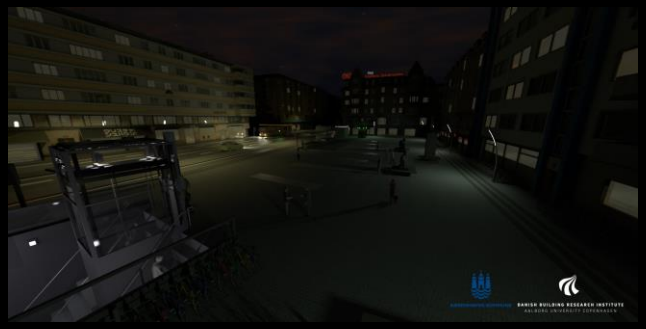
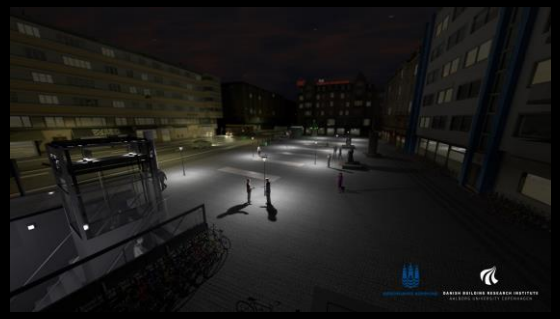


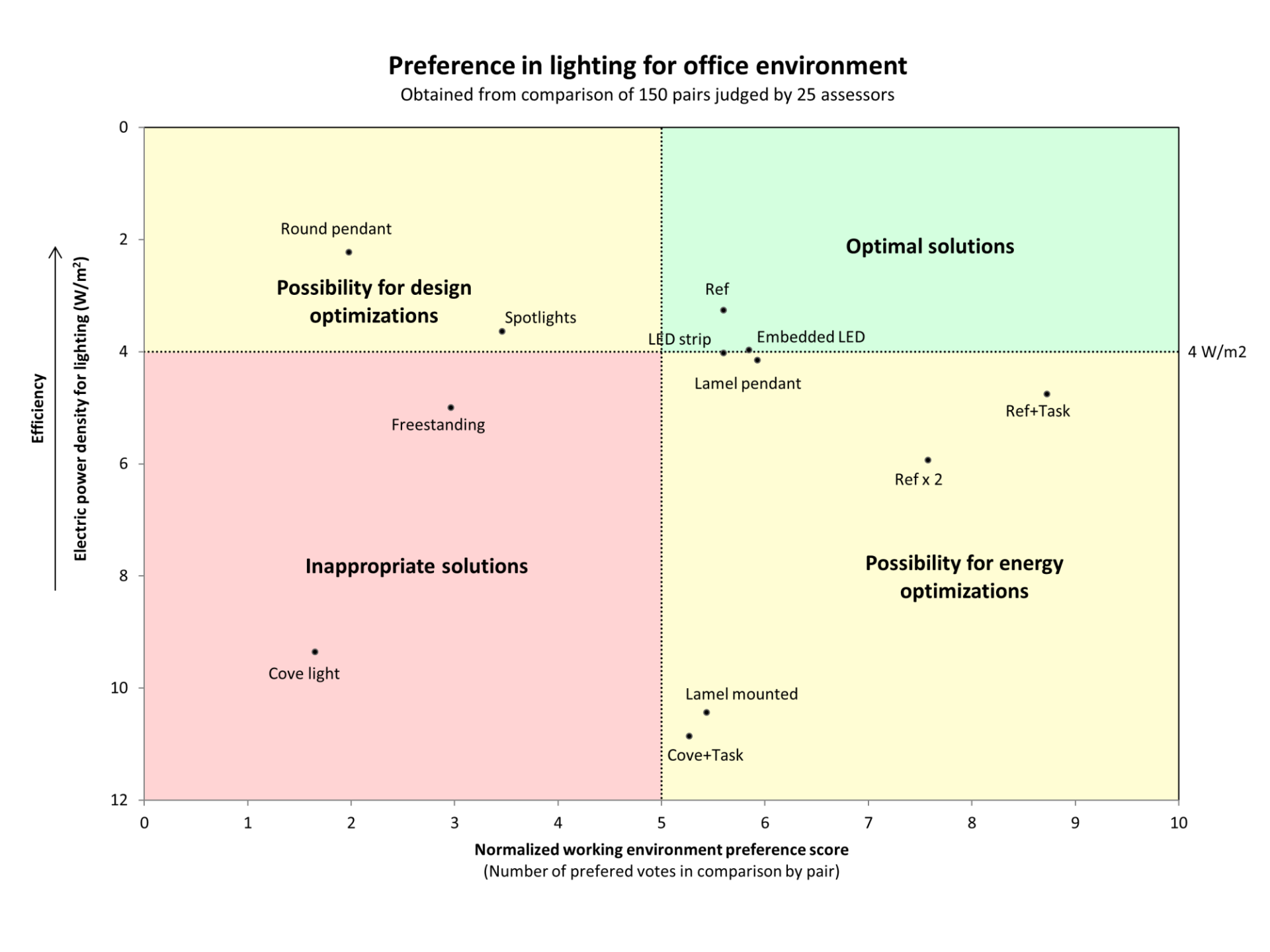

Preference in lighting for office environment
Obtained from comparison of 150 pairs judged by 25 assessors
Efficiency
Electric power density for lighting (W/m²)
0
2
4
6
8
10
12
Optimal solutions
Possibility for design optimizations
Inappropriate solutions
Possibility for energy optimizations
4 W/m2
Round pendant
Spotlights
Ref
LED strip
Embedded LED
Lamel pendant
Freestanding
Ref+Task
Ref x 2
Cove light
Lamel mounted
Cove+Task
0
1
2
3
4
5
6
7
8
9
10
Normalized working environment preference score
(Number of prefered votes in comparison by pair)

Boulangerie





4639 lx
4361 lx
4698 lx
9744 lx

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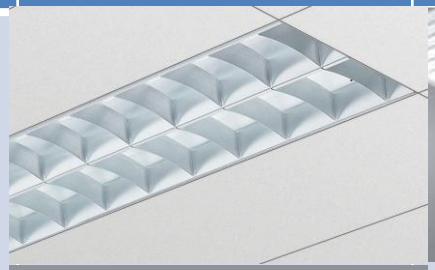
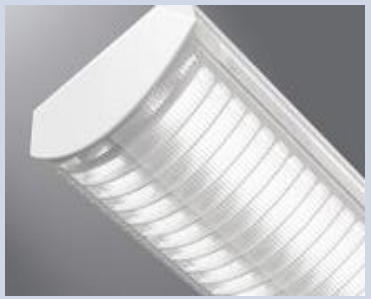
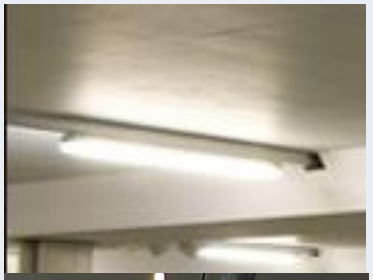
	Industrial building	Office building	School	Store
Reference installation (15 – 30 yrs)				
New generation (2014-2015)				

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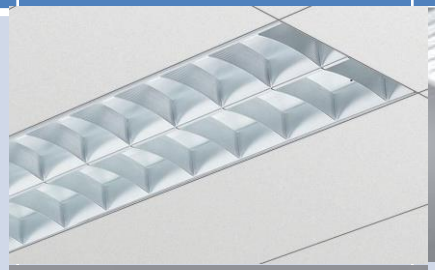
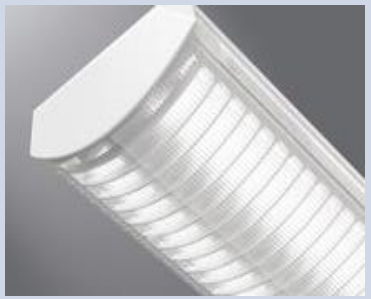
Looking for « low hanging fruits » and best solutions

	Industrial building	Office building	School	Store
Reference installation (15 – 30 yrs)				
New generation (2014-2015)				

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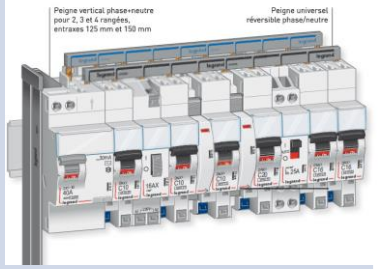
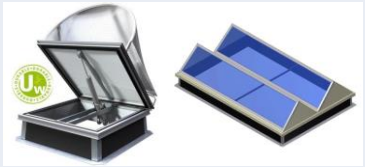
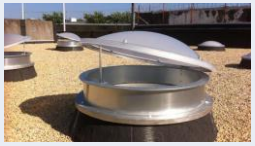
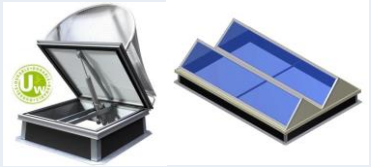
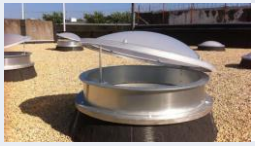
Looking for « low hanging fruits » and best solutions / Daylighting and controls

	Industrial building	Office building	School	Store
Reference installation (15 – 30 yrs)	Insufficient daylight, aging roof monitors, steady electrical lighting.	Individual shadings, on-off and clock controls.	Manually controlled shading and lamps.	 Manual switches, or clock driven.
New generation (2014-2015)	  Roof monitors with improved performance and sunlight control. Daylight responsive sensors.	Daylight sensor Occupancy sensor Sensors and intelligent management tof sunbeams.	Daylight sensor Automatic controls of shading, override, clocks.	  Roof monitors with improved performance and sunlight control. Daylight responsive sensors .

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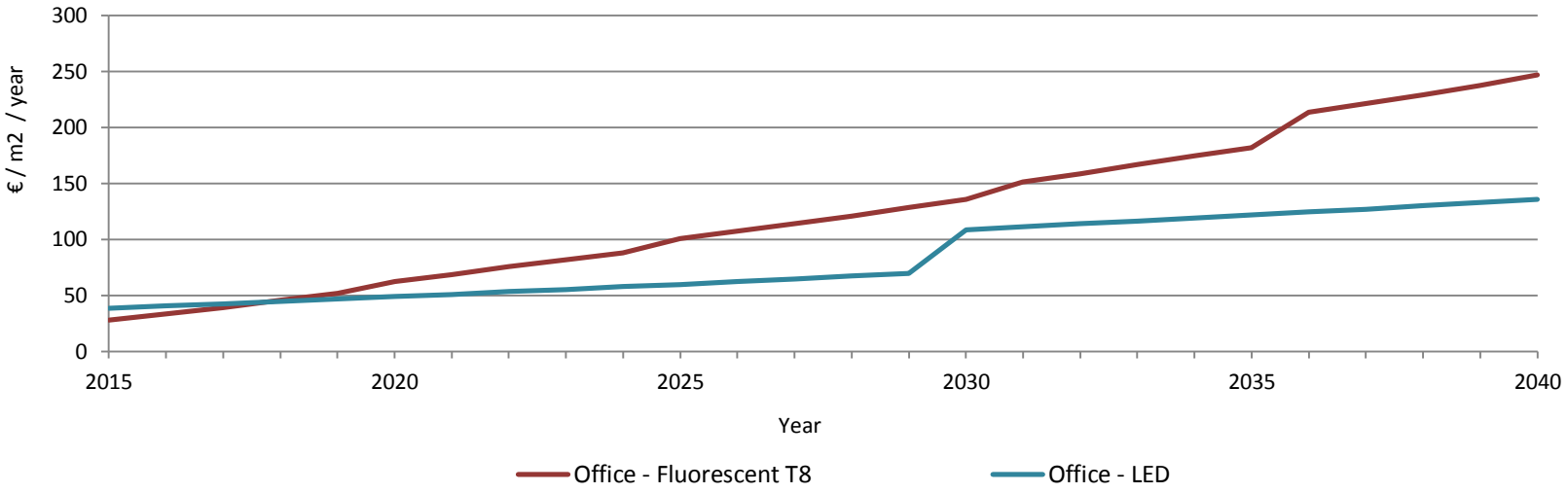
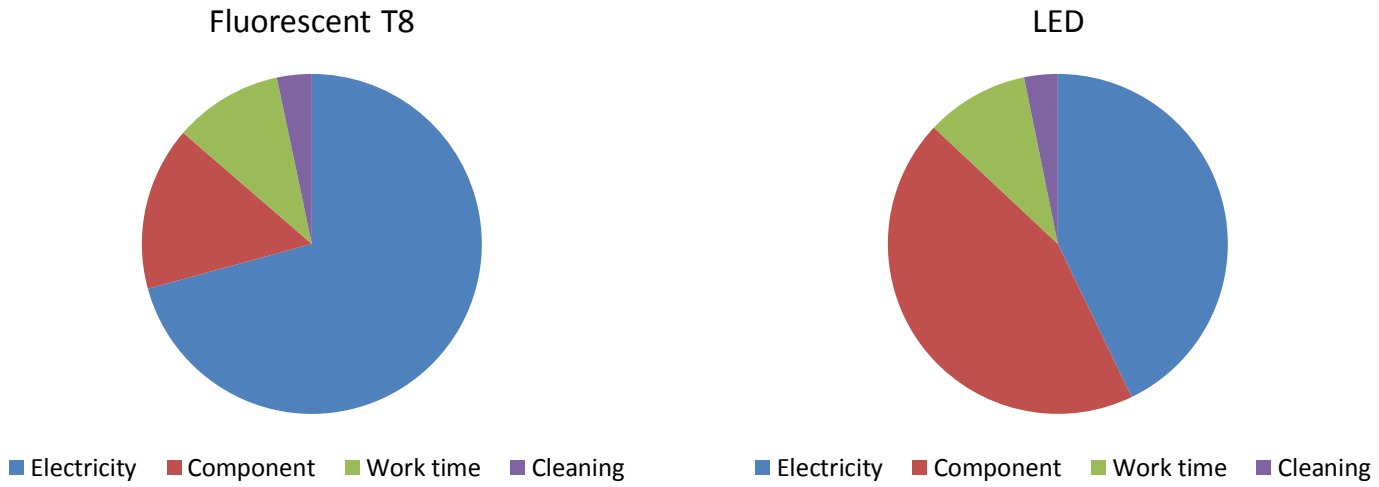
Office building

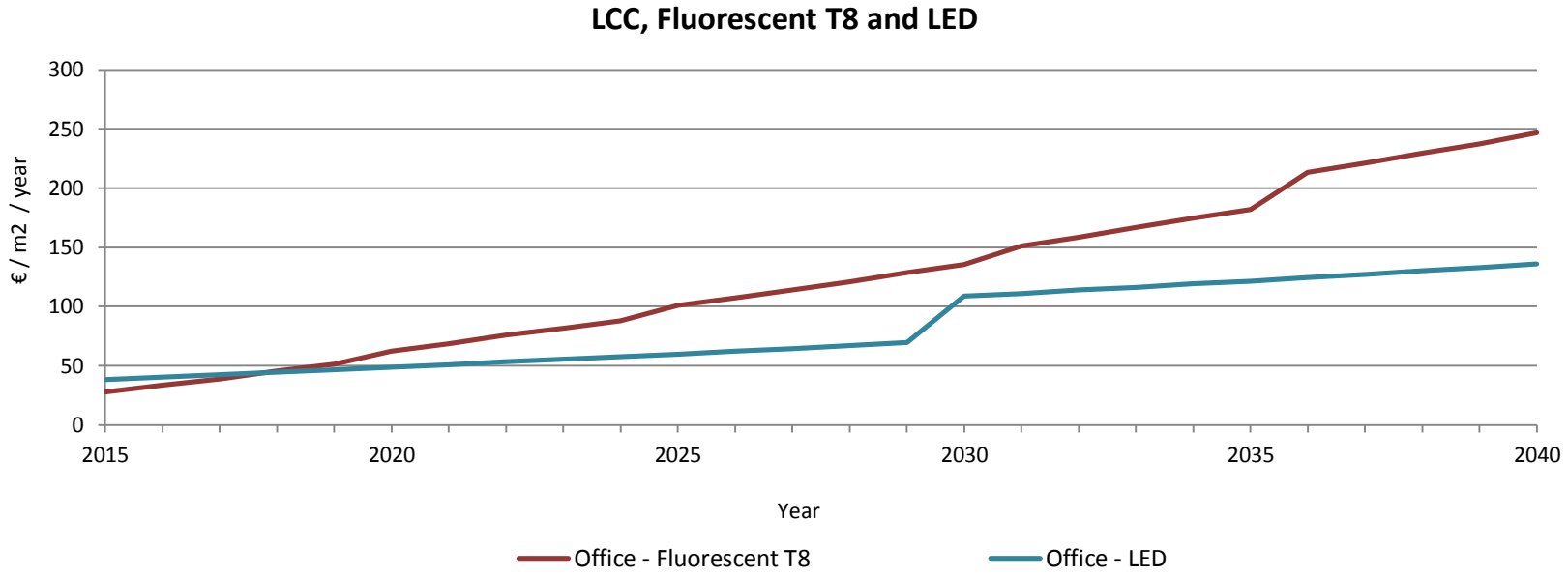
LCC, Fluorescent T8 and LED

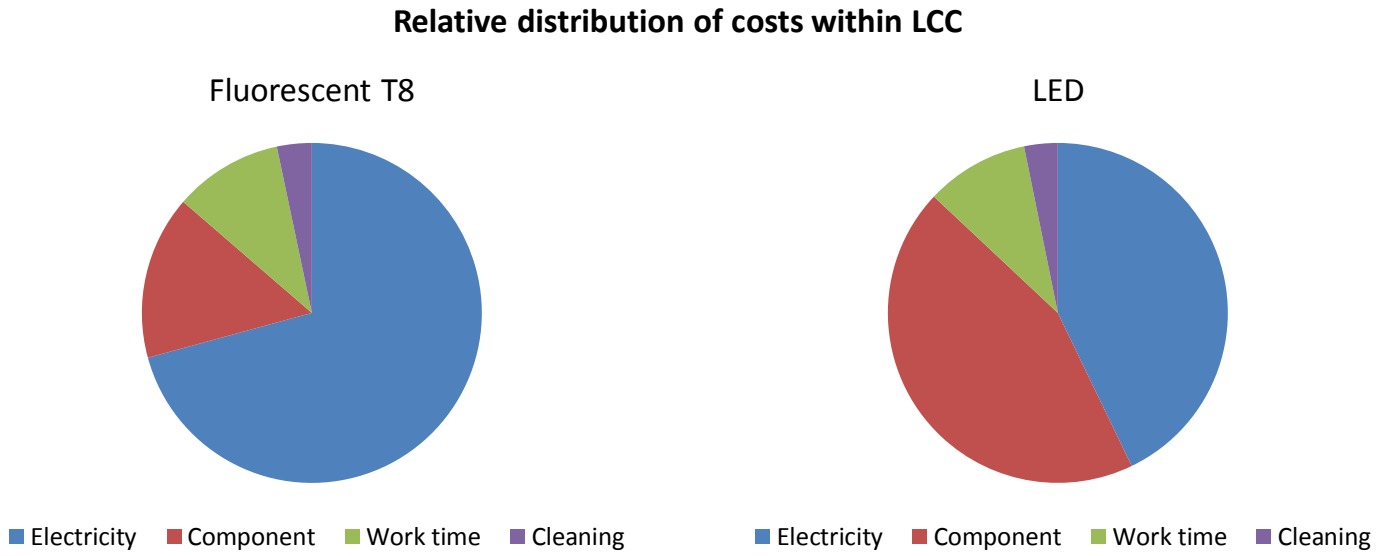


Relative distribution of costs within LCC

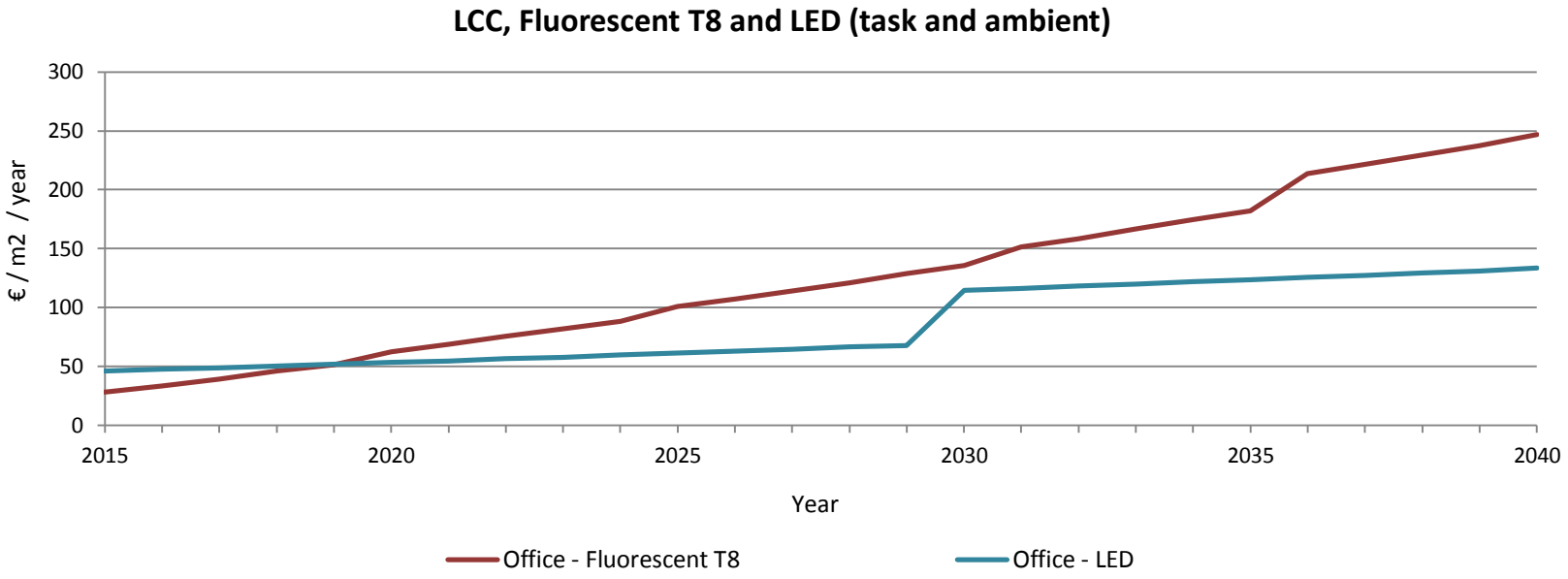


Office building

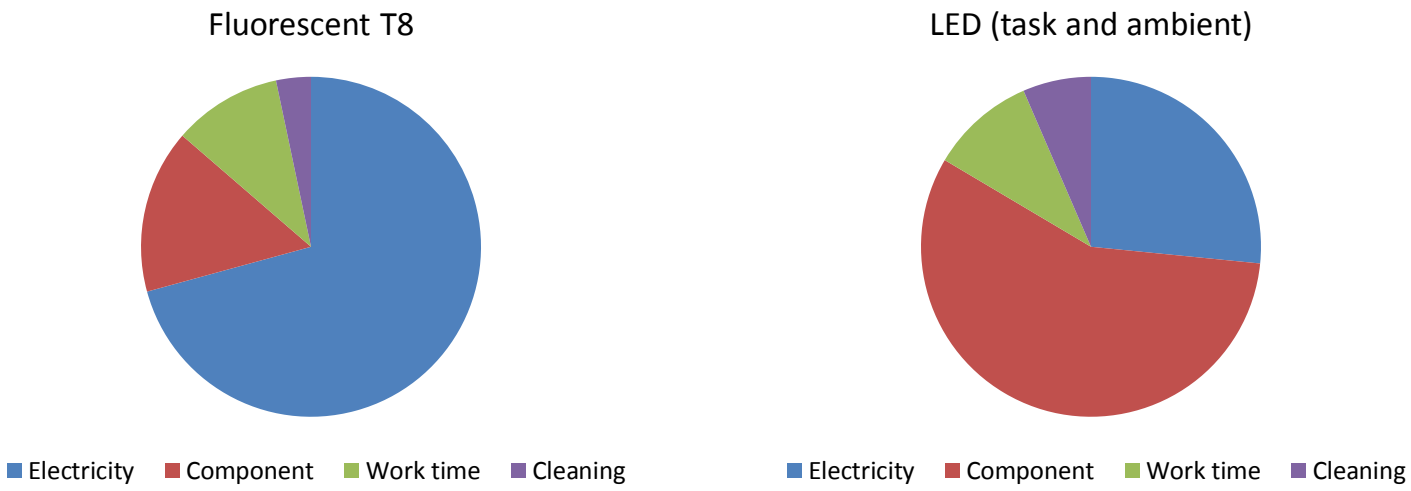




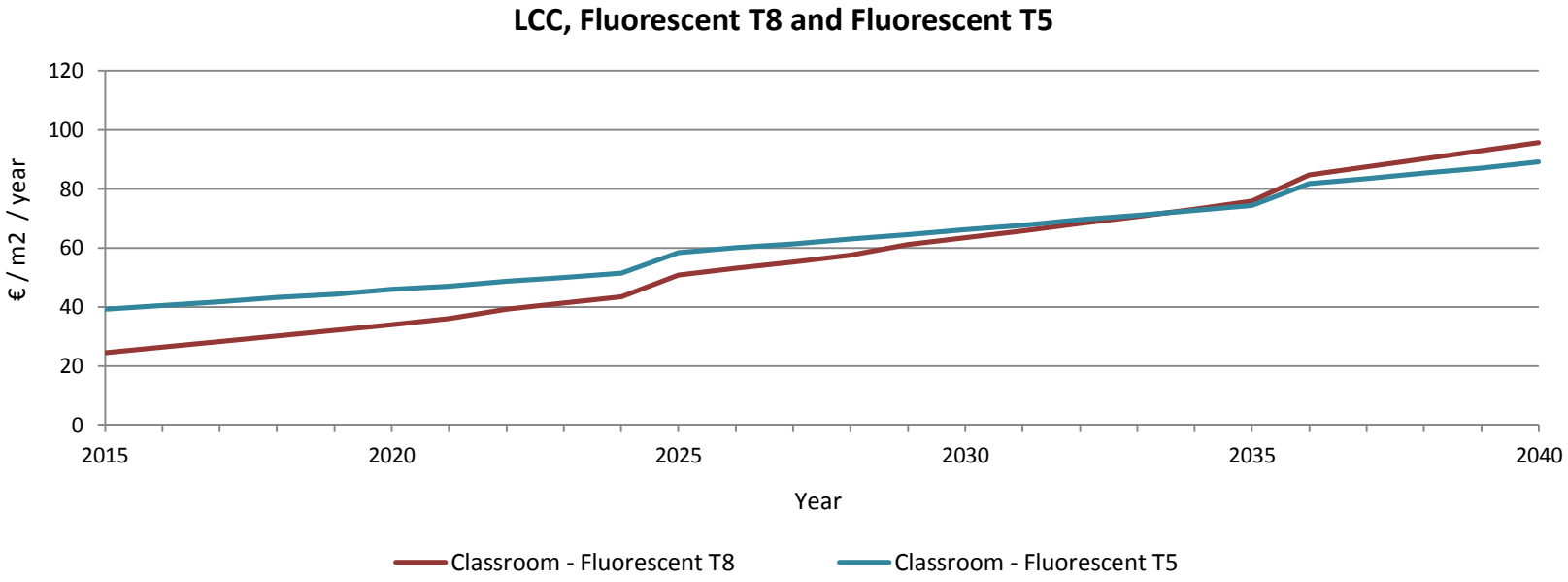
Office building (task and ambient ligthing)

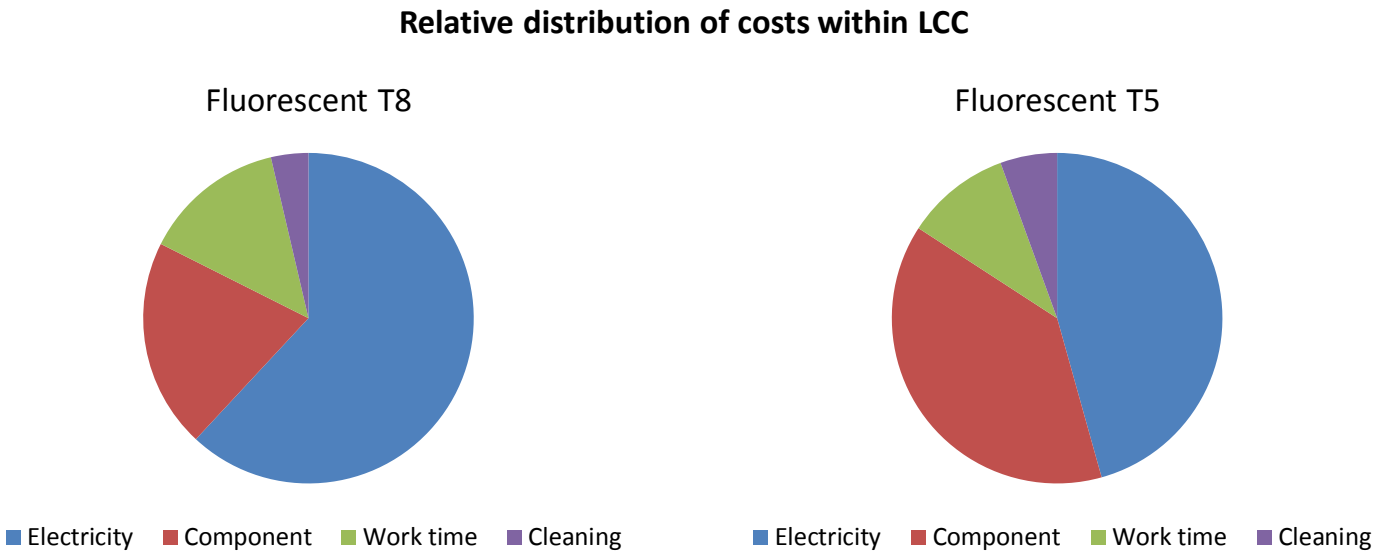


Relative distribution of costs within LCC

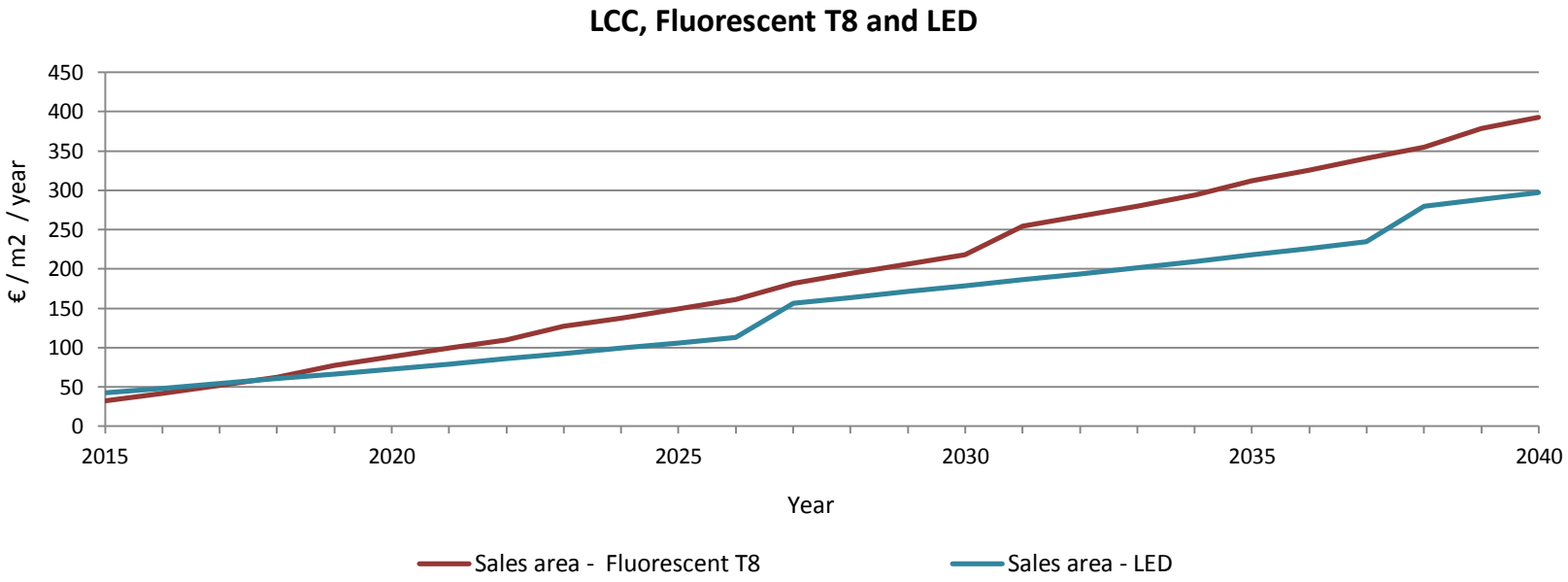


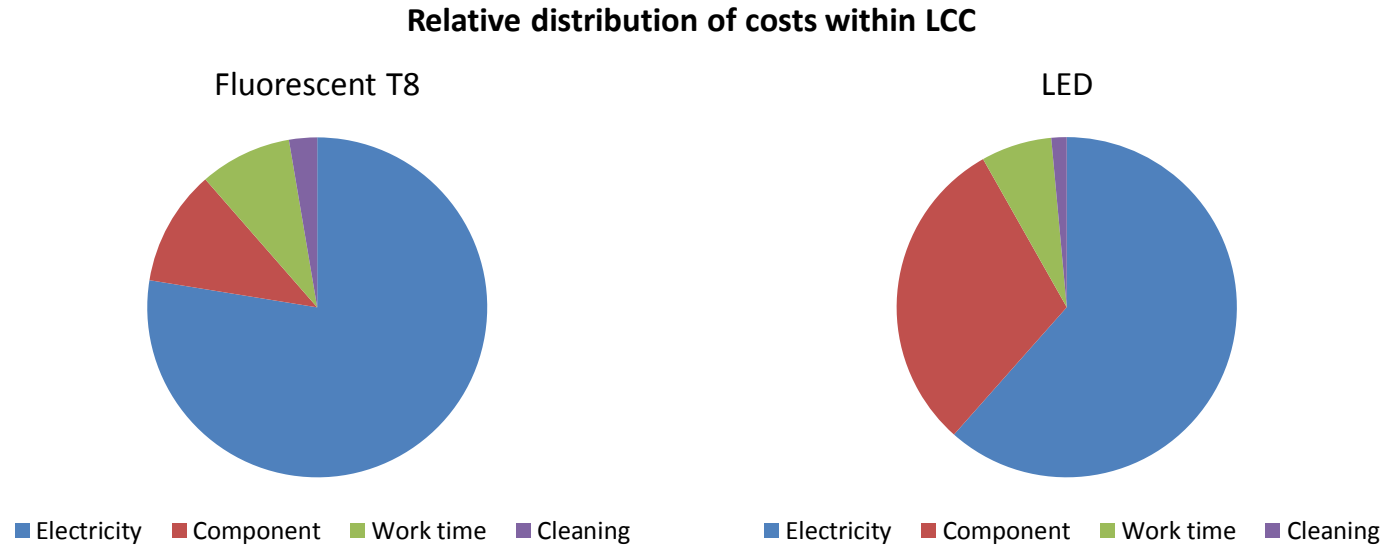
School


LCC, Fluorescent T8 and Fluorescent T5
120
100
80
60
40
20
0
€ / m2 / year
2015
2020
2025
2030
2035
2040
Year
Classroom - Fluorescent T8
Classroom - Fluorescent T5

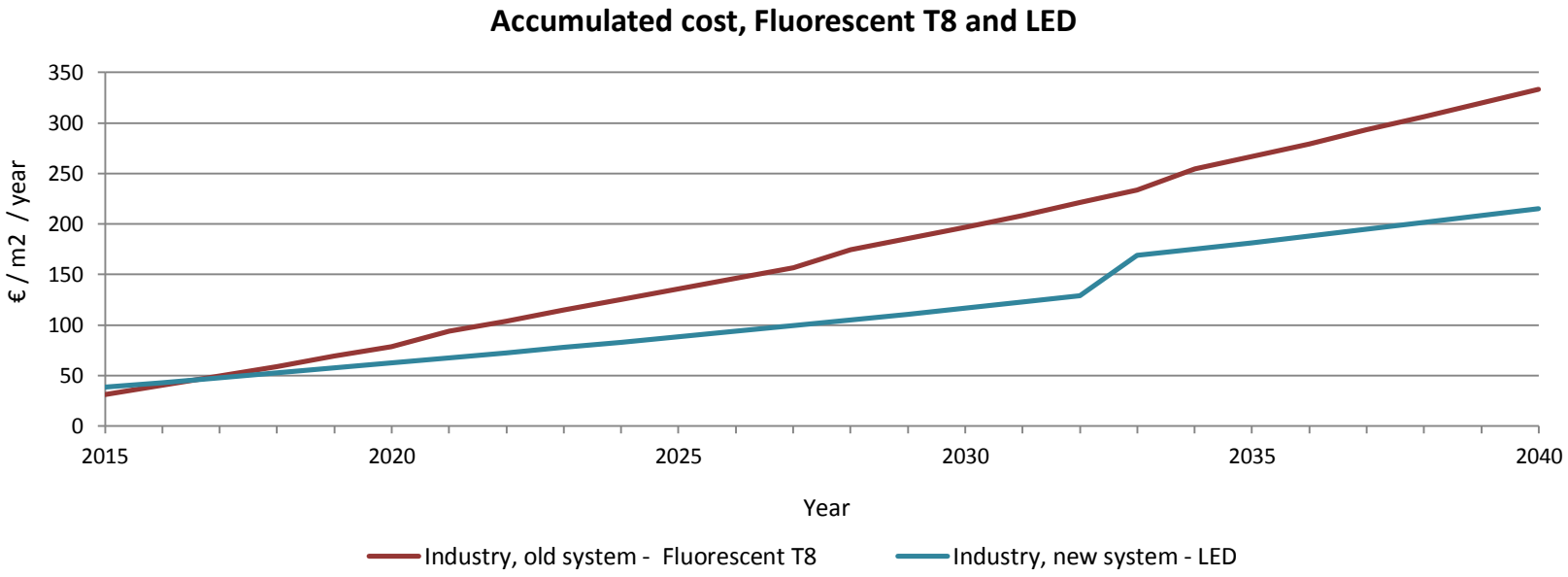

Relative distribution of costs within LCC
Fluorescent T8
Fluorescent T5
Electricity
Component
Work time
Cleaning
Electricity
Component
Work time
Cleaning

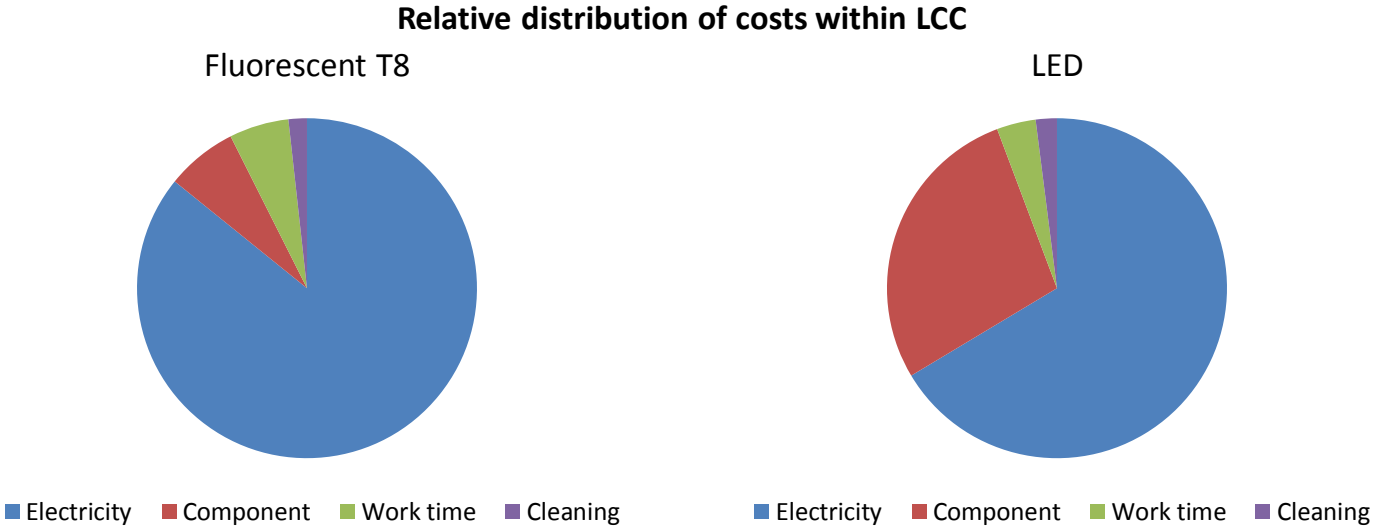
Sales area


LCC, Fluorescent T8 and LED
€ / m2 / year
450
400
350
300
250
200
150
100
50
0
2015
2020
2025
2030
2035
2040
Year
Sales area - Fluorescent T8
Sales area - LED


Relative distribution of costs within LCC
Fluorescent T8
LED
Electricity
Component
Work time
Cleaning
Electricity
Component
Work time
Cleaning

Industrial building





Our Contribution:

Provide input for Lighting Retrofit Advisor

Costs information to trigger decision…

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