Bartenbach
L˙chtLabor

Energieeffiziente elektrische Beleuchtung

Wilfried Pohl

Globaler Stromverbrauch für Beleuchtung

Bartenbach LichtLabor

2005:

- Weltweiter Stromverbrauch für Beleuchtung
  - gesamt 2.650 Milliarden kWh
  - d.h. pro Erdbewohner ca. ca. **400 kWh**
- Kohlendioxidausstoß 1775 Millionen Tonnen
- Vom Gesamtstromverbrauch
  - 19% im weltweiten Schnitt
  - 5% - 15% in entwickelten Industriestaaten
  - bis zu 86% in Entwicklungsländern
- Verteilt sich zu
  - 28% Wohnungen
  - 48% Dienstleistung
  - 16% Industrie
  - 8% Straßenbeleuchtung

Globaler Stromverbrauch für Beleuchtung

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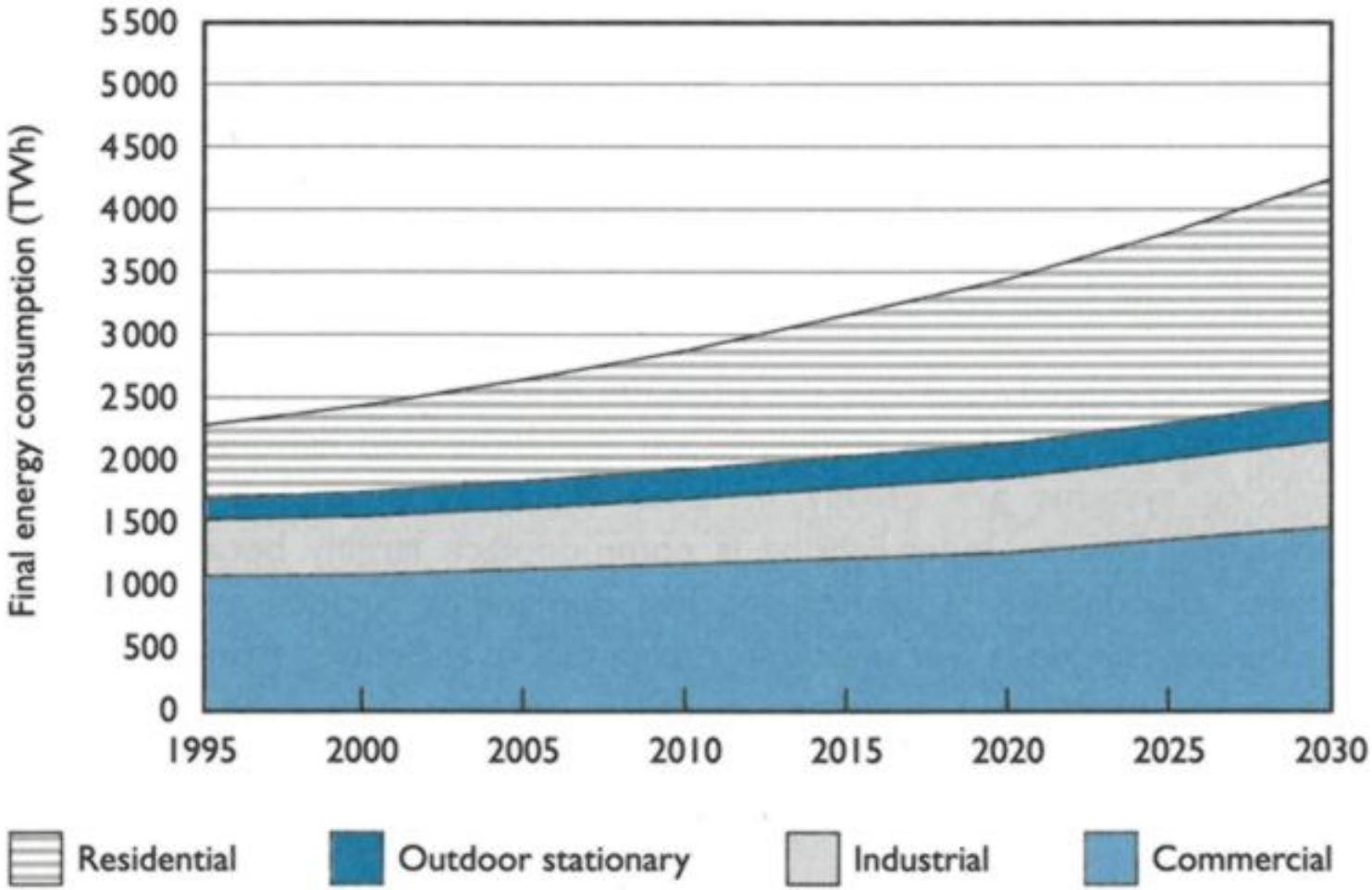
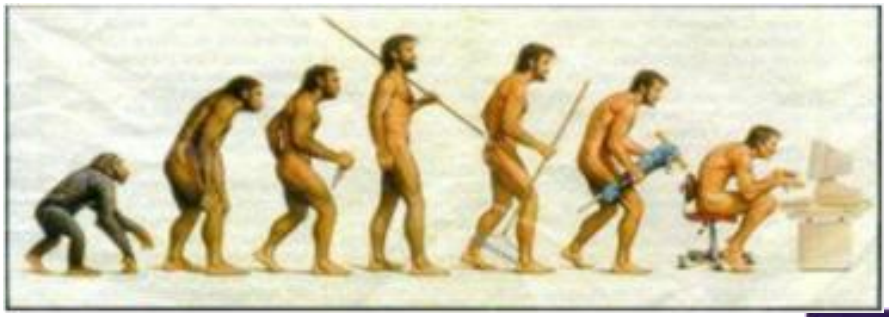


(OECD/IEA 2004)

Die moderne Menschheit

Bartenbach LichtLabor



Amerika um 23:00 ...

IEA *International Energy Agency*

ECBCS *Energy Conservation in Buildings and Community Systems*

Annex 45:

Energy Efficient Electric Lighting for Buildings

(2005 – 2009)

Bartenbach LichtLabor

E³Light

Annex 45
Energy Efficient Electric Lighting for Buildings

Biannual Newsletter 1/2007

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

Web-site: lightinglab.fi/IEAAnnex45

Turning Torso. The lighting in the corridors is done with LEDs.

11th International Symposium on the Science and Technology of Light Sources

20 - 24 May, 2007, Shanghai, China

Nineteen invited, twenty-eight landmark papers, and more than two hundred posters were presented at LS:11. The local organiser was Fudan University.

Continued on page 2

The Light of Tomorrow Today!

Everybody in the lighting fraternity seems to believe that LEDs are THE light source of the future, or at least a major light source in future lighting installations. At the same time most of these people believe it is much too early to start using LEDs in general lighting installations today, replacing CFLs, fluorescent tubes or even low-voltage halogen and incandescent lamps. The right time is somewhere in the distant future.

Here three cases are presented in which LEDs have successfully replaced CFLs, fluorescent tubes, and low-voltage halogen lamps. In all three projects LEDs proved to be beneficial from both the economic and energy points of view; cost-effectiveness and energy saving.

Continued on page 6

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International Energy Agency

Energy Conservation in Buildings and Community Systems Programme

Annex 45

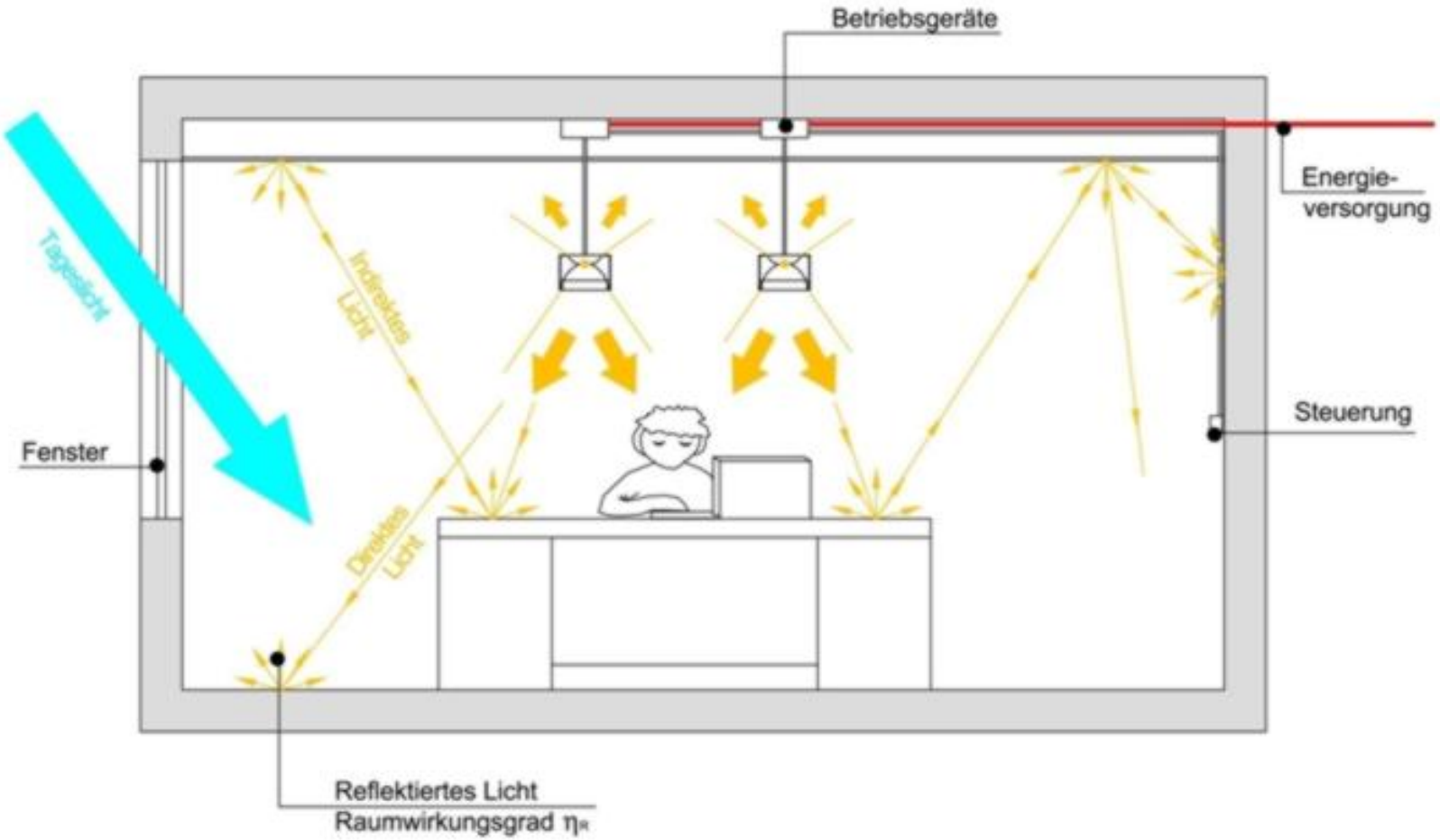
Energy Efficient Electric Lighting for Buildings

Guidebook on Energy Efficient Electric Lighting for Buildings

Edited by Liisa Halonen & Eino Tetri
Helsinki University of Technology
Lighting Laboratory

Vom Strom > visuellen Umgebung

Bartenbach LichtLabor



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Drei Ebenen

vom Stromanschluß > bis zur visuellen Umgebung

- Leuchtmittel
  (Lichtausbeute in lm/W, inklusive Betriebsgeräte)
- Leuchte
  (Leuchtenbetriebswirkungsgrad)
- Raum
  (Raumwirkungsgrad)

Lichtausbeute der Lampe

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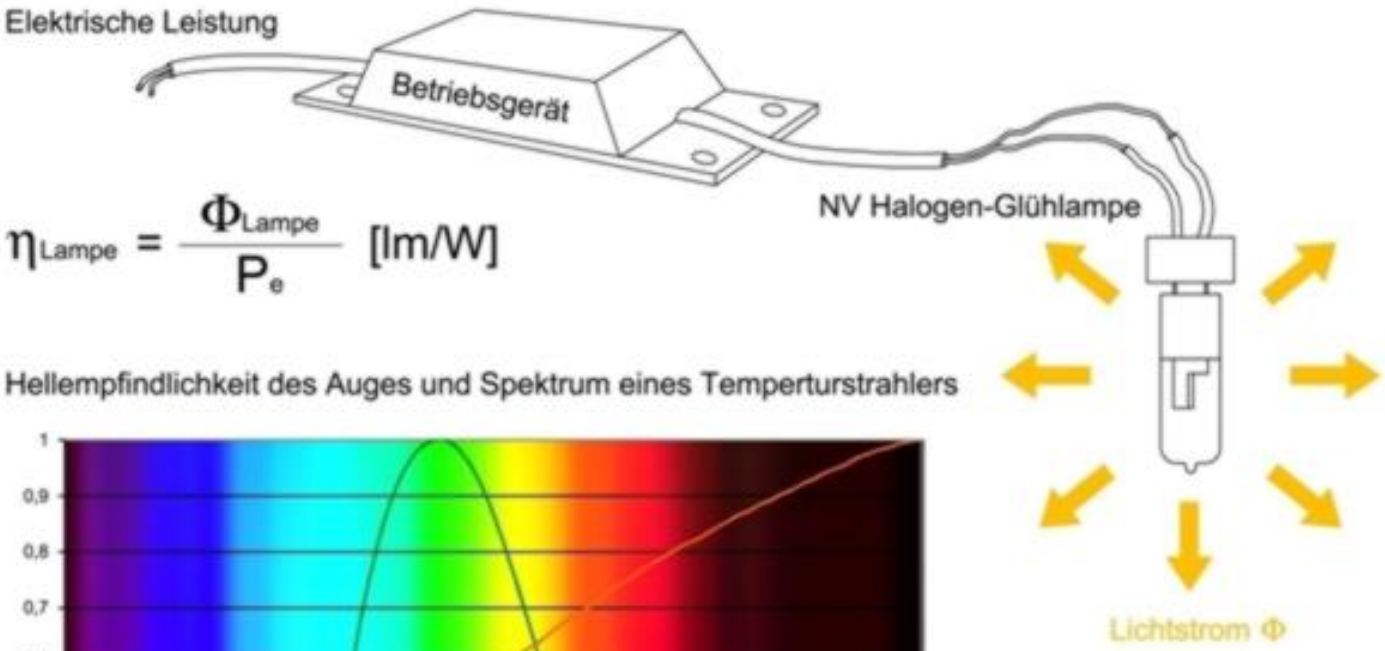
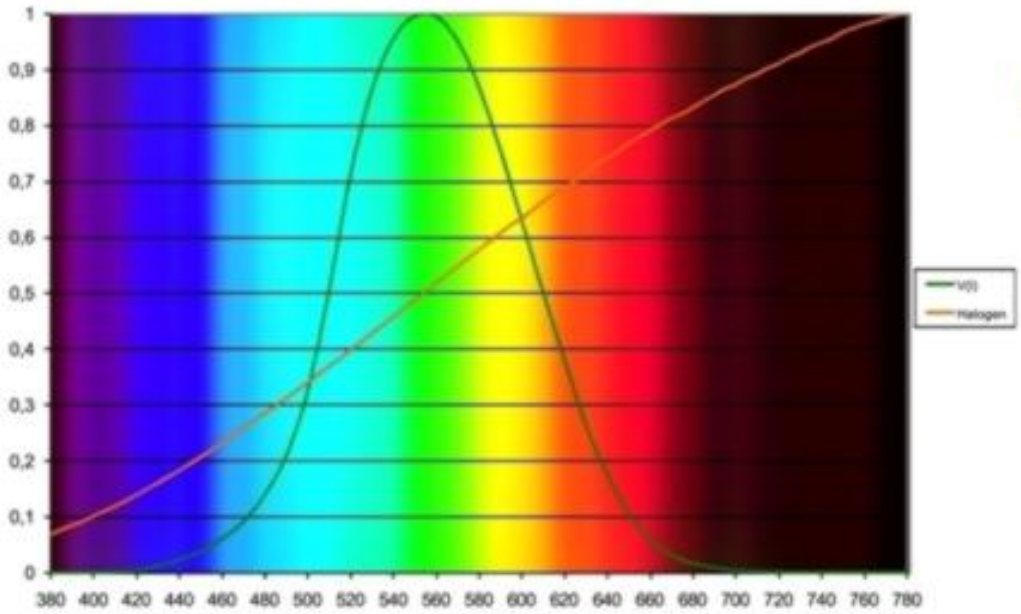


Hellempfindlichkeit des Auges und Spektrum eines Temperturstrahlers



Leuchtenbetriebswirkungsgrad

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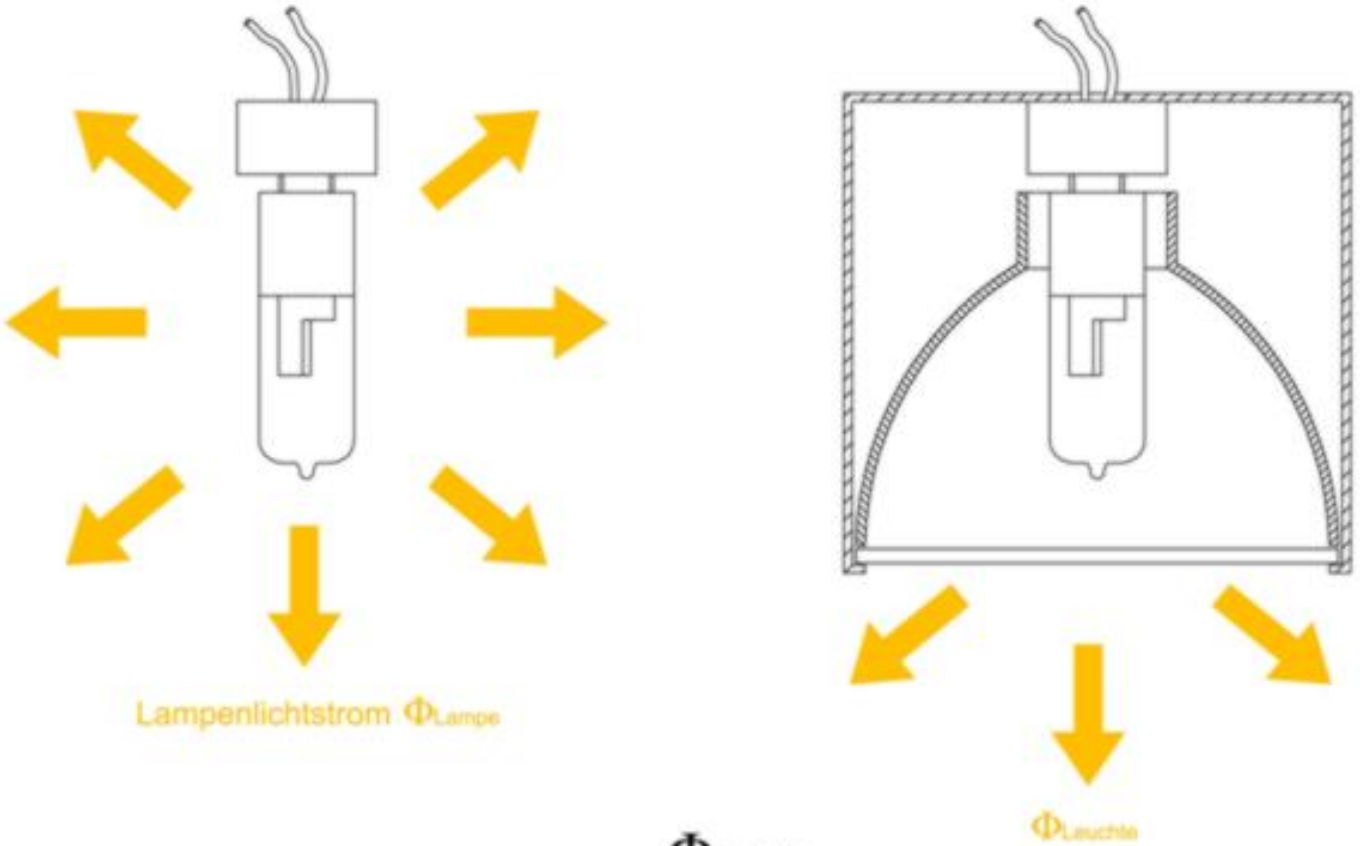

$$\eta_{LB} = \frac{\Phi_{Leuchte}}{\Phi_{Lampe}}$$

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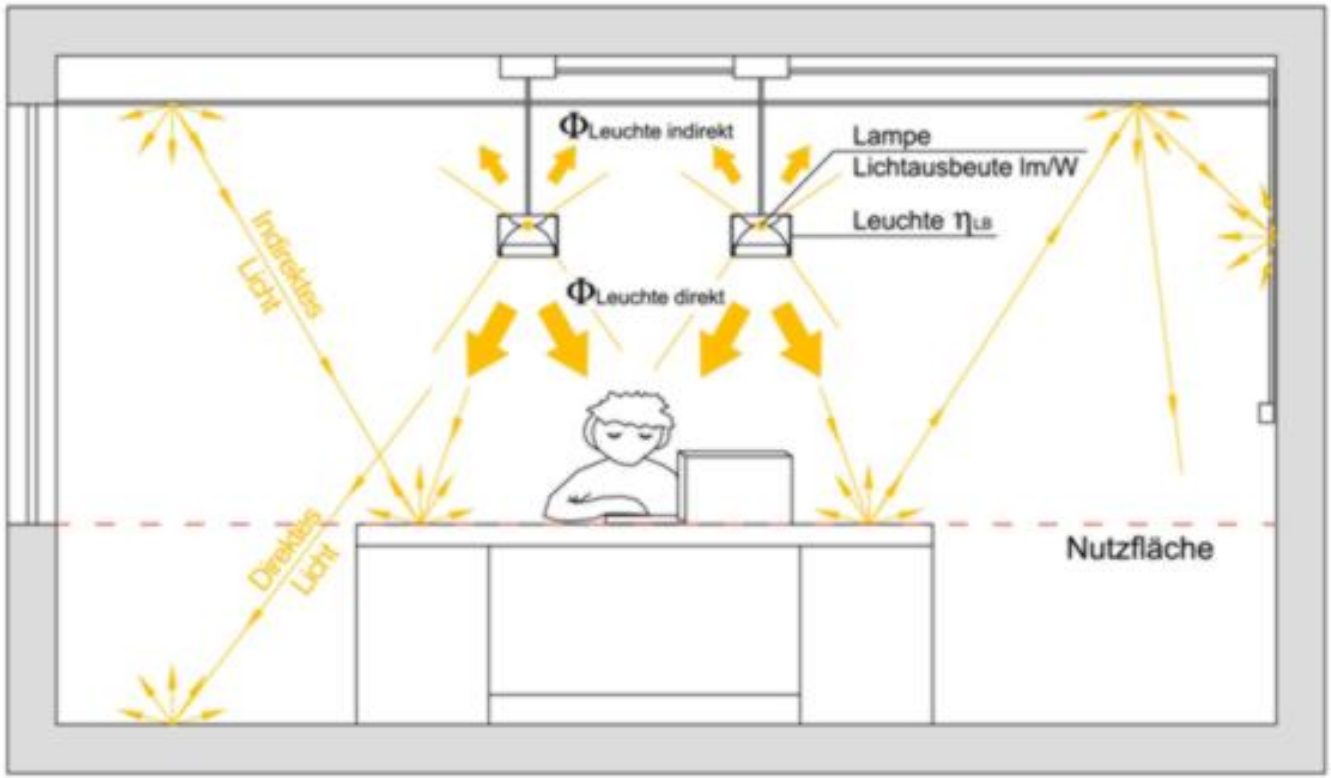
Raumwirkungsgrad h_R



$$\eta_{Raum} = \frac{\Phi_{Nutzfläche}}{\sum \Phi_{Leuchten}}$$

Von der Kerze > LED

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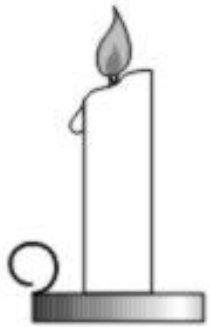
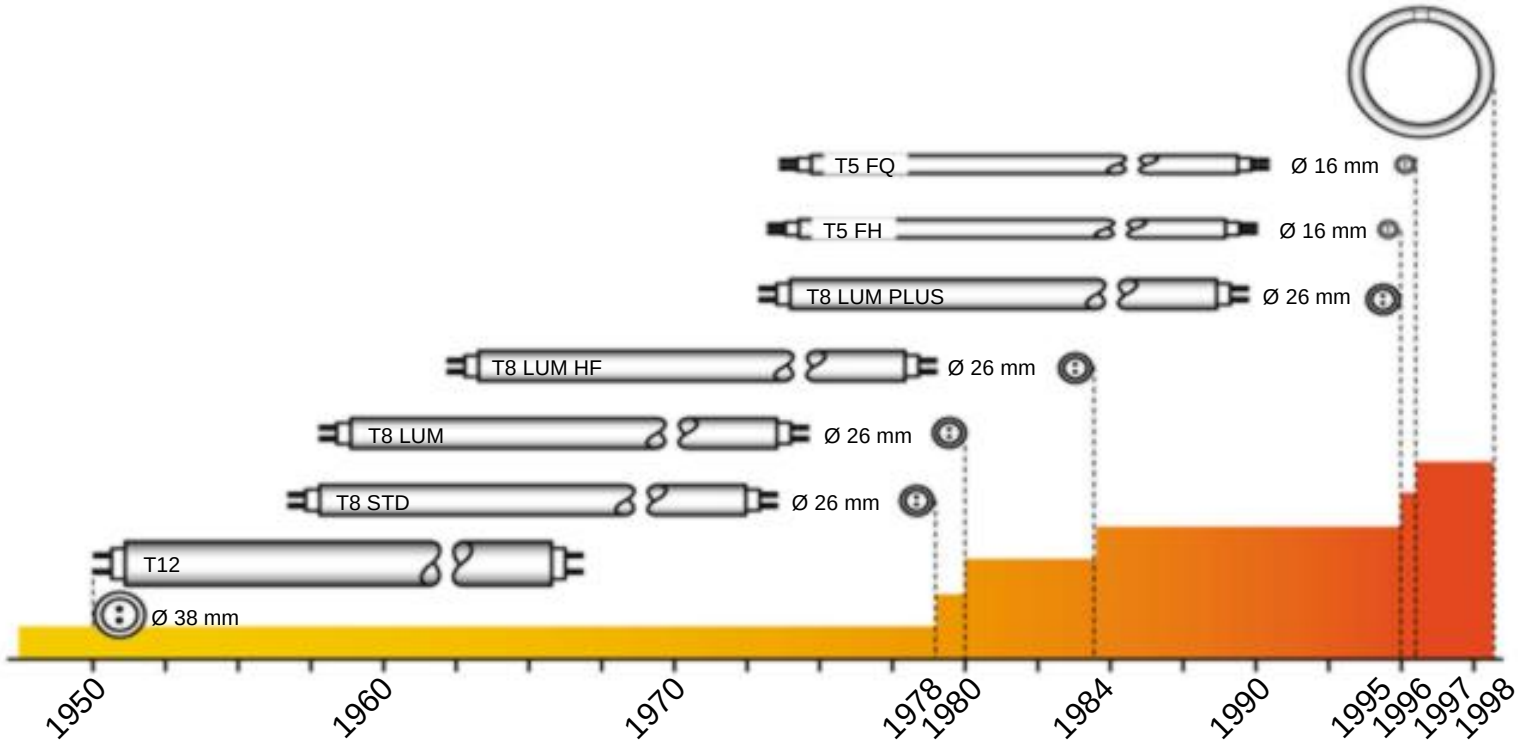
	15.	19.	20. Jahrhundert...		
					
				HQI	LED
Lichtausbeute lm/W	**< 1**	**10 – 15**	**70 – 104**	**70 – 190**	**50**
Wirkungs-grad (rel.)	**< 1%**	**5 – 9%**	**25 – 30%**	**30 – 35%**	**20 – 30%**

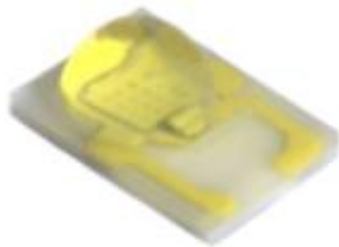
Die Leuchtstofflampe

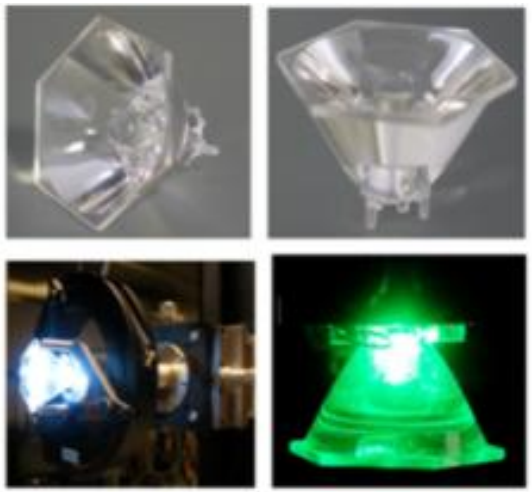
Bartenbach LichtLabor



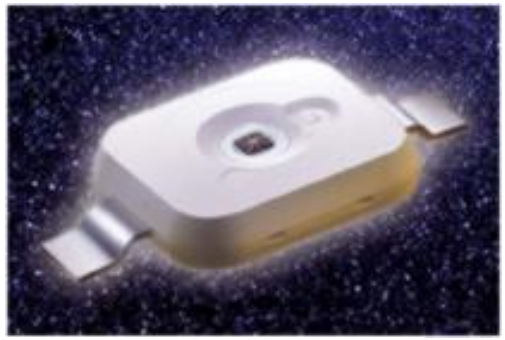
Die Glühlampe

Bartenbach LichtLabor





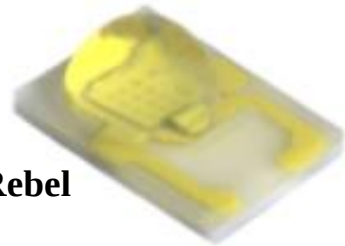
Cree XLamp



Osram Golden Dragon

Lumileds: Luxeon I

Luxeon K2



Rebel

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Chip: 1x1 mm², >2A, ~250 A/cm²

	PC White	
	Today	Future
Light Extraction Efficiency — C_{ext} (%)	~90	**~90** ✓
Internal Quantum Efficiency — IQE (%)	~40	**~90**
External Quantum Efficiency — EQE (%)	~36	**~80**
Forward Voltage — V_f (V)	~4.2	**~2.9**
Power Conversion Efficiency — PCE (%)	~25	**~75**
Luminous Efficacy — LE (lm/W)	~61	**~160**

Ausblick: **~ 160 lm/W, KW (6.000K), 1000-lm/LED**
~ 115 lm/W, WW (4.000K), 750-lm/LED

LED’s Anwendungsbeispiele

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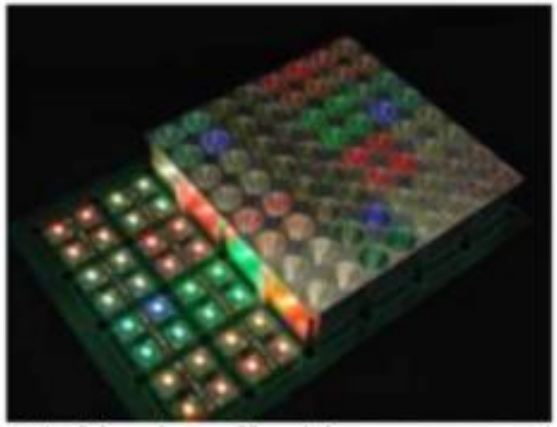
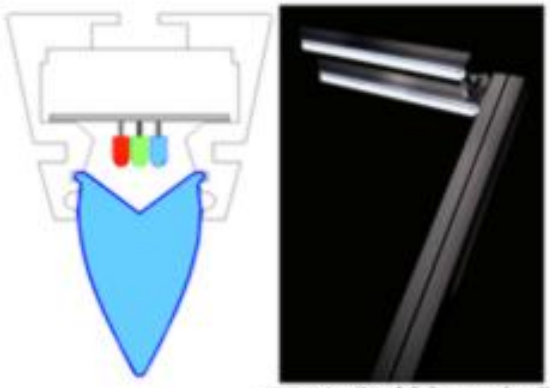


Metalised reflective component to generate a narrow beam angle

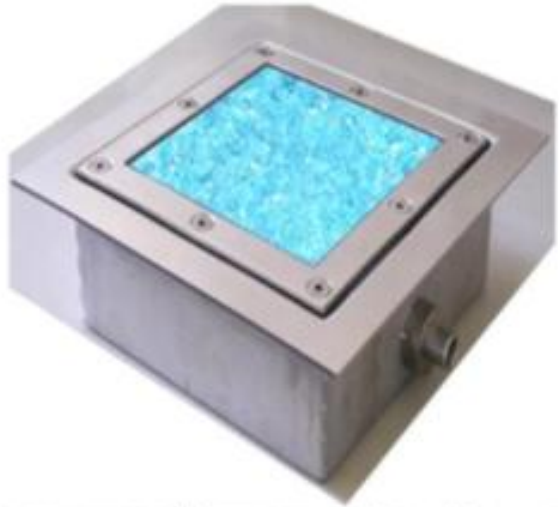


HESS “Millennio”
Aspheric lens mixing RGB-LED´s for street lighting application

LEDs combined with halogen lamp for adjustable ambient lighting

Conference room with LED

TRUMPF “iLED 5” Surgical Light



BERNDORF BÄDERBAU “Lichtfliese”

Bartenbach LichtLabor

Fassadenbeleuchtung / Effektbeleuchtung

Strukturwandel in der Beleuchtungsindustrie

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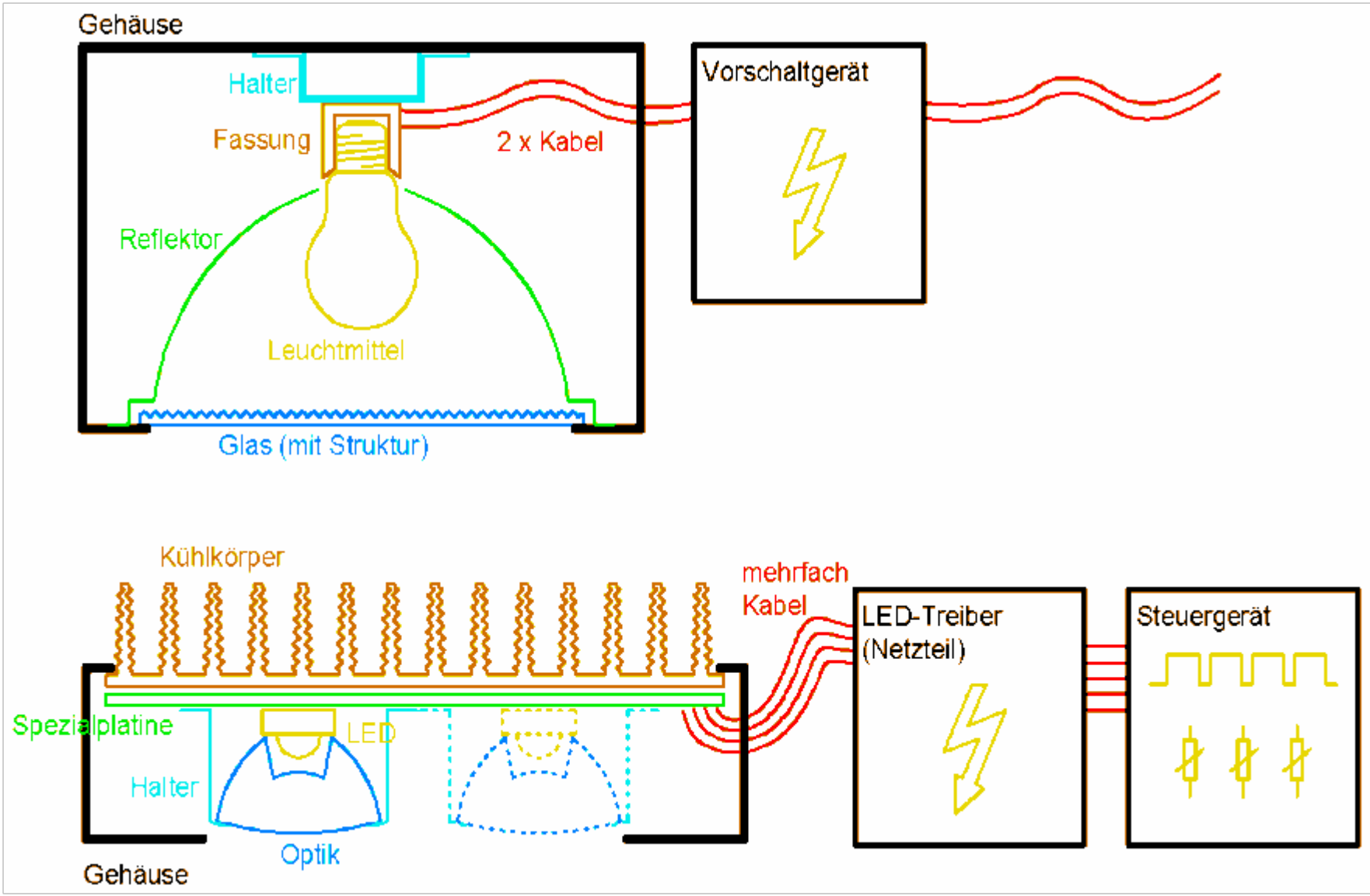
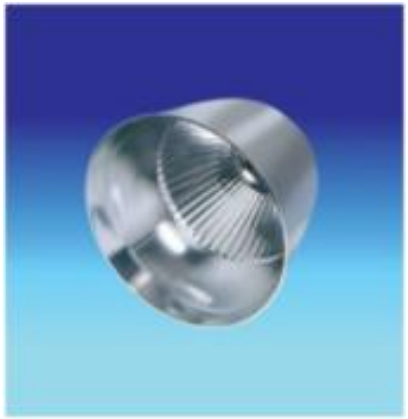
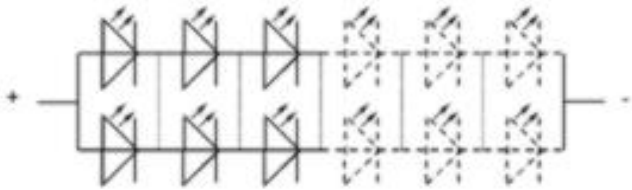


Strukturwandel in der Beleuchtungsindustrie

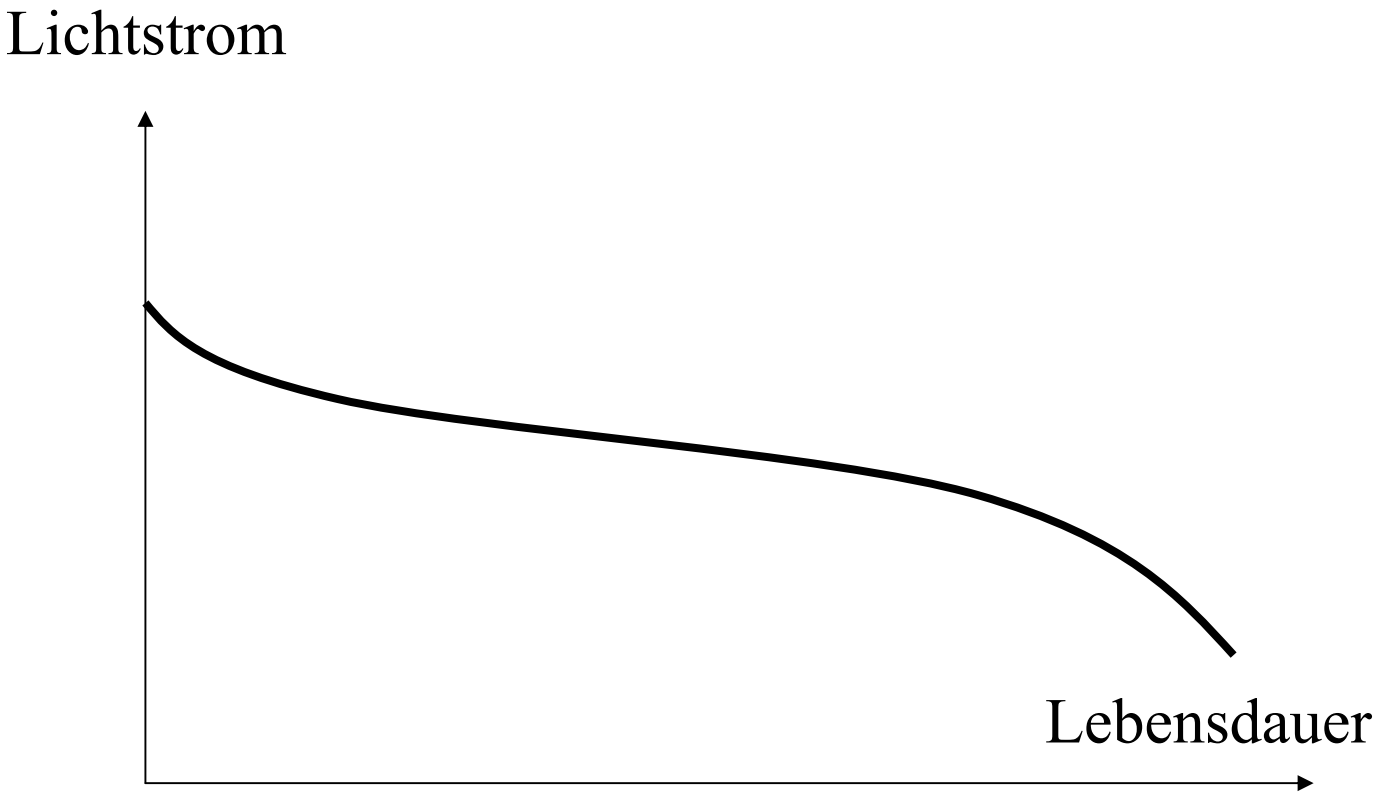
Bartenbach LichtLabor



Metallbearbeitung > Elektronikindustrie



Bartenbach LichtLabor



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Mangelnde Wartung verringert die Beleuchtungsqualität
und
verschwendet hochwertige elektrische Energie !

Ein Wartungsplan beinhaltet regelmäßige(n):

- Leuchtmittel-Tausch (vor Ausfall !)
- Austausch anderer Komponenten (z. Bsp. Betriebsgeräte)
- Reinigung (Leuchten, Tageslichtsysteme, Raum)
- Erneuerung bzw. Austausch alter, antiquierter Systeme und Komponenten

Beleuchtungskonzepte

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Energy standards regarding Lighting

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pure Lighting:

EN 12464-1	Light and lighting – Lighting of Workplaces – Part 1: Indoor Workplaces
EN 15193	Energy performance of buildings – Energy requirements for lighting
CIE 69	Methodes for characterizing illuminance meters and luminance meters; performance, characteristics and specifications

overlapping with Lighting:

prEN 15255	Thermal performance of buildings – *room cooling…*
prEN 15265	Thermal performance of buildings – *energy for cooling…*
EN ISO….	Ergonomics of the thermal environment - …..

EN15193 Power limits

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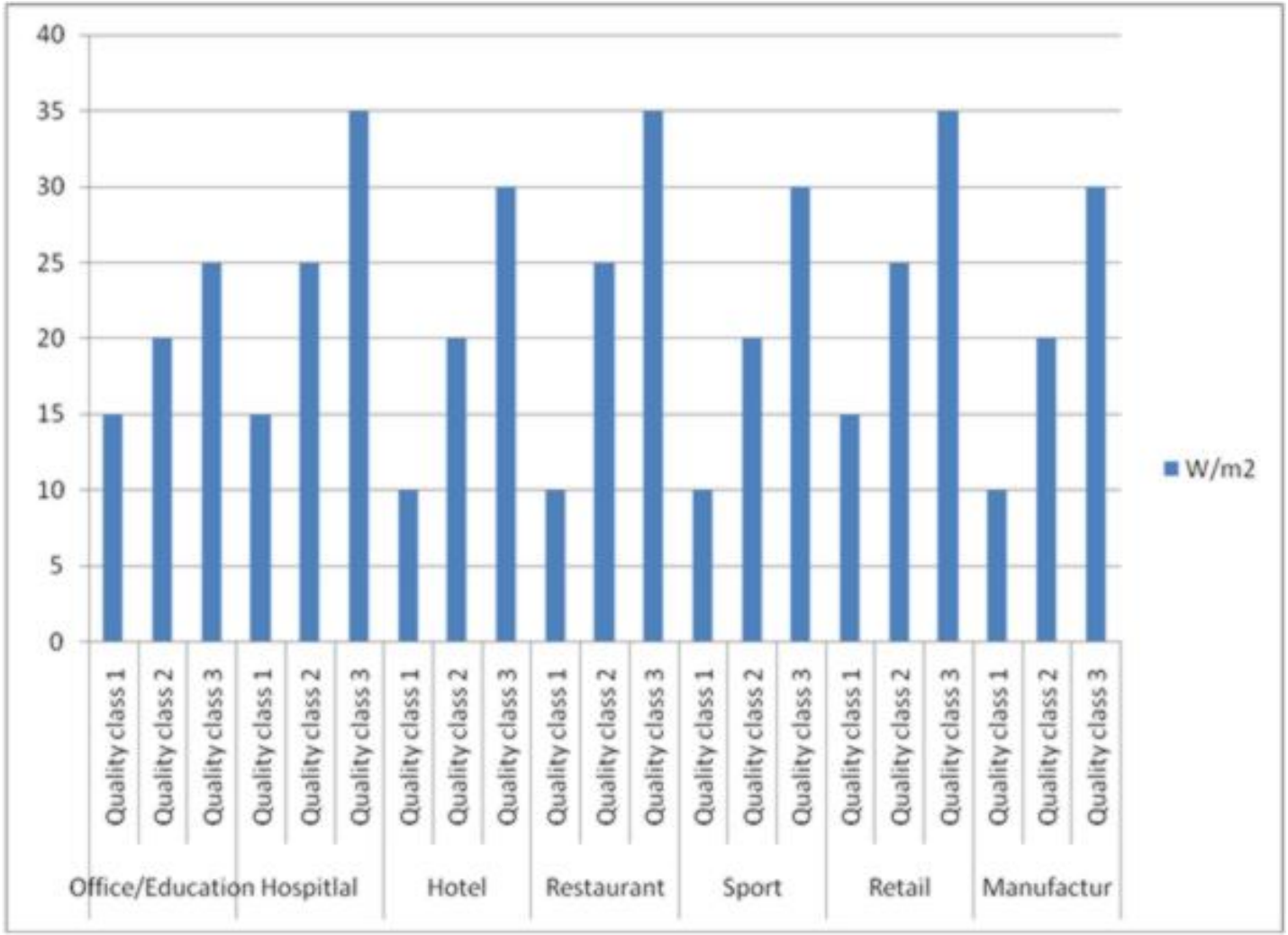
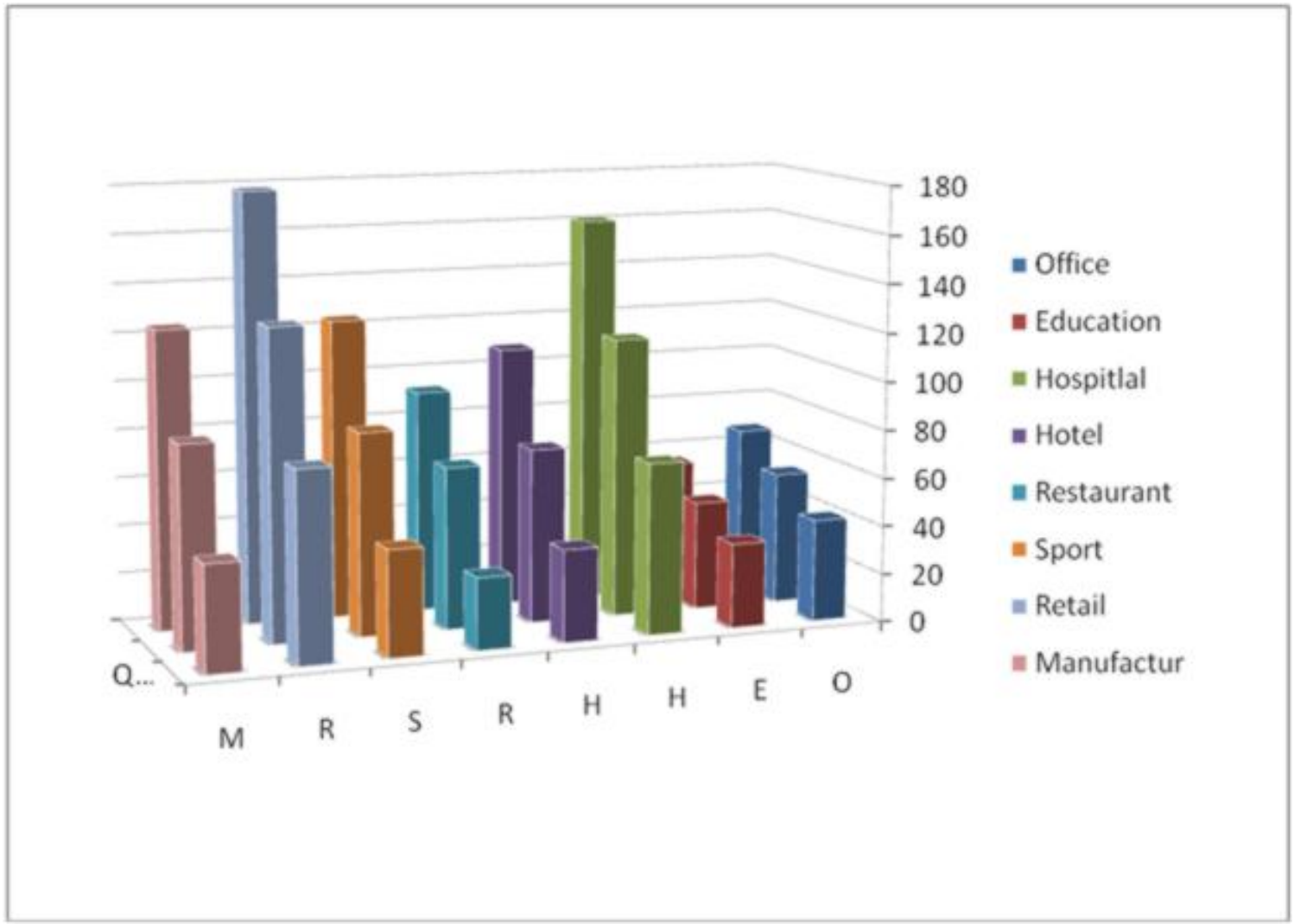
Limits for connected lighting power (in W/m^2) according to EN15193 for different building types and quality levels.



EN15193 Energy limits

Bartenbach LichtLabor

Limits for energy consumption (in kWh/m²year) according to EN15193 for different building types and quality levels



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Was können wir tun ?

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Bestehende Installationen

- **95% > 10 Jahre**
- **90% > 20 Jahre**

> Extremes Energieeinsparpotential !

Renovierungsbeispiel: Laternen für A'dam

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Refurbishment of historic „Ritter Lantern", City of Amsterdam, Netherlands

EXISTING LANTERN
SON-T 50W

$E_{mean/street}$ = 2.6 lx

15 W Energy-Saving

20 € Savings/Lantern
(operation cost a year)

3.400 Lanterns

68.000 € Total Savings
(operation cost a year)

Power: x 2/3

Illuminance: x 3

NEW RITTER LANTERN
CDM-T 35W

$E_{mean/street}$ = 7.5 lx

Die Leuchtstofflampe

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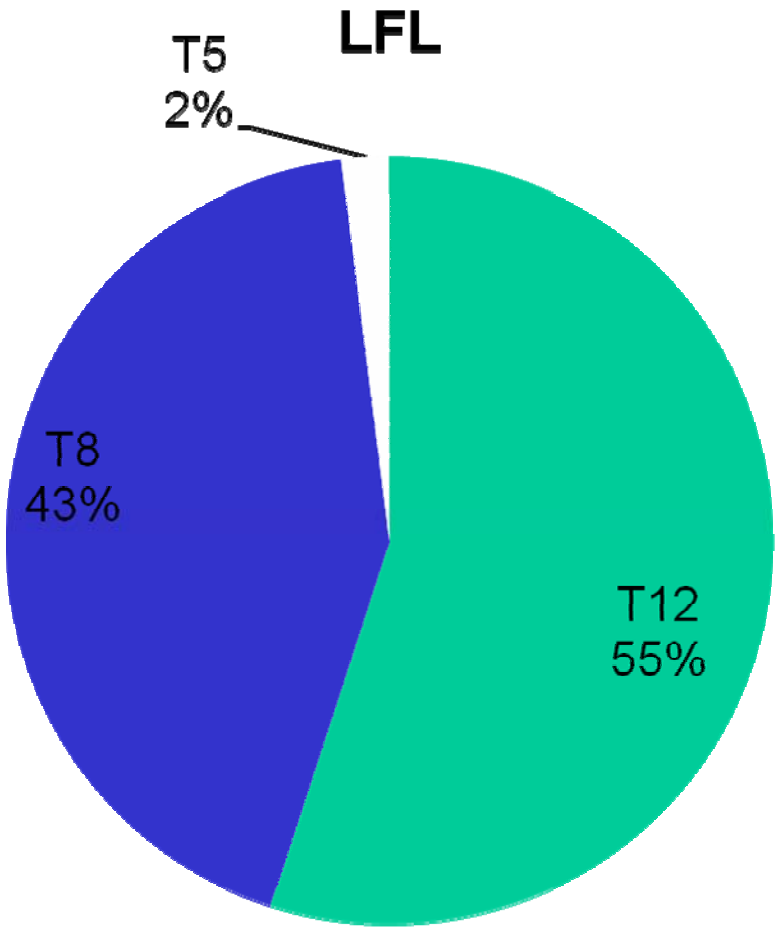

Beleuchtungsbestand LL T12 (38mm)

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Lebenszykluskosten (Bsp. Shop-Beleuchtung)

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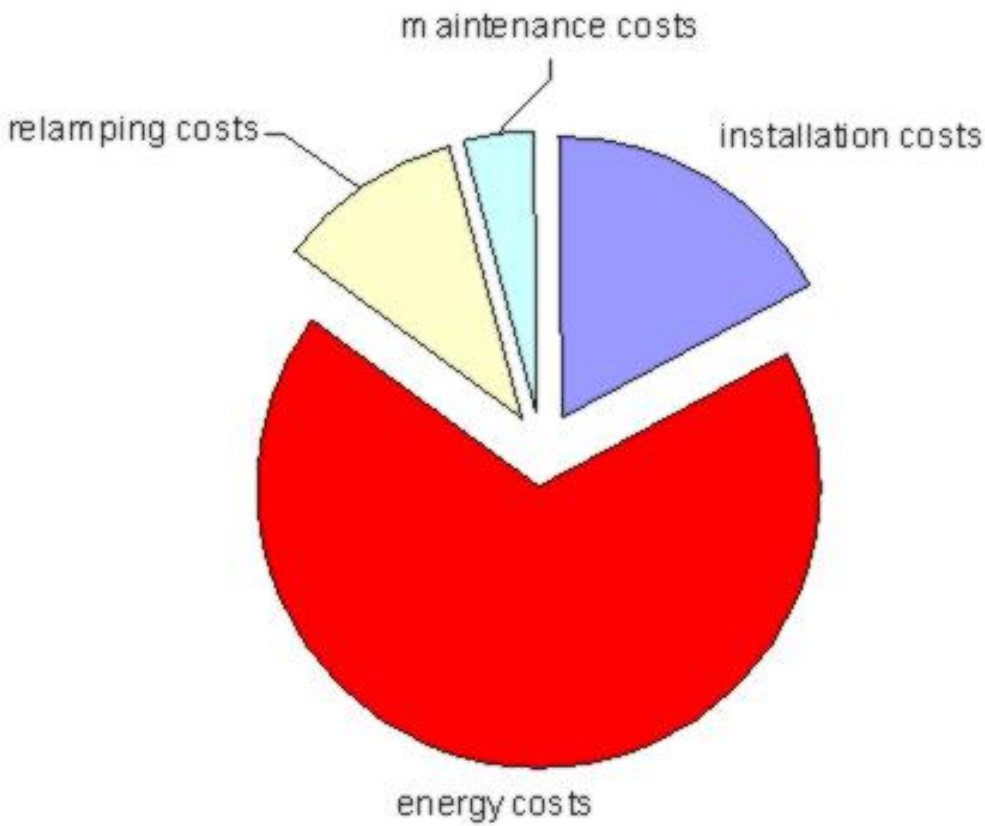
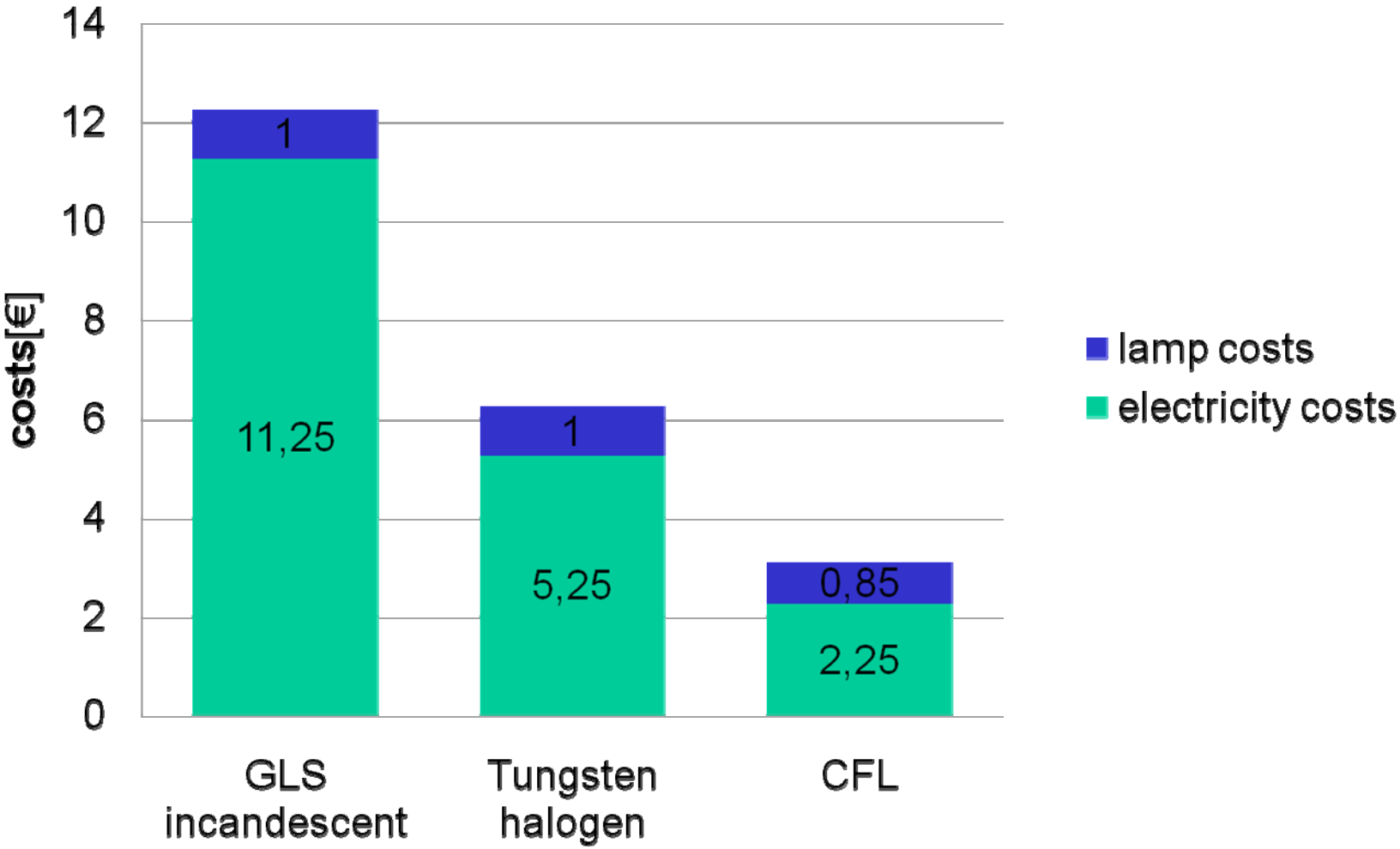


Gesamtkosten 15,- €/Jahr.m^2

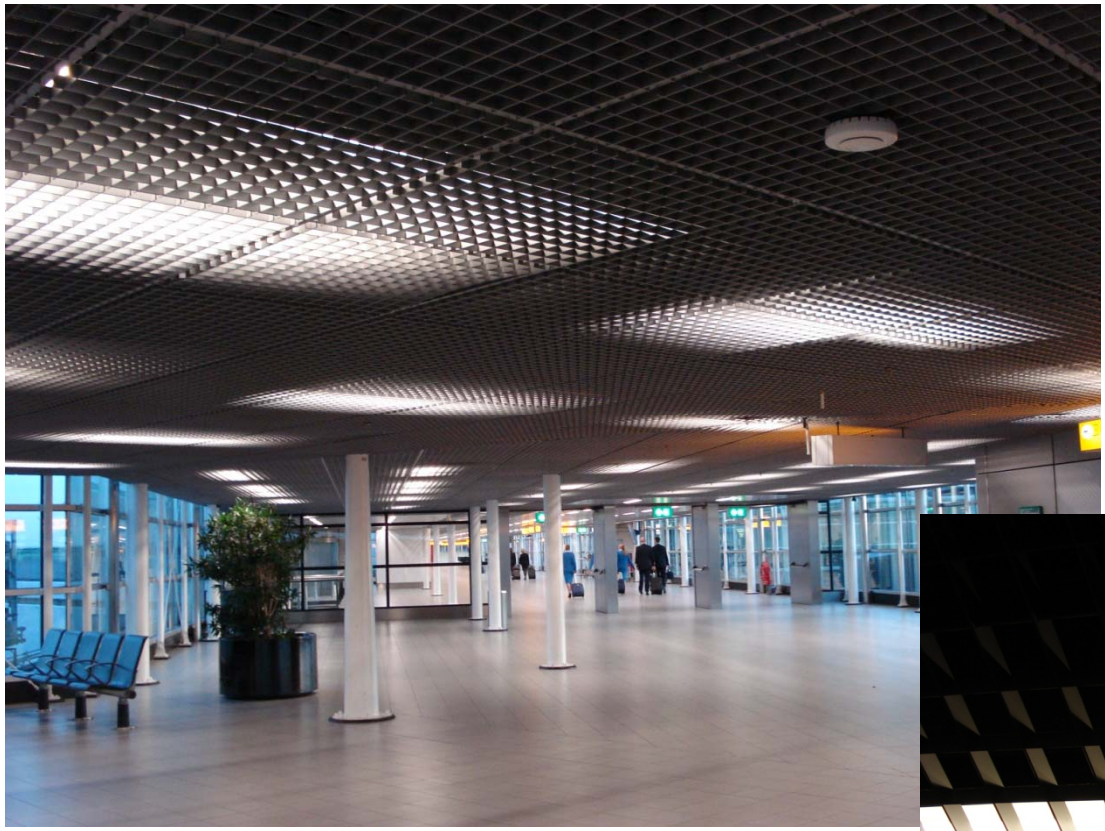
Vergleich Lebenszykluskosten

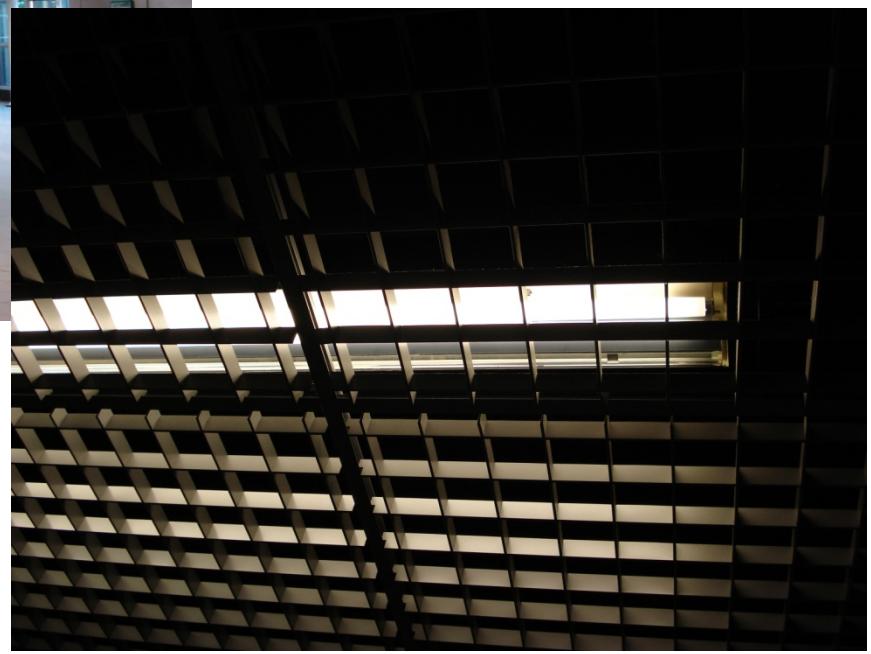
Allgebrauchsglühlampe – Halogenglühlampe - Kompaktleuchtstofflampe



Beleuchtungskonzepte

Bartenbach LichtLabor





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$$\eta_{utilization} = f_{direct} + f_{indirect} \Rightarrow f_{indirect} = \frac{A_{workplane}}{A_{room}} \cdot \frac{\rho_{mean}}{1 - \rho_{mean}}$$

Beispiel: Büroraum $A_{Nutzebene}/A_{Raum} = 30\%$

zusätzlicher Indirektanteil über Vielfachreflexion an den Raumoberflächen (Anteil $f_{indirekt}$)

$\rho_{mittel} = 0{,}2 > f_{indirekt} =$ **8%**

$\rho_{mittel} = 0{,}7 > f_{indirekt} =$ **70% !!**

Intelligente Architektur

Bartenbach LichtLabor

- Nutzung von Tageslicht, Kunstlicht nur ergänzend
- effiziente Kunstlicht-Konzepte, helle Oberflächen

Energieeffiziente Lichtinstallationen

- intelligente und energieeeffiziente Beleuchtungskonzepte (Raumwirkungsgrad, inklusive Tageslichtnutzung)
- Gebrauch hochwertiger Leuchten (Wirkungsgrad) und Leuchtmittel (Lichtausbeute)
- intelligente Regelung (Dimmung bei Tageslicht, Ausschalten wenn nicht benötigt)

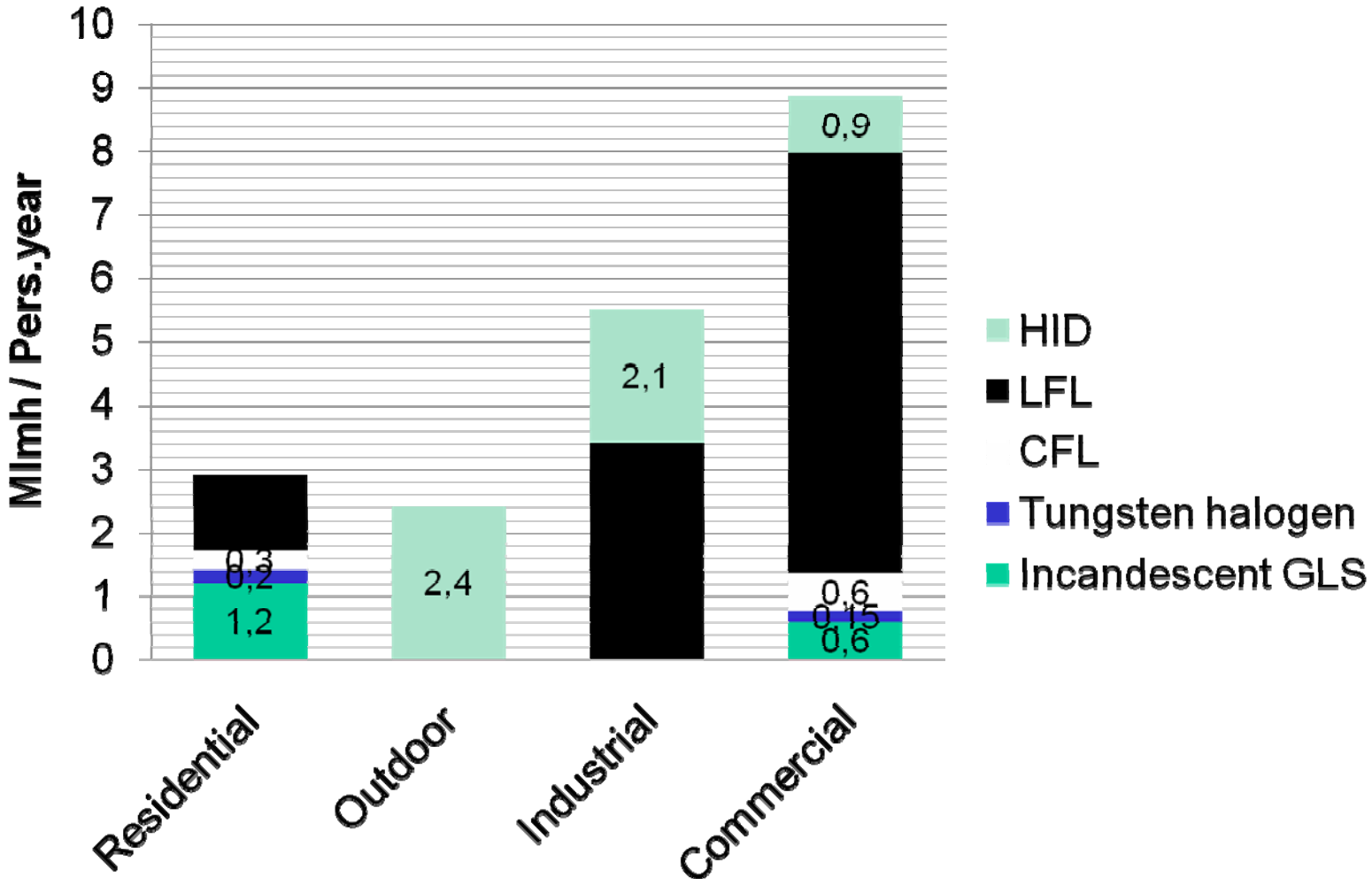
Licht ausschalten !

Bartenbach LichtLabor

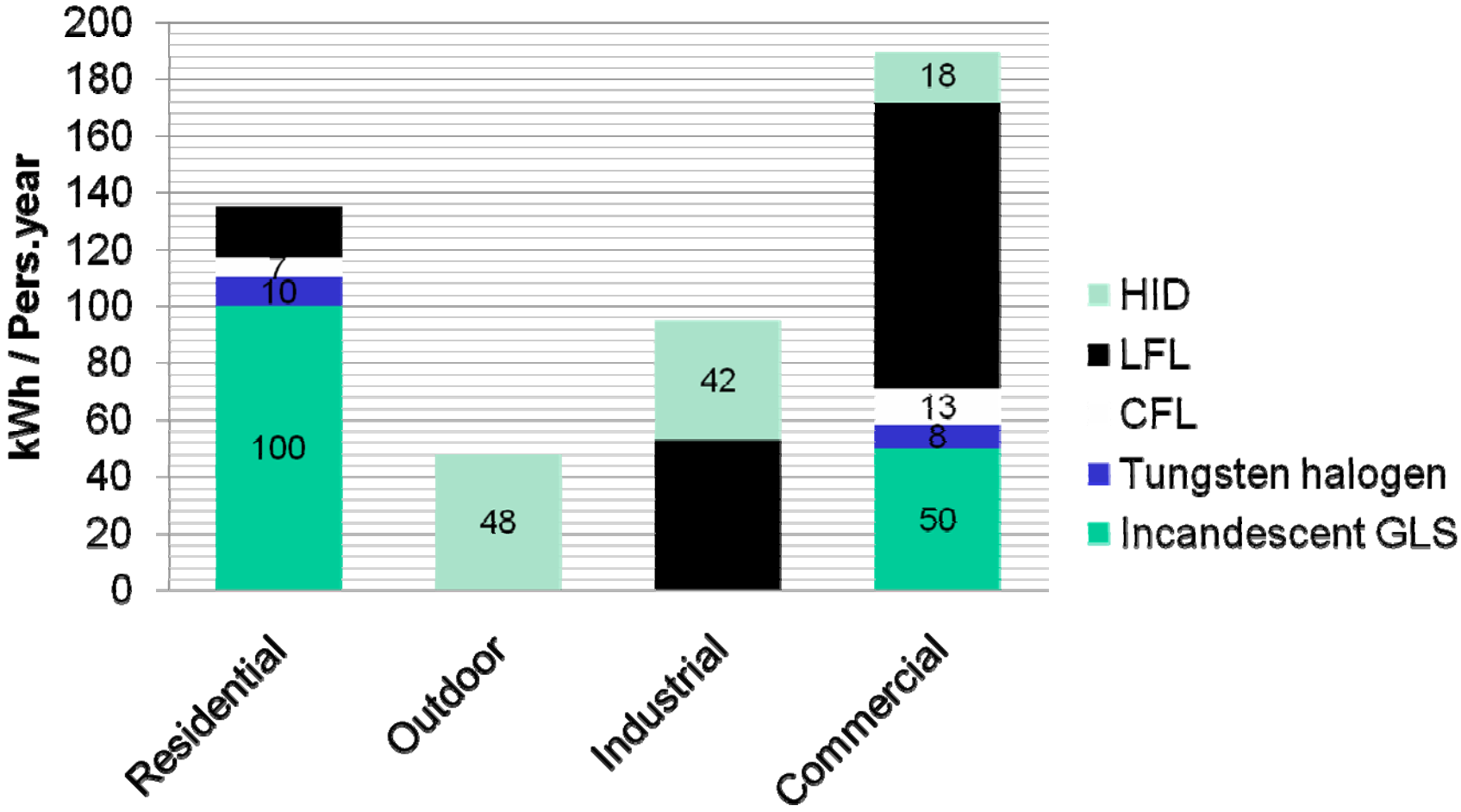
Bartenbach LichtLabor

Was können wir damit bewirken ?

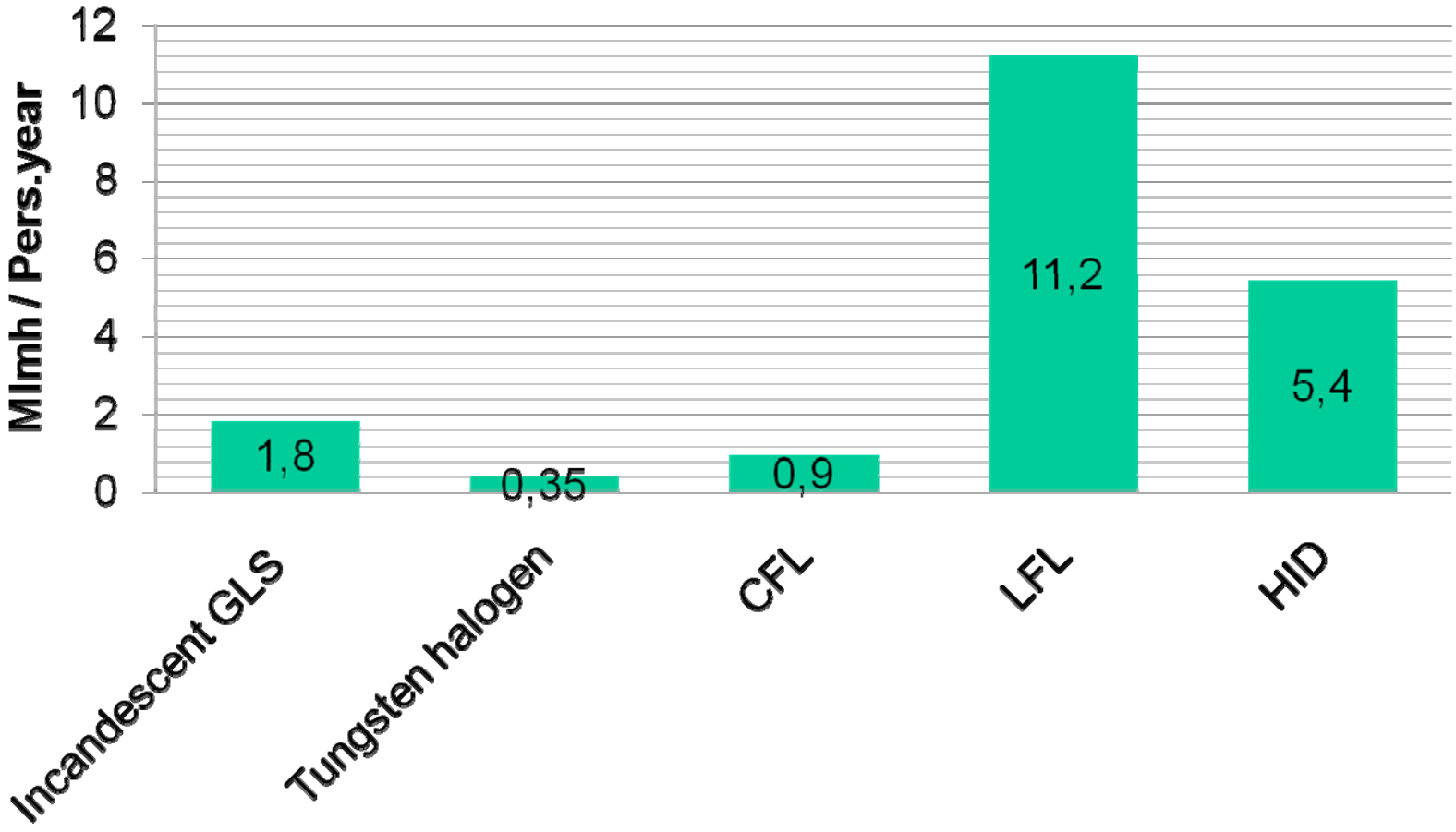
Light production 2005 (by end user and lamp type)
total: 19,65 Mlmh/pers. year



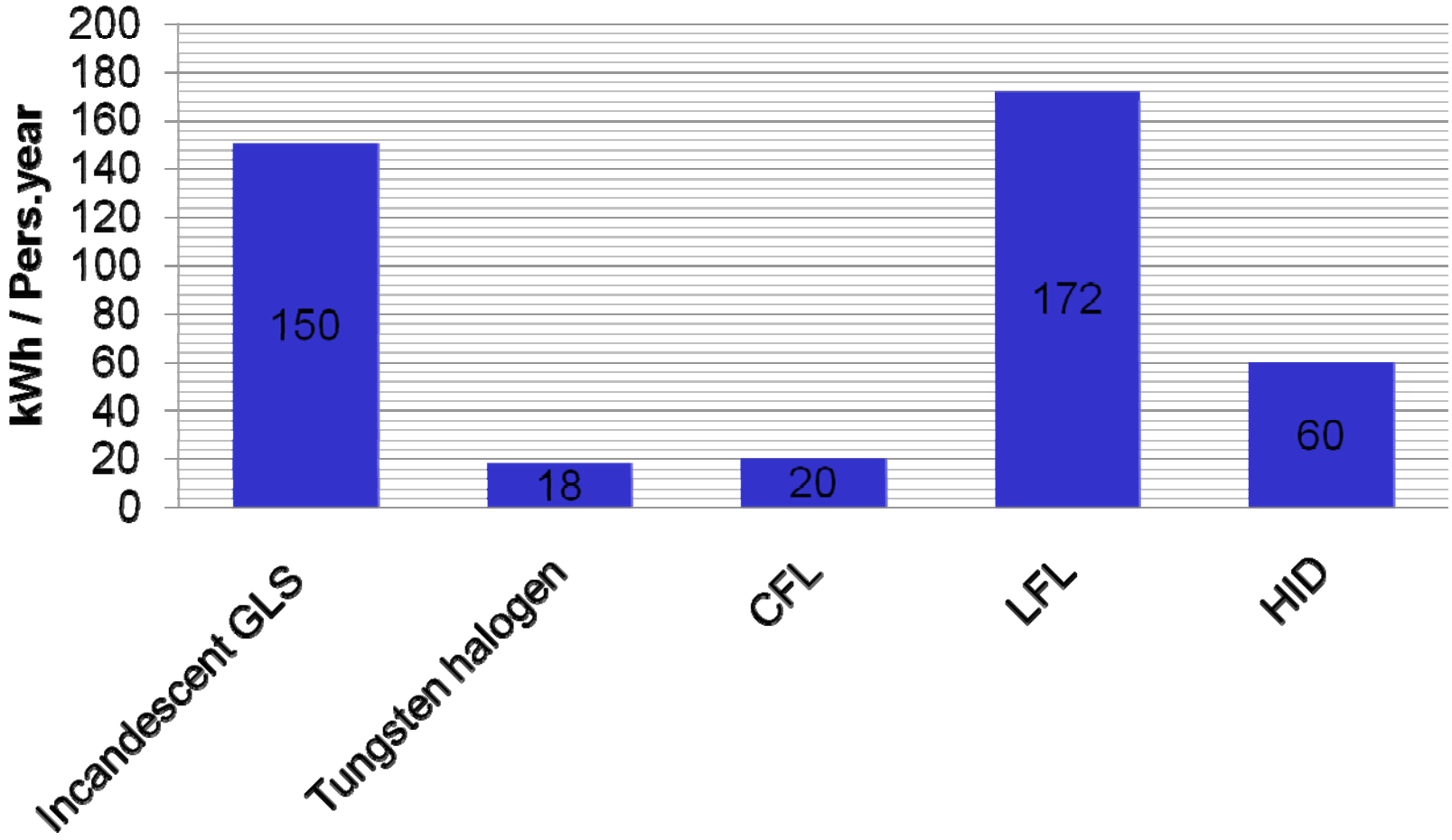
Power consumption 2005 (by end user and lamp type)
total: 468 kWh/persyear



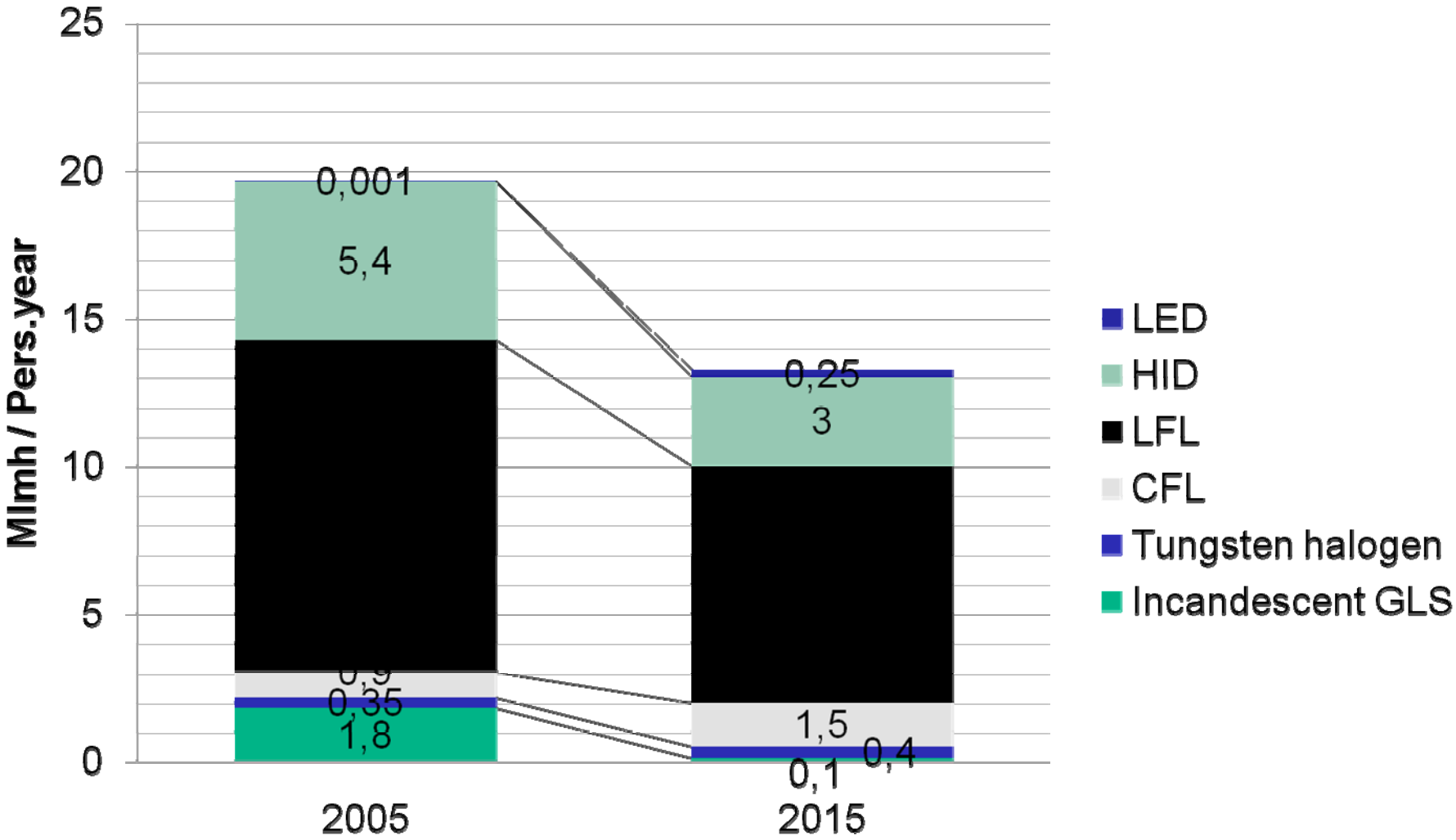
Light production 2005 (by lamp type)



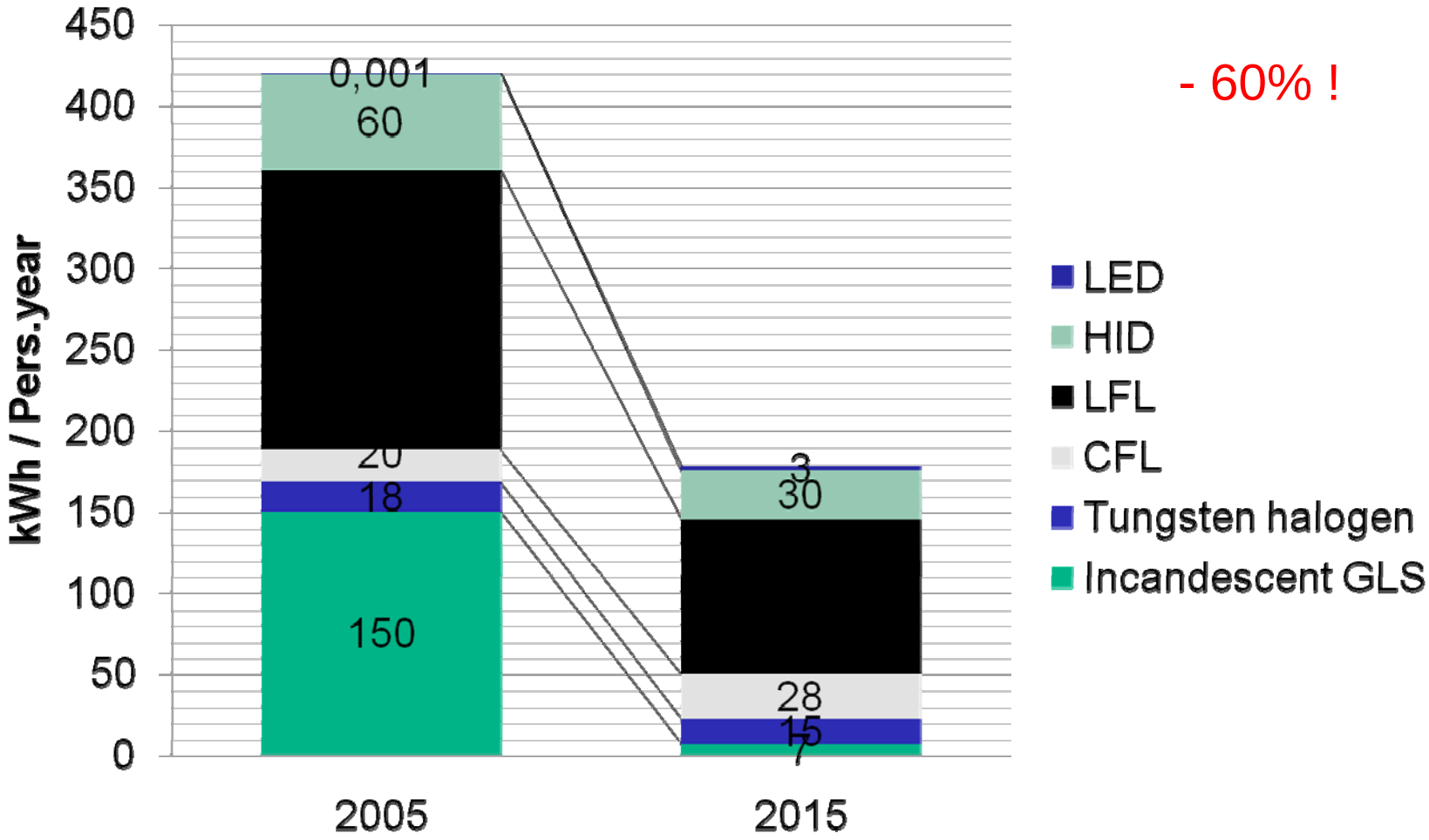
Power consumption 2005 (by lamp type)



Saving potential – Light production



Saving potential – Power consumption



- 60% !

Realistische Prognose

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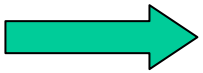
+

- **Einsatz moderner, energieeffizienter Techniken (Leuchtmittel > Leuchte > Raum, inkl. Regelung)**
- **Lebens-Zyklus-Kosten betrachten**
- **Tageslichtnutzung**
- **Energiepaß**
- **antiquierte Installationen erneuern**

-

- **zunehmende Anforderungen, neue Anwendungen und Trends (Licht&Gesundheit, Stadtbeleuchtung, ..)**



Wachstum eindämmen realistisch
30% Reduktion möglich ?

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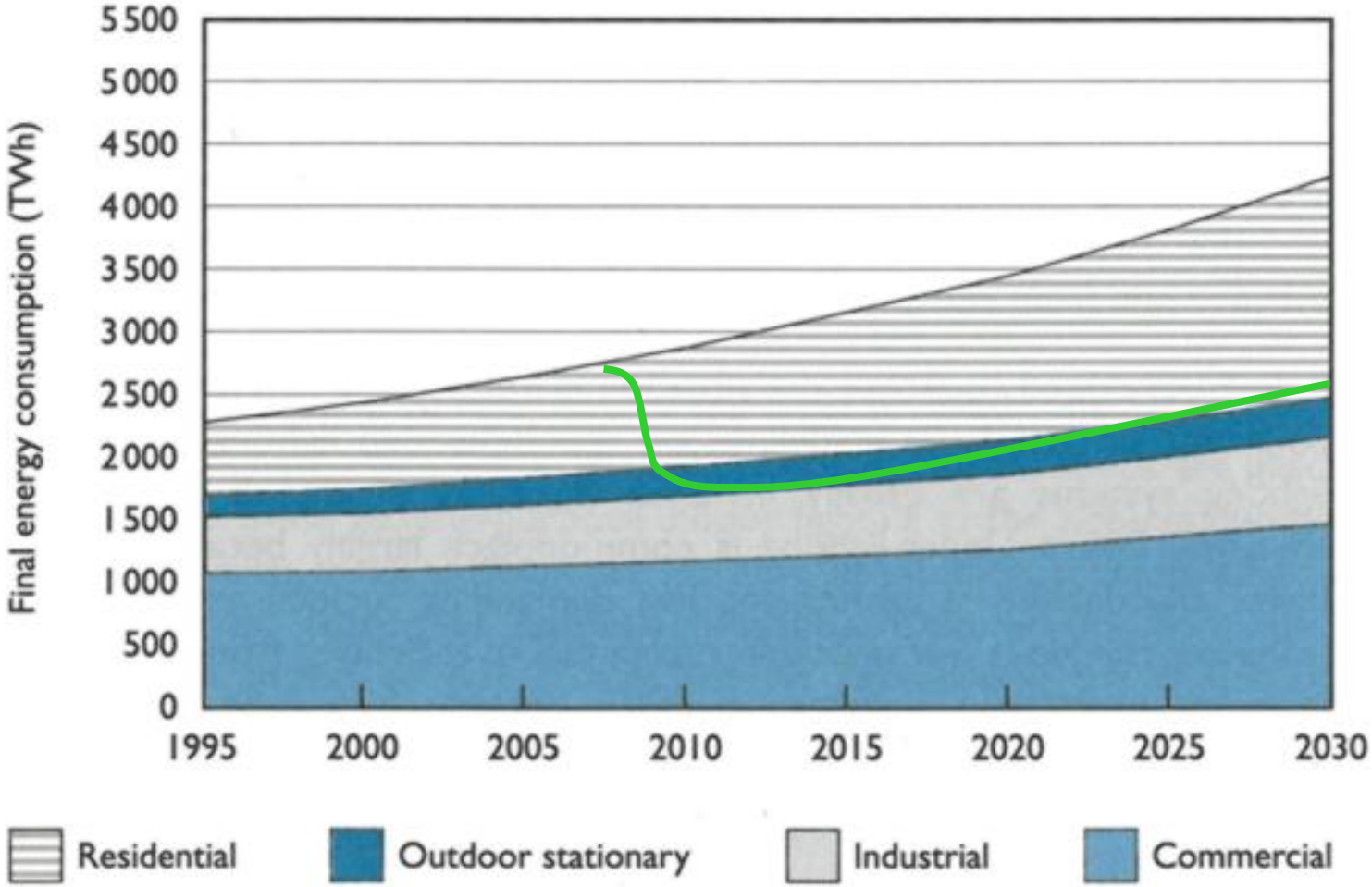

(OECD/IEA 2004)

Gestaltung und Qualität !!!

Bartenbach LichtLabor

DANKE !

wilfried.pohl@

bartenbach.com

www.bartenbach.com

mit freundlicher Unterstützung des

BMVIT