Industry Workshop, Lund, Sweden,
March 20. 2013

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

http://task50.iea-shc.org/

Financial models to justify lighting retrofits: *where are the benefits*?

Opportunities with *Solid State Lighting (SSL)* technologies.

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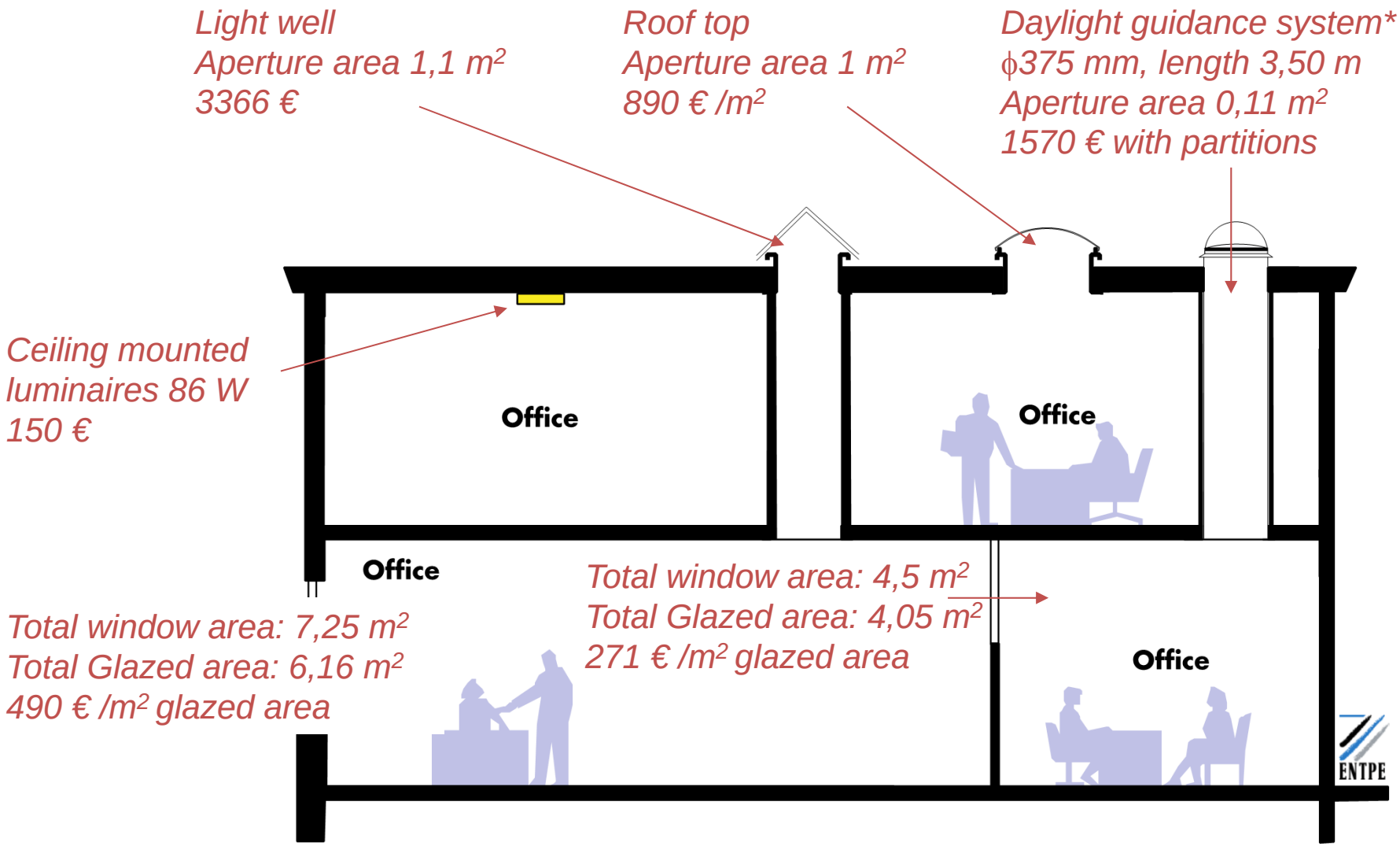
IEA-SHC Task 50
"Advanced Lighting Solutions for Retrofitting Buildings"

An opportunity to engage a dialogue with stakeholders (investors, installers, industry, building managers) around benefits associated with retrofitting lighting installations

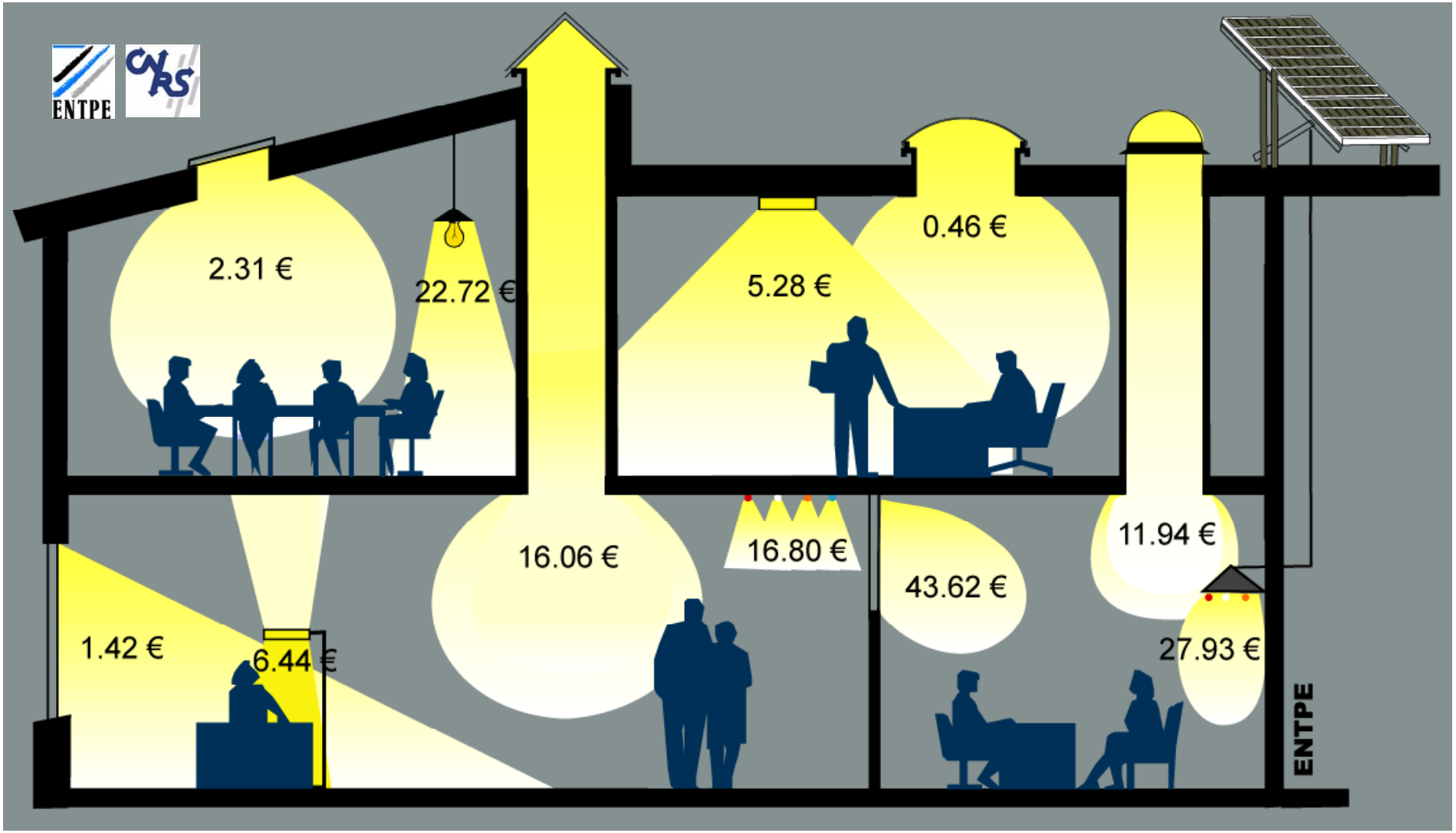
Share informations, data, successes and failures.

Costs data

Total Cost of Ownership (EL/DL)
Evolution of investment costs ($/klm)
Evolution of stakeholders / players
Costs vs Benefits associated to lighting retrofits

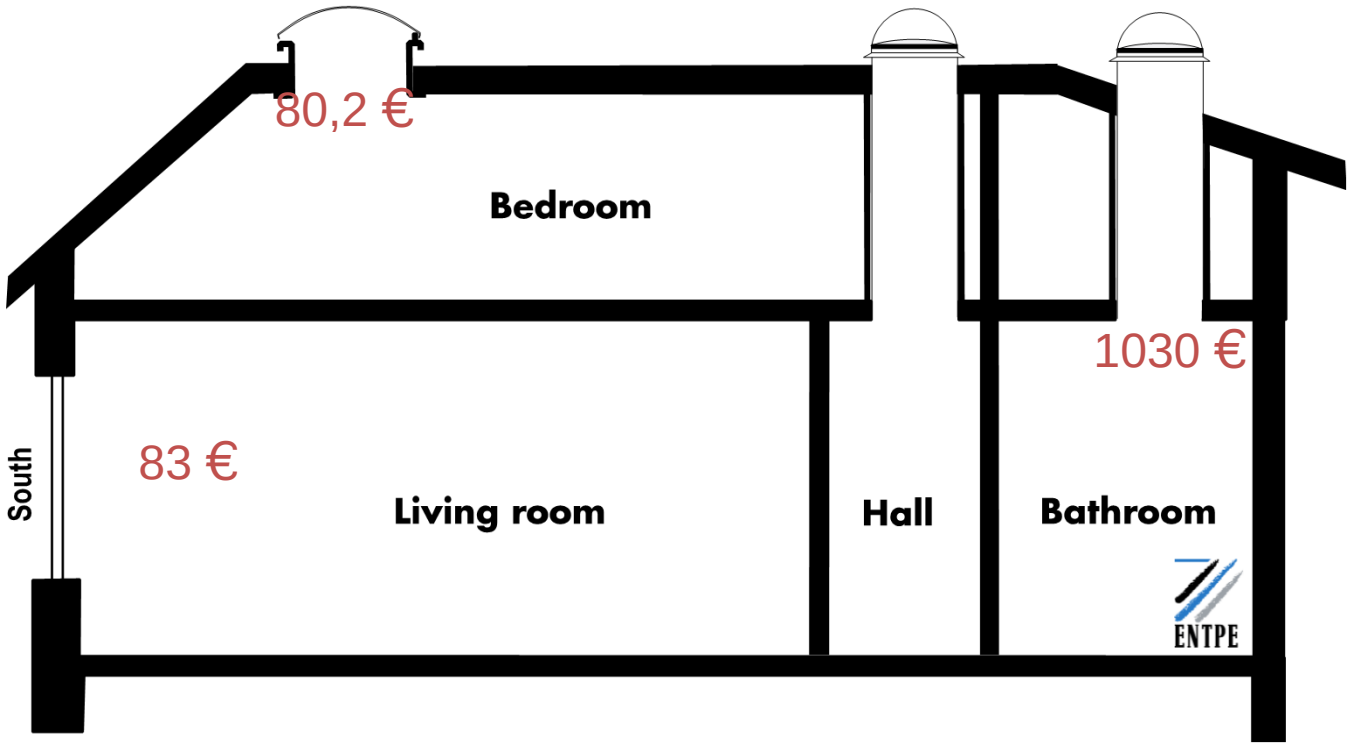


Investisment costs of daylighting systems, including installation (commercial building, France)

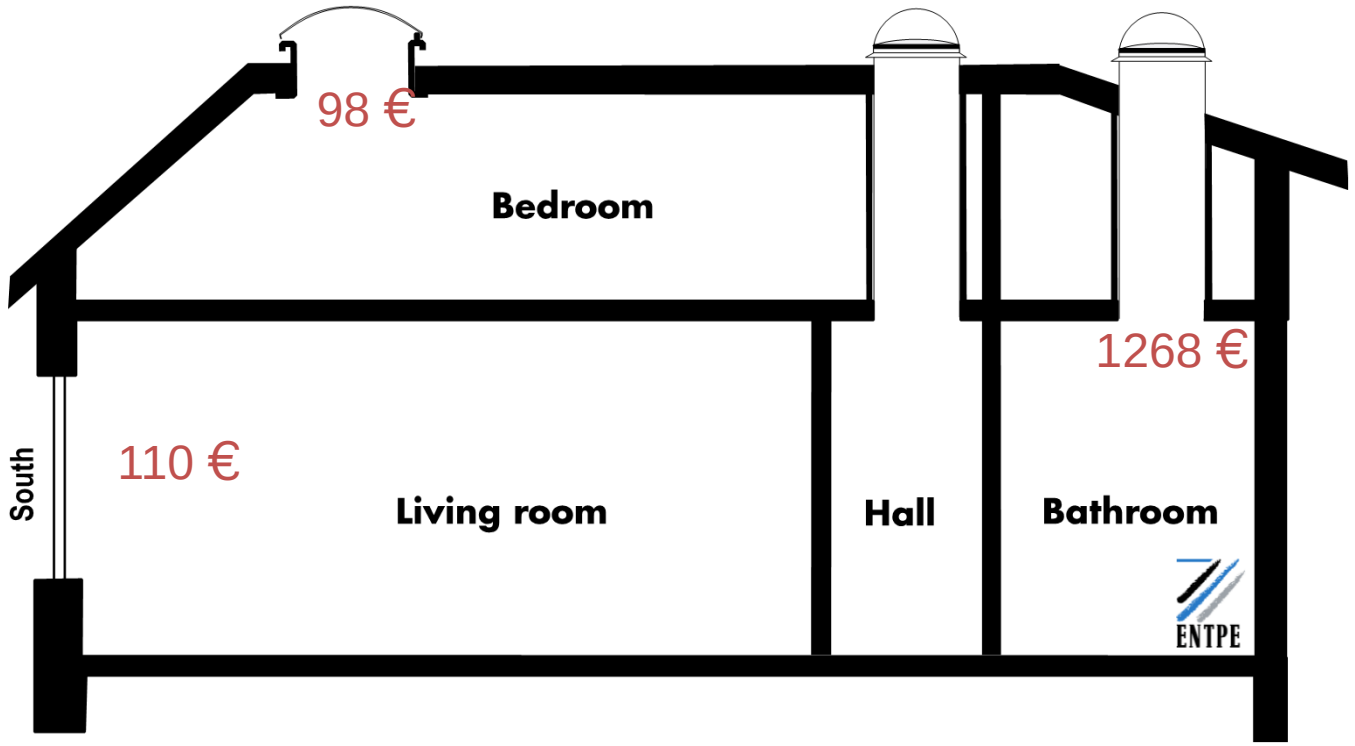


Annual amortized cost of illumination delivered as a function of the lighting scenario (units : € / Mlm.hr per year) for various daylighting and electric lighting options

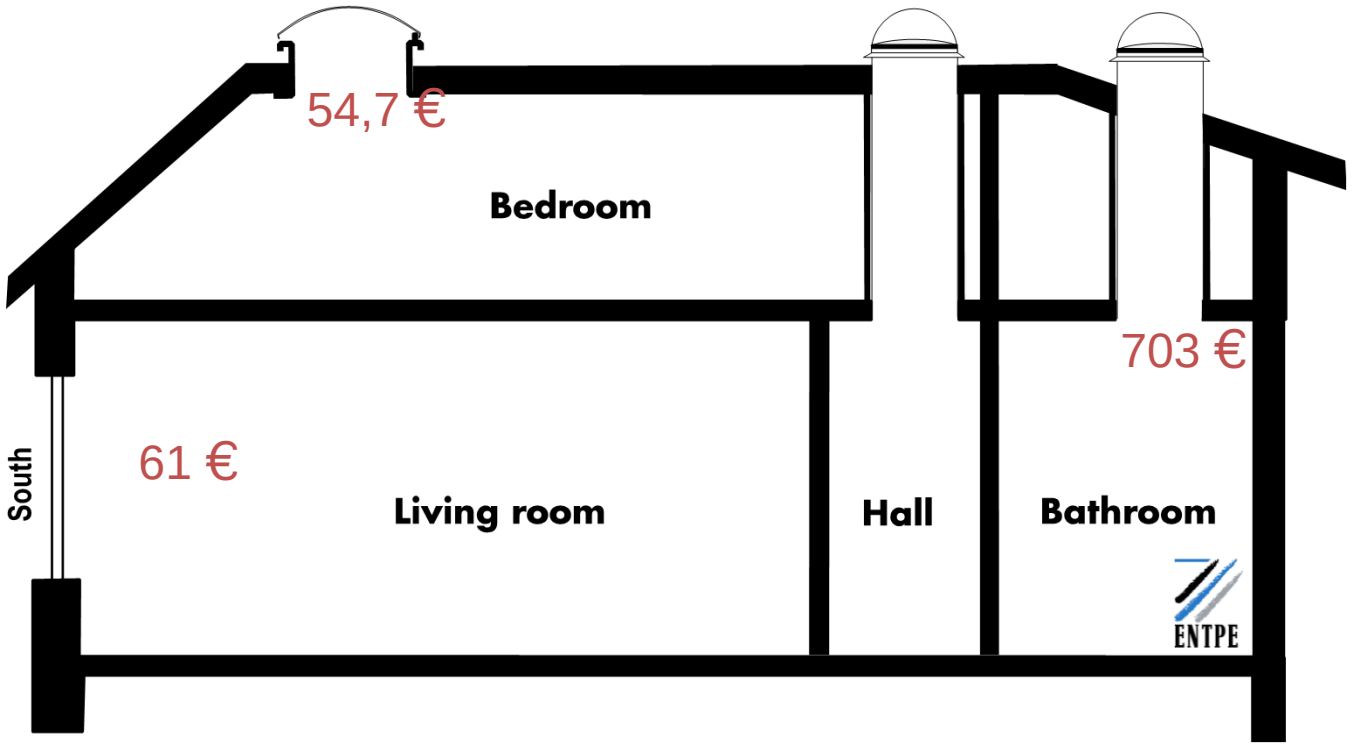
Source: Marc Fontoynont, Long term assessment of costs associated with lighting and daylighting techniques *Published in Light and Engineering, January 2008.*



Cost of total light quantities supplied per year taking into account energy cost and depreciation (climate: Lyon) - Unites: €/Mega.lm.hour/yr



Cost of total light quantities supplied per year taking into account energy cost and depreciation (climate: Brussels) - Unites: €/Mega.lm.hour/yr



Cost of total light quantities supplied per year taking into account energy cost and depreciation (climate: Roma) - Unites: €/Mega.lm.hour/yr

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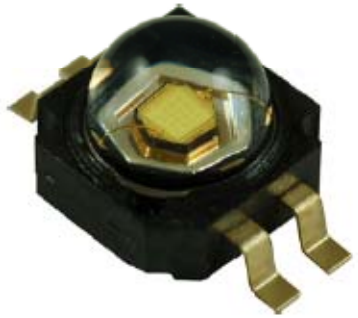
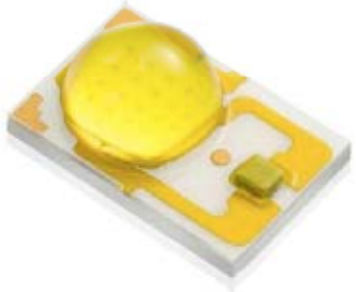
Les progrès sont encore trop rapides pour stabiliser l'offre et la rendre « Future-Proof »

- Rapidly changing LEDs and performance to accommodate the lm/W and lm/$ roadmap at LED level

K2 (2007)	Rebel (2008)	Rebel ES (2010)	5630(2011)
			
45 Lm/W (2007)	60 Lm/W (2008)	85 Lm/W (2010)	110 Lm/W (2011)

Hot performance 4000K, CRI80
All LEDs driven at reasonable currents

PHILIPS

Accelerate adoption: Innovations in LED lighting

Lm/W and lm/$ roadmap should be considered at system level rather than at LED level

Example: Philips MASTERLED *(both product similar lumens)*

Retail sales price €49,99

Launch Q1 2009

Retail sales price €22,99

Launch Q4 2010

New DOE Information

- New DOE SSL Technology Roadmap forecasts
  - *Solid-State Lighting Research and Development: Multi Year Program Plan, March 2011* http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_manuf-roadmap_july2011.pdf

Table 5.5: Summary of LED Luminaire Performance Targets (at operating temperatures)

Metric	2010	2012	2015	2020
Package Efficacy – Commercial Warm White (lm/W, 25°C)	92	141	202	266
Thermal Efficiency	86%	86%	88%	90%
Efficiency of Driver	85%	86%	89%	92%
Efficiency of Fixture	85%	86%	89%	92%
Resultant luminaire efficiency	62%	64%	69%	76%
Luminaire Efficacy – Commercial Warm White (lm/W)	57	91	139	202
High Current Luminaire Efficacy – Commercial Warm White (lm/W)	44	74	123	202

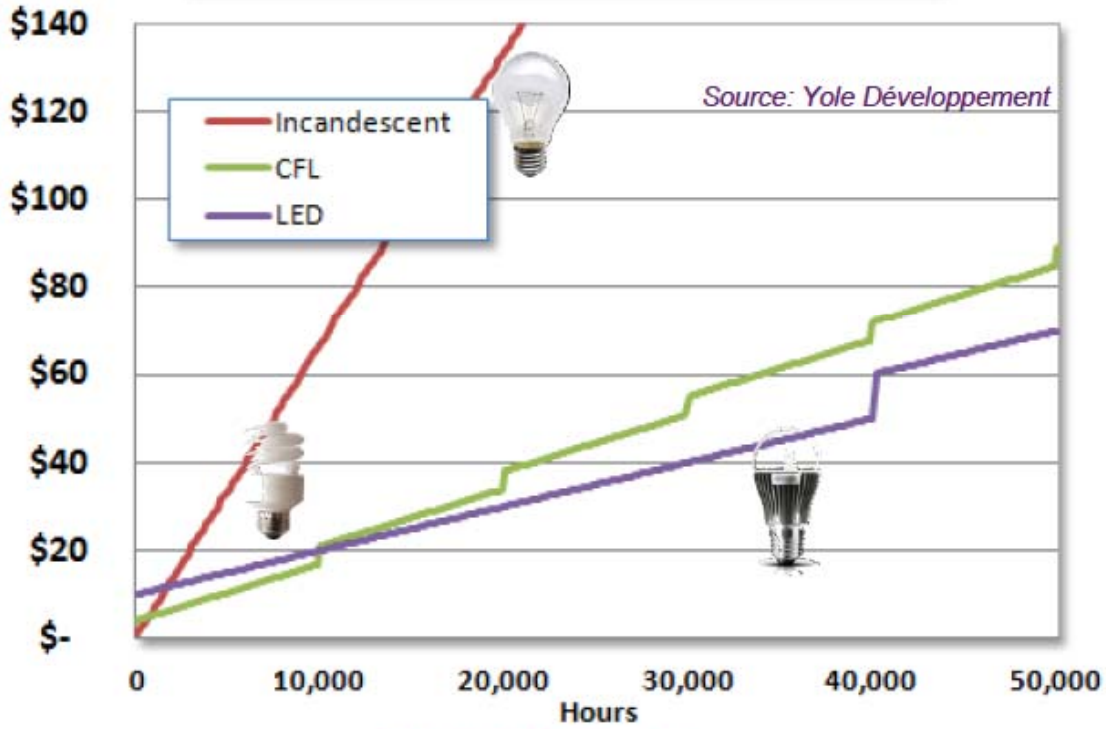
Notes:

1. Efficacy projections for warm white luminaires assume CCT=2580-3710K and CRI=80-90.
2. All projections assume a drive current density of 35 A/cm^2, reasonable package life and operating temperature.
3. Luminaire efficacies are obtained by multiplying the resultant luminaire efficiency by the package efficacy values.

	2010 Status	2020 Targets
Price of LED Package	$10-15/klm (cool) $20-25/klm (warm)	$1/klm
Price of Luminaire or replacement lamp	$50/klm	$5/klm

Cumulated Cost: Examples

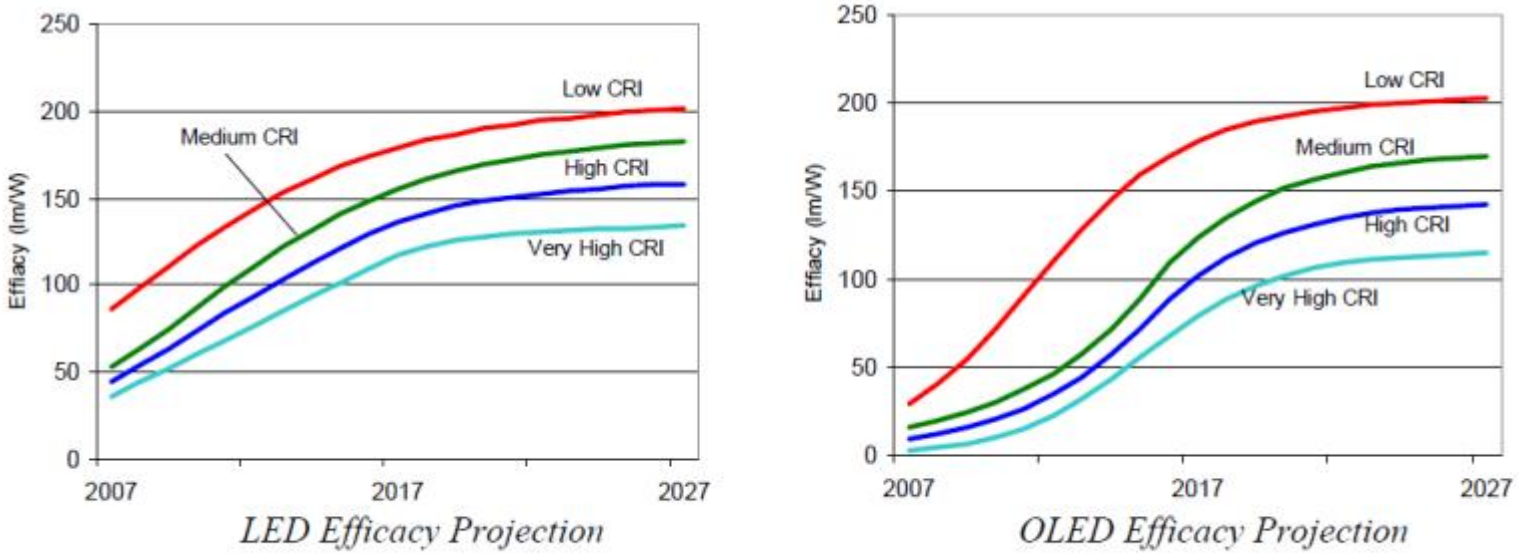
Cumulated Cost of Ownership.



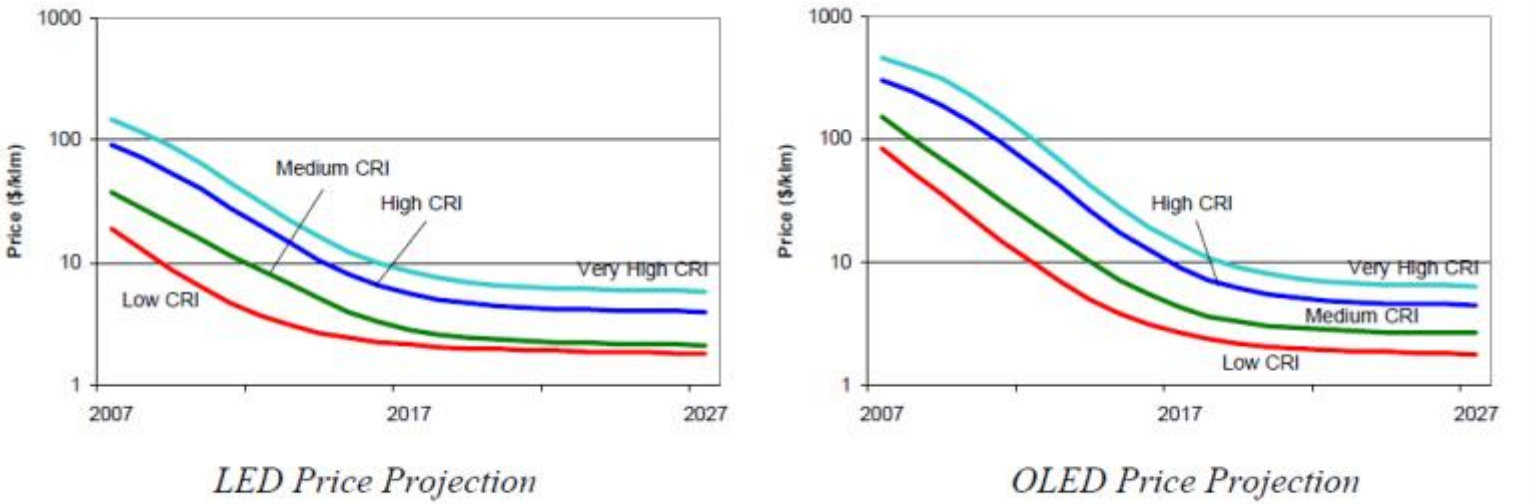
$10 LED Bulb:

LED CCO better than other light source + acceptable upfront cost

→ trigger for massive market adoption



Commercialized SSL Efficacy Improvements for the SSL Scenarios



Commercialized SSL Price Improvements for the SSL Scenarios

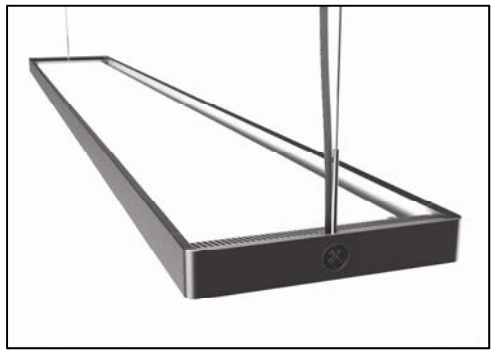
Source: Energy Savings Potential of Solid State Lighting in General Illumination Applications Lighting Research and Development Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy, Navigant Consulting Inc. 1801 K Street, NW Suite 500 Washington DC, December 2006

Market Developments (USA)

- New high performance, integrated SSL troffers that compete with fluorescent troffers
  - Efficacy equal or better than T8 troffers
  - Excellent light quality and light distribution
  - As a result, integral SSL troffers becoming competitive with fluorescent; examples:
    - Cree CR 24
    - GE LED Edge Lighting
    - Acuity RT LED & others

Cree CR 24

- 90-110 lm/W
- Step dimming to 50%
- 50k to 75k L_{70}
- Low glare
- Modest price

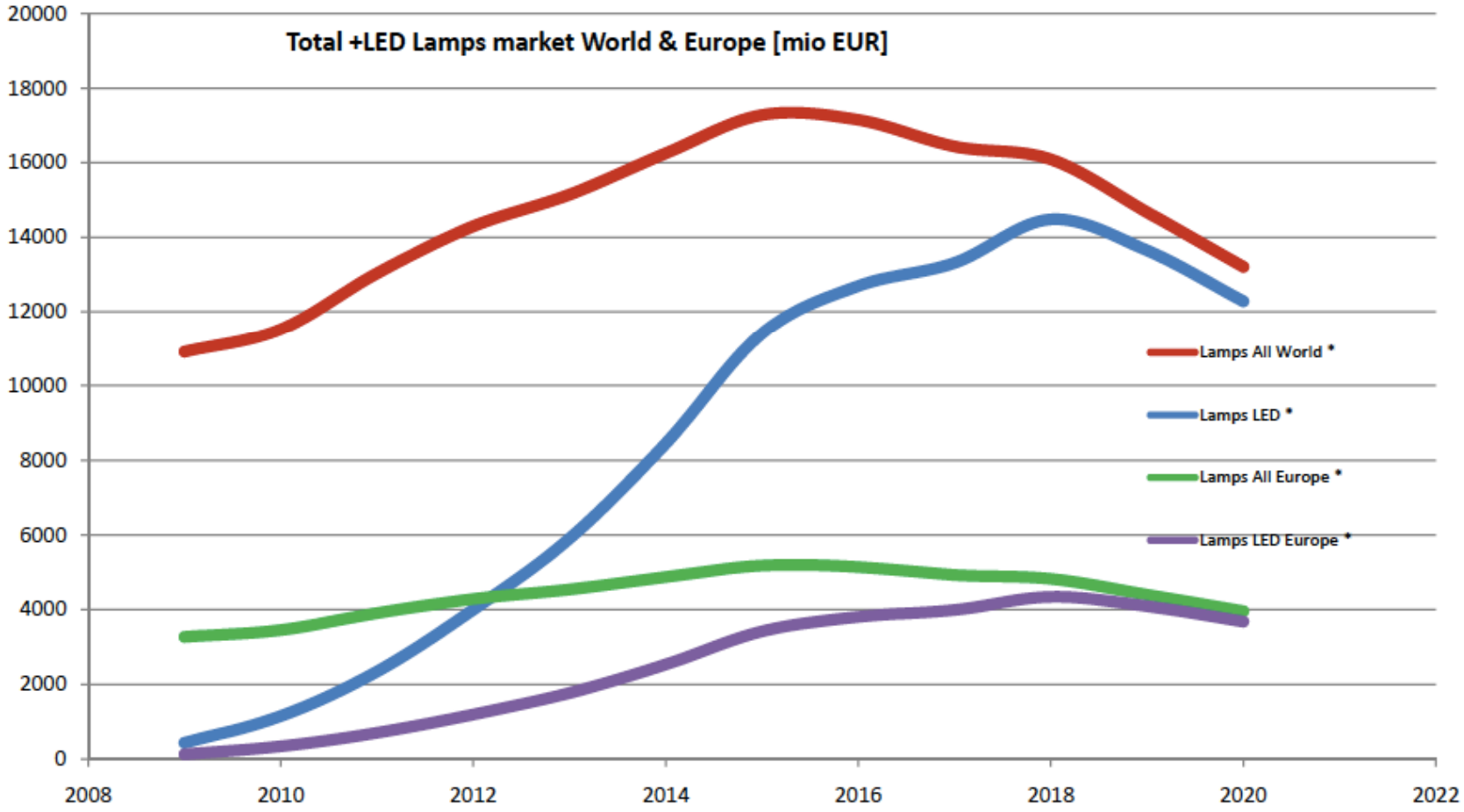


GE LED Edge Lighting

- Panels are edge lit
- Uses micro-lens film for shaping emissions

Source: Marc Ledbetter, PNNL, USA)

Comme toutes les technologies à base de semi-conducteurs, il est prévu à terme, une baisse globale des revenus *(Source Global Lighting Forum)*



The cost of lighting

Trend: a shift of Total Cost of Ownership toward investment and installation:

« In a world soon free of incandescent lamps, cost will be dominated by early investments (installation and equipment), and electrity costs will be reduced due to higher lamp efficacy and smarter control) »

Electricity consumption »It is dominated by installation costs, the share of light sources will decrease

Costs vs Benefits associated to lighting retrofits

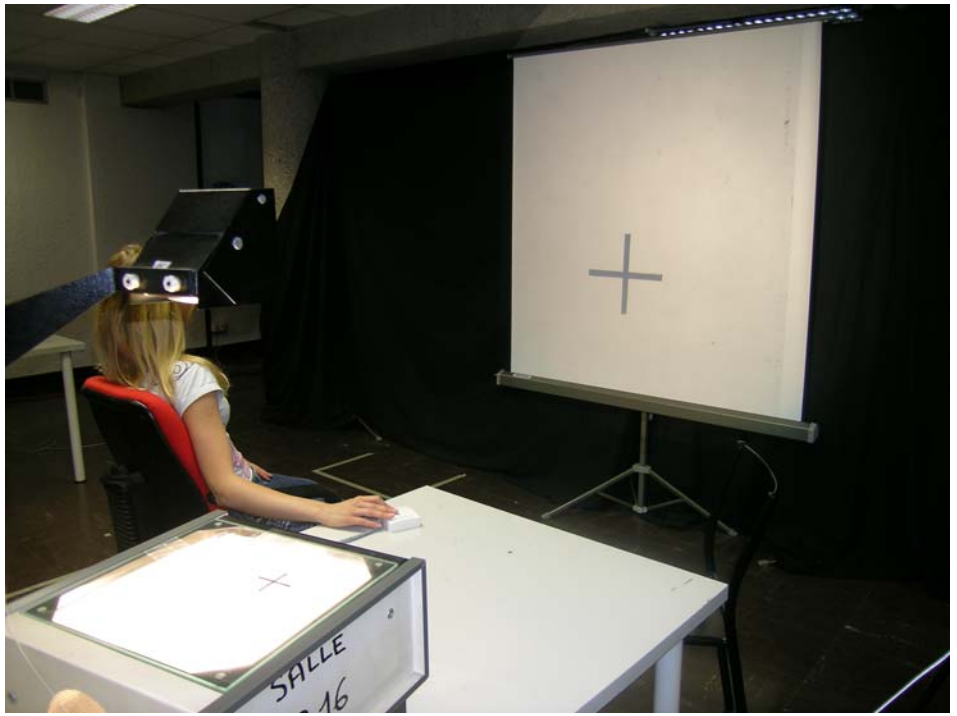
On productivity / well being (benefits to managers, companies, employees…)
More intensive visual task (screen, multiple window, speed of data processing)
Benefit related to better working conditions (productivity)
Benefit of low glare luminares (prismatic filter, direct /indirect, wall washers),
Salaries / cost to employer: 40,000€/yr , using $10m^2$: **4,000€/m^2 of salary**

Refurbishment (benefits to owners,)
Frequencies of refurbishments: 10 Years / 15 years / 20 years?
Lighting part alone **(20-50€/m2)**
Lighting part of ceiling refurbishment **(100-200€/m2** of investment, gains of lighting efficiency (equipment, painting)
$4W/m^2$ - 1000 hrs/yr - 0.15€/KWh leads to benefits **<1€/m^2**

Added value of high quality lighting
Investment in high quality fenestration system can be fully paid for
in housing building (100%**) (100-200€/m2)**
Commercial value of high quality lighting (commercial centers , stores) can be paid for in less tha a year.

Other benefits:

Improved vision,
Improved security,
improved services
New functionalities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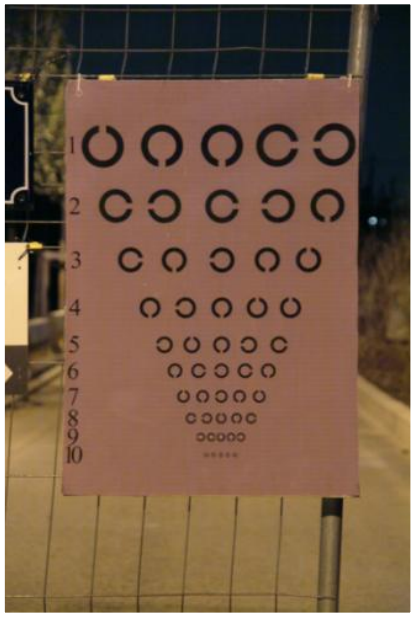

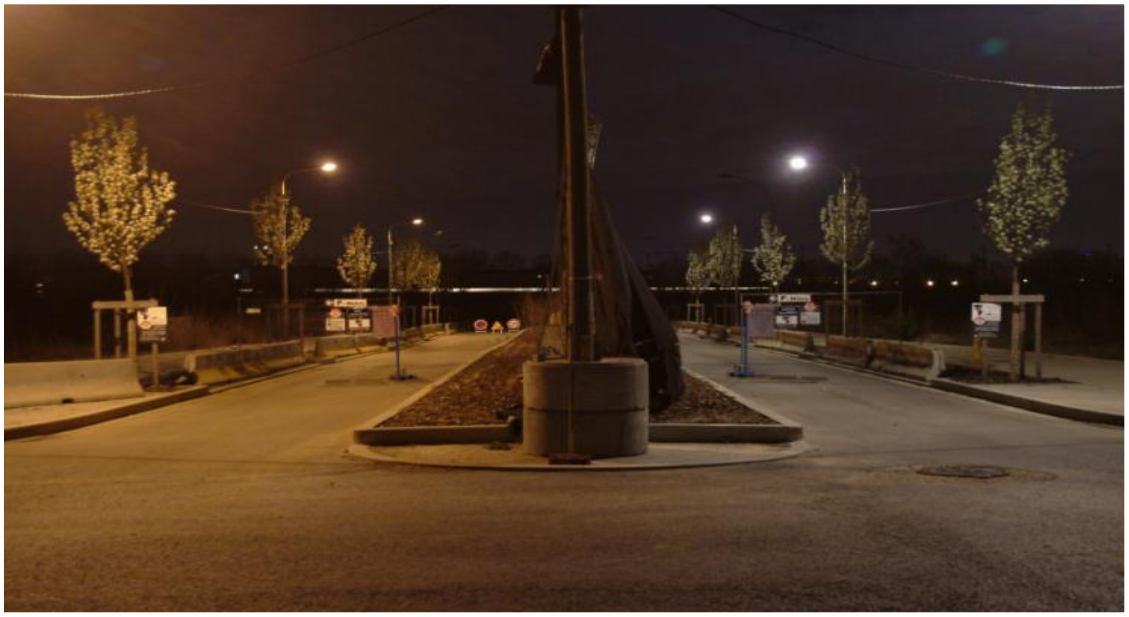

Field comparison of Metal Halide and High Pressure sodium
Lighting: comparison based on object detection, road sign reading, face recognition under various power densities.

Results: Improvement of spectral caracteristics lead to possibilities to reduce power, except for some specific targets.

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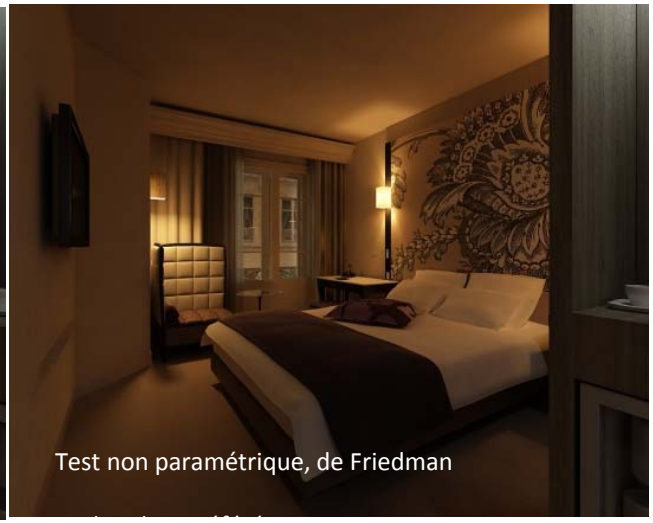
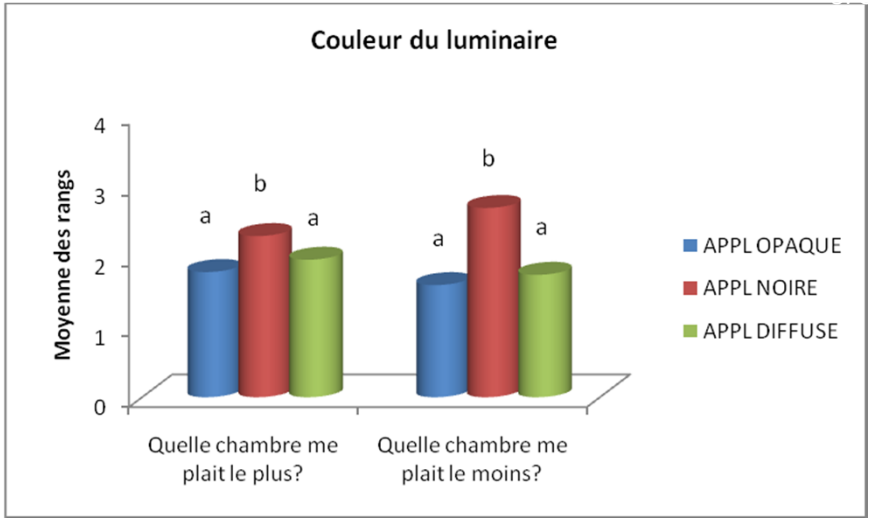
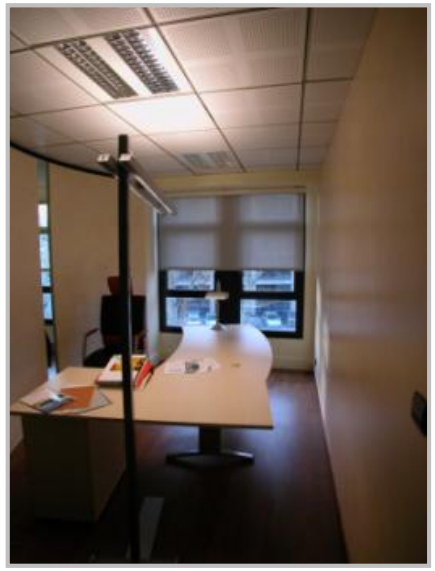
Tests conducted with a panel of 30 observers, 2008
SSL preferred: higher functionality offered by increased number of light points, cabinet lighting.

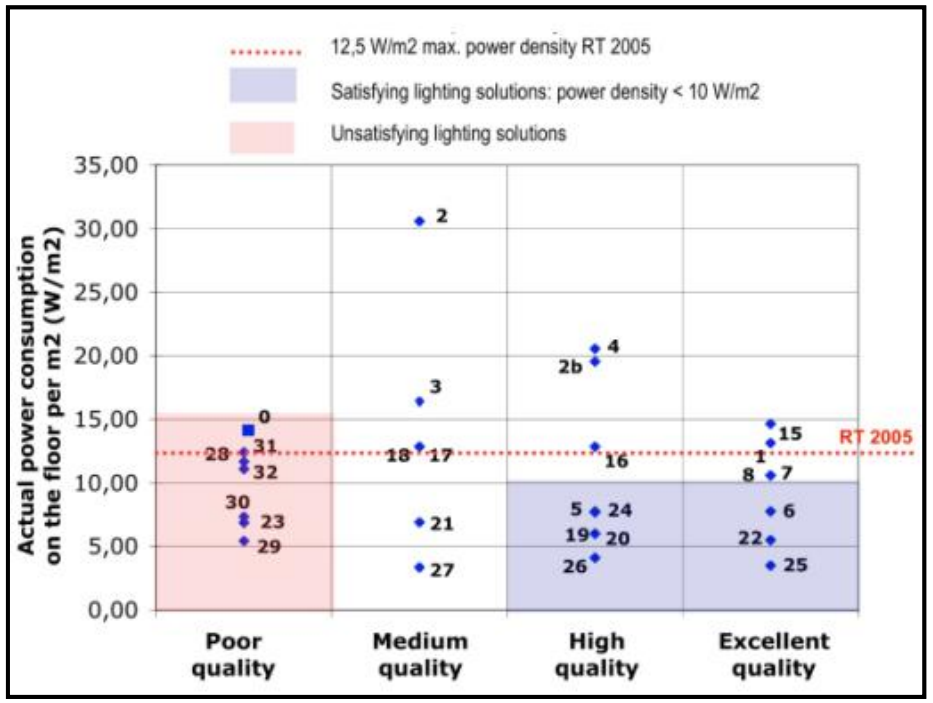
Source: LED-Habitat Proramme ADEME, ENTPE, Schneider Electric, Ingelux, SONEPAR

Use of Virtual Reality to explore light schemes in hotels








12,5 W/m2 max. power density RT 2005
Satisfying lighting solutions: power density < 10 W/m2
Unsatisfying lighting solutions
Actual power consumption on the floor per m2 (W/m2)
35,00
30,00
25,00
20,00
15,00
10,00
5,00
0,00
RT 2005
Poor quality
Medium quality
High quality
Excellent quality

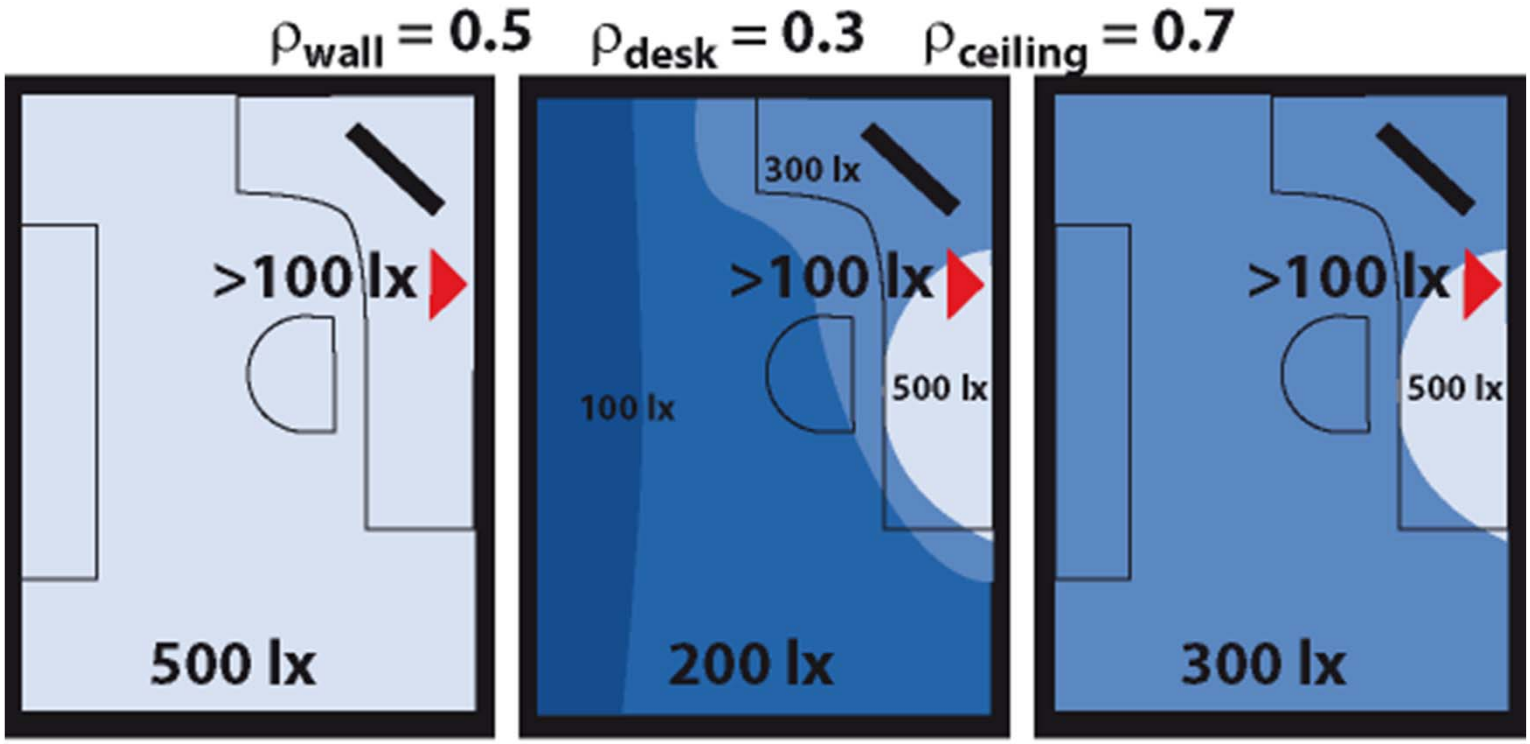
Test feasibility, on-site performance and acceptability of SSL

Standard schemes, uniform lighting,
500lx, fluorescent recessed luminaires
7 to 12 W/m^2

Ambient/ task lighting, 200 lx / 500lx
using 100 % SSL, matching new
EN 12 464-1 standard, 4,5 W /m^2

Opportunities for LEDs:

Task-ambient lighting schemes allow improved balance of light distribution. Opportunities for wall washers. But verify glare issues.



Ceiling luminaire	11 W/m2	Ceiling luminaire Task focused lighting	4.4 W/m2 1.7 W/m2	Ceiling luminaire Task focused lighting	6.6 W/m2 1.7 W/m2
Surface	12 m2	Surface	12 m2	Surface	12 m2
Hours	2000 h	Ceiling 2000 h	Task 1600 h	Ceiling 2000 h	Task 1600 h
Kwh/yr without daylight	264 Kwh/yr	Kwh/yr without daylight	138 Kwh/yr	Kwh/yr without daylight	191 Kwh/yr
Kwh/yr with daylight (30%)	**185 Kwh/yr 15.4 KWh/m2.yr**	Kwh/yr with daylight (70%)	**41 Kwh/yr 3.41 KWh/m2.yr**	Kwh/yr with daylight (50%)	**95 Kwh/yr 7.91 KWh/m2.yr**

IEA Annex 45 / Energy Efficient Lighting for Buildings, Comparison of field monitoring, Marc Fontoynont, 2008

« Luminance based lighting »

Museum – Pyramid & Facades

2011-2012

Diagnostic & new lighting design for the Pyramid & facades

Product requirements definition for Toshiba luminaires

Project management & integration

Lighting / Product certification

Confidence is unsufficient with respect to innovative lighting products (Solid State Lighting) .

Need testing by third body, international collaboration, Traceabiliy of products.

Link with building certification (LEEDS, BREEAM, etc.)

Non-directional Lamps

Directional Lamps

Downlight Fixtures

LED Linear Fluorescent replacement lamps

Outdoor Luminaires

A.1. Global economical models

Thee assessment Total Cost of Ownership (TCO) of lighting possible new models for costs and performance associated to new generation of lightings schemes, with higher luminous efficacy, longer life.

Results

A comparative assessment of TCO of various lighting scenarios (Daylighting and electrical lighting)
A model for estimating cost and energy benefits of lighting retrofit
Production of strategic information for strategic decision

Activities

Collect data, compare retrofit schemes, assess performance, propose model.
Collect information on barriers and opportunities.

A.2. Barriers and benefits

Collect evidence on existing reasons for conducting lighting retrofit today, and identify various barriers which lead to postponement of lighting retrofits, even when they are needed and cost effective.
This will lead to identify the possible perimeter of actions dealing with retrofitting: typical budgets for investments, typical payback period, also relation between the expected performance and the acceptable costs.

Results
An identification of barriers and opportunities for lighting retrofit, beyond lighting
An identification of typical budgets being allocated, or which could be allocated

A.3. Building energy regulation and certification

We will therefore conduct a critical analysis of regulation and certification documents. We will identify some incoherence in these documents, and identify also opportunities. We will propose some adjustment of these reference documents.

Results

Benchmarking of documents (regulations, building certification)
Proposal for adjustment of texts in the documents.

Activities

Collect information on the way lighting retrofit is integrated in documents used for regulation and certification.
Provide comparison
Make proposals.

A.4. Proposals of action concerning the value chain

We will identify how lighting retrofit benefits are assessed by stakeholders (manufacturers, installers, building managers, etc.) . We will identify the key strategic actions, or key strategic data to deliver to each stakeholder to possibly trigger a decision concerning lighting retrofit.

Objectives

To identify possible lack of awareness and know-how in the value chain
To identify strategic information to deliver to stakeholders

Results

Recording of information from stakeholders
Proposal of actions