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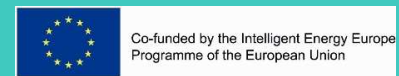
Solid State Lighting

LIDIA CAPPARELLI

PARTNERS



CO-FUNDED BY



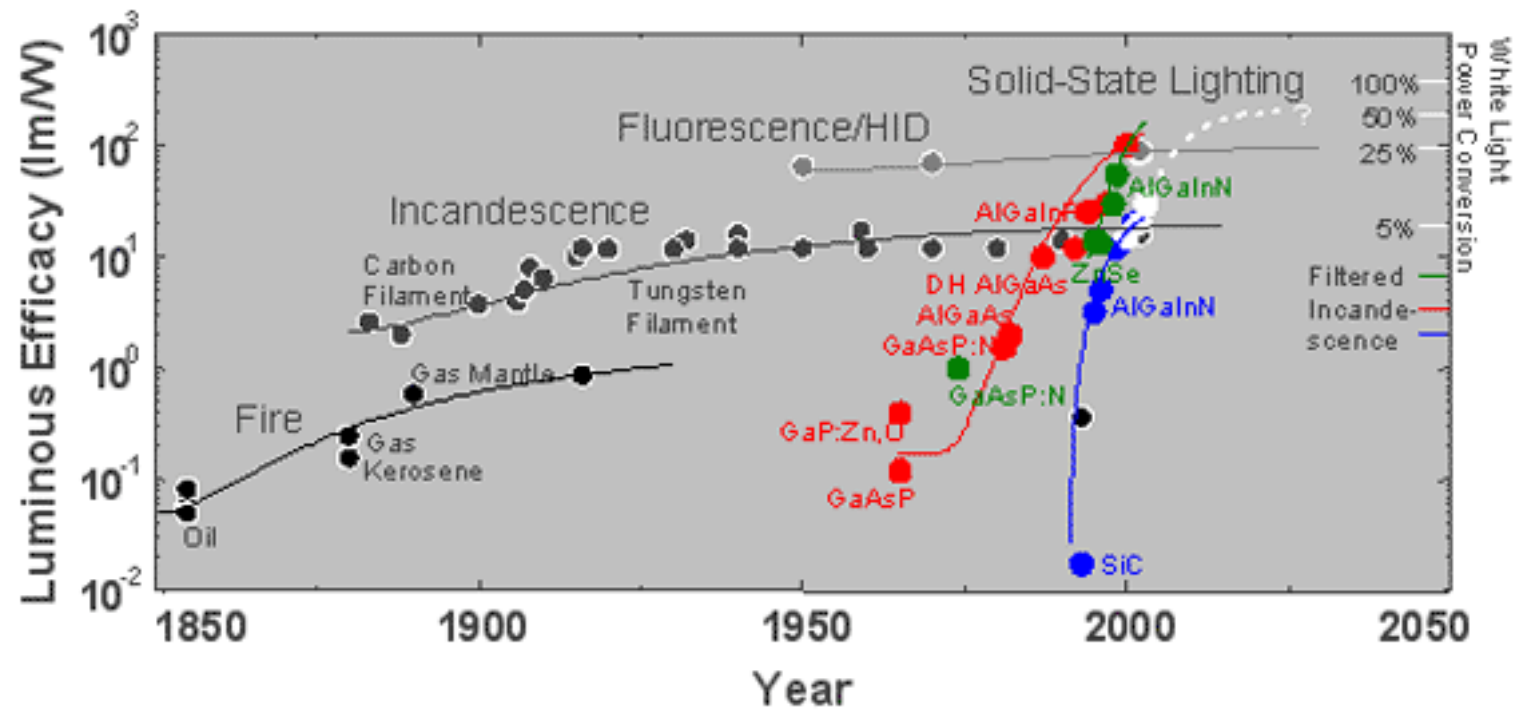
Reference

1. Solid State Lighting Annex: Life Cycle Assessment of Solid State Lighting – Final Report, *International Energy Agency, September 2014*
2. Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products Part I: Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent, and LED Lamps, *Navigant Consulting, Inc. Steve Bland, Makarand Chipalkatti, Heather Dillon, Monica Hansen Cree, Brad Hollomon, Noah Horowitz, Michael Scholand, Leena Tahkamo Aalto University & Université Paul Sabatier (Toulouse III), Fred Welsh, 2012,*
3. PRIMES Life Cycle Costs (LCC) in GPP, *ICLEI, 2012*

Reference

4. Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products Part 2: LED Manufacturing and Performance, *Pacific Northwest National Laboratory, Michael J. Scholand, LC Heather E. Dillon, June 2012*
5. US Department of Energy: Technology fact sheet on efficient lighting strategies.
<http://www.eere.energy.gov/buildings/documents/pdfs/26467.pdf>
6. Life cycle assessment of light sources – Case studies and review of the analyse, *Leena Tähkämö, Department of Electronics, Lighting Unit, September 2013*
7. Environmental Benefits of LED Lamps Using LED lamps to replace halogen MR16 lamps, *Philips LED Lamps, October 2012*

History of Lighting



Energy Life-cycle of Incandescent, CFL and LED lamps

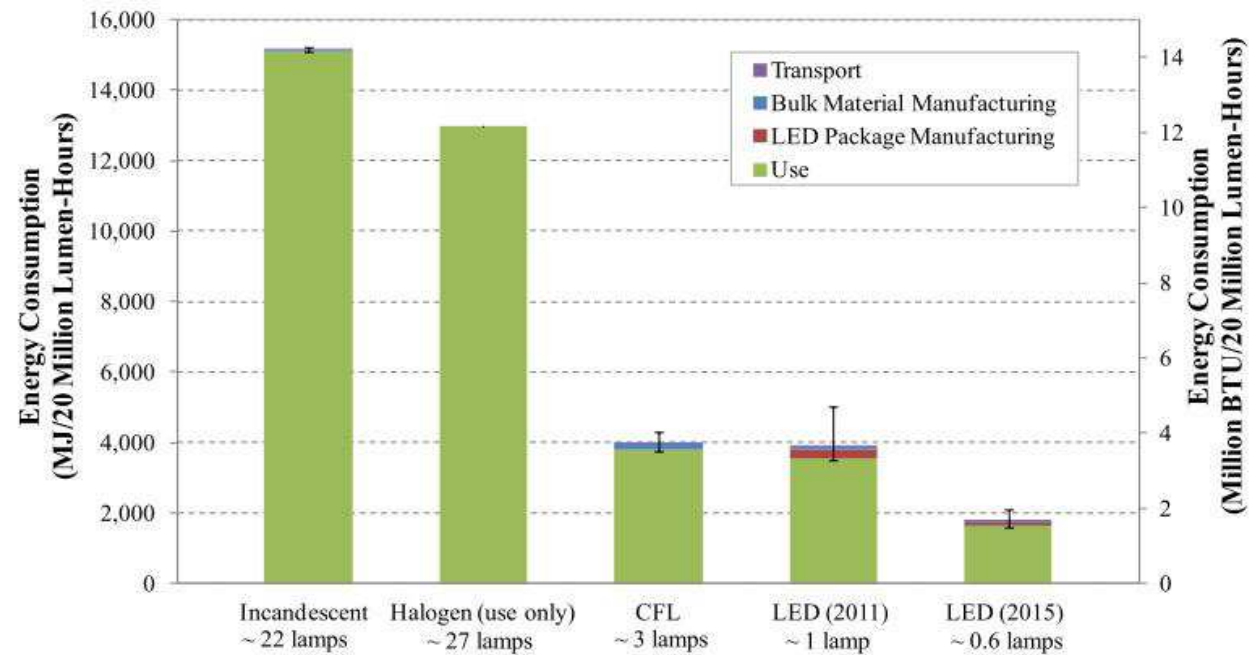


Figure 4.6 Life-Cycle Energy of Incandescent Lamps, CFLs, and LED Lamps

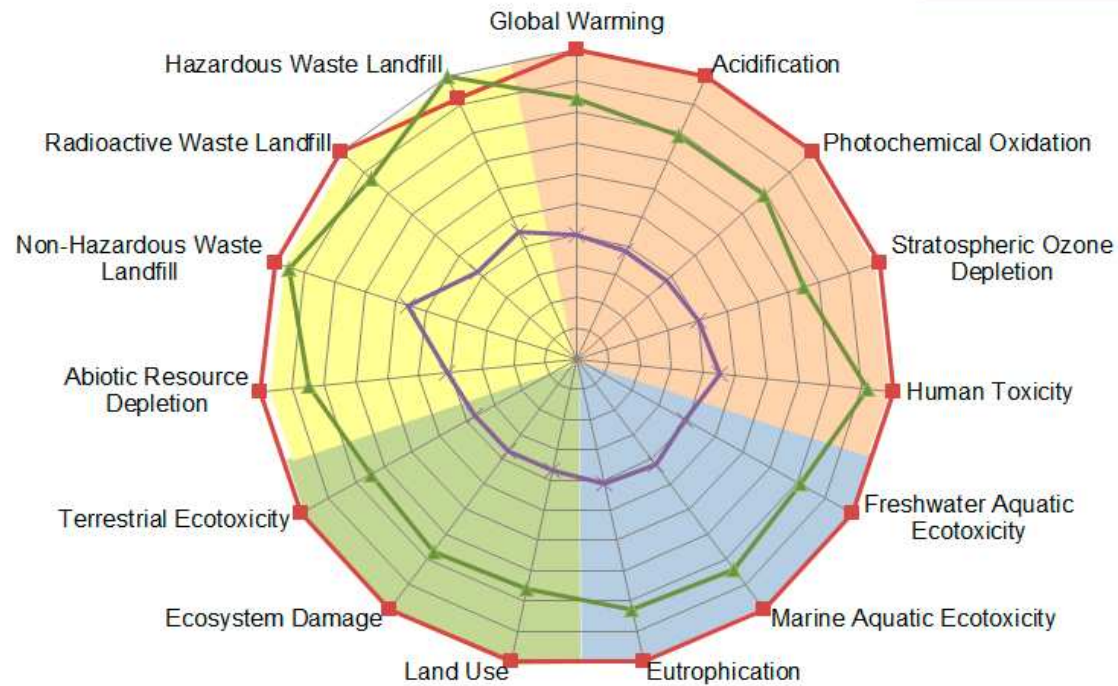
Part I: Review of the Life-Cycle Energy
Consumption of Incandescent, Compact
Fluorescent, and LED Lamps **Feb 2012, updated Aug 2012**

It is forecasted that LED lighting will represent 46 percent of general illumination lumen-hour sales by 2030, resulting in an annual primary energy savings of 3.4 quads (Navigant Consulting, Inc., 2012a).

LCA study by US DOE

Resource Impacts

Air Impacts



Soil Impacts

— CFL — LED-2012 — LED-2017

Water Impacts

Life-cycle environmental impacts of three household lamp technologies including current (2012) and future (2017) LED lamps (US DOE 2012b).

Energy used in Extraction+Processing+Manufacture

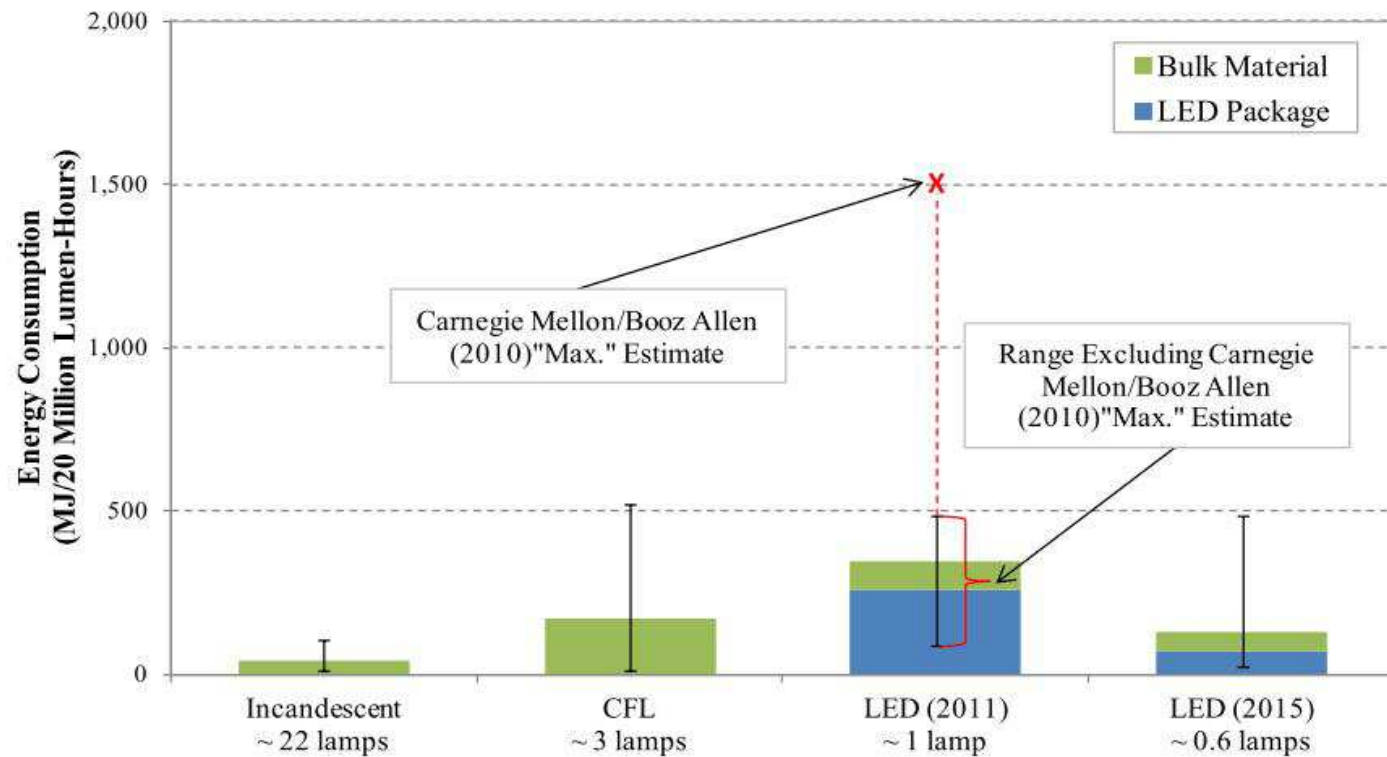


Figure 4.4 Life-Cycle Manufacturing Primary Energy (MJ/20 million lumen-hours)

Total Life-Cycle Primary Energy (MJ/20 million lumen-hours) Life-Cycle

Life-Cycle Phase	Incandescent			CFL			LED (2011)			LED - future (2015)		
	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
Bulk Lamp Material Manufacturing	10.1	42.2	106	11.3	170	521	38.0	87.3	154	25.4	58.5	103
LED Package Manufacturing	N/A	N/A	N/A	N/A	N/A	N/A	1.88	256	1,340	0.54	73.0	381
Total Manufacturing	10.1	42.2	106	11.3	170	521	39.9	343	1,490	26.0	131	484
Transport	0.26	0.27	0.27	1.42	1.57	1.71	1.23	2.71	4.19	0.77	1.69	2.62
Use	15,100	15,100	15,100	3,780	3,780	3,780	3,540	3,540	3,540	1,630	1,630	1,630
Total	15,100	15,100	15,200	3,790	3,950	4,300	3,580	3,890	5,030	1,660	1,760	2,120

Outdoor use

LED LAMP SAVINGS	NORMALLIGHT	H P SODIUM	LED
Number of lights	2000	2000	2000
Electricity price per kwh	\$0.20	\$0.20	\$0.20
Lamp hours per day	10	10	10
Maintenance per lamp (year)	\$450	\$220	\$0.00
Life time hours per lamp	2,000	16,000	60,000
Watts consumed per lamp	250	150	100
Cost a year per 2000 lamps	\$365,000	\$219,000	\$146,000
Total Maintenance cost (year)	\$900,000	\$440,000	\$0.00
Total cost a year current prices	\$1,265,000	\$659,000	\$146,000
Life time per lamp in years	0.55	4.38	16.44
Electricity / Maintenance (lifetime)	\$20,794,521	\$10,832,877	\$2,400,000

Outdoor use

ROI	LED vs Normal Light	LED vs Sodium Light
Lamp price per unit	500	500
Investment for 2000 lamps	1,000,000	1,000,000
Total savings per year	1,119,000	513,000
Lifetime savings on lights	18,394,521	8,432,877
Payback on LED investment	0.89 (under one year)	1.95 (under two years)

Outdoor use

	Unit	HQL-125W	SPNa-70W	Metal Halide 50W	Valopaa LED 35W
Input Power	KW	0,16	0,08	0,58	0,035
Purchase price and installation	€	0	140	165	330
Energy costs / year	€	72	36	26	16
Mass replacement	€/vuosi	12	10	20	0
Repair costs	€/vuosi	10	10	15	3
Costs at purchase	€	0	140	165	330
Costs after:					
1 year	€	94	196	226	349
2 years	€	188	252	287	368
3 years	€	282	308	348	386
4 years	€	376	364	409	405
5 years	€	470	420	471	424
6 years	€	564	476	532	443
7 years	€	658	532	593	461
8 years	€	752	588	654	480
9 years	€	846	644	715	499
10 years	€		700	726	518
20 years	€		1260	1387	705
30 years	€		1820	2003	890

Energy and cost savings with high quality efficient lamp technology – Indoor use





Criteria	Incandescent 	Halogen 	CFL 	LED 
Lumen (lm)	660	700	740	810
Watt (W)	60	46	14	12
Efficacy (lm/W)	11	15	52	67
Lifetime (hrs)	1000	2000	10000	30000
Purchase price (€) 10 years*	10	20	9	10
Energy costs (€) 10 years*	72 €	55 €	17 €	14 €

Fig. 4 Energy and cost savings

* Assumption: operation time 1000 hrs/a

Table 5-1. Performance Parameters for Lamps Considered in this Analysis

Characteristics	Incandescent	CFL	LED lamp – 2012	LED lamp – 2017
Power Consumption	60 watts	15 watts	12.5 watts	6.1 watts
Lumen Output	900 lumens	825 lumens	812 lumens	824 lumens
Efficacy	15 lm/W	55 lm/W	65 lm/W	134 lm/W
Lamp Lifetime	1500 hours	8000 hours	25,000 hours	40,000 hours
Total Lifetime Light Output	1.35 Mlm-hr	6.6 Mlm-hr	20.3 Mlm-hr*	33.0 Mlm-hr
Impacts Scalar	15.04	3.08	1.00	0.61

Technical specifications:

Indoor lighting

- ⊙ CRI (Colour Rendering Index)>80
- ⊙ Colour temperature (Kelvin) 2700-3000
- ⊙ General lighting-efficiency (lumen/watt)> 50
- ⊙ Effect lighting -efficiency (lumen/watt)> 40
- ⊙ Life-span (hours at L70)> 20000

Outdoor lighting

- ⊙ CRI (Colour Rendering Index)>75
- ⊙ Colour temperature (Kelvin) 3000-4000
- ⊙ General lighting-efficiency (lumen/watt)> 50
- ⊙ Life-span (hours at L70)> 20000

Kolding, Denmark



Award criteria:

- ⦿ Life-cycle costs have been given a weighting of 55%. These are broken down by: purchase price (35%), lifetime (35%) and operating costs (30%)
- ⦿ Energy-efficiency (lumen/watt) (25%)
- ⦿ Light quality (CRI) (20%)

Results:

- ⦿ The deadline for responding to the call for tender is set for the end of February. The results of the tender will be available on the SMART SPP website when the process is completed.

Source: @ https://www.koldingkommune.dk/indkøb/indkobsplan-2018-2020

Features and Benefits of LEDs

1. The LEAST costly alternative available today. LED Street Lights deliver the best economic return compared to conventional alternatives considering the total life-cycle costs including installation, maintenance and energy.
2. Consume less energy. Generally, a LED consumes less than 1.15 watts to operate. This low power consumption means you save on your energy costs.
3. No heat output, less CO₂ pollution. LEDs can convert almost all the energy used into light, creating a highly efficient light source. In contrast, conventional lighting emits heat and/or light pollution.
4. Long lifetime. An LED can last for up to 100,000 hours. High Power LEDs can last up to 50,000 hours. In comparison the lifespan of an incandescent light is about 1,000 hours and for a halogen light is about 2,000 hours.

5. Environmentally safe. LEDs are made from non-toxic materials - unlike fluorescent lights which contain mercury. Plus they can also be recycled.
6. No Cleaning Necessary. No burned insects accumulate on the surface, so no reduction of light intensity - unlike conventional lamps.
7. No Radiation. No ultraviolet or infrared emissions. LEDs only emit light in the visible spectrum.