



**STUDY ON EXTERNAL
ENVIRONMENTAL EFFECTS
RELATED TO THE LIFE
CYCLE OF PRODUCTS AND
SERVICES**

APPENDIX 2

CASE STUDIES

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EUROPEAN COMMISSION
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LAMPS: FLUOCOMPACTS VS. FILAMENT LAMPS

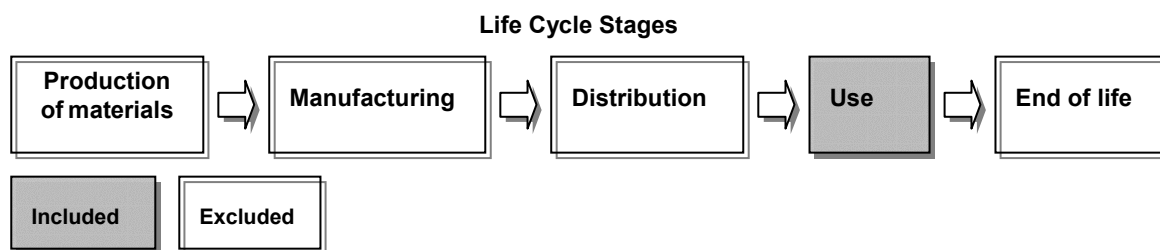
A. Functional Unit

10 million lumens¹ hours. (This correspond to roughly 1.6 times the light yield of a conventional filament lamp and a bout one fifth of that of a compact fluorescent lamp).

B. Reference

The International Journals of Life Cycle Assessment, Vol. 1 N°1 1996, page 8. Case studies: Comparison between Filament lamps and Compact Fluorescent Lamps. Rolf P. Pfeifer.

C. System Studied



Four different alternative types of lamp were selected for analysis:

- A conventional standard filament lamp, with a power input of 60W, a light output of 650 lm, and an average life of 1000 h.
- A compact fluorescent lamp with integral electronic control gear, a power input of 15 W, a light output of 600 lm, and an average life of 8000 h.
- A compact fluorescent lamp with integral inductive control gear, a power input of 13 W, a light output of 650 lm, and an average life time of 8000 h.
- A compact fluorescent lamp with a separate ballast, a total power input of 11 W, a light output of 600 lm and an average life time of 8000 h for the lamp and 32 000 h for the ballast.

The authors were forced to use exclusively data from the literature reference available in the public domain, as none of the lamp producers was willing to provide further information. The author stress explicitly that the available data is insufficient and that there are, in part, substantial data gap.

Only energy consumption of the production and use phases is considered in this paper.

[TAB 1] ENERGY CONSUMPTION IN MJ

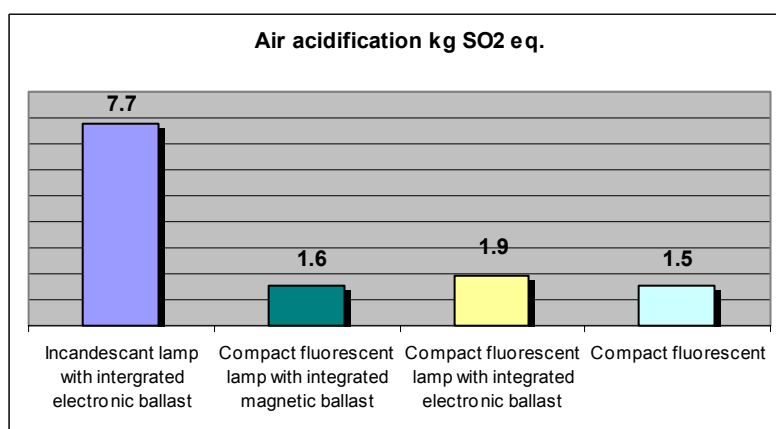
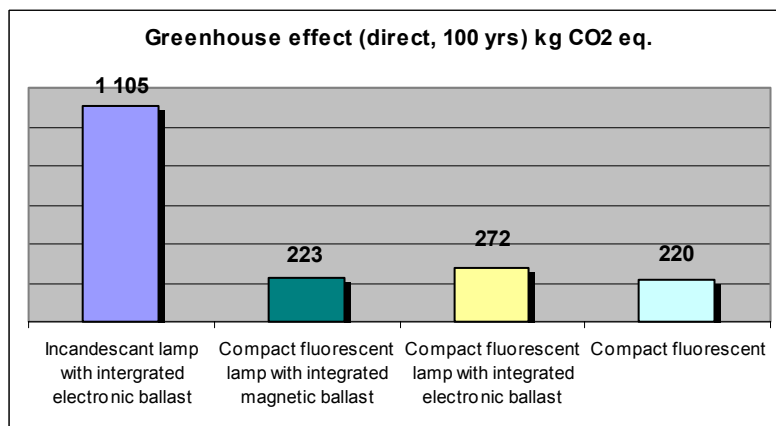
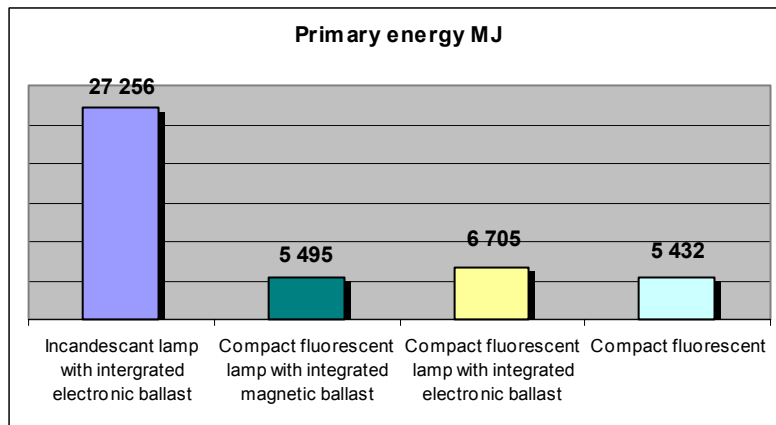
	Incandescent lamp	Compact fluo lamp with integrated magnetic ballast	Compact fluo lamp with integrated electronic ballast	Compact fluo lamp
Production step	0.8-3.1	1.1-3.7	1.0-2.1	0.6
Use step	875	174	189-214	116-174
Total	875-878	175-177	190-216	117-175

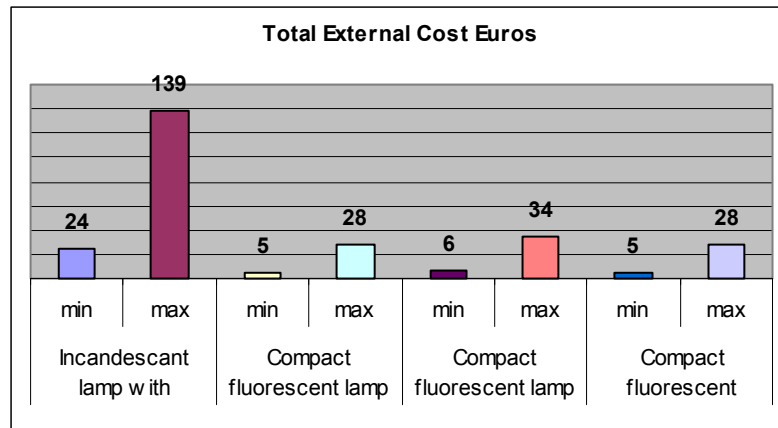
¹ Lm (lumen) is the unit of luminous flux, and thus quantifies the light output emitted by a source or, colloquially speaking, the "brightness" of a lamp. Lux is the unit of illumination of a surface, whereby one lux equals to one lumen per square meter.

[TAB 2] MIX OF ENERGY IN THE ELECTRICITY MODEL – 1 kWh

Electricity from coal B250	kWh	17,4%
Electricity from gas B250	kWh	7,4%
Electricity from hydropower B250	kWh	16,4%
Electricity from lignite B250	kWh	7,8%
Electricity from uranium B250	kWh	40,3%
Electricity from oil B250	kWh	10,7%

D. Main Results for one million lumen hours





E. Conclusions of the authors

The LCA clearly finds much more favourable results for the compact fluorescent lamp. The decisive weak point of the conventional filament lamp is its energy consumption in the use stage. Only some 1-5% of the total primary energy consumption are to produce the lamp itself, while approx. 95-99% are consumed in the use stage. In total, a filament lamp consumes about five to height times more primary energy than a compact fluorescent lamp. A further consequence of the higher consumption of the filament lamp is that its ascribable emissions to air are much higher than those of the compact fluorescent lamp.

Mercury emissions:

Compact fluorescent lamps use mercury in production, and contain mercury in the final product. The total emissions of mercury over the whole life cycle of both lamp types, the filament and the compact fluorescent lamp, are approximately equal. This is due to the fact that the comparatively higher mercury emissions of the compact fluorescent lamp in the production and disposal stages are compensated by the mercury emissions of the filament lamp that follow from its higher energy consumption. Coal has a slight, but detectable mercury content, and this is emitted by the conventional coal-fired power plants that supply the power for the lamp.

F. Differences between options

FLUOCOMPACT VS. FILAMENT LAMP	Factor between the option having the lowest environmental impact and the option having the highest environmental impact
Primary Energy Consumption	5
Global Warming	5
Air acidification	5

G. Detailed results

Functional unit: one million lumen hour

A/ Environmental Impacts

Linked to resources consumption

Depletion of non renewable resources	kg antimony eq.	8	2	2	2
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Linked to air emissions

Greenhouse effect (direct, 100 yrs)	kg CO ₂ eq.	1 105	223	272	220
Stratospheric Ozone Depletion	g CFC-11 eq.	0.22	0.04	0.05	0.04
Air acidification	kg SO ₂ eq.	7.7	1.6	1.9	1.5
Photochemical oxidation	g ethylene eq.	674	136	166	134

Linked to water effluents

Eutrophication	g PO ₄ eq.	32.2	6.5	7.9	6.4
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Linked to human health

Human Toxicity	kg eq. 1-4-dichlorobenzene	12 031	2 425	2 960	2 398
Years of Life Lost	year	3.4E-04	6.8E-05	8.3E-05	6.7E-05

Linked to ecotoxicological risk

Aquatic Ecotoxicity	kg eq. 1-4-dichlorobenzene	2 336	471	575	466
Sediment Ecotoxicity	kg eq. 1-4-dichlorobenzene	7 490	1 510	1 843	1 493
Terrestrial Ecotoxicity	kg eq. 1-4-dichlorobenzene	90	18	22	18

B/ Other Environmental Indicators

Primary energy	MJ	27 256	5 495	6 705	5 432
Fossil energy	MJ				
Consumption of raw materials	kg	670	135	165	134
Dusts	g	1 247	251	307	249
Dioxins	g				
Metals into air	g	376	76	93	75
Metals into water	g	1 119	226	275	223
Metals into soil	g				
Municipal and industrial waste	kg				
Hazardous waste	kg				
Inert waste	kg				

C/ External Cost

Linked to air emissions

Greenhouse effect (direct, 100 yrs)	Euros	21.0	53.0	4.2	10.7	5.2	13.0	4.2	10.6
Stratospheric Ozone Depletion	Euros	1.5E-04	1.5E-04	3.0E-05	3.0E-05	3.7E-05	3.7E-05	3.0E-05	3.0E-05
Air acidification	Euros	1.1	11.3	0.2	2.3	0.3	2.8	0.2	2.2
Photochemical oxidation	Euros	0.49	0.63	0.10	0.13	0.12	0.15	0.10	0.12

Linked to water effluents

Eutrophication	Euros	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
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Linked to solid waste

Disaminty caused by incineration	Euros								
Disaminty caused by landfilling	Euros								

Linked to human health

Carcinogenic potential of heavy metals	Euros	4.7E-03	4.7E-03	9.5E-04	9.5E-04	1.2E-03	1.2E-03	9.4E-04	9.4E-04
Human health effects caused by dusts	Euros	1.73	73.93	0.35	14.90	0.43	18.19	0.35	14.74
Human health effects caused by dioxins	Euros								

Total External Cost Euros

	Incandescent lamp with intergrated electronic ballast	Compact fluorescent lamp with integrated magnetic ballast	Compact fluorescent lamp with integrated electronic ballast	Compact fluorescent				
Values								
	8	2	2	2				
	1 105	223	272	220				
	0.22	0.04	0.05	0.04				
	7.7	1.6	1.9	1.5				
	674	136	166	134				
	32.2	6.5	7.9	6.4				
	12 031	2 425	2 960	2 398				
	3.4E-04	6.8E-05	8.3E-05	6.7E-05				
	2 336	471	575	466				
	7 490	1 510	1 843	1 493				
	90	18	22	18				
Values								
	27 256	5 495	6 705	5 432				
	670	135	165	134				
	1 247	251	307	249				
	376	76	93	75				
	1 119	226	275	223				
Values								
	min	max	min	max	min	max	min	max
	21.0	53.0	4.2	10.7	5.2	13.0	4.2	10.6
	1.5E-04	1.5E-04	3.0E-05	3.0E-05	3.7E-05	3.7E-05	3.0E-05	3.0E-05
	1.1	11.3	0.2	2.3	0.3	2.8	0.2	2.2
	0.49	0.63	0.10	0.13	0.12	0.15	0.10	0.12
	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
	4.7E-03	4.7E-03	9.5E-04	9.5E-04	1.2E-03	1.2E-03	9.4E-04	9.4E-04
	1.73	73.93	0.35	14.90	0.43	18.19	0.35	14.74
	24	139	5	28	6	34	5	28

	Compact fluorescent	Incandescent lamp with intergrated electronic ballast	Compact fluorescent lamp with integrated magnetic ballast	Compact fluorescent lamp with integrated electronic ballast
A/ Environmental Impacts				
Linked to resources consumption				
Depletion of non renewable resources	100%	502%	101%	123%
Linked to air emissions				
Greenhouse effect (direct, 100 yrs)	100%	502%	101%	123%
Stratospheric Ozone Depletion	100%	502%	101%	123%
Air acidification	100%	502%	101%	123%
Photochemical oxidation	100%	502%	101%	123%
Linked to water effluents				
Eutrophication	100%	502%	101%	123%
Linked to human health				
Human Toxicity	100%	502%	101%	123%
Years of Life Lost	100%	502%	101%	123%
Linked to ecotoxicological risk				
Aquatic Ecotoxicity	100%	502%	101%	123%
Sediment Ecotoxicity	100%	502%	101%	123%
Terrestrial Ecotoxicity	100%	502%	101%	123%
B/ Other Environmental Indicators				
Primary energy	100%	502%	101%	123%
Fossil energy				
Consumption of raw materials	100%	502%	101%	123%
Dusts	100%	502%	101%	123%
Dioxins				
Metals into air	100%	502%	101%	123%
Metals into water	100%	502%	101%	123%
Metals into soil				
Municipal and industrial waste				
Hazardous waste				
Inert waste				