

Hybrid Fiber Illumination System – a trans-disciplinary cooperation project

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By

Araceli Bjarklev

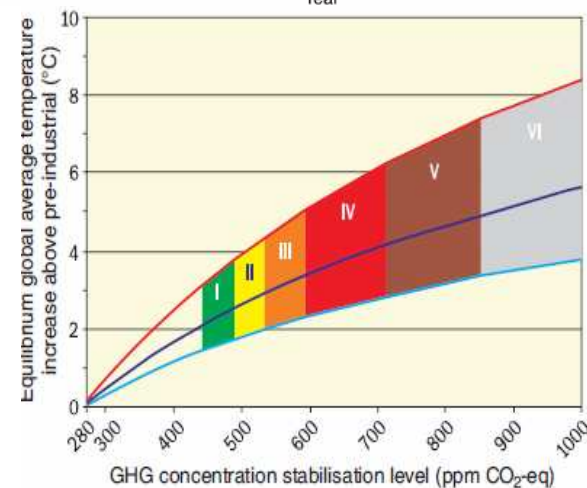
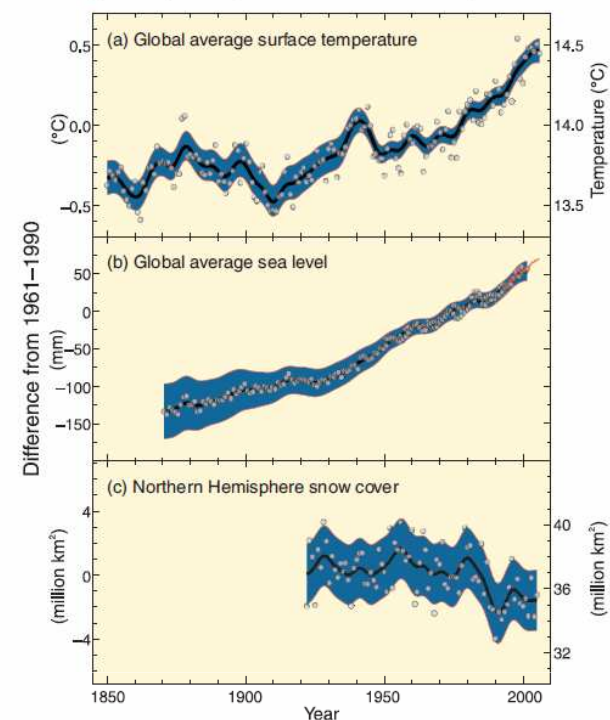
Program

- Introduction to my PhD project
- Four important concepts
- Office lighting– state of the art
- Possibilities
- Trans disciplinary cooperation

Climate challenge

- Temperature raise should not exceed 2°C
- Global climate has already changed 0.7°C from pre-industrial times
- Concentrations of GHG not higher than 450 ppm
- GHG-emissions have to be reduced in an order of 50-85%

Changes in temperature, sea level and Northern Hemisphere snow cover



Source: based on [IPCC Climate Change 2007: The Physical Science Basis, Summary for Policymakers \(2007\)](#)

Climate challenge

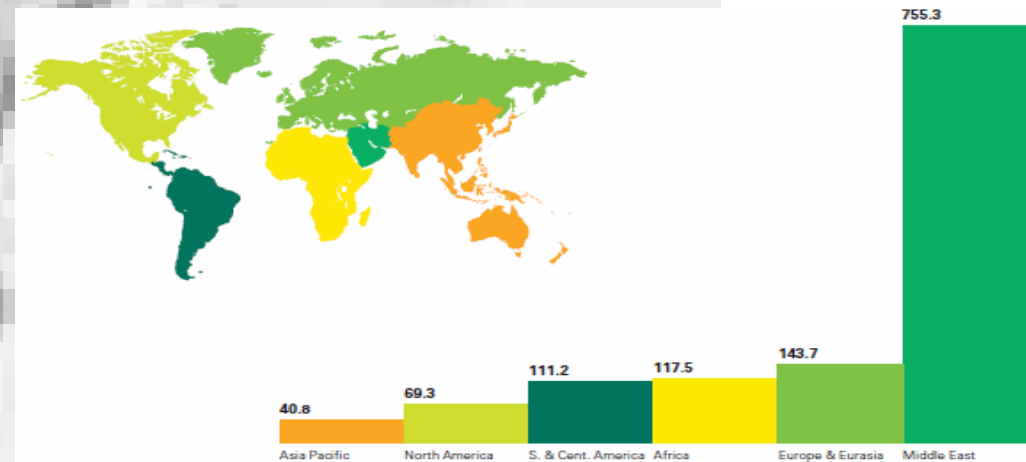
- 20% of the total electricity produced in the world is used for illumination
- Total electricity consumption across the EU-27 had an absolute increase of 28.7% between 1990 and 2005
- Europe wastes at least 20% of the energy it uses
- The energy to supply lighting produces 1900 Mt of CO₂ yearly
- 1.6 billion people without electric lighting yet

Energy challenge

- **Availability of Resources**

- Steep decline of the oil supply after peak in 2005
- Geographic distribution of other main resources problematic for self sufficiency

Resource	World's Reserves-to-production ratio (years)	EU-Share of world reserves
OIL	41.6	2%
Gas	63	3.5%
Coal	133	12.3%
Uranium	100	1.9%



Source [BP June 2008].

El-consumption over the time:

- - almost doubled from 1980 to 2007
- - Production: rised with 20.2% from 1990 to 2007
- - Trade & service: rised with 30.5% from 1990 to 2007
- - Households: increased with 5.7% from 1990 to 2007

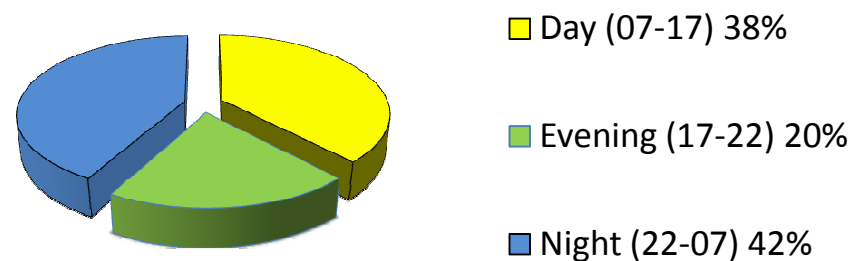


El-consumption due to illumination

- Tertiary sector uses 22% more electricity for lighting than the residential sector.

Sector	GWh	%
Trade/ Public and Private	2,923GWh	54.27%
Households	1,744 GWh	32.38%
Industry	718GWh	13.33%

- Annual average consumption of electricity for lighting in Danish working places



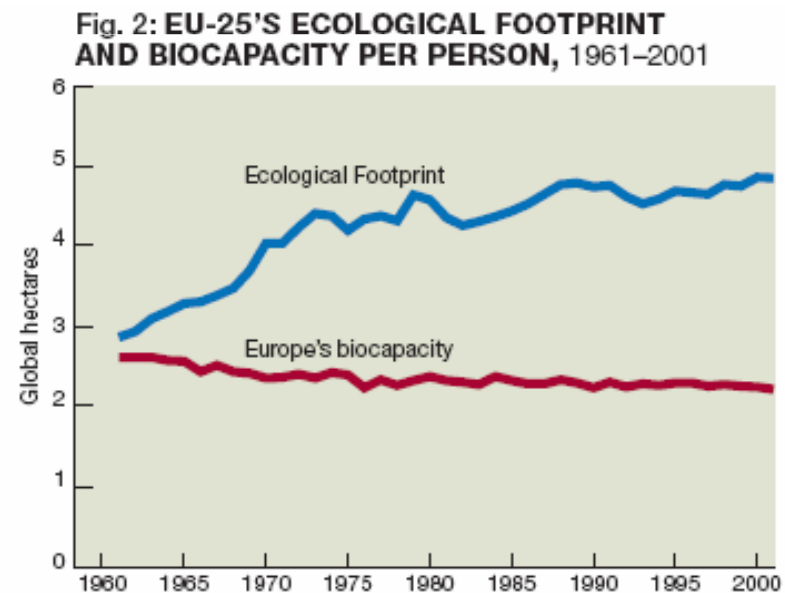
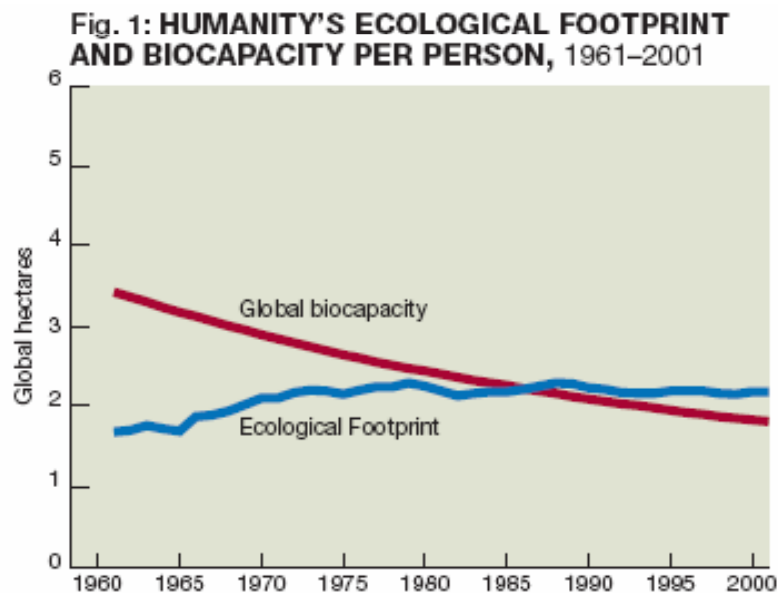
- Source: elsparefonden <http://application.sparel.dk/EIWebUI/EI/index.aspx>

Four important concepts

- Ecological footprint
- Life cycle
- Eco-efficiency
- Eco-innovation

Ecological footprint

- total area required to produce what a country consumes, to absorb its waste, and provide space for its infrastructure (WWF 2005)



Source: WWF 2009

Global ecological footprint

- Danish eco-footprint has increased from 4 hectares per person (1961) to 5.8 hectares (2007) even with the increasing number of energy saving products!

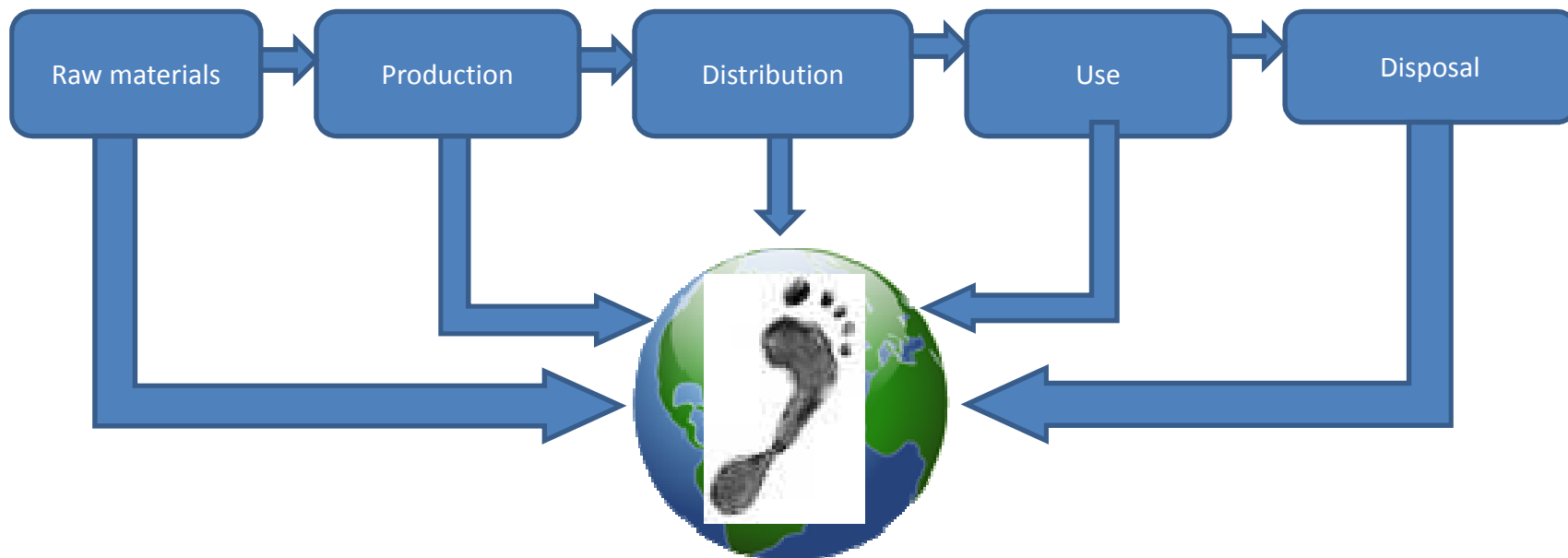


Foto by: Araceli Bjarklev



Life cycle

- Takes into account the consecutive and interlinked stages of a product system, from raw materials acquisition or generation from natural resources to final disposal” (ISO 14044 2006).



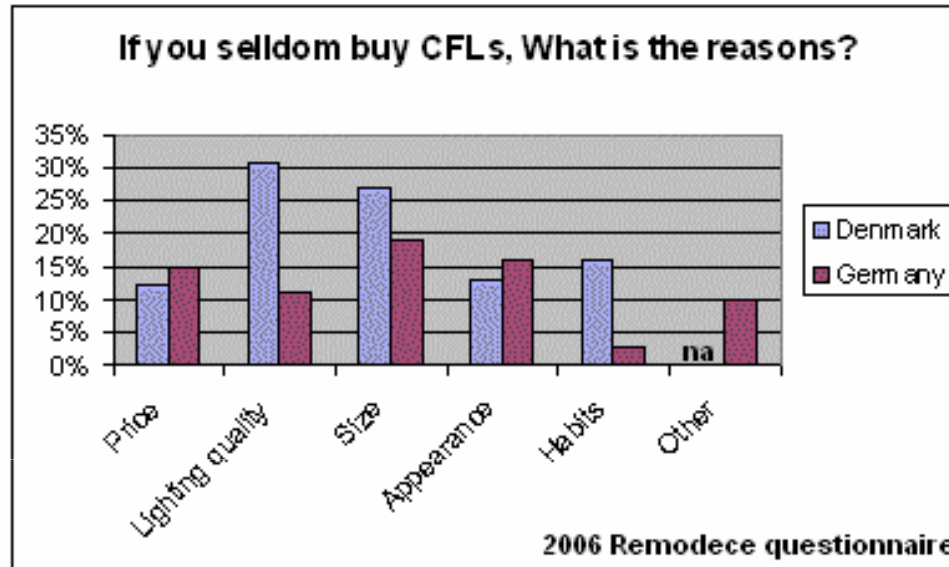
Energy, Materials, Chemicals

Eco-efficiency

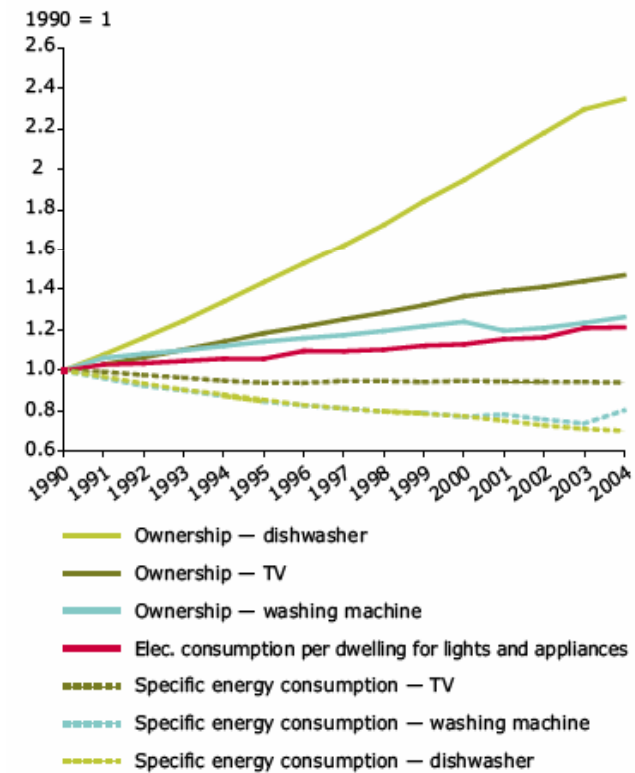
• **Eco-efficiency:** is reached by the delivery of *competitively priced* goods and services while progressively reducing ecological impacts and resource intensity (Lovins 2008)



Eco-efficiency



Trends in energy efficient ownership and overall energy consumption of selected household appliances, EU 15



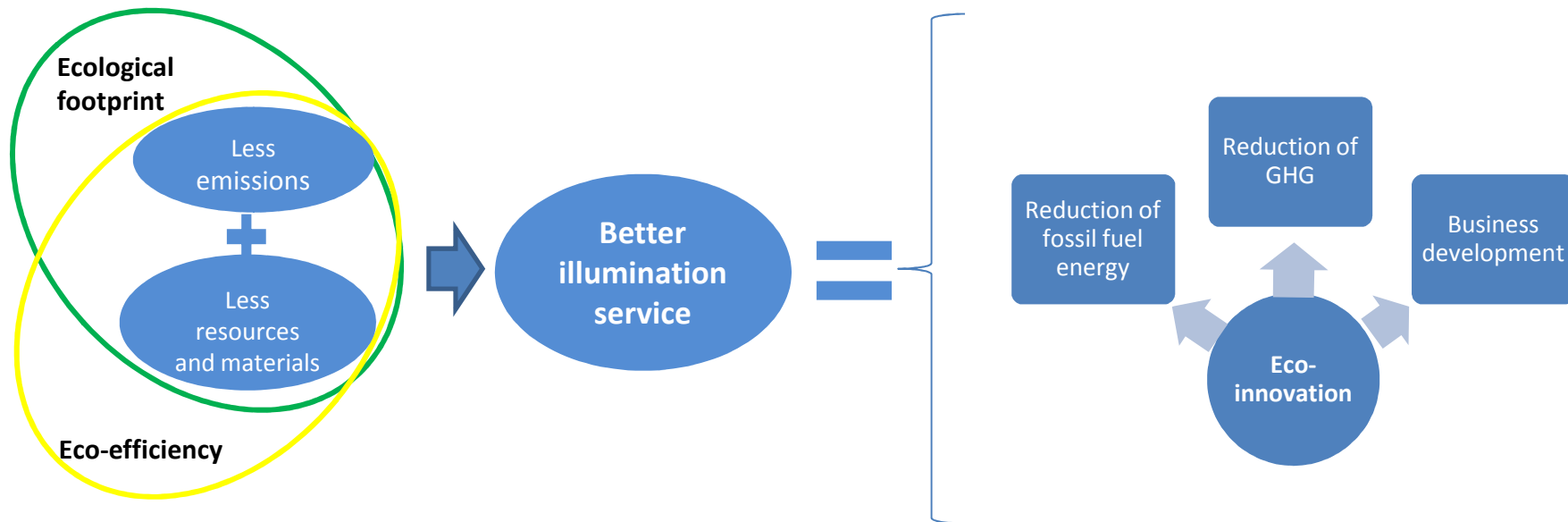
Source: Enerdata, 2006.

Consumer Demand Challenges

- Emerging lighting technologies have to provide *exceptional service* to be accepted in relation to their prices

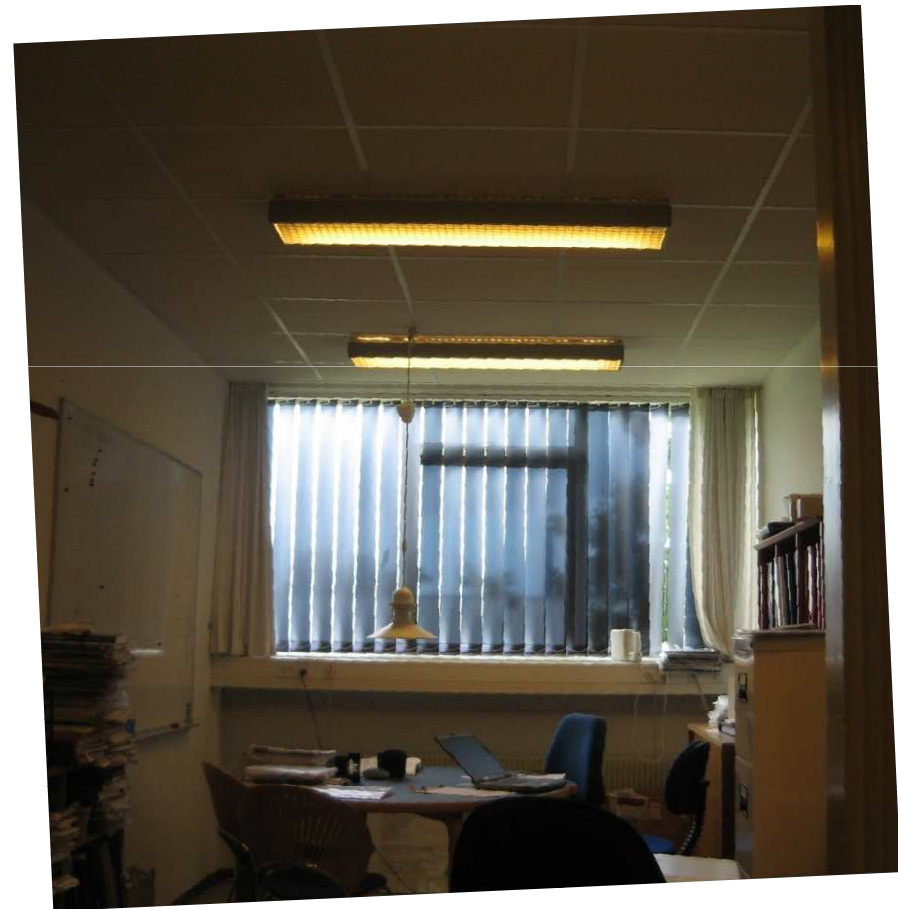
Eco-innovation

Eco-innovation means all forms of innovation activities resulting in or aimed at significantly improving environmental protection. http://ec.europa.eu/environment/eco-innovation/what_en.htm



Office lighting -State of the Art

- Higher ECO-design requirements Directives: 2005/32/EC (fluorescent lamps) and 2000/55/EC (ballast and luminaries)
- Higher lighting standard requirements for working places: EN 12464-1 (2004) (500 lux, comfort requirements on glare and colour rendering)
- These requirements will need designing new and more eco-efficient technologies for the future



Results of Implementing 2005/32 EC Directive

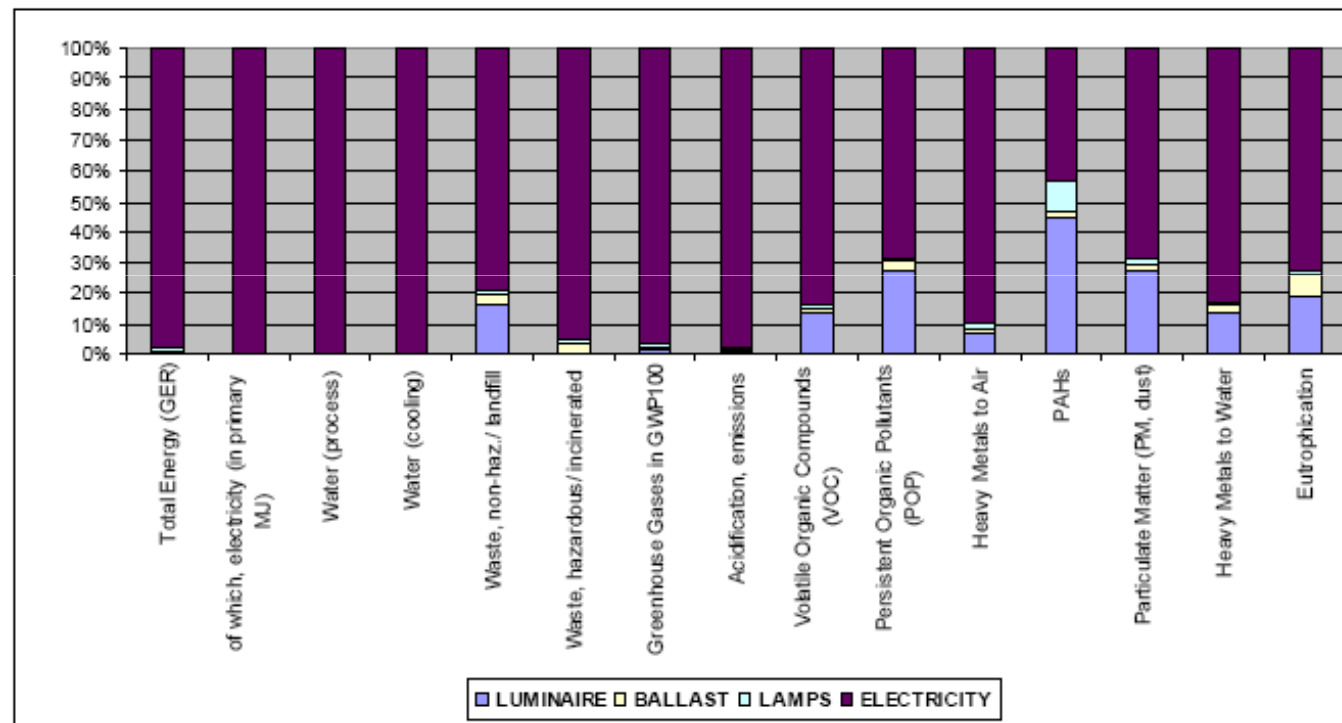
- According to the European Assessment for Energy using products (EuP) for the illumination sector, the best available technology today for the office sector is the ***tri-phosphate fluorescent lamp using electronic ballast***.
- Even with the BAT the consumption of electricity compared to what was used in 1990, will be in 2020...
 - Using 25% more energy,
 - producing 66% more emissions of persistent organic pollutants and,
 - emitting almost 30% more CO₂ than in 1990 (www.eup4light.net).



Use phase the most critical stage

Energy Losses

- The largest environmental impact in this sector comes from the use of electricity

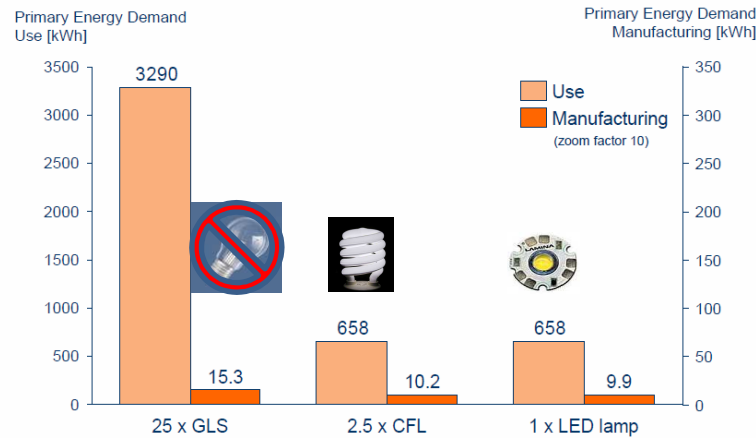


Distribution of impacts over luminaire, ballast use, lamp use, electricity use A1 (similar for A2)

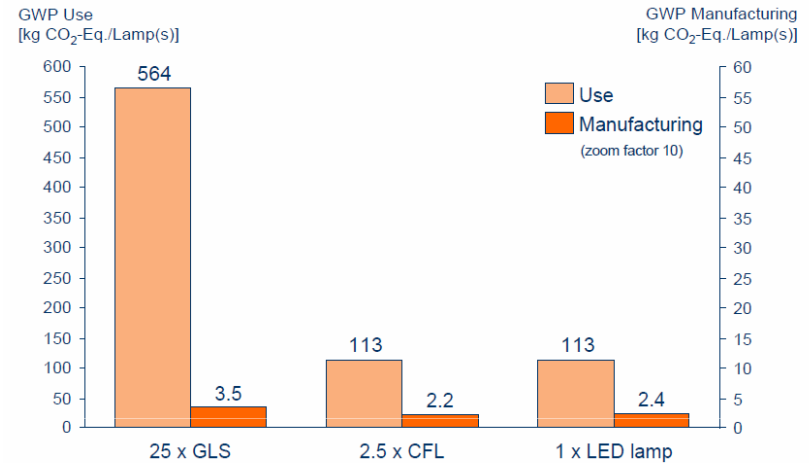
Source: Preparatory Studies for Eco-design requirements of EuPs –Final Report Lot 8:Office lighting.

Potential alternatives

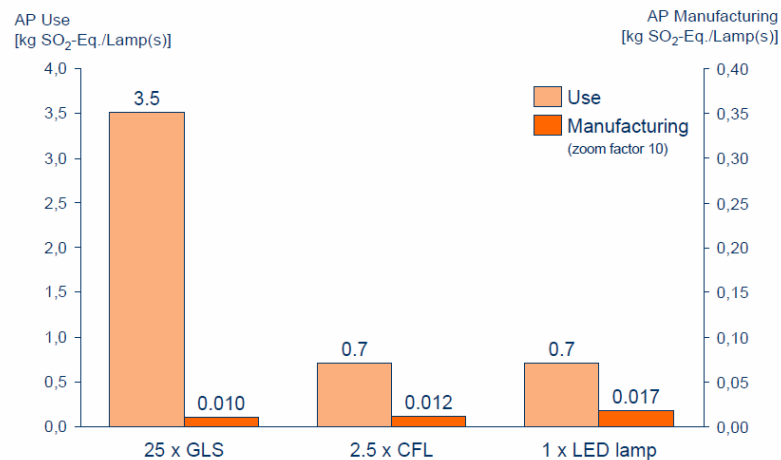
Primary Energy Demand for manufacturing and use of all three lamps



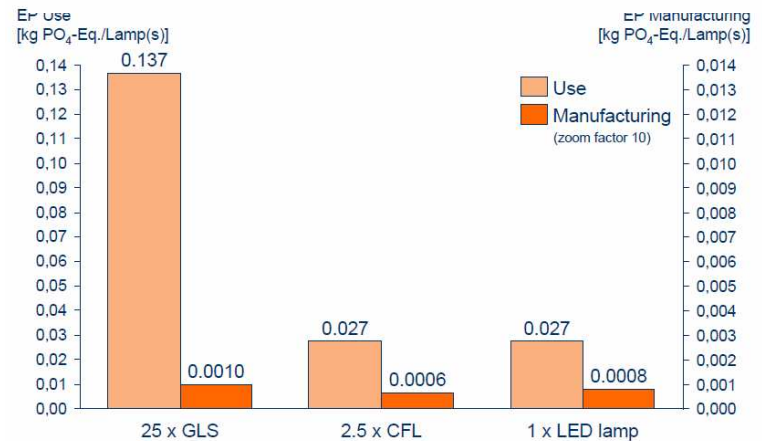
Global Warming Potential for manufacturing and use of all three lamps



Acidification Potential for manufacturing and use of all three lamps



Eutrophication Potential for manufacturing and use of all three lamps

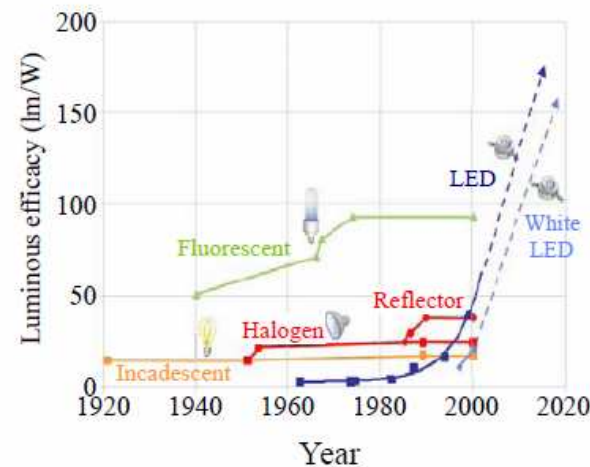


Source: OSRAM Opto Semiconductors GmbH

Future possibilities

Life Cycle Challenge

- Mercury is problematic according to RoHS and WEEE directives and the Flower labelling



1. High energy efficiency 100 lm/W.
2. Directional (no wasted energy).
3. Long life (> 50000h to 70% brightness).
4. Environmentally friendly.
5. Rugged.
6. Dimmable.
7. Controllable (including colour!)

Source: Beata Kardynal 04-12-09

Base-line case and potential alternatives

Base line case:



De luxe triphosphor fluorescent tube + electronic ballast

vs. LEDS



<http://www.thelightbulbshop.co.uk/Shop/G13-T8-Fluorescent-Tube/Product/2506/L18930/T8LumiluxDeluxeFluorescentTube.aspx#>

vs. LEDS+ SOF



Tans- disciplinary cooperation

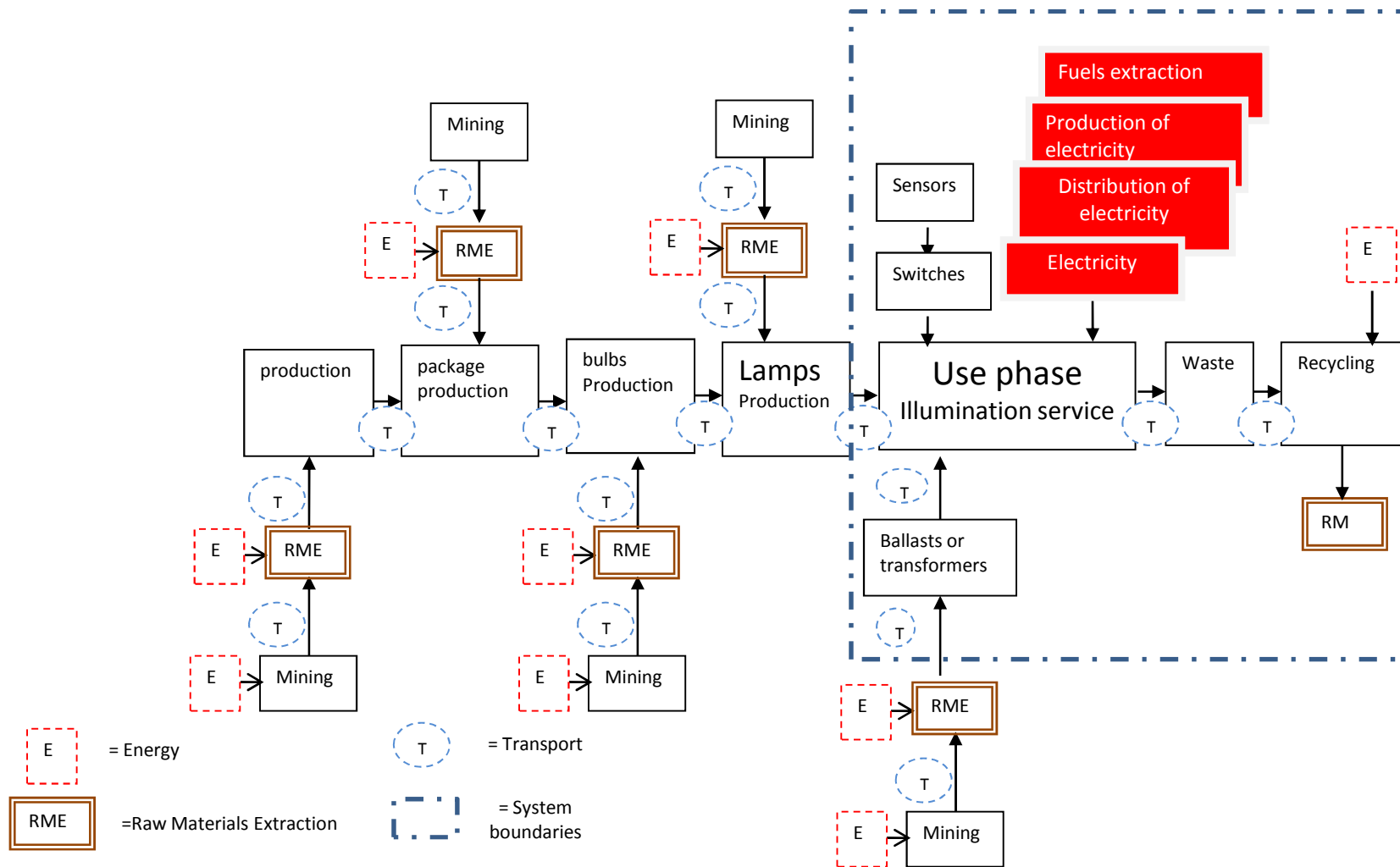
Hybrid Fiber Illumination – directed towards a minor ecological footprint

The most important relation is the service provided (illumination) and the consumption of energy :
luminous efficacy - lm/W
(light that you can see)

- 500 lumens for reading-working
- 200 lumens for general illumination



System boundaries CFLs/LEDs



Trans-disciplinary cooperation



RUC- Department of Environmental,
Social and Spatial Change



DTU-Photonic

Ibsen el-anlæg a/s



Danish consumer owned el-firm

Thanks for your attention

