

Lighting and climate change: Contributions from the LED sector

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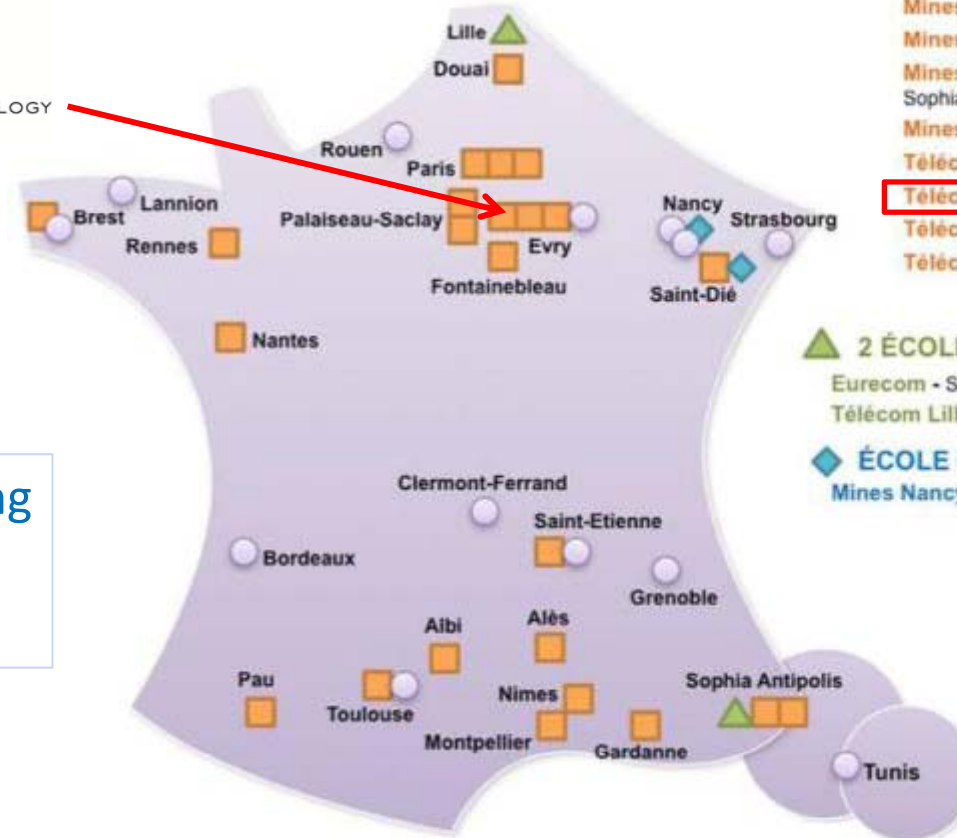
International conference "Our Common Future", Paris, 7 July 2015.



Institut Mines-Télécom



MANAGING THROUGH TECHNOLOGY



10 ÉCOLES MINES ET TÉLÉCOM

- Mines Albi - Albi, Saint-Dié
- Mines Alès - Alès, Montpellier, Nimes, Pau
- Mines Douai - Douai
- Mines Nantes - Nantes
- Mines ParisTech - Paris, Palaiseau, Evry, Fontainebleau, Sophia Antipolis
- Mines Saint-Etienne - Saint-Etienne, Gardanne
- Télécom Bretagne - Brest, Rennes, Toulouse
- Télécom Ecole de Management - Evry, Paris**
- Télécom ParisTech - Paris, Sophia Antipolis
- Télécom SudParis - Evry, Palaiseau-Saclay

2 ÉCOLES FILIALES

- Eurecom - Sophia Antipolis
- Télécom Lille1 - Lille

ÉCOLE PARTENAIRE STRATÉGIQUE

- Mines Nancy - Nancy, Saint-Dié

13 ÉCOLES ASSOCIÉES

- ENIB - Brest
- ENSEEIH - Toulouse
- Enseirb-Matmeca - Bordeaux
- ENSG - Vandœuvre-lès-Nancy
- ENSIIE - Evry
- ENSSAT - Lannion
- ESIGELEC - Rouen
- Grenoble Ecole de Management - Grenoble
- IFMA - Clermont-Ferrand
- Sup'Com Tunis - Tunis
- Télécom Nancy - Villers-lès-Nancy
- Télécom Physique Strasbourg - Strasbourg
- Télécom Saint-Etienne - Saint-Etienne

26 engineering
& business
schools



1. Fraunhofer IZM (DE, Coordination, WP2, 5)
2. EcoDesign Center Wales (EDCW, UK; WP2, 6)
3. Institut Mines-Télécom (IMT, FR; WP8)
4. Nottingham Trent University (NTU, UK; WP3)
5. OUT (DE; WP4)
6. Sirris (BE; WP7)

Research,
Academic

7. ELPRO Elektronik-Produkt Recycling GmbH (DE; WP5)
8. Braun Lighting Solutions (DE; WP4, demonstrator1)
9. ONA (ES; WP4, demonstrator 3)
10. Riva GmbH Lighting (DE; WP4, demonstrator 4)

SMES

11. ETAP Lighting (BE; WP4, demonstrator 2)
12. Philips Lighting (NL; WP6)
13. Umicore (BE; WP5)

Larger
Companies

Outline



1. Introduction

2. Objectives

3. Methods

4. Results



1. Introduction



- IEA: the amount of electricity used by **lighting sources = 20% global electricity consumption**.*
- Lighting = greatest share of electricity expenses of many municipalities (electricity mostly produced with **hydrocarbon energy sources**).
- Nowadays: **switch to LED technologies** (reduced ecological impacts).

* Source: Aman, M. M., G. B. Jasmon, et al. (2013). Analysis of the performance of domestic lighting lamps. *Energy Policy* 52(0), pp. 482-500.

1. Introduction



Lighting in a nutshell: Stage 1 (**flame-based lighting**)

Fuel combustion has dominated the long history of lighting:

- **4,500 years ago**: in modern day **Iraq** oil lamps were used to burn oils made from olives and seeds.
- **2,000** years ago: the first **candles** appeared in Rome.
- **200** years ago: first **gasworks** established in Freiburg by Lampadius (German mineralogist).

1. Introduction

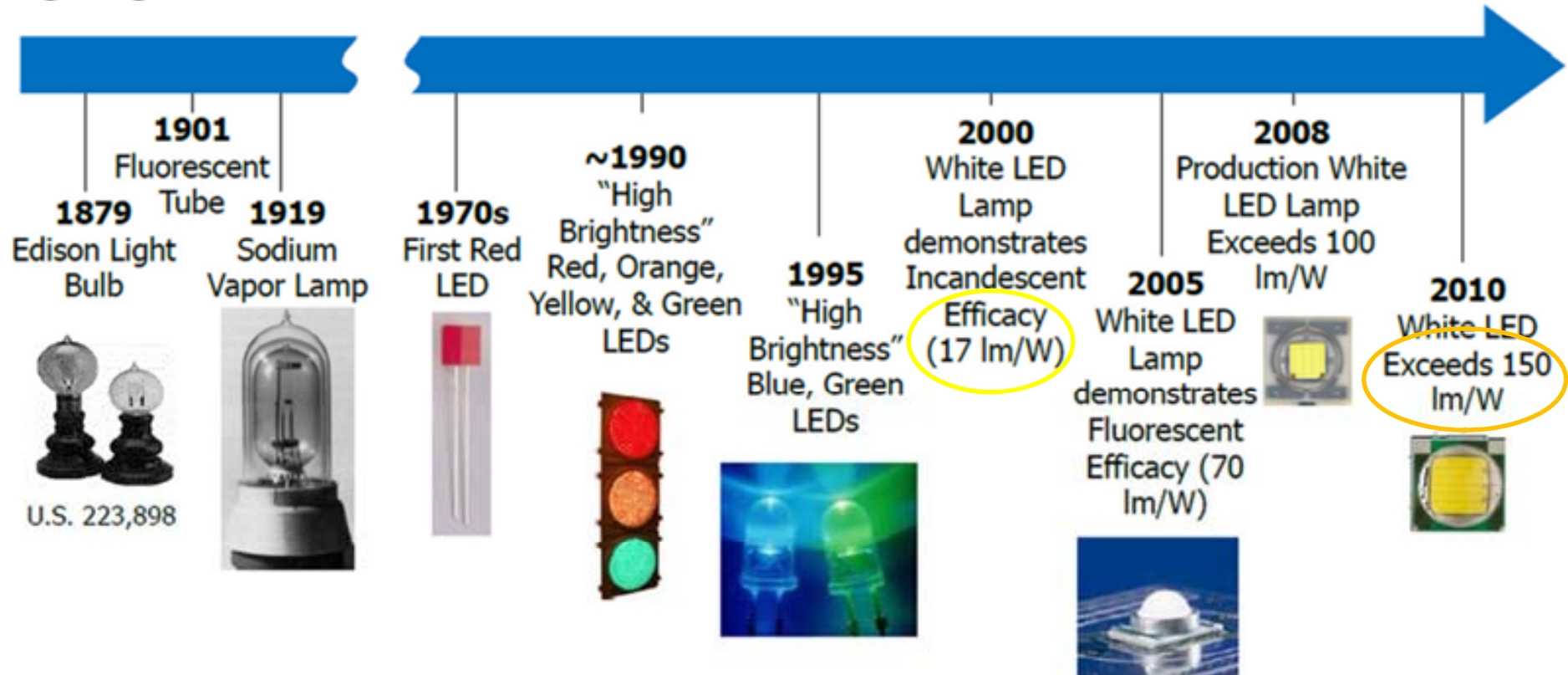


Lighting in a nutshell: Stage 2 (**electricity-based lighting**)

- Early work on incandescent lamps dates from 1840; in October **1879 Edison** built and tested a ‘filament lamp’.
- By 1881, Edison’s company was manufacturing complete lighting systems (wiring, switches, lamps...).
- 1962: red light emitting diodes/LEDs (Holonyak from GE).
- **1994: blue LED** (**Nakamura** from Nichia).
- 1997: white LEDs (ibid.).

1. Introduction

Lighting milestones



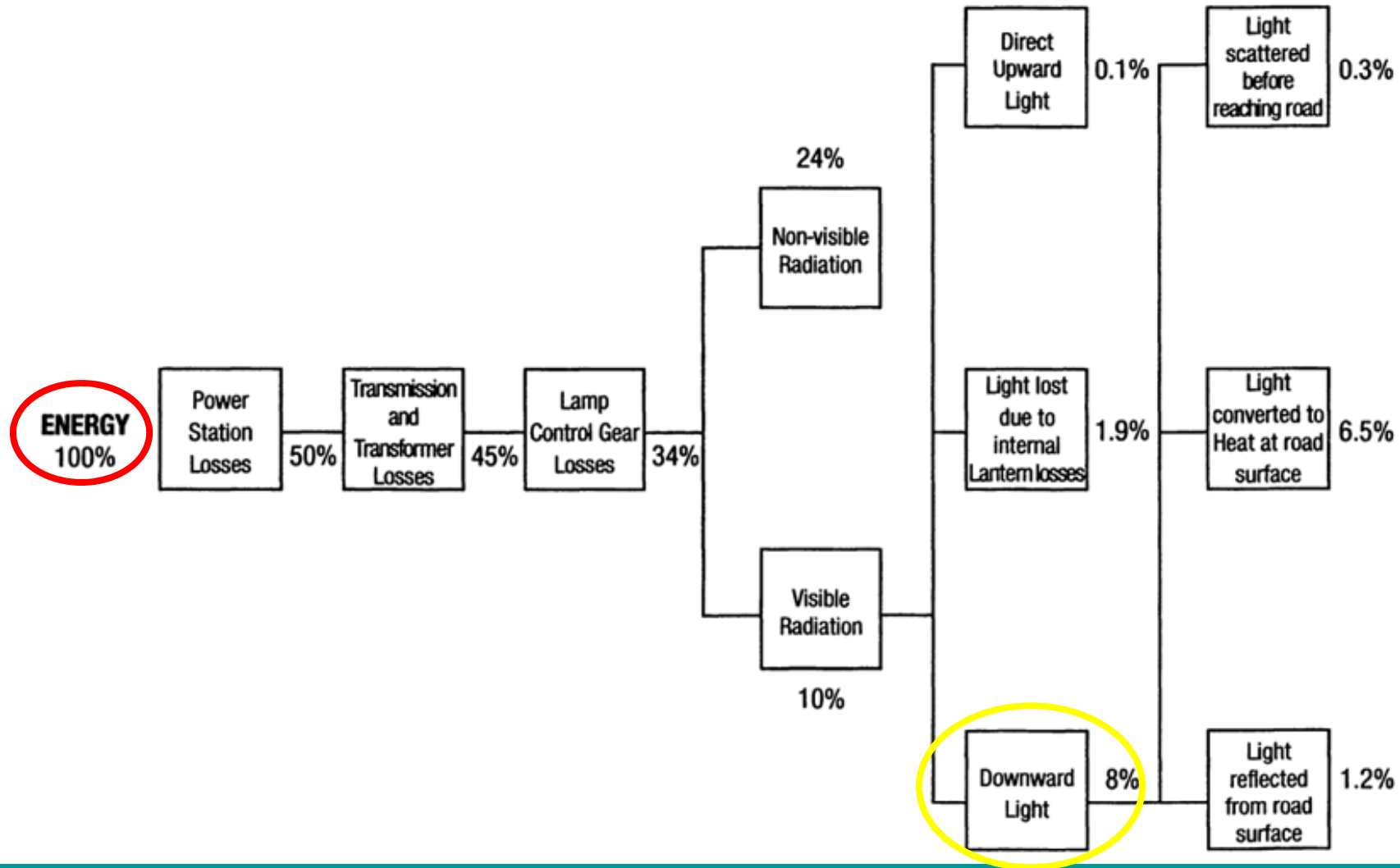
1. Introduction



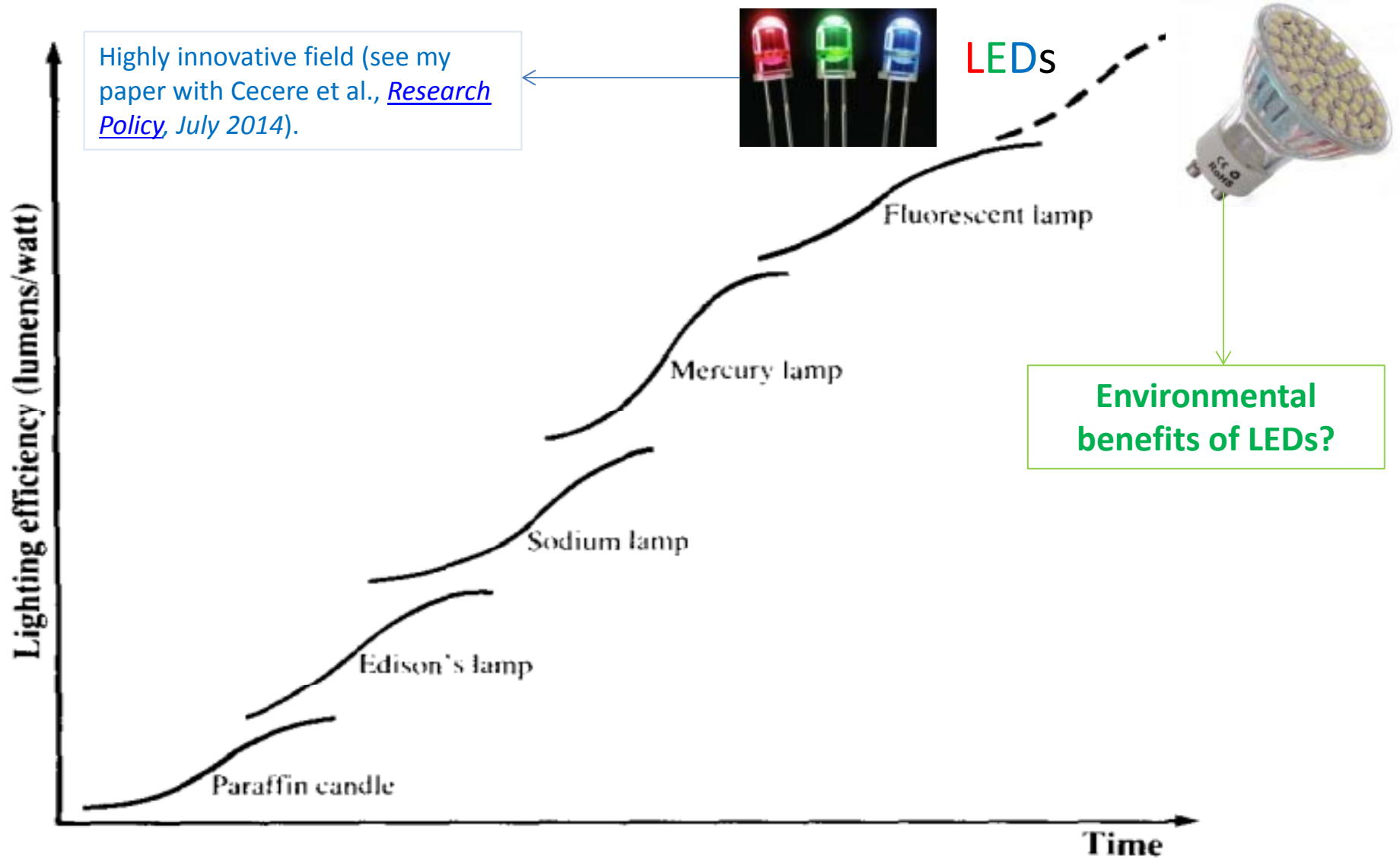
... but more heat than light!



The energy chain from power station to **road lighting**

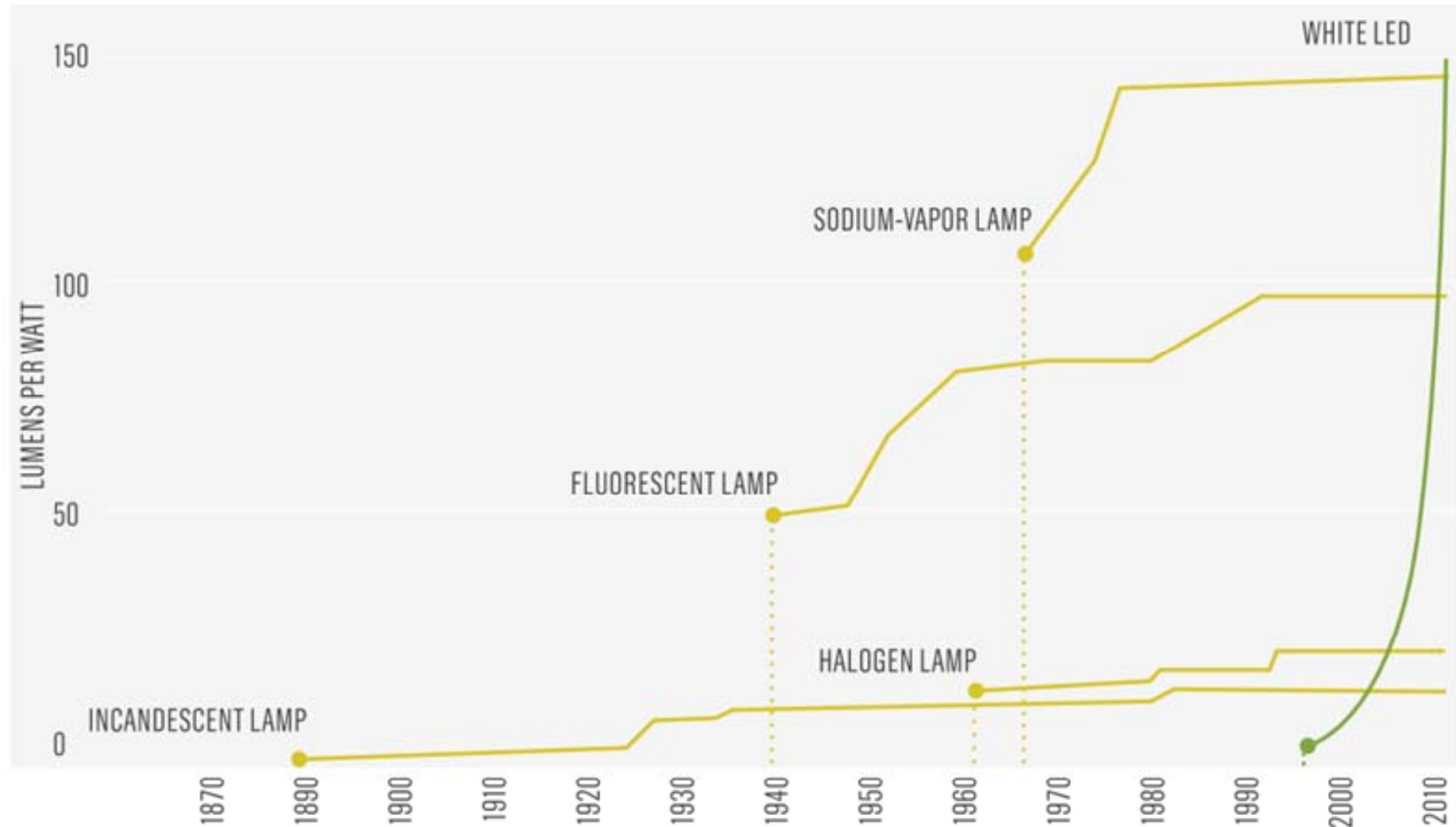


What solutions to inefficient lighting?



Energy benefits of LEDs

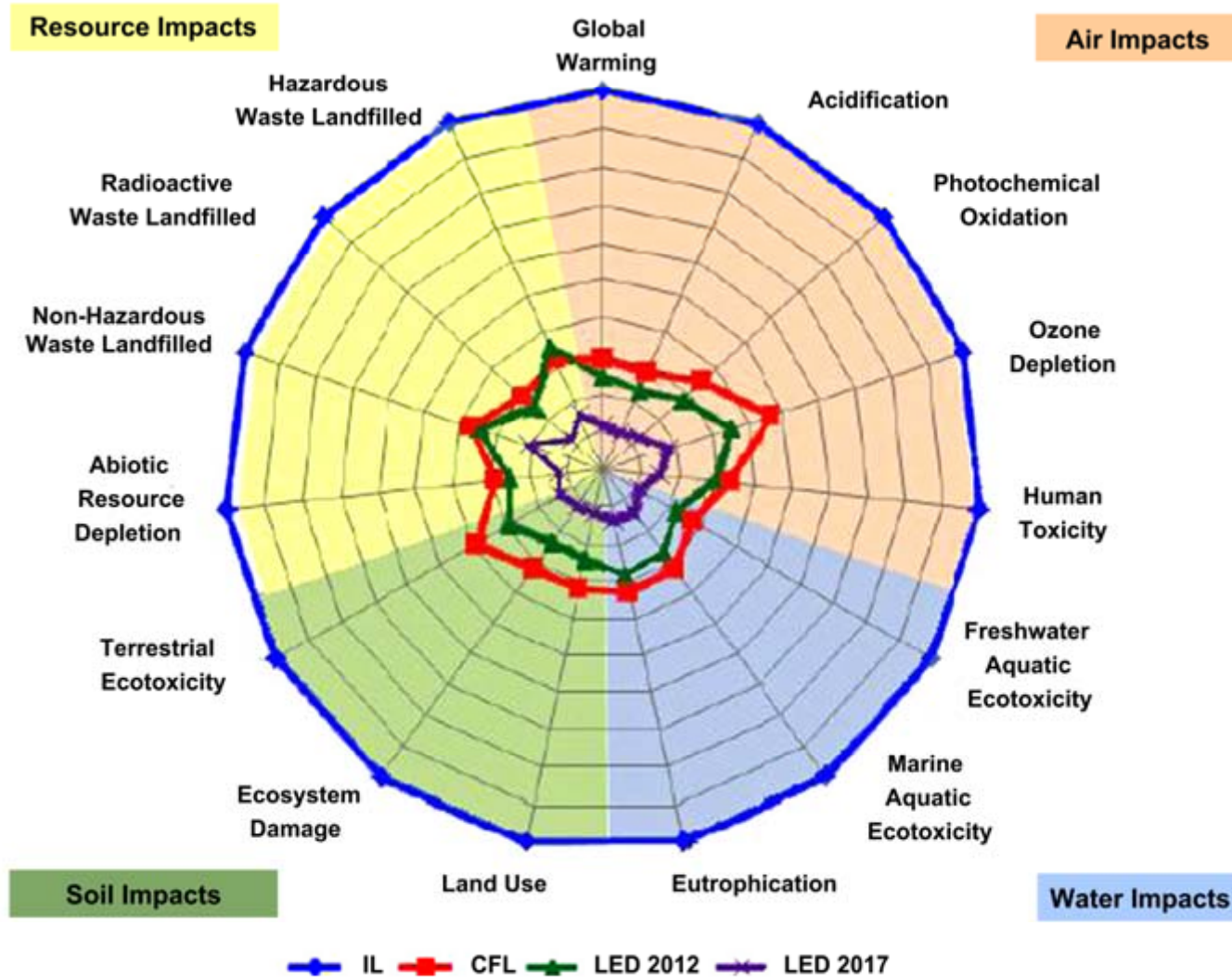
LED efficiency is rapidly surpassing that of incumbent lighting technologies



Environmental benefits of LEDs can still be improved



Life-cycle assessment impacts of IL-CFL and LED lamps



2. Objectives

Identify & overcome

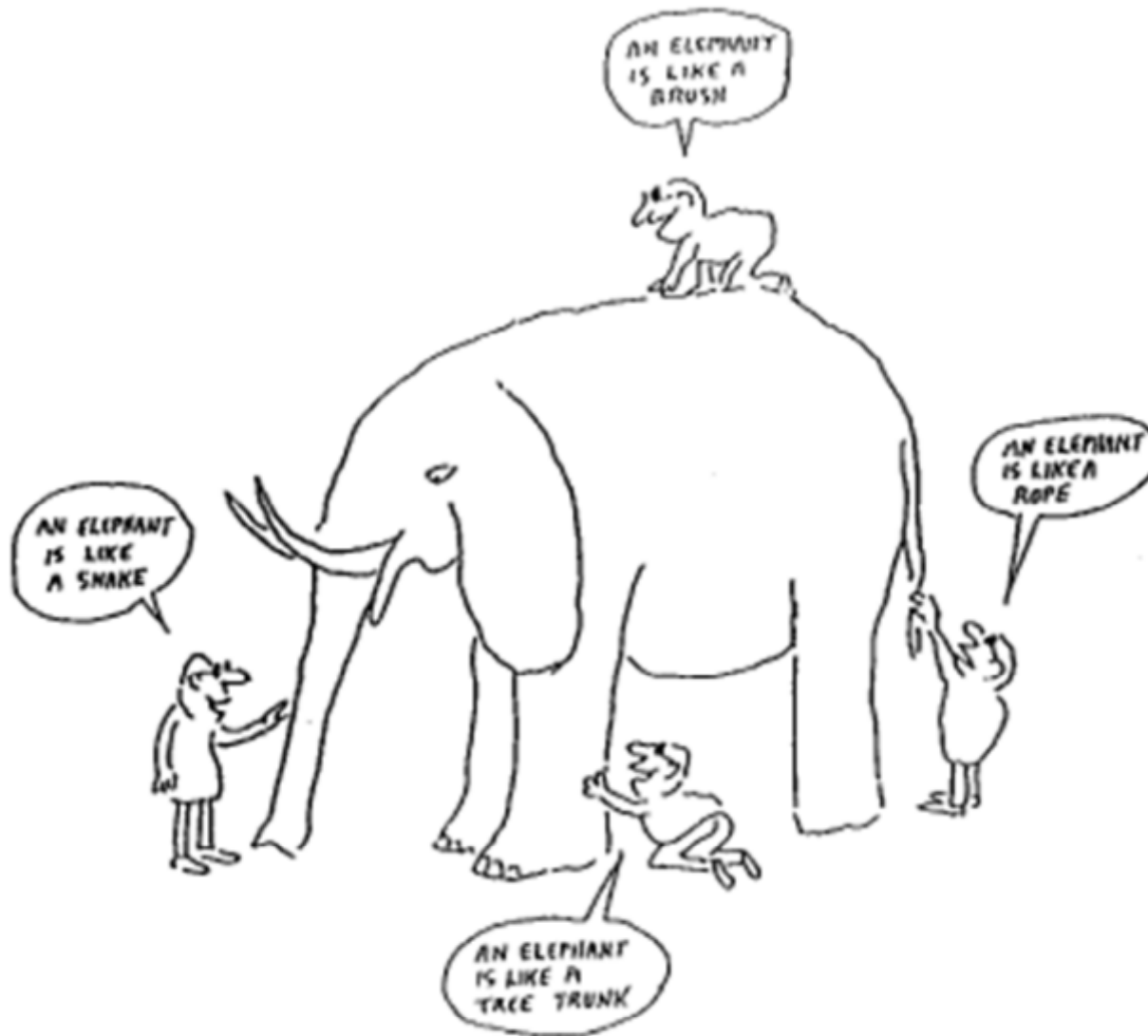
barriers to eco-innovation

in the LED sector

(cycLED WP8)

3. Methods

A plea for methodological pluriformity



Phase I:
Qualitative &
explorative

Phase II:
Quantitative
& extensive

Method for Phase I



Face-to-face interviews:

How problematic is that barrier to EI for your organisation?			
-1	0	1	2
Not a barrier: a support to ecoinnovation	Irrelevant for my organisation	Relevant barrier for my organisation	Major barrier for my organisation

A - BARRIERS WITHIN YOUR ORGANISATION (1/3)

Categories	Barriers	-4	21	10	18	Total score per SME
		Firm 1	Firm 2	Firm 3	Firm 4	Total score per barrier
VISION & STRATEGY	Lack of clear definition of ecoinnovation	-1	0	0	0	-1
	Weak environmental commitments	-1	0	0	0	-1
	Environmental commitments are not realised	-1	1	0	0	0
	...					
INNOVATION & DESIGN MANAGEMENT	Lack of consistent R&D strategy	-1	0	0	0	-1
	Lack of integration of ecological objectives in the design phase	-1	0	0	0	-1
	Too much uncertainty in the timing of innovation	1	0	0	0	1
	Cognitive routines and shared beliefs of designers are not geared towards ecoinnovation	0	0	0	0	0
	Sticky Knowledge: some people are reluctant to share their knowledge, recipients cannot process the information, ...	0	0	0	1	1
...						

Method for Phase II



Online survey of European LED firms:

<http://cycled-survey.eu/>

Survey on Eco-innovations in the Lighting Industry

This survey investigates the barriers to eco-innovation in the lighting industry. We define eco-innovation as any novelty or significant improvement developed or adopted by your company to reduce environmental impacts.

This survey is made within the **CYCLED** project which is supported by the European Commission 7th Framework Program for Research and Technological Development (FP 7).
The results of this survey will be used in a scientific project and the final report will be provided to the participants upon their request.
All contact information will be held confidential and will not be disclosed in survey results. We will use your name and email address to follow-up with you and send you the results.
This survey will take less than 15 min.

0% 100%

English ▾
Field by:

Name:

Job title:

Phone:

Email:

4. Results

Main obstacles to eco-innovation for LED firms

1. Lack of certification mechanisms to check out the technical specifications of LED products.
2. Inadequate support from national policies to support ecoinnovation and emerging LED technologies.
3. Increasing and unfair competition from non-European firms.
4. Early failure of LED drivers.
5. Lack of funding to support SMEs' ecoinnovation.
6. Lack of well trained and educated staff on ecoinnovations.
7. Existence of litigations between firms.

Source: cycLED Policy Brief, <http://gossart.wp.mines-telecom.fr/files/2015/05/cycLED-Policy-Brief.pdf>

What can firms do?



Name of the barrier to ecodesign	Key solutions
Lack of in-house sources of finance	Funding schemes for SMEs to support R&D as well as the diffusion of LED products (marketing campaigns, ...)
LED drivers are barriers to ecodesign	Standardisation and better quality control procedures should be implemented in Europe
The gross intrinsic value is too low	Develop business models more favourable to design for recycling, such as product service systems
Eco-innovation costs are too difficult to control	Support the collaboration between large and small LED firms
Information systems are sources of rigidity that discourage eco-innovation	Provide support to SMEs to carry out technology watch activities
Lack of technical personnel to ecoinnovate	Provide eco-innovation courses to personnel and develop partnerships with local training and technology institutes

What can policy-makers do?



Name of regulatory barrier	Key solutions
Lack of certification mechanisms to check out the technical specifications of products	Launch of an EU programme to guaranty the accuracy of LED products' specifications
National policies do not provide adequate support to ecoinnovation and/or emerging LED technologies	Introduce financial support schemes to reward consumers adopting ecodesigned LEDs
Increasing & unfair competition from non-European firms	Strengthen the environmental requirements of LED products put on the EU market
Existence of litigations between firms	Adopt Fair Reasonable and Non-Discriminatory (FRAND) licensing regimes to LED products
Lack of funding to support SMEs' eco-innovation	Increase specific funding schemes targeting eco-innovative SMEs
Lack of skilled people to repair used LED products	Organise an LED industry-wide training programme to level up the eco-innovation skills of its employees
Educational institutions do not provide enough people well trained to develop ecoinnovations	Strengthen collaboration on LED eco-innovation between research institutes, SMEs and universities
Lack of modularity between radical innovations	Improve the standardisation of LED products and components

More information in the cycLED Policy Brief:



<http://gossart.wp.mines-telecom.fr/files/2015/05/cycLED-Policy-Brief.pdf>



THANK YOU.



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Une école de l'Institut Mines-Télécom

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Co-animator of the interdisciplinary **ICT & Environment Research Network** of the IMT

<http://rt08.wp.mines-telecom.fr>



Backup slides

What is an LED?

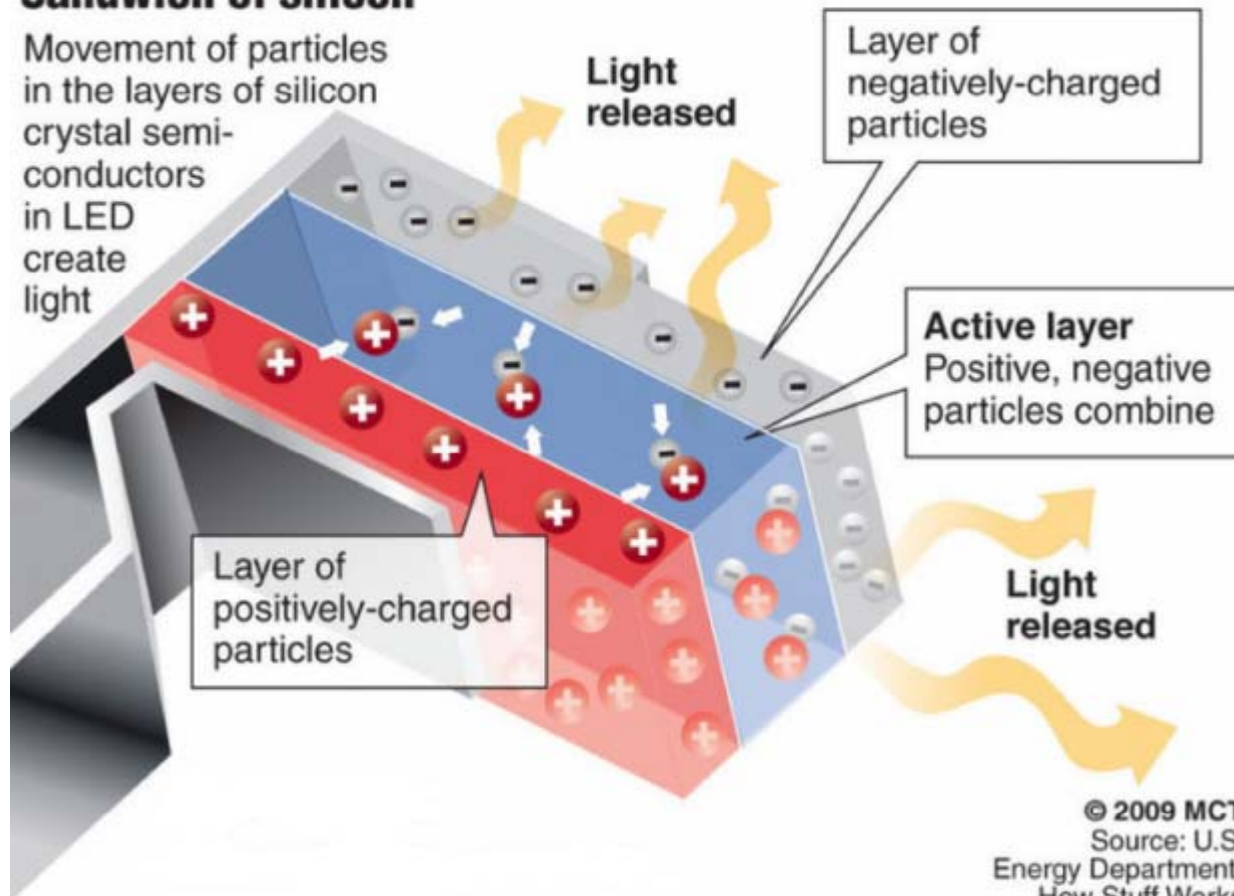


How an LED works

Scientists are making a replacement for the energy-wasting light bulb; "solid-state light" devices made of light emitting diodes (LEDs).

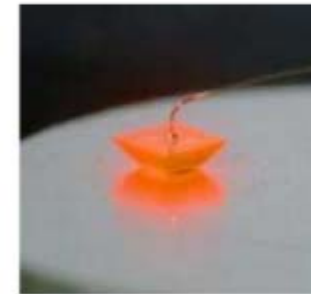
Sandwich of silicon

Movement of particles in the layers of silicon crystal semi-conductors in LED create light



© 2009 MCT
Source: U.S.
Energy Department,
How Stuff Works
Graphic: Lee Hulteng,
Judy Treible

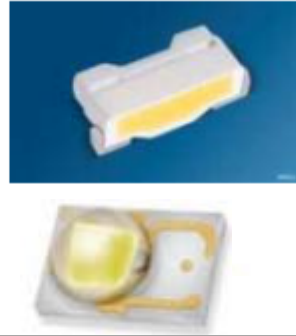
LED die (level 0)



The LED die consists of epitaxial layers of doped semiconductors (III-V): one n-conductive layer with a surplus of electrons and a p-conductive layer with a lack of electrons (or surplus of "positive" holes) and the depletion layer in between. When a voltage is applied, the electrons in the n-layer have enough energy to cross the depletion layer. They recombine with the holes in the p-layer and energy is released in form of electromagnetic radiation (light).

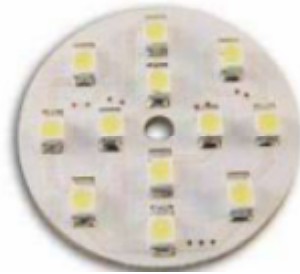
Source: cycLED Deliverable 2.1: Categorization of LED products.

LED package
(level 1)



An assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES, 2010)

LED on PCB
(level 2)



An assembly of LED packages or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES, 2010)

LED module
(level 3)



An integrated assembly comprised of LED packages or LEDs on PCB, LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard base. (IES, 2010)

LED Luminaire
(Level 4)

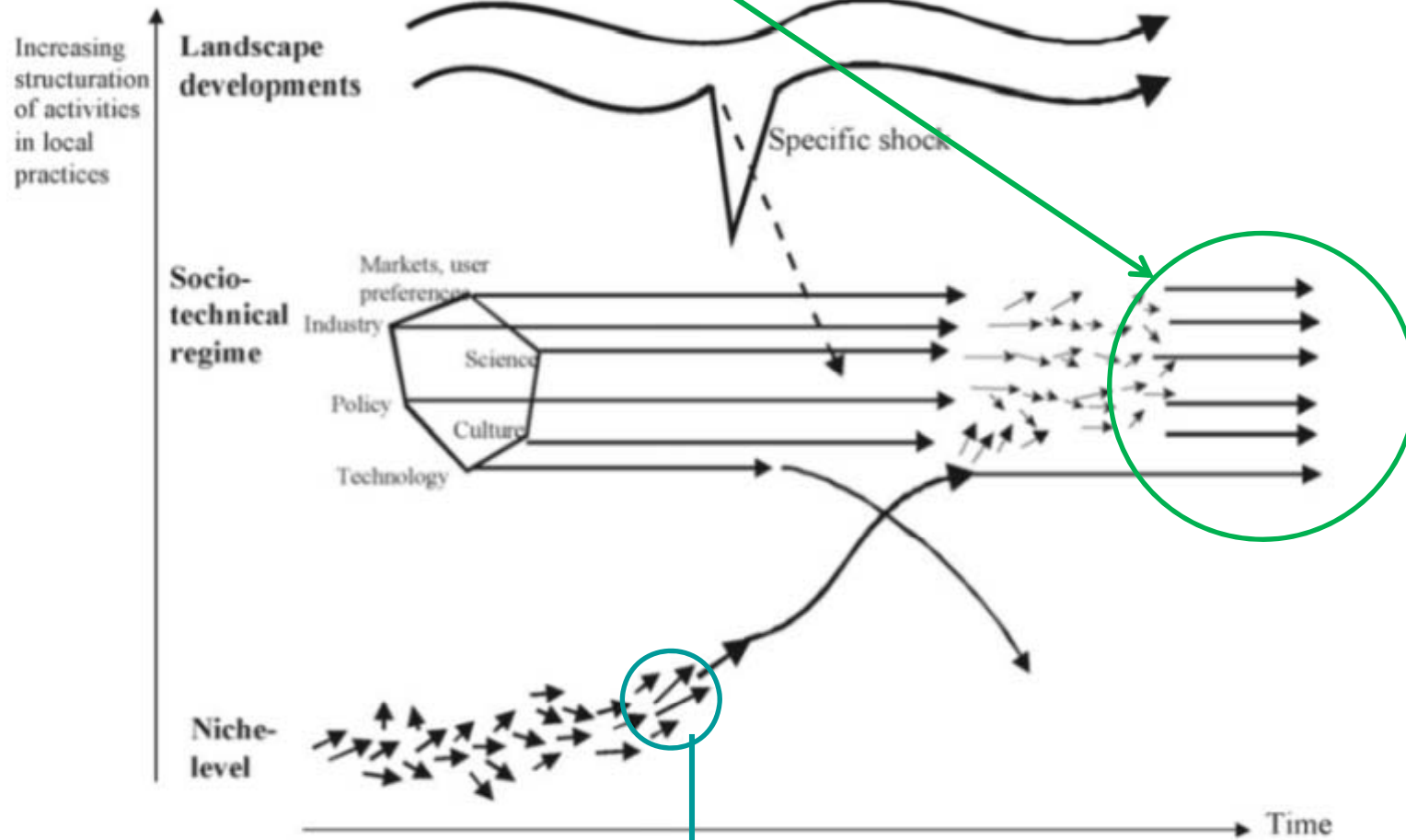


A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit. The LED-based light emitting elements may take the form of LED packages, LEDs on PCB or LED modules. The LED luminaire is intended to connect directly to a branch circuit. (IES, 2010)

Cradle-to-cradle LEDs?



Regime shift following an external shock



Source: Geels and Schot (2007: 410).

cycLED demonstrators



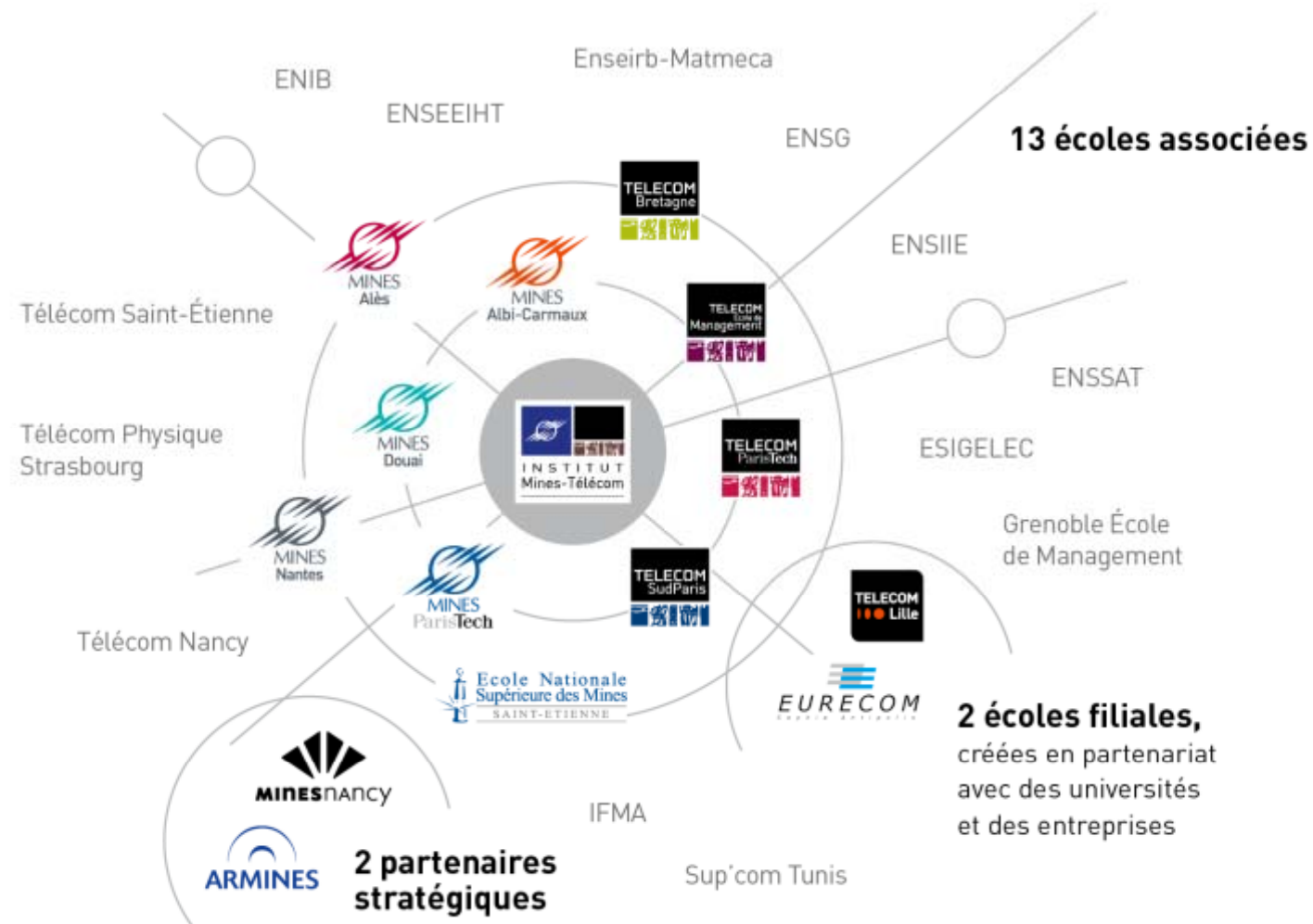
The cycLED project



- Objectives:
 - Minimize consumption of target metals in LED-products via
 - Design for longevity, reuse, repair;
 - Optimized end-of-life of LED products.
 - Produce highly efficient **ecodesigned LED products.**
- Project Duration: 42 months
 - 1 January 2012 to 30 June 2015
- Coordination:
 - Dr. Otmar Deubzer, Fraunhofer IZM
- Financing:
 - ~ 5.4 mio €, co-funding of ~ 4 mio € by EC, FP7 (CP, DG ENV)
- cycLED project web page: www.cyc-LED.eu

- **Main objective**: Investigate possible developments in the cultural association of technology and masculinity within sustainable development, which could impact (positively or negatively) women's participation in eco-innovation.
- **Method**: Face to face interviews with 5 staff members from 2 cycLED partners (ETAP, IZM).
- **Status**: Interviews are being transcribed, they will be coded and analysed between June & October 2014.

Institut Mines-Télécom (IMT)



IMT: Key figures



10 schools

2 subsidiary schools

2 strategic partners

13 associated schools

12,555 students

1,725 PhD students

+4000 graduates per
year

Including over 2,500
engineers

8% engineering
degrees issued in
France

32 % foreign students

38 % grant holders

4,800 staff members

2,000 researchers

2 Carnot Institutes

€121 M research-generated
income per year

About 100 business start-
ups per year at the schools'
incubators

NB: 2012 data, excluding associated schools.