



Lighting, Circular Economy & Life Cycle Assesment, G.Zissis, Seminaire

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UMR 5213


Lighting, Circular Economy & Life Cycle Assessment

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Toulouse, Région Occitanie, France



4th French City
950,000 Inhabitants
100,000 Students

A modern European metropole with
more than 2,000 years of history.




The European aerospace capital
known also for its hospitality
traditions, quality of life and
gastronomy

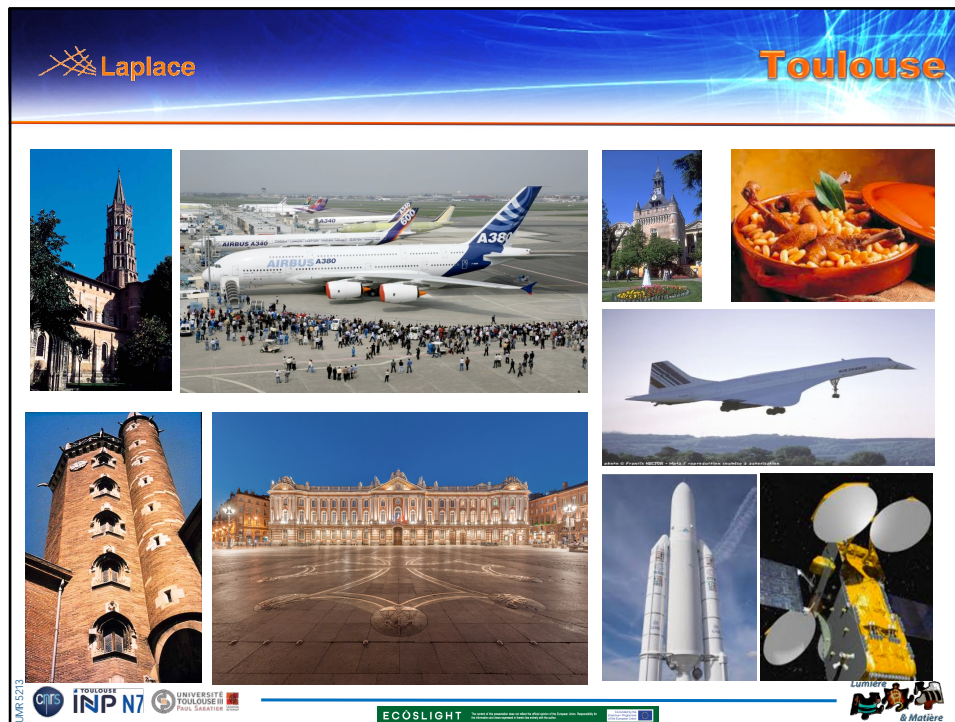




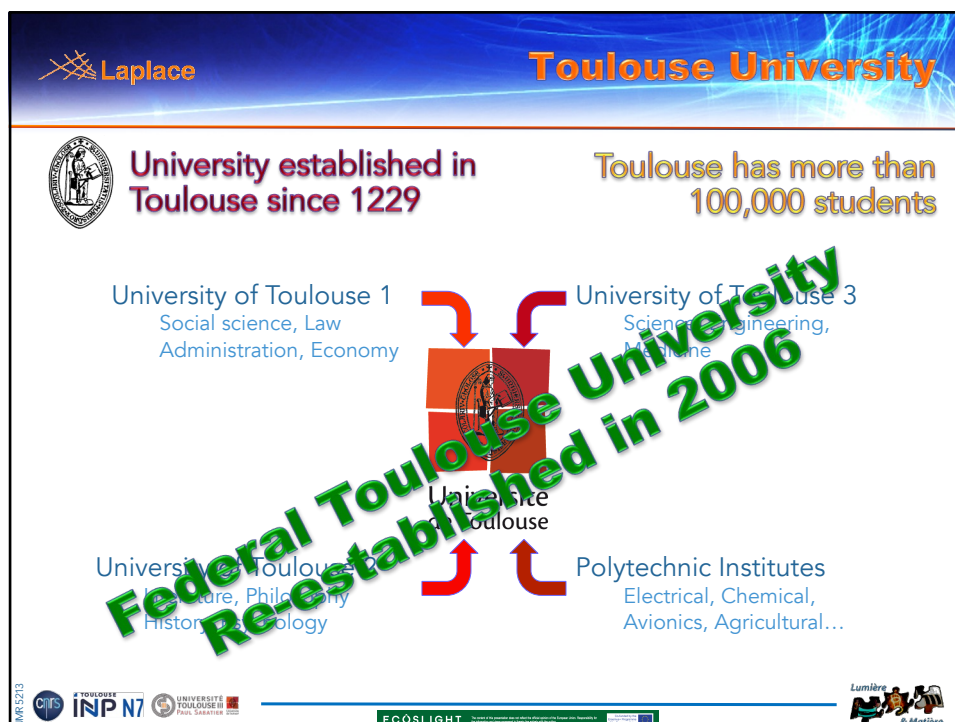




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Laplace **Université Toulouse III Paul Sabatier**

UT3: The 2nd largest French Scientific University (after Paris VI)

Paul Sabatier was born in Carcassonne in 1854. Professor of Chemistry, Nobel Prize in Chemistry In 1912



Health Sciences

Sport & Languages

Faculty of Sciences & Engineering

Natural & Planet Sciences

Physics

Mathematics

Computer Science

Civil & Mech. Engineering

Electrical Engineering




- ✓ 480 M€ of annual budget
- ✓ 384 000 m² of buildings (147 000 m² dedicated to Research)
- ✓ 31 000 students
- ✓ 11 000 graduates per year
- ✓ 400 PhD thesis per year
- ✓ 2350 permanent University academic staff
- ✓ 1100 dedicated researchers (CNRS, INSERM, etc..)
- ✓ 1500 engineers, technicians, administrative staff
- ✓ 1st in Shanghai academic ranking for Tele-detection

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Laplace **Some global figures & Lighting Impacts**

13-14%
2 900 TWh of annual electricity world-production for generating artificial light

~2%
2% of world annual energy primary resources used

1 150 000 000 metric tons CO₂
5% of the world CO₂ annual emissions = 230 million people CO₂ emissions

30 000 000 000
More than 30 billion electric lamps operate everyday worldwide

40-45%
LED market revenue share

\$120 000 000 000
Lighting industry annual turnover US\$ 120 billion and still growing.



Revenues - \$bn

Year

Artificial lighting has a large impact on energy, environment but also on every day's life and world's economy

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Laplace **The “Sustainable Smart Lighting”**

A smart lighting system's principal function is to produce, at any moment, the right light: where it is needed and when it is necessary.

It should adapt the quantity and quality of light to enhance visual performance in agreement with the type of executed tasks.

It must guarantee well-being, health and safety of the end-users.

It should not squander passively the resources of our planet and limit actively the effects of light pollution on the biotope, or, any other impacts on the environment.

Ideally, the system could offer additional services (geo-localisation, data connectivity...) to the end-users through Visible Light Communication protocols.

► **The SSL² concept:**

A Sustainable Smart Lighting (SSL) system uses and optimizes to an intelligent way the best existing technology (Solid State Lighting – SSL) to best fulfil present needs for artificial light and reduce undesirable side-effects, without compromising the ability of future generations to innovate.

Light-up smart, to a sustainable & affordable way, where it is needed, when it is necessary and as best as possible!

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Laplace **Circular Economy - Definition**

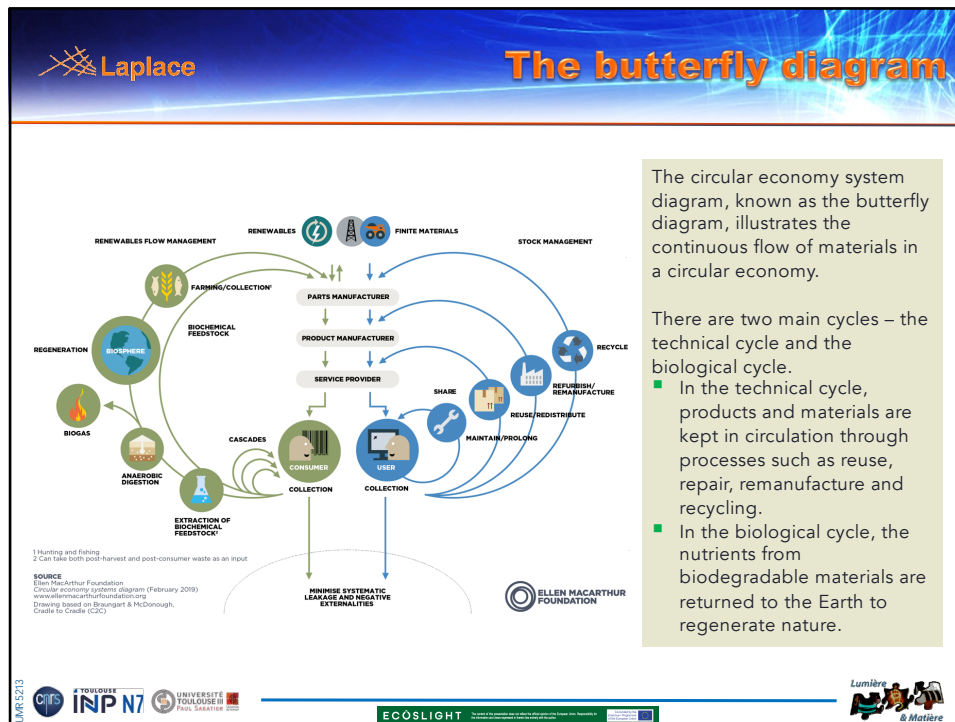
- ✓ Circular economy aims to redefine growth, focusing on positive society-wide benefits.
- ✓ Looking beyond the linear model “Extract-Produce-Consume-Waste” current industrial model.
- ✓ It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system.
- ✓ It is built on three principles, driven by design:
 - Eliminate waste and pollution
 - Circulate products and materials (at their highest value)
 - Regenerate nature

Linear economy model

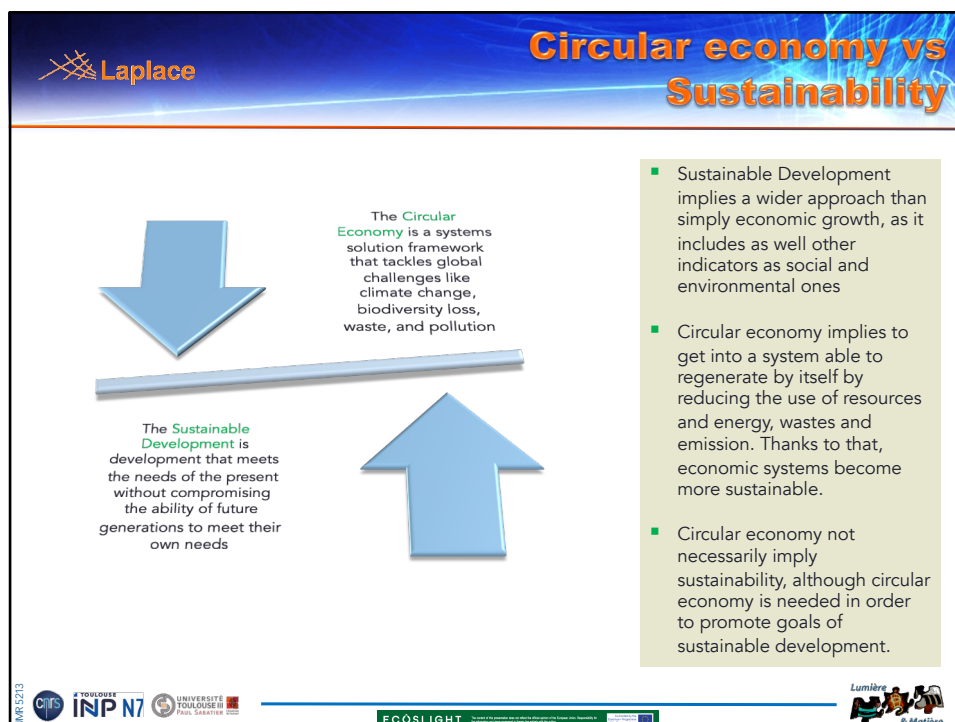
Circular economy model

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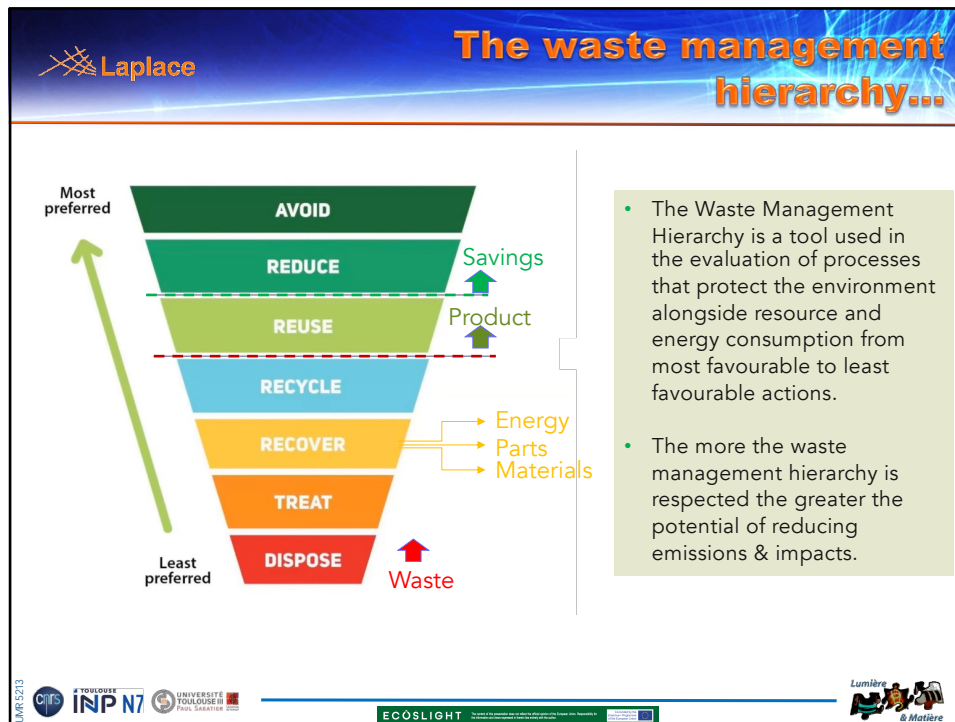
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Laplace **Recycling vs Reusing**

Recycling:

- ✓ Enables to reduce demand in raw materials
- ✓ Demands less energy than production of primary materials.

Savings in energy use and greenhouse gas emissions by recycling will be between 40-80% for most recycled materials compared to the energy needed to produce primary materials.

EU recycling targets:

- All packaging: 70% by 2030
- Municipal waste: 65% by 2035

Reusing:

- ✓ Reducing demand for primary raw materials by:
 - making products more durable or easier to repair from the design stage
 - or remanufacturing processes where a product or component is returned to a new like condition.

Examples/Initiatives:

- Predictive maintenance solutions.
- Second hand markets, community initiatives...

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Laplace **Reduce**

✓ Reduce the demand of a product

- Rethinking the concept of ownership ("lease than own")

FOR EXAMPLE Light as a Service (LaaS concept)

- Pay for electricity rather than lightbulbs
- Switch from lighting replacement products to financing and leasing lighting as a service

100 Current OpEx

10 Cash Savings

60 Lighting as a Service Contract

30 New OpEx

70 Cash Savings

30 New OpEx

Before Contract Savings Generated After Contract

“...This will reap not only the direct economic benefits of lighting but also the benefits beyond lighting fully in line with the transition from a linear to a circular economy...” (Signify)

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Laplace **Avoid**

✓ Making the full process more energy efficient

- Turning one industry's by-product into another industry's raw material or/and energy.
- Increase reparability and facilitate maintenance
- Increase modularity and “intelligence” of the product
- Standardise the product

FOR EXAMPLE Improving the serviceability of lighting products (luminares)

- Luminaires can be repaired and have a longer technical lifetime thereby improving the material efficiency of the sector and reducing wastes.
- Serviceable luminaires enable new business models and create new jobs (new opportunities arise for professionals offering monitoring, maintenance, data analytics etc.)

Outdoor luminaire with connectivity plug

Connect now or later. It's plug and play.

Luminaire Extension Module

Driver

LED Module(s)

The driver and the LED module are replaceable; connectivity can be enabled by plugging in for example a module.


Source: White Paper, LightingEurope

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How do evaluate the impact of a product?



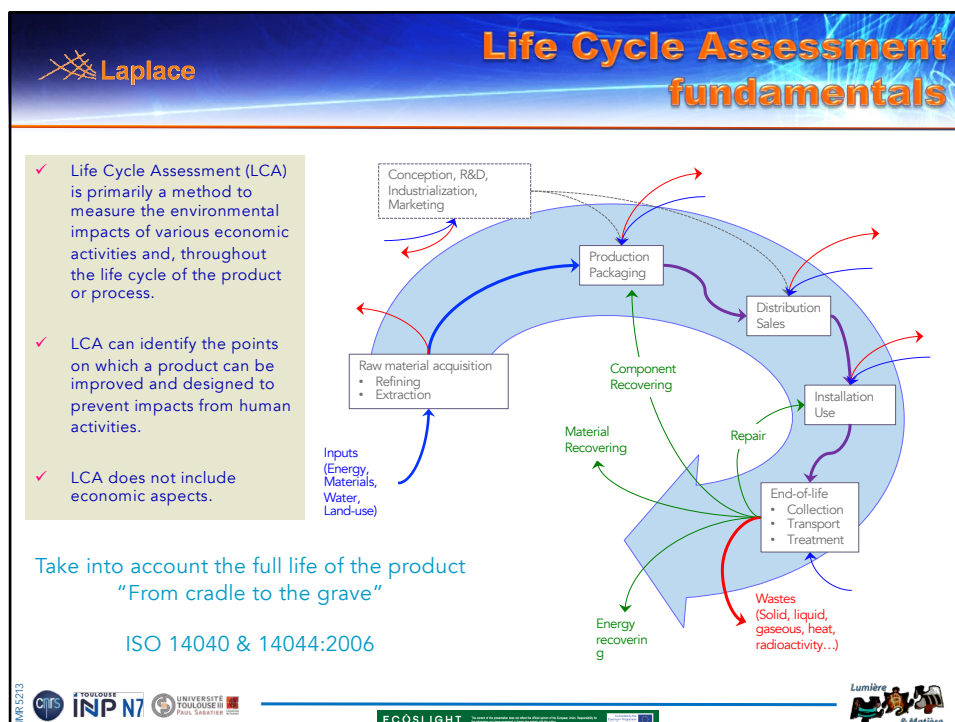
Challenges in lighting

- Reduced impacts related to energy consumption
- Avoid/limit the extraction of critical raw materials
- Avoid/limit use of toxic materials
- Avoid/limit impacts on human health & wellbeing
- Avoid/limit ecosystem disturbances

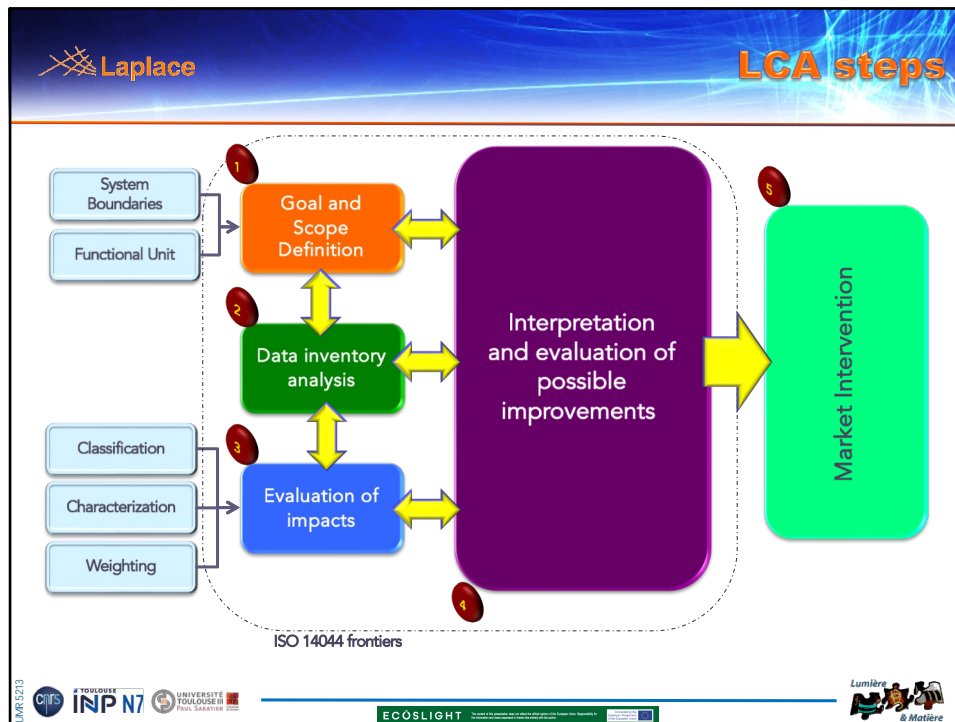
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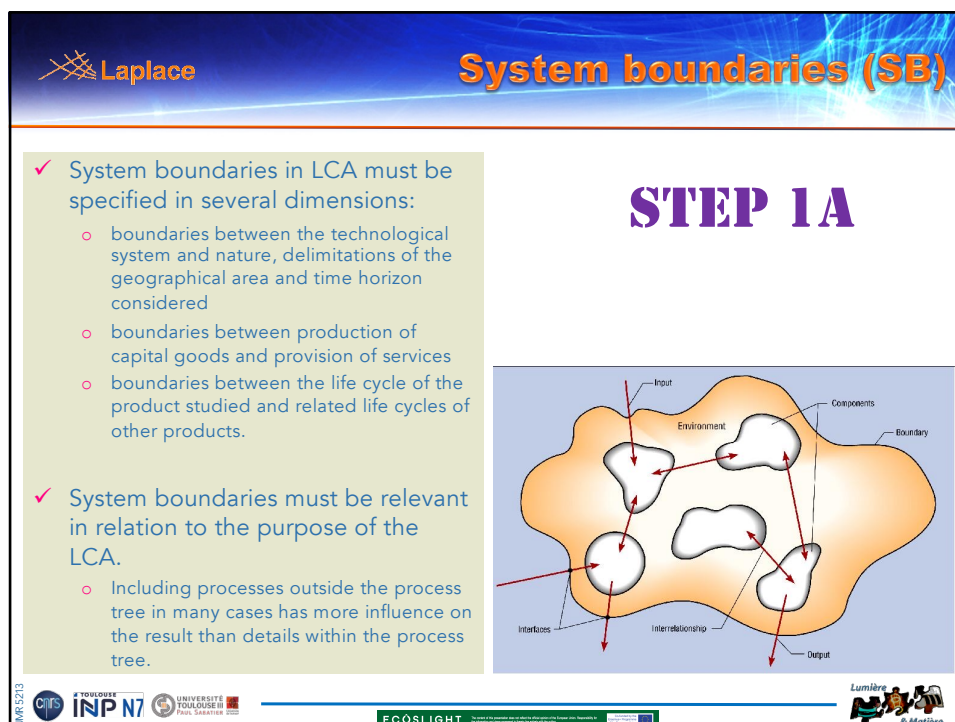
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Functional Unit (FU)


- ✓ A FU refers to the product, service, or system whose impacts are calculated by a LCA
 - The FU is an arbitrary parameter of standardization used to describe the final outcome
 - The FU is a measure of the performance of the product.
- ✓ The definition of a FU is essential for building and modelling a product system in LCA.
 - A FU should as far as possible relate to the functions of the product rather than to the physical product.

EXAMPLE
 For example, use rather "annual light quantity needed for illuminating a work area of 10 m² with 300 lx", than "number of bulbs providing 30 000 lm for one year".


STEP 1B

In a comparative study, the functional unit has to be the same for all the compared product or systems.

Remind: you can't compare apples and pears...



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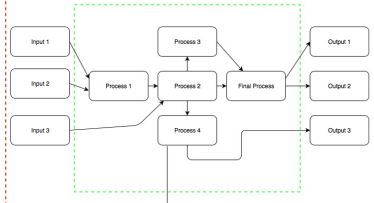


Life Cycle Inventory (LCI)

- ✓ The inventory relates to the compilation of various environmental inputs and outputs involved in the life cycle of a product.
- ✓ Compiling and preparing life cycle inventory data is a critical step in conducting an LCA.
- ✓ Inventory analysis translates in practice to data collection and analysis.
- ✓ Data collection involves the recording of the relevant inputs and outputs of the life cycle of a product or process.
 - ✓ Establish the life cycle flow map, detailing which processes are included within the boundaries of your LCA.
 - ✓ Decide if enough data for each process, or for the overall system are collected.
 - ✓ Compile relevant data such as electricity consumption, natural gas, materials, etc.
 - ✓ Ensure listing appropriate units and all relevant details and/or calculations for easier understanding

STEP 2

Key:
 LCA/LCA Boundary: - - - - -
 Process Boundary: - - - - -
 Functional Unit: per predefined unit

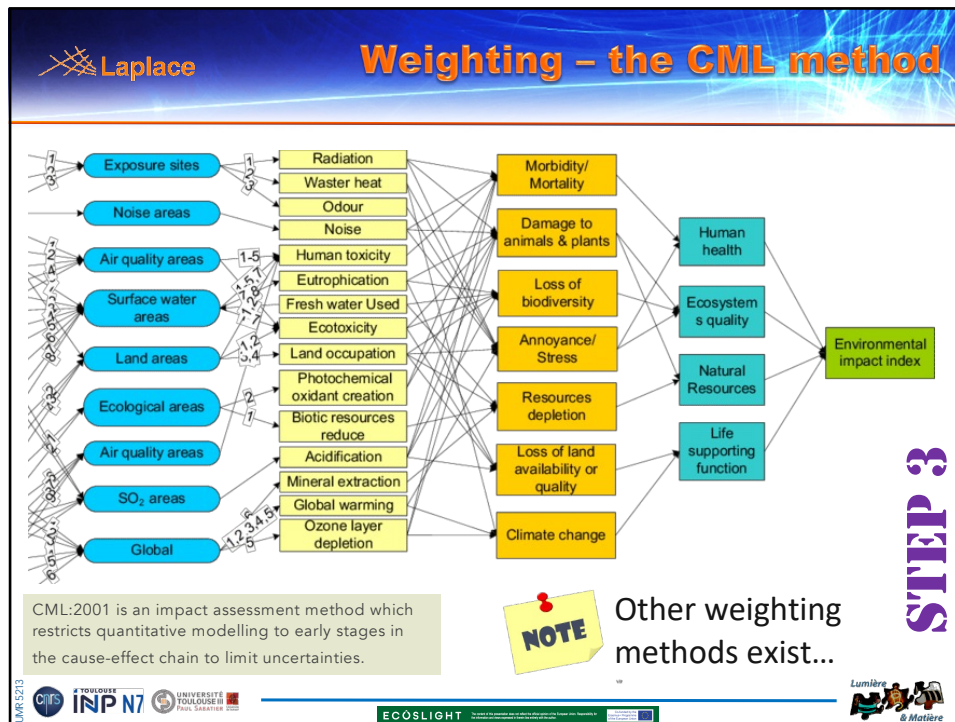


Outside LCA Scope

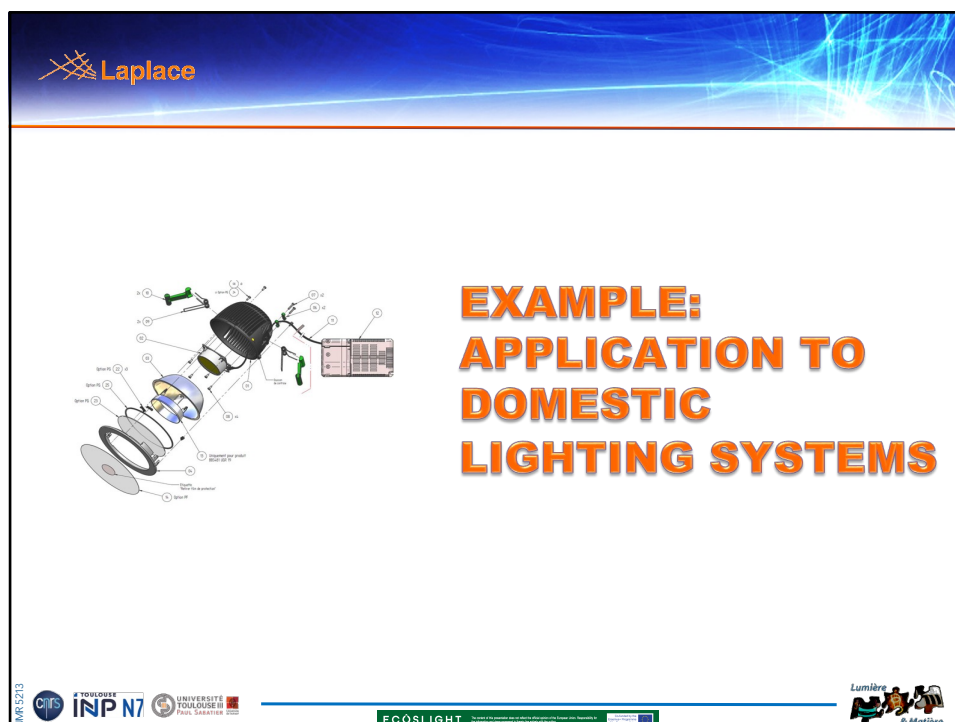
Remind: If the data set is not representative of the process, the LCA results will be skewed and irrelevant.

Examples of existing LCI databases

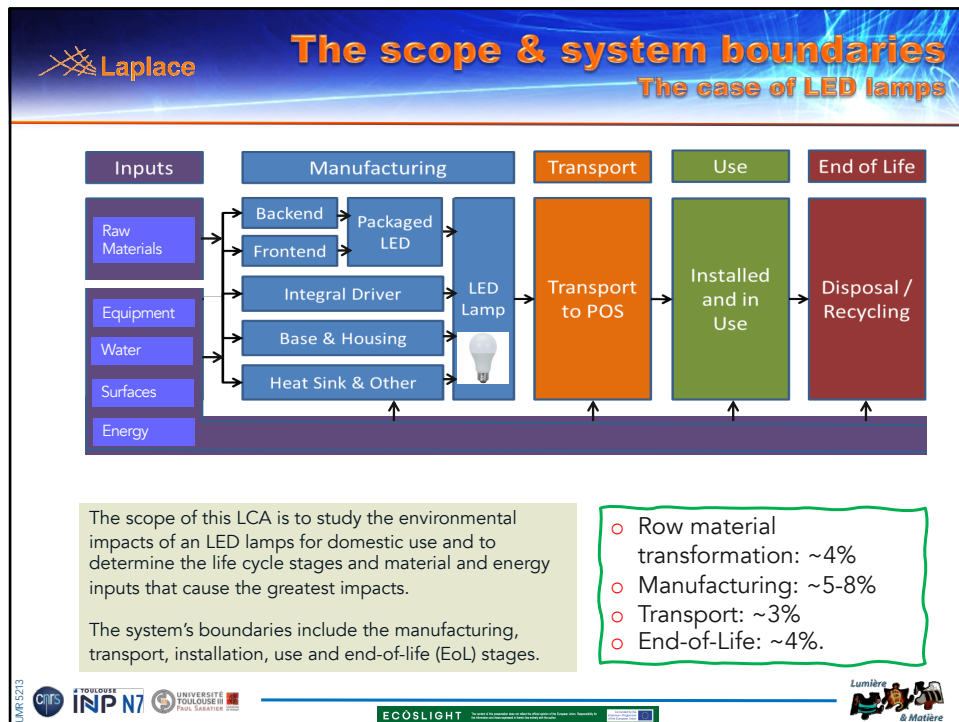
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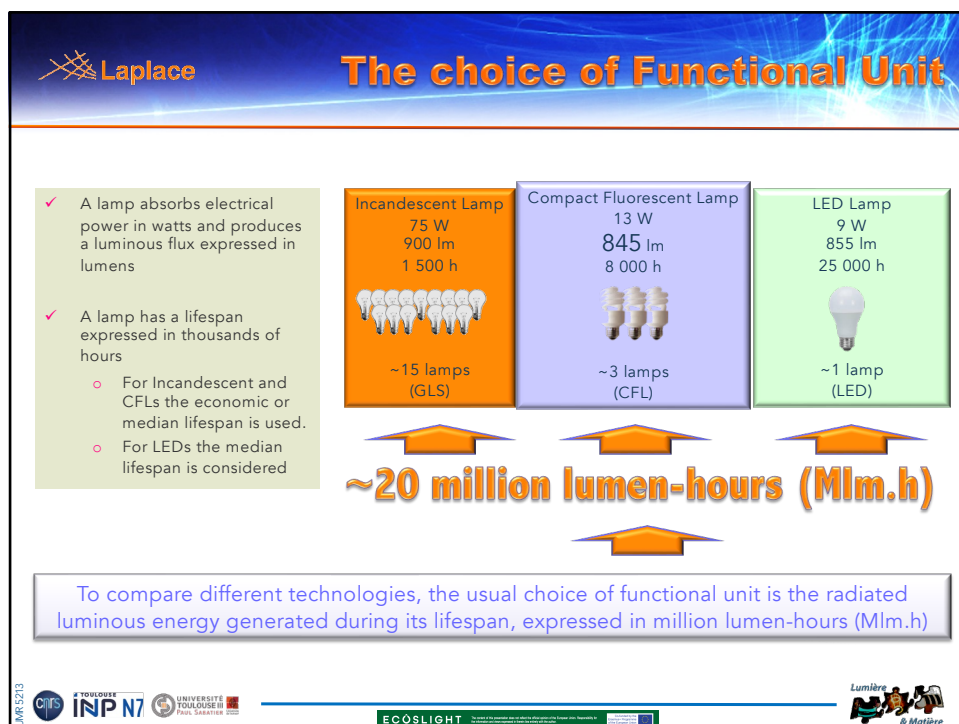
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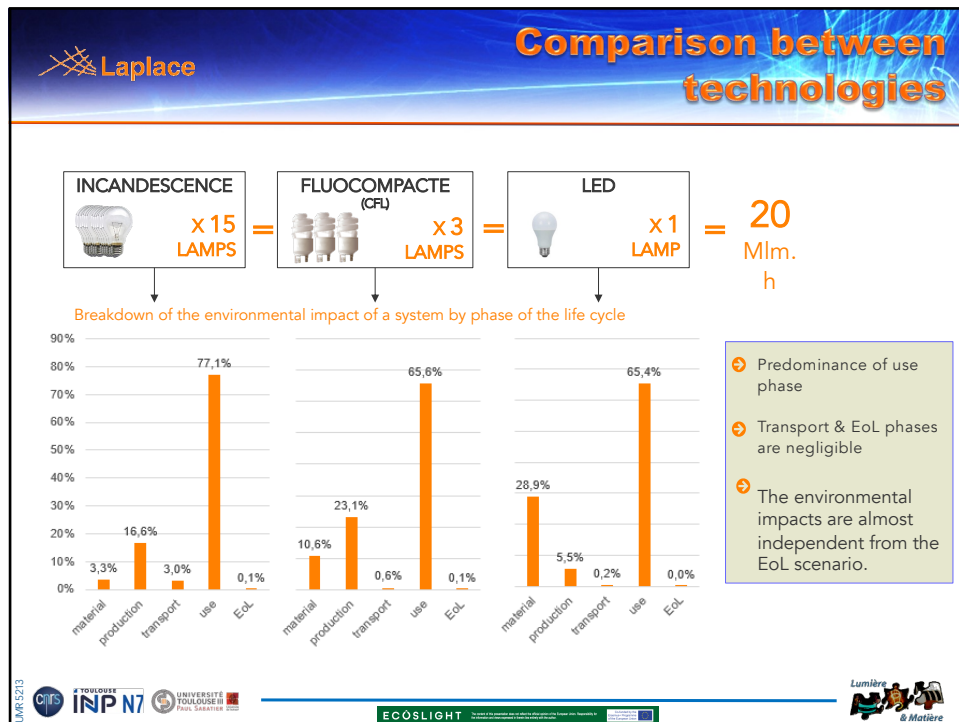
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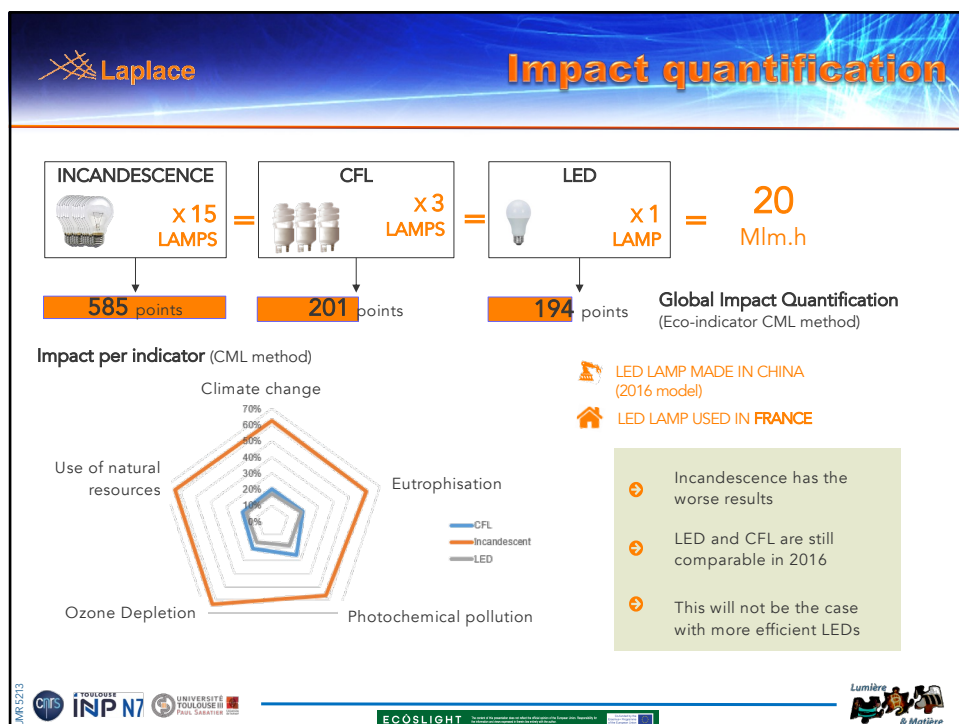
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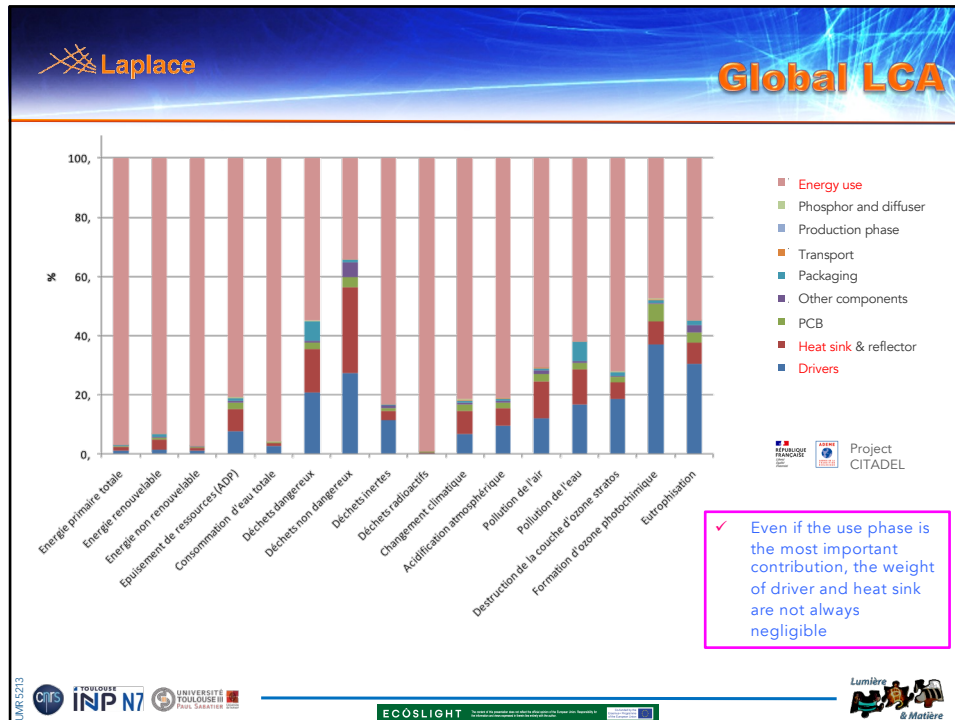
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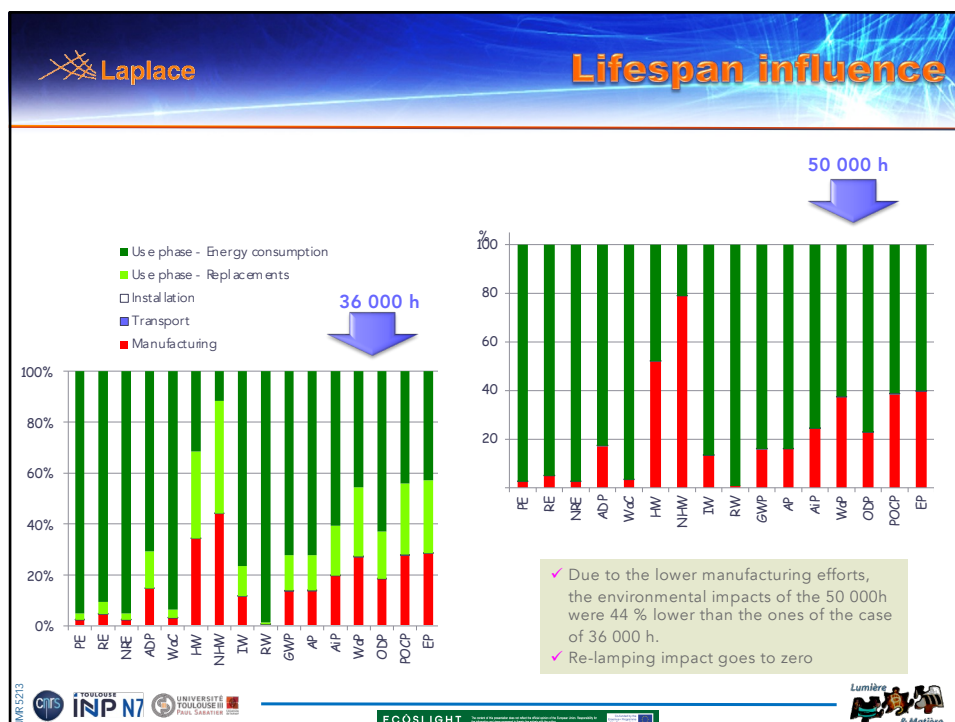
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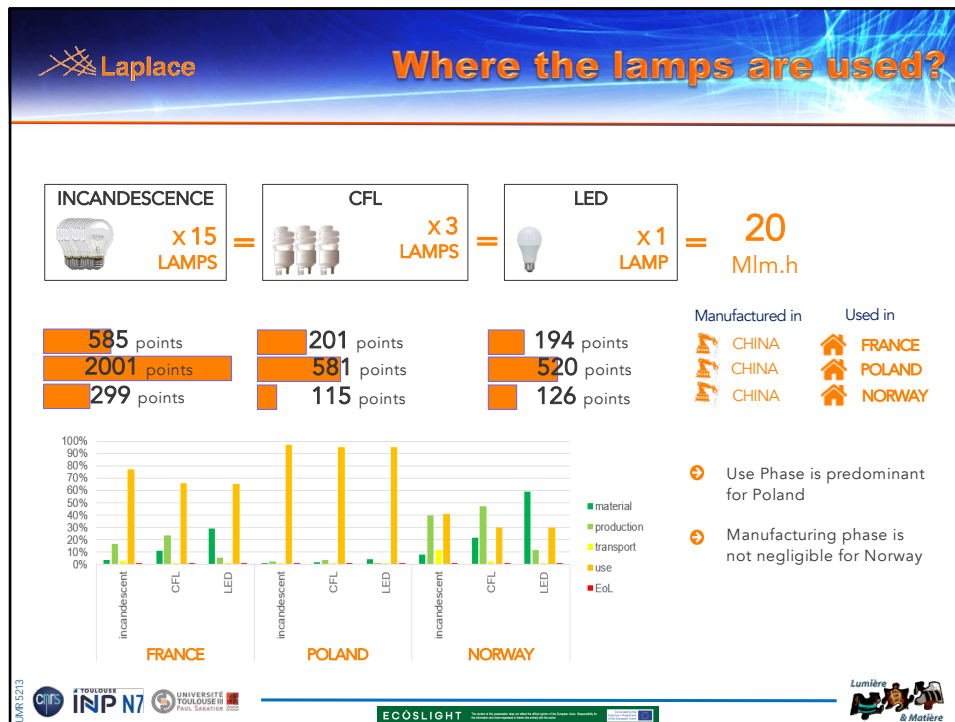
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Laplace **LCA of Lighting Systems Interpretations and Limits**

interpretation

- ✓ Incandescent lamp is the most impacting lamps regardless of any other compared technology.
- ✓ LEDs will be the champion.
- ✓ Electricity production plays a major role in LCA : the higher the proportion of renewables in the electricity mix, lower is the impact of use phase for each lamp.

Limits

- ✓ It's difficult to conclude for other lamp-types on a generic use case.
- ✓ LED global performance depends on lifetime/efficacy couple, therefore it relies on quality of manufacturing and materials, but also on social aspects like how people use LED lamps (rated lifetime vs real time of use). LCA doesn't include social aspects.
- ✓ There is a lack of information on EoL, disposal or recycling process and facilities.
- ✓ Quality of lighting and impact on human health during use phase are not considered.

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PhD Fellowship for October 2023




Development of a model for optimizing the environmental performance of products according to their lifespan. Application: the case of lighting systems

PhD Advisors: Georges Zissis & Marc Méquignon

✓ 3 year working contract with Toulouse III university
~2 100 €/Month net (including social security & full health coverage)








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Thank you Dankjewel, Merci










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Existing Guidelines and Standards

✓ For further information on circular economy look at:

- Waste Electrical and Electronic Equipment (WEEE) directive
- EcoDesign for Energy Related products
- EU legislation via the EcoDesign (section 4) route comes into force on 1st September 2021
- EU Single Lighting Regulation - (EU)2019/2020 laying down the EcoDesign requirements for light sources and separate control gears
- European Commission - Integrated Product Policy (IPP)
- Extended Producer Responsibility (EPR)
- Environment (Principles & Governance) Bill 2018, presented by the Department of Environment, Food and Rural Affairs (DEFRA).
- BS8887-220:2010 covers the 'Design for manufacture, assembly, disassembly and end-of-life processing (MADE). The process of remanufacture. Specification'

