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UMR 5213

Lighting 4.0: The human-centric Smart lighting challenge

afe
Échangeons la lumière
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Evolutions & revolutions...

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Solid State Lighting (SSL)

Connected lighting

Incandescence

Luminescence

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Laplace **Today, artificial Lighting is everywhere**

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Multiples Usages...

- Monument Lighting
- Street Lighting
- Indoor Lighting
- Signage & displays
- Vehicles & transport
- Industrial Applications



Toulouse by night

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Laplace **Some global figures**

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16,5%
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

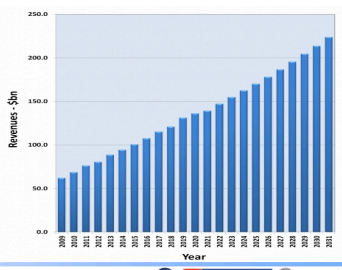


30 000 000 000
More than 30 billion electric lamps operate everyday worldwide

40-45%
LED market share

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

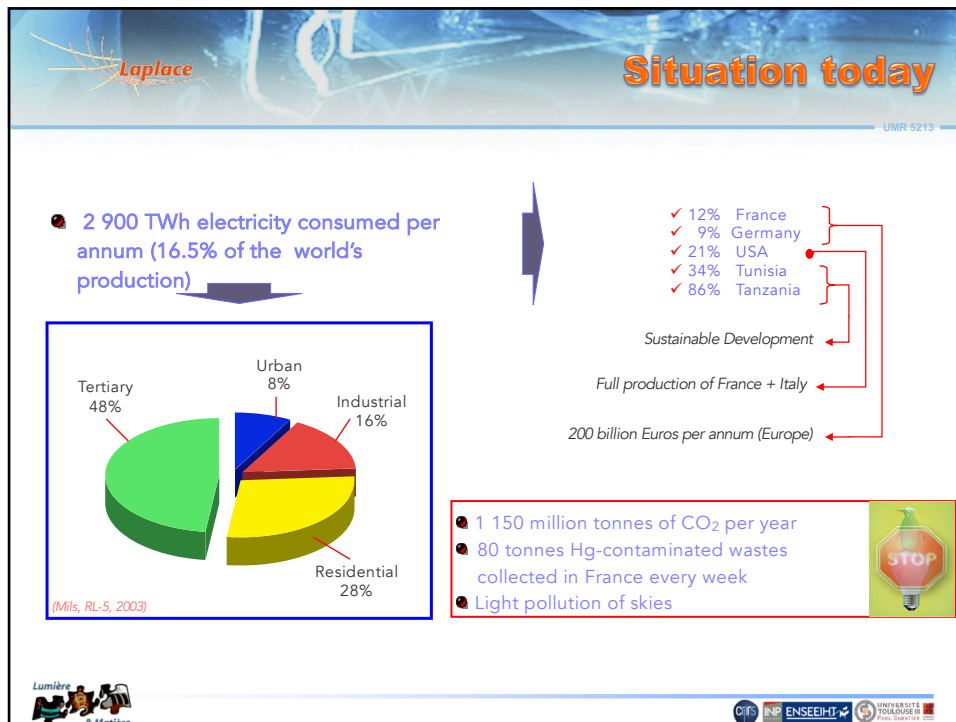
Artificial lighting has a large impact on energy, environment but also on every day's life and world's economy



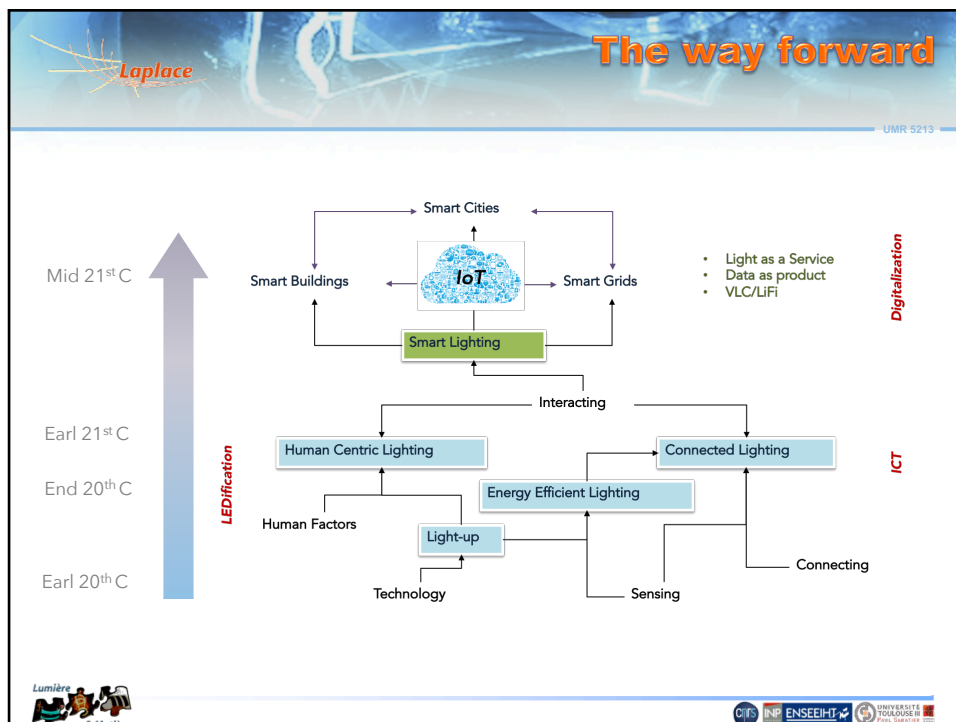
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Transformative characteristics of smart lighting

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- ✓ **Human-centric Smart Lighting systems in buildings can produce the “right light”** in quality and quantity when and where it is needed, reducing that way useless energy consumption and providing the best lighting conditions for high visual performance and high comfort for the end-user adapted to a task.
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- ✓ **A connected lighting system can be use as basis for connecting communicating objects** thanks to visual light communication (VLC) and LiFi functionalities. Objects can communicate between them or/and a central system. VLC/LiFi offer a large band-pass to allow large data flows. A lighting network forms a dense mesh that can be uses among others for geo-localization purposes.
- ✓ **Illumination will become a sub-function of a more complex ICT (Information Communication Technology) system** which will be a sub-system in the Internet-of-Things (IoT) global system. Light light will be the vector of new services and carrier of dataflows that will spawn additional products
- ✓ **In smart cities, so-called smart urban objects can be used in public areas to increase the sense of security of older people**, which can enhance their participation in public life. Connected smart lighting poles can recognize social alarms, hazardous citations, accidents and broadcast information to vulnerable public space users (i.e. elder or disable people). Safety in everyday life is improved by overcoming barriers such as dark areas at night without being in obligation to squander energy for illuminating empty spaces.


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Smart Lighting, an answer to grand challenges

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- ✓ **Contribute to Energy savings**
In 2017, the lighting US market model estimated that LED penetration reached about 19% of all lighting installations, enabling 1.1 quadrillion British thermal units (quads) in energy savings. DOE anticipates that from 2017 to 2035, a total cumulative energy savings of 78 quads is possible if the DOE SSL Program Goals for LED efficacy and connected lighting are achieved – equivalent to approximately \$890 billion in avoided energy costs.
- ✓ **Contribute to the Silver Economy**
Visual cues in design of a space aid us in our interactions with our surroundings. Using natural and electric lighting to illuminate objects in a space while minimizing negative effects such as glare and low contrast is beneficial. Smart Lighting systems can provide the best lighting conditions to elder or/and visually impaired persons in order to facilitate the every-days actions and life offering them the feeling of larger autonomy and security.
- ✓ **Contribute to Healthy working environments and high task performance:**
Human Centric Lighting (HCL) is becoming the next big step in lighting. Biologically effective lighting represents lighting systems that are appropriate to stimulate the biological organism, thus improving cognitive performance. Emotionally effective lighting systems are designed to create emotionally stimulating environments and appealing atmospheres. Thus, human centric lighting simultaneously considers our requirements for good vision as well as our emotional and biological needs.
- ✓ **Contribute to Lighting and IT industry rise:**
According to market research, Li-Fi and in general VLC are expected to garner US\$ 115 billion by 2022, registering a CAGR of 116,8% during the forecast period 2016 – 2022. US host important national lighting and ICT related industries that smart lighting technologies development will contribute in consolidating world leader position in that segments. US has also some important R&D centers (GE CRD, Osram-Sylvania, CREE) in lighting technology and world-famous academic research institutes in this domain (New York, California). This technology needs national leadership to develop standards and prototypes. The NSF along with the IEEE could marry policy with engineering know-how.








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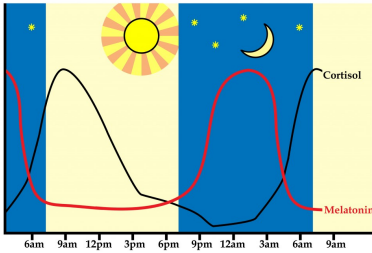
Light quantity and colour change during daytime



A lot of light
High colour temperature
Uniform light

Less light
Low colour temperature
Non-uniform distribution

The concentration of melatonin and cortisol depend on the variation of light



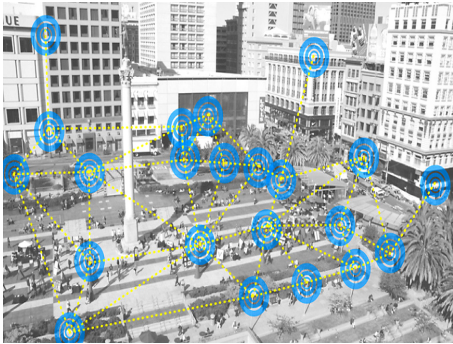
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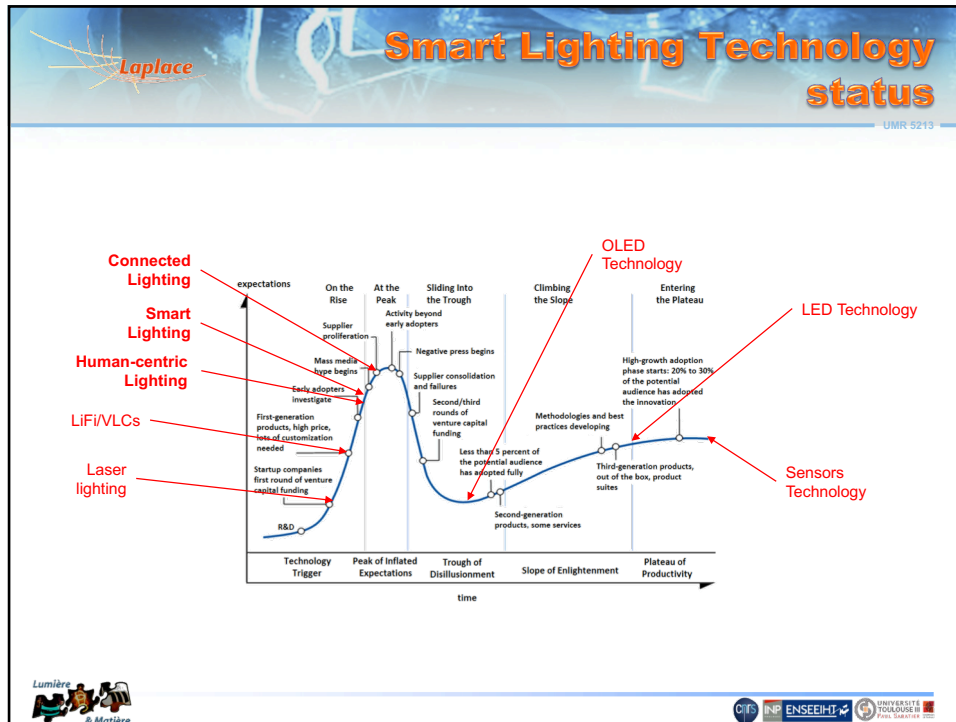
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SMART URBAN COMMUNICATION NETWORK

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The ultimate solution: "right human-centric lighting" concept

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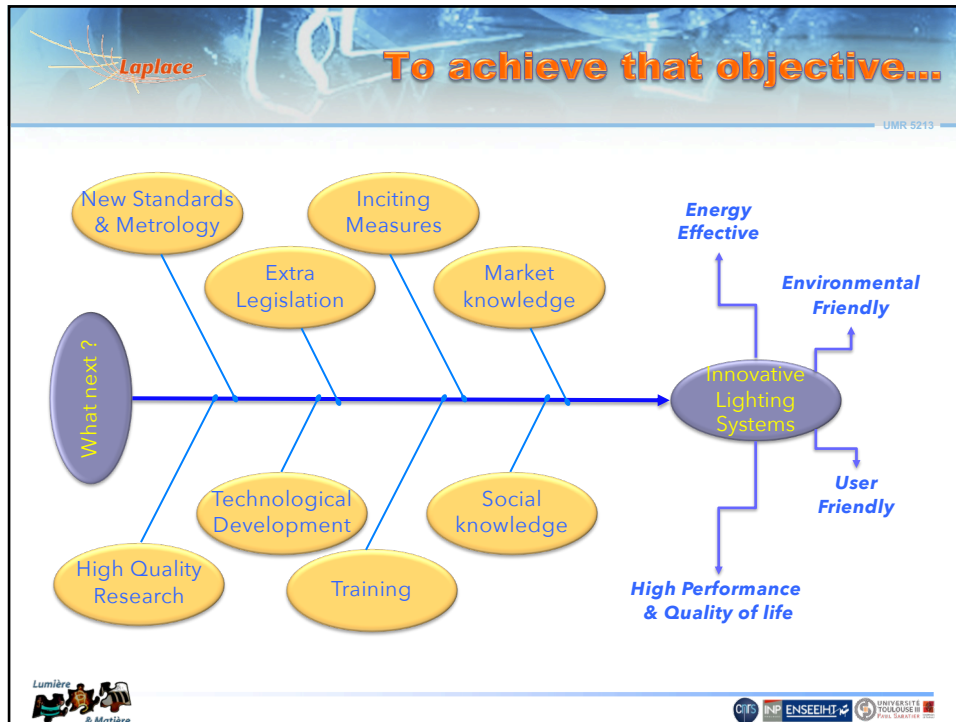
✓ Light-up smart, where it is needed, when it is necessary and as best as possible!

"Illuminate" doesn't mean "flood" objects, people or buildings with light!

The diagram shows three interlocking gears: Technology, Impacts, and Human & Social needs, with arrows indicating a clockwise cycle between them.

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