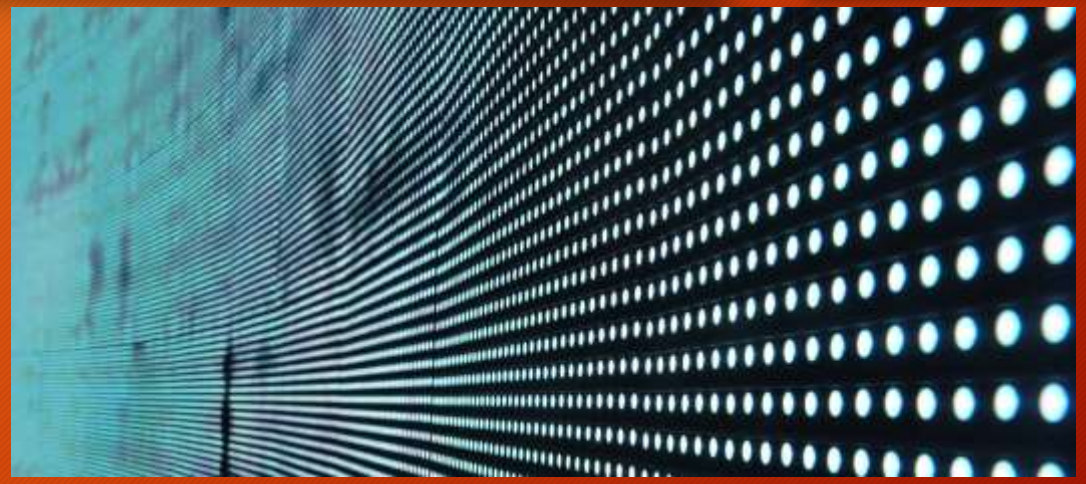
Lighting, energy efficiency and well-being in the building sector

ENERGY EFFICIENCY CONFERENCE 2020

09-07-2020

Stelios Zerefos, Professor School of Applied Arts, Hellenic Open University,
Director of M.A. “Lighting Design”

Lighting and energy

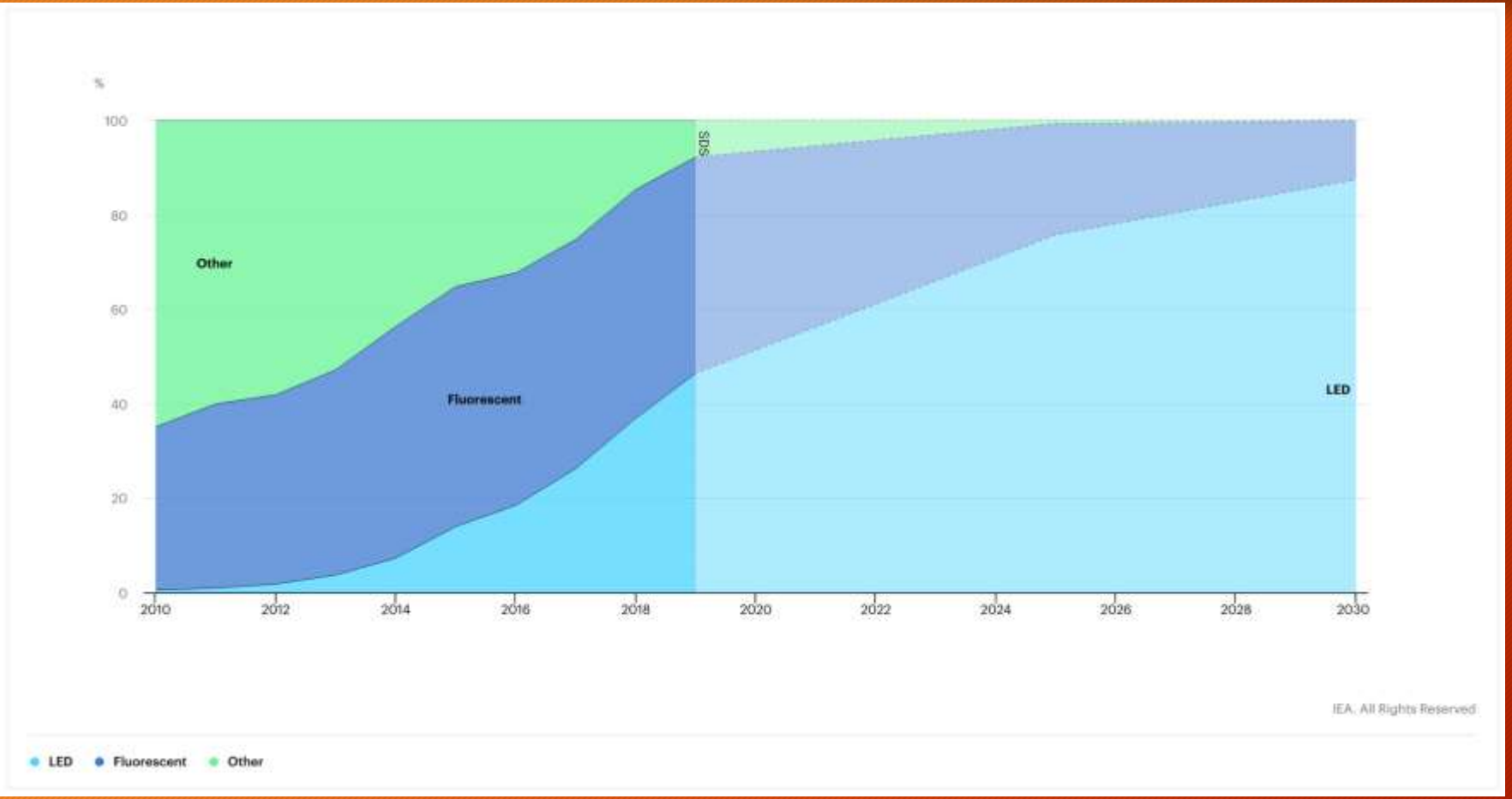


4500BC – 1800AD

1880 – 2015

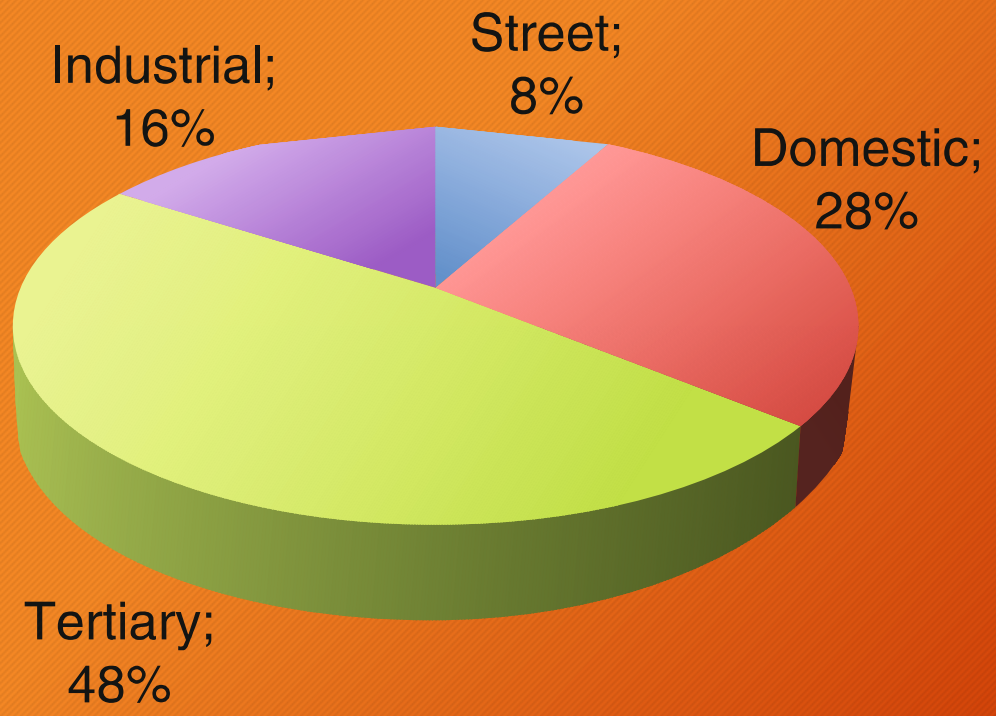
2015+

Lighting and energy



Lighting sales by type in the Sustainable Development Scenario, 2010-2030. IEA 2020.

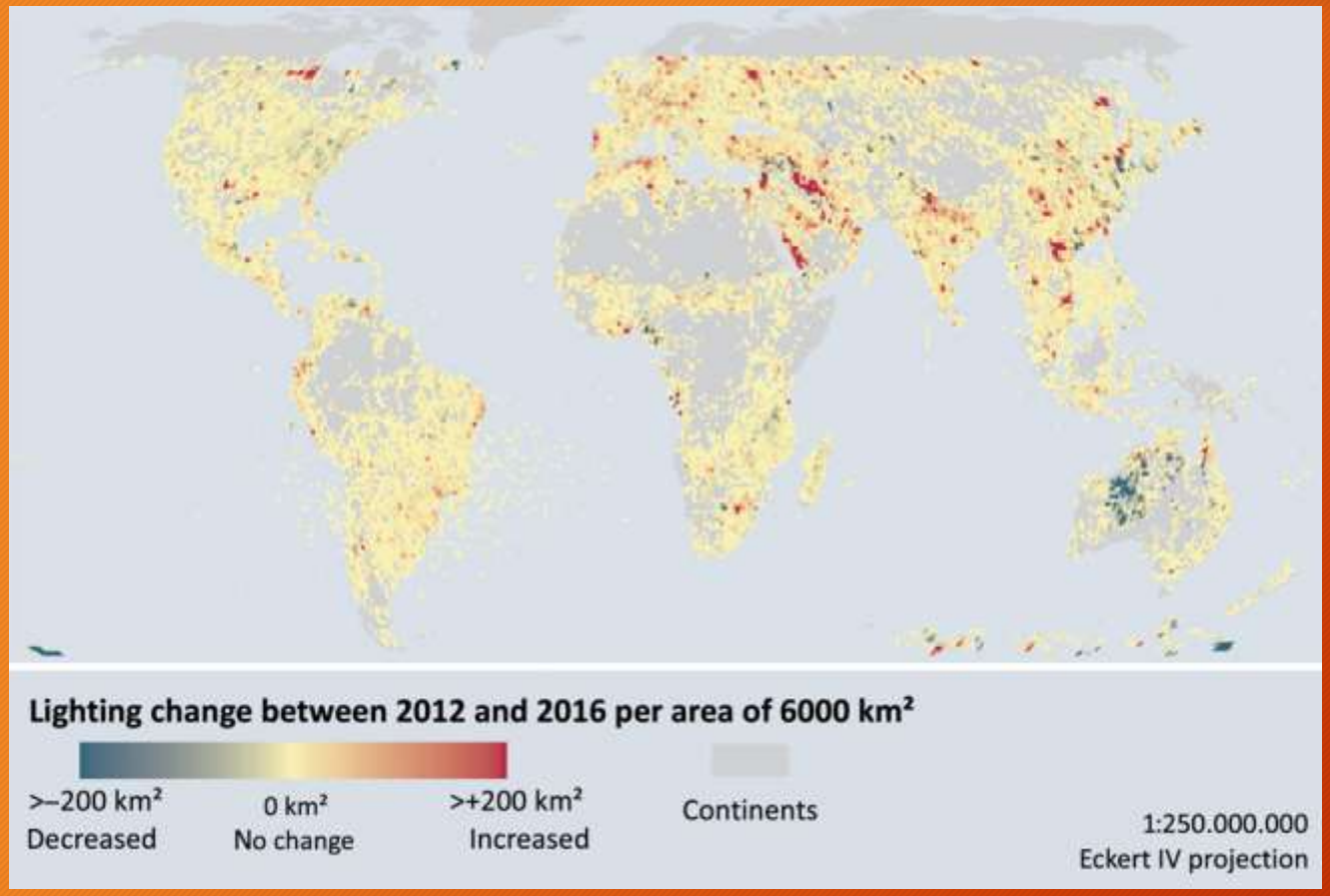
Lighting and energy



Source: Zissis G. Energy Consumption and Environmental and Economic Impact of Lighting. 2017

- 17-20% of electricity consumption on a global scale goes to artificial lighting (2017 values).
- 76% of electricity for lighting is consumed by the building sector (2006 values).

Lighting and environment



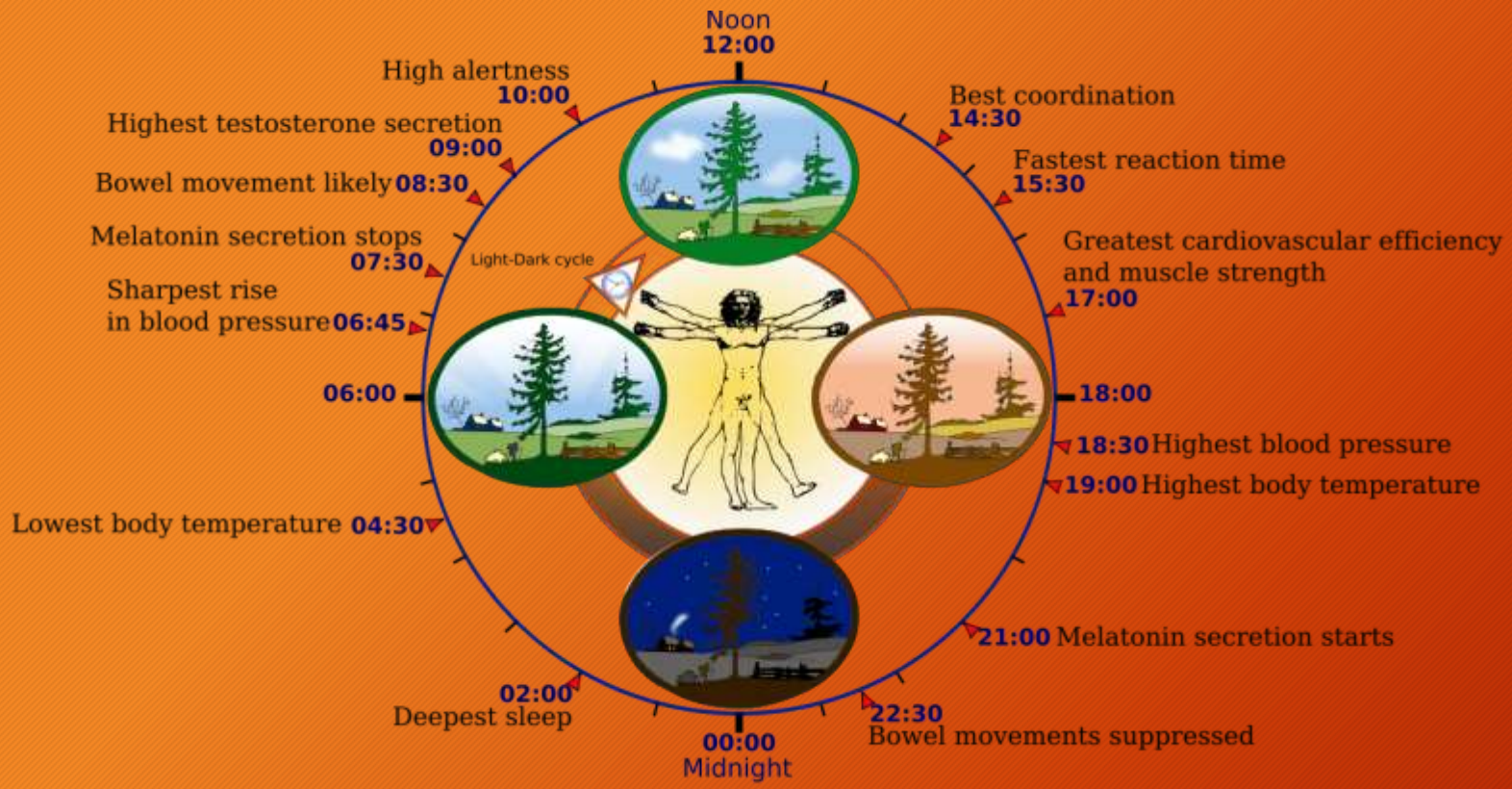
C. M. Kyba et. Al. (2017) Artificially lit surface of Earth at night increasing in radiance and extent. Science Advances, 3:11

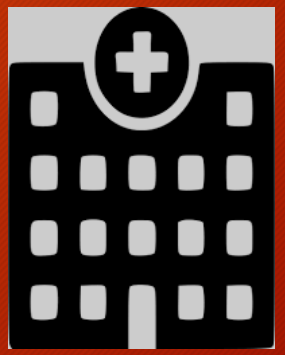
- Although new lighting sources consume less energy, lit areas worldwide increased by 2.2% per year in a 4 year period (2012-2016).
- Reduced maintenance costs and longer lifespan trigger increased usage and installations.

Lighting and environment

- Light pollution has increased by an average of 1.8% in the visible spectrum (2012-2016).
- Reduced maintenance costs and longer lifespan trigger increased usage and installations.
- Biodiversity threatened.

Lighting and Well-being





Lighting and Well-being

Problem	Consequences	Probable Cause	Possible solution
Eye strain	Headaches	Flickering, Glare	Change light sources, Change lighting design
Stress	Circadian disruption	Spectral distribution, luminous intensity, flickering	Implement human-centric lighting, Change lighting design
Limited views	Psychological Strain	External glare, disruptive lighting	Inform stakeholders, introduce blinds
Blue light hazard	Retina damage	Intensity of blue portion of light	Install diffusers and dimmers, limit direct eye contact
Special cases	Photophobia	All of the above	Direct control of lighting system
Advanced age	Operational and safety issues	Insufficient lighting	More luminous environments

Lighting and Well-being

WELL Standard v2 Factor	Summary
Light Exposure and Education	To ensure appropriate light exposure in indoor environments by using daylighting or electric lighting strategies. To encourage users to seek light exposure on their own.
Visual Lighting Design	To provide appropriate illuminances on work planes for regular users of all age groups.
Circadian Lighting Design	To provide users with appropriate exposure to light for maintaining circadian health and aligning the circadian rhythm with the day-night cycle.
Glare Control	To manage glare by using a combination of strategies such as calculating of glare, choosing appropriate light fixtures for the space and using shading techniques.
Enhanced Daylight Access	To design spaces to integrate daylight into indoor environments so that daylight may be used for visual tasks along with electric lighting. It also provides individuals with a connection to outdoor spaces
Visual Balance	To develop and implement strategies that take into account the light sources used in a space and create a visually comfortable lighting environment.
Electric Light Quality	To take into account characteristics of electric light used in the space such as color rendering, color quality and flicker.
Occupant Control of Lighting Environments	To implement innovative lighting strategies that take into account personal preferences of users as well as their interaction with the physical space.

Lighting, energy efficiency and Well-being

LEED Credit	Summary
Light Pollution Reduction	To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve night- time visibility through glare reduction and reduce development impact from lighting on nocturnal environments.
Minimum Energy Performance	To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.
Optimize Energy Performance	To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.
Controllability of Systems – Lighting	To provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g. classrooms and conference areas) and promote their productivity, comfort and well-being.
Daylight and Views – Daylight	To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.
Innovation and Design Process	To provide design teams and projects with the opportunity to achieve exceptional performance above the requirements set by the LEED® Green Building Rating System and/or innovative performance in green building categories not specifically addressed by the LEED® Green Building Rating System.
Interior Lighting Quality	Provide for occupant comfort by establishing quality criteria for interior lighting within a space.

Lighting, energy efficiency and well-being in the building sector

- *G. Zissis. 2017. Energy Consumption and Environmental and Economic Impact of Lighting. Springer.*
- *C. M. Kyba et al. 2017. Artificially lit surface of Earth at night increasing in radiance and extent. Science Advances, 3:11*
- *P. R. Boyce. 2014. Human Factors in Lighting. CRC Press.*
- *v2.wellcertified.com*
- *www.usgbc.org/leed*
- *www.cost-lone.eu*
- *www.iea.org*