Influence of Light on IEQ

A Guide for Owners and Occupants

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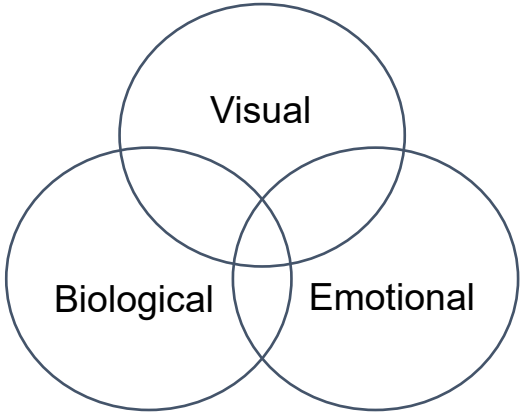
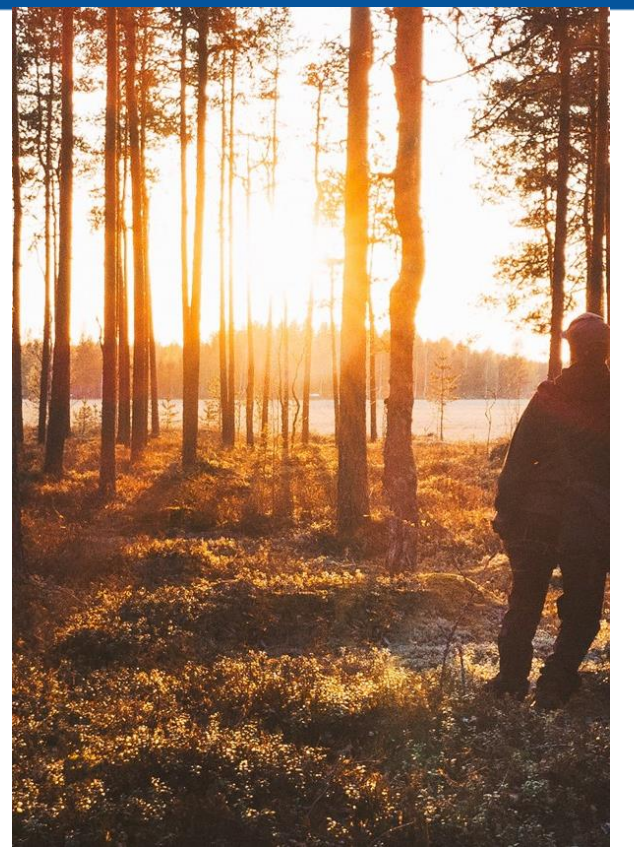
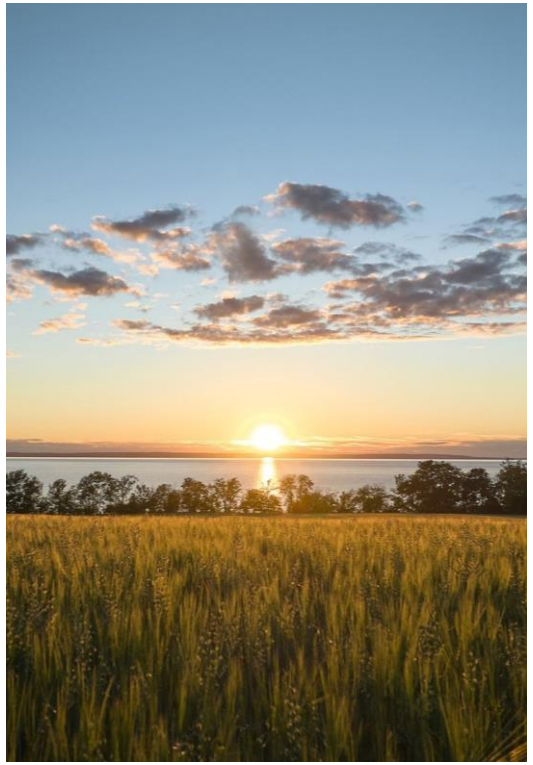
Light influences us in many ways





- The **visual pathways** have been well-known for the last century, but the biological lane has only been known since the discovery of the 3' receptor in the retina in 2003.
- The **visual photopic lane** goes from the rods and the cones in our retina trough the optical nerve to our visual cortex in the back of our brain where the visual center is located.
- The **biological lane** goes from some of the ganglion cells in our retina to the hypophysis that regulates our daily and seasonal circadian rhythms down to the adrenal cortex where it produces the hormone cortisol and back to the pineal gland where the hormone melatonin is being produced. The balance between cortisol and melatonin regulates our daily and our seasonal circadian rhythm.

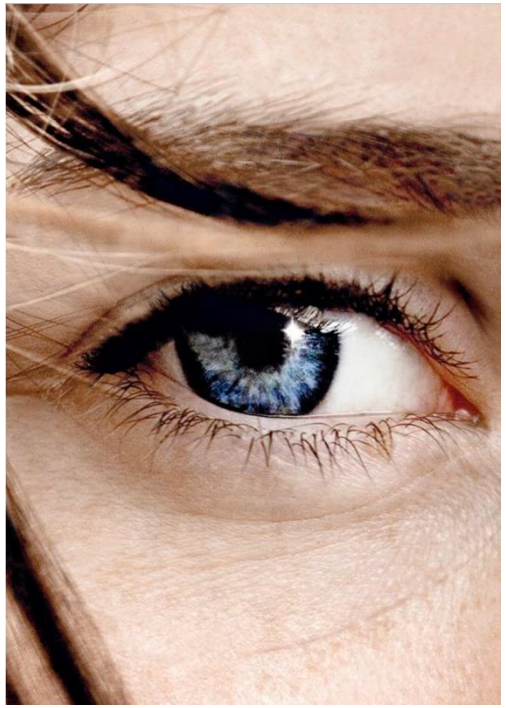
Human evolution and light: a radical environmental shift



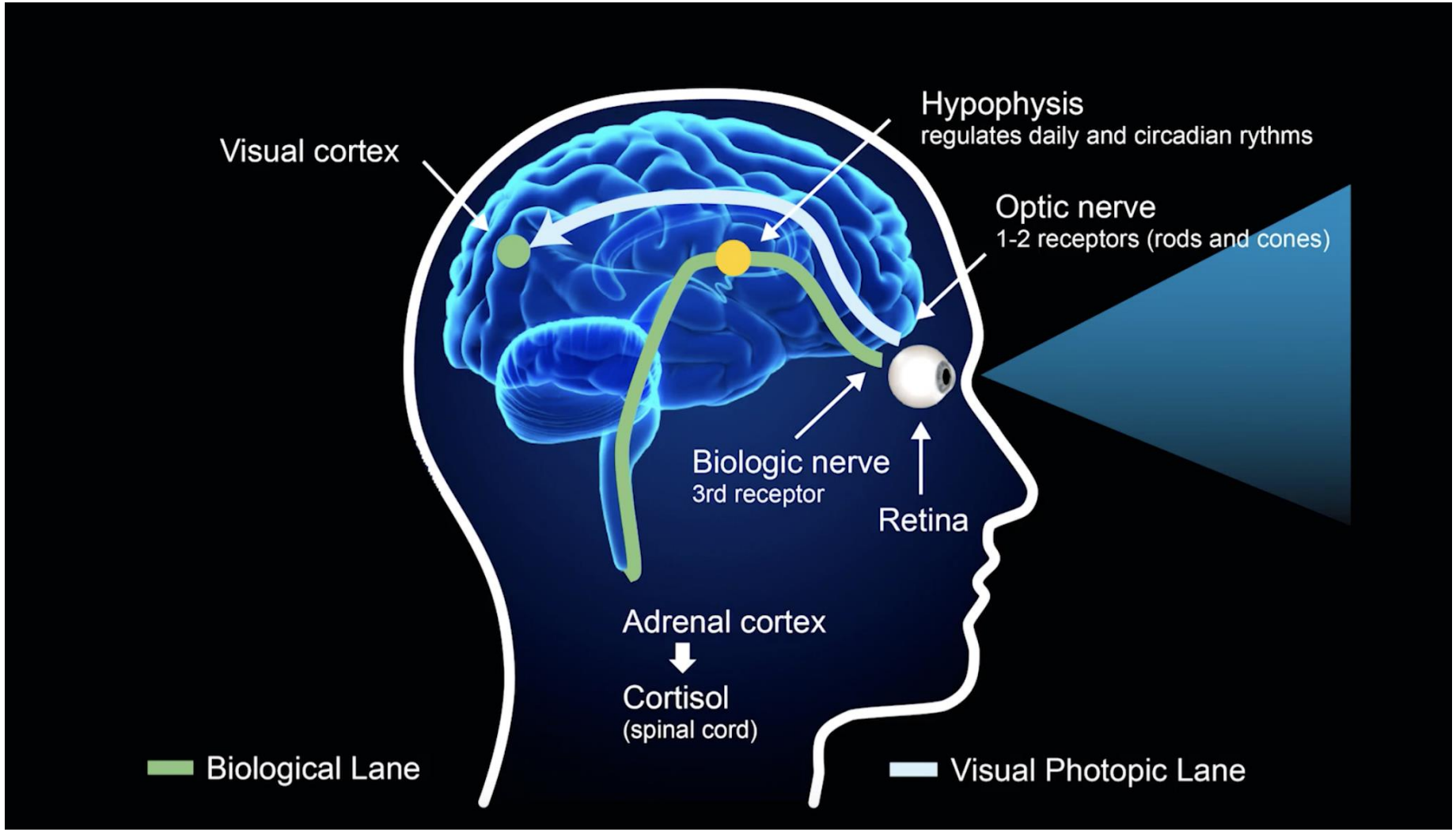
- For most of human history, people lived and worked outdoors, with their activity naturally synchronized to the cycles of sunlight and darkness.
- Today, however, we spend around 90% of our time indoors, exposed mainly to artificial lighting. This radical lifestyle change has a direct impact on our visual, biological, and emotional health.
- Poorly designed artificial light can disrupt circadian rhythms, affect sleep quality, reduce productivity, and even influence mood.
- That's why designing interior environments with high-quality artificial lighting—which mimics the principles of natural light—is not just about comfort, but a true need for health and well-being.

Circadian light

- The term “Circadian Lighting” (CL) emerged after the 2002 discovery of the intrinsically photosensitive retinal ganglion cells (ipRGCs) by researcher Berson.
- Unlike traditional rods and cones, these cells respond directly to light and are connected to the suprachiasmatic nucleus in the hypothalamus — the body’s master biological clock.
- This discovery revealed that light influences not only vision, but also biological functions such as sleep, alertness, and the production of melatonin and cortisol, which synchronize the body’s circadian rhythm.
- From this milestone, the concept of Circadian Lighting was born: a lighting strategy or source that is efficient in stimulating the circadian system (Boyce, 2006)
- Designing spaces with this approach improves health, well-being, and cognitive performance, especially in indoor environments where exposure to natural light is limited.

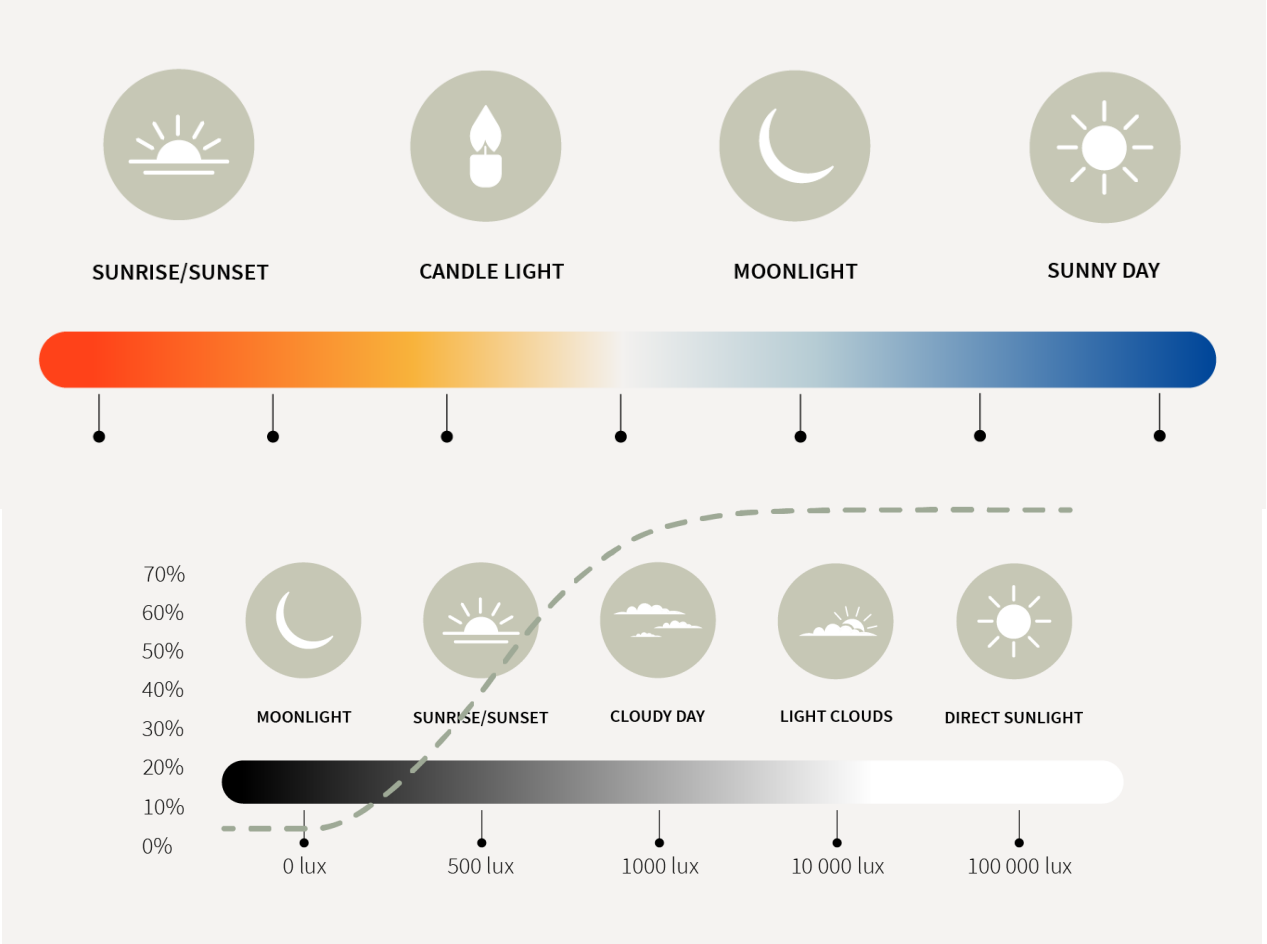


Visual Photopic and Biological Lanes



Human centric lighting, *(Page 1 of 3)*

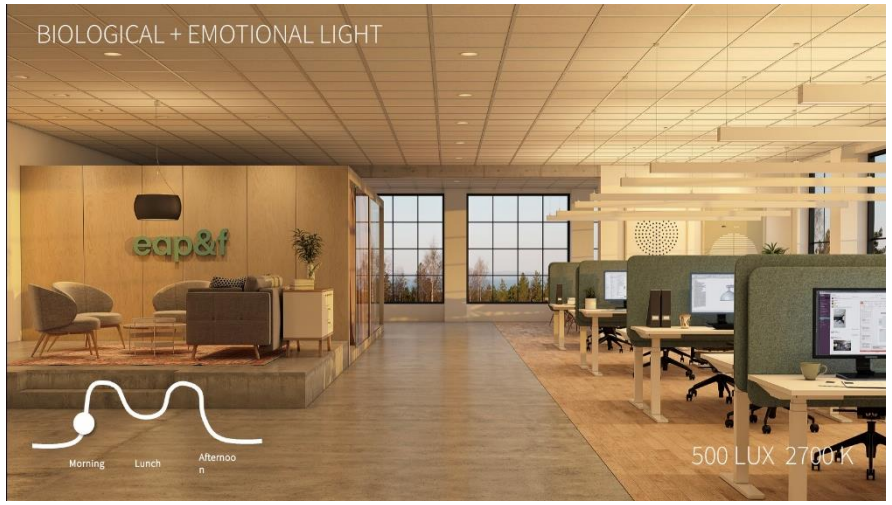
- Human centric lighting (HCL) is an advanced lighting approach that takes into account the biological, emotional and cognitive needs of people, not just their visual requirements.
- HCL systems adapt the intensity, color temperature, and timing of artificial light throughout the day to mimic the effects of natural daylight.
  - In the morning, cooler light (5000–6500K) boosts alertness and concentration.
  - In the evening, warmer tones (2700K) promote relaxation and melatonin production.
  - Throughout the day, dynamic changes support the circadian rhythm, improve mood, and enhance performance.

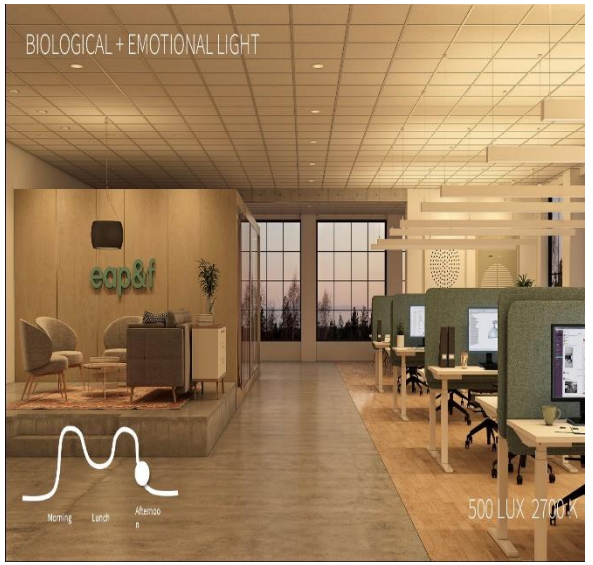


Human centric lighting, *(Page 2 of 3)*

- HCL integrates technology and human physiology to create healthier and more productive indoor environments, especially in workplaces, schools, and healthcare settings.
- While Circadian Lighting focuses solely on supporting our biological rhythms, Human Centric Lighting takes a broader approach—addressing not just biology, but also emotional well-being, cognitive performance, and visual comfort.
- Beyond supporting our internal rhythms, the right lighting makes it easier to do a good job. Well-designed lighting reduces stress, improves concentration, and creates a healthier, more positive workspace. When lighting is tailored to the task, the person, and the time of day, it becomes a powerful tool for daily performance and well-being.

Human centric lighting, *(Page 3 of 3)*





Lighting and workplace ergonomics, *(Page 1 of 2)*

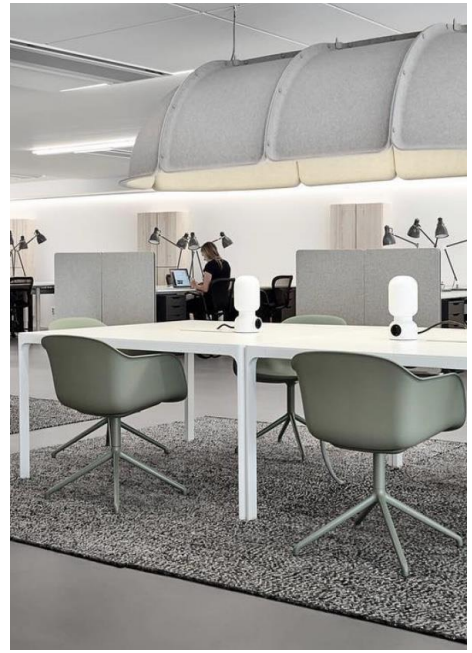
Proper lighting is a critical part of workplace ergonomics. It's not just about hitting the right lux levels—light must adapt to people, tasks, and spaces.

To achieve that, we must consider:

- **Direction and focus:** lighting should support the task, avoiding glare or shadow.
- **Appropriate color temperature:** cooler tones for focus, warmer for relaxation.
- **Zoned lighting:** each space should have its own strategy, aligned with its function.
- **Reduced visual noise:** balanced lighting reduces fatigue and improves perceived acoustic comfort.
- **User control:** allowing individuals to adjust intensity, color, and direction enhances comfort and performance.

Lighting and workplace ergonomics, *(Page 2 of 2)*

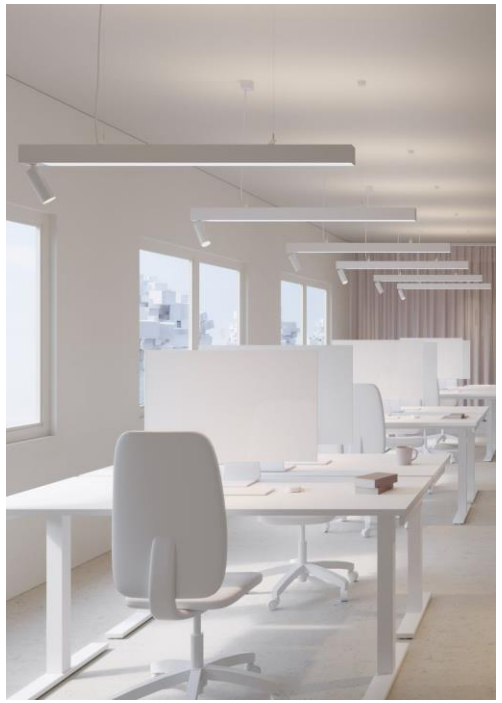
- Lighting shouldn't just look good—it should feel good. It's an active tool for comfort, focus, and well-being.
- Incorrect placement of general lighting can lead to glare, reflections, and shadows, compromising both visibility and comfort. In contrast, localized suspended luminaires with direct/indirect distribution create ideal lighting conditions, enabling better light distribution at the task area, reduced glare and visual discomfort.
- Personal control: users can adjust the lighting to their preferences, task, or time of day. This not only improves the work experience, but also supports employee well-being, by allowing greater control over the environment. Personalized lighting is a core principle of modern ergonomic design in the workplace.



Effective lighting design, *(Page 1 of 2)*

1. Adapt light to the task and the user

- Minimum 500 lux on the task plane (per standards).
- Personal control of direction, intensity, and color temperature.
- Improves comfort, visual health, and cognitive performance.



2. Combine general and task lighting

- Uniform lighting, no glare or shadows.
- Suspended or directed luminaires over work surfaces.
- Maintain good luminance balance between ceilings, walls, and desks.

3. Simulate natural light

- Maximize access to daylight.
- Recreate dynamic variation using a mix of luminaires (color, direction).
- Enhances well-being, reduces fatigue, and improves spatial perception.

Effective lighting design, *(Page 2 of 2)*

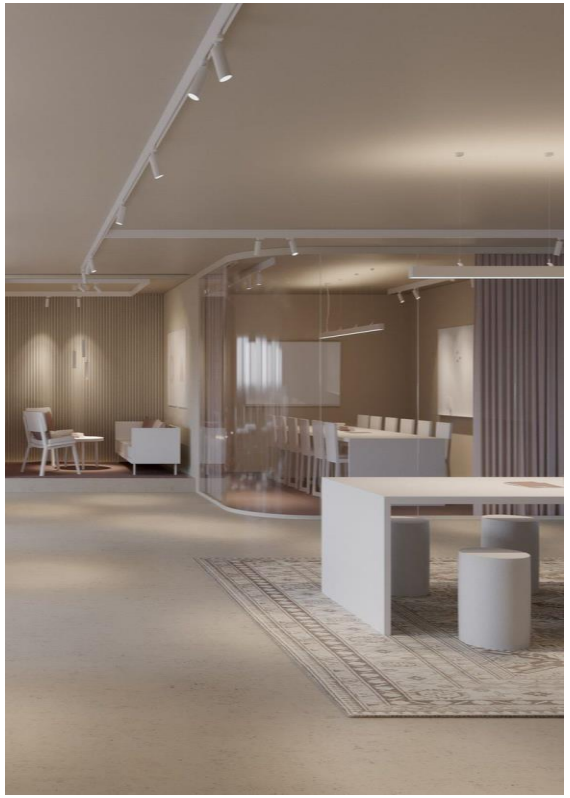
4. Design by space type

Collaboration: neutral/cool light, diffuse, general coverage.

Focus zones: directed, warm/neutral light, adjustable.

Meeting rooms/offices: mix of direct and indirect lighting.

Open-plan: ≥ 300 lux on ceilings, ≥ 250 lux on walls.



5. Avoid common planning mistakes

Misplaced luminaires not aligned with furniture.

Reflections on screens or shiny surfaces.

Poor uniformity (Emin/Eavg < 0.6).

No personal control for users.

Good lighting doesn't just illuminate—it structures, connects, and enhances the workspace.

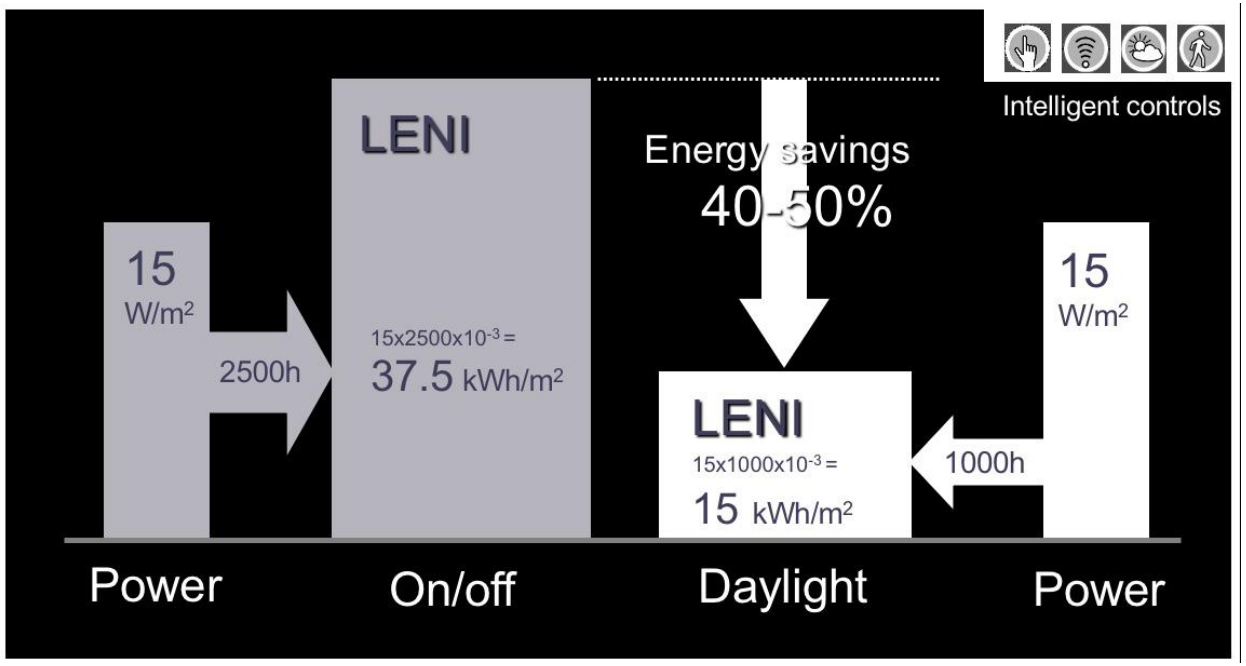
Energy efficiency: smart lighting, *(Page 1 of 2)*

The LENI (Lighting Energy Numeric Indicator) measures the energy consumption of a lighting system in a space, expressed in kWh/m²·year. It allows for the comparison of different solutions and the optimization of energy performance.

Conventional system:

- LENI = 15 W/m² × 2500 h = 37.5 kWh/m²·year
- Efficient system with intelligent control:
- LENI = 15 W/m² × 1000 h = 15 kWh/m²·year

- This translates into 40–60% energy savings thanks to the implementation of control technologies.

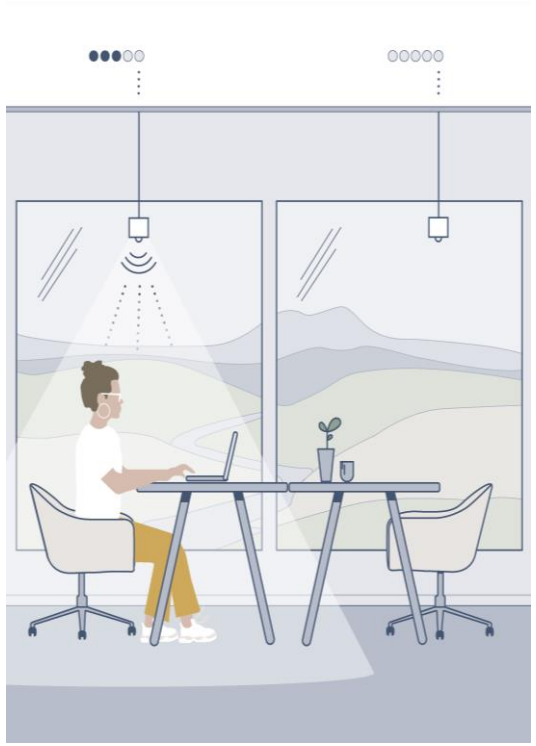


Improving the LENI indicator relies not only on the choice of luminaires, but above all on the use of precise and advanced lighting control systems. In recent years, these systems have evolved to enable dynamic lighting management through the coordinated use of occupancy sensors, daylight detection, scheduling, and continuous dimming. Their integration into centralized platforms such as BMS (Building Management Systems) enables building-wide control, real-time energy monitoring, and continuous optimization. These advances have made lighting an active tool for efficiency, comfort, and sustainability.

Energy efficiency: smart lighting, *(Page 1 of 2)*

LED Light Sources

- High efficiency (up to 150 lm/W)
- Long lifespan (>50,000 h) & low maintenance
- High visual quality (CRI >80), flicker-free
- Dimmable & compatible with control systems (DALI, KNX, 1-10V)



Integrated Sensors

- Daylight sensors: adjust brightness based on natural light
- Presence sensors: activate lighting only when needed
- Energy use adapts automatically to real conditions

Key Benefits

- Up to 60% energy savings
- Improved visual comfort, productivity, and well-being
- Enables automation and centralized control via BMS

Energy savings in various rooms with sensors

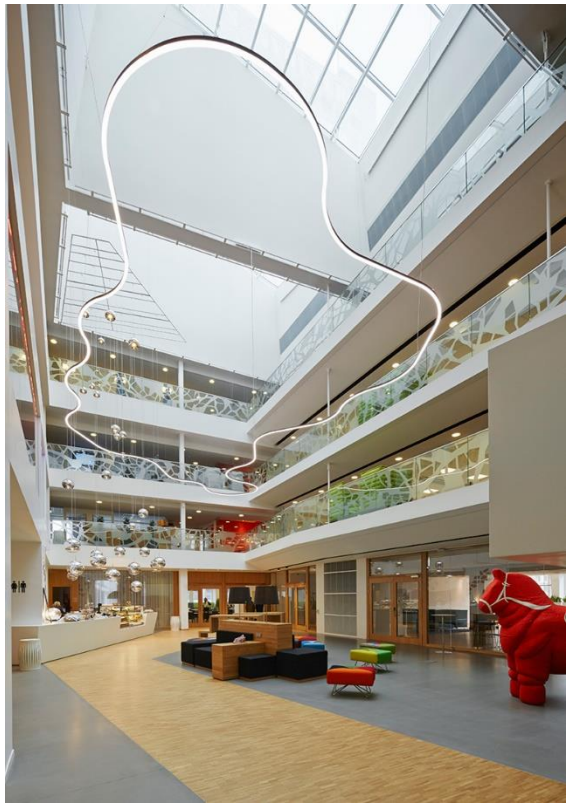
Energy savings with sensor solutions

	Presence control	Daylight control	Presence- and daylight control
Cellular office >10 m^2	40 %	44 %	66 %
Large office >12 m^2	10 %	23 %	31 %
Corridor	25 %	43 %	57 %
Restroom	40 %	18 %	51 %
Meeting room	51 %	23 %	62 %

Source: Ljus & Rum based on SS-EN 12464-1

The office of the future: catalyst for collaboration

- Creativity, innovation and team performance don't come from stylish features—they come from people and the way they connect. Research shows that ideas flow more easily when teams can interact in person, co-create, solve problems together and build informal relationships.
- These interactions are far more likely to happen in well-designed physical environments, where spontaneous exchanges and natural conversations can take place.
- The office of the future must be flexible, human-centered, and designed to foster well-being, collaboration, and a sense of belonging. Light, acoustics, layout, and atmosphere will be key to creating meaningful and effective spaces.
- In this new paradigm, lighting becomes a central element: it not only ensures visibility, but also regulates visual comfort, influences mood, and supports biological rhythms. Well-designed lighting can turn an office into a dynamic, healthy environment that adapts to the needs of each moment.



Additional Resources

For more resources related to this guide, visit the Lighting topic page within IEQ Resources on ASHRAE.org.