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Biologically Efficient Illumination

Socio-Economic Benefits by Application of Scientific Evidence in Lighting

Lighting has a much higher importance for humans than simply enabling sight. It is known and accepted that besides visual functions, light has additional effects on humans which directly influence biological processes. As scientific research and evidence points out, proper lighting has the ability to: diminish symptoms of certain diseases; address performance possibilities; facilitate healthier workplaces; and combat Seasonal Affective Disorder. It also has the potential to create opportunity for industry leadership in Europe while considering socio-economic changes. It is the position of the European lighting industry, represented by ELC and CELMA, that these positive biological effects warrant the consideration of Competitiveness and Innovation Framework Program (CIP) pilot calls in 2012 on “Information Communication Technology Policy Support Program (ICT PSP) for Ageing Well” to focus predominantly on SSL technology (Solid State Lighting, LED). SSL is a quantum leap in the development of lighting given its enhancing light quality, high energy efficiency, and distinct advantages over “classical” technologies. It is also the position of the European lighting industry that there is a need for quality standards in order not to compromise the biological effectiveness and minimum performance standards under the revision of the EU EcoDesign Regulation for non-directional household lamps (244/2009 EU) and Regulation for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps (245/2009 EU).

The Health Dimension

The effect of light can be divided into two different mechanisms. The first is the visual effect-- the seeing function itself--starting with the perception of visual details, brightness and darkness, colours, movements, all ending with the uptake of information. The second pathway is the biological effect, which mainly affects the internal clock and modulates the circadian rhythm, but also influences hormone production, metabolism and blood circulation.

While visual perception - that is the seeing function – is achieved via the optic nerves and visual centres in the brain, the biological effect follows a different route. It connects light sensitive ganglion cells in the retina to the suprachiasmatic nuclei and the pineal gland, both controlling the human inner clock.

During the day, light reaching the eye is directly stimulating daytime activity and stabilizing the circadian rhythm. Biological effects of light are basically known since the 1960s. In laboratory experiments, human volunteers were isolated from daylight and other environmental factors, kept in semi-darkness and their sleep/wake cycle was studied. This clearly proved the synchronization of the human internal clock by the natural 24 hour rhythm of daylight and night.

A stabilised circadian rhythm is achieved by:

- a) bright light with blue components during daytime via natural daylight or when this is insufficient (in winter or in long stays in windowless interiors) by artificial light and;
- b) low levels of (warm) light in evening and night with reduced levels of blue light to avoid melatonin suppression and increasing alertness at the wrong time.

As a consequence sleep quality will be improved, resulting in a lower probability of accidents and higher performance during active living daytime.

For many years, the effects of light on the human circadian system were supposed to be only dependent on high light levels. High brightness was related to a strong circadian stimulus. The successful introduction of bright light therapy (BLT) to cure Seasonal Affective Disorder (SAD) in the 1980s was based on this understanding.

In 2001 Brainard and Thapan demonstrated a strong involvement of the spectral characteristics of light. Both proved the existence of a “third type of photoreceptor” in the human eye that differs considerably in spectral sensitivity from all known photoreceptors. The result of these findings gave the insights to vary the light spectra of lamps to elicit biological effects without raising illumination levels. Accordingly not only the lamp manufacturers have developed light sources with specific spectral distribution, but also the luminaire industry introduced products qualified to offer a biological and healthy illumination with a positive impact on wellbeing.

The value of bright, daylight-like light for the improvement of wellbeing, stabilisation of circadian rhythms and the internal clock, improvement of mood, and strengthening of the immune system is widely accepted. Still clear and generally accepted design recommendations and rules for the practical transfer of this insight into lighting applications have to be provided.

The Socio-Economic Dimension

The socio-economic benefits cannot be underestimated and are applicable and important throughout all phases and areas of human life. From schools to work places and nursing homes, light has the potential to improve quality of life. For example, it is known that older people need much higher light levels for good visual performance, such as reading text. The main reason is the degrading transmission of the lenses in the eye. But this condition is not only affecting the visual performance. The lenses of older people show a yellow tone, causing a strong absorption of the blue spectral components of light. This strong effect must be taken into account when designing lighting installations for the elderly in nursing homes, or in existing structures, thereby enabling people to remain in their domestic surroundings. Scientific studies have shown evidence that lighting can have encouraging results in the treatment of Alzheimer patients.

With respect to the ageing population, it is imperative that lighting can address these issues. The need for biological efficiency must be balanced with energy efficiency needs when revising EU EcoDesign requirements.

The Industry Dimension

The European industry is in the leading position to serve as a benchmark to other regions in regards to the positive effects of light on human health. At present there is good cooperation between scientific research and development of economic value. Besides a huge market potential in Europe there is also growth potential for the European industry for export to markets facing similar socio-economic challenges. Especially for creative SMEs huge development potential is expected to deliver tailor-made solutions, to engage more employees and to gain additional market share.

Conclusion and Next Steps

Basically the mentioned effects are independent from the technology to produce and distribute light. However, the actual fast development of LED solutions and related new possibilities in the market offers big opportunities not only to save energy, but also to offer new options to easier tune lighting levels and blue light content to give people the 'healthy' light they need.

Given the strong interdependencies between health and efficient lighting, it is the position of the European Lighting Industry that a holistic approach to this issue can lead to a win-win situation that will improve health benefits, answer social challenges, and boost economic growth. To ensure this development, there remains a strong need for: additional standardization (started in CEN/TC 169 WG 13); inclusion in "ICT PSP for Ageing Well"—particularly in relation to the LED solutions; coordinated awareness campaigns on a European level; and policy measures with real benefits for citizens.

The European Lighting Industry

The European Lighting Industry is represented by its European Associations CELMA and the ELC. The European Lighting Industry (light sources, luminaires and components) consists of thousands of luminaires companies in Europe, most of them small and medium-sized enterprises.

The European Lamp Companies Federation (ELC) is representing the leading European lamp manufacturers. ELC has 8 member companies, represents 50,000 people employed in Europe and generates 5 billion euros annual turnover in Europe. The ELC is dedicated to promoting efficient lighting practice for the benefit of the global environment, human comfort and the health and safety of consumers. More information about ELC can be found at www.elcfed.org.

CELMA is the Federation of National Manufacturers Associations for Luminaires and Electrotechnical Components for Luminaires in the European Union. CELMA represents 19 Manufacturers Associations from 13 EU countries, over 1,000 companies (majority of small and medium-sized enterprises), 107,000 people employed in Europe and generates 15 billion euros annual turnover in Europe. For more information about CELMA please visit www.celma.org.