ADVANCED DAYLIGHTING SYSTEMS – HUMAN BEHAVIOUR AND COSTS

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A modern design for interior lighting systems has to consider all the environmental issues – a proper electric lighting use in accordance with the daylight availability, energy, materials and equipment, maintenance programme, optimum quality of the light in space (photometric and colorimetric aspects) and of the electric network (harmonics), the users comfort and satisfaction.

Significant savings in energy consumption, and therefore cost, of providing lighting without reducing standards can be achieved by applying an energy-effective-design approach to lighting installations. The objective is clearly to provide lighting to the quantity and quality standards required, with the minimum usage of electrical energy. The energy consumed by a lighting installation depends upon *the installed load* and *the hours of use.* The hours of use of a lighting installation depend upon the occupancy patterns of the space, the daylight available in the space and the control system used.

There are two natural barriers to implement an energy efficient lighting: economical and educational. The low level of people income does not permit the purchasing of the newest energy efficient and good color rendering lamps. The lighting knowledge is lacking many times even through the educated people, and there are no media-dedicated programmes to improve it.

The EN 12464 (Lighting of work places) and EN 12665 (General terms and criteria for specifying lighting requirements) offer a new quality of further lighting installations – responsibility of the illumination design author for results of his work and responsibility of the users for proper maintenance of the installations. Comparative with a lighting system based on general lighting, a localised lighting system (for task area) with additional ambient lighting (for immediate surrounding) may fall the specific power from 10-15 W/m^2 to 6-10 W/m^2, representing about 50% savings [Govén 2001].

Lighting represents an important part of building energy consumption in the EU – around 10% of the total electricity consumption, ranging from 5% (Belgium, Luxemburg) to 15% (Denmark, The Netherlands, and, as well, Japan). The global electric lighting energy use may be split in four sectors: services 48%, residential 28%, industrial 16% and street lighting and other 8% [Mills 2002]. Lighting systems design trends are dynamics both in time and between countries. The recommended illuminance level represents only one of the design parameters, but it is determinant for a lighting system and its energy consumption [Mills & Borg 1998].

Lighting electricity consumption accounts for about 20 to 30% of the total energy required by an office building. On average, the investment cost of lighting facilities for an office building works out at around 1 to 2% of total investment. The power density for standard fluorescent lighting installations varies from 13 to 20 W/m^2. Recent progress in equipment and design demonstrates the possibility to reduce these values in the range of 7 to 10 W/m^2. A minimum acceptable lighting power density of about 7 W/m^2 will leads to annual lighting consumption of 16 kWh/m^2. Dimming or extinction of lamps of ambient lighting may lead to annual consumption below 10 kWh/m^2 [Fontoynont, Escaffre & Marty 2002]. Based on the few comprehensive estimates studies, there is stipulated an approximate commercial sector lighting savings potential in the range of 25% to 40% [Mills 2002]. In practice savings will vary by country, depending on existing baseline conditions.

Daylight may cover the entire lighting need in very few buildings, and, in the same time, daylighting

can make an important energy contribution for many buildings. Both daylighting and electric lighting should be considered when designing a new building and lighting installation. The lack of knowledge on the performance of daylighting systems and lighting control strategies, the lack of daylighting design tools, of evidence of the advantages of daylighting prevent many designers to take into consideration daylight in their building design.

Direct use of daylight in buildings interior is available for the area closed with glazed areas on the building envelope – windows, skylights. The remote systems using light tubes or other devices redirect daylight into deep areas of buildings, unlit by conventional glazing.

A daylighting system through windows is concerned with the users requirements: (1) ***Change and Variety*** - the nature of sun and sky; (2) ***Colour and View*** - the contact with the weather and the world outside; (3) ***Modelling and orientation, Sunlight effect*** - the mood created by the variation of light. What is offering a remote lighting system of daylight in buildings interior? Some people state "gratuity". Yes, the solar light source is free of costs. But, what the costs of the lighting collector and transport systems are? And, what the efficiency of the whole system is? Are the requirements for an improved mood, behaviour or well-being under the daylight received through a remote lighting system accomplished? Cost and energy efficiency comparison between different systems and installations is difficult due to their diversity and complexity and the prototype character of many of them. The remote lighting systems may cost between 300 €/m^2 for active zenithal systems (nearly 10 times that of a conventional electric lighting system) to 50-75 €/m^2 for passive zenithal guides (which is comparable with electric lighting). The most commercially spread system is that with the roof passive collectors, light tubes transport, and interior opalescent emitters - many thousands of such systems world-wide. The capital costs are depended by the pipe configuration and accommodation work required on building fabric. Light is distributed in an interior by emitters which differ little from conventional luminaires. The payback time for several case studies are at the level of 3-4 years. However many passive zenithal systems are incapable of providing satisfactory task illuminance and require an electric system as supplement and backup [Carter 2004].

The daylight is free, but the glazing or remote lighting systems of daylight can be very expensive. The daylight offered in the buildings interior by light tubes systems is NOT THE SAME as the daylight received through windows.

Proiectarea modernă a sistemelor de iluminat interior trebuie să considere toate componentele ambientale – un iluminat electric adecvat în concordanță cu disponibilitatea luminii naturale, energia, materialele de construcție şi finisare şi echipamentul luminotehnic, programul de întreținere, distribuția optimă a luminii în spațiu (aspecte fotometrice şi colorimetrice ale calității iluminatului), rețeaua electrică de alimentare (armonici), confortul şi satisfacția utilizatorilor.

Lumina naturală poate să asigure întregul necesar de iluminat în foarte puține clădiri dar, în acelaşi timp, poate să aducă o contribuție energetică importantă pentru multe clădiri… Lipsa cunoaşterii performanțelor sistemelor de iluminat natural şi a strategiilor de control al iluminatului electric, a unor instrumente de proiectare şi a evidențierii avantajelor iluminatului natural constituie impedimente majore pentru mulți proiectanți în considerarea luminii naturale în proiectarea clădirilor.

Utilizarea directă a luminii naturale în interiorul clădirilor este posibilă doar pentru o zonă limitată din apropierea suprafețelor vitrate ale anvelopei clădirii - ferestre sau luminatoare. Sistemele de transport la distanță a luminii utilizând tuburi de lumină sau alte dispozitive redirecționează lumina naturală adânc în interiorul clădirilor, în zone neiluminate de sistemele convenționale de vitrare…. Ce oferă un sistem de transport la distanță a luminii în interiorul clădirilor? Unii susțin "gratuitate". Desigur, sursa de lumină solară este gratuită. Dar, care sunt costurile colectorului de lumină şi ale sistemului de transport? Şi care este eficiența întregului sistem? Sunt îndeplinite cerințele umane pentru un ambient confortabil, plăcut şi care să determine o stare de bine sub efectul unei lumini naturale primite printr-un tub? …

Lumina naturală este gratuită, dar sistemele de vitrare sau de transport la distanță ale luminii naturale pot să fie foarte scumpe.