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ENVIRONMENTAL ASSESSMENT OF LIGHTING SYSTEMS IN BUILDINGS

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Today, the environmental assessment of buildings gained importance due to the shortage of the fossil energy sources, growing energy costs and the negative environmental impact of energy use. Energy efficient design strategies enable the reduction of both CO₂ emissions and high energy costs. Lighting systems constitute a considerable portion of the energy consumption of buildings' active systems. The lighting energy consumption can be reduced by proper design of daylighting and artificial lighting systems depending on the following parameters; external daylight illumination related to the geographical location, natural and built-environmental external obstructions, light reflectance of the ground depending on the materials color, room dimensions, interior surface colors and light reflectance, window dimensions and other specifications like glazing, frame and maintenance, window direction and shading devices, energy efficiency of chosen lamps and luminaries, control system. The values of these parameters should be determined adequately in order to reduce the energy consumption while providing the visual comfort conditions.

In this context, several methods were developed to assess the sustainability of buildings in the design and post-construction cases. This study aims to introduce 3 of these methods, LEED, BREEAM and CASBEE, and discuss the methods in terms of assessing the lighting systems in residential buildings.

LEED is a certification program prepared by US Green Buildings Council in 1998, which is a nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health; sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED rating systems differ due to the different building typologies thus for residential buildings is LEED for Homes, that promotes the design and construction of high-performance green homes, use less energy, water and natural resources; create less waste; and are healthier and more comfortable for the occupants. LEED for Homes has 136 points in total qualified as platinum level, 4 of which are related with lighting. In Innovation and Design section, 1 point is related with daylighting and solar control in residential buildings. Lighting section under the heading of Energy and Atmosphere in LEED certification system for homes offer 3 maximum credits with the opportunity of using improved lighting system with 1.5 credits or advanced lighting with 3 credits.

- Innovation and Design, Integrated Project Planning
Building Orientation for Solar Design (1 point)

The given requirements aim to maximize the solar gains through south windows and provide shading during the overheated period. At least 90% of the glazing on the south wall is completely shaded at noon on June 21st and unshaded at noon on December 21st.

- Energy and Atmosphere
Lighting (3 Maximum Points)

Prerequisite: Installing at least four qualified energy labeled light fixtures or compact fluorescent bulbs.

Improved Lighting (1.5 Points)

-Indoor lighting (0.5 point) In this credit, three additional qualified energy labeled light fixtures or compact fluorescent bulbs are recommended to be installed.

-Outdoor lighting (1 point) All exterior lighting is recommended to have motion sensor controls or integrated PV cells.

Advanced Lighting (3 Points)

In order to have this credit, energy efficient installations are recommended in a total of at least 80 % of the fixtures throughout the home.

The BREEAM family of assessment methods and tools are all designed to help construction professionals, understand and mitigate the environmental impacts of the developments they design and build. BREEAM Buildings and BREEAM Tools act at different stages of the construction process; i.e. for the manufacture of building materials through design stage during construction and post construction. The Code for Sustainable Homes 2008 assesses the buildings in 9 categories; 104 credits in total, 7 of which are related with lighting.

- Energy and CO2 Emissions
Internal Lighting (2 Points)

Energy efficient compact fluorescent lamps should be used in order to reduce the CO2 emissions.

External Lighting (2 Points)

Credits are awarded where all external lighting within the development is provided by dedicated energy efficient fittings including space and security lighting. The requirement is to provide energy efficient lighting that is adequately controlled to minimize energy consumption.

-Health and Wellbeing
Daylighting (3 Points)

Credits are awarded where kitchens, all living rooms, dining rooms and studies achieve a minimum average daylight factor; and a percentage of these rooms receive direct light from the sky.

CASBEE was prepared by Japan Building and Environment Conservation Institute in 2002, and CASBEE Home, which is a version of CASBEE that concentrates on houses was published in 2007. CASBEE Home evaluates a building from the viewpoints of environmental quality and performance (Q = quality) and environmental load on the external environment (LR = load reduction). And a BEE point is calculated by the proportion of these two assessment points ($Q/LR = \text{BEE point}$). Lighting of homes is to be assessed in the following categories, each of which has its own weight in the total.



- Comfortable, Healthy and Safe Indoor Environment

Brightness – Use of Daylight (%4,5 of Q Points)

Structural arrangements for daylight penetration into the rooms based on the window opening ratio, window direction, and presence of daylight utilization facilities.

- Conserving Energy and Water

Energy Saving through Equipment Performance - Lighting fixtures, home electric appliances, and kitchen equipment (%3,25 of LR Points)

Energy-saving standard achievement rate of lighting fixtures are assessed according to type of lamps mainly used in rooms, especially fluorescent lamps are preferred.

Environmental assessment methods differ according to the lighting related categories and the percentages of these categories in the overall building assessment. It is obvious that energy efficiency recommendations should be determined basing on the local specifications which result in the external daylight illumination and direct sunlight availability. On the other hand, the building certification systems should address the related building regulations and standards. EN 15193 Energy performance of buildings specifies the calculation methodology for the evaluation of the energy use for indoor lighting and provides a numeric indicator for lighting energy requirements used for certification purposes. EN 15193 provides a methodology for the calculation of dynamic lighting energy use for the estimation of the total energy performance of the building. In order to minimize the energy consumption without compromising the visual comfort conditions, EN 12464 Light and lighting - Lighting of work places must also be appealed for providing energy efficient and visually comfortable livable environments in buildings.