E³Light

Annex 45
Energy Efficient Electric Lighting for Buildings

Biannual Newsletter 2/2008

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

Annex website:
lightinglab.fi/IEAAnnex45

New Doctors in the Lighting Field

The first doctoral thesis in Finland on solid-state lighting was defended by M.Sc. Paulo Pinho at Helsinki University of Technology on September 19 2008.

Professor Paula Elomaa from Department of Applied Biology, Helsinki University in Finland and Professor Uli Lemmer from Lichttechnisches Institut, Universität Karlsruhe in Germany were the official opponents.

The thesis begins with an introductory part in which the basic aspects related to the photosynthetic radiation, the photobiology of plants and the technology of light-emitting diodes (LEDs) are overviewed. This is followed by a review of related research that has been conducted during the last two decades, and by the main design issues of LED luminaires for plant growth. The nextpart of the thesis reports the experimental growth tests performed.

From left: opponent Prof. Paula Elomaa, candidate Paulo Pinho, supervisor Prof. Liisa Halonen and opponent Prof. Uli Lemmer.

Continued on page 2.

LED Lighting for a Media House

Lars Bylund

The new building for Media House should be a show case for the use of new and energy efficient technologies and at the same time provide a good and stimulating working environment.

Stavanger Aftenblad, a leading media house in Norway, established in 1893 and including today daily news papers, magazines, radio- and TV channels as well as IT news network, decided three years ago to start planning for a new head-quarters building.

Mr Leif Sirevag, director and responsible for the project had the vision that the new building should be a show case for the use of new and energy efficient technologies and at the same time provide a good and stimulating working environment.

To obtain the last requirement it was requested from Mr Sirevag that the building should make maximum use of daylight, which also at the same time should minimize the use of electrical lighting. It was therefore decided to plan for as much transparency as possible. This was accomplished by facades with glass from floor to ceiling and placing the working areas around an atrium to get daylight into the core of the building.
The building was planned to have a area of 22 600 m^2 consisting of 13 000 m^2 office and media zones, an atrium of 3600 m^2 and the rest commercial areas.

New ideas on energy efficient lighting were decided upon, among others LEDs for general lighting and a new strategy for daylighting. The installed power for lighting should not exceed 6 W/m^2 in office areas but still give a minimum of 500 lux at the work stations.

Continued on page 3.

Management of the Annex

The Executive Committee of the Energy Conservation in Buildings and Community Systems (ECBCS) programme established a new research project (Annex) in June 2004, called Energy Efficient Electric Lighting for Buildings. Professor Liisa Halonen from the Lighting Laboratory of Helsinki University of Technology was elected as the Operating Agent of Annex 45.

Operating Agent: Finland, Helsinki University of Technology
Professor Liisa Halonen

Subtask A Leader: France, École Nationale des Travaux Publics de l'État
Professor Marc Fontoynont

Subtask B Leader: Austria, Bartenbach LichtLabor GmbH
General Manager Wilfried Pohl

Subtask C Leader: France, Centre Scientifique et Technique du Batiment
Mireille Jandon and Nicolas Couillaud

Subtask D Leader: Finland, Helsinki University of Technology
D.Sc. Eino Tetri

Objectives

Identify and accelerate the use of energy efficient high-quality lighting technologies and their integration with other building systems

Assess and document the technical performance of existing and future lighting technologies

Assess and document barriers to the adoption of energy efficient technologies and propose means to surmount these barriers

Annex website:
lightinglab.fi/IEAAnnex45

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New Doctors in the Lighting Field

Usage and Control of Solid-state Light Sources for Plant Growth

The effects of the radiation emitted by spectrally tailored LED luminaires on plant growth have been investigated. A total of four growth tests using lettuce and radish cultivars were performed.

Two basic approaches were used to investigate the effects and the future possibilities of the usage of solid-state lighting (SSL) in plant growth. The first approach evaluated the growth development of lettuce plants in real greenhouse conditions using LEDs as supplementary light sources to natural daylight. In the second approach the evaluation was carried out with a total absence of natural daylight by growing lettuce and radish plants in phytotron-chamber conditions. The effects of SSL treatments on the growth development and quality of crops were compared with reference lighting systems composed of conventional and well-established light-source technologies, such as fluorescent and high-pressure sodium lamps. During the process of the investigation, arose the need to coherently quantify and evaluate the spectral quality of the radiation in terms of its photosynthetic appetence. Different metrics are still being used indiscriminately to quantify radiation used by plants for photosynthesis. Therefore, the existing metrics are discussed and a new proposal for coherent systematization is presented. The proposed system is referred to phyllophotometric, and it is developed by using the average photosynthetic spectral quantum yield response curve of plants. The results of the growth tests showed that the usage of SSL in plant growth offers an unprecedented possibility to optimize the morphogenesis, the photosynthesis and the nutritional quality of crops. This can be done by controlling the quantity and the spectral composition of the radiation provided, areas where LED-based luminaires excel. These possibilities can contribute to respond to the increasing demand for high-quality horticultural products by the consumers and to the conservation of global natural environment and resources.

The dissertation is available at http://lib.tkk.fi/Diss/2008/isbn9789512295029.

LED Lighting for a Media House

Lars Bylund

Continued from page 1.

To solve the problem associated with the solar gain, the transparent roof of the atrium was redesigned in such a way that the diffuse daylight was transmitted without any blinds or shielding but the direct solar radiation was avoided. Along all the facades on each floor it was mounted a light shelf with integrated LED light sources. During daytime daylight is reflected into the working areas and after sunset the LEDs distribute light in the same manner as the daylight which makes it hard to distinguish the difference between daylighting and artificial illumination.

Practically all fixtures for the Media House project are new developed fixtures. Since no standard fixtures were available on the market it was necessary to find a manufacturer willing, ready and able to participate in developing new types of LED fixtures. After thoroughly investigating the European market to find a suitable manufacturer accepting the requirements and not only be willing to develop LED fixtures but also have the innovative capacity to fulfil the project, the cooperation with the Slovenian INTRA Lightings subsidiary INTRA Lighting Scandinavia was established.

Office: Intra Light shelf (daylight + 7,5 W LED Seoul P4 / m length)
Corridors
Intra LED profile 7,5W/m LED Seoul P4
Intra LED profile Asymmetric 7,5 W/m LED Seoul P4
Trail spot 6 W LED
Stairs: Intra wall lamp 9 W LED (3x3W Rebel)

Light shelf with integrated LED light sources

To use LEDs economically and with energy efficient solutions, T5 or CDM fixtures can not be replaced with LED fixtures 1 to 1. The conceptual thinking and planning methods must be quite different. E.g. for the workstations there is a combination with indirect lighting based on CDM 70 W and task lighting with LED 3 W. All other areas like conference and meeting rooms, corridors, communication areas and stairs are illuminated only with LEDs.

Visually the office environment gives an impression of lightness and open space mainly because all vertical areas are illuminated. Six months after the building has been finished, inquiries among the employees shows great satisfaction with the new LED lighting. The main attribute is considered to be the light spectra perceived similarity to daylight, its “crispiness” and good colour rendition.

One advantage is considered to be that the LEDs in this project have a spectrum corresponding partially well to diffuse daylight. This, according to recent findings, might be of great biological importance since the absorption peak of the “third receptor” is around 470 nm.

Finally it would be appropriate to try to define some of the obstacles and barriers which have been most hindering in the introduction of LEDs for general lighting of building space, initially also in the Media House project.

The planning process and specifications as well as the procurement are often done a couple of years before the actual installation time. This means that most of the time the planning is based on proven but not visionary knowledge and on proven products of yesterdays.

Last but not least of obstacles is our own mind. Our ability or eagerness to adapt to new technologies and methods.

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Concept of Lighting Engineering Development Forecast

Julian Aizenberg

At the present phase of science and technology development, it becomes possible for the first time to create an environment having all the necessary parameters for the life of human beings. The lighting environment, which is an integral part of the living environment, also improves and develops, and now provides near-optimal visual comfort for work and rest recuperation, and for the improvement of the health of people as well as their mood and behavior.

Background

An all-round approach to the study of the lighting environment was developed in the 1970s and 1980s during the analysis of the following problems: "Light as a Component of the Human Living Environment" (S.G. Yurov and N.S. Ivanova, VNIITE), "Man and Light" (Ogarev MGU), "Multifunction Home Lighting Appliances" (VNISI). It was suggested to use the multifunction nature of light which is not only needed to ensure good visibility of the surrounding environment but also to serve other purposes – psychological, biological, aesthetic, and so on. Already at that time, it was suggested to adopt an all-round approach to designing a lighting environment with the aid of automatically controlled lighting systems, used for the purposes of illumination, irradiation and decoration, or using combinations of such systems. However, the capabilities of lighting engineering at that time were somewhat limited and theoretical studies could not always be translated into practical results.

Yet, the improvement of lighting engineering devices, which are used to form a lighting environment (light sources, lighting equipment, equipment for the control and redistribution of radiation over the entire optical spectrum), went ahead and, in the 1990s, resulted in improved opportunities for the formation of a dynamic lighting environment with good visual comfort and with all the above characteristics. Thus, multifunction lighting and irradiating lamps were developed, such as Biolux series luminescent lamps (Osram), whose radiation spectrum is close to that of the sun (color temperature T_{col} = 5,000, 6,000, and 6,500 K) and is saturated with strictly proportioned near UV. Also developed were "intelligent" engineering lighting systems which provide broad opportunities for lighting environment control. In this type of lighting environment, people are able to interact with it. It also became possible to define and broadly vary the quantitative and qualitative characteristics of lighting to produce the necessary degree of visual comfort using new ways of redistribution of the luminous flux in lighting installations.

Change in Lighting Design

Moreover, recent progress in lighting engineering is characterized not only by new technological advances. Our conception of illumination has changed, we have begun using techniques and methods previously used only in special lighting applications of "art lighting" (in theaters, cinemas, and on television). It has also become very common to experiment freely with color. The correlation between general and local lighting has shifted; the shadow-forming capabilities of lighting installations are also frequently used now. As a result, there are some lighting installations now that can justly be called works of art. Lighting design, as a separate trend, has much to do with finding an all-round solution to the aesthetic, functional, technical and economic problems of lighting. Earlier, this was true only of structures where the aesthetic component was rather prominent, but now it is often necessary to use light to create a distinctive art image of such "down-to-earth" structures as exhibition and trading halls, sports arenas and facilities, airports, etc., where, only very recently, the functional requirements dominated to the exclusion of everything else.

There is no doubt that lighting design will continue to develop because it is one of the most important components of the optimal lighting environment for people today.

Development of lighting engineering is based on a wider use of computers in preliminary studies, in the design of products and lighting installations. It is also based on a wider use of electronics in lighting products themselves and in their control systems, as well as on the use of new structural and engineering materials and their manufacturing processes.

Future Trends in Lighting Engineering

These considerable achievements in lighting engineering in the last decade of the 20th century will necessarily lead to future qualitative changes – ***a growing role for lighting engineering in the life of society and its inevitable influence on humans.***

This process should be expected to have the following trends. First, it will lead to continued studies of the lighting environment where light is viewed as one of the essential "elixirs of life" for human beings and where light also plays a very important role in preventive medicine and health protection and in improvement of working conditions. We should also mention here the findings of G.C. Brainard's recent studies concerning the non-visual effects of light on human physiology and behavior, and stimulation of human activities on a totally new existential level. The results of such studies may force us all to change our approach to illumination standardization and implementation of this approach might lead to improved opportunities for development of human individuals as well as society as a whole. Technological advances, especially those in electronics, make it possible now to develop a flexible, controlled lighting environment, ***which eliminates the need for human beings to adapt to it and which itself can be adapted to the needs of human beings.***

Future lighting installations will be multifunctional lighting systems producing high levels of visual comfort. And they will also be energy-efficient, effective and environmentally safe, and they will produce light exactly as needed. This is the main trend of lighting engineering development which emphasizes its great importance.

Energy Conservation

The problem of saving energy in lighting installations has taken on great importance over the last few years in many countries of the world, in developed and in developing countries. To a large extent, the future of our civilization depends on the successful solution of this problem. It is so because the resources of fossil fuel used to produce electricity gradually run out and also because of environmental pollution by emissions of toxic substances into the atmosphere (carbon and sulfur dioxides as well as mercury) as a result of burning fuel to produce electric power.

In this respect, many countries in the world have adopted special energy conservation programs which are being implemented now. These programs have separate sections on lighting installations. The most advanced is the US Green Light program and energy conservation programs adopted in Britain, the Netherlands, Denmark, and Sweden. The US Green Light program has also been used as a basis for similar programs developed in China, Brazil, South Korea, Thailand, Mexico, and the Czech Republic. These programs foresee a drastic reduction in electric power consumption in lighting installations (by 20% to 50%) and reduction in the amount of toxic substances discharged into the atmosphere. Under these programs, the reduction in energy consumption is achieved with the aid of diverse measures targeting the production structure of lighting products, the quality of manufactured lighting equipment, and its efficient use. It is important to note that all these documents have the following in common: they emphasize the use of compact luminescence lamps and their introduction into the most important and "responsive" applications – residential houses, commercial, administrative and public buildings, especially those in the public sector. At last years the role of LEDs has quickly grown.

A general program for energy conservation has also been adopted in Russia and separate programs have been initiated in some regions of the country. The implementation of such programs is slow and uneven because of lack of target funding and of necessary motivation and preconditions for their fulfillment.

Use of Daylight

One of the more important ways to reduce energy consumption in lighting installations, and one that is, as a rule, not given enough attention, is a much wider use of natural illumination, and especially the use of direct solar radiation. This is especially important for deep-recess buildings, high-rise buildings with dark central zones, underground facilities, buildings without day lighting and for windowless structures. The recent achievement of lighting engineering – the use of different type light guide systems.

Especially wide application will receive simple systems with short Hollow Light Guides (Solar Project, Solar Spot).

Integration to Building Systems

The concept of development forecast for lighting engineering would be incomplete without mentioning here the necessity and full feasibility of using an all-round integral approach to all engineering systems of buildings in the 21st century: protective screens, natural and artificial illumination systems, heating, ventilation, and air conditioning. A new qualitative level of technical and economical characteristics and a greater degree of visual comfort can only be achieved on the basis of an all-round approach to the design and construction of buildings and other structures.

And, finally, it is also important to note the growing importance of lighting design in both the development of lighting products and construction of lighting installations.

Concept of Development Forecast for Lighting Engineering

1. **Recognition of the increasing role that lighting engineering plays in the life of society and its growing influence on society development.**
2. **Development of a flexible controlled lighting environment to serve the needs of people.**
3. **Development and manufacture of high-efficiency lighting installations that are also power efficient and environmentally friendly, including dynamic installation General transition from filament to discharge lamp, before of all on CFL and after this - on LED.**
4. **Use of the multi-functional nature of light to provide excellent visibility and serve all other functions, that is, psychological, physiological, aesthetic, etc.**
5. **Comprehensive design of all engineering systems of buildings and structures: protective devices and screens, illumination, heating, ventilation, and air conditioning.**
6. **A wider use of natural illumination, including its introduction into and distribution inside deep-recess multi-story buildings.**
7. **Recognition of the rapidly growing role of lighting design in the design and development of lighting systems. Tremendous perspectives attack from LED at next 4-5 year.**

Lighting Engineering Development

Dealing with the concept of development forecast for lighting engineering for the next five years, we should note the following. This industry depends entirely on the positive development of the huge economic mechanism. Yet, the rates and trends of this development are not yet fully definable. Therefore, any forecast at the present time faces many difficulties which can only be overcome if we concern ourselves, first and foremost, with qualitative aspects as well as with the entire complex of problems that have to be rapidly solved if we want to eliminate the gap between recent advances in world lighting engineering and engineering. In addition, it also appears necessary to make a number of quantitative estimates (above all, regarding possible power saving in lighting installations and the resultant reduction in the amount of toxic substances discharged into the atmosphere).

The principles in table ought, therefore, to underlie the concept of development forecast for lighting engineering. The successful fulfillment of this program of lighting engineering development, in accordance with this concept, will allow a saving of 45% of electric power and reduction of toxic substances discharged into the atmosphere.

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Julian AIzenberg, VNISI, Russia

Commissioning of Lighting Systems

Mireille Jandon, Nicolas Couillad, Arnaud Deneyer &Ahmad Husaunndee

Commissioning is a quality-oriented process for achieving, verifying and documenting whether the performance of a building's systems and assemblies meet defined objectives and criteria. The purpose of the commissioning plan is to provide direction for the commissioning process during construction, providing resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals, and coordination.

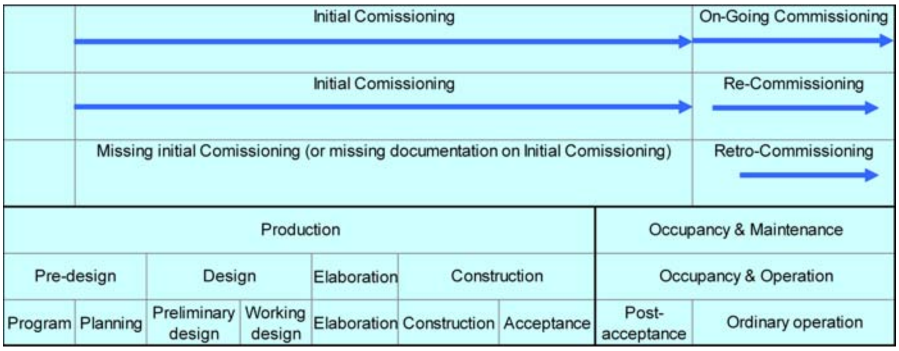
Commissioning Process

The commissioning process deals with the identification of suitable commissioning organizations adapted to the complexity and quality expectations of a given project in terms of cost and benefit.

Commissioning is a quality-oriented process for achieving, verifying and documenting whether the performance of a building's systems and assemblies meet defined objectives and criteria. Very often it is viewed as a task performed after a building is constructed and before it is handed over to the building owner to check operational performance: this leads to deficiencies in performance which can result in excessive energy consumption.

This broader view of the commissioning process begins at project inception during the pre-design phase and continues for the life of the facility through the occupancy & operation phase. Four types of commissioning have been identified in Annex 40. (Annex 40 Commissioning of Building HVAC Systems for Improving Energy Performance.)

- Initial Commissioning (I-Cx) is a systematic process applied to production of a new building and/or an installation of new systems.
- Retro-Commissioning (Retro-Cx) is the first time commissioning implemented in an existing building in which a documented commissioning process was not previously implemented.
- Re-Commissioning (Re-Cx) is a commissioning process implemented after I-Cx and Retro-Cx when the owner hopes to verify, improve and document the performance of building systems.
- On-Going Commissioning (On-Going Cx) is a commissioning process conducted continually for the purpose of maintaining, improving and optimizing the performance of building systems after I-Cx and Retro-Cx.



Comissioning plan.

Purpose of the Commissioning Plan

The purpose of the commissioning plan is to provide direction for the commissioning process during construction, providing resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals, and coordination.

Commissioning Goals and Objectives

Commissioning is a systematic process of ensuring that the building systems perform according to the design intent and the owner's operational requirements. All equipment and systems should be installed according to manufacturer's recommendations and the best practices and standards of the industry.

Commissioning will include documenting the design intent, followed by activities in the construction, acceptance, and warranty phases of the project. The participation of the contractors in commissioning activities will follow the requirements defined in the specifications. The three main goals of the commissioning process are:

- Facilitate the final acceptance of the project at the earliest possible date.
- Facilitate the transfer of the project to the owner's maintenance staff.
- Ensure that the comfort systems meet the requirements of the occupants.

Commissioning is also intended to achieve the following specific objectives:

- Document that equipment is installed and started per manufacturer's recommendations.
- Document that equipment and systems receive complete operational checkout by installing contractors.
- Document system performance with thorough functional performance testing and monitoring.
- Verify the completeness of operations and maintenance materials.
- Ensure that the owner's operating personnel are adequately trained on the operation and maintenance of building equipment.

Objective of Lighting Systems

To enable people to perform visual tasks efficiently and accurately, adequate and appropriate lighting should be provided. The illumination can be provided by daylight, artificial lighting or a combination of both.

For good lighting practice it is essential that in addition to the required illuminance, qualitative and quantitative needs are satisfied.

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Expert Meetings

The 8th Expert Meeting of Annex 45 was on June 17 – 18 2008 in Delft, The Netherlands. The meeting was hosted by Truus de Bruin-Hordijk and Regina Bokel from Technical University of Delft. There were 12 participants from 7 countries.

The 9th Expert Meeting of Annex 45 was on October 15 – 17 2008 in Malmö, Sweden. The meeting was hosted by Nils Svendenius, School of Engineering, Jönköping and Peter Pertola, WSP Ljusdesign. There were 18 participants from 11 countries.

Right: Participants of the Malmö meeting.

EEDAL'09 - 5th International Conference on Energy Efficiency in Domestic Appliances and Lighting

Berlin Germany, June 16-18, 2009

Private households are responsible for a large share of global energy and electricity consumption and the related CO_2 emissions into the atmosphere. Residential energy demand is also rapidly increasing due to larger homes, new services and additional appliances, putting a strain on the economies and energy infrastructures of both developed and developing countries.

EEDAL'09 will provide a unique forum to discuss and debate the latest developments in energy efficiency of residential appliances and lighting, heating and cooling equipment and ICT equipment. The policies and programmes adopted and planned, as well as the technical and commercial advances in the dissemination and penetration of energy efficiency in the fields will be presented.

The three-day conference will include plenary sessions where key representatives of governments and international organizations, manufacturers and academia will present their views and programmes. Parallel sessions on specific themes and topics will allow in-depth discussions among participants.

The oficial registration and information website will be launched at the end of October 2008: www.EEDAL.eu.

LUX PACIFICA 2009

VI International Lighting Conference of the Illuminating Engineering Societies of the Pacific Basin Region

Light without borders!

Khabarovsk, Russia, April 23-25, 2009

LUX PACIFICA is the organization established in the late 1980s which unites the Illuminating engineering societies of the Pacific Basin Region. The member lighting societies are: IES of Australia & New Zealand, IES of North America, Illuminating Engineering Institute of Japan, China Illuminating Engineering Society, Indian Society of Lighting Engineers, The IES of Russia, The IES of South Africa and The IES of Thailand. The Chairman of LUX PACIFICA is Dr. Warren Julian, IESANZ.

The first LUX PACIFICA conference was held in Shanghai (China) in 1989. That was very successful; with Thailand offering to host the second LUX PACIFICA was in 1993. Then followed, Nagoya (Japan) in 1997, New Delhi (India) in 2002 (rather than 2001) and The Illuminating Engineering Society of Australia and New Zealand hosted this important regional conference in 2005.

LUX PACIFICA 2009 will be organized by the Illuminating Engineering Society of Russia. It is an open conference and different countries are invited to participate in it.

Subjects of the Conference

- Fundamentals of lighting and daylighting
- Vision and Colour
- Energy Efficiency
- Outdoor and Indoor Lighting
- Light and Health
- Light and Architecture
- Lighting Design
- Lighting Fixtures
- Sources of Light and Control Systems
- LEDs and their application
- Irradiation Systems
- Light Measurements
- Standards of Lighting
- Optical devices, sensors and displays
- Radiometric or optical properties of materials.

More information from http://www.vnisi.ru/eng/events/luxpacifica2009/

Want more info? Contact your country representatives or Operating Agent!

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Annex 45 Expert meetings

10th Expert meeting
6-8 April 2009
Gliwice, Poland
Zbigniew Mantorski
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International Energy Agency
Energy Conservation in Buildings and Community Systems Programme