E³Light

Annex 45
Energy Efficient Electric Lighting for Buildings

Biannual Newsletter
1/2009

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

Annex website:
lightinglab.fi/IEAAnnex45

New Doctors in the Lighting Field

M.Sc. Pramod Bhusal defended his doctoral thesis *Energy-Efficient Electric Lighting for Buildings in Developed and Developing Countries* at Helsinki University of Technology, Finland. Prof. Dave Irvine Halliday, professor from the University of Calgary and the founder of the Light Up the World (LUTW) organization was the opponent of his doctoral defense.

M.Sc. Liping Guo defended her doctoral thesis *Intelligent Road Lighting Control Systems - Experiences, Measurements, and Lighting Control Strategies* at Helsinki University of Technology, Finland.

Continued on page 2.

Light Up the World

Light Up The World Foundation (LUTW) is an international humanitarian organization dedicated to illuminating the lives of the world's poor. It utilizes solid-state lighting technologies to bring affordable, safe, healthy, efficient, and environmentally responsible lighting to people currently without access to proper lighting.

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Guidebook on Energy Efficient Electric Lighting for Buildings

Annex 45

The aim of the Annex 45 is to assess and document the technical performance of the existing promising, but largely underutilized, innovative lighting technologies, as well as future lighting technologies and their impact on other building equipment and systems (ie: daylighting, HVAC). These novel lighting system concepts have to meet the functional, aesthetic, and comfort requirements of building occupants. The main deliverable of the Annex 45 will be the guidebook on energy-efficient lighting.

Guidebook will be the achievement of the work done in the IEA (International Energy Agency) ECBCS (Energy Conservation in Buildings and Community Systems) Annex 45 Energy Efficient Electric Lighting for Buildings. In the Annex work took part 20 countries and more than 30 organisations. The Guidebook will be available as a printed copy (summary), CD-ROM version and on the internet. Guidebook is intended to be useful for lighting designers, electrical building services and system integrators in buildings, the end-users/owners and all others interested in energy efficient lighting.

Lighting is a large and rapidly growing source of energy demand and greenhouse gas emissions. At the same time the savings potential of lighting energy is high even with the current technology and there are new energy efficient technologies coming on the market. More efficient use of lighting energy would limit the rate of increase of electric power consumption, reduce the economic and social costs resulting from constructing new generating capacity, and reduce the emissions of greenhouse gases and other pollutants. Important factors for lighting today are energy savings, daylight use, individual control of light, quality of light, emissions during life cycle and total costs. Novel lighting system concepts have to meet the functional, aesthetic, and comfort requirements of building occupants.

CONTENT

Annex 45
Energy Efficient Electric Lighting for Buildings

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**

Annex website:
lightinglab.fi/IEAAnnex45

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

Continued from page 1.

New Doctors in the Lighting Field

Energy-Efficient Electric Lighting for Buildings in Developed and Developing Countries

Pramod Bhusal

Solar electricity for lighting in remote Nepali village.

The main objectives of this work were to review different aspects of lighting quality and energy efficiency and to test the existing technologies for efficient lighting. An additional aim of the work was to examine the new opportunities provided by LED technology in providing lighting in rural areas of developing countries and to compare LED lighting with existing fuel-based lighting.

Three different lighting control systems in office rooms were compared for energy efficiency and the quality of lighting by means of measurements. The results of the measurements showed a significant potential for saving energy by the use of daylight-based dimming and occupancy control. The renovation of an auditorium with a new lighting installation resulted in higher illuminance levels and better colour rendering, while reducing energy consumption.

The work presents a study and evaluation of traditional pine stick lighting and new white LED-based lighting used in rural Nepali villages. The use of different renewable energy sources in combination with efficient lighting technology is found to be a realistic and sustainable option to provide clean and efficient lighting services in developing countries.

The dissertation can be found at http://lib.tkk.fi/Diss/2009/isbn9789512296385/

Road Lighting Control Systems - Experiences, Measurements, and Lighting Control Strategies

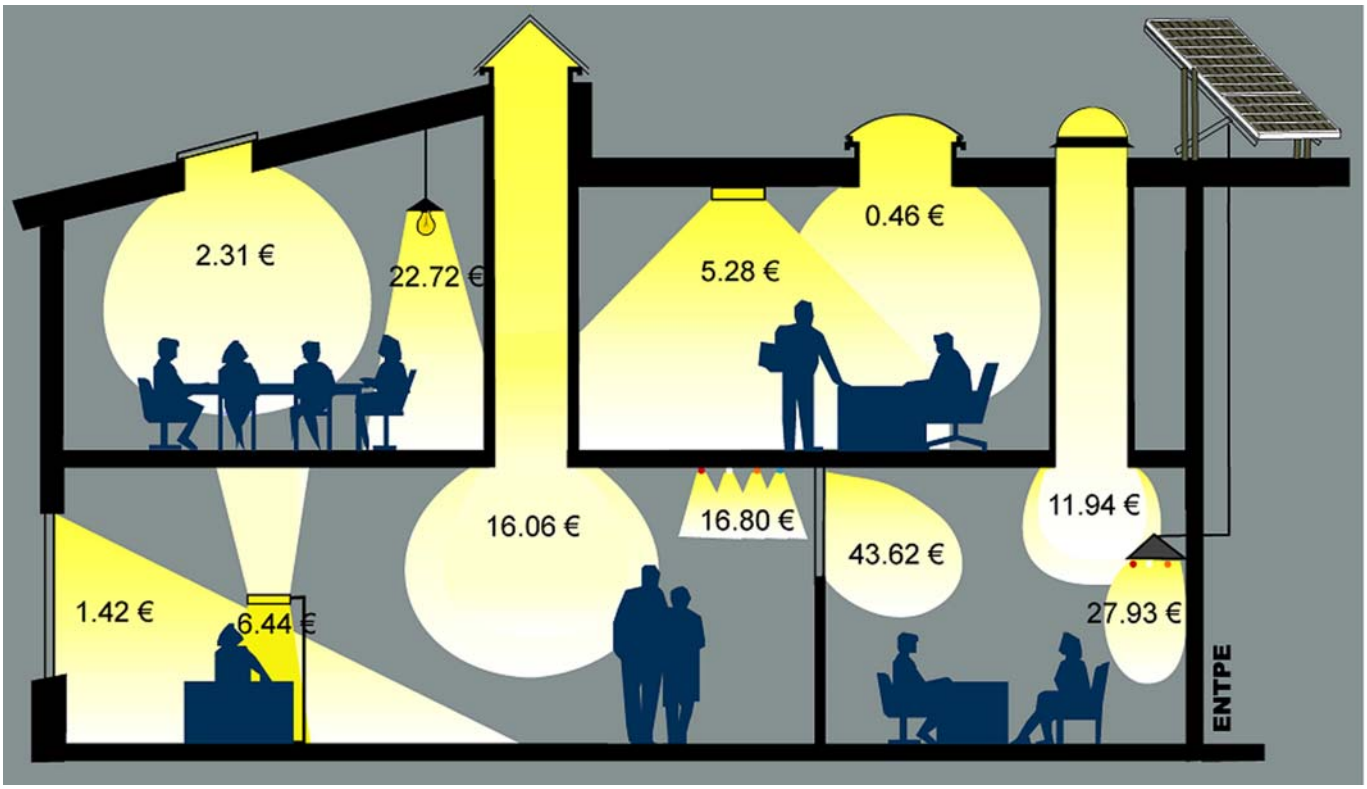
Liping Guo

The work starts with a brief overview of the main issues concerning road lighting control systems. Then the work focuses on the performance of intelligent road lighting control systems by using the examples of two installations in Finland, Ring III and VT7. The real benefits and drawbacks are discussed and financial calculations are given. The work continues with the subject of road surface luminance measurements in order to suggest ways in which the performance of intelligent road lighting control systems might be optimized. The work also investigates the main control parameters and strategies that are applied currently and tries to to find basis of dynamically changing light levels.

The dissertation can be found at http:\\lib.tkk.fi/Diss/2008/isbn9789512296200

Long Term Assessment of Costs Associated with Lighting and Daylighting Techniques

Marc Fontoynont



This paper provides financial data leading to the comparison of costs of various daylighting and lighting techniques over long time periods. The techniques are compared on the basis of illumination delivered on work plane per year. The selected daylighting techniques were: roof monitors, façade windows, borrowed light windows, light wells, daylight guidance systems, as well as off-grid lighting based on LEDs powered by photovoltaics. These solutions were compared with electric lighting installations consisting of various sources: fluorescent, tungsten and LED. Figure shows the annual costs for various options (€/Mlmh)

Background

This study aimed at producing data which would give a new approach of low energy lighting options, and instead of producing robust reference data, we prefer to propose protocols and models. It should be regarded as a way to trigger the debate about the long-term cost of lighting solutions.

Limitations of the model

It is clear that these data are highly dependent on the hypotheses which were defined: for instance the fact we referred to "daylight hours" and not occupation schedule reduces significantly the differences with other climates. More important, we had to define values for parameters such as: duration of the systems, installation costs, maintenance costs which clearly differ very much from project to project, in a ratio which can easily be in excess of two. We therefore recommend the readers to carefully check the hypotheses and adjust the parameters accordingly. Most of the time, the adjustment could be easily done, since most cost figures are proportional to the input.

We are aware of the limitation of our model, where all daylight supplied by the daylighting systems is taken into account, for any level and any time.

Other approaches

The proposed next step would be to take into account only daylight supplied during the time where the building will be occupied. The predictable consequence would be to extend the lifespan of the electric lighting systems relatively to the one of the daylighting systems.

Another useful approach would be to include the cost of energy associated to the production, the transportation and the installation of the products.

Results

Here are some general results:

Result 1: Apertures in the envelope of the building are cost effective to bring light in the peripherical spaces of a building, mainly if they are durable and require little maintenance.

Result 2: Daylighting systems aimed at bringing daylight deeply into a building are generally not cost effective, unless they use ready-made industrial products with high optical performance and low maintenance, and collect daylight directly from the building envelope.

Result 3: Tungsten lamps, when used continuously for lighting, are very expensive and need to be replaced by fluorescent sources or LEDs.

Result 4: Depending of the evolution of performances and costs of LEDs and photovoltaic panels, there could be also options to generalize lighting based on LED and possibly to supply them with electricity generated directly from photovoltaic panels.

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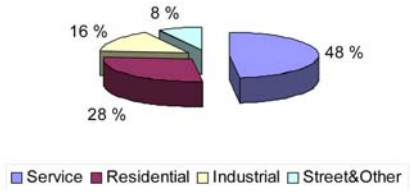
Lighting energy in buildings

According to the IEA study, global grid based lighting consumed about 2650 TWh of electricity in 2005; an equivalent of 19 percent of total global electricity consumption. More than 50% of this lighting electricity is consumed in IEA member countries, but this case will not be the same in few years due to the increasing growth rate of lighting electricity use in non IEA countries.

The share of electricity use for lighting over total electricity use varies from 5 % to 15% for the industrialized countries, while the share is up to 86% in developing countries.



Distribution of the global lighting electricity.

Primary energy and CO_2 in Europe

1 kWh electricity ~ 527 g CO_2

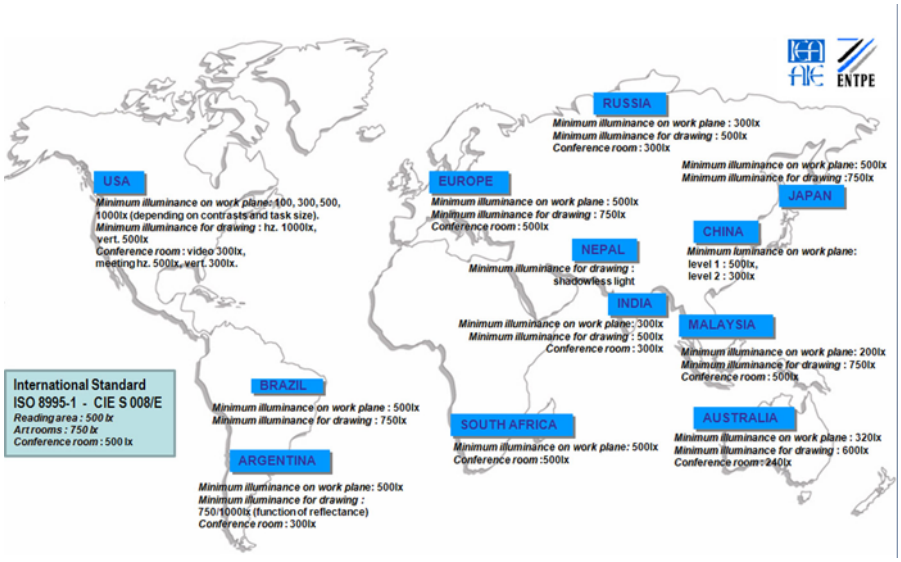
1 kWh electricity ~
2,5 kWh primary energy

The building sector in the EU consumes over 40 % of the energy use in EU and is responsible for over 40 % of its carbon dioxide emissions. To promote the improvement of the energy performance of buildings within the community, the European Parliament has adopted the Directive 2002/91/EC on the energy performance of buildings.

Total electricity (%) use for lighting in EU buildings

Building types	%
Offices	50
Hospitals	20-30
Factories	15
Schools	10-15
Private Buildings	10

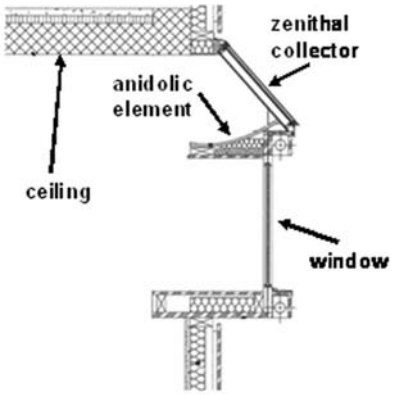
Lighting and energy standards and codes



Comparison on specifications for visual performance in offices, minimum illuminances on workplane and for drawing, illuminance for conference room.

The major international organization in charge of coordinating the production of standards, recommendations and technical reports in the field of lighting is the Commission Internationale de l'Eclairage (CIE). (www.cie.co. at)
The recommendations of the CIE have been interpreted in different manners at national levels. Hence some discrepancy exists between recommendations worldwide. The figure shows as an example a map of minimum illuminances on workplane for office work, drawing and conference rooms. These values vary from 200 to 500 lx. Basically, the differences in specifications are not very large, since they tend to be related to the CIE recommendations.

Case Studies



Southern façade of the building and section from the façade's system.

In office building in Switzerland a mirror redirects daylight from the sky to the room's diffuse ceiling from where it is reflected into the room. Daylight is guided towards the ceiling by a mirror in order to be lead to the rest of the room. The lighting power density is 4.5W/m². The average illuminance (artificial lighting only) on the work plane was 235 lux. All occupants have answered they were very satisfied with their lighting conditions.

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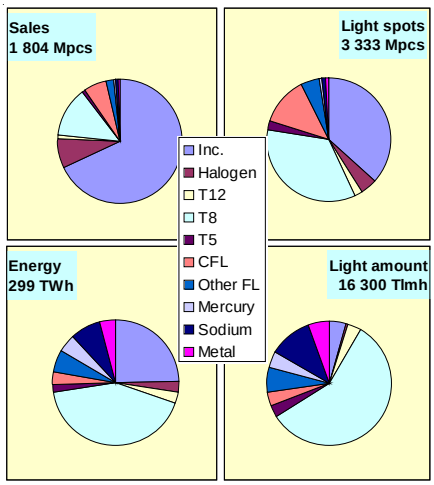
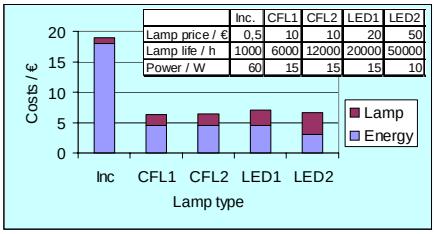
Lighting technologies

Van Tichelen et.al. have given estimation of the total lamp sales on 2004 in EU-25. However, annual sales do not give the total amount of light spots in use. For instance, the lamp life of T8 lamps is 12 000 hours on average and yearly burning hours in office use can be 2500 hours. Thus the amount of lamps in use is almost fivefold (12000/2500 = 4.8). From the lamp sales the amount of light spots in use, the energy lamps are using and the amount of light they are producing has been calculated. Assumptions of the average lamp power and ballast losses, annual burning hours, luminous efficacy and lamp life has been made.

T12-lamps should be replaced with T5-lamps with their dedicated luminaires. Also new alternatives for the T8-lamp has to be found. In the near future more efficient light source is T5-lamp with electronic ballast and in the long run LEDs with their potential efficacy reaching 200 lm/W and more.

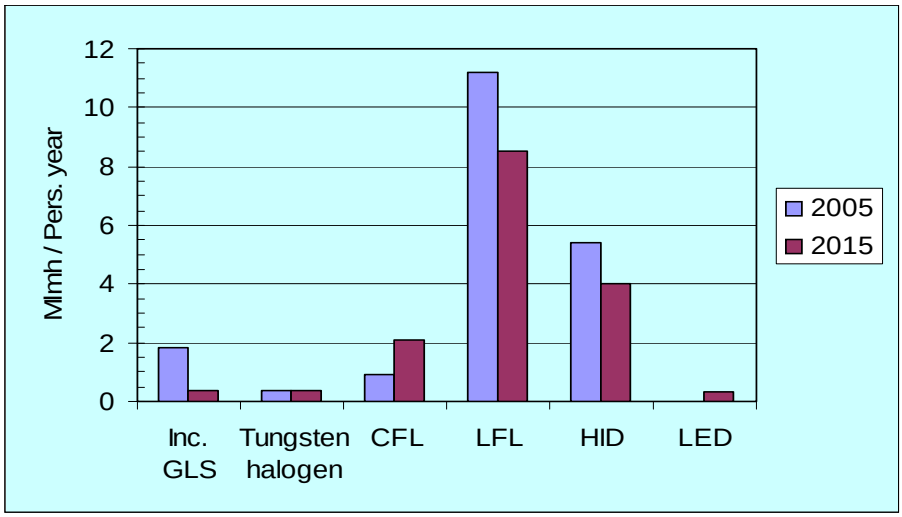


Estimated lamp sales, and calculated values of the amount of light spots in use, the energy consumption and the amount of light.



Lamp costs and energy costs of different lamp types with 2000 burning hours, electricity 15 c/kWh, interest rate 5 %, repayment period is lamp life divided by annual burning hours.

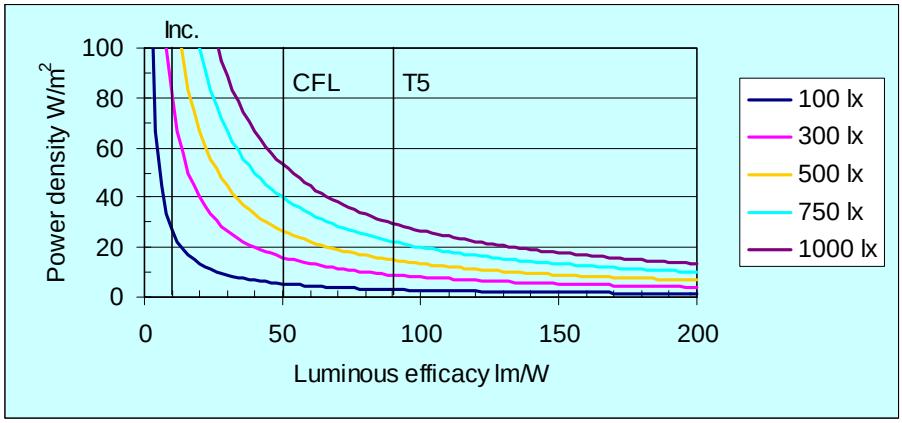
Technical potential for energy efficient lighting and savings



Change of light production estimated by IEA Annex 45, Wilfried Pohl, 03/2009.

Figure represents an estimation of the development of the global electrical-light production in the year 2015 compared to year 2005. Generally, in comparison to 2005, an increase of approximately + 25% is to be expected. It is estimated, however, that due to an improved facility efficiency factor of 0.8 and service-life optimization factor of 0.8, this will be reduced. All together, the outcome is a reduction in the overall light production of approximately 20%.

At the same time, it can be expected that there will be a clear reduction of the standard incandescent lamps due to legal regulations (step by step abolition of the standard incandescent lamps in the EU) and an increase in compact fluorescent lamps and LED lamps.



Power density (W/m²) as a function of luminous efficacy (lm/W) on different illuminance levels (lx), maintenance factor was 0.75 and utilization factor 0.5.

Figure shows power densities as a function of the luminous efficacy. Illuminance has been used as a parameter (100 lx, 300 lx, etc.), maintenance factor was 0.75 (lumen depreciation caused by aging of lamps and dirt on reflectors and walls 25 %), utilization factor 0.5 (50 % of the luminous flux of the lamps comes on the illuminated area).

For white LEDs target luminous efficacy is 200 lm/W. The power density with that eddicacy will be from 1,3 W/m² to 13,3 W/m² with illuminaces ranging from 100 lx to 1000 lx.

LED Illuminates the Office and Saves Energy

Kirsi Hemmilä, YIT Group

YIT have developed a suspended ceiling element which integrates the entire building technology. The latest version of the element utilises LED light. The energy efficient lighting has also gained popularity among its users.

Thanks to its simplified design, LuxCool fits well into different environments. LED lighting reminiscent of daylight is pleasant according to user feedback.

In the new YIT office building in Käpylä, Helsinki, there is no need for wall-mounted radiators for heating or separate cooling beams for cooling. All the technology that is needed in an office space, lighting, heating, cooling, air conditioning, as well as their adjustment and controls, has been integrated into the LuxCool suspended ceiling element.

On one floor of the office building, LED lights installed into the LuxCool suspended ceiling element were introduced at the beginning of the year 2009. The office area is approximately 2,400 square meters.

LuxCools are delivered to a site as ready-to-install elements ready to be attached to the ceiling. The pipes and cables can be connected directly to the systems in place. Electrical and data cables can be brought to the workspaces through the LuxCool element, and there is no need to install separate cable trunking or floor mounting boxes. In addition to ordinary technology, security systems and automation solutions can also be installed to the element.

Energy savings with LED lights

The LuxCool suspended ceiling element is the result of YIT's own development work. "For several years, we have developed the product itself as well as the whole process from the prefabrication to the site, eventually into an energy efficient real estate, which offers its users a good environment," says Mikko Myyryläinen, Building Systems Services Project Development Manager at YIT.

"In the latest model of the LuxCool we have implemented the lighting with LED light. This increases energy efficiency considerably because LED light consumes significantly less electricity than fluorescent tubes. According to our experiences this saves 15-30% energy compared with the fluorescent tubes on the market and up to 75 compared with CFLs.

"We are currently testing different LED lights with LuxCools on one floor of our office building. We measure the energy consumption of each floor of the office building separately so that we gain as accurate an understanding as possible of the energy consumption of different forms of lighting," says Mikko Myyryläinen.

Users

"LED's have developed rapidly and they already produce a lighting level for workspaces that is in accordance with lighting standards. The lamps are also of uniform quality. Since the beginning of the year, we have been using approximately 500 lamps of which only one has been determined to be faulty," explains Myyryläinen.

In addition to its low electricity consumption, there are also other reasons for using LED lighting. The quality of the light is close to that of daylight and its colour rendering is good. According to Myyryläinen, users have been pleased with LED lighting.

Adjustments even with a mobile phone

"In the next development version of LuxCool, luminosity can be adjusted for each individual light. This increases the level of comfort because the user can adjust the luminosity in their workspace as they please. In future, the adjustment can be made even with a mobile phone," explains Myyryläinen.

The office floor, approximately 2,400 square meters in area, is completely illuminated with LED lights.

YIT Group

YIT is a European service company operating in building systems, construction services and services for industry. YIT is a leading company in the Nordic Countries in the field of Building Systems.

YIT runs the CoolHeat building systems development programme funded by Tekes (the Finnish Funding Agency for Technology and Innovation), which aims to improve real estate energy efficiency by developing building system solutions and to increase productivity through prefabrication and productisation of building systems. The extent of the CoolHeat technology programme is over EUR 2 million.

Light Up the World

Continued from page 1.

http://lutw.org

Mission: Light Up The World Foundation is an international humanitarian organization dedicated to providing funding and facilitation for the development of renewable energy based solid state lighting for the world's poor and underserved.

Vision: The Foundation will work to provide affordable, safe, healthy, efficient, and environmentally responsible renewable energy based solid state lighting solutions to the two billion people worldwide currently without access to proper lighting.

- Approximately 2 billion people in the world have no access to electric lighting in their homes.
- Fuel based lighting is expensive, inefficient, unhealthy, ecologically unsound, and unsafe.
- The cost to people and governments in terms of fuel dependency and subsidies is very high.
- Lack of suitable lighting is directly linked to the cycle of illiteracy & poverty.

10th Expert Meeting

The 10th Expert Meeting of Annex 45 was on April 6 – 8 2009 in Gliwice, Poland. The meeting was hosted by Zbigniew Mantorski from W.A.S.K.O. S.A.

Conference subjects:

Lighting and the Environment
Energy Efficiency
Lighting Quality
Light for People at Work
Health and Lighting
Lighting in Architecture
Lighting in the Cities
Adaptive Lighting
Standards of Lighting
Sustainable Lighting
Measurement

LUX EUROPA 2009

11th European Lighting Congress
Lighting and the Environment
Licht und die Umwelt
Lumière et l´Environnement

Istanbul, Turkey, September 9 - 11, 2009

Conference website: http://www.luxeuropa2009.org.tr

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON LLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

CIE Central Bureau Kegelgasse 27 A-1030 Wien Austria

http://www.cie.co.at/

CIE 2010
Lighting Quality & Energy Efficiency

March 14 - 17, 2010
Vienna, Austria

"The CIE, founded in 1913, is the oldest and most respected International Lighting Organisation, which deals with all the different aspects of this subject. It is totally committed to the development of energy efficient lighting technologies and standards but without sacrificing safety, security and other important aspects of lighting quality. This objective can be achieved through the intelligent use of new technologies and a scientific understanding of the varied human needs for different types of lighting in different settings.", says Dr Hengstberger in his invitation letter.

Dr Hengstberger continues: As President of the CIE, and as Conference President, I am proud to present CIE 2010 "Lighting Quality & Energy Efficiency" as a unique forum to get to know the latest developments and results and invite you to join in the effort to enhance lighting quality and reduce energy consumption worldwide.

Further information on the conference website at vienna2010.cie.co.at.

CIE 2010 will highlight

* Surveys of experimental projects
* Lighting techniques & scenarios
* Integrated approaches in Lighting Design
* Lighting quality criteria
* Future possible lighting schemes
* Methods to compare lighting installations
* Case studies of energy-efficient lighting
* Review of energy-efficient lighting control systems
* Energy efficiency and environmental compatibility

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

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Annex 45 Expert meetings

11th Expert meeting
9-11 September 2009, Istanbul, Turkey (During Lux Europa)

International Energy Agency
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