E³Light

Annex 45
Energy Efficient Electric Lighting for Buildings

Biannual
Newsletter
1/2005

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

Web-site:
lightinglab.fi/IEAAnnex45

The Executive Committee of the Energy Conservation in Buildings and Community Systems (ECBCS) program 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 for the Operating Agent of the Annex 45.

The objectives of Annex 45 are to identify and accelerate the use of energy-efficient high-quality lighting technologies and their integration with other building system, to assess and document the technical performance of existing and future lighting technologies, as well as to assess and document barriers preventing the adoption of energy-efficient technologies, and to propose means to resolve these barriers.

Workshop meeting 5 – 6 April 2004, Helsinki

Annex Workshop meeting was held on 5 – 6 April 2004, in Helsinki. The meeting was hosted by HUT (Helsinki University of Technology). There were 18 participants from 9 countries. The workshop included presentations by the participants of their research work and possible input to the Annex. The Annex draft to be presented to ExCo in June 2004 was processed in the Workshop. The management of the Annex (Operating Agent and Subtask Leaders) was decided and the participants of different Subtasks and timetable were agreed.

Annex preparation phase meeting 20 – 21 October 2004, Paris

The Annex preparation phase meeting was hosted by CSTB (Centre Scientifique et Technique du Batiment). The Annex workplan was reviewed and modified during the meeting on group discussions and overall discussions and the Annex work programme was agreed.

Annex 45
Energy Efficient Electric Lighting for Buildings

Introduction

International Energy Agency (IEA) is an intergovernmental body committed to advancing security of energy supply, economic growth and environmental sustainability through energy policy co-operation. IEA has Implementing Agreements (IA) to organize research. One of these IAs is Energy Conservation in Buildings and Community Systems (ECBCS). The function of ECBCS is to undertake research and provide an international focus for building energy efficiency. Tasks are undertaken through a series of annexes that are directed at energy saving technologies and activities that support their application in practice. Results are also used in the formulation of energy conservation policies and standards.

The Executive Committee of the ECBCS program established a new Annex in June 2004 called Energy Efficient Electric Lighting for Buildings. Professor Liisa Halonen from Lighting Laboratory of Helsinki University of Technology was elected for the Operating Agent of the Annex 45.

Background

Lighting-related electricity production for the year 1997 was 2016 TWh of which 1066 TWh was attributable to IEA member countries. Global lighting electricity use is distributed approximately 28 % to the residential sector, 48 % to the service sector, 16 % to the industrial sector, and 8 % to street and other lighting. For the industrialized countries national lighting electricity use ranges from 5 % to 15 %, while in developing countries the value can be as high as 86 % of the total electricity use. The corresponding carbon dioxide emissions were 1775 million tonnes, of which approximately 511 million tonnes was attributable to the IEA member countries. [1]

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. New aspects of desired lighting are energy savings, daylight use, individual control of light, quality of light, emissions during life cycle and total costs.

The building sector in the EU consumes over 40 % of energy use in EU and is responsible for over 40 % of its carbon dioxide emissions. Lighting is a substantial energy consumer, and a major component of the service costs in many buildings. The percentage of the electricity used for lighting in European buildings is 50 % in offices, 20-30 % in hospitals, 15 % in factories, 10-15 % in schools and 10 % in residential buildings [2]. 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. [3]

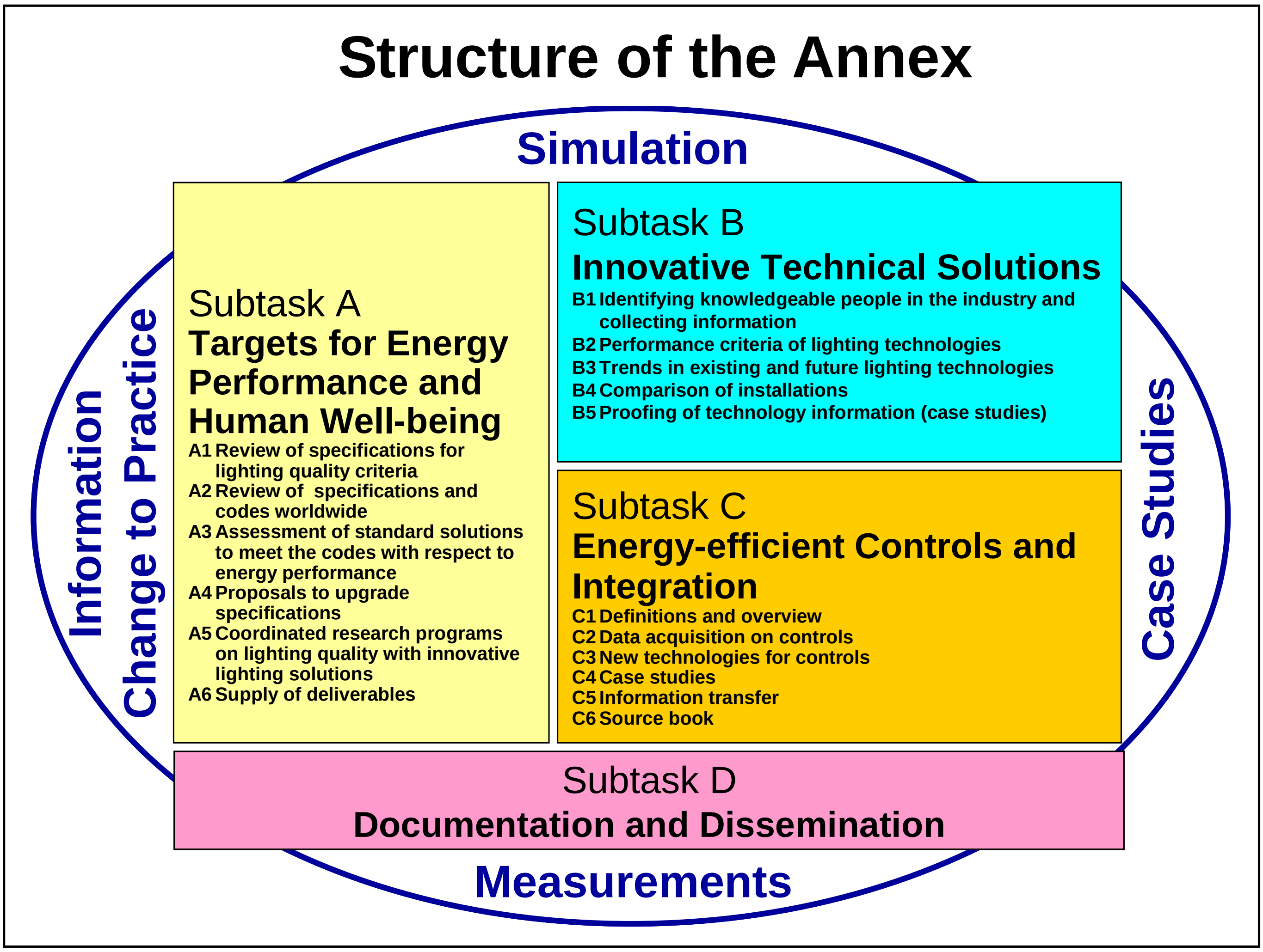
"Valotalo", at Helsinki University of Technology, was built as a demonstration building for lighting research in which the newest technologies for energy-efficient lighting were applied.

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 preventing the adoption of energy efficient technologies and propose means to resolve these barriers



Subtask A: Targets for Energy Performance and Human Well-Being

The objective are to document the effect of design and targets for energy use, lighting quality and human well-being and performance and give examples of good practice.

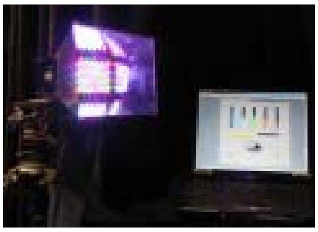
The performance criteria include the spectral, electrical and user related issues. The energy criteria include energy efficiency , life cycle energy considerations, maintenance and operation. The economical criteria include cost of devices and of application.

Office lighting with manual and daylight control systems.

Subtask B: Innovative Technical Solutions

The objective is to identify, assess and document the performance, energy and economical criteria of the existing promising and innovative future lighting technologies and their impact on other building equipment and systems. The purpose is to reduce the energy use of buildings by investigating the saving potential by comparing the existing and future technologies and by applying information on concepts, products and lighting solutions.

The technical solutions cover power supply, light sources, luminaries and concepts of controls.



White light is created by mixing five different LED colours.

Subtask C: Energy-Efficient Controls and Integration

The Subtask C will focus on controls that enable the occupant and facility manager to modify the electric lighting according to individual needs and preferences, within acceptable building operative requirements focusing on energy savings. These controls will be integrated with other building systems (daylighting, HVAC, and demand energy management). The communication and data exchange between the control components (such as sensors, actuators and electronic ballasts) is the key focus of control strategies.

Glass cube for daylight measurements on the roof of "Valotalo".

Subtask D: Documentation and Dissemination

The objective of Subtask D is to improve current lighting practices in a manner that accelerates the use of energy efficient products, improves overall building performance and enhances the occupants' environmental satisfaction.

The objective of Subtask D is to compile and widely disseminate the Annex research results of Subtasks A, B and C and to identify the means to influence the energy policies and regulations in order to promote the use of energy efficient lighting.

Lamp life test with T8 fluorescent lamps.

Trends in energy efficient lighting

Electric light is obtained as a result of combination of lighting equipment. Modern lighting system needs light sources, ballasts, luminaires and controls. Part of the power input to the lighting unit is transformed into light, while the rest is considered as loss. Energy is lost in lamps, luminaires and ballasts in the form of heat. The saving of lighting energy requires the use of energy efficient components as well as the application of control, dimming, and the use of daylight.

Govén presented a 35 % improvement in efficiency of T5 fluorescent lamp using mirror louvre fixture over an equivalent T8 mirror louvre fixture while using a high-frequency ballast and a standard aluminium reflector. The corresponding improvement in efficiency shown over a luminaire of the same type with a conventional ballast was about 65 %. [4]

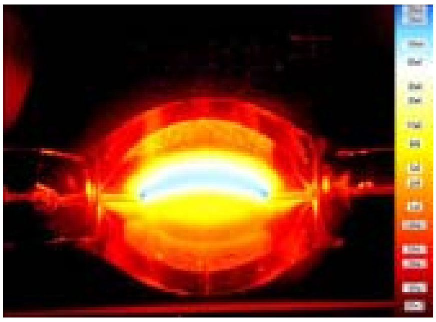
Directive 2000/55/EC gives energy efficiency requirements for ballasts for fluorescent lamps. The maximum power of ballast-lamp circuit, for example, of a 36 W fluorescent lamp should be less than 45 W after 21 May 2002 and less than 43 W after 21 November 2005. [5]

High pressure discharge lamps are very energy-efficient lamp types. Their small discharge body allows an efficient reflector design for luminaires so that the luminous flux leaving the luminaire can be distributed effectively in the room. Typically, it takes 3 minutes to reach 80% of the nominal luminous flux of a high pressure discharge lamp. For automotive lamps, this time has been reduced to 3 seconds already [6].

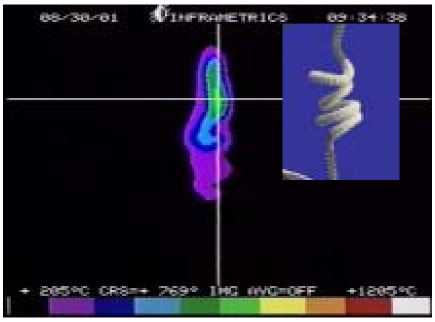
At present, high pressure discharge lamps cannot replace other lamp types. Reasons are given in the start performance and in restricted dimming performance. Research on the interaction of ballast electronics and high pressure discharge lamps may significantly improve the performance of this lamp type.

LEDs (Light Emitting Diodes) are new alternative light sources, which are foreseen to revolutionise the lighting technology in the near future. According to Agilent Technologies the lumens/package value of red LEDs has been increasing 30 times per decade whereas the price is decreasing 10 times per decade [7].

According to one scenario , the LED's share of lighting market can be 20 % in 2010 and 50 % in 2020 [8]. The use of LED based lighting could decrease the lighting energy consumption by 50 % by 2025 [9]. The foreseeable future of LED luminaires targeted for general illumination will use arrays of LEDs and not a single LED [10].



Gas discharge of a metal halide lamp (TU Berlin, Lichtechnik).



Fluorescent lamp electrode (small picture) and an infra-red image of the hot electrode.

Management of the Annex

Operating Agent:	**Finland, Helsinki University of Technology** **Professor Liisa Halonen**
Subtask A Leader:	**France, École Nationale des Travaux Publics de l'État (ENTPE)** **Professor Marc Fontoynont**
Subtask B Leader:	**Austria, Zumtobel Staff GmbH** **Dipl.Ing. Peter Dehoff**
Subtask C Leader:	**Germany, Technische Universität Berlin** **Professor Dr. rer. nat. Heinrich Kaase**
Subtask D Leader:	**Finland, Helsinki University of Technology** **D.Sc. Eino Tetri**

References

[1] Mills E. 2002. Why we're here: The $320-billion global lighting energy bill. Right Light 5, Nice, France. pp. 369-385.

[2] http://www.europa.eu.int/comm/energy_transport /atlas/html/lightdintro.html, accessed on 24.4.2004.

[3 Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings,

[4] Govén T. 1997. Energy savings through improved lighting design and engineering. Right Light 4. Proceedings of the 4th European Conference on Energy-Efficient Lighting. Copenhagen, Denmark.. pp. 17-22.

[5] Directive 2000/55/EC of the European parliament and of the council of 18 September 2000 on energy efficiency requirements for ballasts for fluorescent lighting.

[6] Kaase H. 2004. Entwicklungstendenzen, Strategien und Visionen der Lichttechnik; LICHT 4/04; Germany.

[7] Haitz R. 2001. Another Semiconductor Revolution: This Time it's Lighting; Proceedings of 9th International Symposium on the Science and technology of Light Sources; Ithaca, NY, USA.

[8] Kendall M. & Scholand M. 2001. Energy Savings Potential of Solid State Lighting in General Lighting Applications, Final Report. Prepared by Arthur D. Little, Inc. for U.S. Department of Energy.

[9] Edited by Tsao J. Y. 2002. Light Emitting Diodes (LEDs) for General Illumination An OIDA Technology Roadmap Update 2002 September 2002 Optoelectronics Industry Development Association (OIDA) Sandia National Laboratories

[10] Narendran N. & Bullough J. D. 2001. Light Emitting Diodes as Light Sources; Proceedings of 9th International Symposium on the Science and technology of Light Sources; Ithaca, NY, USA.

Deliverables

Design Guidebook
Semi-Annual Newsletter
Seminars

Integarting sphere for luminous flux measurements.

Information

For more information, please contact:

Liisa Halonen
liisa.halonen@hut.fi

or

Eino Tetri
eino.tetri@hut.fi

Helsinki University of Technology

or check the Annex website: lightinglab.fi/IEAAnnex45

Website includes:
- **Workplan**
- **Participants**
- **Meetings**
- **Contact information**
- **Links, etc.**

Deliverables

The design guidebook of energy efficient lighting will be the final product of the Annex. It will be published as a book, as a CD-ROM and on the web. The other deliverables are semi-annual newsletters, seminars and a web-site.

Subtask A
State-of-the-art quality criteria
State-of-the-art specificatons
Comparisons of existing practice
Performance assessment

Subtask B
Identification
Technology report
Documentation of case studies
Matrix for end-users and owners
Lighting Desing Matrix for designers

Subtask C
Glossary of Terms, Metrics
Questionnaire
Conventional Best Practice
Evaluation of new technologies for controls for case studies

Subtask D
Newsletters
Seminars
Web-site
Guidebook

Schedule

The Annex will run for four and a half year from July 2004. Preparation and planning will be carried out during the first half a year and the following four years will be full working years.

Annex beneficiaries

The main target groups of the deliverables are lighting designers, electrical building services and system integrators in buildings and the end-users/ owners. The results will also be disseminated by delivering information to standardisation and recommendations and by providing educational material to educational institutions in order to positively affect the future lighting professionals. The integration of lighting to building services benefits the occupant, the building operator, the owner and the society at large. The objective is to positively impact the current lighting practices in a manner that accelerates the use of energy efficient products, thus benefiting lighting industry, improves the overall building performance and enhances the occupant's environmental satisfaction.

National Interest Groups

Finland
Helvar Oy
* Max Bjorkgren

Senaatti-kiinteistöt
* Juha Muttilainen
* Pasi Hyyppä

Idman Oy
* Henri Juslen

France
Ingelux
* Laurent Escaffre
* Christophe Marty

Participants and Corresponding Members

Australia
Queensland University of Technology
* Steve Coyne
Arup Australasia
* Phillip Greenup

Austria
Zumtobel Staff GmbH
* Peter Dehoff

Belgium
Belgian Building Research Institute
* Arnaud Deneyer
Université Catholique de Louvain
* Magali Bodart

Canada
University of British Columbia
* Lorne Whitehead
* Michele Mossman
* Alexander Rosemann

China
Fudan University
* Chen Dahua
* Edward Yuan

Finland
Helsinki University of Technology
* Liisa Halonen
* Eino Tetri

France
Ecole Nationale des Travaux Publics de l'État (ENTPE)
* Marc Fontoynont
CSTB
* Ahmad Husaunndee
* Michel Perraudeau
Lumen Art
* Susanne Fleischer

Germany
Technische Universität Berlin
* Heinrich Kaase
* Henri Kretschmer
* Felix Serick
Fraunhofer Institute
* Jan de Boer

Italy
Università di Roma "La Sapienza"
* Fabio Bisegna
ENEA Ispra
* Simonetta Fumagalli

Japan
National Institute for Land and Infrastructure Management
* Yasuhiro Miki
Tokai University
* Toshie Iwata

The Netherlands
Delft University of Technology
* Regina Bokel
* M. van der Voorden

Norway
NTNU and SINTEF
* Barbara Matusiak

Poland
Silesian University of Technology
* Zbigniew Mantorski

Singapore
National University of Singapore
* Lee Siew Eang

Sweden
Lund University
* Nils Svendenius
* Sven Huldt
WSP Elteknik
* Peter Pertola
BAS Bergen school of architecture
* Lars Bylund

Switzerland
Solar Energy and Building Physics Lab, EPFL
* Nicolas Morel
* David Lindelöf
University of Applied Sciences of Western Switzerland
* Gilles Courret
Miloni Lichtplanung
* Reto Miloni

United Kingdom
University of Nottingham
* Li Shao
Helvar
* Trevor Forrest

USA
Lawrence Berkeley National Laboratory
* Stephen Selkowitz

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Operating Agent
Finland
Professor Liisa Halonen
Helsinki University of Technology
Lighting Laboratory
P.O.Box 3000
FIN-02015 HUT
FINLAND
Phone +358 9 451 2418
Fax +358 9 451 4982
liisa.halonen@hut.fi

Website
lightinglab.fi/IEAAnnex45

Annex 45 Expert meetings

1st Expert Meeting
22-23 April 2005
San Francisco, USA

2nd Expert Meeting
15-16 September 2005
Berlin, Germany

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