ANNEX 45

GUIDEBOOK ON ENERGY EFFICIENT ELECTRIC LIGHTING FOR BUILDINGS

Espoo 2010

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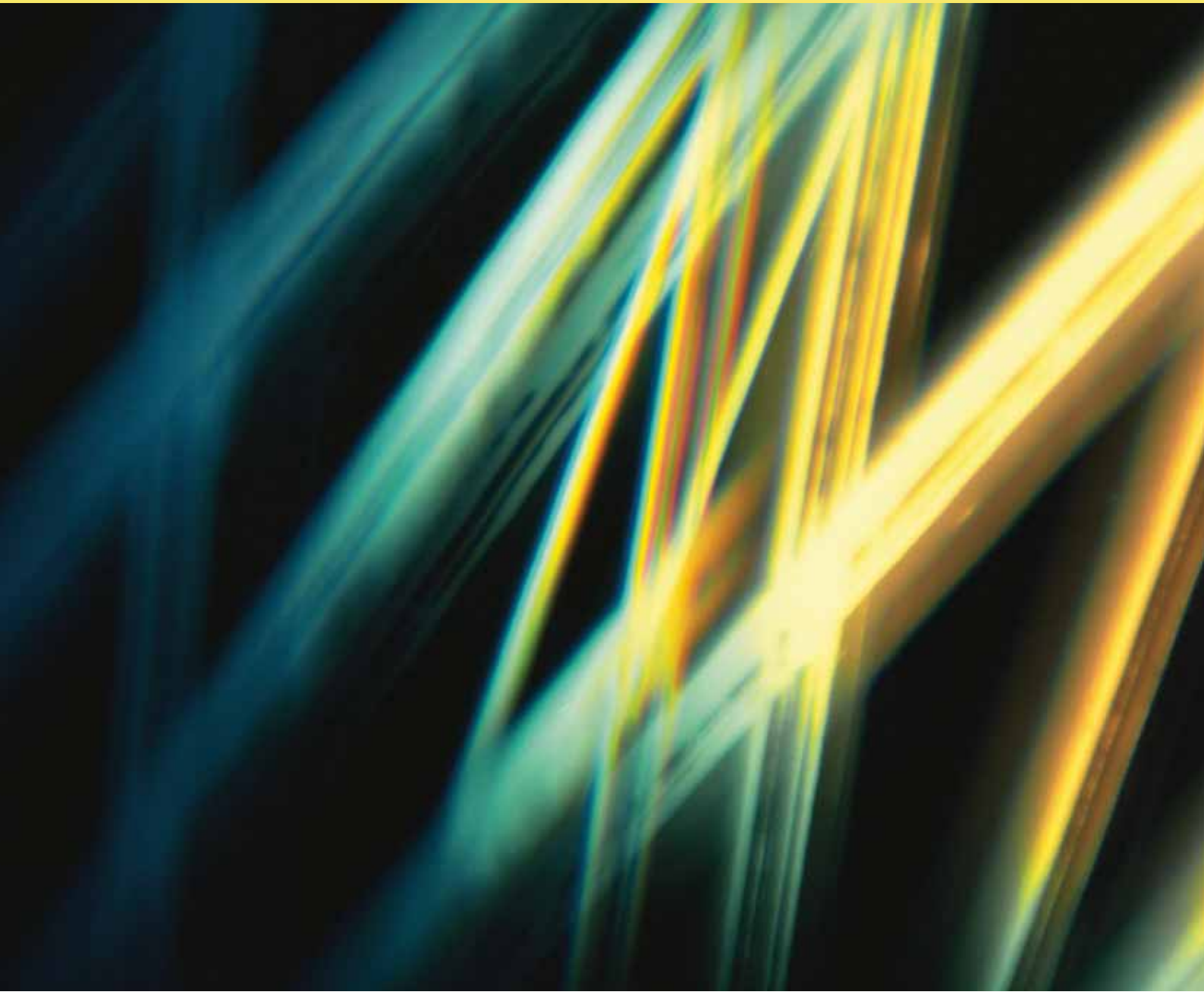

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School of Science
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International Energy Agency
Energy Conservation in
Buildings and Community
Systems Programme

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GUIDEBOOK ON ENERGY EFFICIENT ELECTRIC LIGHTING FOR BUILDINGS

Guidebook on Energy Efficient Electric Lighting for Buildings
IEA - International Energy Agency
ECBCS - Energy Conservation in Buildings and Community Systems
Annex 45 - Energy Efficient Electric Lighting for Buildings

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Abstract

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 lighting technologies coming onto the market. Currently, more than 33 billion lamps operate worldwide, consuming more than 2650 TWh of energy annually, which is 19% of the global electricity consumption.

The goal of IEA ECBCS Annex 45 was to identify and to accelerate the widespread use of appropriate energy efficient high-quality lighting technologies and their integration with other building systems, making them the preferred choice of lighting designers, owners and users. The aim was to assess and document the technical performance of the existing promising, but largely under-utilized, innovative lighting technologies, as well as future lighting technologies. These novel lighting system concepts have to meet the functional, aesthetic, and comfort requirements of building occupants. The guidebook mostly concerns the lighting of offices and schools.

The content of the Guidebook includes an Introduction, Lighting energy in buildings, Lighting quality, Lighting and energy standards and codes, Lighting technologies, Lighting control systems, Life cycle analysis and life cycle costs, Lighting design and a survey on lighting today and in the future, Commissioning of lighting systems, Case studies, Technical potential for energy efficient lighting and savings, Proposals to upgrade lighting standards and recommendations, and a Summary and conclusions.

There is significant potential to the improve energy efficiency of old and new lighting installations even with the existing technology. The energy efficiency of lighting installations can be improved with the following measures:

- the choice of lamps. Incandescent lamps should be replaced by CFLs, infrared coated tungsten halogen lamps or LEDs, mercury lamps by high-pressure sodium lamps, metal halide lamps, or LEDs, and ferromagnetic ballasts by electronic ballasts
- the usage of controllable electronic ballasts with low losses
- the lighting design: the use of efficient luminaires and localized task lighting
- the control of light with manual dimming, presence sensors, and dimming according to daylight
- the usage of daylight
- the use of high efficiency LED-based lighting systems.

Annex 45 suggests that clear international initiatives (by the IEA, EU, CIE, IEC, CEN and other international bodies) are taken up in order to:

- upgrade lighting standards and recommendations
- integrate values of lighting energy density (kWh/m2, a) into building energy codes
- monitor and regulate the quality of innovative light sources
- pursue research into fundamental human requirements for lighting (visual and non-visual effects of light)
- stimulate the renovation of inefficient old lighting installations by targeted measures

The introduction of more energy efficient lighting products and procedures can at the same time provide better living and working environments and also contribute in a cost-effective manner to the global reduction of energy consumption and greenhouse gas emissions.

Preface

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster co-operation among the twenty-eight IEA participating countries and to increase energy security through energy conservation, development of alternative energy sources and energy research, development and demonstration (RD&D).

ENERGY CONSERVATION IN BUILDINGS AND COMMUNITY SYSTEMS (ECBCS)

The IEA co-ordinates research and development in a number of areas related to energy. The mission of one of those areas, the ECBCS - Energy Conservation for Building and Community Systems Programme, is to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, through innovation and research.

The research and development strategies of the ECBCS Programme are derived from research drivers, national programmes within IEA countries, and the IEA Future Building Forum Think Tank Workshop, held in March 2007. The R&D strategies represent a collective input of the Executive Committee members to exploit technological opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy conservation technologies. The R&D strategies apply to residential, commercial, office buildings and community systems, and will impact the building industry in three focus areas of R&D activities:

- Dissemination
- Decision-making
- Building products and systems

THE EXECUTIVE COMMITTEE

Overall control of the program is maintained by an Executive Committee, which not only monitors existing projects but also identifies new areas where collaborative effort may be beneficial. To date the following projects have been initiated by the executive committee on Energy Conservation in Buildings and Community Systems:

ONGOING ANNEXES

Annex	Title	Duration
55	Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO)	2009-2013
WG	Working Group on Energy Efficient Communities	2009-2012
54	Analysis of Micro-Generation & Related Energy Technologies in Buildings	2009-2013
53	Total Energy Use in Buildings: Analysis & Evaluation Methods	2008-2012
52	Towards Net Zero Energy Solar Buildings	2008-2013
51	Energy Efficient Communities	2007-2011
50	Prefabricated Systems for Low Energy Renovation of Residential Buildings	2006-2010
49	Low Exergy Systems for High Performance Buildings and Communities	2006-2010
48	Heat Pumping and Reversible Air Conditioning	2006-2009
47	Cost Effective Commissioning of Existing and Low Energy Buildings	2005-2008
46	Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo)	2005-2008
45	Energy-Efficient Future Electric Lighting for Buildings	2004-2008
44	Integrating Environmentally Responsive Elements in Buildings	2004-2009
5	Air Infiltration and Ventilation Centre	1979-

COMPLETED ANNEXES		
Annex	Title	Duration
43	Testing and Validation of Building Energy Simulation Tools	2003-2007
42	The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (COGEN-SIM)	2003-2007
41	Whole Building Heat, Air and Moisture Response (MOIST-EN)	2003-2007
40	Commissioning of Building HVAC Systems for Improved Energy Performance	2001-2004
39	High Performance Thermal Insulation (HiPTI)	2001-2004
38	Solar Sustainable Housing	1999-2003
37	Low Exergy Systems for Heating and Cooling	1999-2003
36	Retrofitting in Educational Buildings - Energy Concept Adviser for Technical Retrofit Measures	1998-2002
36WG	Annex 36 Working Group Extension 'The Energy Concept Adviser'	2003-2005
35	Control Strategies for Hybrid Ventilation in New and Retorfitted Office Buildings (HybVent)	1998-2002
34	Computer-Aided Evaluation of HVAC System Performance	1997-2001
33	Advanced Local Energy Planning	1996-1998
32	Integral Building Envelope Performance Assessment	1996-1999
31	Energy Related Environmental Impact of Buildings	1996-1999
WG	Working Group on Indicators of Energy Efficiency in Cold Climate Buildings	1995-1999
30	Bringing Simulation to Application	1995-1998
29	Daylight in Buildings	1995-1999
28	Low Energy Cooling Systems	1993-1997
27	Evaluation and Demonstration of Domestic Ventilation Systems	1993-2002
26	Energy Efficient Ventilation of Large Enclosures	1993-1996
25	Real Time HEVAC Simulation	1991-1995
24	Heat, Air and Moisture Transport in Insulated Envelope Parts	1991-1995
23	Multizone Air Flow Modelling	1990-1996
22	Energy Efficient Communities	1991-1993
21	Environmental Performance of Buildings	1988-1993
20	Air Flow Patterns within Buildings	1988-1991
19	Low Slope Roof Systems	1987-1993
18	Demand Controlled Ventilating Systems	1987-1992
17	Building Energy Management Systems - Evaluation and Emulation Techniques	1988-1992
16	Building Energy Management Systems - User Interfaces and System Integration	1987-1991
15	Energy Efficiency in Schools	1988-1990
15WG	Working Group on Energy Efficiency in Educational Buildings	1992-1995
14	Condensation and Energy	1987-1990
13	Energy Management in Hospitals	1985-1989
12	Windows and Fenestration	1982-1986
11	Energy Auditing	1982-1987
10	Building HEVAC Systems Simulation	1982-1987
9	Minimum Ventilation Rates	1982-1986
8	Inhabitant Behaviour with Regard to Ventilation	1984-1987
7	Local Government Energy Planning	1981-1983
6	Energy Systems and Design of Communities	1979-1981
4	Glasgow Commercial Building Monitoring	1979-1982
3	Energy Conservation in Residential Buildings	1979-1982
2	Ekistics and Advanced Community Energy Systems	1976-1978
1	Load Energy Determination of Buildings	1977-1980

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