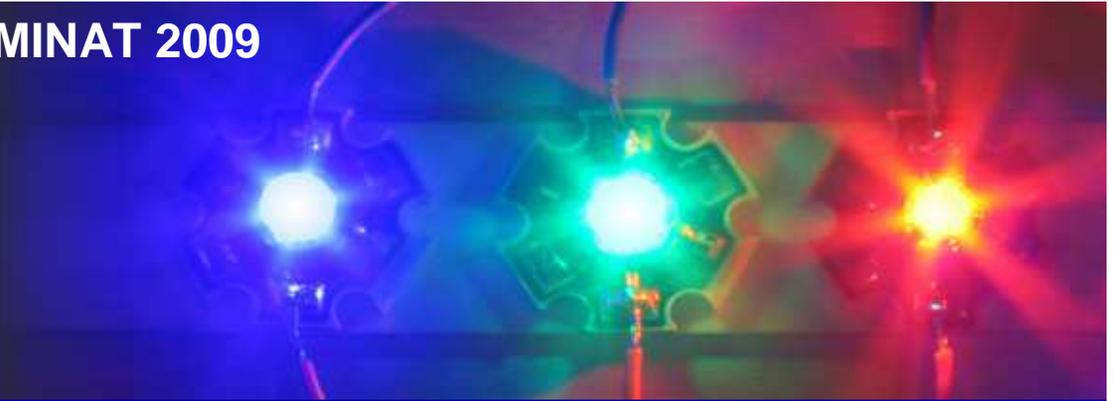


The 5th International Conference ILUMINAT 2009
Cluj-Napoca, Romania
20 February 2009



Lighting Efficiency and LED Lighting Applications in Industrialized and Developing Countries

Prof. Liisa Halonen
D.Sc. Eino Tetri



HELSINKI UNIVERSITY OF TECHNOLOGY
Department of Electronics
Lighting Unit

Outline

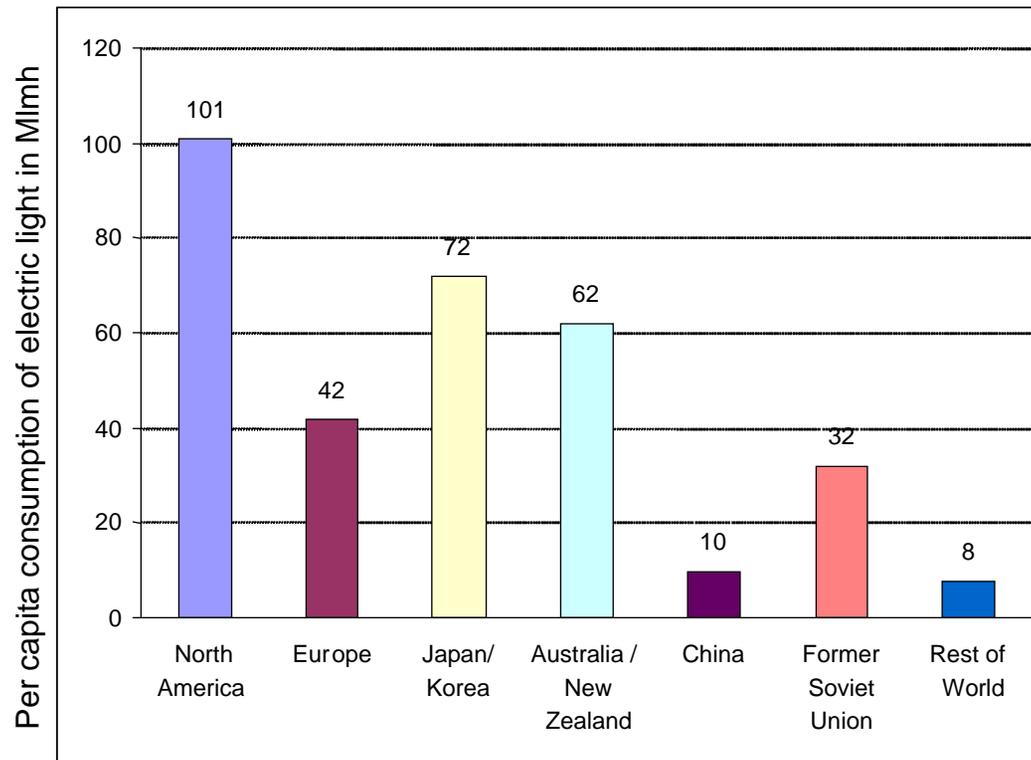
- ❑ **Lighting Energy and Efficiency**
- ❑ **IEA Annex 45 Energy Efficient Electric Lighting for Buildings**
- ❑ **LED lighting**
- ❑ **Lighting and Energy in Developing Countries**

Energy Usage of Lighting

- ❑ In 2005 the electricity consumed by lighting was 2 650 TWh worldwide, about 19 % of the total global electricity consumption.
- ❑ Carbon dioxide emissions (Lighting) were 1775 million tonnes, of which approximately 511 million tonnes in IEA member countries
- ❑ Lighting electricity use ranges from 5 % to 15 % in industrialized countries, up to 86 % in developing countries of the total electricity use
- ❑ Global lighting electricity use is distributed: 28 % residential, 48% service, 16 % industrial, 8 % street and other lighting
- ❑ More than one-quarter of world's population uses liquid fuel (kerosene) to provide lighting



Per Capita Consumption of Electric Light

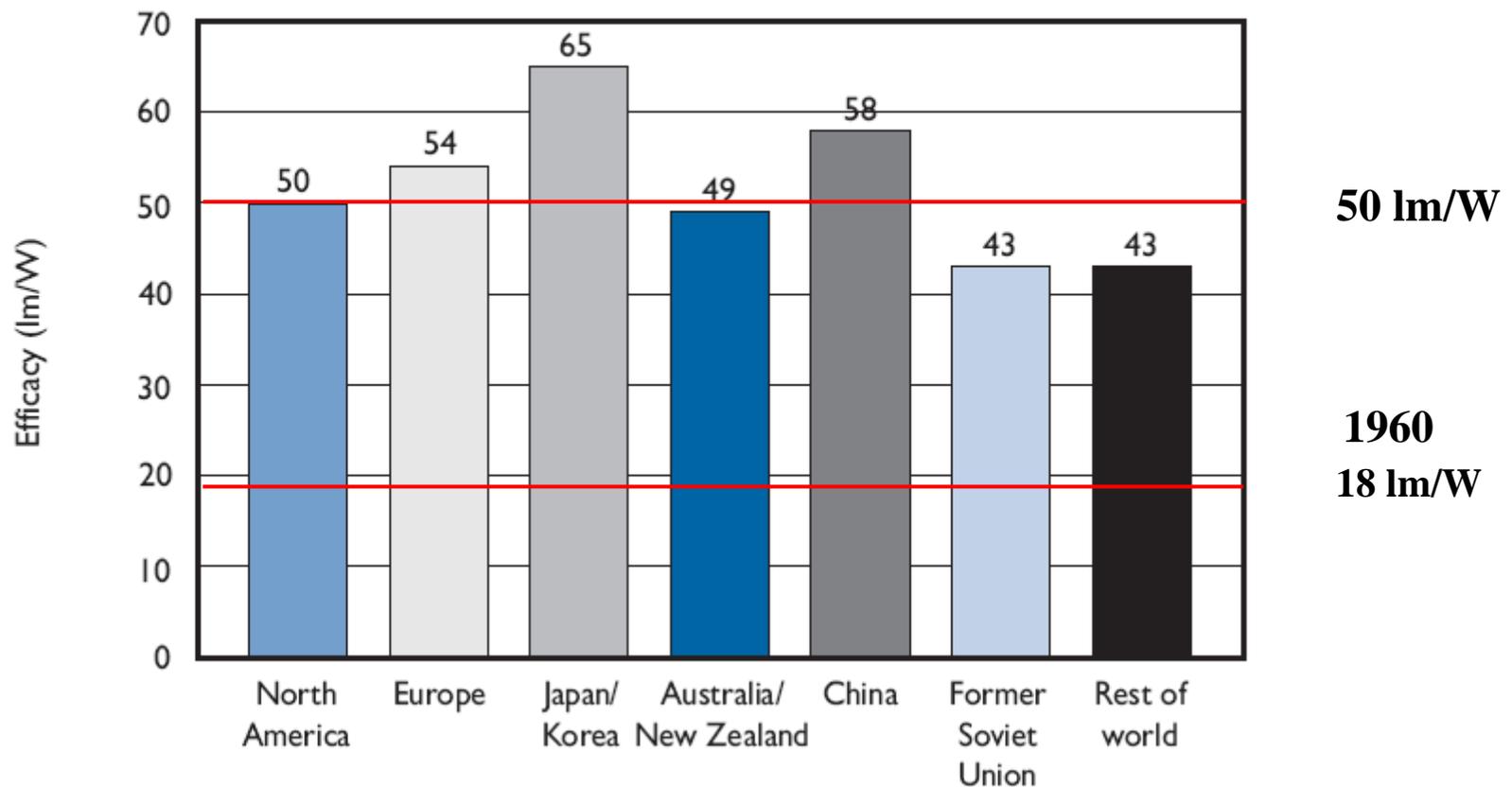


Global consumption of artificial light 133 Plmh

- Annual consumption by people with access to electricity – 27.6 Mlmh
- Annual consumption by people without access to electricity – 50 klmh

Average Electric Lighting System Efficacy

Average lighting-system efficacy by region in 2005



IEA Annex 45

Energy Efficient Electric Lighting for Buildings

2004 - 2009

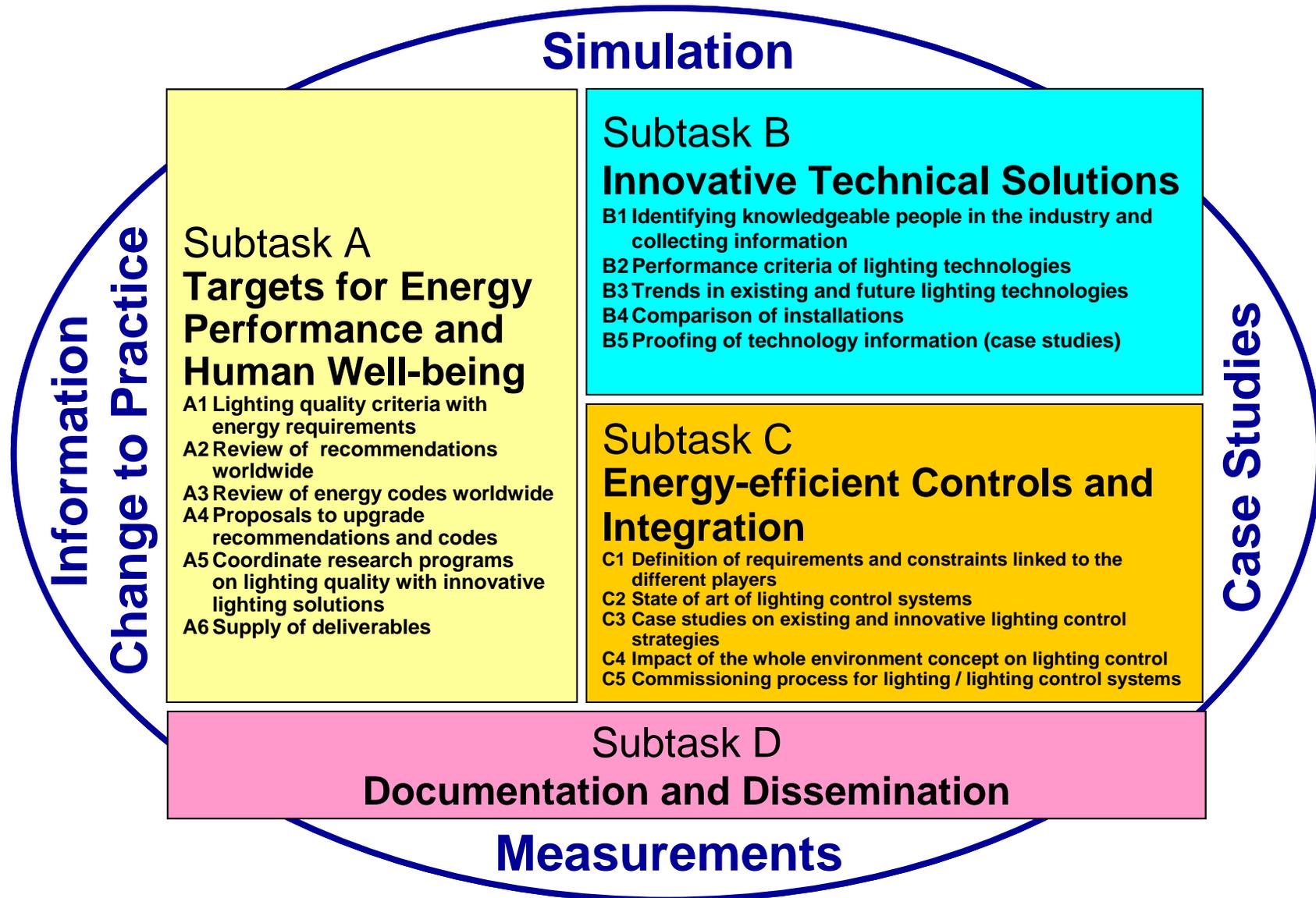


International Energy Agency
**Energy Conservation in
Buildings and Community
Systems Programme**

IEA Annex 45: Participating and Corresponding Members 21 Countries and 37 Organizations

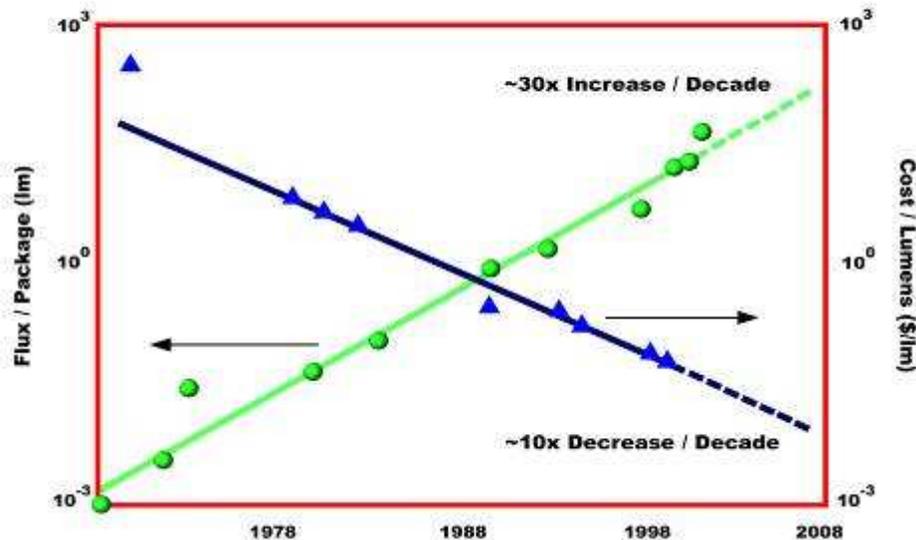


Structure of IEA Annex 45



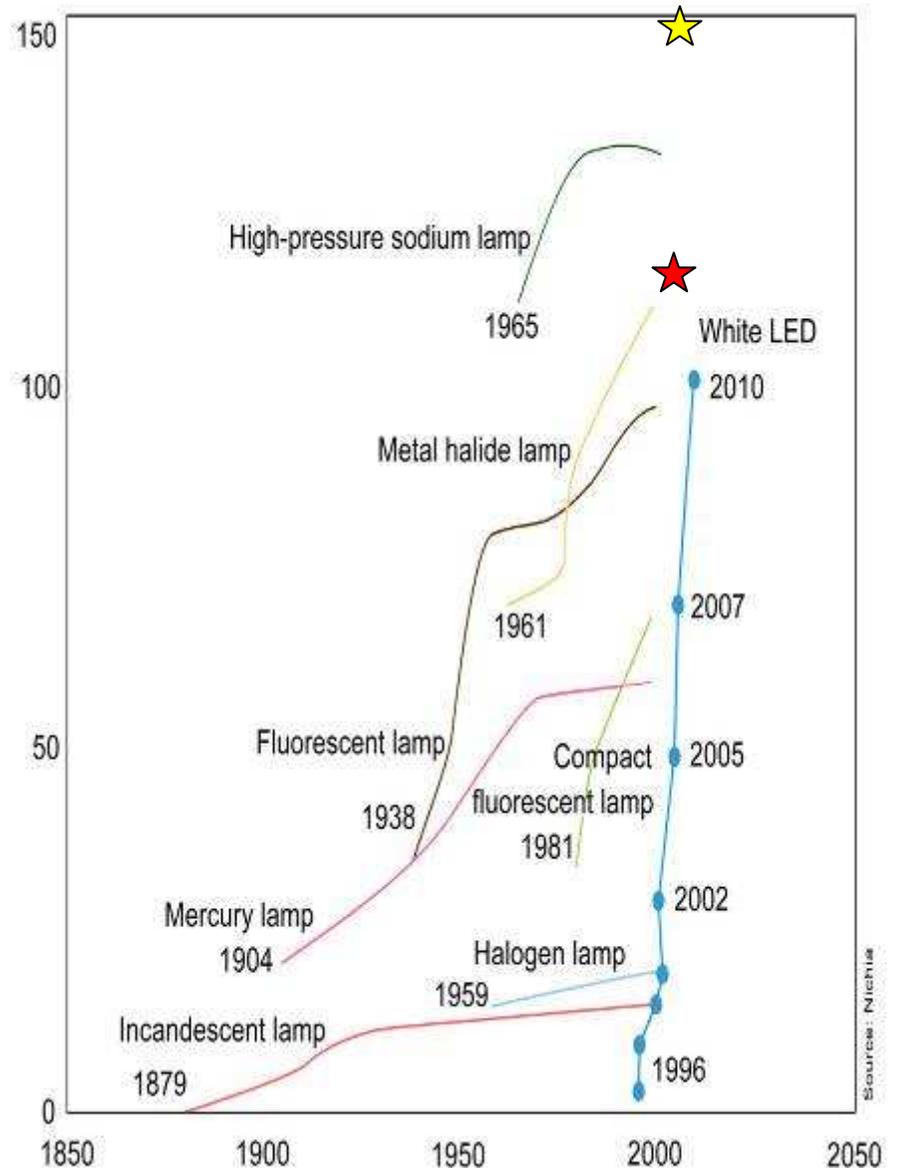
Light Emitting Diodes

The Evolution of lm/package and cost/lm for red LEDs
(Roland Haitz, Agilent Technologies)

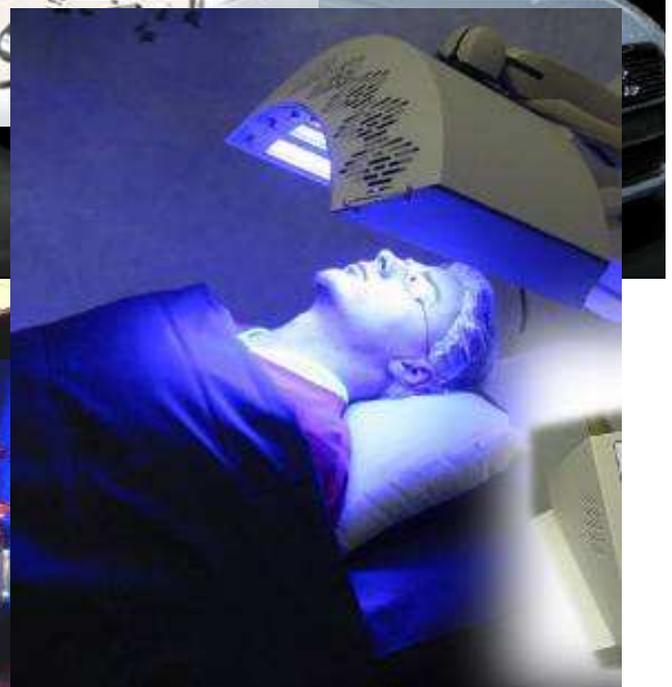
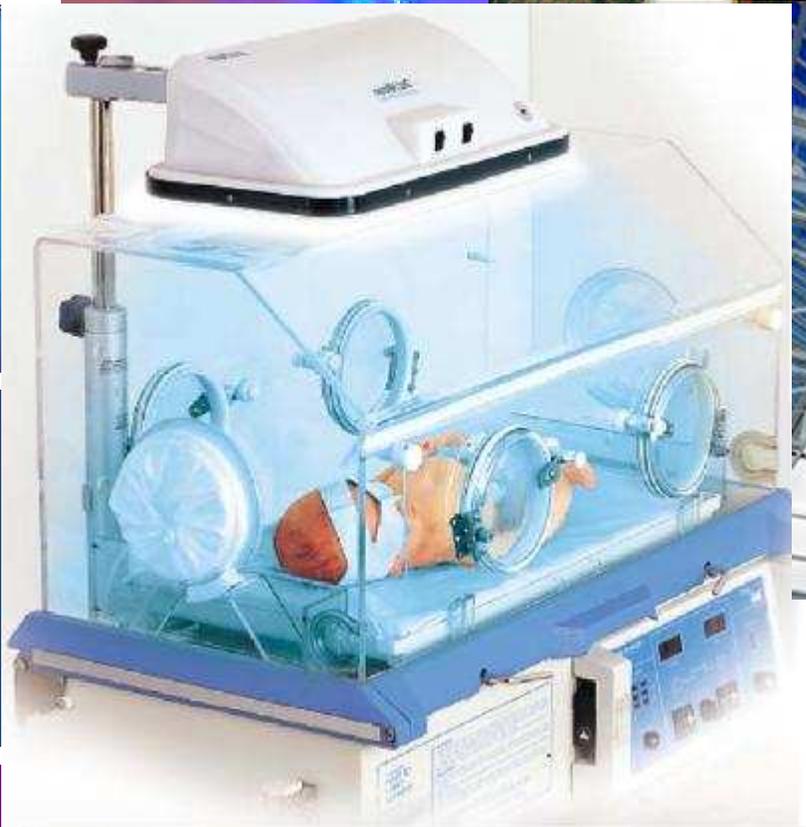


According to one scenario
LED's share of lighting market:

- ❑ 20% of all illumination by 2010, 50% of all illumination by 2025
- ❑ Solid state lighting could reduce global energy use for lighting by 50% by 2025



LED Applications

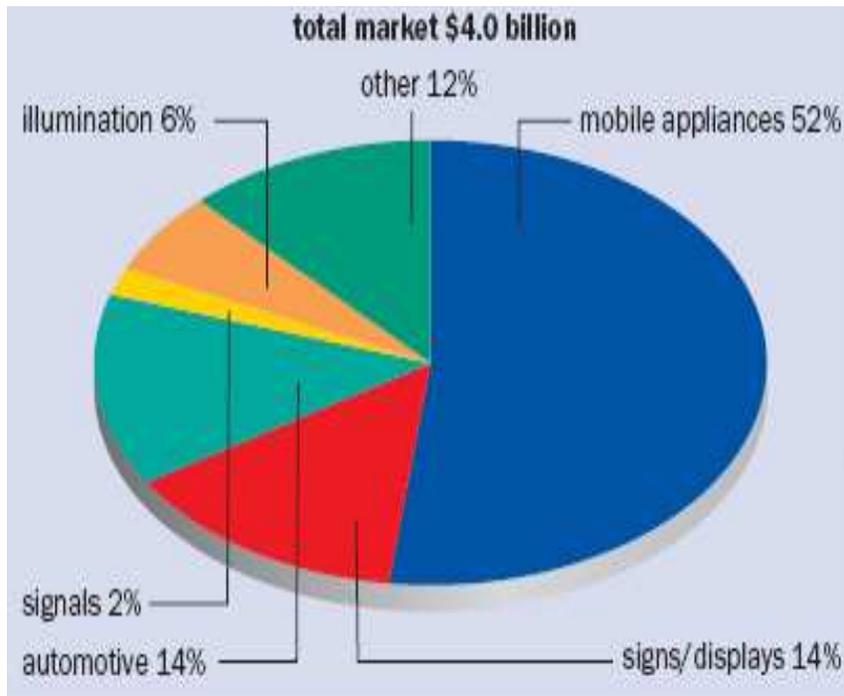


Automotive Signage

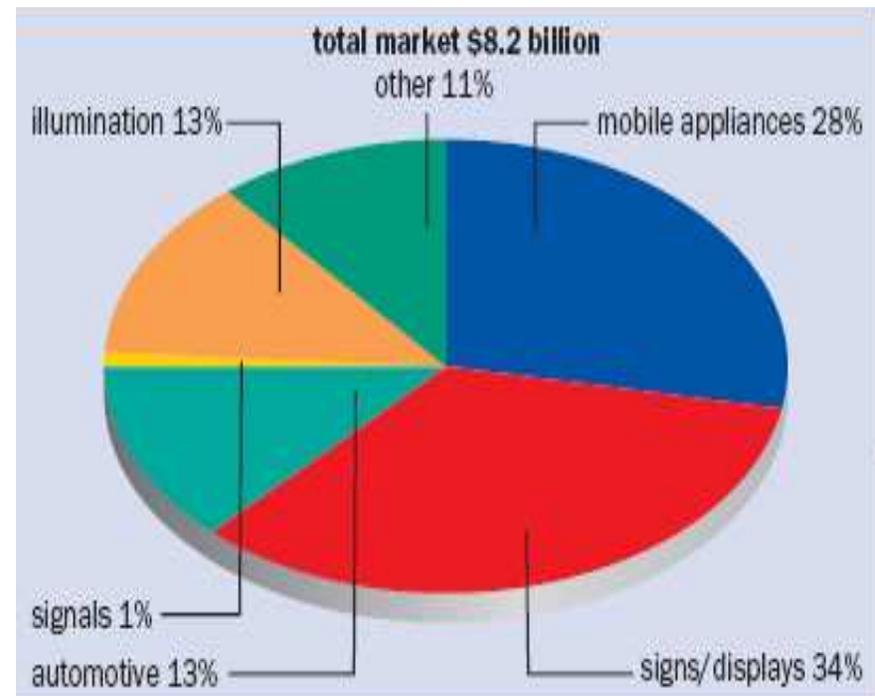
Market Value Evolution

HB-LED Market Value Evolution per Applications

2005

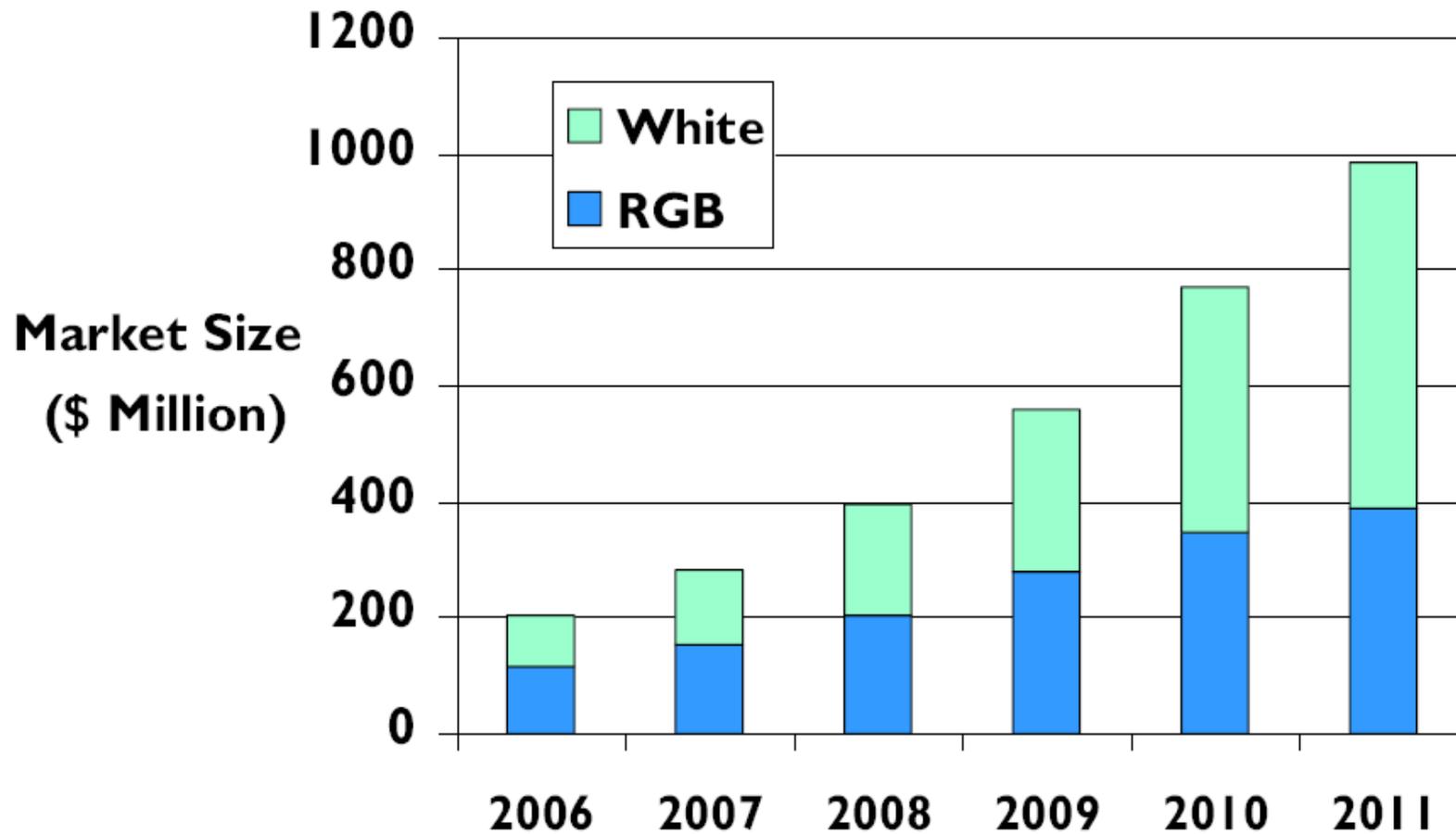


2010



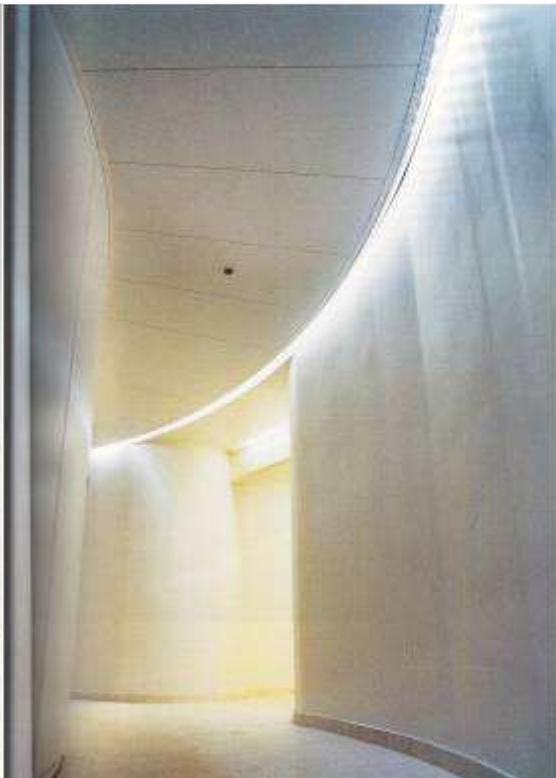
Source: Strategies Unlimited

LED Illumination Market Forecast

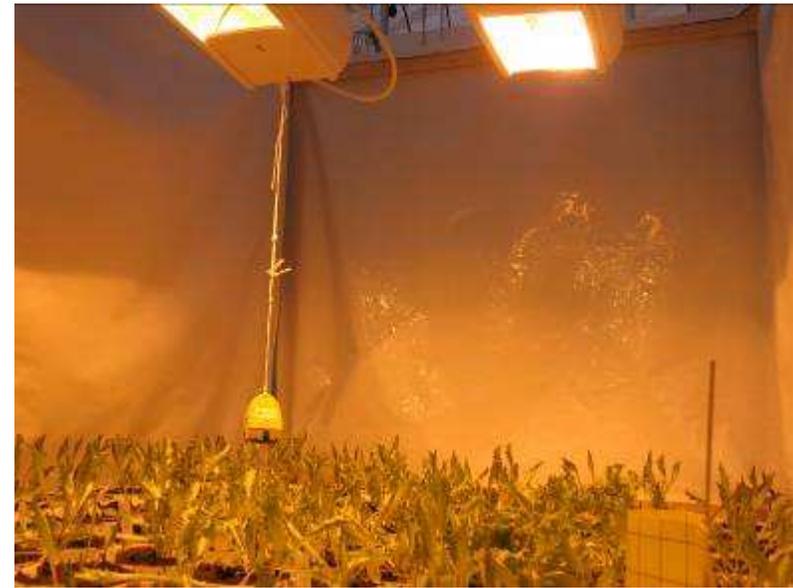


Strategies Unlimited 2007
Status, Prospects and Strategies for LEDs in General Lighting

LEDs in general lighting



LED-based lighting system for plant illumination





International Energy Agency
Energy Conservation in
Buildings and Community
Systems Programme

Web-site:
lightinglab.fi/IEAAnnex45



COMMISSION INTERNATIONALE DE L'ÉCLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

CIE Statement on Energy Conservation

The issue of energy conservation in lighting was present in most debates during CIE Session held in Beijing in July 2007. It was brought to the General Assembly by the Finnish National Committee, and its concern was largely shared by other delegates. After the Session CIE published a statement on energy conservation.

Continued on page 2.

26th Session of the CIE

4 - 11 July Beijing, China

Three invited, one hundred and six presented papers and more than two hundred posters were presented at 26th Session of the CIE. In the conference there was a session on energy, chaired by Lillieien from Norway. Report on the Session can be found on the CIE News 4/2007, <http://www.cie.co.at/news/news83.pdf>.



The winner of the 2006 Millennium Technology Prize, Shuji Nakamura and Professor Liisa Halonen who received this year's Millennium Distinction Award.

Millennium Distinction Award 2007

Millennium Distinction Awards 2007 were given for developers and researchers working in the Finnish optoelectronics sector.

Two Finnish growth companies and two university professors received this year's Millennium Distinction Awards from the Millennium Technology Prize Foundation. Heikki and Ulla Mustonen of Tepcomp Oy and Harry Asonen of Corelase Oy received Millennium Distinction Awards in the category "Founders and drivers of growth companies based on the productive exploitation of innovative new technology." Professor Liisa Halonen (Helsinki University of Technology) and Professor Markus Pessa (Tampere University of Technology) received Millennium Distinction Awards for their valuable contributions to the furthering of Finnish university education in the optoelectronics sector and for initiating associated high-level research activities in Finland.

New Doctors in the Lighting Field

M.Sc. Hemri Juslén defended his Doctoral Thesis *Lighting, productivity and preferred illuminances - field studies in the industrial environment* at Helsinki University of Technology, Finland.

Continued on page 6.

<http://lightinglab.fi/IEAAnnex45>

CIE Statement on Energy Conservation

ENERGY CONSERVATION REQUIRES SMART LIGHTING

- ❑ Recognizing that lighting consumes substantial energy, the International **Commission on Illumination** (the CIE) at a congress held in Beijing, China 4-11 July 2007, **called for a worldwide effort to reduce energy consumed for lighting.**
- ❑ This is possible through intelligent use of new technology and a scientific understanding of the varied human needs for different types of lighting in different settings.
- ❑ A more efficient use of daylight augmented with the use of more efficient lamps and the latest lighting technology now enable us **to save energy without sacrificing good lighting.**

IEA Annex 45 Guidebook



International Energy Agency
Energy Conservation in
Buildings and Community
Systems Programme

Annex 45
Energy Efficient Electric
Lighting for Buildings

Guidebook on Energy Efficient Electric Lighting for Buildings

Edited by Liisa Halonen & Eino Tetri
Helsinki University of Technology
Lighting Laboratory



HELSINKI UNIVERSITY OF TECHNOLOGY
Lighting Laboratory

Contents

- 1 Introduction
- 2 Lighting electricity statistics in buildings
- 3 Lighting quality criteria
- 4 Energy codes
- 5 Experts' opinions on lighting today and in the future
- 6 Lighting technologies
- 7 Lighting control
- 8 Commissioning process for lighting (control) systems
- 9 Case studies
- 10 Technical potential for energy efficient lighting and savings
- 11 Proposals to upgrade recommendations and codes
- 12 Conclusions

Lighting in developing countries



Lighting in developing countries

**“We will make electricity so cheap
that only the rich will burn candles”
-Thomas Edison**



**There are more non-electrified households
today than the total number of households
in Edison's time**

Lighting in Developing Countries

- ❑ More than 2 billion people – without access to electricity – use fuel based lighting
- ❑ Almost all of them live in developing countries



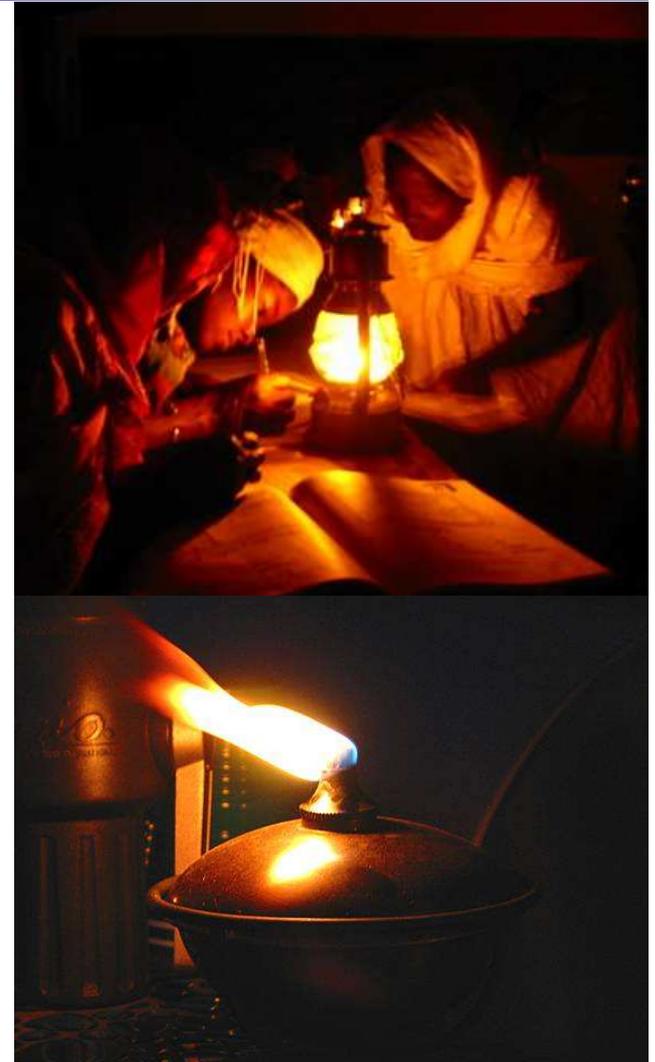
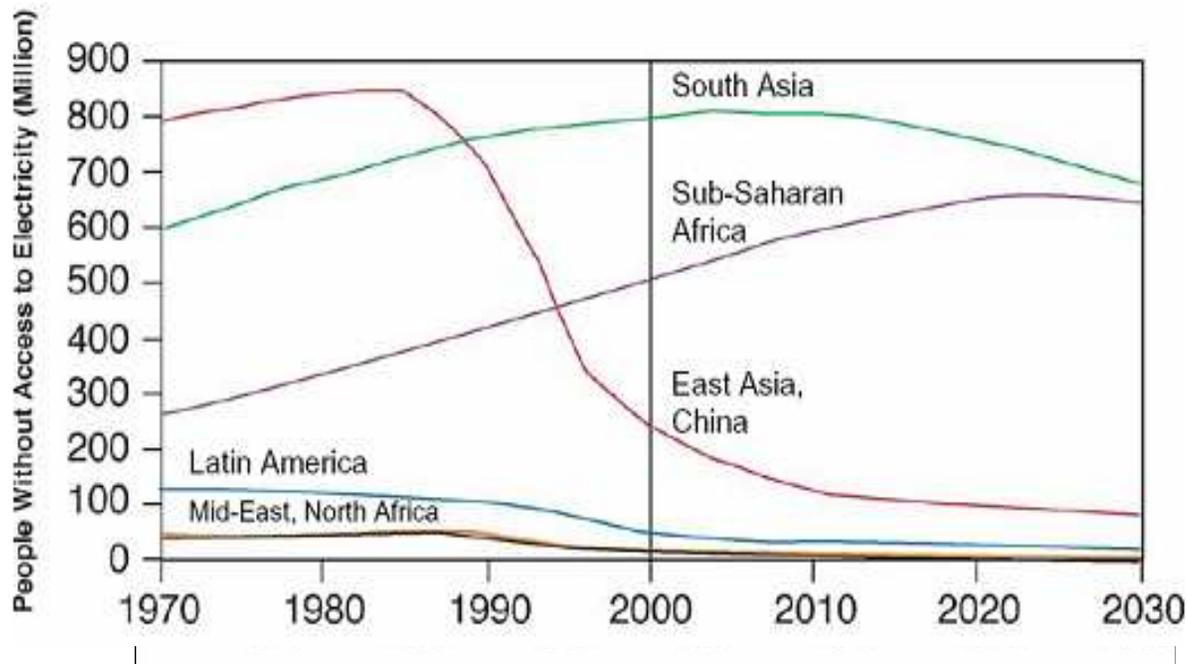
In 2000 in developing countries

- ❑ 14% of urban population and 49% of rural population had no access to electricity
- ❑ In Ethiopia and Uganda only 1% of households had electricity



Lighting in Developing Countries

- ❑ Intermittent access
 - Madhya Pradesh (India) - over 90% of rural electrified households use kerosene as a backup fuel for lighting**
- ❑ Population growth rate is higher than electrification rate



EC Asia-Link ENLIGHTEN

Partners

TKK Lighting Laboratory Finland
Co-ordinator

Kathmandu University Nepal
Vilnius University Lithuania



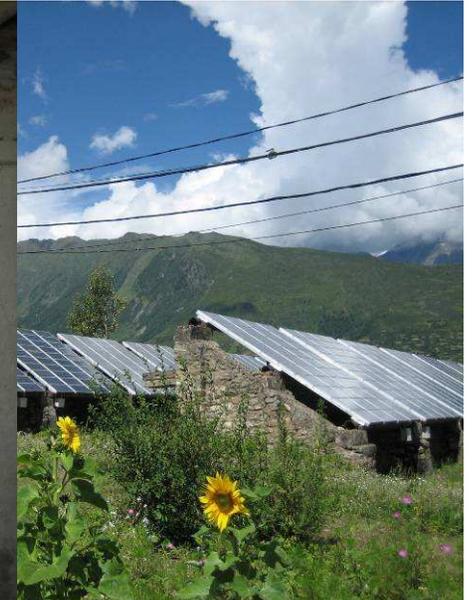
Household LED lighting activities in Nepal

- Co-operation with *Light up the World* Foundation
- Over 5 000 households and schools in remote communities of Nepal have been equipped with white-LED based lightning systems
- Powered by pedal DC generators, solar cells, and wind turbines
- Low maintenance costs (\$3/household/year).

Lighting with LEDs using Renewables



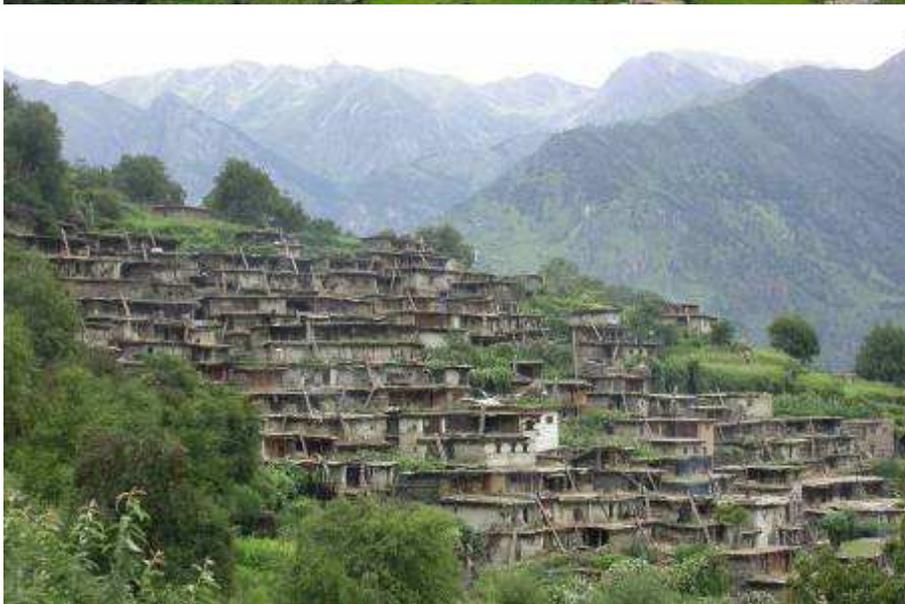
In ENLIGHTEN project efforts were made to promote the use of LEDs for lighting in remote Nepalese villages, where they can be combined with solar panels.



Remote and Rural Nepal - HUMLA



Most remote place of Nepal, probably one of the world's remotest places



Remote and Rural Nepal - Humla



Fuel Based Lighting



Kerosene lighting



Jharro lighting

Price of liquid fuels increases proportionally with distance to nearest road



“Jharro”- Pine stick



Open fireplace for cooking and lighting

Fuel Based Lighting

- ❖ Average illuminance 2 lx in one meter periphery
- ❖ Daily need for firewood per family for cooking and lighting is 20 -40 kg
- ❖ Impact on health, like respiratory problems, blindness, heart diseases



EC Asia-Link ENLIGHTEN

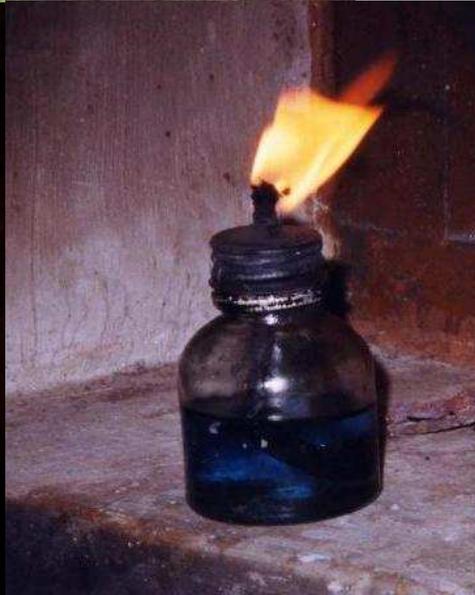


Luminous efficacy

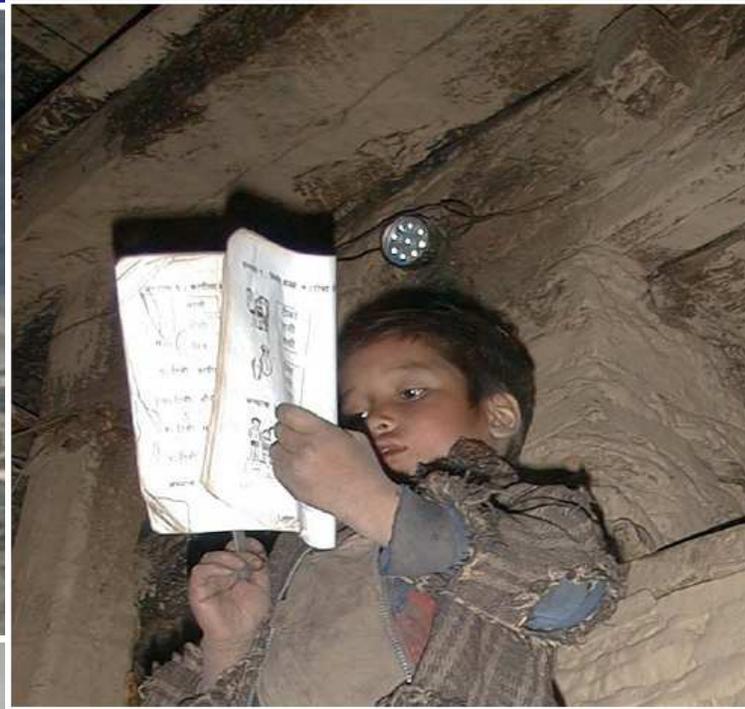
- pine stick "jharro" 0,04 lm/W
- kerosine 0,08 lm/W
- LED 15 lm/W

Costs \$/klmh

- pine stick "jharro" \$4,36 / klmh
- kerosine \$0,78 / klmh
- LED \$0,22 / klmh



LED Lighting in Nepal



A schoolboy
from remote
village reading
in White LED
lamp light



Thank You!

