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Introduction to Solid State Lighting & Standards

K.Seshadri

Senior Consultant. Philips Lighting Asia Pacific
CEO, Gritti Consulting Pte Ltd

Industry Forum on Light Emitting Diodes (LEDs)
A* Expoit Technologies

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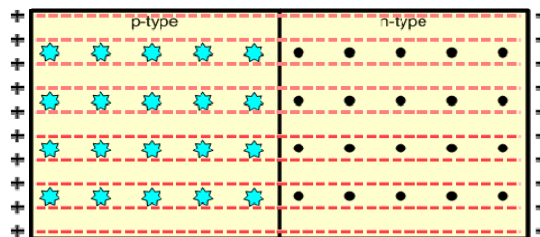
k.seshadri@philips.com

k.seshadri@gritticonsulting.org

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Light Emitting Diode - LED

- LED is of Semiconductor technology
- There is **Light emitted** and **heat produced**
- LED can have life of up to 100,000 hours



k.seshadri@philips.com

k.seshadri@gritticonsulting.org





LED – A Brief history

- 1962 First LED : Red (gallium arsenide)
- 1971 Blue LED invented (gallium nitride)
- 1983 High Brightness Red LED invented
- Mid-80s... More bright red + orange and yellow LED
- 1993 High Brightness Blue LED commercialized
- 1995 R,G, B (and B,Y) research to “White”
- 1997..... White LED (blue coated with phosphor)
- 2002..... White High Brightness LED commercialized
- 2006..... White LED Market Upturn
- 2010+?... White LED to displace some conventional lamps?

Kathryn Conway (Conway & Silver Associates) 2007

Benefits of LED

Conventional Lamps

- Incandescent 
- Halogen 
- Fluorescent 
- Gas-discharge (example: Sodium) 



LED

Benefits

- Ultra long life
- Low power consumption
- Low maintenance
- No moving parts
- No UV radiation
- Cool beam of light
- Digitally controllable
- Environment -friendly



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Comparison of Light efficacies

Lamp	Power (W)	Output (Lumens)	Efficacy (Lumens per W)
Incandescent bulb	GLS 75W	900	12
Compact Fluorescent Lamp	PLEU 15W	900	60
Fluorescent Cool Daylight	TLD 36W/54	2500	70
Fluorescent Tri-Phosphor	TLD 36W/865	3200	90
High Pressure Sodium	SON-T 400W	54000	135
LED (Commercial)	1-10W	-----	60-70

Energy Star requirement from 2009
Just 35 Lumens/Watt of 'Luminaire Efficacy'

k.seshadri@philips.com

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'Luminance & Illuminance' applications



LUMINANCE



ILLUMINANCE

k.seshadri@philips.com

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SS 531:2006 – the Singapore Lighting Code

Sl.No	Type of Interior	E (Lux)	Unified Glare Rating	CRI
3.1	Filing, copying	300	19	80
3.2	Writing, reading, Data processing	500	19	80
3.3	Technical drawings	750	16	80
3.4	CAD work stations	500	19	80
3.5	Conf & Meeting rooms	500	19	80
3.6	Reception desk	300	22	80
3.7	Archives	200	25	80

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Age Vs Illumination

(For working)

12 years = 200 lux

40 years = 600 lux

60 years = 3000 lux

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LED Light output and Scalability

- LEDs are available in a huge assortment of physical sizes, efficacy claims, and power ratings
- Efficacy and output vary greatly among different color LEDs
- LEDs have many variables; there is no simple system to gauge relative output
- **Good news:** Big choice in cost, output, efficacy, light quality, etc.
- **Bad news:** Many ways to cheat on these claims

White Light SSL Challenges

- **Lifetime & Lumen maintenance**
- **Heat management**
- **Luminaire Efficacy (*Energy Star award basis*)**
- **Color Quality (especially CRI >80)**
- **Light Output package**
- **Cost**
- **Testing/Reporting standards**

Energy Star SSL Criteria Update

- Became effective September 30, 2008
- ENERGY STAR strategy for SSL **general illumination**
Two-category approach:
 - **Category A** – Near-term applications,
 - **Category B** - Wider range of future applications
- **Category A** only calls for a **Luminaire Efficacy** of 35 Lumens/Watt at present.
- Category A will be abolished in a couple of years and category B will become the sole basis for ENERGY STAR.



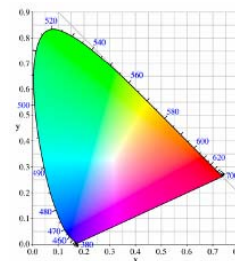
Energy Star SSL Criteria Update

Category 'A' Applications (most suitable now)

- Undercabinet Kitchen work
- Cabinet close-proximity lighting (Supermarket Freezers)
- Desk light / Task light
- Shop lighting with low contrast or low accent
- Recessed Downlights
- Outdoor Wall-mounted Porch
- Outdoor Step light
- Outdoor Pathway

Performance Standards and Test Methods

- SSL/LED Performance Standards/Test Methods
 - ANSI/IESNA
 - ANSI C82.XX1 Power Supply (First Draft)
 - IESNA RP-16 Nomenclature/Definitions for Illuminating Engineers (In Draft)
 - IESNA LM-80 Life-testing (Draft by 11/2)
 - IESNA LM-79 Electrical and Photometric Measurements (Final Draft)
 - ANSI C78.XX1 Specification for Chromaticity of White SSL Products (In Draft)



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Performance Standards and Test Methods

International

- IEC TC76
 - IEC 60825-1
 - 76/338/CDV
- BS 08/30183157 DC
- BS IEC/TS 62504. Terms and definitions for LEDs and LED modules in general lighting 29-May-2008
 - IEC 62471 (Photobiological Safety of Lamps and Lamp Systems
 - IEC 60825.15 (Guide in WD Stage)
- Harmonization Process



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Possible customer concerns

LED Promise: <i>what customers may hear</i>	LED Pitfalls: <i>What customers have to watch for</i>
<ul style="list-style-type: none"> • Size • Life • Optical superiority • Safe, reliable • Controllable • Cheap (oops!) 	<ul style="list-style-type: none"> • Ambient light levels • How long life? • Uniformity • Directionality vs. viewing angle • Control complexity & cost • Though of higher price, Reputable Brands are more trust-worthy.

Source: Mark Rousch, LD&A 2007

LED people ! – Better to learn *Lighting* Lingo

- Customers and Specifiers continue to be *more familiar* with conventional lighting than LED.
- **LED industry** has to standardize on many expressions to be better understood by **lighting community**. *What is “high-power” LED ? (when there are many lamps that deliver > 100,000 Lumens ?)*
- To understand how **Lighting people** think, every LED professional should preferably seek out and attend training on:
 - *Fundamentals of Illumination and Colour characteristics*
 - *Lamps, ballasts and circuits*
 - *Principles of indoor and Outdoor lighting Design (Office, industry, Road, Sports, Hotel, Shops etc)*
- Contemplate joining the proposed **Lighting Association of Singapore** whose objectives (among others) is to promote energy-efficient, innovative and sustainable light products and applications

Thank you !