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sense and simplicity

LED Lighting for Public Areas

Indranil Goswami

General Manager – Lighting Application Services

Philips Lighting

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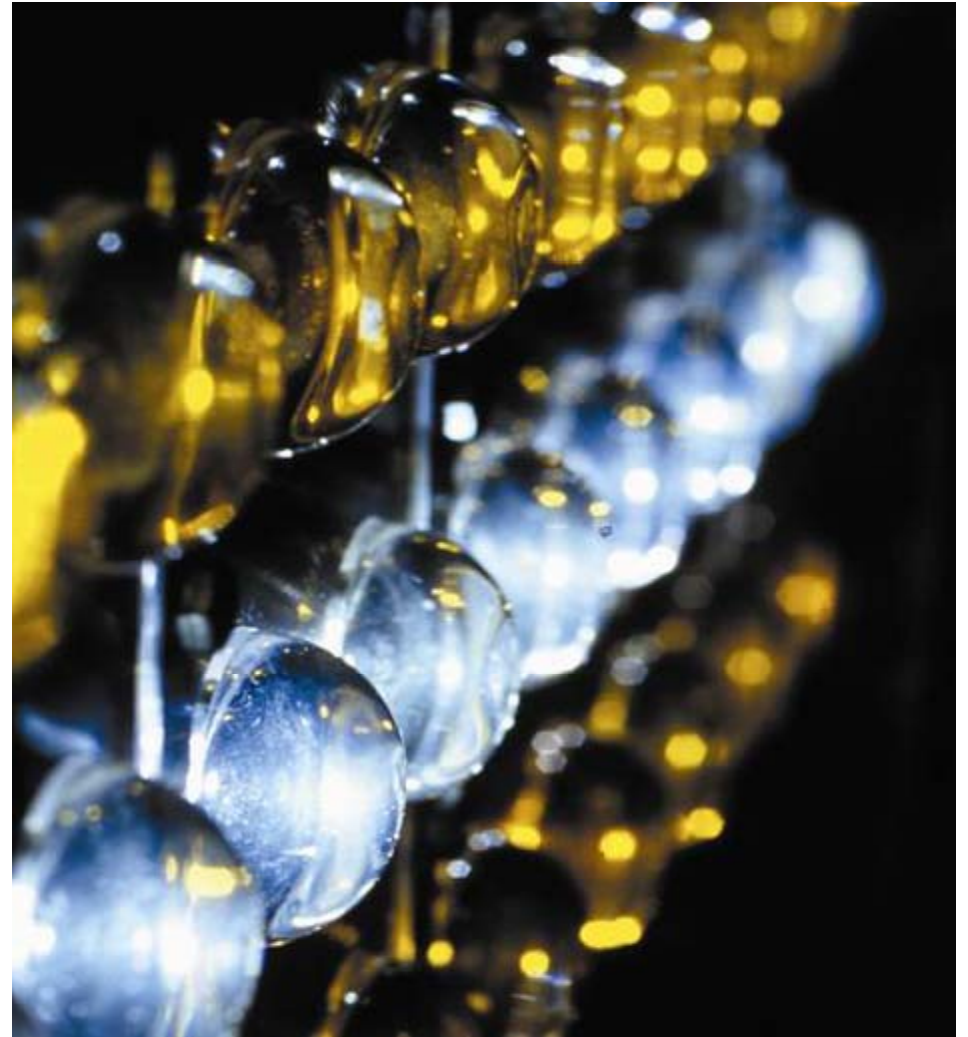
LED Lighting for Public Areas



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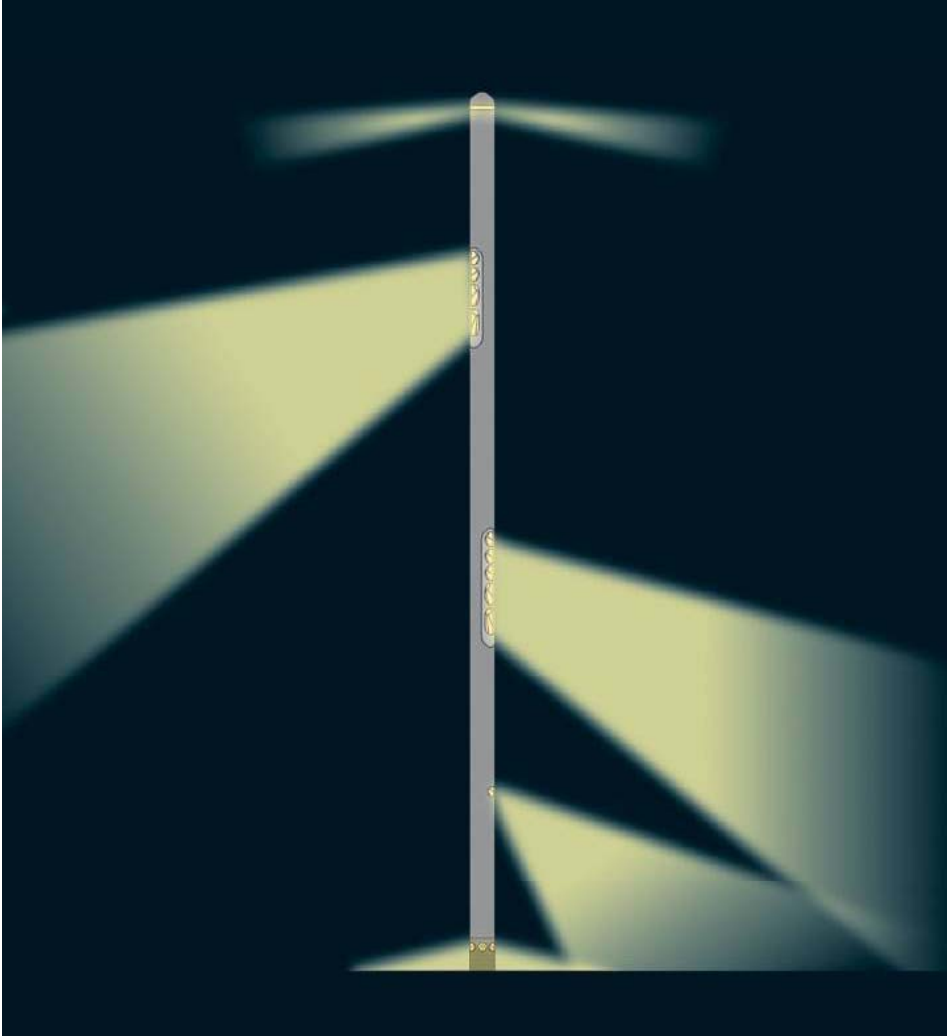
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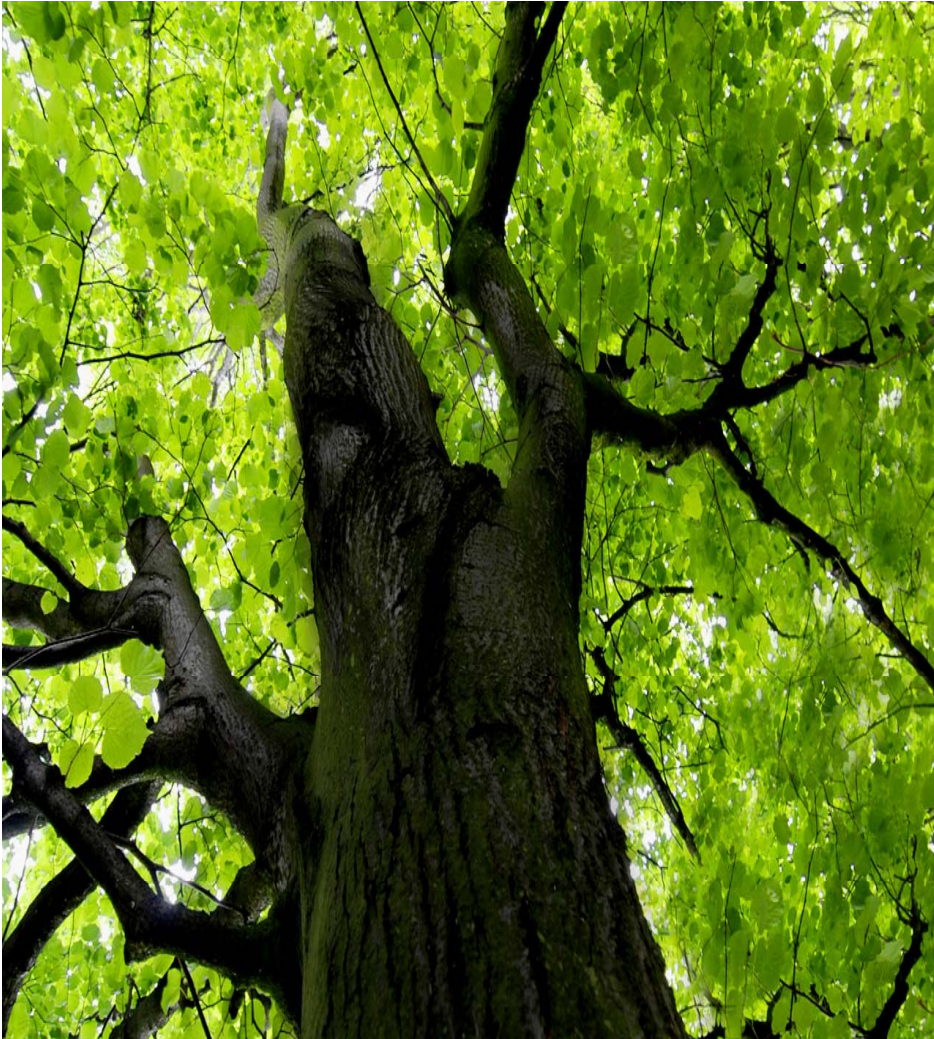
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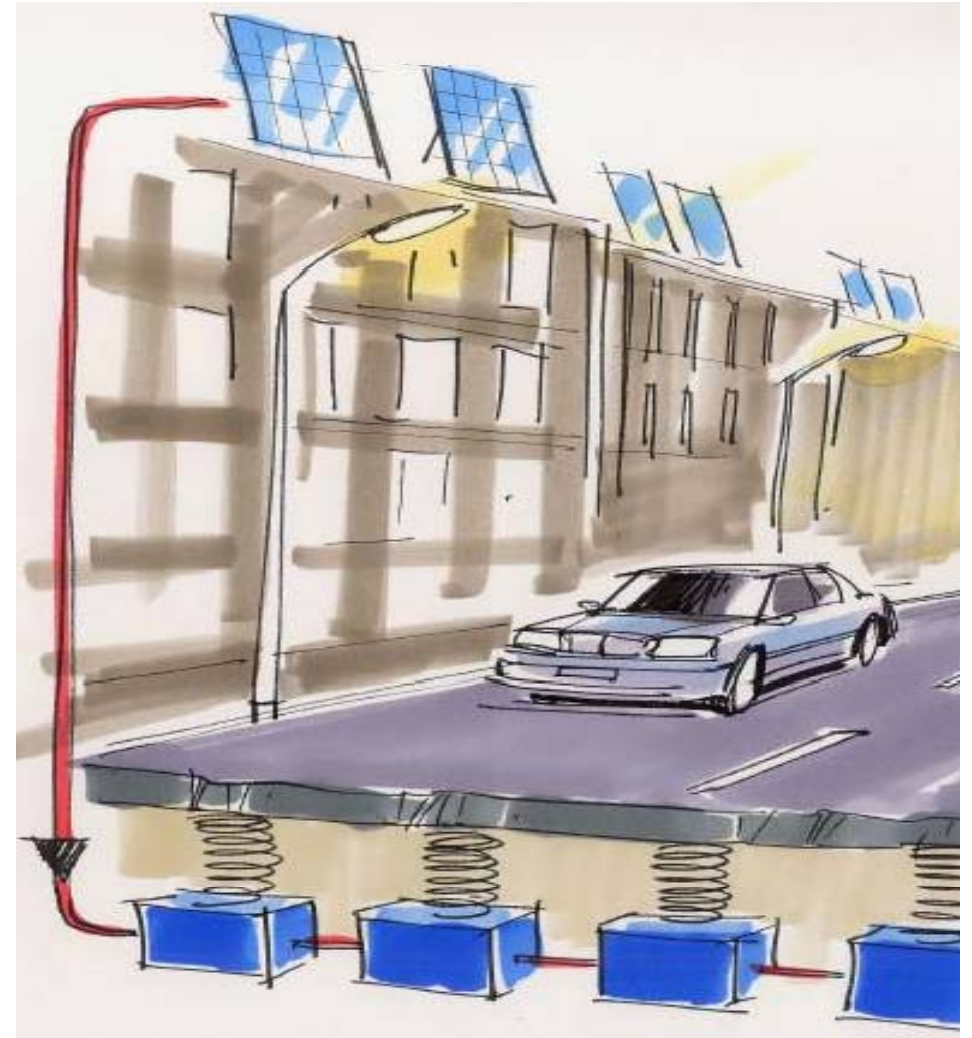
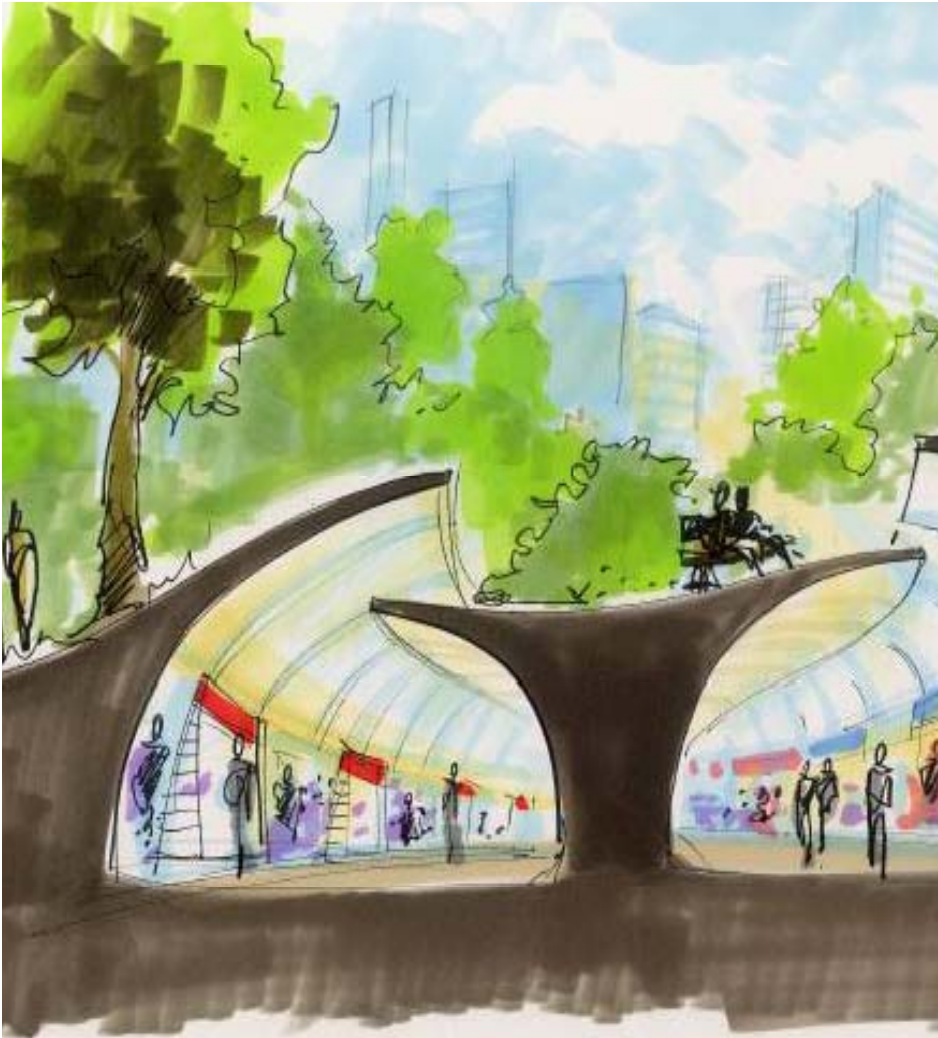
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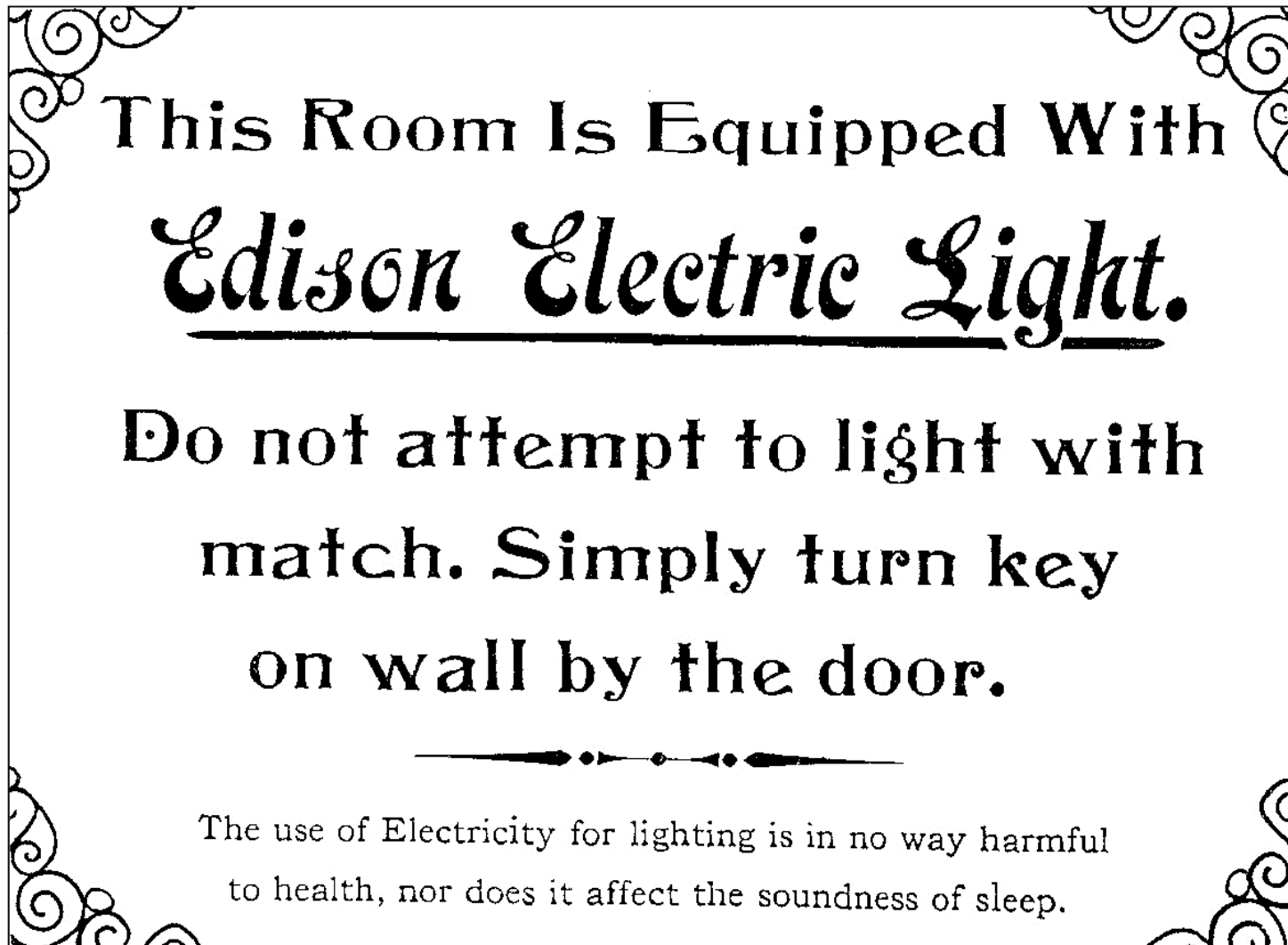


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LED Lighting for Public Areas



1890: Electric Light shifted the Lighting Paradigm



LED Lighting for Public Areas



Horse drawn carriage



The horseless carriage

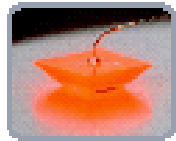


1956: electrical street light



2005: Philips LED street light

LED Lighting System: What is Involved



Level 0: Die



Level 1: Packaged die



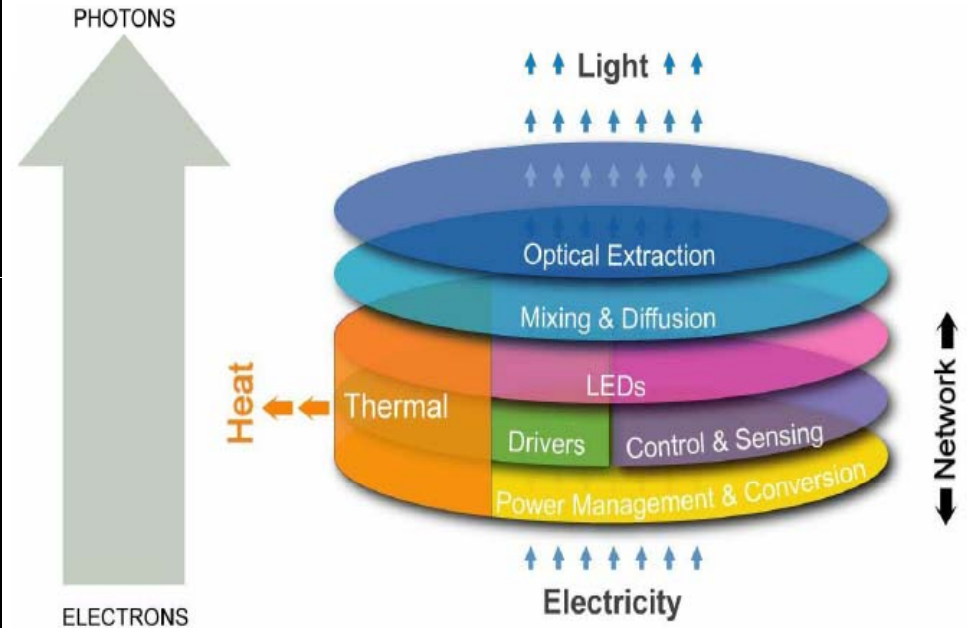
Level 2: LEDs on PCB



Level 3: Module + driver/optics/thermal



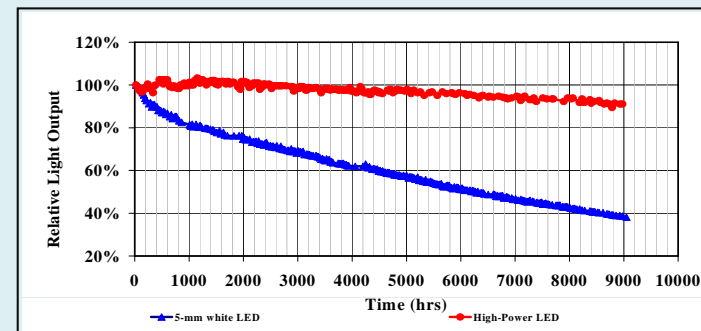
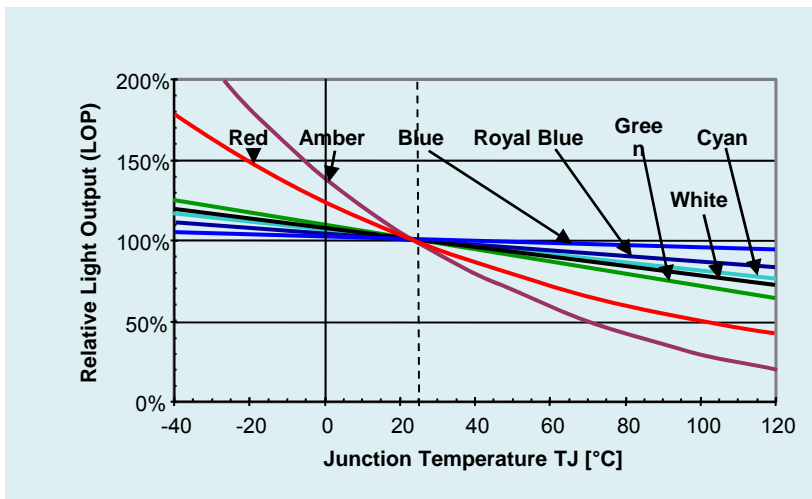
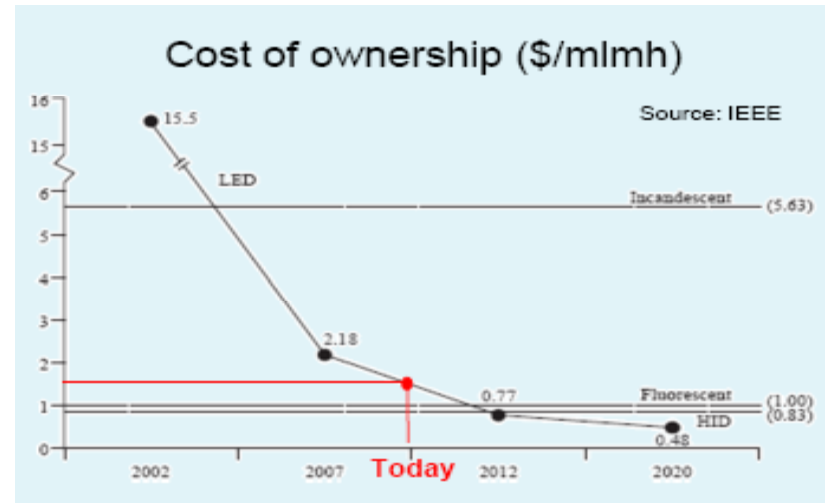
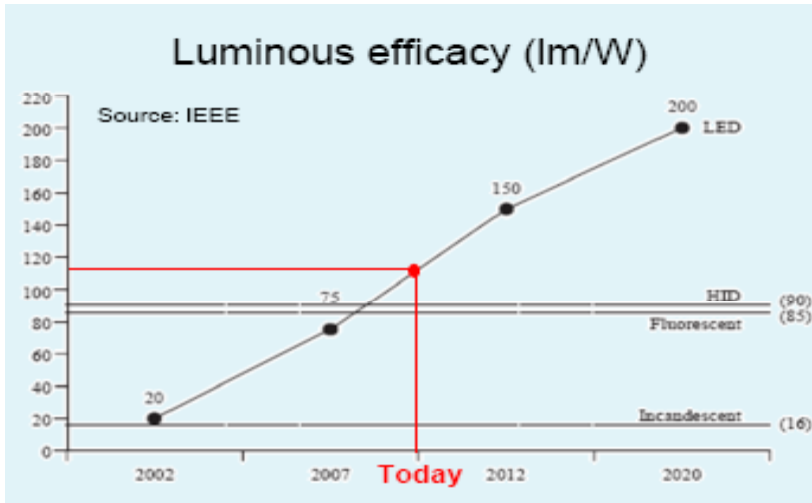
Level 4: Ledinaire



Philips is active in all five stages of the LED lighting value chain – from the basic semiconductor die right through to the LED luminaire (Ledinaire)

- More than 225 patent families
- More than 425 issued patents
- About 770 patents pending
- Worldwide
(e.g. US, Europe, China, Japan, Korea, Canada, Australia, Taiwan, Hong Kong)

Understanding LED Performance



Source: Ongoing test data from the Lighting Research Center

Understanding LED Performance

Topline and bottomline performance

LED	Data sheet flux
MFR 1	91 lm
MFR 2	107 lm
MFR 3	130 lm
MFR 4	100 lm

Requirements:

- at least 70% light output after 50000 hours

Understanding LED Performance

Topline and bottomline performance

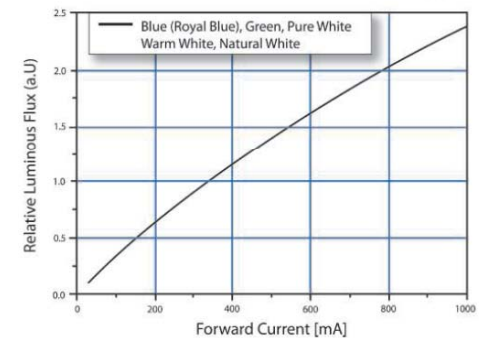
LED	Data sheet flux	Data sheet drive current	Data sheet test temp
MFR 1	91 lm	350mA	Ta 25C
MFR 2	107 lm	350mA	Tj 25C
MFR 3	130 lm	700mA	Ta 25C
MFR 4	100 lm	350mA	Tpad 25C

Ta Ambient Temperature
 Tj Junction Temperature
 Tpad Solder Pad Temperature

Requirements:

- at least 70% light output after 50000 hours

Forward Current vs. Normalized Relative Luminous Flux, T_A = 25 °C



Understanding LED Performance

Topline and bottomline performance

LED	Data sheet flux	Data sheet drive current	Data sheet test temp	Normalize to drive current	Normalize min flux @ 700mA	Oper Tj @ 25 deg C amb, Rth 50K/W
MFR 1	91 lm	350mA	Ta 25C	700mA	164 lm	135C
MFR 2	107 lm	350mA	Tj 25C	700mA	182 lm	128C
MFR 3	130 lm	700mA	Ta 25C	700mA	130 lm	141C
MFR 4	100 lm	350mA	Tpad 25C	700mA	165 lm	130C

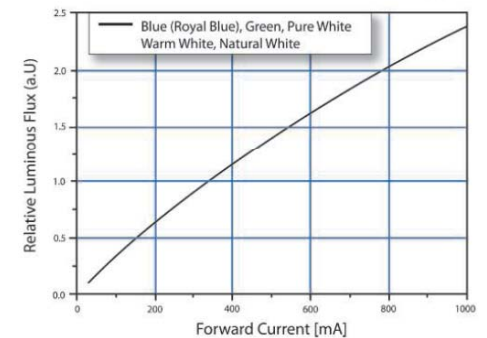
Ta Ambient Temperature
 Tj Junction Temperature
 Tpad Solder Pad Temperature

Rth is thermal resistance [k/W]
 Defined as the increase in temperature (K) when 1W power is driven through the LED

Requirements:

- at least 70% light output after 50000 hours
- drive current set at 700mA
- ambient temperature of 25 degrees C
- Rth of luminaire 50K/W

Forward Current vs. Normalized Relative Luminous Flux, T_A = 25 °C



Understanding LED Performance

Topline and bottomline performance

LED	Data sheet flux	Data sheet drive current	Data sheet test temp	Normalize to drive current	Normalize min flux @ 700mA	Oper Tj @ 25 deg C amb, Rth 50K/W	Data sheet Tj (max)	Flux de rating factor	Actual flux
MFR 1	91 lm	350mA	Ta 25C	700mA	164 lm	135C	145C	72%	118 lm
MFR 2	107 lm	350mA	Tj 25C	700mA	182 lm	128C	150C	78%	142 lm
MFR 3	130 lm	700mA	Ta 25C	700mA	130 lm	141C	125C		
MFR 4	100 lm	350mA	Tpad 25C	700mA	165 lm	130C	150C	81%	133 lm

Ta Ambient Temperature
 Tj Junction Temperature
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Rth is thermal resistance [k/W]
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Requirements:

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Understanding LED Performance

Topline and bottomline performance

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MFR 1	91 lm	350mA	Ta 25C	700mA	164 lm	135C	145C	72%	
MFR 2	107 lm	350mA	Tj 25C	700mA	182 lm	128C	150C	78%	142 lm
MFR 3	130 lm	700mA	Ta 25C	700mA	130 lm	141C	125C		
MFR 4	100 lm	350mA	Tpad 25C	700mA	165 lm	130C	150C	81%	133 lm

Ta Ambient Temperature
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 Rth is thermal resistance [k/W]
 Defined as the increase in temperature (K) when 1W power is driven through the LED

Requirements:

- at least 70% light output after 50000 hours
- drive current set at 700mA
- ambient temperature of 25 degrees C
- Rth of luminaire 50K/W

LED	L70/ 50K conditions	Oper Tj @ 25 deg C amb, Rth 50K/W	Drive current	Final calculated flux
MFR 2	Tj ≤85C, Ta≤25C	128C		
MFR 4	Tj ≤135C & if ≤700mA, Ta N.A.	130C	700mA	133 lm

Understanding LED Performance

Topline performance is not real performance. Look at system performance.

- Look at fine print – declared performance is subject to what conditions
- Look at how luminous flux is influenced by
 - drive current
 - junction temperature
 - ambient temperature
 - luminaire thermal performance (Rth)
- Look at performance over lifetime (L70/50K)

- Look at optical efficiency of the luminaire
- Look at application requirements

Philips Strategy

The complete LED player

components

controls

applications



LUMILEDS (1999)
bodine (2006)
TIR (2007)

GENLYTE (2008)
dynamite (2009)
teletrol (2009)

Partners + Lighting (2006)
COOL KINETICS (2007)
LTII (2008)

GENLYTE (2008)
Selecon (2009)
ILT LUCE (2009)

total strategic LED acquisitions over €
4 billion

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Clearline LED



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ROADSTAR™ PHILIPS LUMEC



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Thank you

Buckingham Palace – London, United Kingdom
Lighting Design: Philips Lighting



