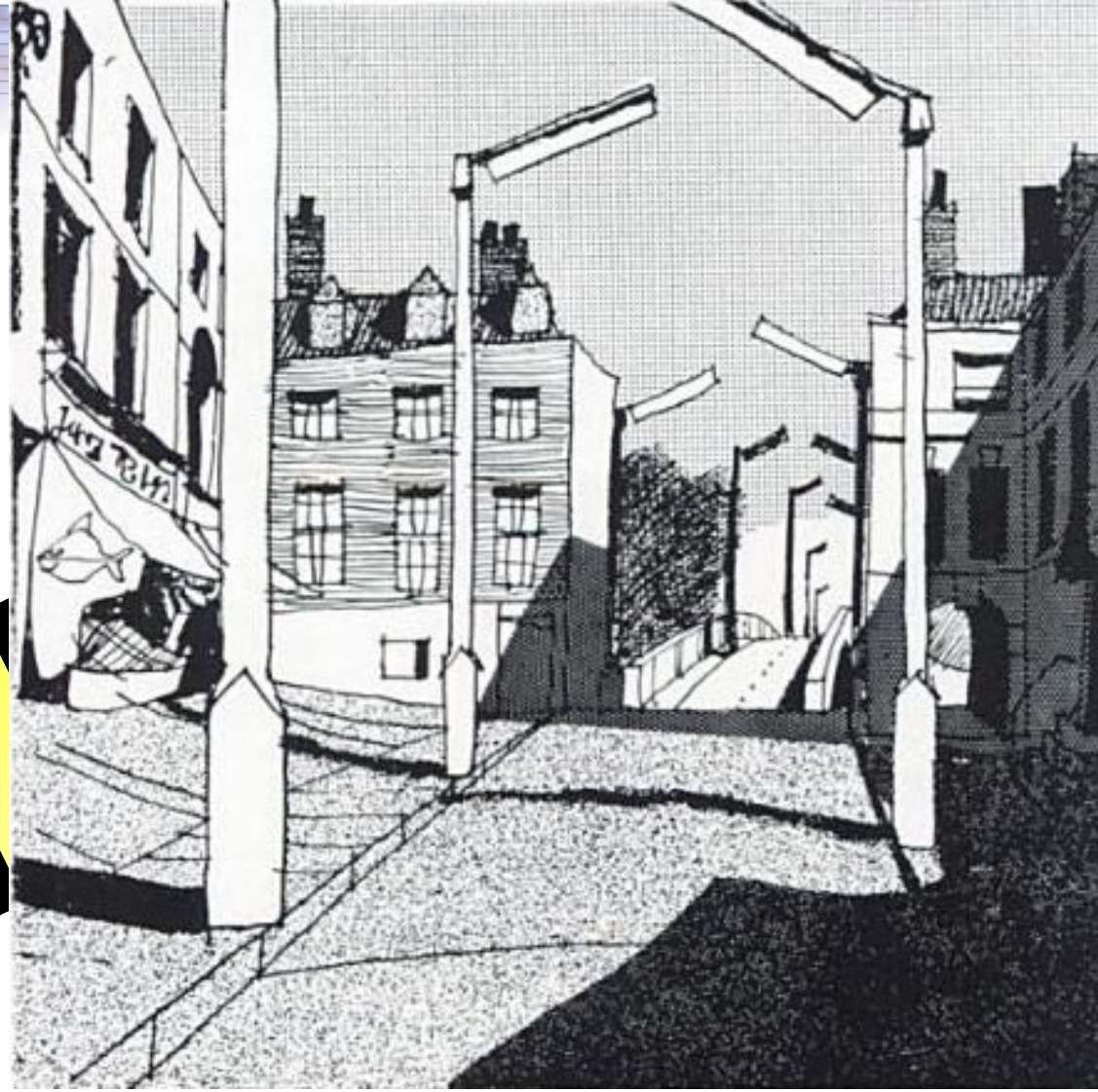
WELCOME

National Seminar On
Energy Efficient Lighting Designs

New Concepts In Street Lighting

Street Lighting & Modern Townscapes

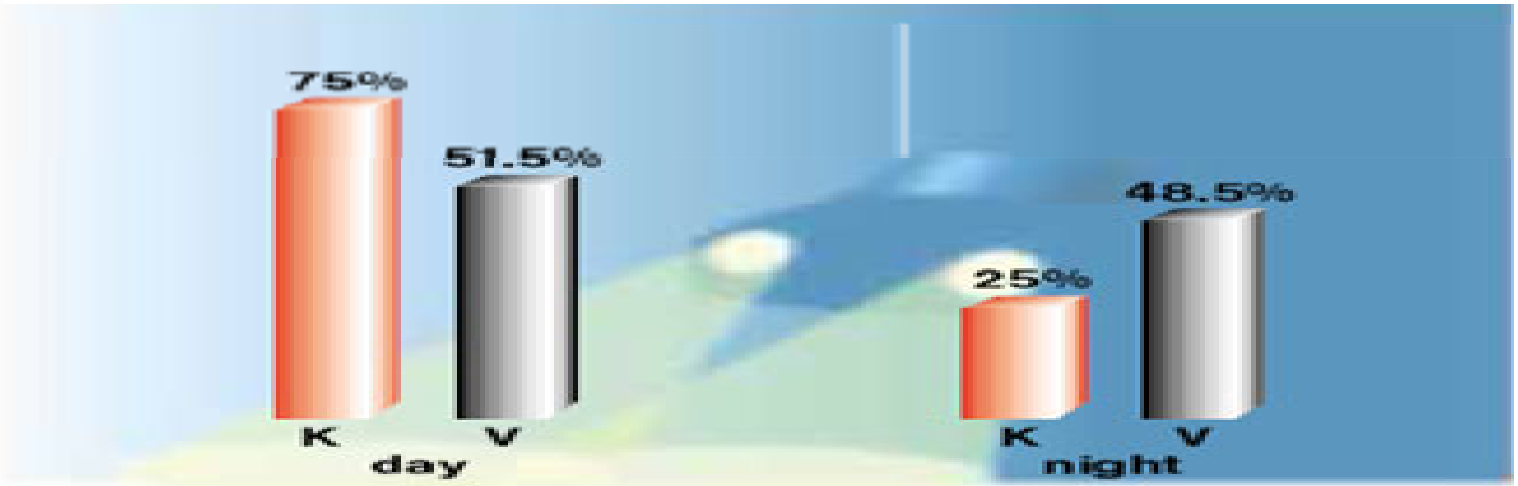


OBJECTIVE OF STREET LIGHTING

- To improve visibility of stakeholders
- To increase traffic & pedestrian Safety
- To promote feeling of Security
- To give character to city in the night
- To Attract Tourism

Street Lighting & Safety

Importance Of Good Street Lighting



Kilometres driven (K) and fatal road accidents (V) during the day and at night

Fig. 8

STREET LIGHTING - Requirements

- Design Requirements
- Total Cost of Ownership
- Energy Efficiency
- Optical Performance
- Soft Controls
- Installation Aesthetics
- Product Cost

Street Lighting Scenario

- Largest single expenditure item for many local councils.
- It is important for Corporations to keep up with developments in lamp and light fitting technology.
- To take advantage of opportunities to reduce the cost, energy use and emissions associated with street lighting, while providing a better service to users.

STREET LIGHTING – Key Factors

- Product Efficiency
- Design Efficiency
- System Efficiency

STREET LIGHTING – Key Factors

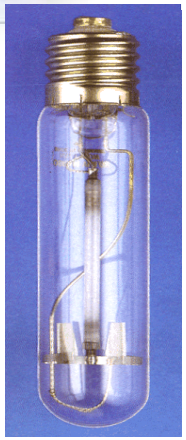
Product Efficiency

Lamp Source

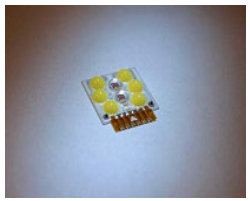
&

Luminaries

Street Light – Scope for efficiency



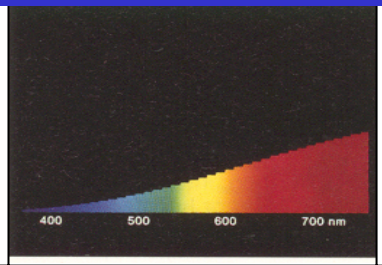
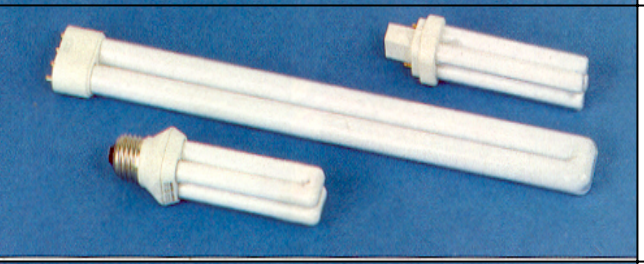
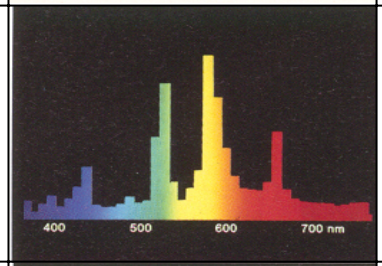
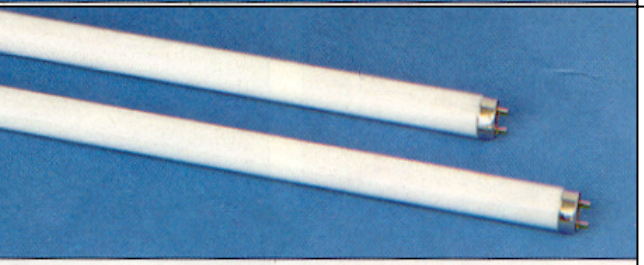
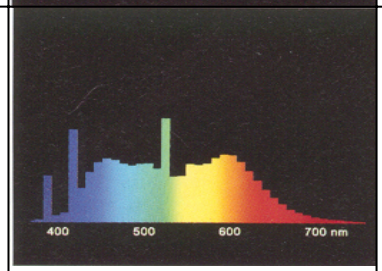
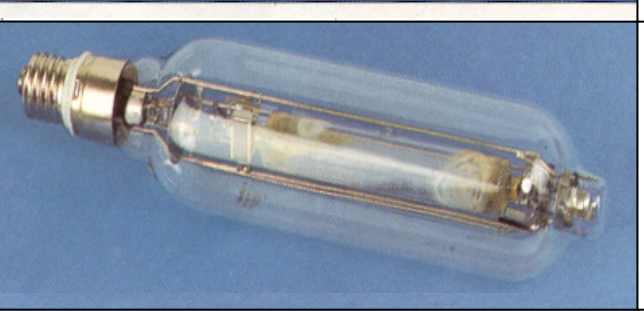
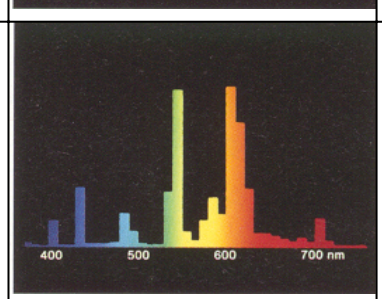
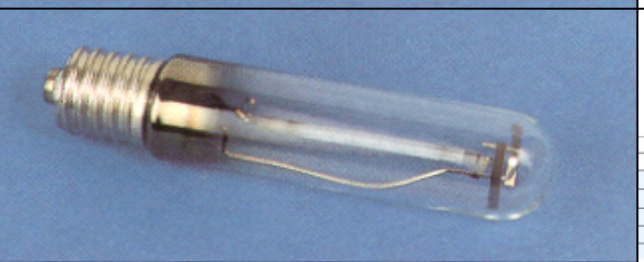
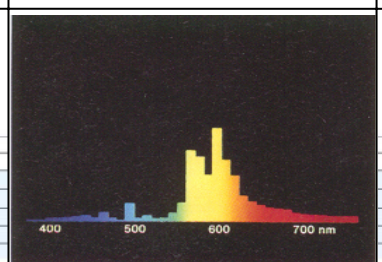
Light Source



Reflector

Luminaire

Installation

TYPE OF LAMP		SPD	CT	R_a
	Halogen		2800 to 3200	100
	CFL		3000 to 6500	50 to 95
	TRI-Phosphor		3000 to 6500	65 to 90
	Metal Halide		3000 to 6500	65 to 90
	HPSV		2100 to 2500	30 to 35

Dept :

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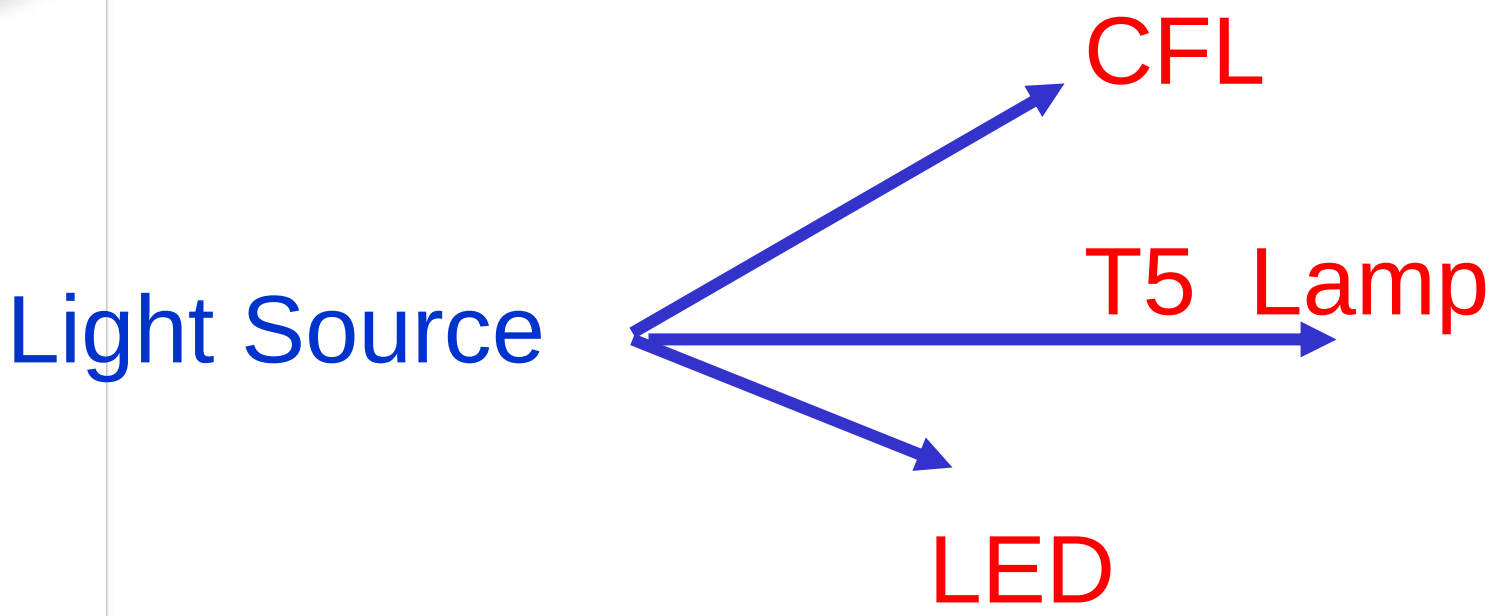
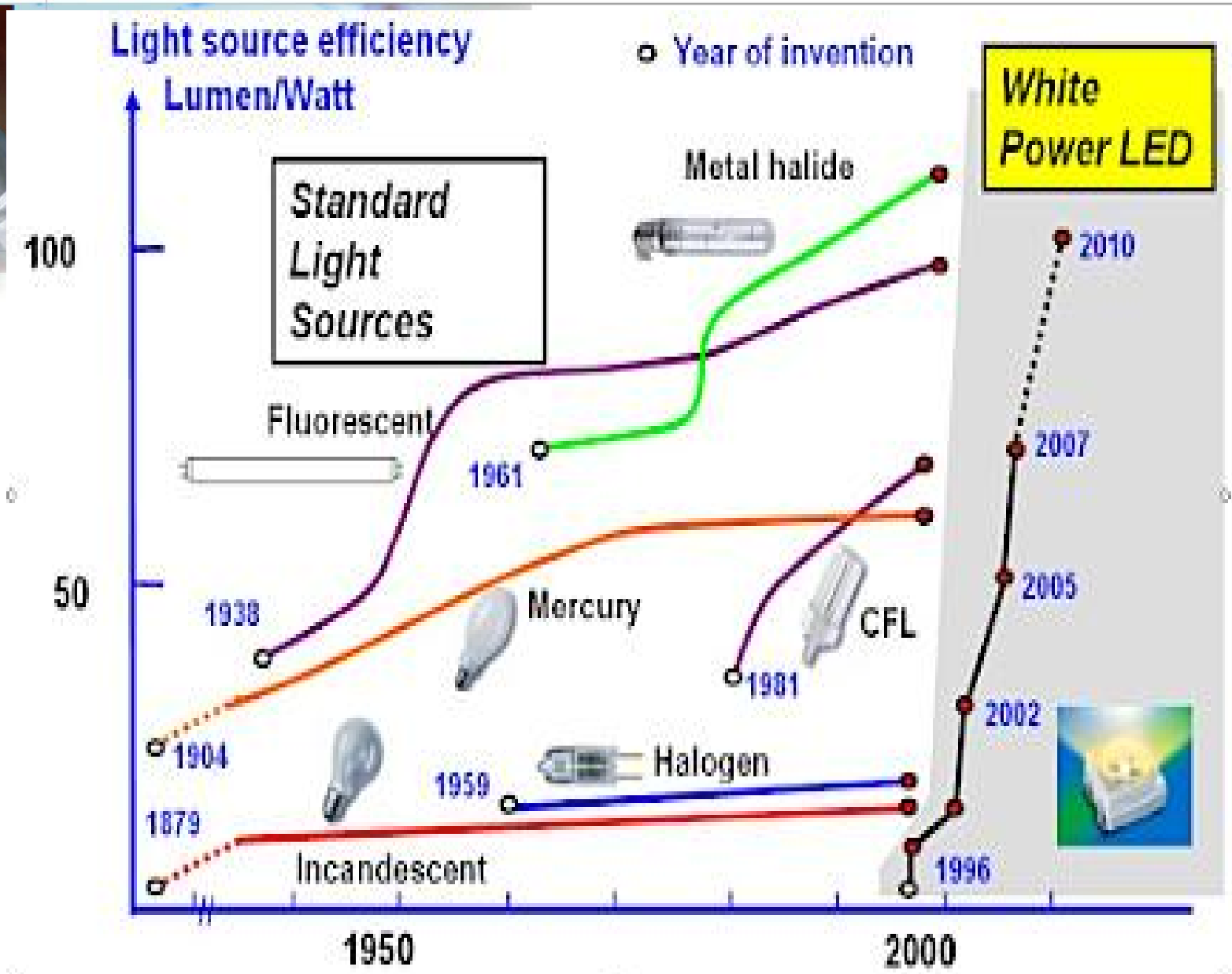
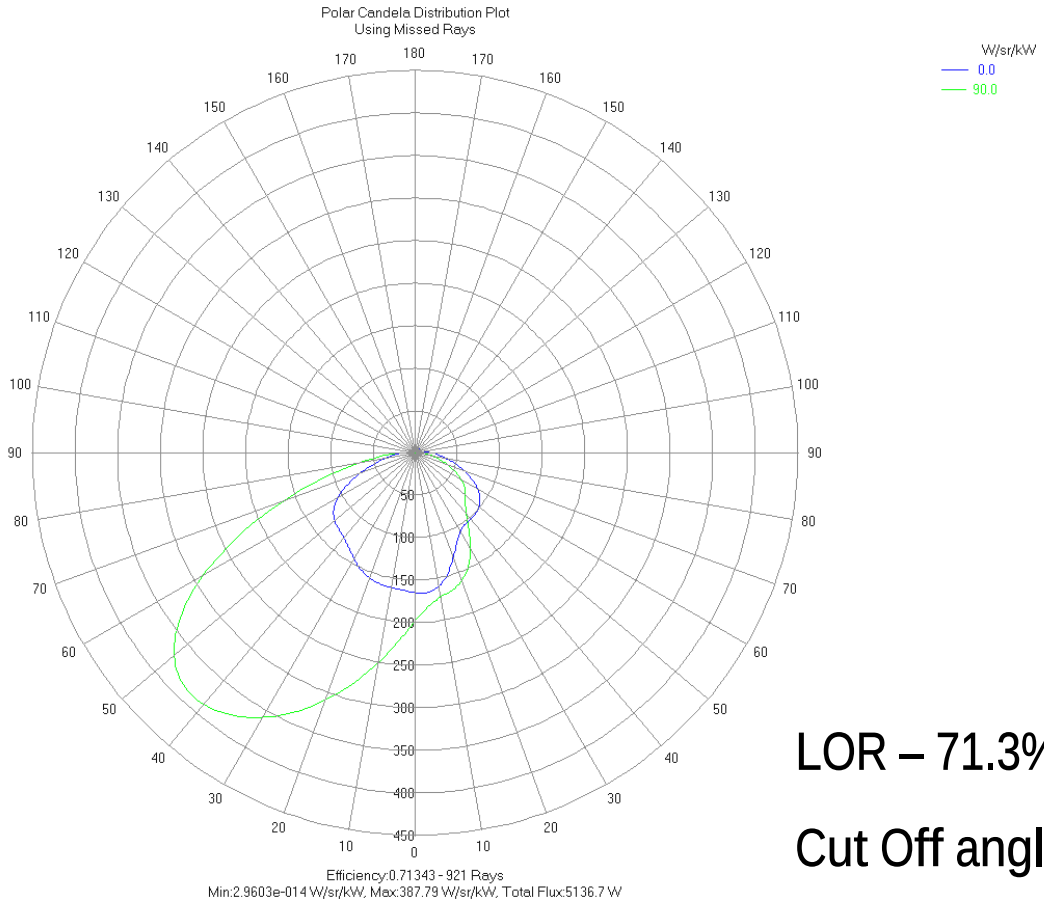
Latest in Street Lighting

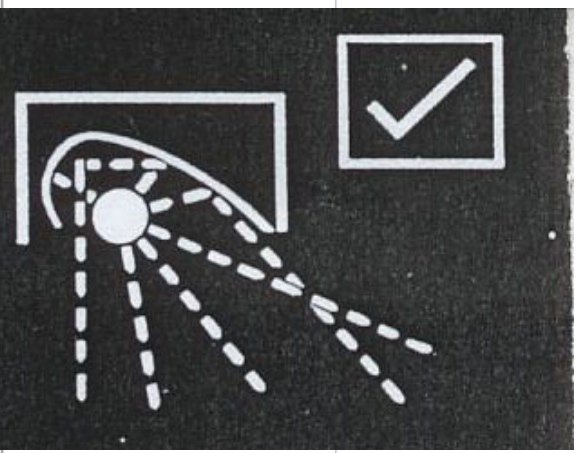




Efficient Reflector Design ?

Testing of Photometry in Trace pro



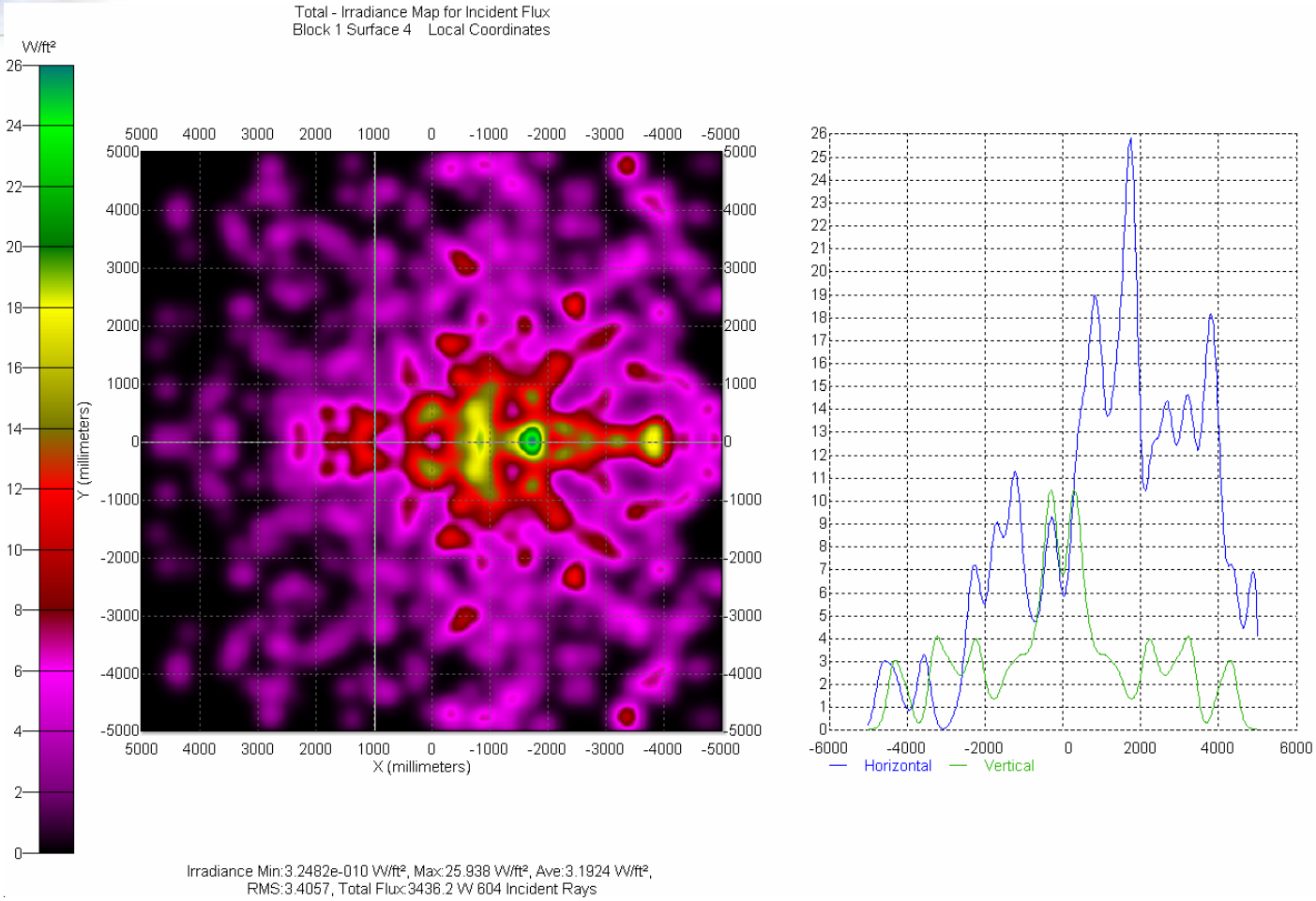


LOR – 71.3%

Cut Off angle -65^{o}

Peak intensity – 45^{o}

Testing of Photometry in Trace pro

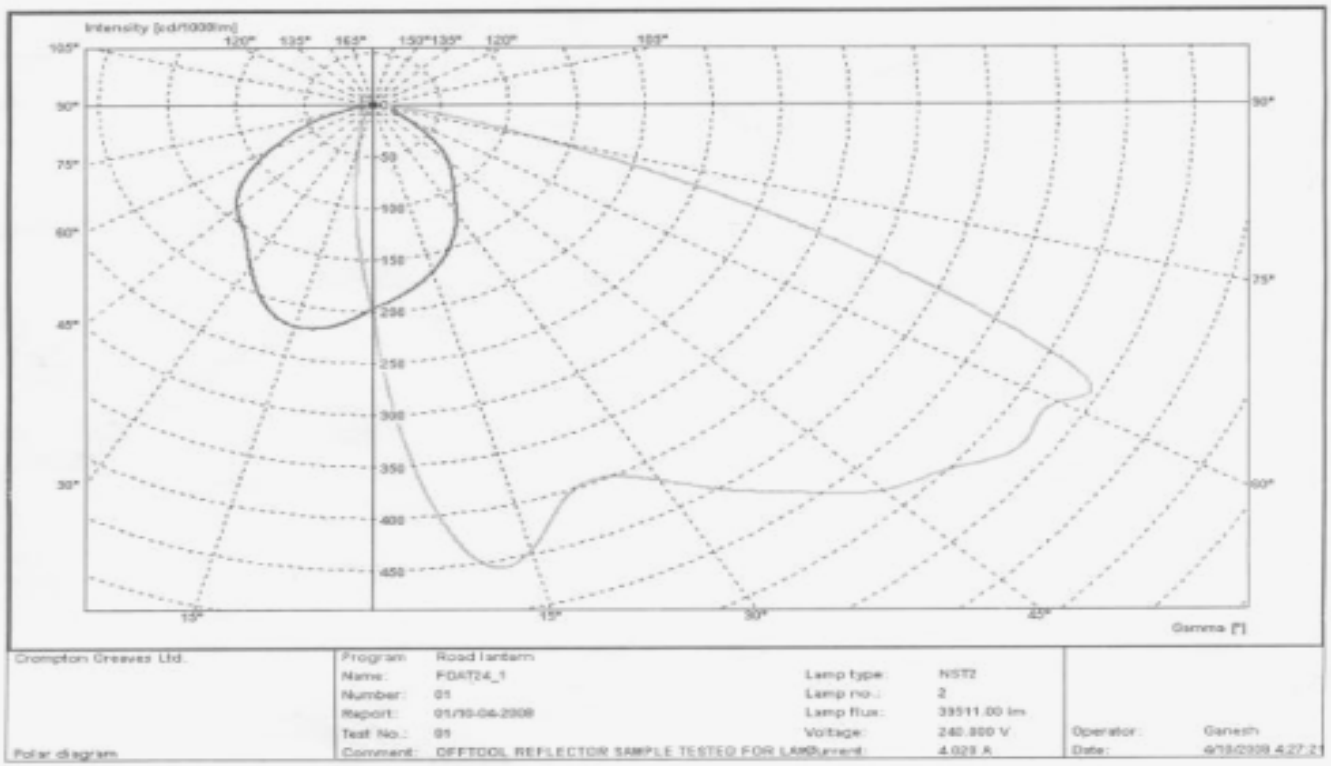


Goniometer Out put

PHOTOMETRIC RESULTS

Name:	FDAT24_1		
Number:	01	Diameter:	0 mm
Report:	01/10-04-2008	Length:	1180 mm
Test no.:	01	Width:	280 mm
Lamp type:	NST2	Height:	0 mm
No. of lamps:	2	Power:	900.4 W
Lamp flux:	47500.00 lm	Operator:	Ganesh
Date:	4/10/2008 4:27:21 PM	LOR:	87.4 %
Comment:	OFFTOOL REFLECTOR SAMPLE TESTED FOR LAMP POSITION 1-1		

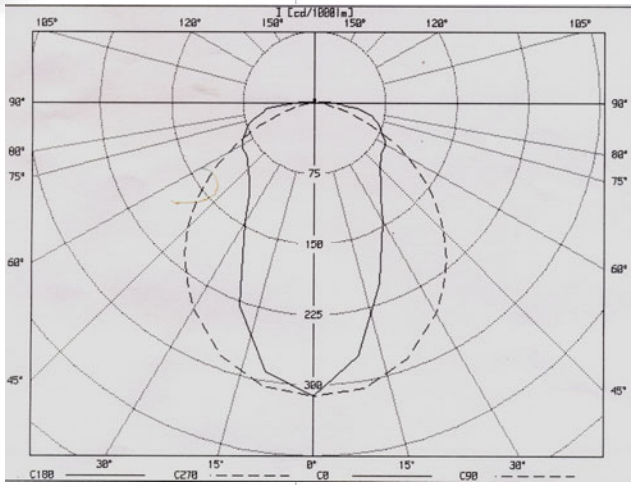
Polar diagram FDAT24_1 / Road lamp table



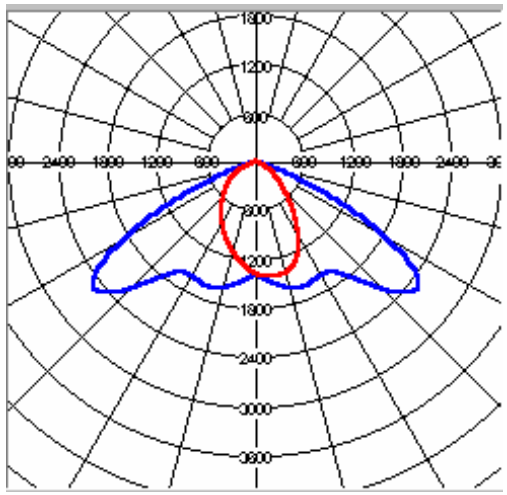
T5 STREET LIGHT

T5 STREETLIGHT COMPARISION

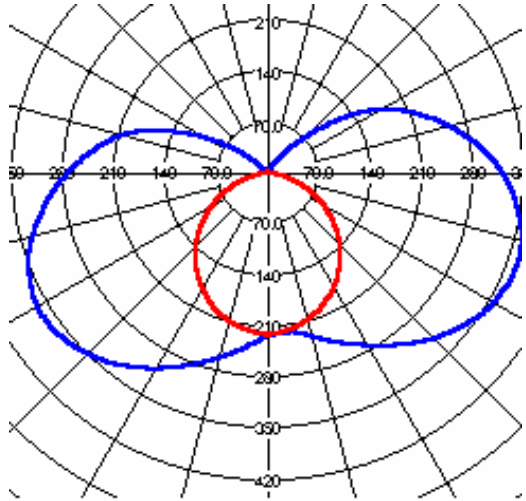
T5 Street Light



70W POT



2 x 40W FTL



T5 STREETLIGHT COMPARISION

Cat.Ref.	Emean	Emin	Emax	Emin/Em (g1)	Emax/Em (g2)
T5Street Light	5.45	1.26	20.31	0.23	0.06
Wattage 104W					
2 x 40W FTL	3.51	1.83	6.24	0.52	0.29
Wattage 105W					
70W SV	9.30	2.75	16.46	0.30	0.17
Wattage 85W					

INGRESS PROTECTION

Sealed lamp compartment
Access from top.

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Testing Facilities Required

Testing Equipments

DUST CHAMBER

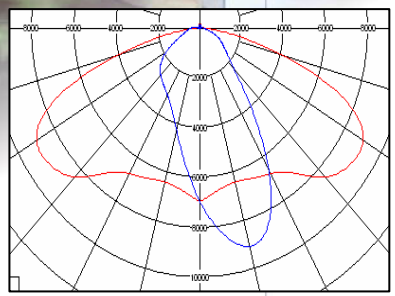
RAIN CHAMBER

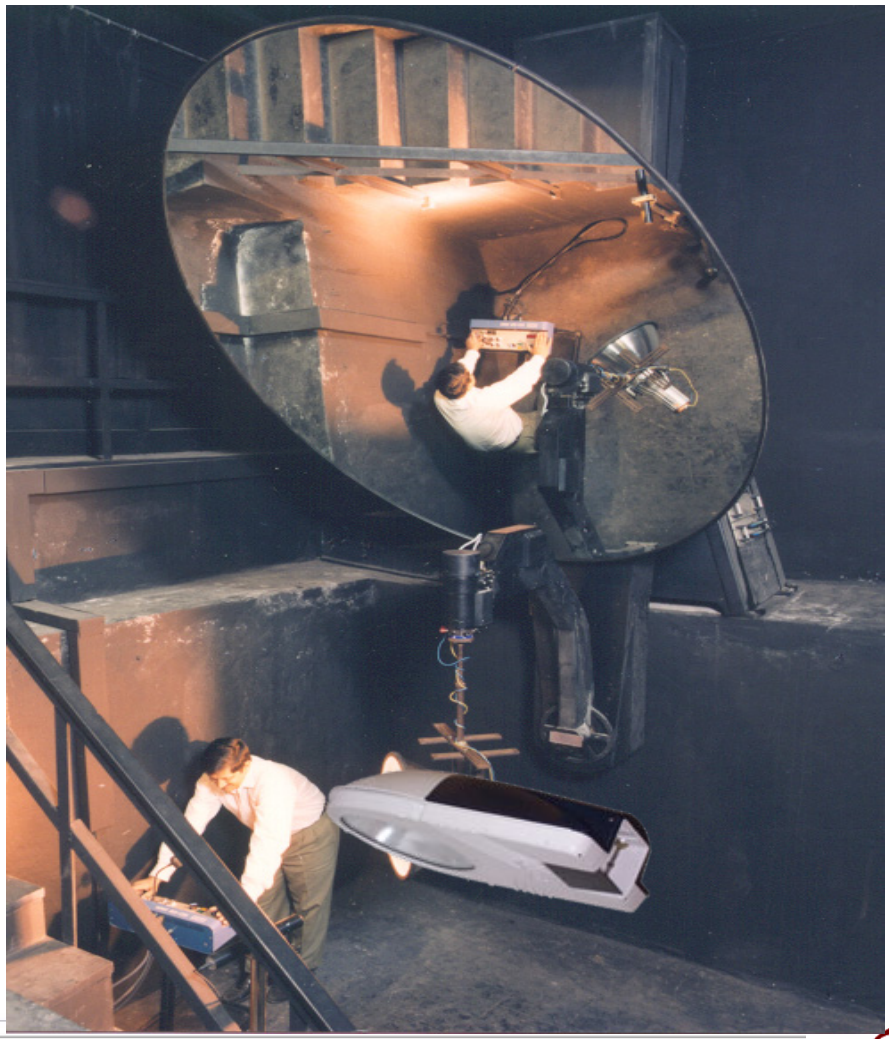
Testing Equipments contd

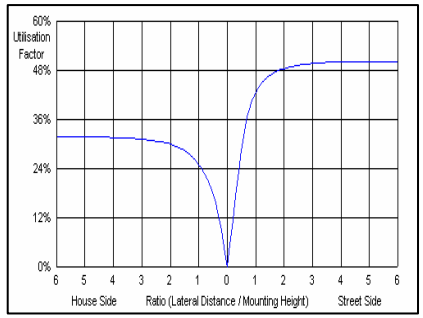
THERMAL ENDURANCE CHAMBER

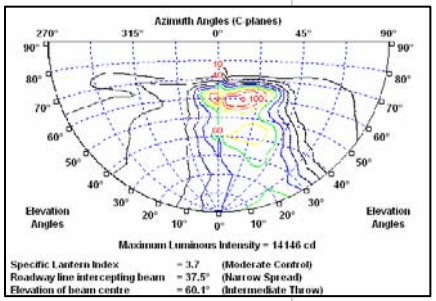
HUMIDITY CHAMBER

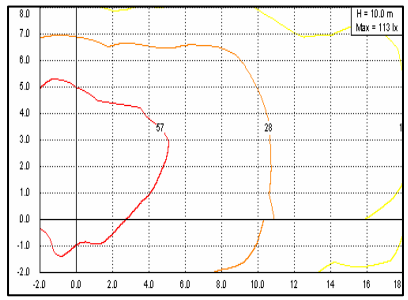
MIRROR GONIOPHOTOMETER











Light Pollution & Luminaire Design

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Light Pollution & Luminaire Design

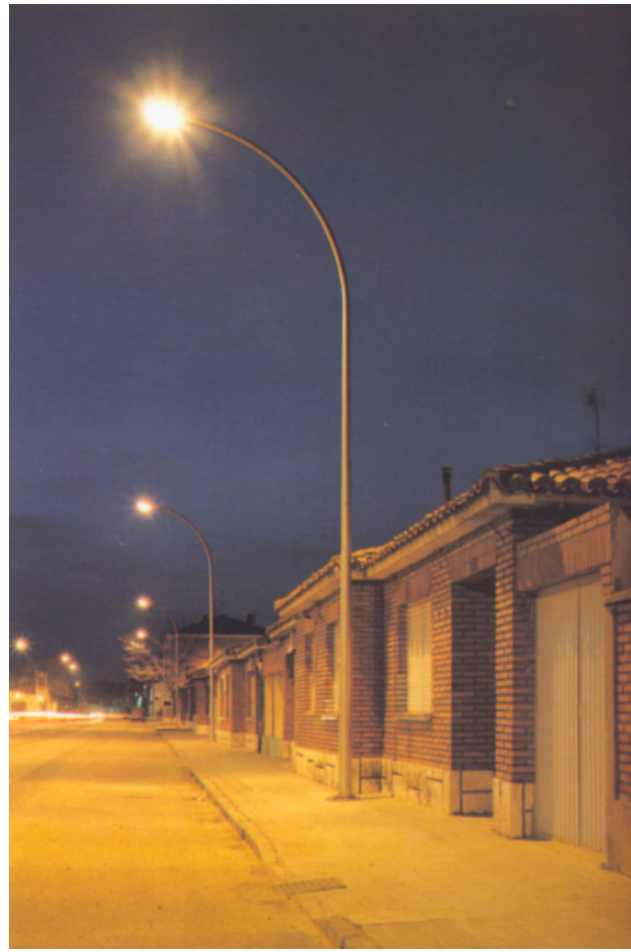
Its COST !!

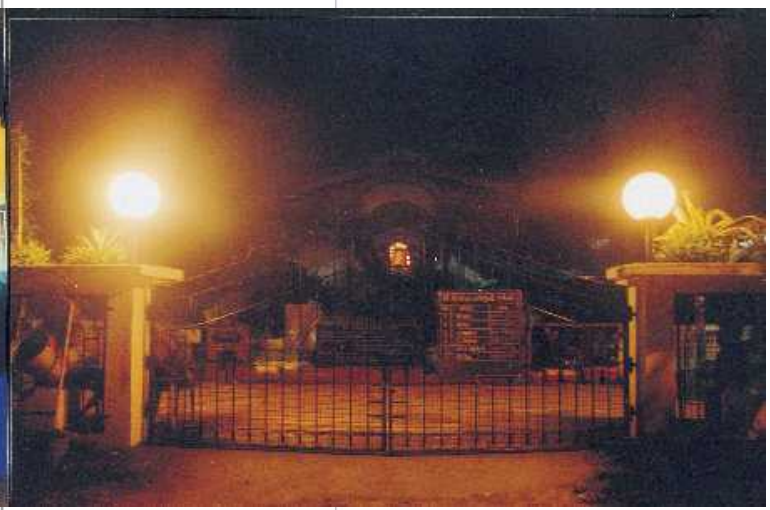
Wasted Energy

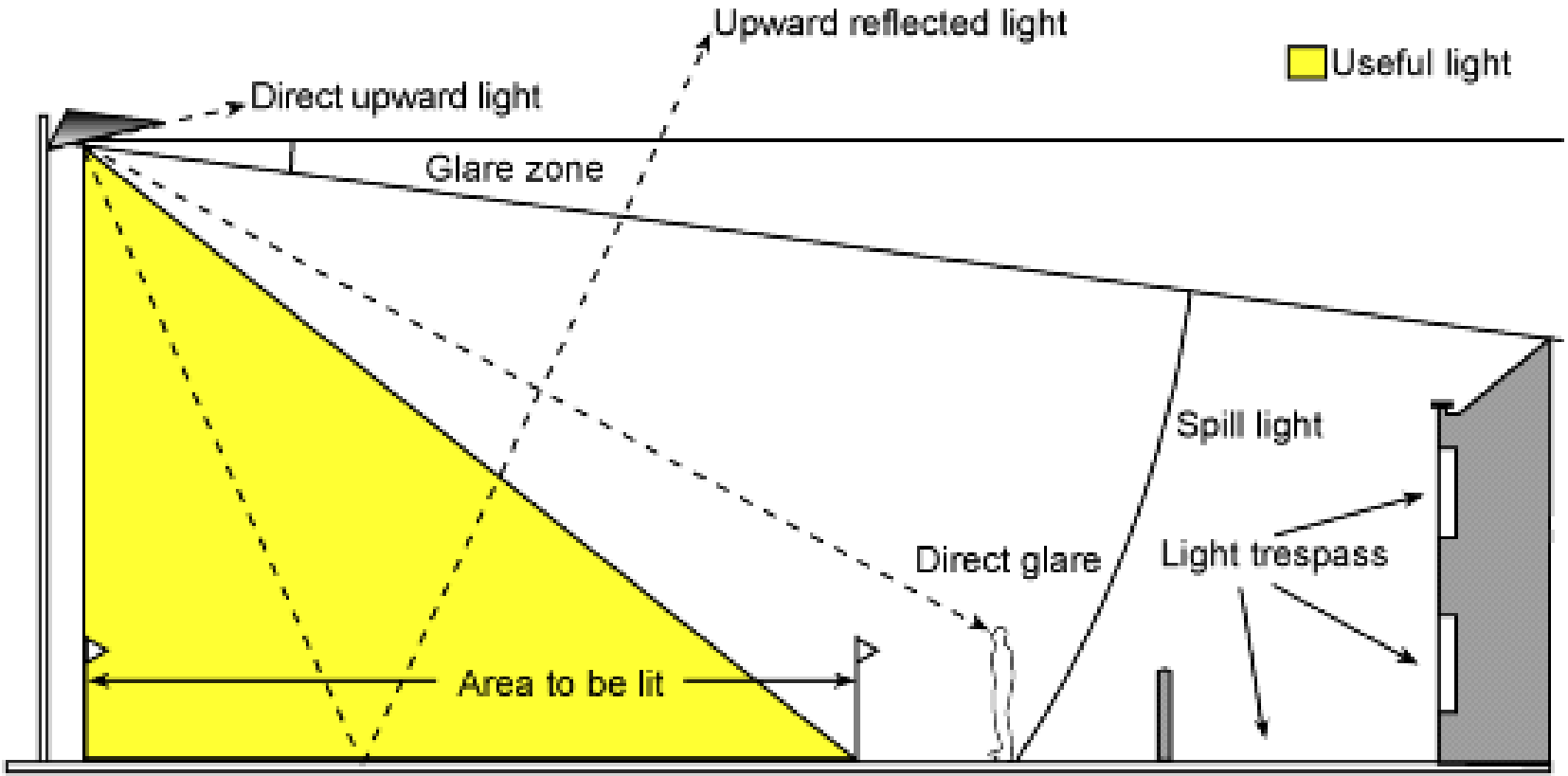
Increased SkyGlow

Greenhouse Gas Emissions

& DISCOMFORT







Light pollution is often caused by the way light is emitted from lighting equipment. Choosing proper equipment and carefully mounting and aiming it can make a significant difference.

Light Pollution

Light Pollution can be defined as spill light from a streetlight or floodlight that enters a window and illuminates an indoor area.

Description of the lighting environmental zones, as adapted by IESNA

Zone rating	Description
E1	Areas with intrinsically dark landscapes National parks or residential areas with strict limits on light trespass Roads usually unlit
E2	Areas of low ambient brightness Outer urban or rural residential areas
E3	Areas of medium ambient brightness Urban residential areas
E4	Areas of high ambient brightness Urban areas, residential and commercial with high levels of night time ativity

Limits on Sky Glow for different environmental zones

Environmental zone	Sky glow ULR* (max %)
E1	0.0
E2	2.5
E3	5.0
E4	15.0

*** ULR is the Upward Light Ratio of the installation and is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.**

Limits on light trespass for different environmental zones

Environmental zone	Light into windows, vertical illuminance (lux)	
	Before 11pm	After 11pm
E1	2	1
E2	5	1
E3	10	2
E4	25	5

Sky Glow

Light that is either emitted directly upward by luminaires or reflected from the ground is scattered by dust and gas molecules in the atmosphere, producing a luminous background.

How can Sky Glow be reduced?

1) Using full cutoff luminaires to minimize upward light
2) Reducing light levels;
3) Turning off unneeded lights;
4) Limiting lighted hours of outdoor sales areas, parking areas, and signs around important observing sights;
5) Limiting lighting installations;

STREET LIGHTING – Key Factors

- Design Efficiency

Luminance

&

Longitudinal Uniformity

DATA MEASUREMENTS FROM Street LIGHTING

LOCATION: - Village Road, Bhandup, Mumbai.

Road Type	B2	Road classification	RCC block cube material
Road Width		9m.	
Span / Distance between two poles		32 m.	
Pole Height		5.5 m.	
Tilt		50	
Overhang		1.7m.	
Bracket Length		0.6m.	
Lamp Type		150w SON-T	

Iluminance calculation	Luminance calculation
Eavg =10 lux Emax = 28.11lux Emin = 1.6 Uo (Emin/ Eavg)= 0.1	Lavg = 2.9 cd/m^2 Lmax = 6.8 cd/m^2 L min = 1cd/m^2 Uo (L min/ L avg)= 0.3

	ROAD CLASSIFICATION	(E) LUX	(U_E)	(L) Cd/m^2	(U_L)
AS PER IS	B2 group, secondary Road, light traffic	4	0.3	_	_
AS PER CIE	RCC block cube road surface	6-8	0.3	0.6-0.8	0.2
AS PER EXP.	B2	10	0.1	2.9	0.3

Continued…

LOCATION: - Village Road, Bhandup, Mumbai.

a. Road surface is RCC block made smooth, road reflectance is much brighter than Asphalt road.

b. This is secondary road with light traffic, so 70w lamp is sufficient and energy efficient too although uniformity is poor.

c. Required lux level is satisfied as IS standard but luminance is much better because of concrete made cube road surface.

Light level is good appeared according to pedestrians and motorist.

a. We can use 70 w HPSV-T with same installation.

b. We can use 70 w HPSV-T by decreasing the spacing and increasing the height.

DESCRIPTION	EXISTING LUMINAIRE [150w, SON-T]	RECOMENDED LUMINAIRE [70w, SON-T]
No of luminaire/km	31	31
Total load (lamp+ ballast) kw	5.3	2.6
Energy consumption/annum in kwh @ 4000hrs/annum	21200	10540
cost in lakh (Rs 4.10/kwh)	0.8	0.4

Energy saving is 10660 kwh if 70w replace the 150w-SON-T.

STREET LIGHTING – Key Factors

- System Efficiency

  Reducing operating hours

  Replacing inefficient switching equipment

  Improving maintenance practices

Energy Management System

Street Lighting Automation : Present Scenario

- Street Lights are being controlled using simple Time-switches or Photocell
- Operates at pre-programmed set times irrespective of twilight or sunset / sunrise times leading to wastage of substantial energy.
- Photocell sensor based systems have calibration issues hence prone to errors. Also unless maintained, these sensors lead to energy wastages over a period of time.

Street Lighting Automation : Present Scenario

Existing solutions

- Are without any additional control features like Off hours after midnight or Alternate pattern in lighting so as to save energy during light traffic conditions prevailing after midnight.
- Are without any remote control actuation of output channels during heavy clouding or excessive mist.
- Do not take into account of fluctuating power supply that reduce lamp life.

Proposed Automation and Energy Saving Systems

- Solution 1: Dimming in Off Peak Hours
- Solution 2 : Lighting Automation with Astronomical Time Switch Control
- Solution 3: Astronomical time-switch based Lighting Automation with Flux Stabilizer with Astronomical Control
- Solution 4: Astronomical Time-switch based automation with Remote control using GSM Technology
- Solution 5: A combination of solution 3 and solution 4
- Solution 6: Wireless controls
- Solution 7: GSM/GPRS based controls

Solution 1 - Dimming in Off Peak Hours

The operation of street lighting is based on two period

1.PEAK HOURS :

During 6.30 P.M. to 10.30 P.M. the traffic density is very high and hence calls for lamps to glow at their rated power to achieve the required illumination on the road.

2. OFF-PEAK HOURS :

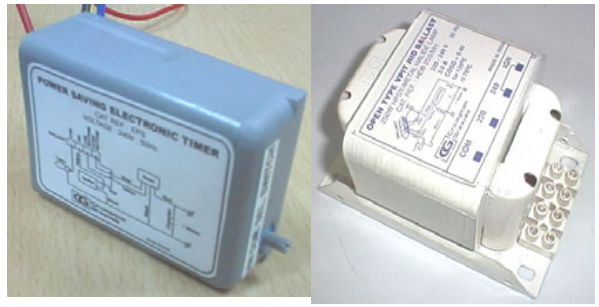
During 12.00 mid night to 6.30 A.M. the traffic density is less and hence calls for lower illumination level on the road.

The existing practice is to switch off alternate street lights to save energy at the cost of uniformity and safety.

THERE ARE TWO TYPES OF POWER SAVER

A. Power saver for new installation -

Street Lights duly wired with specially made ballast with electronic timer in addition to ignitor & capacitor.



B. Street Smart - Retro-fit Power Saver for existing installation

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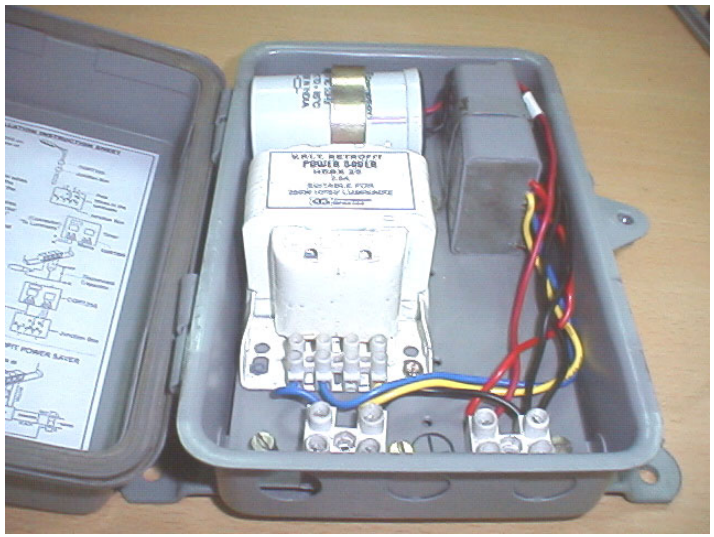
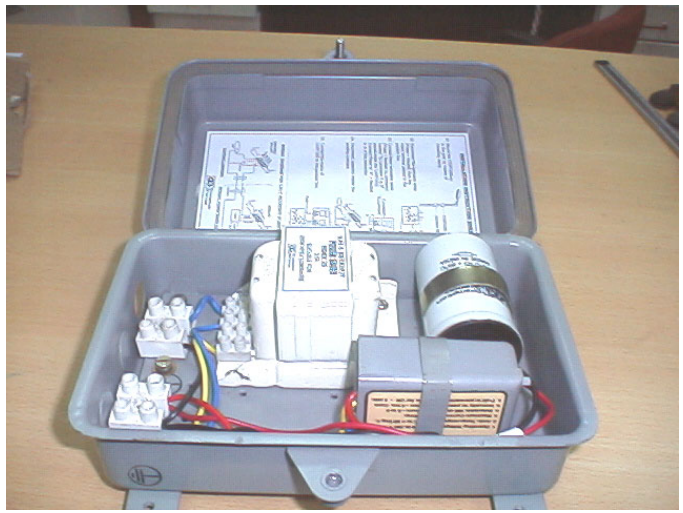
Street Smart is a retrofit control gear with special ballast, electronic timer and a capacitor to be used with existing street light installation (without altering the existing accessories) to save energy.





Solution 2 : Lighting Automation with Astronomical Time Switch

Main Features

- Accurate switching at sunrise / sunset by astronomical algorithm thereby eliminating use of sensors.
- Switching can also be triggered at twilight thereby saving more energy and using maximum available natural light after sunset or before sunrise.

Other Features

- Allows switching off lights at any time after night . This is a useful feature for garden/fountain lights within the campus
- Control of alternate lights in a 3 phase distributed lighting system after midnight if desired.
- Weekly off feature will automatically keeps off the output on weekly off days.

Solution 3: Astronomical time-switch based Lighting Automation with Stabilizer

- Ideally, lighting lamps should be powered with a voltage that does not exceed 5% of its nominal value.
- Consequences of such voltage fluctuations considerably reduce lamp life.
- Street lighting systems particularly have this disadvantage due to over voltages common during the night leading to reduced lamp life and increased power loss.

Solution 3: Astronomical time-switch based Lighting Automation with Stabilizer

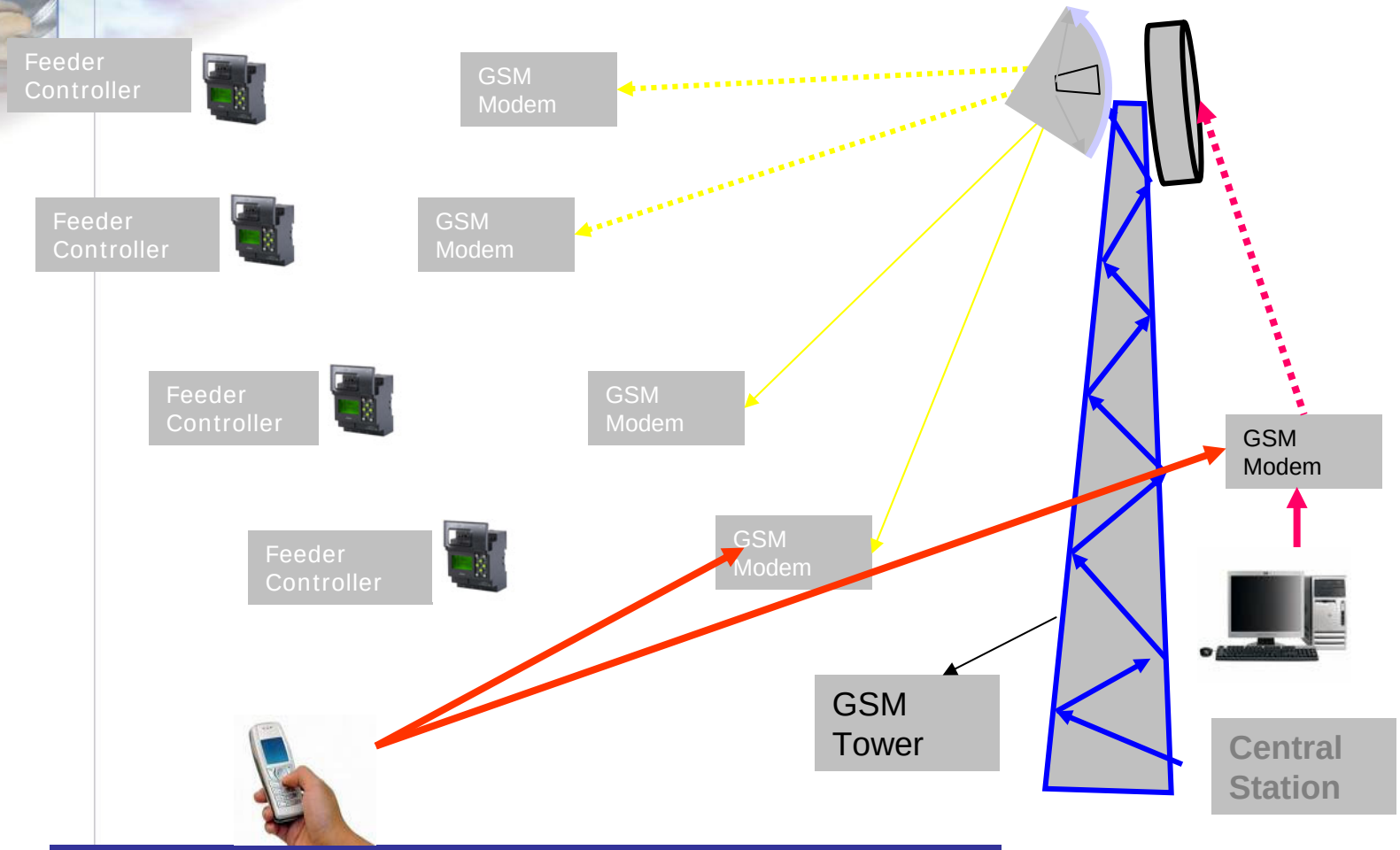
- Over current tripping for set amount of time.
- Under/ Over Voltage limits can be defined as well.
- Energy measurement can be done & energy parameters can be sent to PC by means of wireless GSM modem. GSM modem is an option.

Typical Example of Savings

Type	HPSV 150W	HPSV 250W
Recommended Lamps for one system	66	40
Total KW @ 230V *	13.66	12.42
Total Load (kW)@ 200 V	10.54	9.58
Energy Savings (Range 230 -200 V)	29.60%	29.60%
Energy Savings due to trigger on twilight with usage of Astro Controller	8.84%	8.84%
Total Savings	38.44%	38.44%

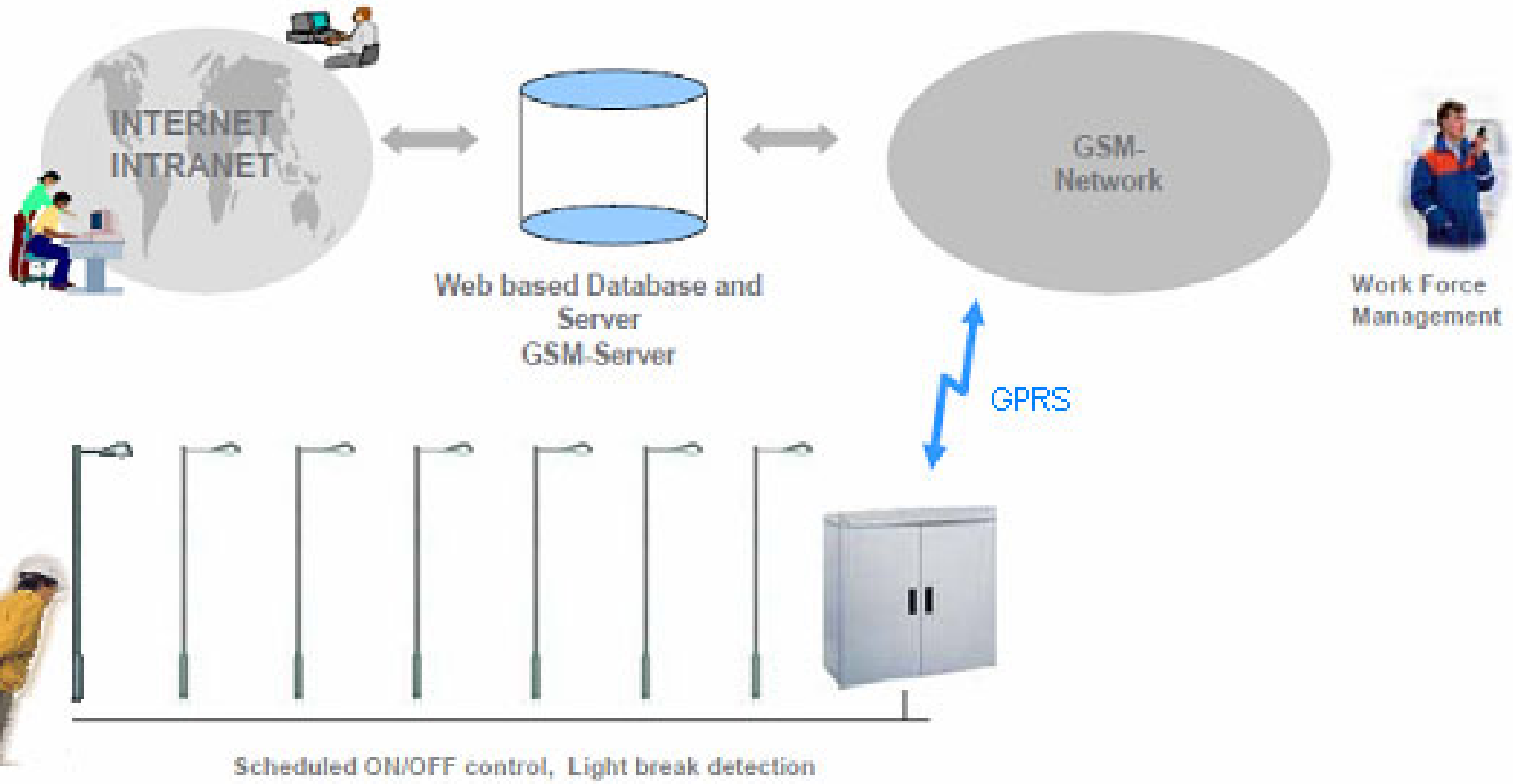
*** This saving is for a maximum voltage of 230V, savings will be higher at higher voltages**

Solution 4 : Astronomical Time-switch based automation with remote control using GSM Technology



Authorized Switching and Data acquisition through Mobile Handset

Solution 5 : Astronomical Time-switch , GSM Technology & Voltage regulation



Features:

- Easy to install with wireless (GPRS) connectivity to data server
- 32 bit microcontroller based embedded system for control panel
- Remote control (ON-OFF)
- Remote Monitoring (V, I, [P, KWh] etc..)
- Time based ON-OFF
- Turn ON/OFF time configurable from SCADA, on fortnight basis
- Ambient Light intensity based On-Off using IR sensing.

Benefits:

- Centralized monitoring and control solution
- Energy saving,
  - ON-OFF synchronized with ambient light intensity
  - Load control schemes
  - Load voltage regulation (line voltage > 230V)
  - Dimming
- Improved life of components
- Less turn around time in case of fault due to instant alarms
- Web based end user interface enables operation from anywhere in the world.

Panel for Stabilizer-GSM Lighting Automation Control

Solution 6 : Wireless Controls

WHAT IS ZIGBEE ?

- ZigBee is a wireless communication standard that provides a short-range cost effective networking capability.
- It has been developed with the emphasis on low cost battery powered applications,

Why ZigBee ?

- **Standard in a fragmented market**
  - Many proprietary solutions, interoperability issues
- **Low Power consumption**
  - Users expect battery to last months to years!
- **Designed for wireless controls and sensors**
- **Low Cost**
- **Simple protocol, global implementation**

What it Consists

- Wireless Dimming Ballast with RF Module
- Coordinator
- GSM Module
- Router or Repeater
- Zig BEE based Energy Meter (Optional)

Advantages of System

Reliable : As operating on 2.4 GHz frequency and encrypted codes data reliability and operation is secured no one except authorized person can crash in to system. No human iterface

Economical : The system is very economical as compared with other wireless communication and control system.

Easy Installation Easy Operation : The device is very handy and fits inside the fixture with out disturbing existing system.

Solution 7 : Street Light Management (GSM/GPRS BASED)

SYSTEM OPERATION

GSM/GPRS Communication

TRUNK NODE

BRANCH NODE

BRANCH NODE

RF Communication

LEAF NODES (max 256)

LEAF NODES (max 256)

Lumen ratings don't tell the user everything about potential visibility

Energy Management is not only way to save Energy

Smart lighting solutions - LEDs

Smart solutions.
Strong relationships.

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NEW VALUE SYSTEM

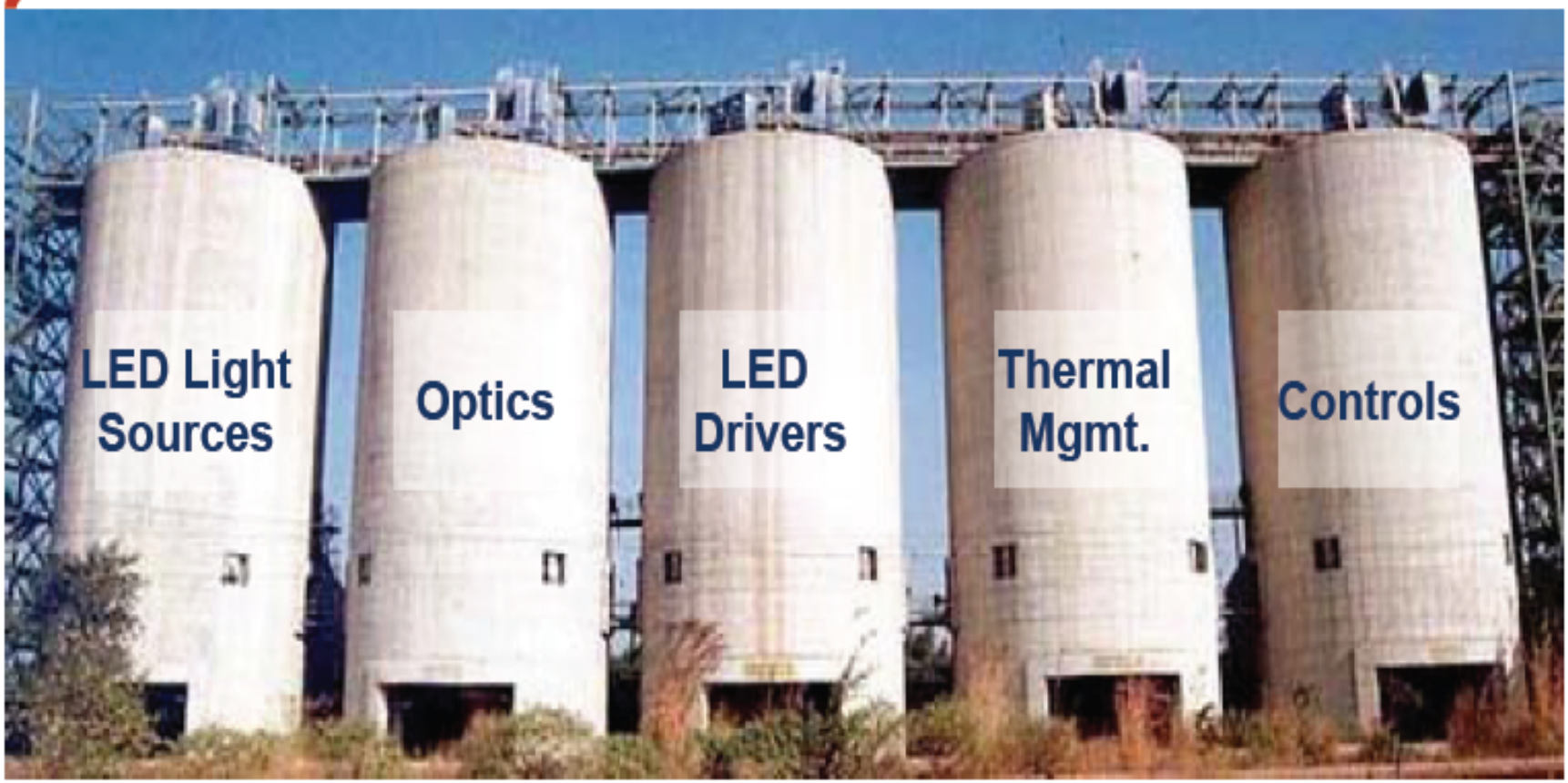
- Value sustainability
- Producing goods that meet new standards of durability and reliability
- Products that are re useable and not disposable
- If reuse not possible then at least recyclable
- Energy efficiency

What's Driving LED business

- TECHNOLOGY
  - 150 LUMENS /WATT COOL WHITE
  - 120 LUMENS /WATT WARM WHITE
- ADOPTION IN GENERAL LIGHTING
  - Quality lighting solutions are beginning to make their presence felt
  - Cost reduction due to volumes leading to TCO
  - System advances – Driver technology + controls
  - Green issue
- ENVIRONMENT
  - Potential to reduce global electricity consumption by 10%
  - 200M Tons / year reduction in global carbon emission

SSL -Luminaire

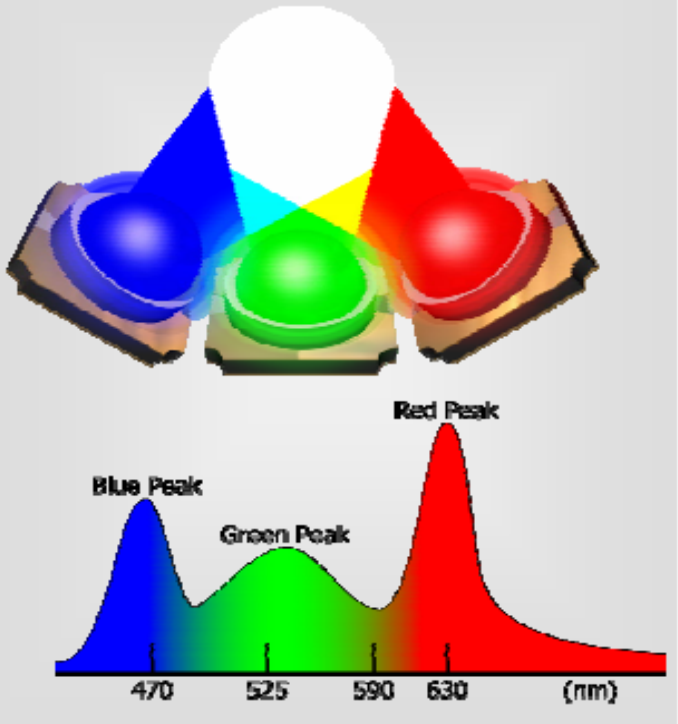
- Integrating the following systems comprises a SSL LUMINAIRE



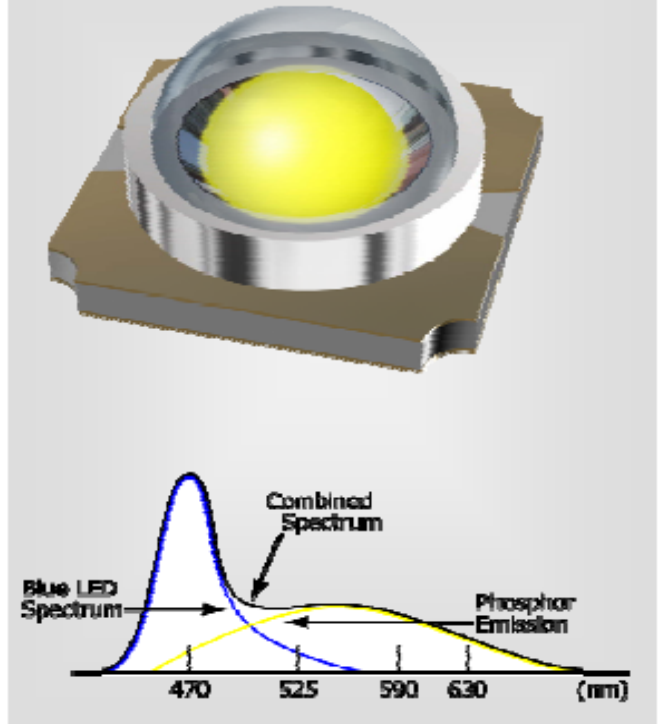
LED Operation - White Light

Two Ways To Produce White Light with LEDs

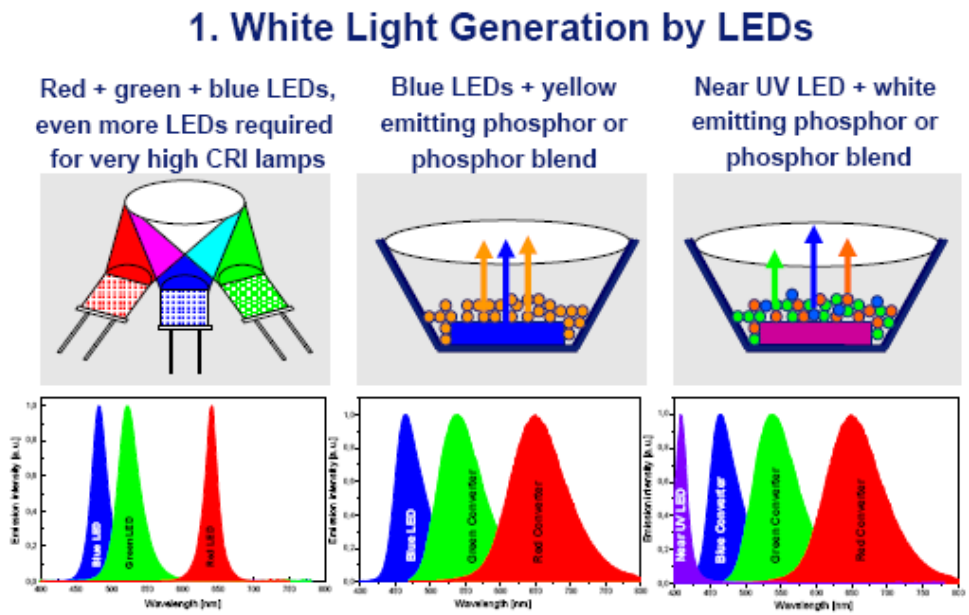
RGB (Red, Green, Blue)



Blue + Yellow Phosphor



White Light – How is it got from LED's



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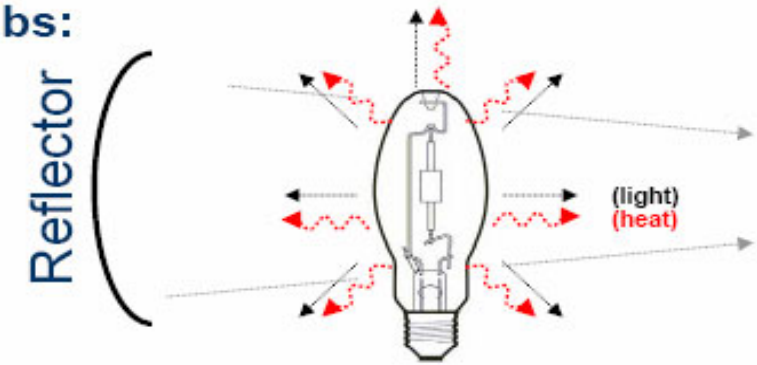
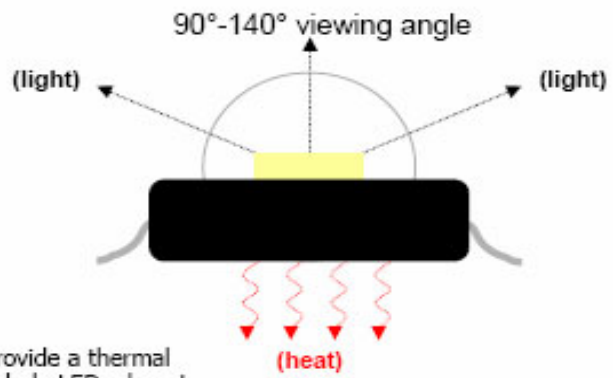
LED Operation

Bulb vs. LED Technology

Bulbs:



LEDs:



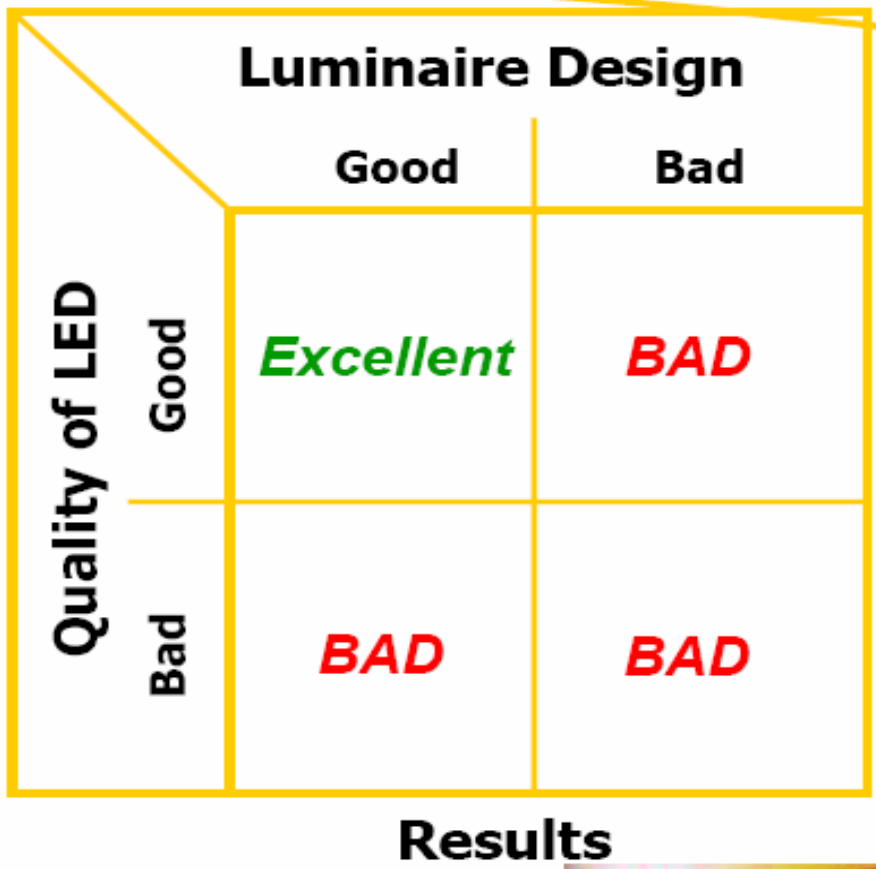
Note: Power LEDs provide a thermal path, typical through-hole LEDs do not

- **From an applications standpoint, the most important differences are in:**
  - **Directionality of generated light**
    - **Omni-directional vs. directional**
  - **Means of evacuating generated heat**
    - **Convection vs. conduction**

LED Operation – The Matrix

Your LED Lighting Results May Vary…

- To enable general illumination, LED systems must deliver real benefits
- Keys to success
  - Lighting-class LEDs
  - Thermal design
  - Optical design
  - Electronic design
- Integrated System!!



Lumens per watt – The Inside story

Some Quick Math

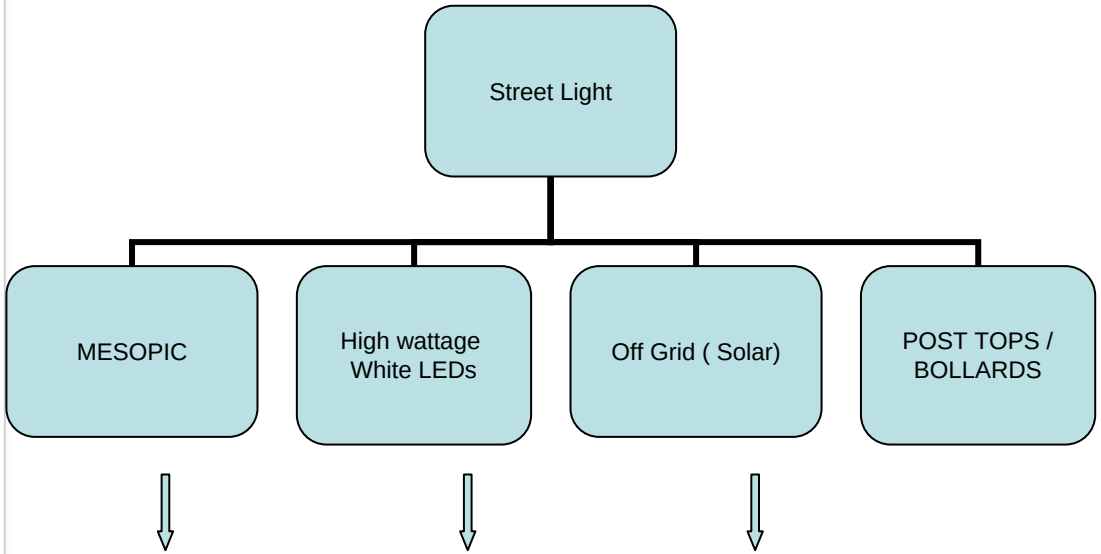
System efficiency = Driver efficiency X Optical efficiency X Thermal efficiency X LED efficacy

So small inefficiencies get multiplied!

Example
LED efficacy 90 lumens / watt (LPW)
Driver efficiency 85%
2 component optical system (TIR and reflector)
    85% TIR and 90% reflector
Thermal degradation 8%
System efficiency = 90X0.85X0.85X0.9X0.92=53.8 LPW

Too many fixture manufacturers are advertising the LED LPW @ 25C Tj! Don't be one of them! Our industry depends on integrity!

Segment – Street Lights -Portfolio



LSL 4 16/MP

LSL 4 32/MP

LSL 6 48/MP

18W

30W,60W

90W, 120W

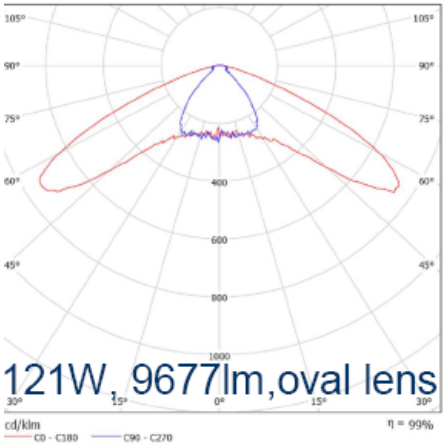
Integrated Solutions with SPVs +Battery +Poles

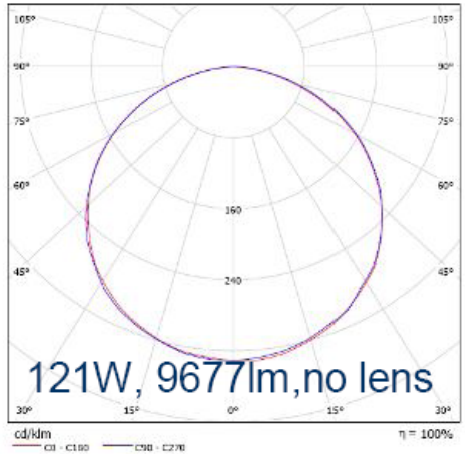
White LEDs

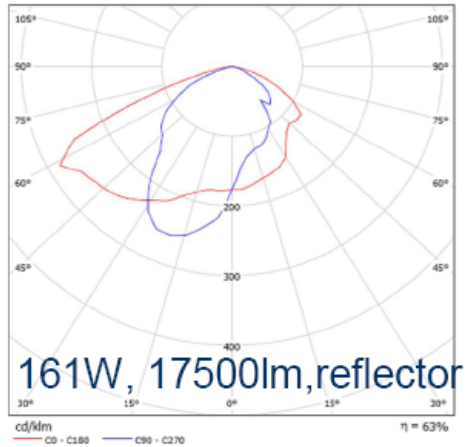
Street lighting with 108W LED lamp

Street Light - LEDs with Lens Vs. without

Comparison of LED (with or without lens) and HPS

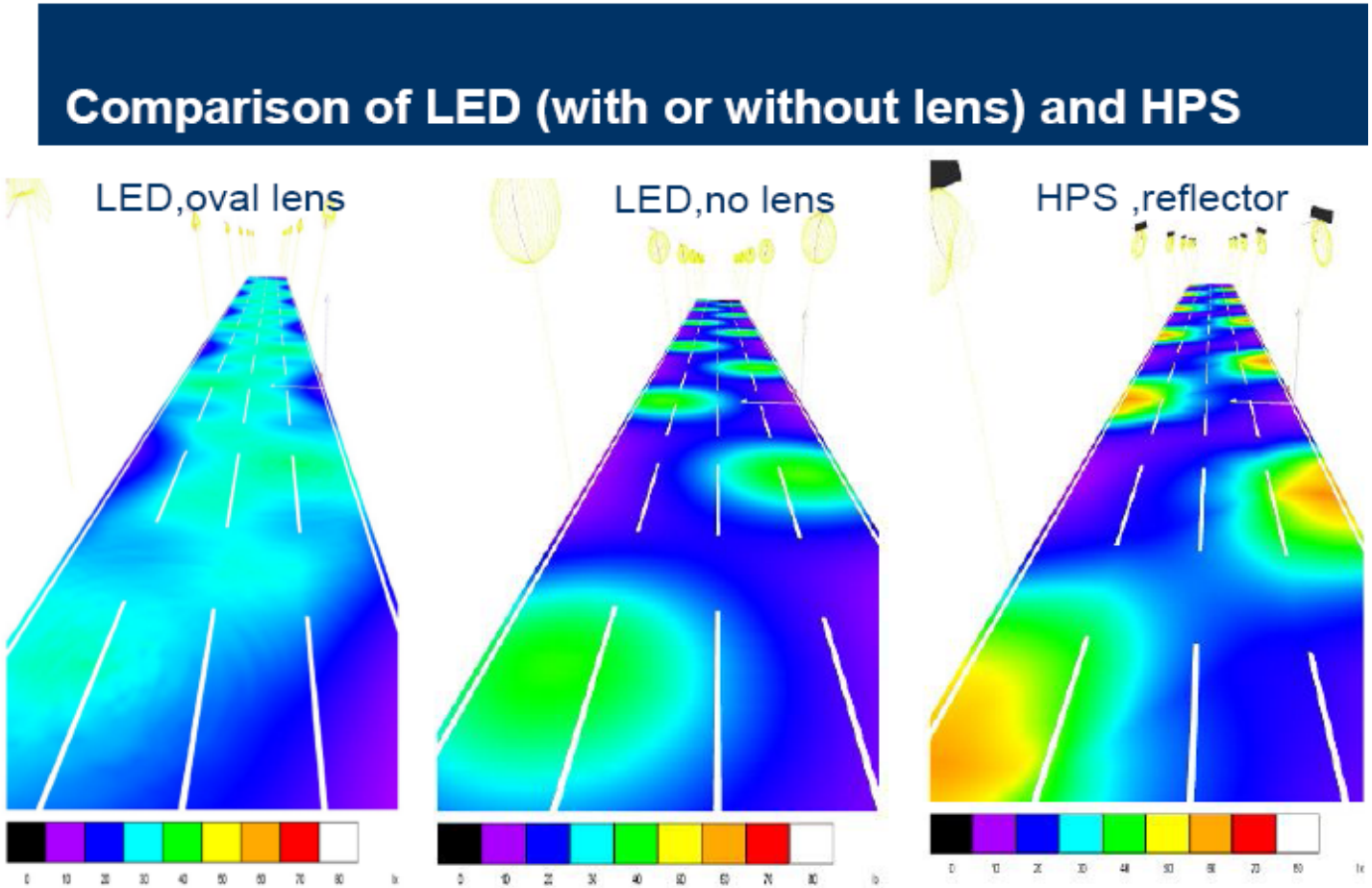






Watt=121w 33% ↓	Watt=121w	Watt=161w
E_{av}=30lx 15% ↑	E_{av}=23lx	E_{av}=26lx
U_O=0.66 50% ↑	U_O=0.54	U_O=0.44
E_{min}/E_{max}=0.59 180% ↑	E_{min}/E_{max}=0.31	E_{min}/E_{max}=0.21
TI(%)=7 28% ↓	TI(%)=6	TI(%)=9

Street Light – Lens Vs. w/o Lens



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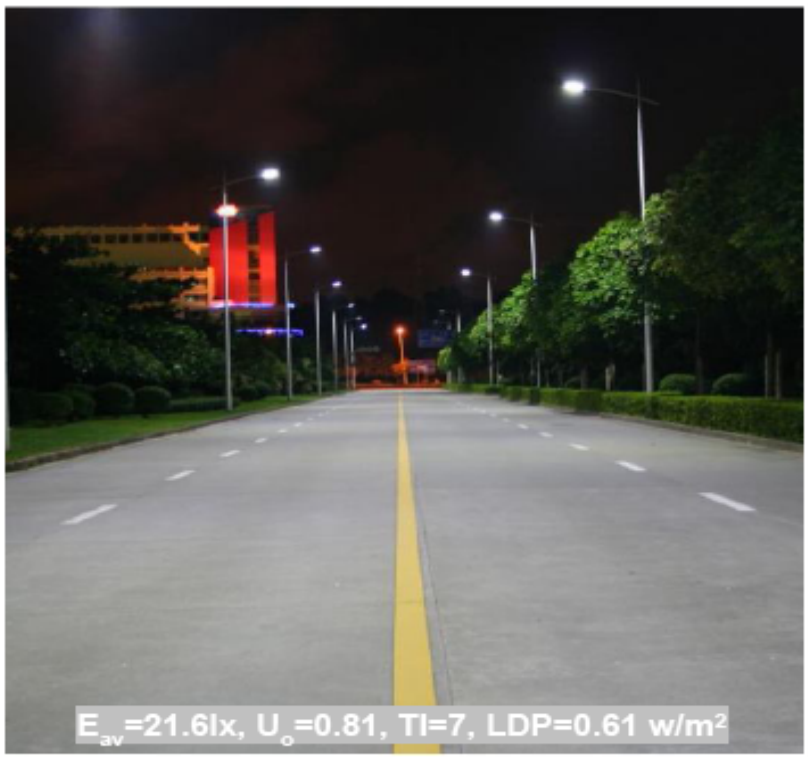
White LEDs

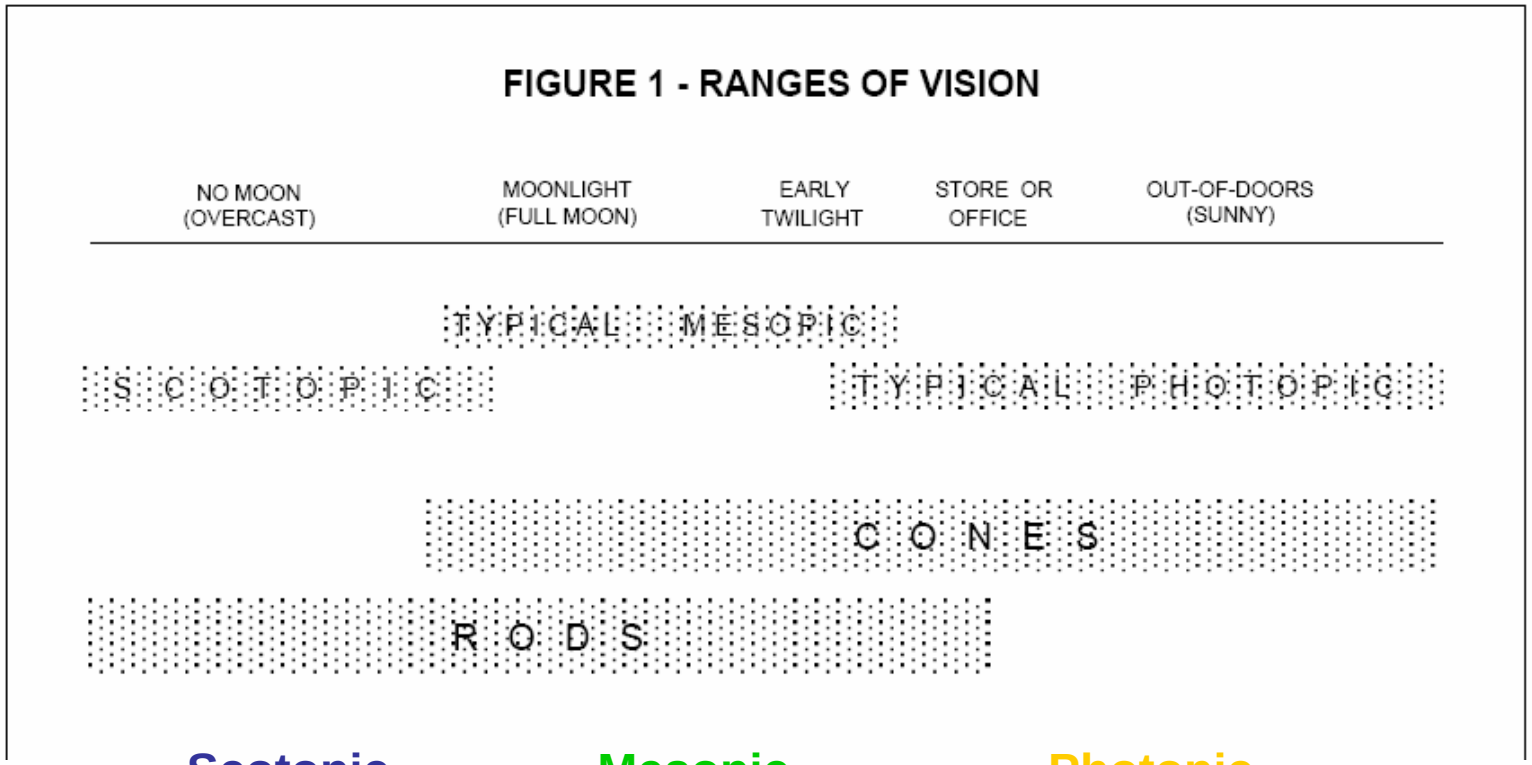
Compare lighting quality with LED and HPS lamps

Street lighting with 108W LED lamp



Street lighting with 250W HPS lamp

Mesopic range



Scotopic **Mesopic** **Photopic**

<0,01 cd/m² **|0,001 cd/m² 3 cd/m² |** > 3cd/m²

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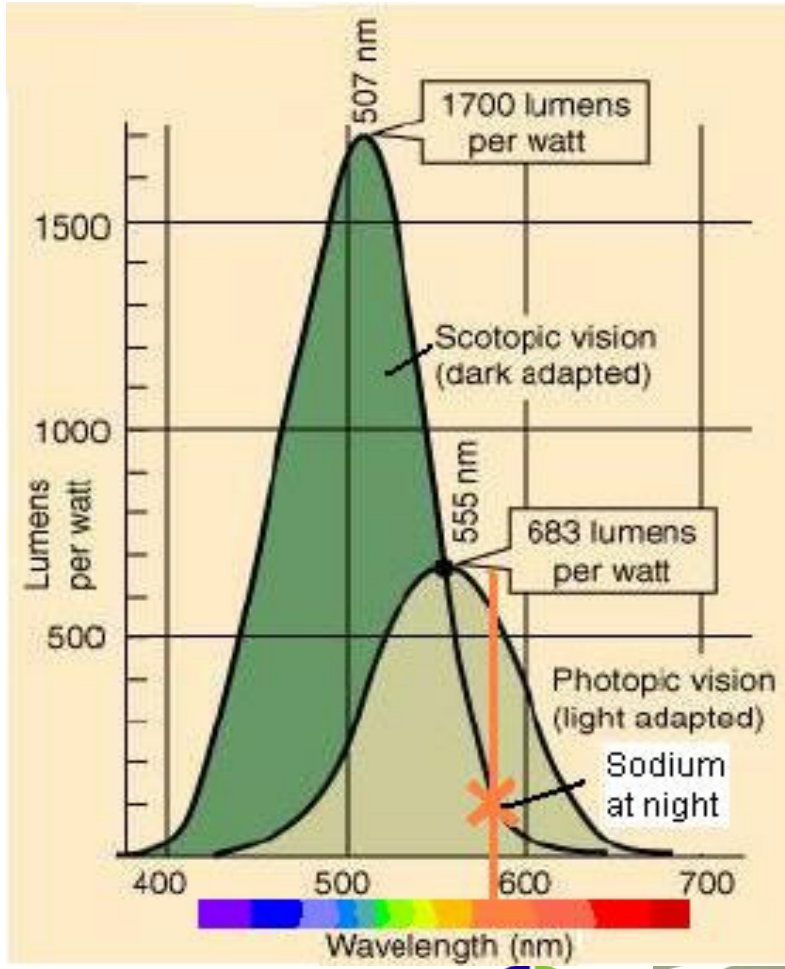
Mesopic light is adapting to the eye

- Human eye is more sensative to green towards blue at night (Purkinje shift)

- Using yellow or white light requires higher wattages to provide good vision at night

- Lemnis produces a green/blue light to highten visibility at night



Academic Research

International developments

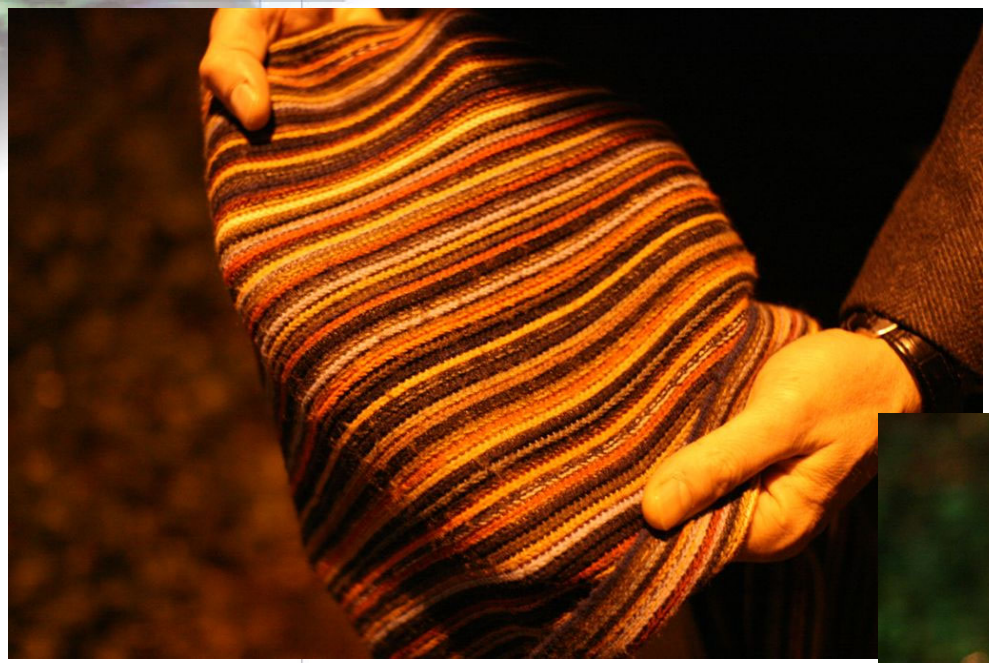
•**MOVE - Mesopic Optimisation of Visual Efficiency**
Research project under the EC Competitive and Sustainable Growth Program.

•**CIE TC 1-58 "Visual Performance in the Mesopic Range"**

•CIE has established a Technical Committee TC 1-58 to study performance based mesopic photometry. The first meeting of the TC 1-58 was held in Tokyo in June 2004 along the CIE Div1&2 meetings.

•Many other papers issued by science and industry **on the topic**

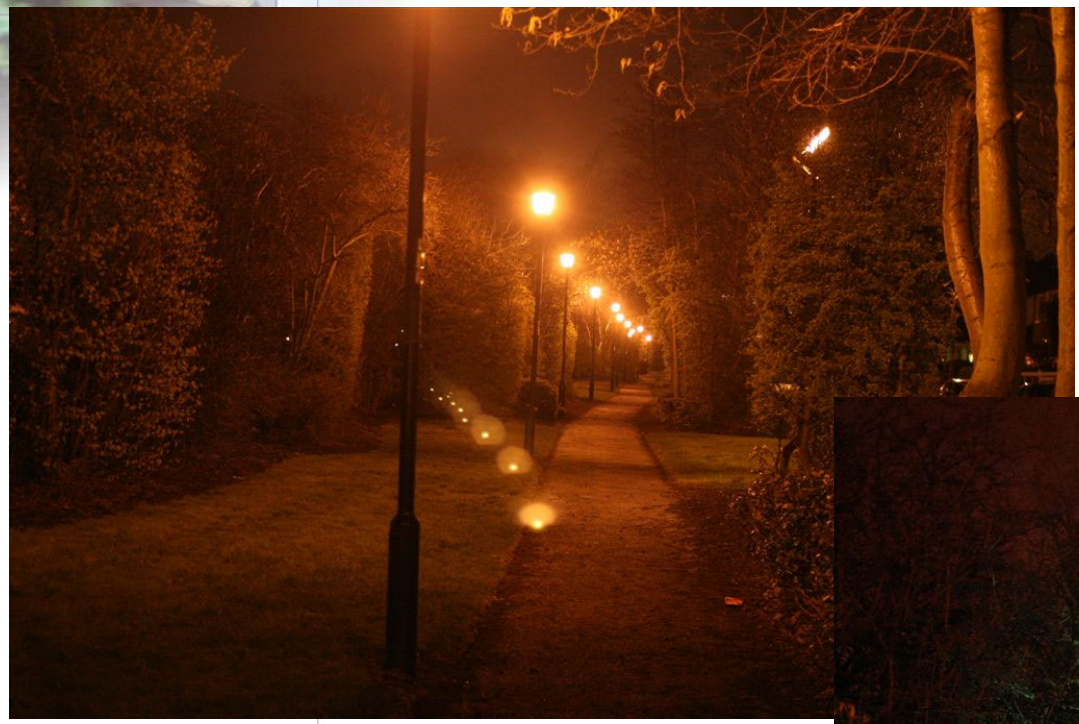
Color recognition



HPSV lamp

Mesopic LEDs

Sodium v.s. colored LEDs



70W HPSV lamps

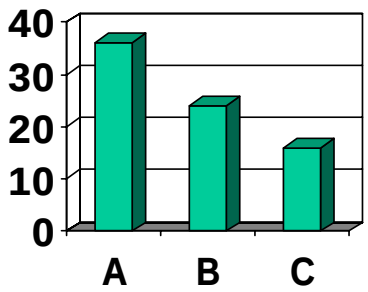
Same path with 20W Mesopic LED lamps

Street lighting

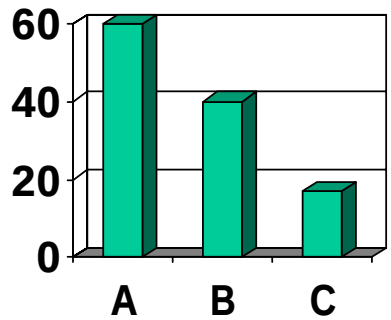
CG & Lemnis have developed a fixture with LED light source that has significant benefits versus most used alternative (CFL 36), while complying light pattern and regulation

- Life time of 15 year (vs. 3 year)
- Energy usage of 16 Watt (vs.36Watt) – 55% reduction
- Low maintenance cost
- 100 % recycling (vs. CFL has mercury and phosphor components)

Usage (Watt)



CO2 emission (kg/year)



A – PL36
B – PL24
C - CG Lemnis

Outdoor lighting

Benefits outdoor lighting

- Long lifetime of > 15 years
- Low total cost of ownership
- Light spectrum adapted to mesopic vision
- Better vision at low light levels
- Efficient optics
- Light directed to where it is needed
- Designed for new and retrofit
- Off grid solution possible (with solar)

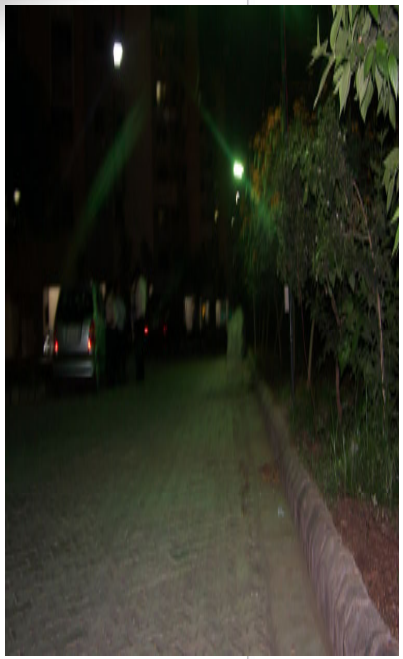
Product features

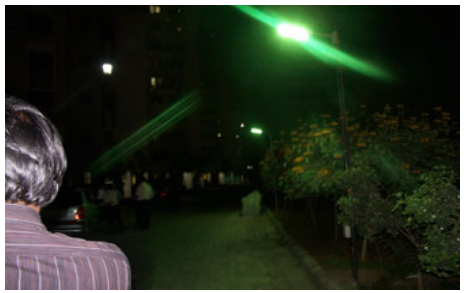
Fitting	Outdoor light
Voltage	240 V
Color	Green and Eco white mesopic
Energy	16 /32 Watt
Lifetime	50,000 hours

London – Pottersfield park
70 Watt high pressure sodium lamps replaced by 36 Watt LED

London – Pottersfield park
70 Watt high pressure sodium lamps replaced by 36 Watt LED

Magarpatta City Installation





- The three main criteria for a good sustainable lighting installation befitting a prestigious project with a stated mission of a clean and green environment

1) Social responsibility of meeting the highest energy efficiency thereby reducing green house gases.

2) No mercury disposal issues as LED's are ROHS compliant.

3) High quality lighting – lux levels excellent uniformity and color rendering

Modern ?? – What's modern?

- Relating to present or recent times
- Using Most up to date technique or equipment
- Marked by a departure from a traditional values

Conventional roadway lighting illuminates the surface of the roadway.

One proposal for roadway lighting involves acknowledging the work done by automotive headlamps in illuminating the surface of the roadway, allowing luminaires to illuminate potential hazards near the roadway.

FACTS

- Luminaire cost represent as little as 4% of overall life-cycle cost
- Maintenance & labor cost represent as little as 8% of overall life cy
- Energy c er the life c mp represent as much as 88% of the overall

88%

THANK YOU

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