## SS 530: 2006 Power densities allowed

| No | Type of usage | Maximum lighting power budget Watts/M2 |
|---|---|---|
| 1 | Offices | 15 |
| 2 | Class rooms | 15 |
| 3 | Lecture theatres | 15 |
| 4 | Auditoriums / Concert halls | 10 |
| 5 | Shops / Supermarkets / Departmental Stores (including general, accent & display lighting | 25 |
| 6 | Restaurants | 15 |

## SS 530: 2006 Power densities allowed (Continued)

| No | Type of usage | Maximum lighting power budget Watts/M2 |
|---|---|---|
| 7 | Lobbies / Atriums / Concourse | 10 |
| 8 | Stairs / Corridors | 10 |
| 9 | Car parks | 5 |
| 10 | Electronic manufacturing and fine detail / Assembly industries | 20 |
| 11 | Medium and heavy industries | 15 |
| 12 | Warehouses / Storage areas | 10 |

## Illuminance and energy consumption

| | |
|---|---|
| Our eye is used to | = 100,000 lux |
| Recommended office lighting level | = 500 lux |
| The electrical load density for this | = 10W / $m^2$ |
| @ 8 $m^2$ per pax, the lighting load / person | = 80W |
| For 10 hrs per day, energy consumed | = 80 x 10 WHr<br>= 0.80 Kw Hr |
| @S$ 0.25 / KwHr, the cost of energy / day | = S$ 0.20! |

How much does a cup of tea cost ?

How many cups would we drink everyday?

## TLD Super 80 Colors

| Lamp type | Output | Color Temp | CRI |
|---|---|---|---|
| TLD 36W / 827 | 3200 lm | 2700K | >80 |
| TLD 36W / 830 | 3200 lm | 3000K | >80 |
| TLD 36W / 840 | 3350 lm | 4000K | >80 |
| TLD 36W / 850 | 3200 lm | 5000K | >80 |
| TLD 36W / 865 | 3200 lm | 6500K | >80 |
| TLD 36W / 54 | 2500 lm | 6500K | 72 |

## 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

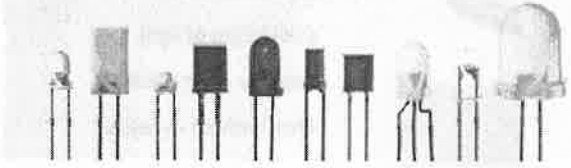
2006..... White LED Market Upturn

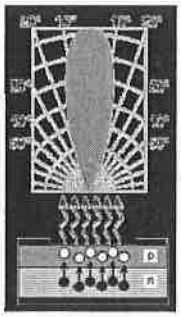
2010+?... White LED to displace some conventional lamps to produce ***Illuminance***?

*Kathryn Conway (Conway & Silver Associates) 2007*

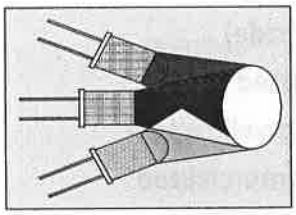
## LED light emission

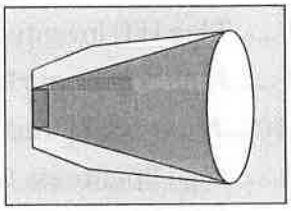
- Typical radiation pattern shows that most of the energy is emitted within 20° of the direction of maximum light.
- Some packages for LEDs include plastic lenses to spread the light for a greater angle of visibility.

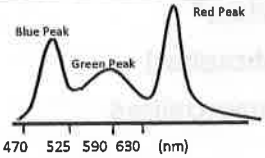




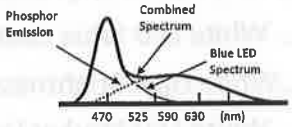
## How to make white LED light








By mixing Red, Green and Blue (RGB) sources any colour light, including White, can be made




Blue emission is converted to yellow by the phosphor coating over the chip and reflector cup. The mixture of blue and yellow light appears white

The 'Luminaire efficacy' of LED is about 30-50 lm/W

## 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

## 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** | **2,500** | **70** |
| **Fluorescent Tri-Phosphor** | **TLD 36W/865** | **3,200** | **90** |
| **Ceramic Discharge Metal halide** | **CDM-T 35W** | **3,300** | **94** |
| **High Pressure Sodium** | **SON-T 400W** | **54,000** | **135** |
| **LED (Commercial)** | **1-10W** | **-----** | **60-70** |

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

## 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 |

## Age Vs Illuminanation

(For working)

12 years = 200 lux

40 years = 600 lux

60 years = 3000 lux

## Take Away :

color kinetics LEDs are available in a huge assortment of physical sizes, efficacy claims, and power ratings

Efficacy and output vary greatly amongst the different color LEDs

color kinetics LEDs have many variables; there is no simple system to gauge relative output

Good news: Huge selection of choice in cost, output, efficacy, light quality, etc.

Bad news: Any 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 30th, 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.
- Category A will be abolished in a couple of years and category B will become the sole basis for ENERGY STAR.