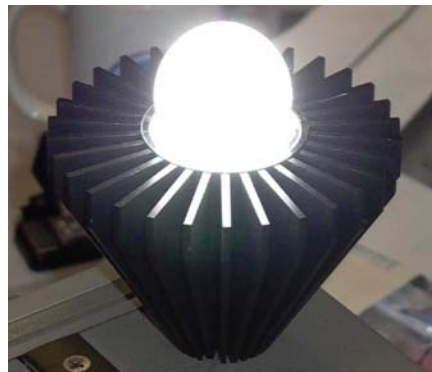


# ***LEDs—the maturing of solid state lighting***

Nada El-Zein

**Green/light-energy**

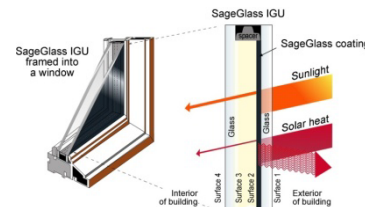
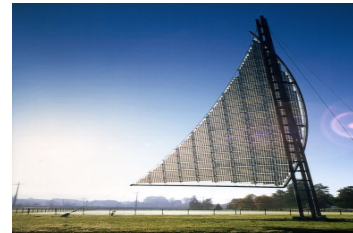
SESAM, Abu Dhabi conference  
November 3<sup>rd</sup>, 2008



# Who is green/light-energy?

Advise, consult and provide solutions in the Middle East region

- Renewable energy production
  - Solar
  - Wind
- Energy efficiency
  - Electrochromic glass
  - LED lighting
- Sustainable building products
  - Hycrete hydrophobic concrete







This Room Is Equipped With

Edison Electric Light.

Do not attempt to light with  
match. Simply turn key  
on wall by the door.



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The use of Electricity for lighting is in no way harmful  
to health, nor does it affect the soundness of sleep.

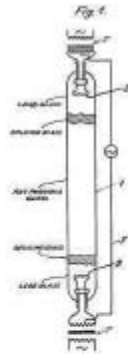
# A Step back in lighting history...



Incandescent



Mercury Vapor



Fluorescent



Infrared LED



Metal Halide



CFL



GaN\* LED

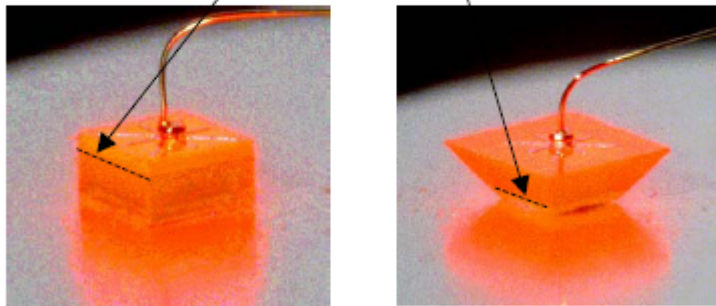
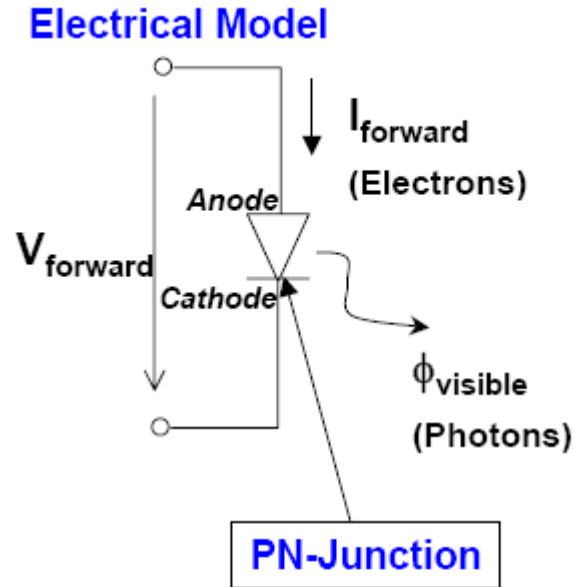


High-Power LED



- 1962 – First LED developed by Nick Holonyak at Bell labs. Novelty...
- Late 60's low output red LEDs find commercial application in indicator lamps
- Mid 70's – Green LEDs develop
- Early 90's Blue LEDs developed by Nichia in Japan
- Late 90's HIGH BRIGHTNESS LEDs and the birth of solid state lighting

# What is an LED?



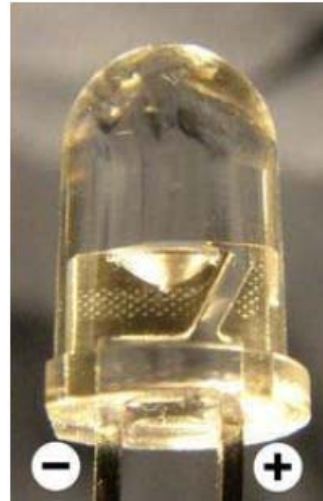
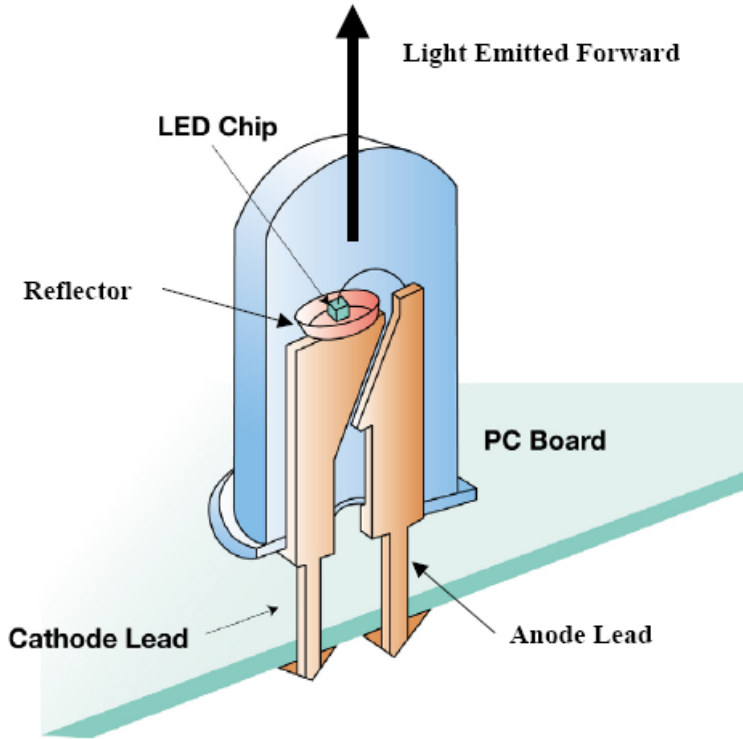
Courtesy of Lumileds

An LED is an electrical device that emits light (photons) when a there is a electrical signal across it.

In the case of the one in the picture the light emitted is orange.

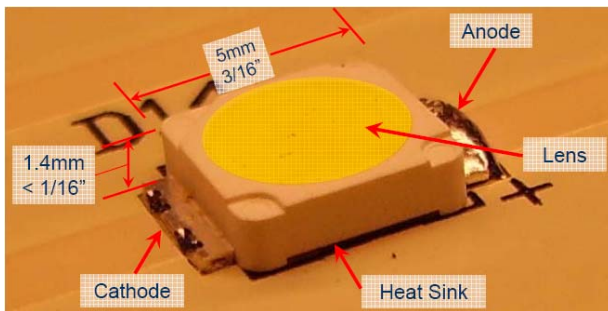
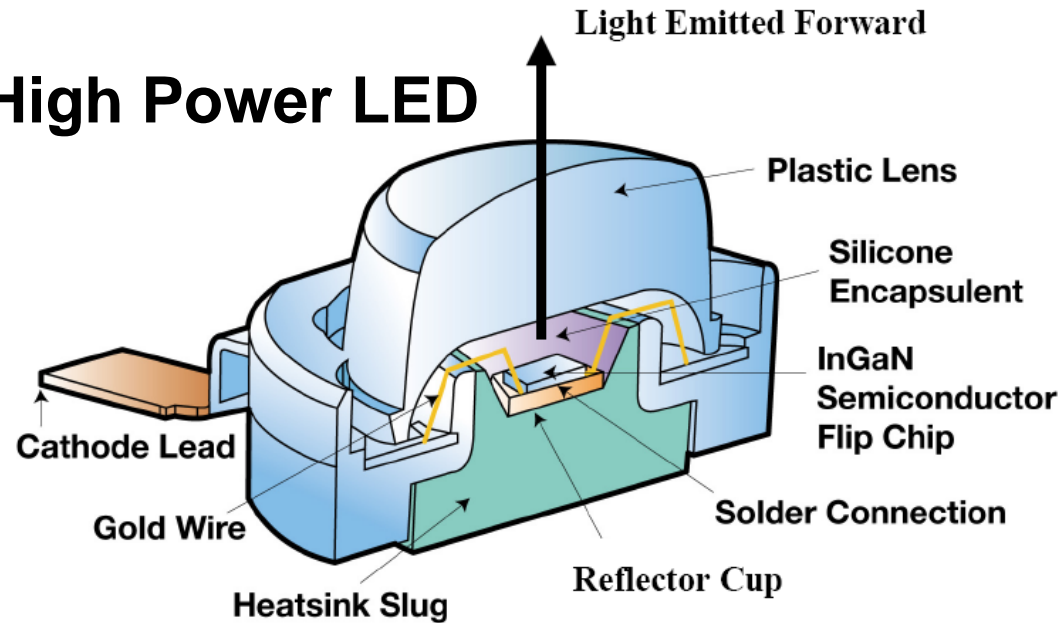


# What is an LED?



Lamp type, through whole

## High Power LED



# Where are LEDs used?

## Notebook PCs with LED Backlit Displays



Apple MacBook Air



Dell Latitude D430



HP Compaq 2710p



Sony Vaio TX



Mobile appliances



Signals



Signs and Displays



## Automotive and yes HEADLAMPS!

### LED Headlamps

2008 Cadillac Escalade Platinum



2008 Audi R8



2008 Lexus LS 600h

**BUT WE ARE INTERESTED IN ILLUMINATION**

# Why LEDs for lighting?

## Energy Efficient

LEDs save between 80% and 30% of the energy consumption of incandescent and compact fluorescents (CFL), respectively

## Long life

LEDs last more than 20x or 5x longer than incandescent and CFL, respectively, which lowers maintenance cost (no bulb to replace and lasts more than 15 years)

## Environmentally safe

All fluorescent lamps and tubes including CFL, contain mercury (considered a toxic waste everywhere in the world). LEDs have no toxic materials and emit no harmful UV rays.

## Virtually unbreakable

LED fixtures are extremely durable which is an advantage to builders and consumers. Lightweight durable fixtures will simplify and lower total installed cost.

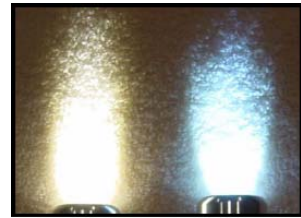
## No heat produced

LEDs do not radiate heat in the living/office space. This can help lower AC energy consumption since the lights do not contribute to “heating” the interior of rooms.



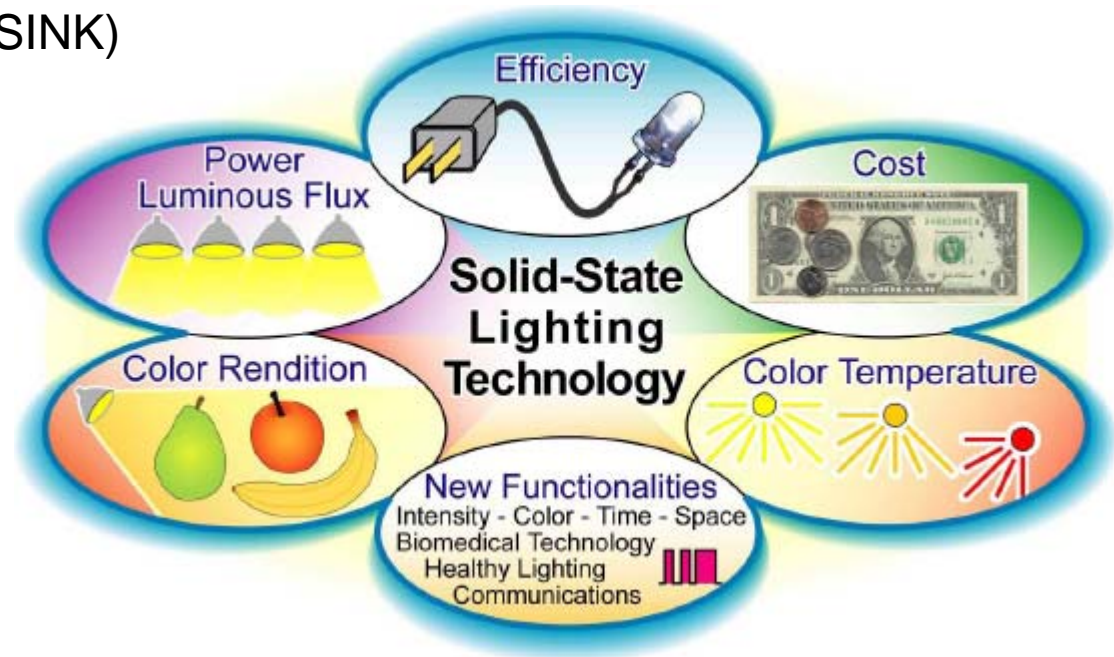
# What should you look for?

- Quality of white light:
  - Color temperature: (CCT)
    - Warm tones 2700-3500K, skin tones look better under warm light that is why incandescent lighting is so popular in the bathroom.
    - Fluorescent lighting is “cool” around 5000-6000K
  - Color Rendering (CRI): how well you can “see” color under the light
  - Radiation pattern: wide vs narrow beam
- Reliability:
  - 35-60K hours
  - How well is it cooled? (HEAT SINK)
- Cost and payback
- Efficiency
- Manufacturer

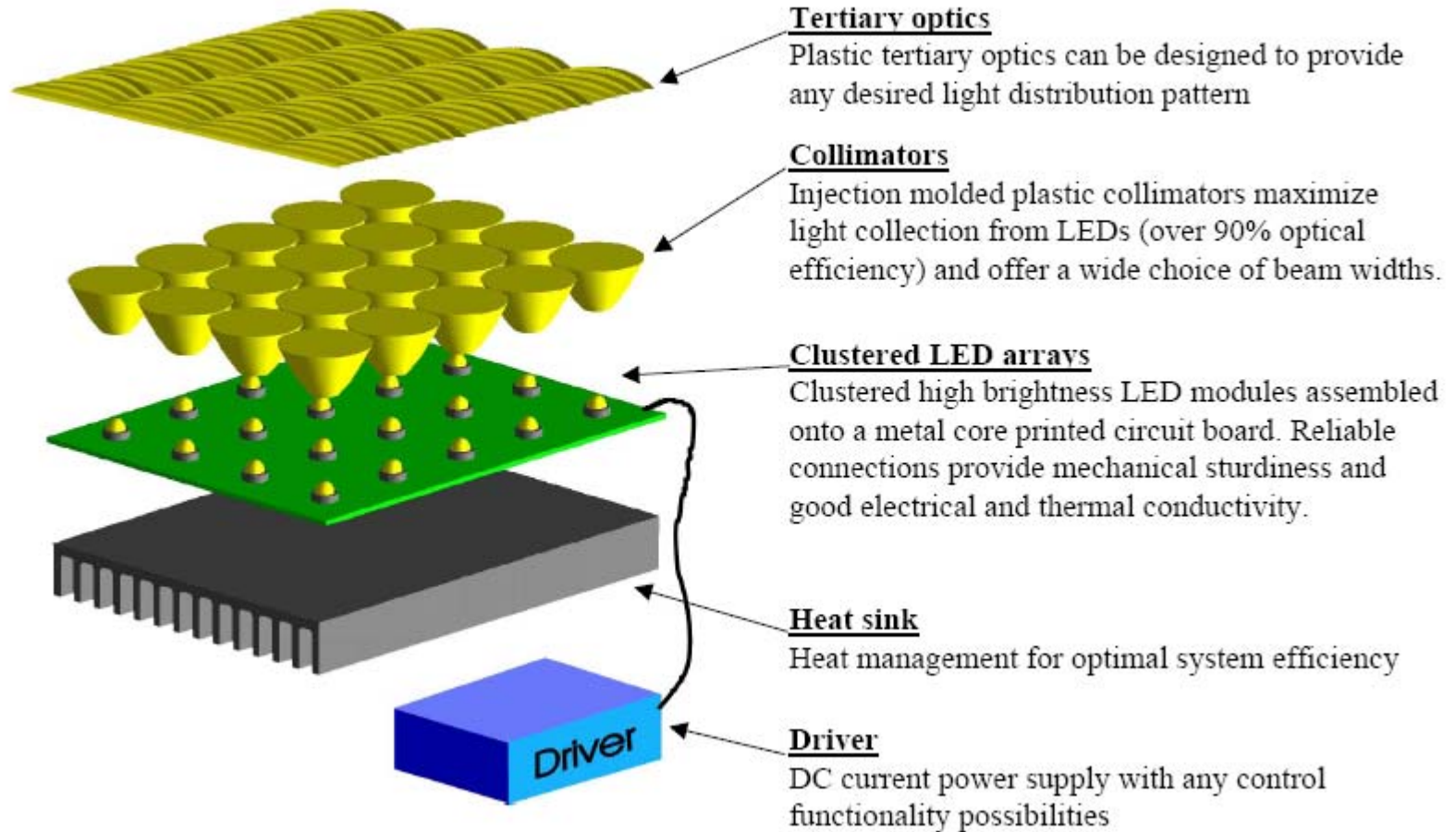


3200K

8000K



# Luminaire design – components in a fixture



# WHAT IS CRI???

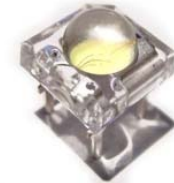


“The color rendering index (CRI), is a measure of the ability of a light source to reproduce the colors of various objects being lit by the source (100 is the best CRI).”

<i>Light source</i>	<i>CRI</i>
Sunlight	100
W filament incandescent light	100
Fluorescent light	60 - 85
Existing Phosphor-based white LEDs/OLEDs	> 90 LEDs
Na vapor light	40

Courtesy F. Schubert (RPI)  
and G. Jabbour (ASU)

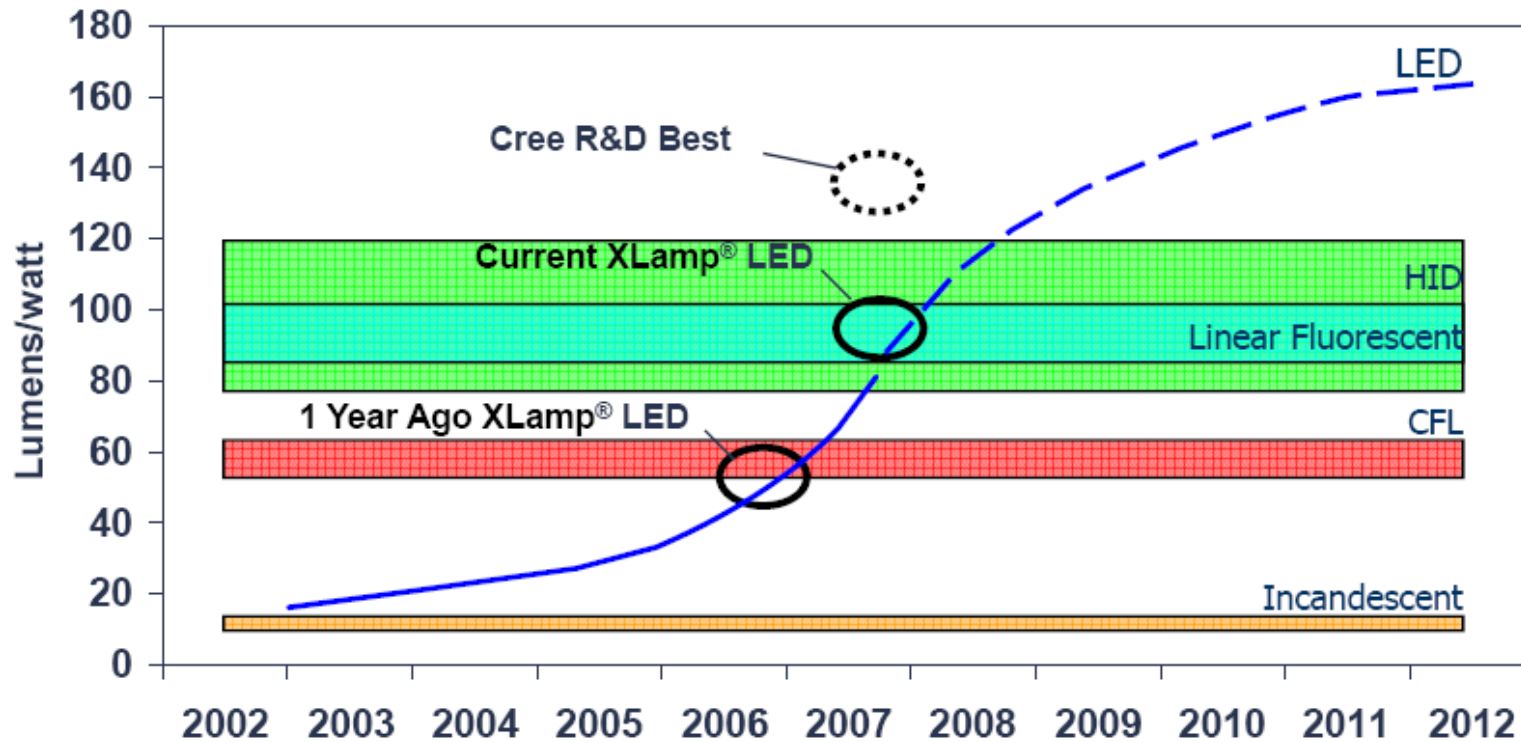
# A comparison to other types of lighting



Lamp Type	Incandescent	Halogen	CFL	LED
Lumens/W	14.5	24	50-60	110
Life - hours	750-1000	1000-3000	6000-15000	50000
UV/IR ?	Yes	Yes	Yes	No
Mercury ?	No	No	Yes	No
Dimmable ?	Yes	Yes	Few	Yes
On/off issues?	Yes	Yes	Yes	No

# Can LEDs do it?

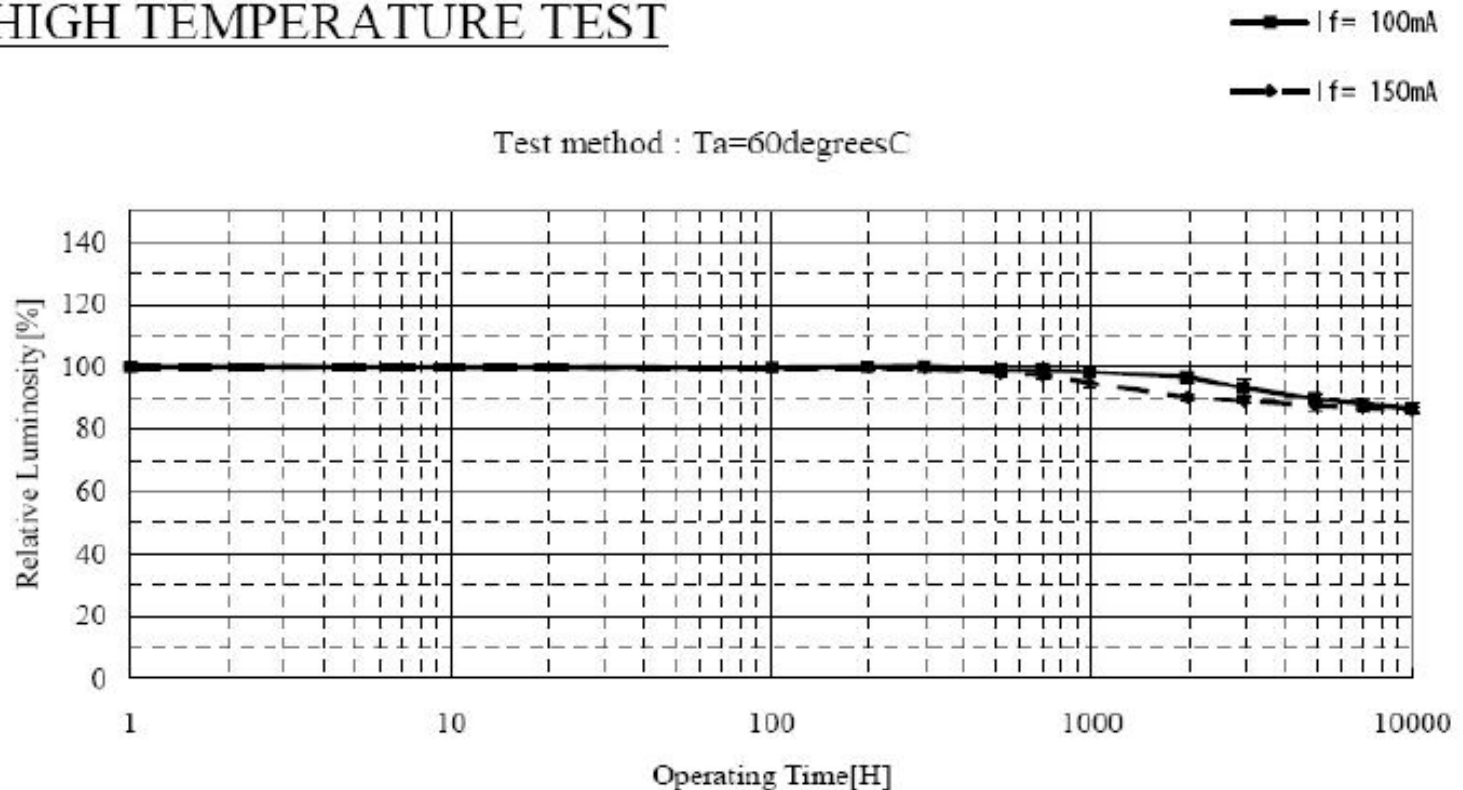
## Light Source Efficiency Trends



YUP....

# Do they really last long?

## HIGH TEMPERATURE TEST



Yes!!! LEDs do last for thousands of hours... This test is run at **60°C**  
They do not abruptly die but rather their intensity reduces gradually over time  
At 50,000 hours or so the human eye may perceive the drop in intensity

# How do they compare??



**U.S. Department of Energy**  
**Energy Efficiency and Renewable Energy**  
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

**Table 2: Comparison of Recessed Downlight Lamping Options**

	<b>65W BR-30 Flood</b>	<b>13W 4-pin Spiral CFL</b>	<b>LED 2</b>
Luminaire light output, initial (lumens)	570	514	730
Luminaire wattage (W)	65	12	12
Luminaire efficacy (lm/W)	9	42	60
CCT (Kelvin)	2700 K	2700 K	2700 K
CRI	100	82	95
Center beam candlepower (candela)	510 cd	154 cd	280 cd
Beam angle (degrees)	55°	120°	105°
Average luminance at 55° (cd/sq meter)	16161	11862	14107
Dimmable	Y	N	Y

Based on photometric reports for three products.

# Can it really save me money??



12V  
150lm  
MR16 fitting  
50mm x 47mm  
Warm or cool light

## 25W

3,000h lifetime



12V  
150lm  
MR16 fitting  
50mm x 47mm  
Warm or cool light

## 5W

>30,000h lifetime

+ No UV or IR radiation, Low heat emission (reduced AC load)  
 Contain no toxic materials, highly durable, reduced maintenance costs

**Become recognised as a leader in energy conservation.**

Contact us for a free demonstration of the LED MR16 and many other LED lighting products that will save you energy and money.

greenlight-energy  
*Leading the way to a green future*

greenlight-energy LLC, Dubai, UAE, +971 4 3419910, [www.greenlight-energy.com](http://www.greenlight-energy.com)

Also available: AR111, PAR20/30,  
 track lights, downlights, sign lights  
 floodlights, linear lights.....

**SPOT THE DIFFERENCE.**  
 Save energy and money by switching to  
 the new greenlight-energy 5W MR16

**Energy savings example**

Number of lamps per room	10
Energy consumption using 25W halogen MR16	250W
Energy consumption using 5W LED MR16	50W
Energy savings	200W (80%)
Energy savings per year (1 room)	600KWh
Equivalent to	312KgCO <sub>2</sub> /yr
Energy savings per year (100 rooms)	60000KWh
Equivalent to	31200KgCO <sub>2</sub> /yr

Many 50W halogen lamps can also be replaced by the 5W LED MR16, resulting in even greater savings.



# Payback calculations exp

## Energy savings calculation

Date	08/09/2008
Customer	XXXXXXXX
Contact name	XXXXXXXX
Related Quotation No.	GLE 0809 15

## Summary

Energy reduction	86%
KWh reduction /yr	63000
CO <sub>2</sub> reduction tons/yr	31.5
Electricity savings AED/yr	20790

## Savings roadmap

	year 1	year 2	year 3	year 4	...year 9
Electricity savings AED/yr	20790	20790	20790	20790	20790
Halogen replacement costs AED/yr	7000	7000	7000	7000	7000
LED replacement costs AED/yr	56000	0	0	0	0
Transformer replacement costs AED	17500	0	0	0	0
Total AED savings /AED	-45710	-17920	9870	37660	138950

5W LED MR16 replacing 35W Halogen MR16  
 Using 0.33/kWh for Dubai  
 On 10 hours/day, 300 days/year

# EMS example in DUBAI



Lighting =  $\sim 5\text{W}/\text{m}^2$

Fixtures used



x37



x8



x15

**greenlight-energy**  
*leading the way to a green future*

It is hereby certified that

**Energy Management Services**

Of

**Dubai, UAE**

Having installed a greenlight-energy LED lighting system have reduced their lighting energy consumption from

2299W to 845W

A saving of 4362KWh/yr

Equivalent to 2181Kg CO<sub>2</sub>/yr

**A 63% reduction**

Robert Viehweger

Robert Viehweger - General Manager

# More Examples...



All LED kitchen ~150W (earlier 700W)



# More Examples...



Better Day BP - Racine, Wisconsin  
FIRST EVER LED LIGHTING GAS STATION

"We're the **first ones in the world, period**, to use all LED lighting for a gas station...the product is unbelievable; **it gives everything a very clean look**. You can stand under it, your car looks clean, your shoes look clean."

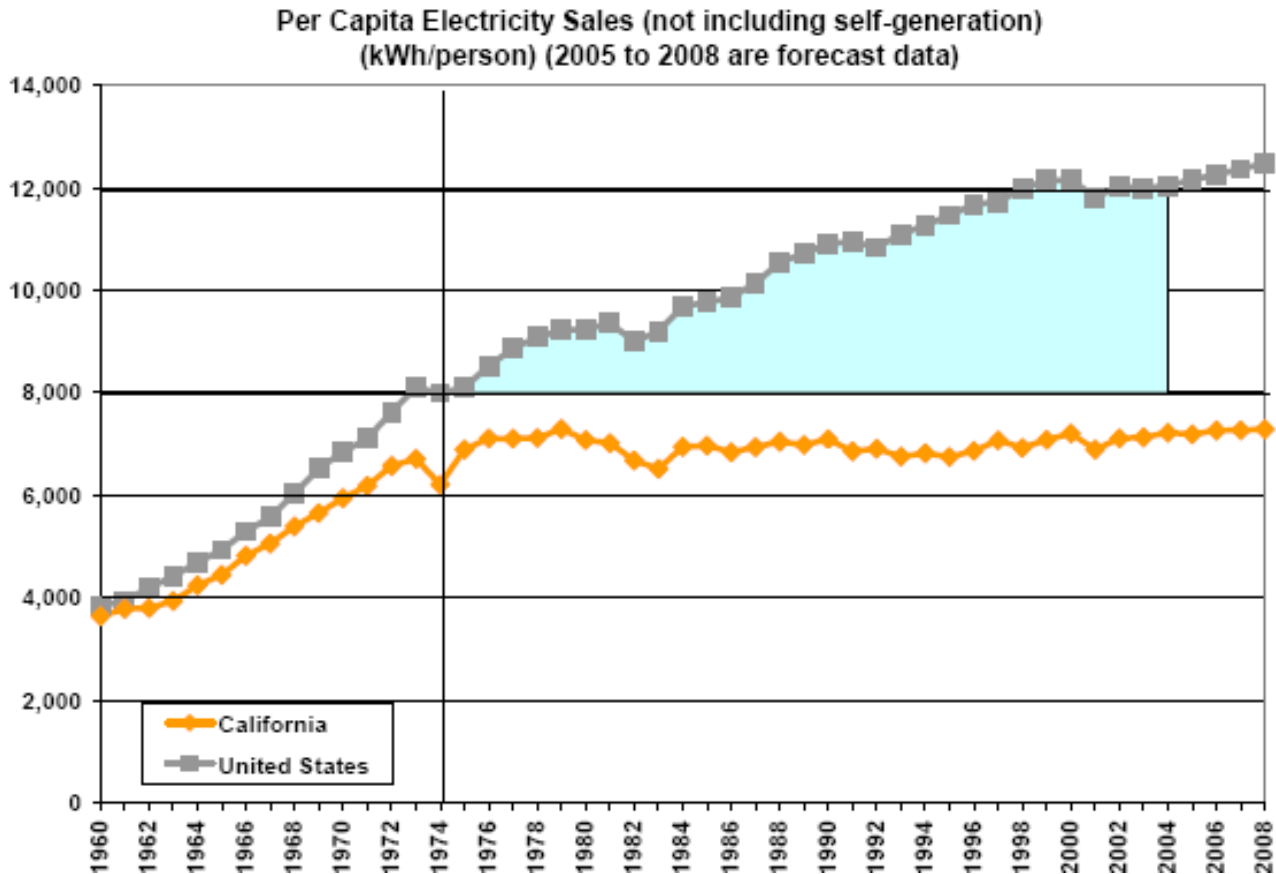
Courtesy of BetaLED



Restaurant: 948W with LEDs, 5135W with 65W incandescent

# ENERGY CONSUMPTION...

Can you really reduce energy consumption significantly by being “EFFICIENT?”



**YES!!!**

Source CEC

# So, Can you really make a difference with LED lighting?

Lighting accounts for 19% of electricity use

Potential savings up to 40%

106 billion Euros in electricity costs/year  
(40% savings @ EUR 10 cts/KWh)

555 million tons of CO<sub>2</sub> emissions/year

More than 1.5 billion barrels of oil/year

Output of more than 530 power plants  
(@ 2TWh/yr)

All possible with available technology



# Established LED success stories



## 1. Traffic Signals

- Quality and consistency: LED technology is standard
- Reliability: 7 years and counting without an LED failure
- Supportability: 23 Million LED Chips (Luxeon in this case) delivered
- Payback: <2 years on energy savings
- 3.4 TWh of energy saved/year
- 2,720,000 tons of CO2 removed

## 2. Refrigeration

- Quality and consistency: 100% customer acceptance
- Reliability: LEDs last even longer in cold temps
- Supportability: 450 stores deployed
- Enhanced customer shopping experience



Courtesy  
of  
Lumileds

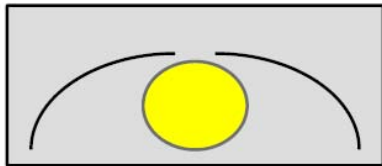


# New way of thinking

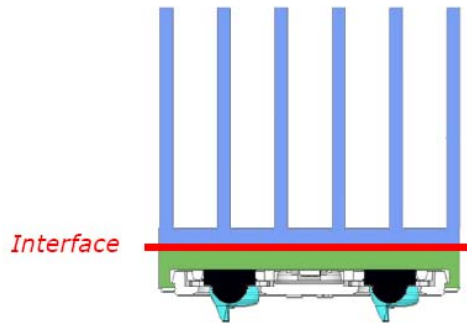
<b>Traditional thinking</b>	<b>New thinking</b>
<p>Single “source of light”</p> <p>Bulbs will be changed</p> <p>Technical lifetime</p> <p>Replacement</p> <p>Separate fitting</p> <p>&gt;10-15 W/sqm for lighting in a space</p> <p>On/Off/Dimming</p>	<p>Multiple sources of light</p> <p>LEDs may last longer than occupancy</p> <p>Economical lifetime</p> <p>Sealed for life</p> <p>Integrated into solution</p> <p>&lt; 10 W/sqm for lighting</p> <p>On/Off/Dimming + location/color/direction</p>

# What is heat sink and why is it important??

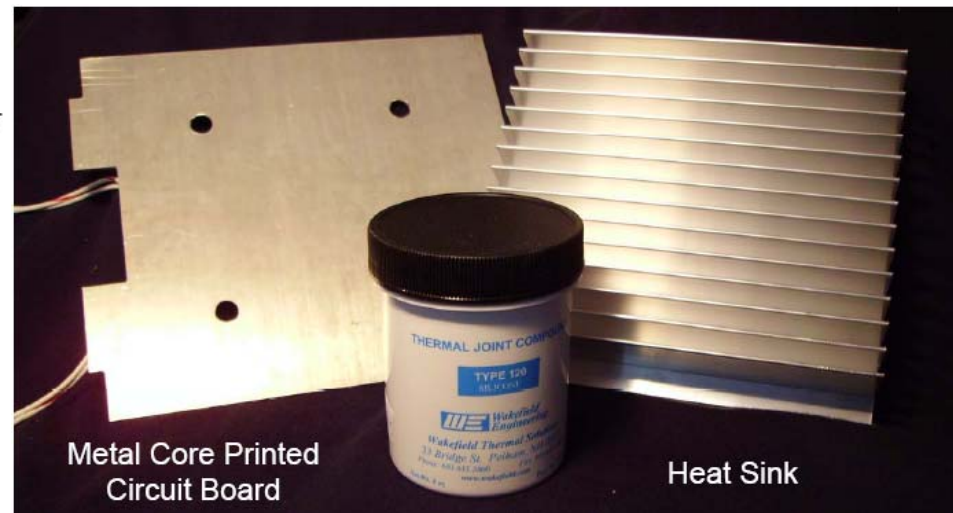
- LEDs do produce heat and it is critical to keep the diode cool so that one can achieve the long lifetimes. It is just like any semiconductor device (think of your computer...)
- “Normal” lighting radiates heat, for LEDs the heat is “conducted” away by using a good thermal conductor in contact with the LED.



Traditional Luminaire:  
Lamp and reflector inside  
box



LED Luminaire:  
Heatsink on one side;  
LED and Optics on the other



Metal Core Printed  
Circuit Board

Heat Sink