Lighting Strategies

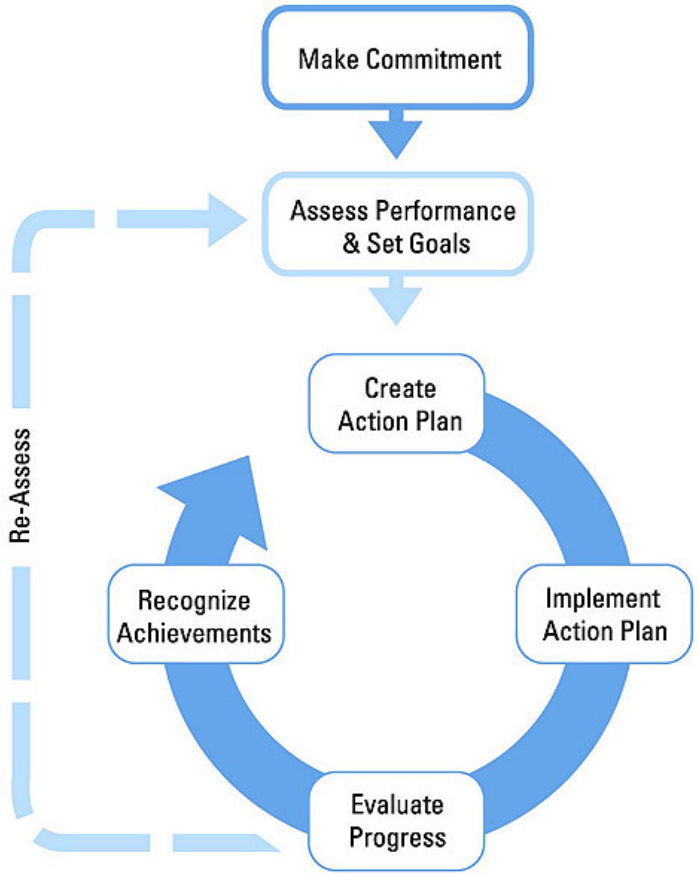
ENERGY STAR

Monthly Partner Web Conference

August 19, 2009

About The Web Conferences

- Monthly
- Topics are structured on a strategic approach to energy management
- Help you continually improve energy performance
- Opportunity to share ideas with others
- Slides are a starting point for discussion
- Open & interactive



Today's Web Conference

Lighting Strategies: New technology & new approaches

- Dan Frering – Lighting Research Center
- Dan Chamberlain – Raytheon
- Discussion
- Announcements

LED Lighting

Lighting Research Center
Rensselaer Polytechnic Institute

August 2009

Lighting Research Center

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New light source technologies

- Now solid-state light sources, LEDs and OLEDs, are evolving to displace some of the traditional light sources in some applications.

LumiLeds

OSRAM Opto

Cree

Light-emitting diode (LED)

Light-emitting polymer (LEP)
Organic light-emitting diode (OLED)

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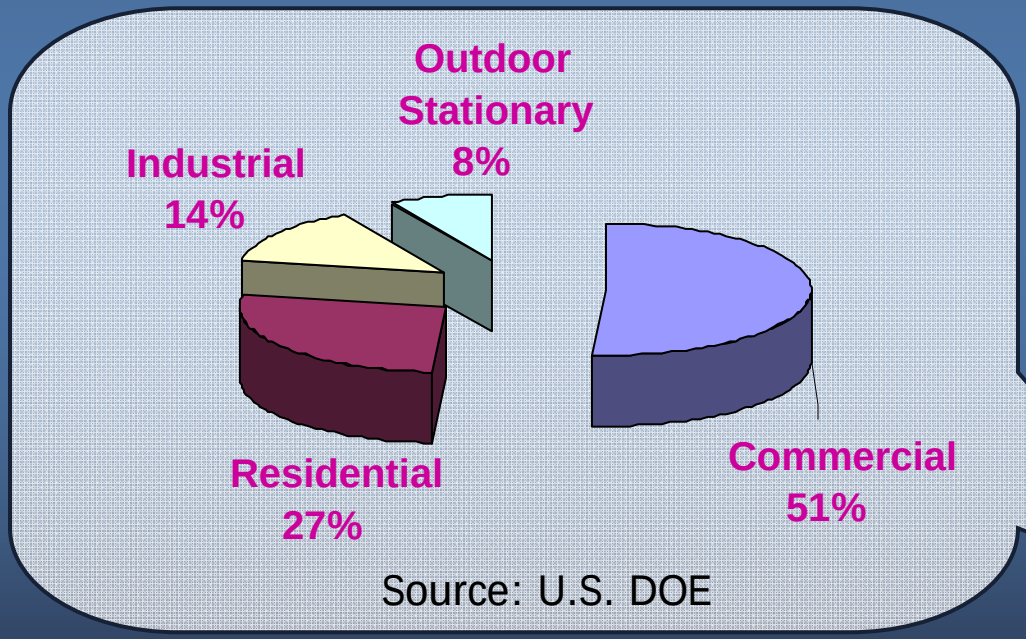
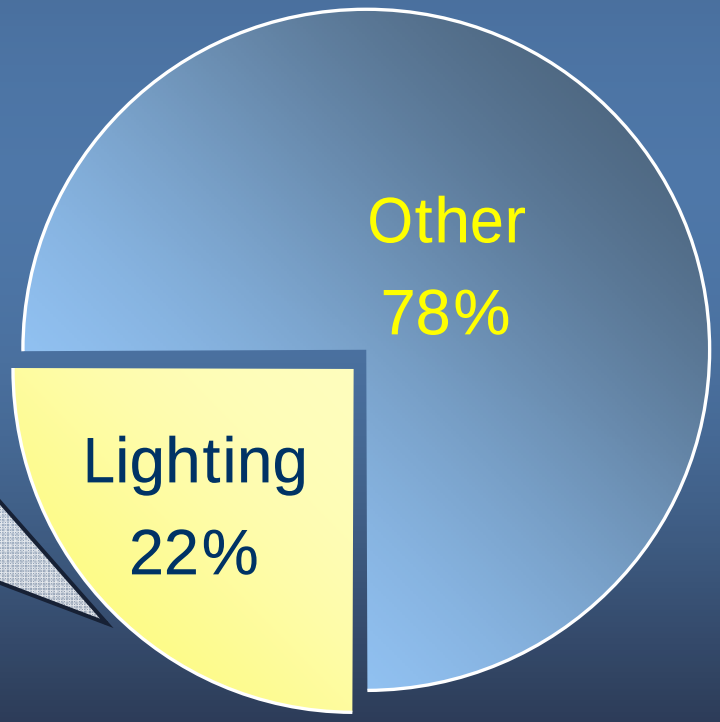
Motivation for solid-state lighting

- About 22% of the total energy use in the U.S.
- Demand for energy keeps increasing





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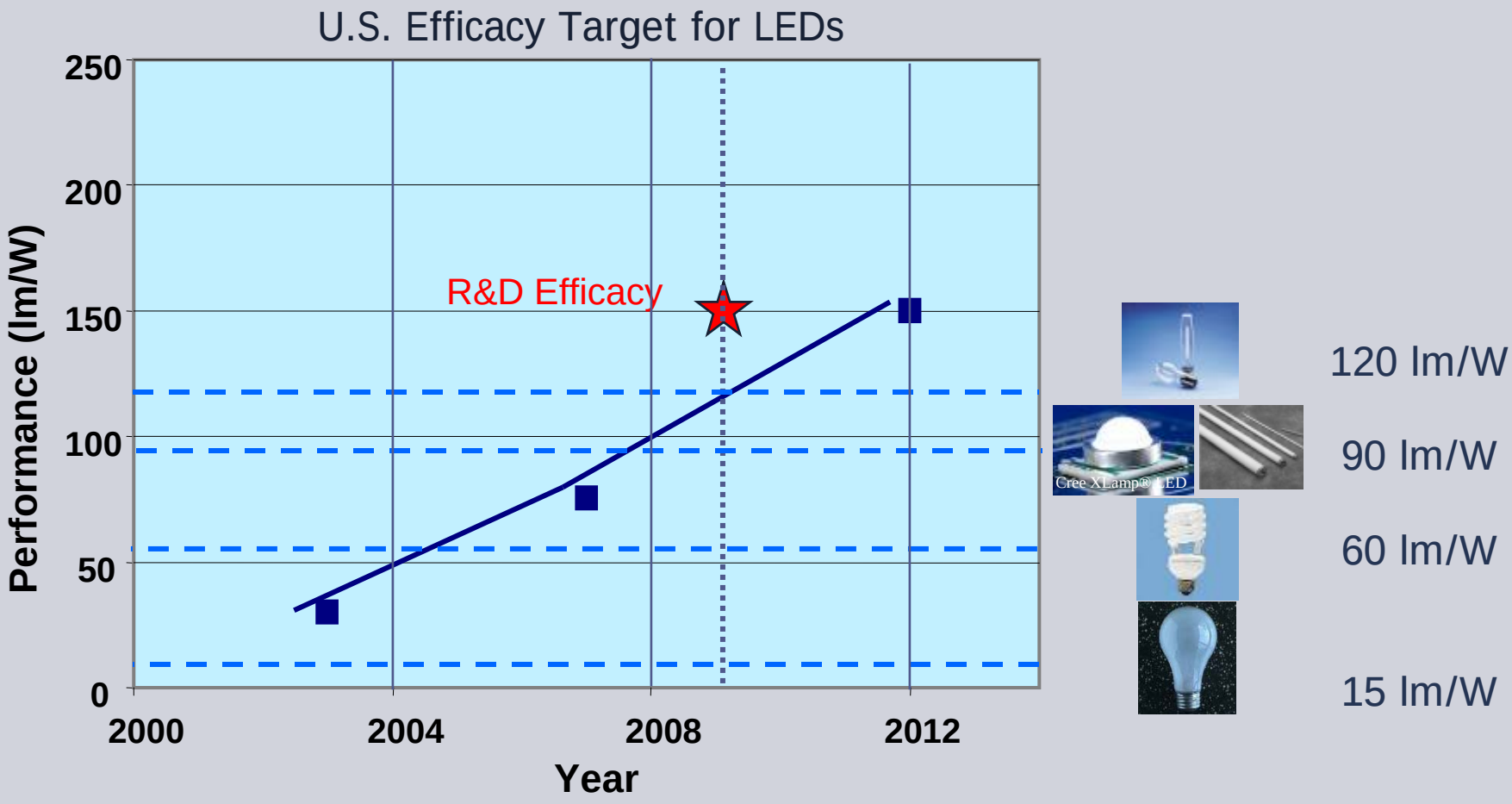
Solid-state lighting roadmap



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Advantages of LEDs

- Potential for energy savings
- Potential for lower replacement cost
- Rugged and durable
- Unique lighting solutions (intensity and color modulation)
- Potential for low ultraviolet (UV) and infrared radiation (IR)
- No mercury

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LED Basics

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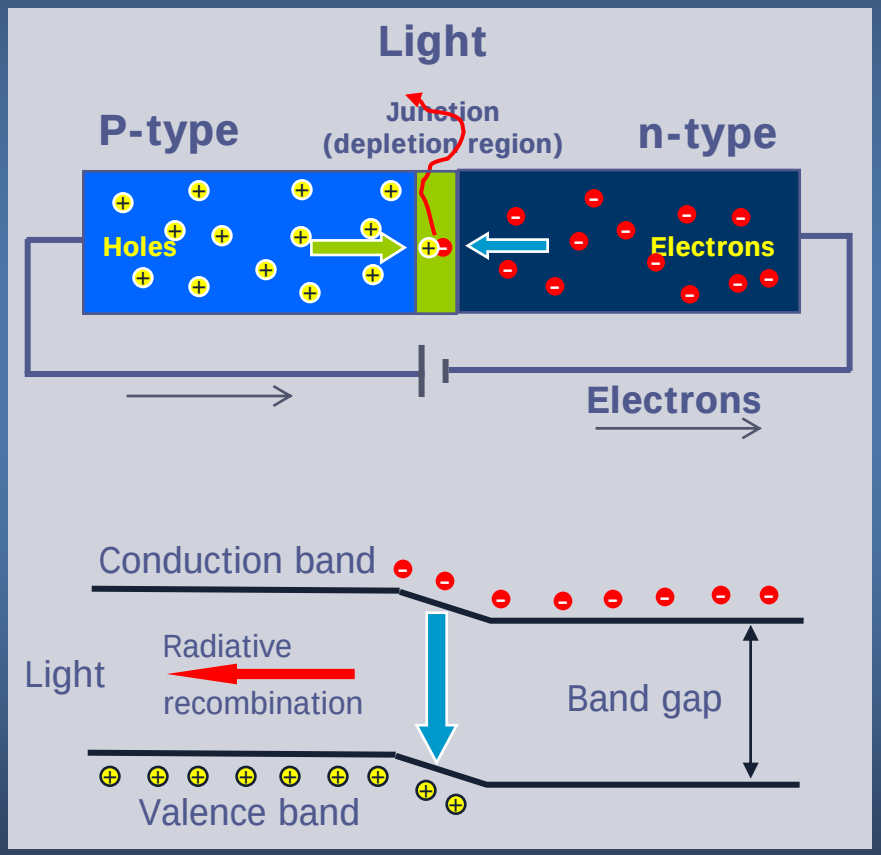
Light-emitting diode: P-N Junction



P material: Has a slight "deficiency" of electrons for molecular bonding when forming a crystal.

N material: Has excess electrons leftover from the crystal bonding process, which can move and carry current.

Photons (light): Generated when the positive and negative charges recombine.

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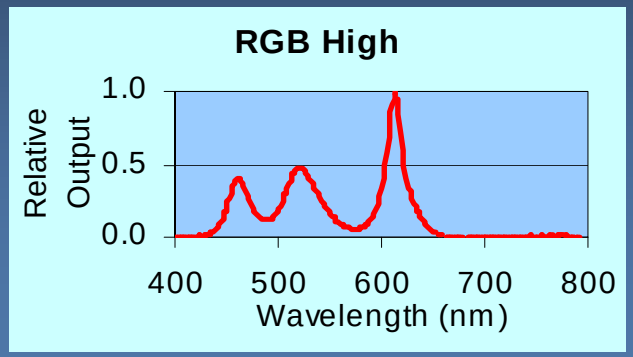
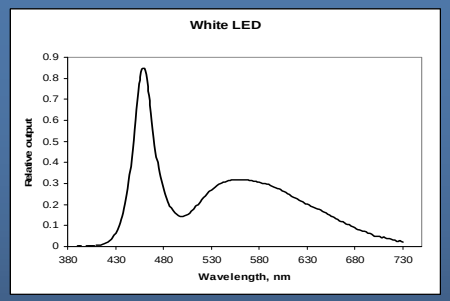
Creating white light with LEDs

Mixing different colored LEDs (red, green, and blue) in the right proportions produces white light.



RGB White



Combining blue LEDs with yellow phosphors produces white light.

Phosphor-converted White (PC-white)

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Luminous efficacy (lumens per watt)

- Luminous efficacy of a light source is the total luminous flux emitted by the lamp divided by the total lamp power (electrical) input
  - Expressed in lumens per electric watt

$$\text{LED Efficacy} = \frac{\text{Flux out of LED Package}}{(V_f \times I_f)}$$

$$\text{LED Luminaire Efficacy} = \frac{\text{Flux out of LED Luminaire}}{\text{Luminaire Input Power}}$$

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Commercial power devices

- Higher flux per device
- Higher efficiency
- Better color properties for white LEDs
  - Good color rendering
  - Much lower color variation between lamps
  - More stable color over time
- Longer life

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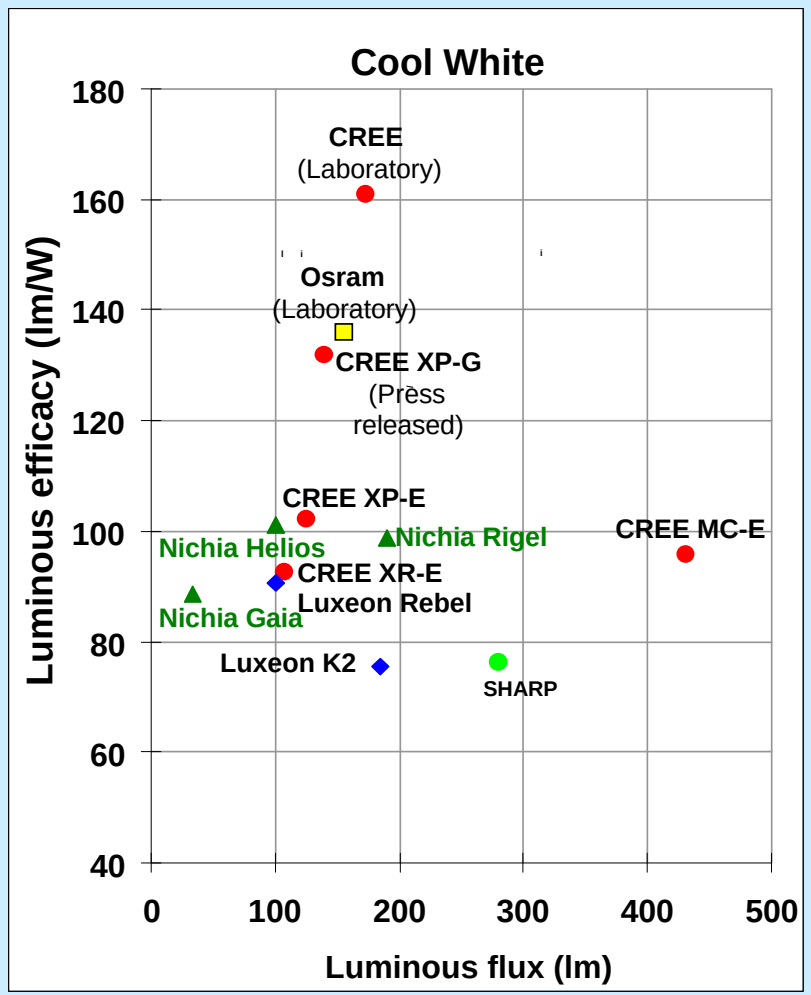
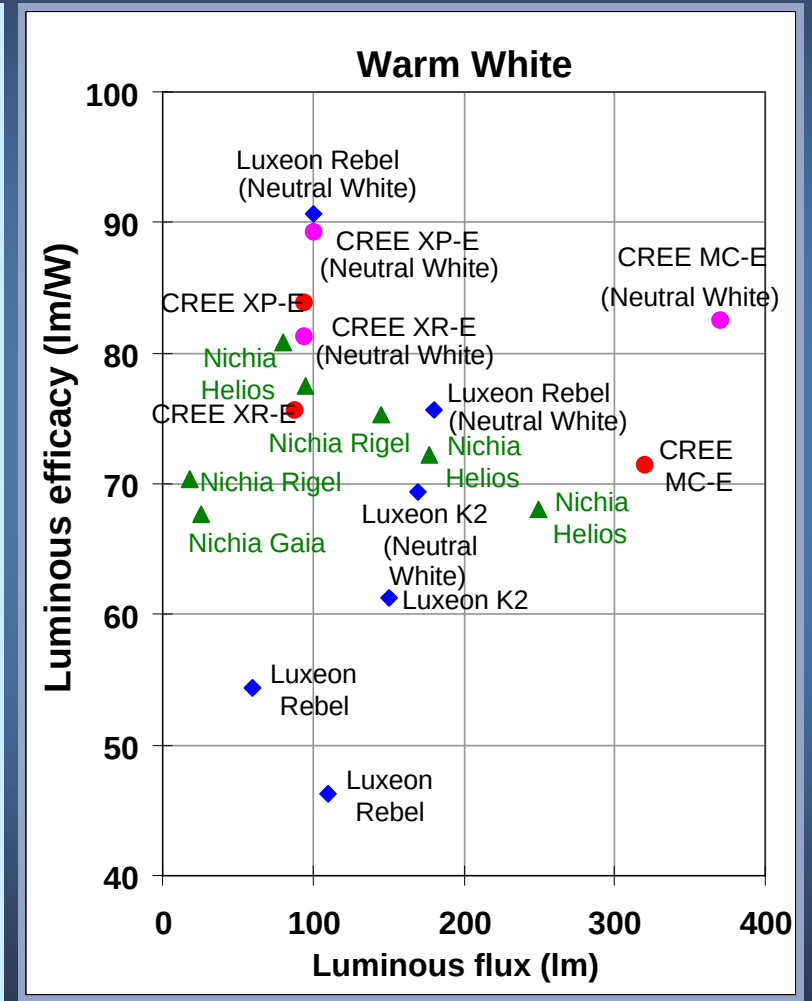
Commercial products – August 2009





All data as published by the respective manufacturers.

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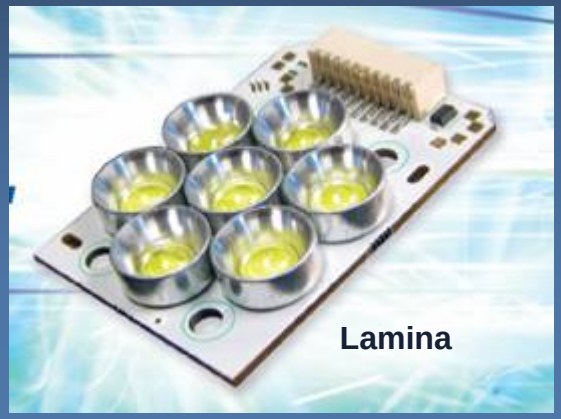
High-flux LEDs

Lumileds



http://seoulsemicon.co.kr/_homepage/home_eng/product/product.asp?topCODE=1&midCODE=25

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LED Life

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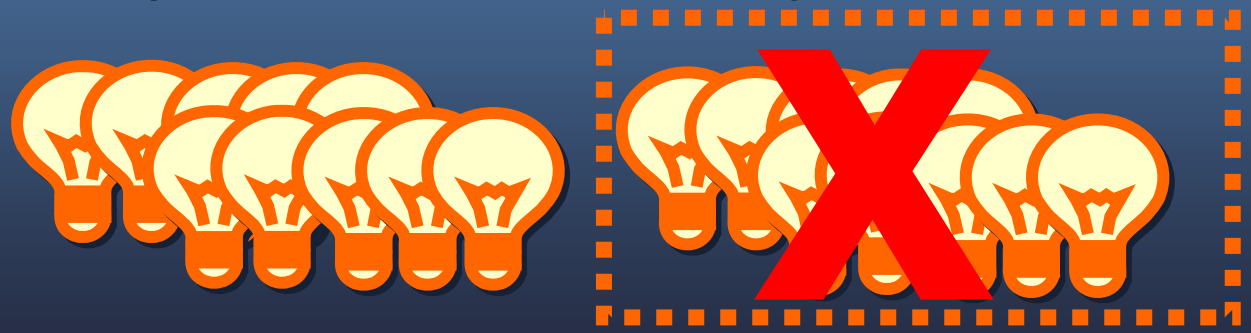
What is lamp life?

- Traditional light sources
  - Lamp life = Time at which 50% of the test samples have burned out
- Test methods
  - Incandescent lamps: Operated continuously at a constant voltage until 50% failure (may be tested at rated voltage or at over voltage conditions)
  - Fluorescent lamps: 3-hr-on/20-min-off cycle until 50% failure
  - HID lamps: 11-hr-on/1-hr-off cycle until 50% failure



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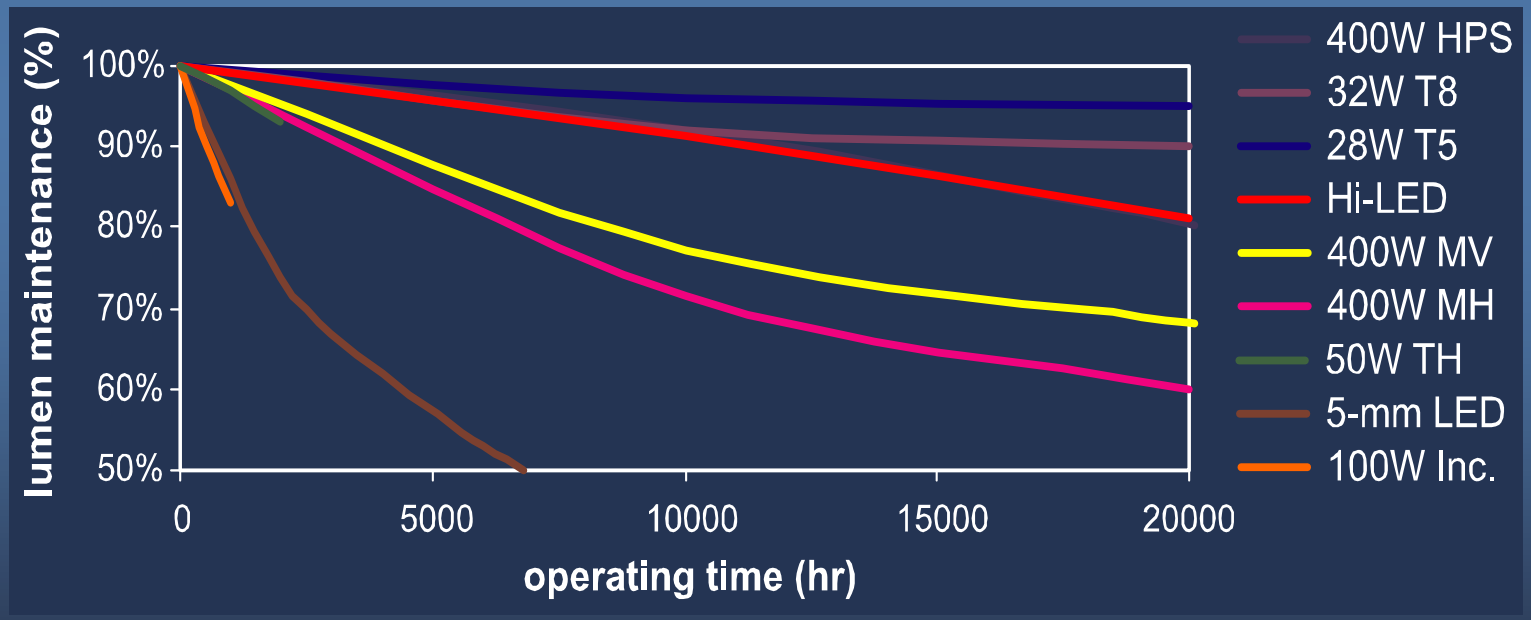
Lumen maintenance

- All light sources undergo lumen depreciation over time
  - Even though they may be functional, long-life light sources may not provide sufficient light for the intended application after a certain amount of time



Lumen maintenance curves for common light sources out to 20,000 hours. (*Lighting Answers: LED Lighting Systems*, 2003; *IES Lighting Handbook* 9th ed., 2000.)

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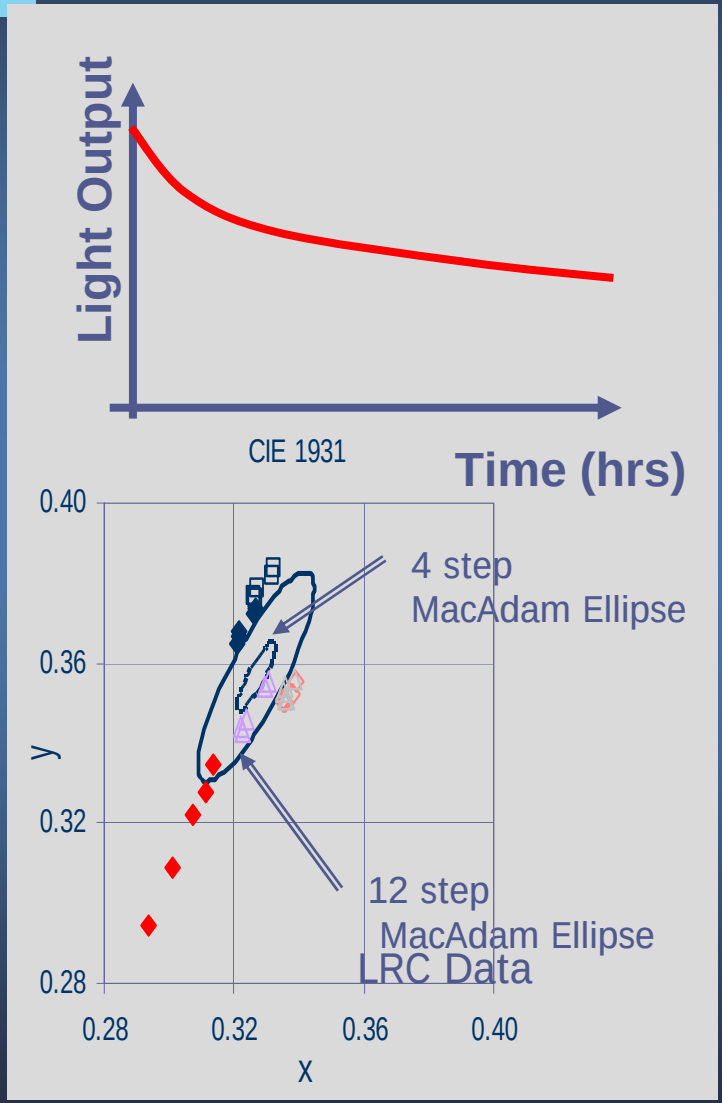
What is lamp life for LEDs?

- Generally, LEDs do not fail catastrophically, but instead their light output slowly decreases with operating time.
  - Useful life: The period in which a light source provides acceptable light level and color for a given application (Narendran et al. JIES 2001)
    - Lumen depreciation
    - Color shift



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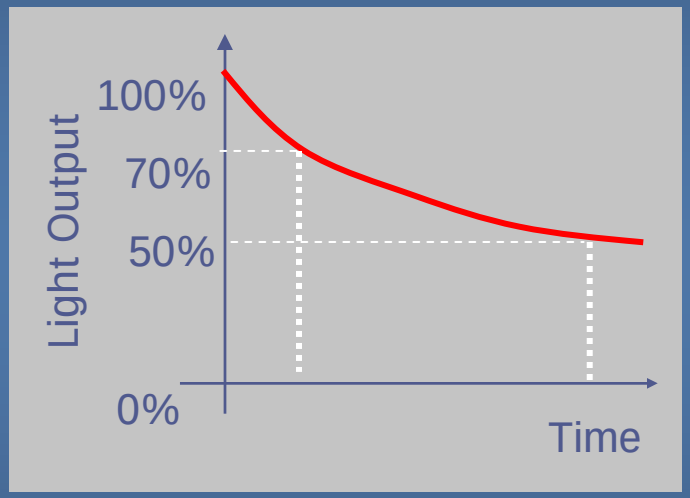
LED life definition

- LM80
  - Initially proposed by ASSIST recommends; end-of-life lumen maintenance values of:
    - 70% for general lighting (L70)
      - L70 = 30% reduction in light output
    - 50% for decorative lighting (L50)
      - L50 = 50% reduction in light output
- Color-shift during this time must be within a 4-step MacAdam ellipse



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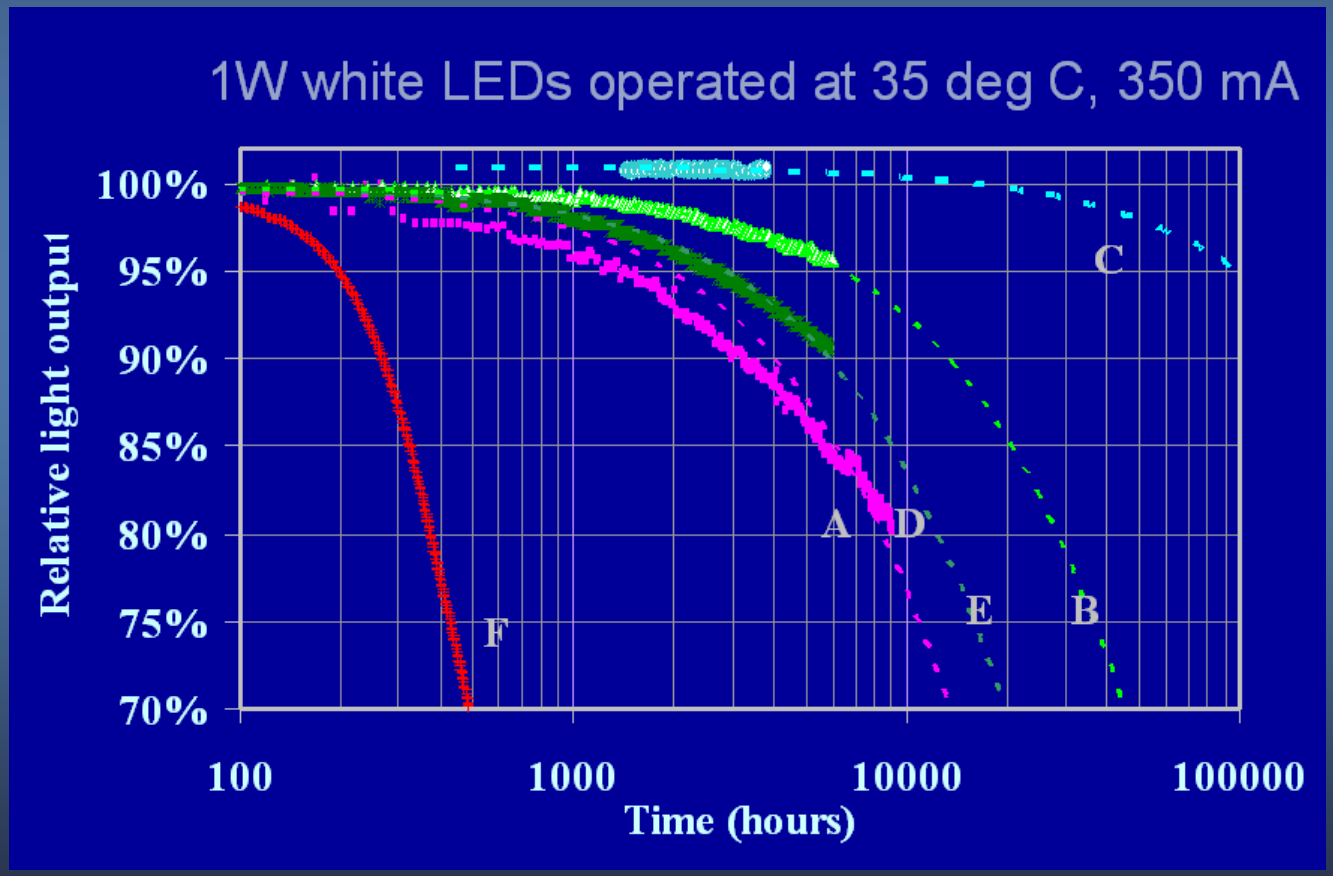
All products are not created equal

- Significant variation between products



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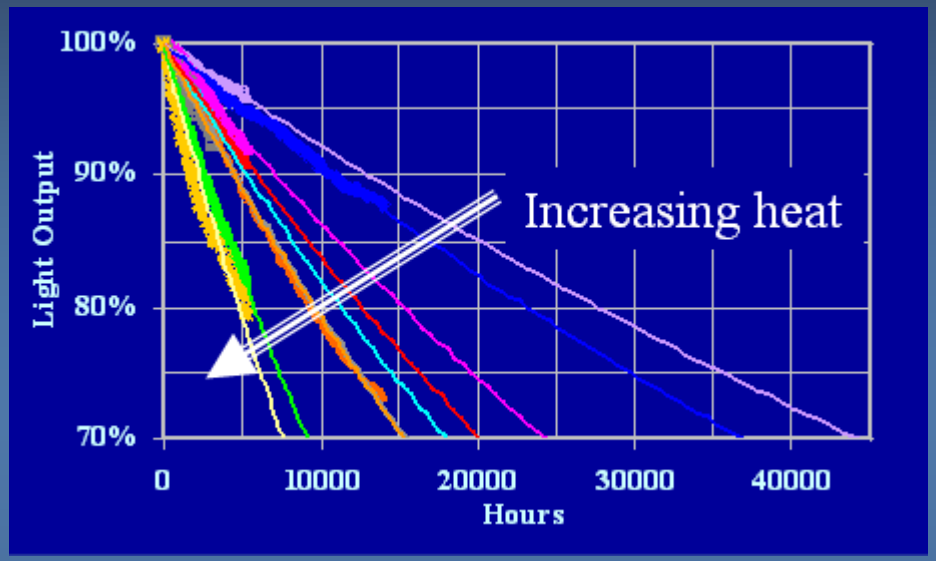
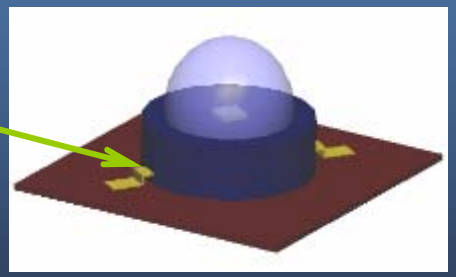
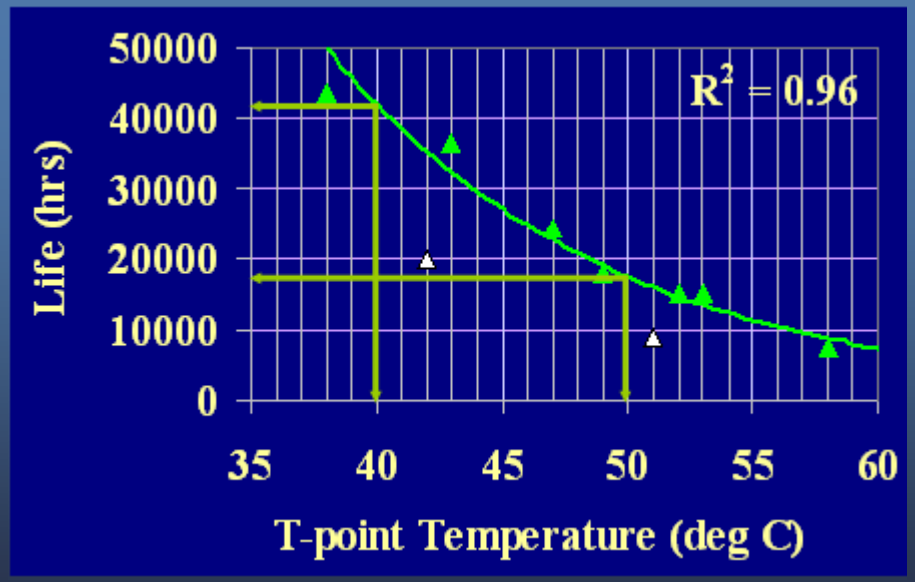
Heat & current affect lumen depreciation



Thermocouple





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White LED Color Issues

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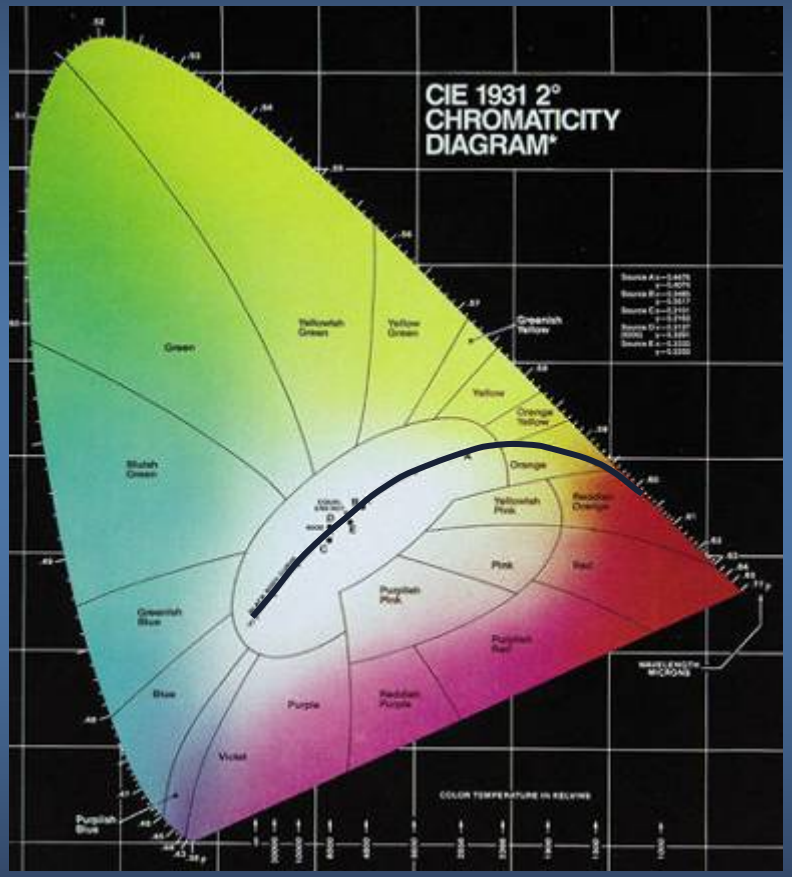
White light

- General illumination
  - CCT: 2800 K to 5500 K
  - CIE x,y values close to the blackbody locus
  - Good color-rendering properties



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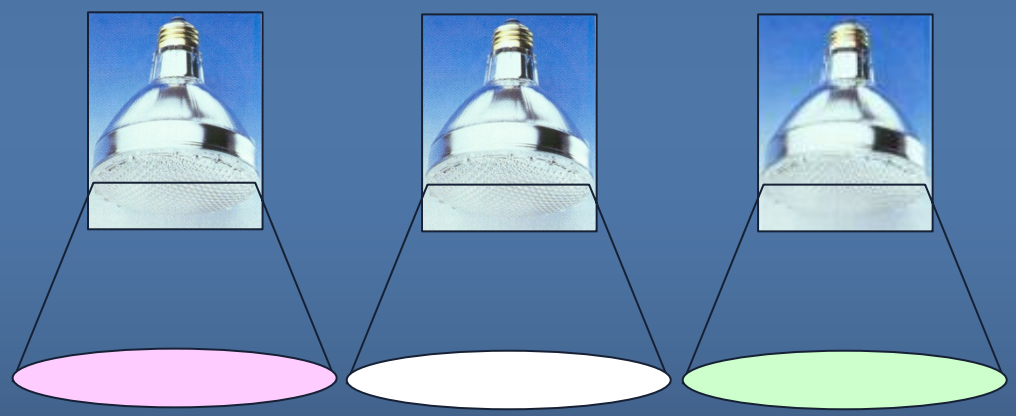
Lamp-to-lamp color variation

- Similar light sources could have perceivable color differences between them



Large color variations between similar light sources is an undesirable feature.

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LED Systems

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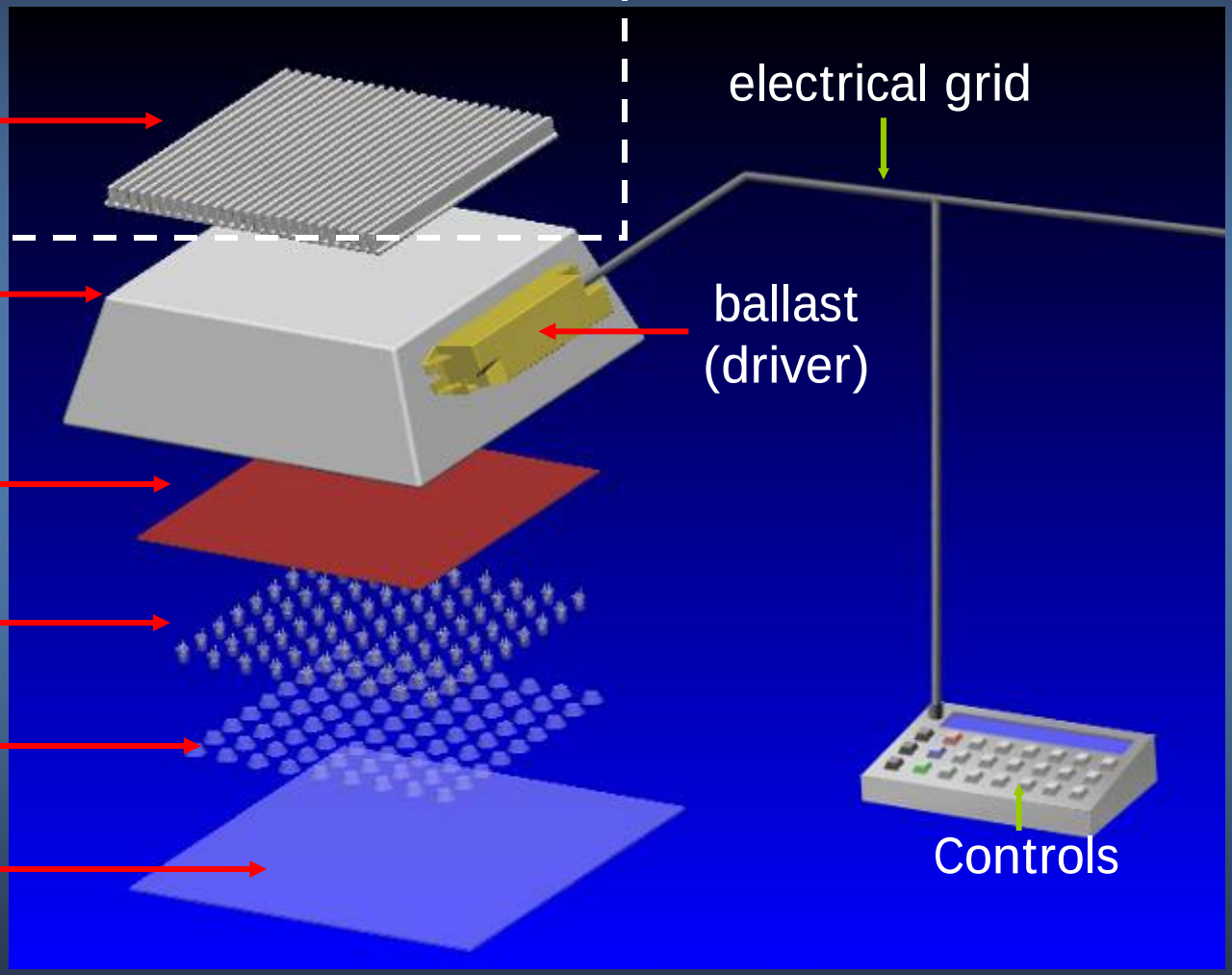
LED lighting system



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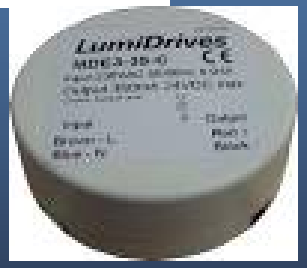
LED system

- Optimized system
  - LED
  - Electrical
  - Optical
  - Mechanical (heat sink / housing)

Luxeon



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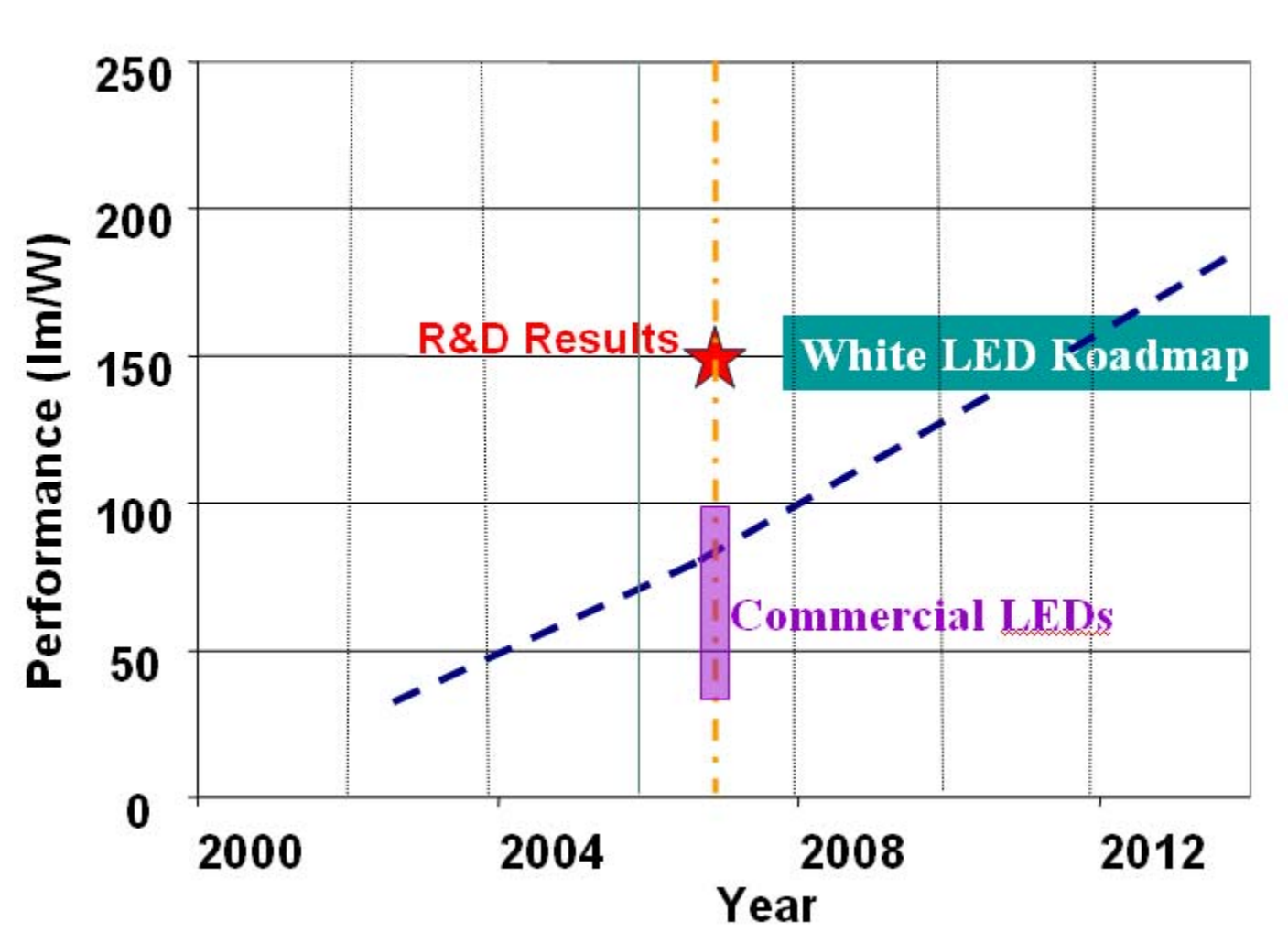
LED efficacy growth



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LED lighting system

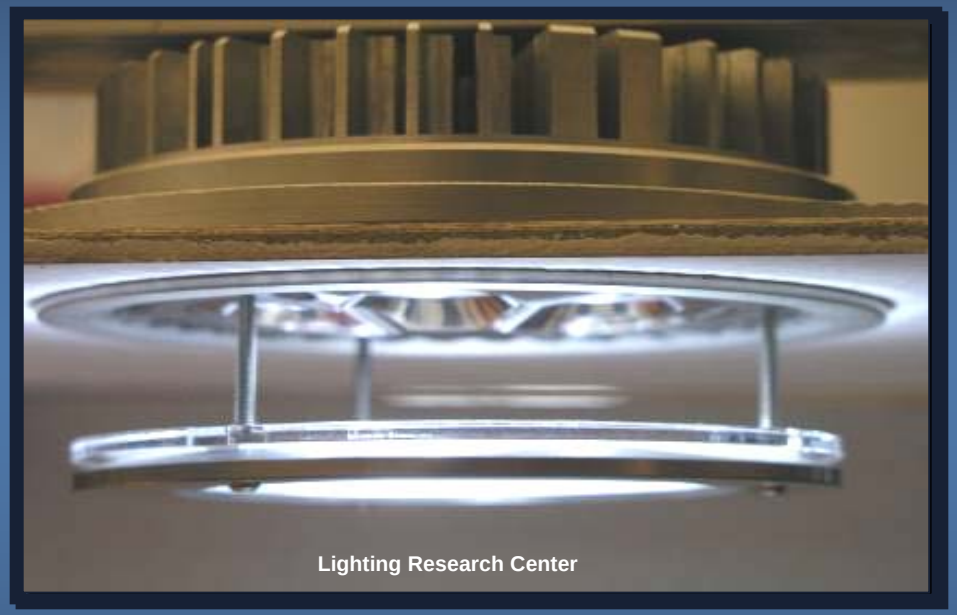
LED

Optical

Thermal

Electrical

System efficiency ~ 58%



System efficacy ~ 55% of LED efficacy

Commercial white LED systems in 2007

- Typical 15 – 60 lm/W

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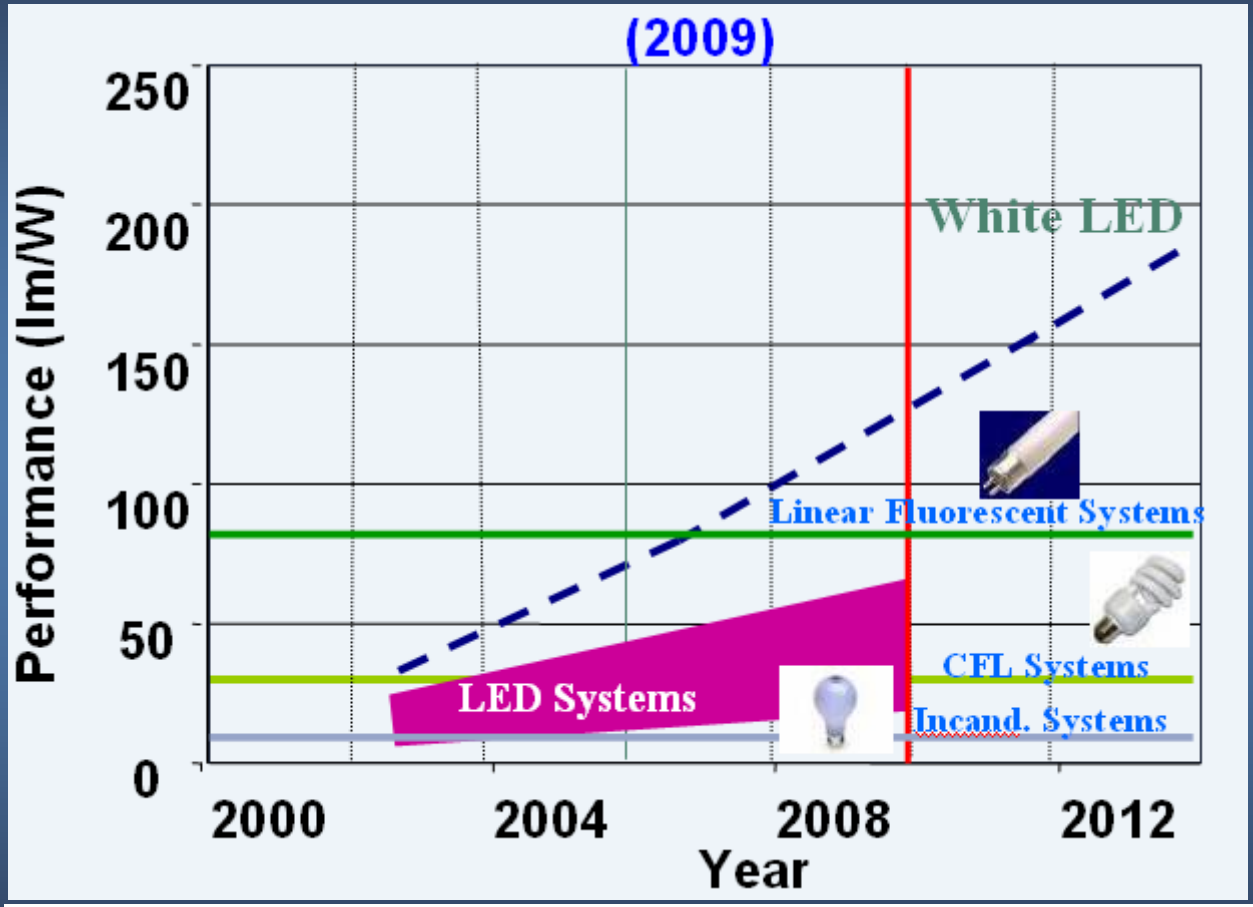
Lighting systems performance



To the end user, system performance matters
...not source performance

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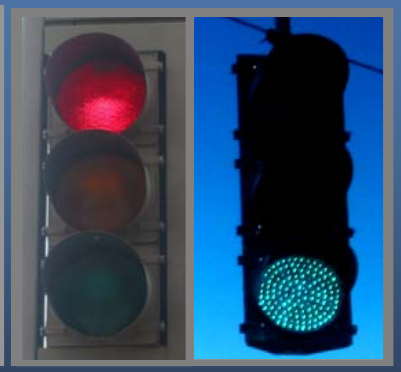
System reliability

- Reduced replacement cost is one of the promises of LEDs
- It is the final system performance that matters to the end user



Market spoilers

Over-promised, under-delivered products

Not good for the LED lighting industry

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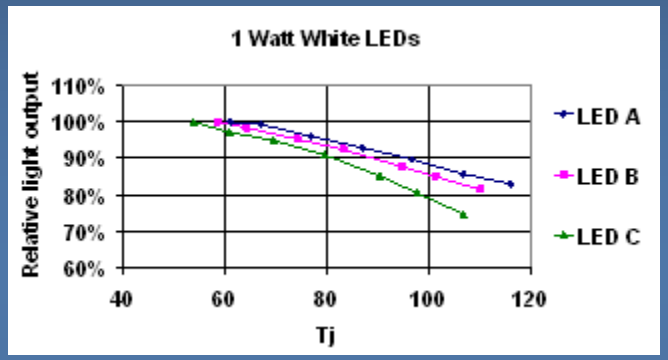
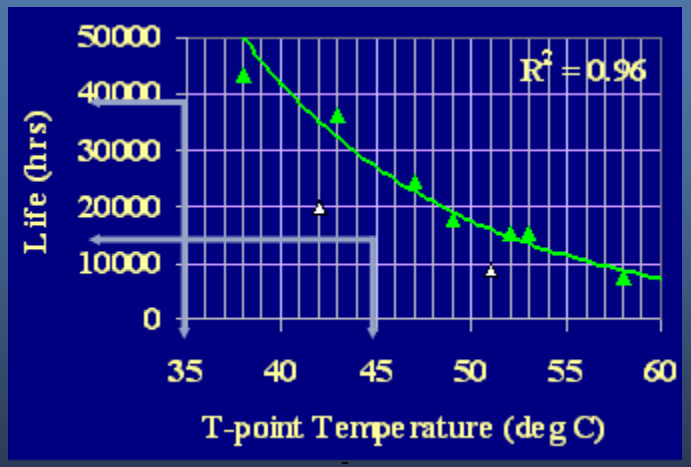
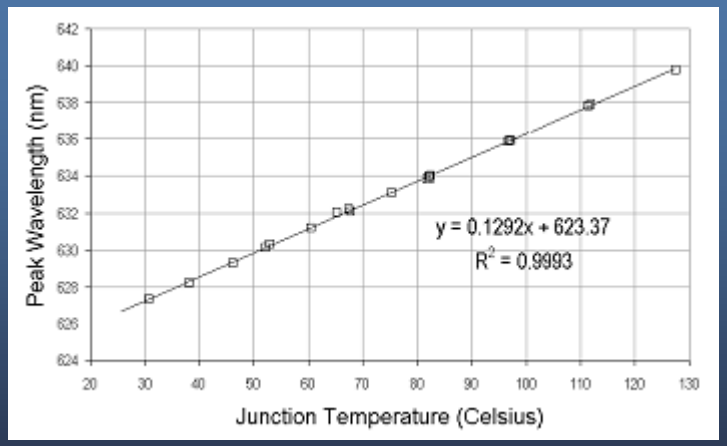
Impact of heat on LEDs

- Heat affects LED performance
  - Light output
  - Color
  - Life







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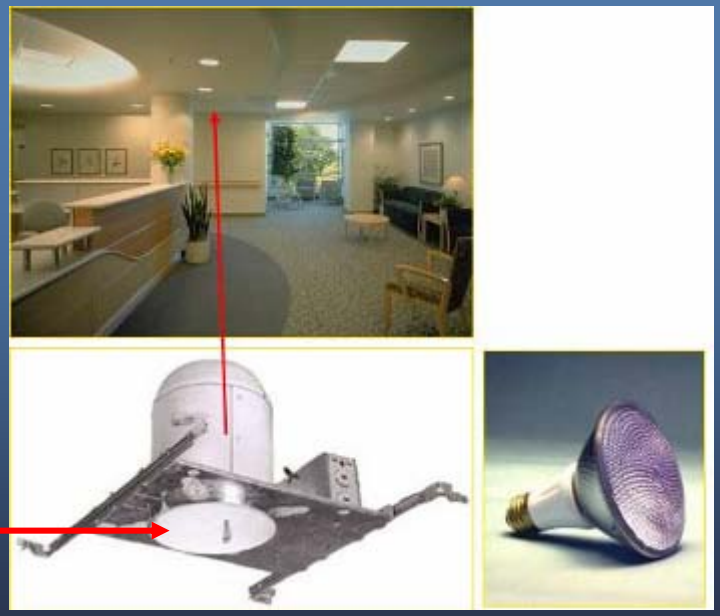
Application issues

- LED products mimicking traditional PAR / MR16 halogen/incandescent lamps are continuously appearing on the market
- They are marketed as one-to-one replacements of traditional light sources



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Application issues

http://www.ylighting.com/linear-system.html

Will both of these lamps perform similarly in the above fixtures?

LED

Halogen

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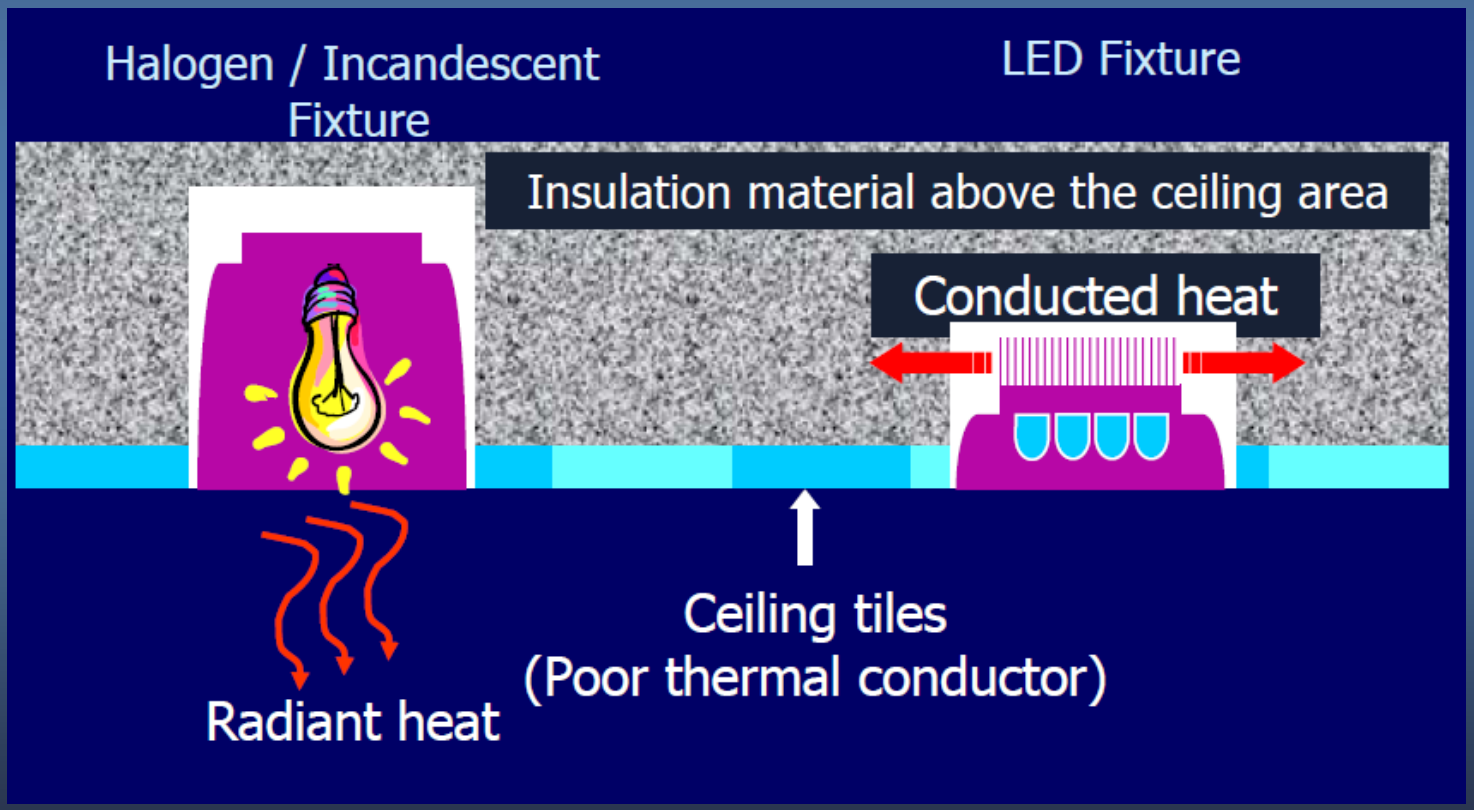
Application issues

- Even a properly designed LED fixture can perform badly if installed incorrectly



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Summary: LED system

- Creating a good LED system requires careful analysis of:
  - Each individual component (LED, driver, optics, and heat sink)
  - Interactions between components
- For any LED system to perform well over a long period of time, the pin (or board) temperature must remain low

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LED Applications Trends

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LED applications

Mid-2000

Early 2000 to mid-2000

Late 1990s to early 2000

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Promising new technology

Like traditional light sources, LEDs have the potential to provide light fixtures of different luminous flux, size, and shape to serve the needs of different lighting applications.

LED fixtures

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Present trend

- Replacement lamps

3W - 10W

10W to 15W

40W – 60W

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Present trend

- Replacement light engines

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Present trend

- Freezer case lighting

Sainsbury's Installs LED Luminaires for Freezer Cabinets

October 16, 2008… Sainsbury's, a UK-based supermarket chain, has selected an LED lighting solution for freezer cabinets from Royal Philips Electronics (Philips). The LED luminaires from Philips light the interiors of its freezer cabinets across 350 stores…

LED Lights in Grocery Case

LED lighting is used inside the grocery cases in place of fluorescent strip fixtures. LED lights have a longer life span than fluorescent lights, produce less heat, and use significantly less energy than typical grocery case

http://walmartstores.com/GlobalWMStoresWeb/navigate.do?catg=445&contId 5677

Supermarkets going green to cut utility bills

Photos

By Steve Adams
GateHouse News Service
Posted Oct 06, 2008 @ 11:05 AM

Shaw's Supermarkets is building a store that's largely "off-the-grid," with 90 percent of its energy supplied by a massive rooftop fuel cell. Stop & Shop Supermarket Co. is replacing power-hungry fluorescent bulbs with efficient LEDs.

Like much of the corporate world, supermarket companies are embracing the so-called green building movement to reduce hefty utility costs. McGraw-Hill Construction estimates that green commercial projects could grow from $3 billion in 2006 to $27 billion by 2010.

Global trend……

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Present trend

- Downlighting

Cree and Zumtobel Announce Strategic Agreement for LED Downlights in Europe

Global Adoption of Solid-State Lighting Accelerating At a Rapid Pace

Lightolier's ColorWash

Sharp Corporation will introduce into the Japanese market six new LED Downlight Lightings, including three that deliver a light intensity equivalent to a 150-watt incandescent lamp, an industry first for downlight models.

Global trend……

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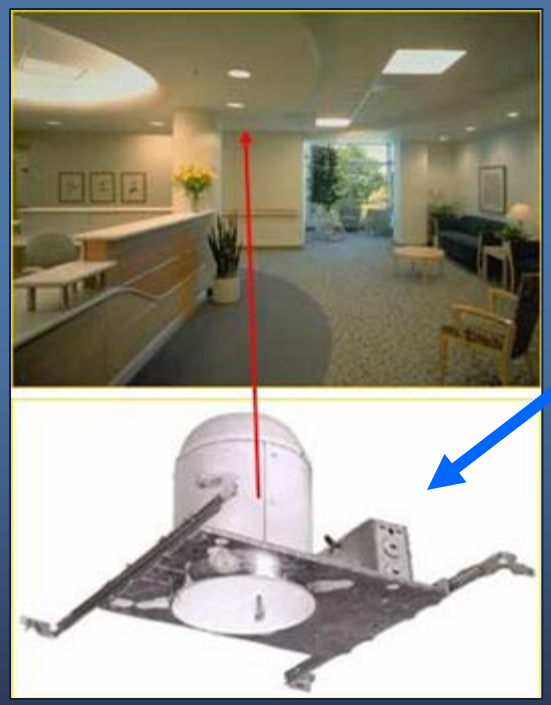
Downlighting

- Now, many technologies can cater to the same application.



Incandescent Halogen

CFL

LED

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Commercial LED Downlight

LLF™ Light Reinvented.™

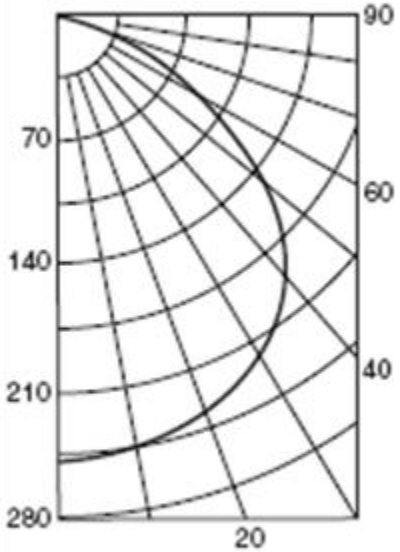
LR6 6" Downlight Module

LR6

Photometry

LR6 – 120V, Incandescent Color (2700K), Edison Base (STANDARD)

Lighting Sciences Inc. Certified Test #22226



Intensity (Candlepower) Summary

ANGLE	MEAN CP
0°	249
5°	248
15°	242
25°	228
35°	203
45°	165
55°	115
65°	62
75°	24
85°	6
90°	0

Zonal Lumen Summary

ZONE	LUMENS	%LAMP	%FIX
0°- 30°	196	30.39	30.39
0°- 40°	323	49.94	49.94
0°- 60°	553	85.35	85.35
0°- 90°	647	100.00	100.00

Performance Sumary

- Nominal delivered light output = 650 lumens
- Nominal input power = 12 Watts
- CRI = 92

http://www.llfinc.com/products.htm

System efficacy = 54 lm/W

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Commercial CFL Downlight

prescolite
An Affiliate of Hubbell Lighting, Inc.

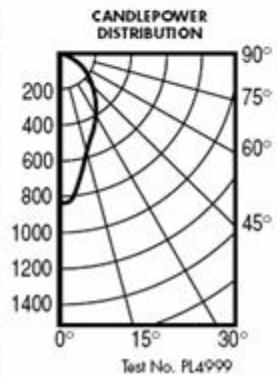
Featuring VirtualSource Reflectors

6" Vertical Quad Open & Wall Wash Downlights

CFQ613EB
CFQ618EB
CFQ626EB

One 13W/18W/26W
Quad Tube 4-Pin Lamp
Non-IC Rated
120V, 208V, 240V, 277V, or 347V

CFQ626EB-STF602
Lower Position
Lamp: One 26W Quad
Spacing Criteria: .7
Efficiency: 61.1%



CANDLEPOWER SUMMARY

Angle	Mean CP	Lumens
0	835	
5	825	76
15	592	170
25	462	214
35	357	223
45	245	192
55	163	145
65	74	72
75	0	7
85	0	0

PHOTOMETRIC DATA

BALLAST DATA	13W Quad	
	120V	**277V**
Total System Watts	16W	17W
Input Current (Amps)	0.13	0.06
Input Frequency in Hz	50/60	50/60
Power Factor	>97%	>97%
Ballast Factor	>98%	>98%
Total Harmonic Distortion	<10%	<10%
Min. Starting Temp.	-18°C (0°F)	-18°C (0°F)

LAMP DATA	
Rated Watts	13W Quad
Rated Lumens	860
Efficacy (LPW)	67
Rated Life	10,000 hours
CRI	82
Min. Starting Temp.	0° F

System efficacy = 33 lm/W

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Initial cost

- At the present time, most LED lighting fixtures have a higher initial purchase cost than incandescent or fluorescent fixtures (approximately 3 to 6 times higher).

- Downlights:
  - Incandescent 75W ~$50
  - CFL ~$90 to $140
  - LEDs (PC) ~$300 to $500
    - (*LLF LED fixture under $100)

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Summary: Downlighting

- Presently, LED systems are more expensive than traditional systems (in most cases)
  - However, when considering lifecycle cost, the cost of using LED systems is approaching the cost of using traditional lighting systems (especially in hospitality applications).

- If a system like LLF ‘s LR6 is used, then the LED system will be the most cost-effective.

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Present trend

Outdoor Street and Area Lighting

www.treehugger.com/files/2008/07/led-streetlights-anchorage-alaska-16000.php

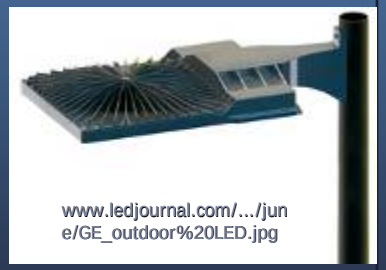
LED streetlights to take over downtown Ann Arbor

17 Oct. 2007 Ann Arbor plans to become the first U.S. city to convert 100 percent of its downtown streetlights to LED technology, with the installation of more than 1,000 LED fixtures.

http://ecoworldly.com/2008/10/17/intelligent-flowery-street-lights-that-smell-humans-provided/

GE Lumination's outdoor LED area light

According to the article, it saves up to 60 percent energy, longer life, and significantly improved light-level uniformity compared with traditional HID lamp sources and optical systems, such as a standard 400-watt quartz metal halide system



www.ledjournal.com/.../june/GE_outdoor%20LED.jpg

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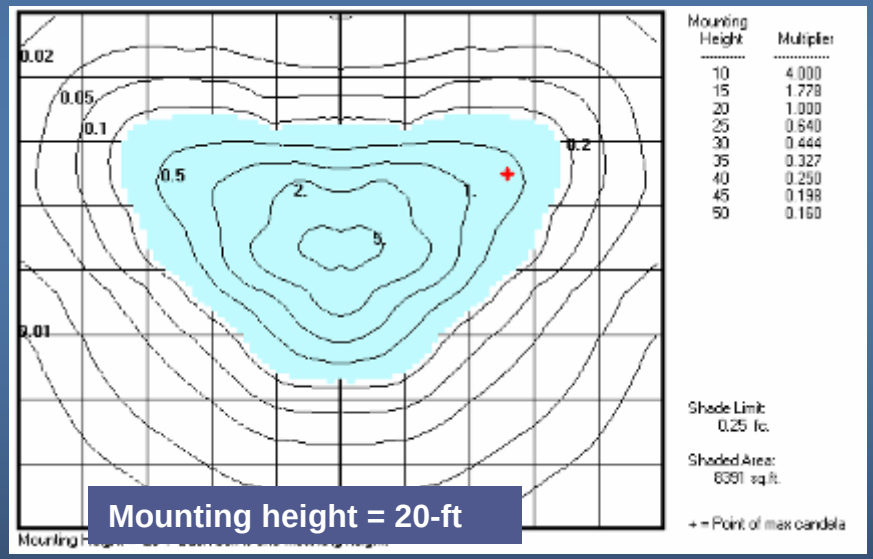
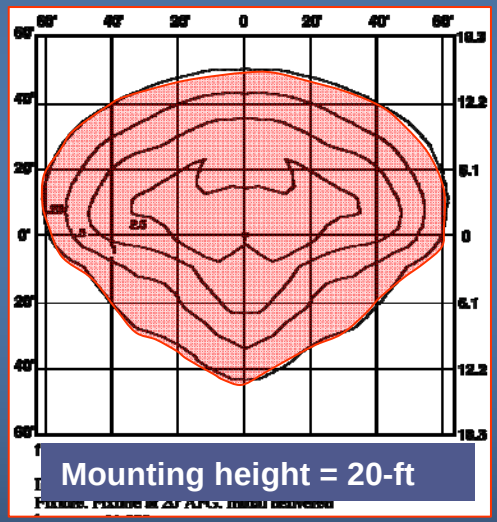
LED fixture performance

150-W HPS
semi-cutoff cobra head

160 1-W white LEDs

Lumens per lamp	**16000-lm (150-W)**		
Lumens per fixture	**12960-lm (150-W)**	**Lumens per fixture**	**10,400-lm**
Fixture power	**189-W (150-W)**	**Fixture power**	**189-W**





- This LED system has performance similar to a traditional HPS fixture.

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Summary

- A rising number of LED street lighting products are in the marketplace.
  - Many of them do not meet the lighting requirements.

- However, a few products are starting to meet the requirements and compete with traditional light sources for area and street lighting applications.

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General illumination

- From the press:
  - "LED manufacturer Cree has been awarded a contract from the U.S. Department of Defense to supply over 4,200 recessed LED lights for the Pentagon. Testing commissioned by the U.S. government determined that Cree's LR24 recessed LED lights would offer a 22 percent energy reduction compared with fluorescent lights, and save the Pentagon 140 tons of carbon dioxide emissions per year."

Before: A Pentagon room before Cree's LED lights were installed. (Credit: Cree)

After: The same room at the Pentagon after Cree's LED lights were installed (Credit: Cree)

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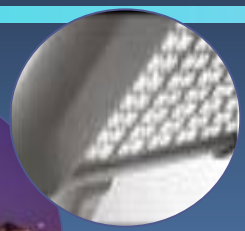
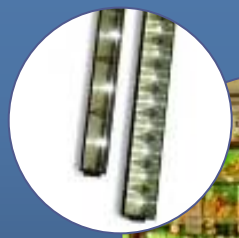
Promising near-term applications

ASSIST *recommends*
Outdoor Lighting Luminaires

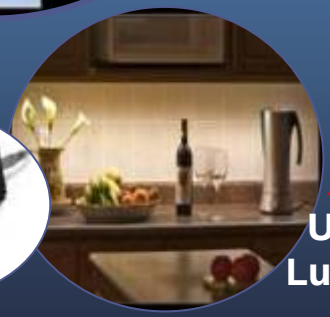


ASSIST *recommends*
Directional Luminaires

ASSIST *recommends*
LED Light Engines



ASSIST *recommends*
Freezer Case Lighting



ASSIST *recommends*
Under-cabinet Lighting Luminaires

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ASSIST *recommends*

- Recommendations to the LED and lighting communities about issues important for the reliable performance of LED lighting
- Best practice guides for different lighting applications
- Recommendations for selecting LED lighting

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LED applications

- Since late 1990s, LED applications have been advancing from signs/displays to colored light environments to now white light illumination
- White light applications are just starting
  - In most cases, higher initial cost compared to traditional sources
    - However, prices are coming down
  - Energy savings only in certain niche applications
  - All products are not created the same
    - Only a few products can meet the requirements of the applications and be cost effective
    - Reliability is unknown and is a concern

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Summary

- Technology trends
  - Rapid advances
    - Higher efficacy and flux per device
    - Improved useful life
    - Better color properties
  - Performance varies significantly among different products
  - LED system performance is not the same as bare LED performance
- Application issues
  - LED is not the solution for all lighting applications
    - Consider applications that can benefit from the LED technology (clear value proposition)
  - Consider application efficacy, not source efficacy
  - Installations must be done correctly for successful application

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Acknowledgments

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Raytheon

Customer Success Is Our Mission

Workspace Specific Intelligent Lighting

David R. Chamberlain
Principal Energy Engineer
Raytheon Company, Integrated Defense Systems (IDS)

ENERGY STAR Web Conference
August 19, 2009

Raytheon IDS Lighting Experience

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- Lots of lighting retrofits during past two decades
  - Have taken advantage of technology improvements over time
  - Examples:
    - Replaced 2x4 acrylic lensed fixtures with deep-cell parabolics; Later replaced those with workspace specific lighting (Ergolights)
    - Replaced high bay fixtures with Pulse Start Metal Halides; Recently changed those to T5 High Output fixtures
  - Other typical projects:
    - T-8 retrofits (bulbs and ballasts only)
    - LED exit signs
    - Occupancy sensors in conference rooms, rest rooms, etc.
- Lesson learned – Minimal light quality improvement for employees
- Researched indirect lighting options
  - Design Lights Consortium (NEEP)
  - Light Right Consortium (Battelle)
  - MA Electric (National Grid)
- Tried pilot project with workspace specific lighting technology (Ergolights)
- Evaluated other similar technologies, including Lightolier Agili-T

Initial Ergolight Experience

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- Technology was introduced to us by our Massachusetts Electric (National Grid) account representative during 2000

- Installation of the Ergolights were expected to:
  - Reduce energy consumption
  - Improve the financial success of the facility
  - Improve employee productivity through improved lighting

- Experimented for 3 months with pilot of 20 fixtures at two sites

- Initial large scale installation completed in 2001
  - Approximately 1,300 installed in three selected sites
  - Approximately 2,225 standard efficiency fixtures removed
  - 1,115 employees effected

What are Ergolights?

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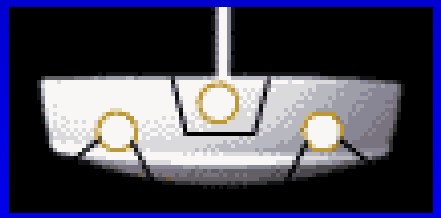
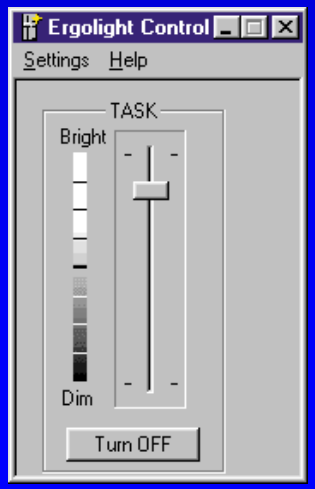
- Manufactured by Ledalite
- Direct/Indirect fixture
- 1 lamp indirect/uplight
- 2 lamps direct / task lights





- Uplight is controlled by lighting management system.
- Onboard occupancy sensor and daylight sensor.
- Task lights are controlled by occupant, occupancy sensor and management system.

How Are Ergolights Controlled?

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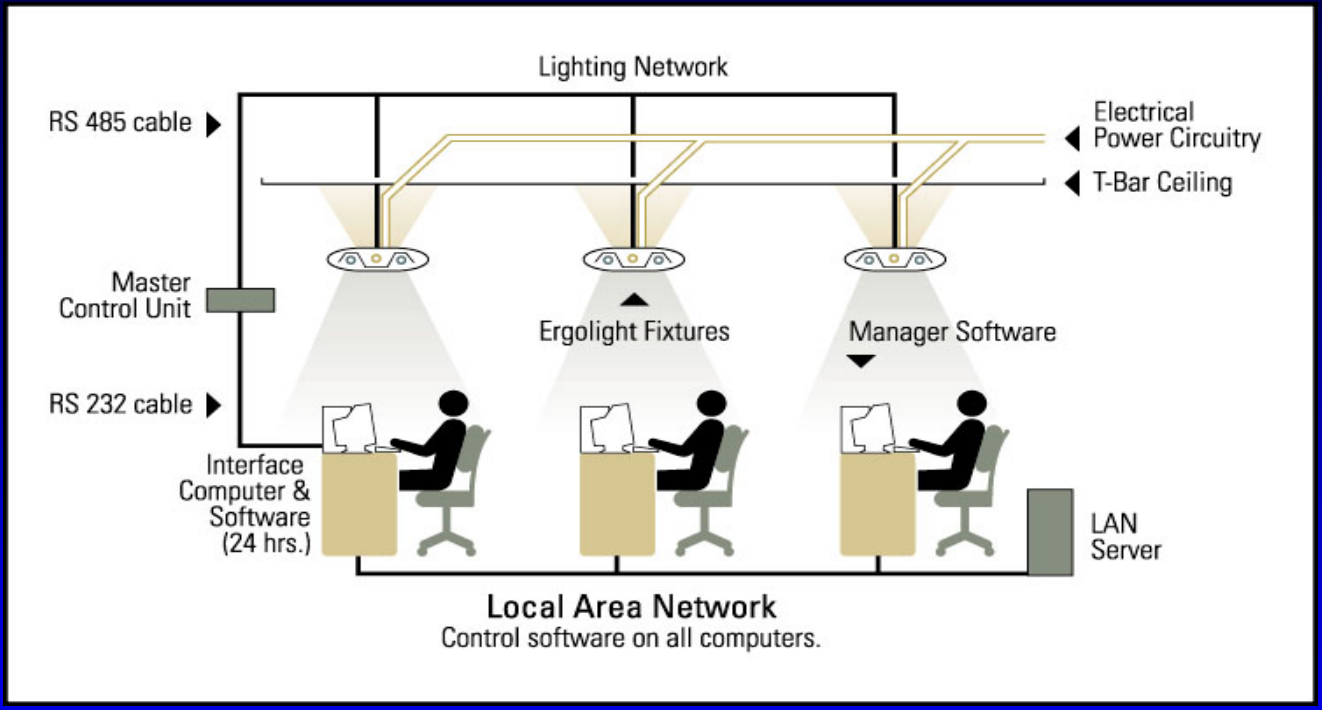

- **Daisy Chain installation.**
- **Fixtures are individually addressable and controlled through computer network.**
- **Fixture database and system software resides on interface computer.**
- **Individual control software resides on occupants computer.**

How Do Ergolights Save Energy?

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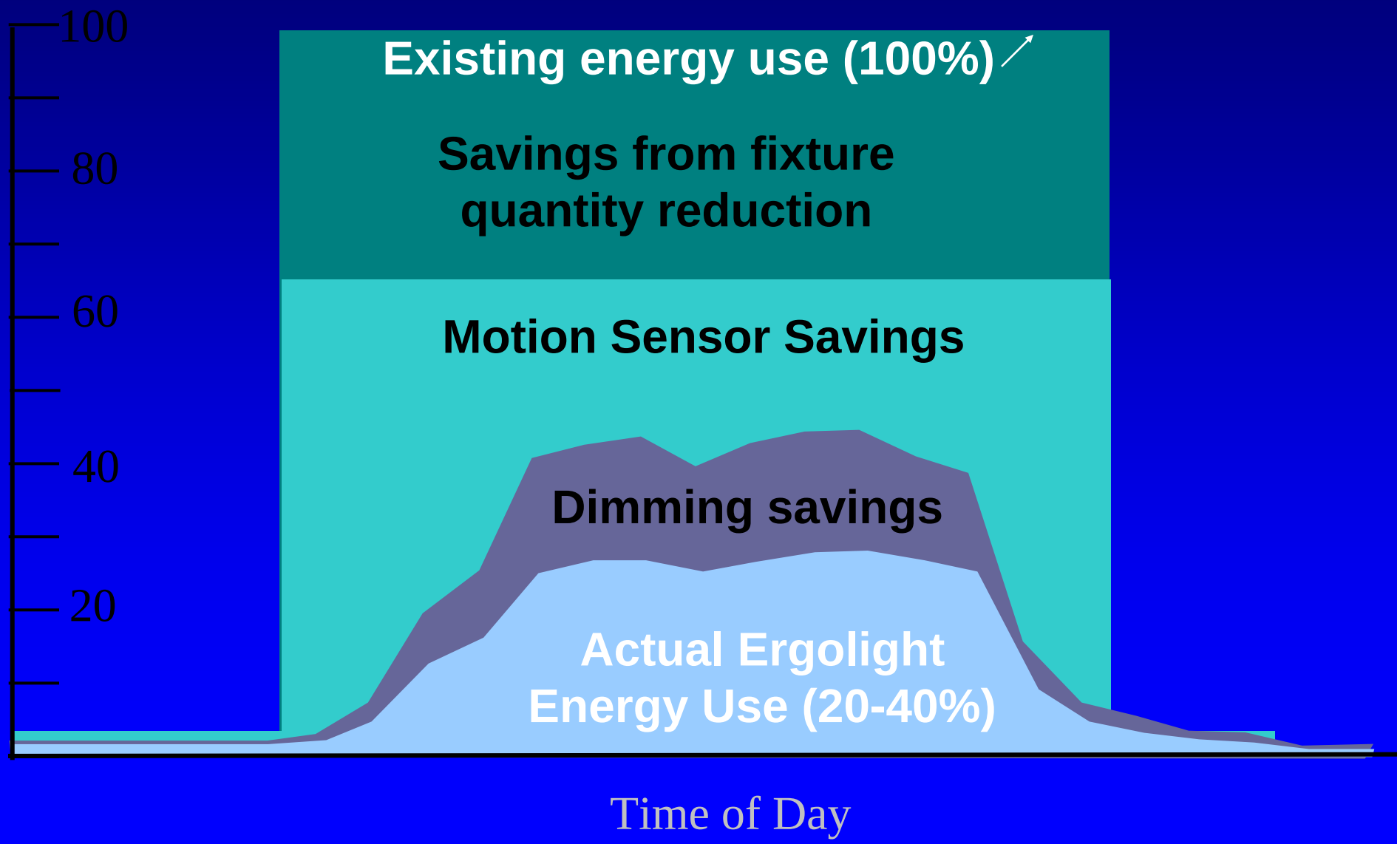

Initial Savings Analyses

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- **Initial installation results:**
  - **Ergolight energy savings tracking surpassed the projected 80%**
  - **Feedback from employees was overall positive**
  - **Fixtures performed mostly as expected**
  - **Manager software did not meet expectations**

Facility Location	Building Area	Ergolights Installed	Fixtures Removed	Employees Impacted	Ergolights Annual KWH	Previous Annual KWH	Annual KWH Saved	% Savings	Annual Savings
Tewksbury	Building 200	498	697	428	80,287	414,715	334,428	80.6%	$31,773
Bedford	Phases 3 & 4	608	1124	426	111,098	685,440	574,342	83.8%	$66,038
Andover	Fab. Offices	137	300	206	30,409	181,718	151,308	83.3%	$14,363
Andover	Purchasing	61	103	55	9,373	23,339	13,965	59.8%	$1,309
Total		**1304**	**2224**	**1114**	**231,168**	**1,305,211**	**1,074,044**	**82.3%**	**$113,483**

Projected Annual KWH Savings per Fixture =	**824**
Projected Annual Savings per Fixture =	**$87.03**

Notes:
1) Ergolight KWH data from Main Computer; Daily rate calculated to compare with previous fixtures
2) Previous KWH/Day = # fixtures removed x Watts per fixture x run-hours per year/1000 Watts/kW x 365 days per year
3) 2001 electricity rates approximately 9-10 cents per KWH (2009 rates 12-14 cents per KWH)

2001 Ergolight Installation Pictures

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Note: Picture distorts actual light pattern on ceiling and walls (i.e. no bright spots as shown here)

Edapt Ergolight Fixtures

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Lessons Learned

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- **Modification in installation process:**
  - **Better procedures implemented to improve assemble time.**
  - **Installed t-connector onto fixture to easier power connections.**
- **Improvements in the roll-out of personal control to the employees:**
  - **Did all at once after area installation complete.**
  - **Made changes to the username and passwords standards.**
  - **Software installation is now web based with online instructions.**
- **Control Improvements:**
  - **Worked on standardizing lighting schedules.**
  - **Modified time delay of occupancy sensor.**
- **Worked with Ledalite on system improvements:**
  - **Repeaters (signal boosters) found to not be sufficient.**
  - **Added the churn feature to deal with moving of people and new computers.**

Current Ergolight Status

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- **Current installation status**
  - **Over 10,000 fixtures installed in MA, RI and AL**
  - **Standard office fixture for renovated areas in IDS locations.**
- **Have established better standards for number of Ergolights per office based on size and number of occupants.**
- **Addressing hallway lighting in conjunction with Ergolights.**
  - **Typical hallway fixture is Lithonia RT5 (low glare).**
  - **Hallway fixtures not needed in some applications.**
- **Employees that do not yet have the fixtures request them.**
  - **Personal control feature is extremely popular.**
  - **Central management makes demand response possible.**
  - **Ledalite has cooperated in making requested improvements.**

Project Recognition

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- Raytheon EH&S Innovation Award, 2001.
- Article in April 2002 issue of Facilities Design and Management.
- Boston Chapter International Facilities Management Association (IFMA) Award for Excellence in Facilities Management, 2002.
- 2002 Energy Project of the Year Award from Association of Energy Engineers - New England Chapter.
- 2003 LEED Certification for Marlboro SATCOM Facility; Included 355 Ergolights
- 2005 Best Practices in Lighting Award from Energy Planning Network (EPN)
- 2006 LEED Certification for Huntsville, AL facility; Included hundreds of Ergolights
- Considered by Light Right Consortium for study
  - Measure impact of quality lighting on worker productivity.

Facilities Design & Management Article

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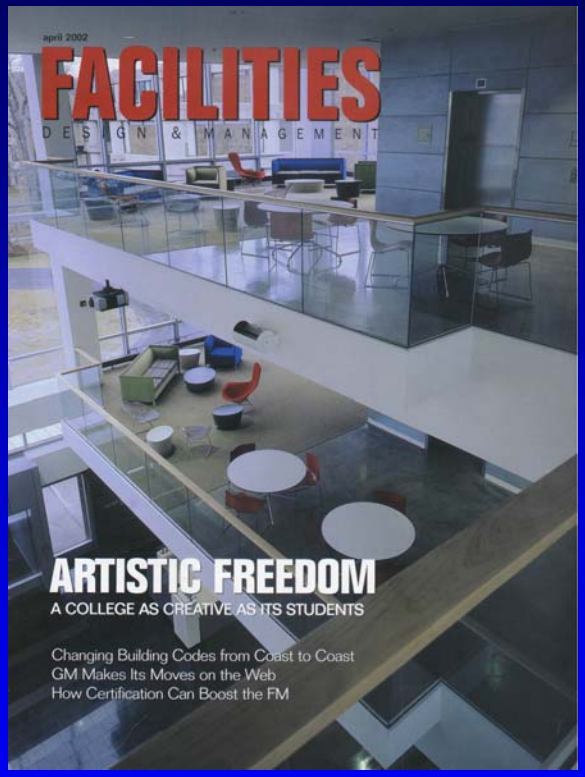

lighting and energy management

SMART FIXTURES GIVE EMPLOYEES CONTROL

Facility managers find that it is no easy task to identify lighting upgrades that fulfill three critical priorities—lowered energy costs; improved workplace ergonomics and sound financial choices. The good news is that recent advances in lighting technology have made the FM's life a lot easier when it comes time to choose a lighting system, a beneficial point when it was decided that Raytheon Company, a provider of commerical and defense electronics, engineering and construction, and business and special mission aircraft products, had a facility that needed to have its present lighting system overhauled. Building 200, in Tewksbury, Massachusetts, is a two-story, 110,000-sq. ft. space with both open plans and private offices housing 450 employees. Building 200 was the first stage of a campus-wide retrofit that was undertaken with a local utility, Massachusetts Electric. An "intelligent" office lighting system called Ergolight from Ledalite Architectural Products, was chosen.

The ideal system

Named Energy Product of the Year at LightFair International 2001, Ergolight is a "workspace-specific" lighting system, ideal for the Raytheon project that was comprised of varying configurations. With one Ergolight suspended over each cubicle or desk, it becomes an employee's personal fixture. Since it is termed intelligent, each luminaire integrates personal dimming, occupancy sensing, and centralized network control.

The early results have been remarkable; the new system already delivered impressive lighting electricity savings of more than 80 percent. Other completed Ergolight installations at Raytheon sites are seeing similar savings levels. Given that lighting electricity costs can comprise up to 30 percent of a commercial building's total electricity consumption, cutting almost 80 percent shows up on expense statements almost immediately, something the financial department can savor.

"I'm really impressed with the return on investment of these new fixtures. It's about two years, including the utility rebate," says Brian Dunn, controller at Raytheon's Electronics Systems Air and Missile Defense Systems (AMDS) and the manager in charge of reviewing the company's retrofit cost and financial returns.

The new lighting retrofit is a "workspace specific" fixture since it works in both private offices (above) or in open plan settings (left). In either case, employees are able to control the amount of light they need based on their task.

Ergonomically concerned

As for the ergonomic concerns, the personal dimming control has been the best received by the employees. This feature allows employees to use computer software to adjust the light levels over their own desks to suit their individual preferences. Another appealing feature is the direct/indirect lighting (one lamp aimed up at the ceiling, two lamps aimed down), which provides high quality lighting for working in both computer and office environments.

Employee response about the new lighting has been very positive, a fact that has not

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FACILITIES DESIGN & MANAGEMENT

This poster kept the employees informed about the new lighting system prior to its installation.

gone unnoticed by senior management. "I've heard from many of our Tewksbury employees, and they like the ability to control lighting levels within their workspace," said Bob Fikou, the Engineering Director for Raytheon's Electronics Systems Air and Missile Defense Systems. "Regardless of whether we can quantify the productivity increases, we've achieved tremendous energy savings to date, which has helped improve morale and the bottom line."

Raytheon's Tewksbury facility is representative of the retrofit challenges faced by many facility management and design professionals—and worth examining in more detail. Prior to the retrofit, the lighting system had a baseline combination of two-lamp and four-lamp 34W T12 fluorescent lamps in lensed fixtures that operated about 5,000 hours per year with scheduling controls. For the retrofit, 697 of these fixtures were replaced with 503 Ergolights. Each 8- by 10-ft. or 10- by 10-ft. cubicle in open areas received one fixture containing three T8 fluorescent lamps, while 10- by 15-ft. private offices received two.

More improvements

Aside from replacing the older, energy-inefficient T12s, the new system is able to capture huge unrealized energy savings through the built-in occupancy sensors. At unoccupied desks in open areas, these sensors slowly dim the two downlights to off after an employee leaves a cubicle, but the uplight remains on to provide ambient light. Now if employees are away at meetings, off sick, or on vacation, wasting electricity to light empty spaces is a thing of the past.

After-hours lighting control has also been improved with the retrofit. Before the Ergolight system was installed, after-hours users would call an extension and request a lighting schedule override for their area. The Ergolight system is programmed to reset the occupancy sensors over cubicles to dim and turn off both the downlights and the uplight at 5:30 p.m. At 6:30 the next weekday morning, the occupancy sensors revert to only controlling the downlight. Therefore, the overnight lighting override is 100 percent automatic based on occupancy; whenever a workspace is occupied, the system delivers the user's preferred brightness level, day or night.

"The goal of the Ergolight technology is to focus on cutting electricity waste and delivering lighting only where and when it's needed," says Damon Wood, director of market development, Ledalite. "The result is an aggressive energy savings program that is embraced by employees."

The workspace-specific lighting concept is intriguing. Based on the strategy of putting fixtures strictly where people work, it is possible to avoid illuminating non-task areas at high levels. The uplighting from adjacent workspaces provides enough ambient lighting for most traffic areas between cubicles.

What the statistics say

Studies of the Tewksbury installation show that putting in fewer of these more efficient fixtures only where they're needed brought in half of the savings. The occupancy sensors delivered about one-fourth of the savings. The remaining savings were a result of personal dimming and the improved after-hours lighting control. While the personal dimming contributes minimal savings, there's little doubt that this is a staff favorite. Most employees prefer the lower lighting levels and dim their lighting by more than 25 percent to reach the setting most comfortable for them.

Since improving employee well-being was a priority, keeping staff informed throughout the installation process was essential. For example, the facility management and engineering staff mounted an internal communications campaign to introduce employees to the new lighting system. Posters were put up, a website was developed, a test installation was set up, and employee tours were conducted.

During the building-wide upgrade, the contractor was instructed to make the changeover at night so as to minimize staff disruption. When employees arrived the next morning to see their new light fixture in place, they were each given user instructions with a mint chocolate attached, accompanied by a note stating, "Here's a little something for helping us save a mint." The resulting changeover went much smoother than anticipated, with very few of the complaints or concerns that might have occurred without this attention to detail.

From an installation viewpoint, these fixtures easily mount right on the T-bar grid. Since the power cables are modular, moving fixtures when shifting the office setup should be easy. Maintenance is also straightforward. "We like working with these fixtures because they are easy to install and maintain in comparison to conventional office fixtures," said Bob Detner, Raytheon's northeast facilities operations director. "We like to keep current with technology, and these Ergolights meet that goal."

In the end, with new technologies like Ergolight being proven on successful projects, our lighting retrofits are on their way to managing the diverse needs of our human resources, minimizing energy use, and ensuring the wise use of our finances. And that's a lesson we think other companies will appreciate. ■

DAVID R. CHAMBERLAIN AND TRACY L. FIALLI

David R. Chamberlain, PE, has been a senior energy engineer for Raytheon Company since 1997.

Tracy L. Fialli, a certified energy manager, has been a senior energy engineer for Raytheon Company since 1992.

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Questions?

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Discussion

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Announcements

- August 25 – Supply Chain Working Group Meeting:
  Electronic Industry Citizen Coalition's Supply Chain Carbon Reporting System.

- Register at:
  energystar.webex.com/meeting

2009 Web Conferences

- September - Our Top Energy Projects
- October - Energy and GHG Management
- November - Energy Management Financing Strategies
- December - No web conference

- Thank you