

ASERTTI Fall 2007 Meeting
October 24, 2007
The Sagamore, Bolton Landing, NY

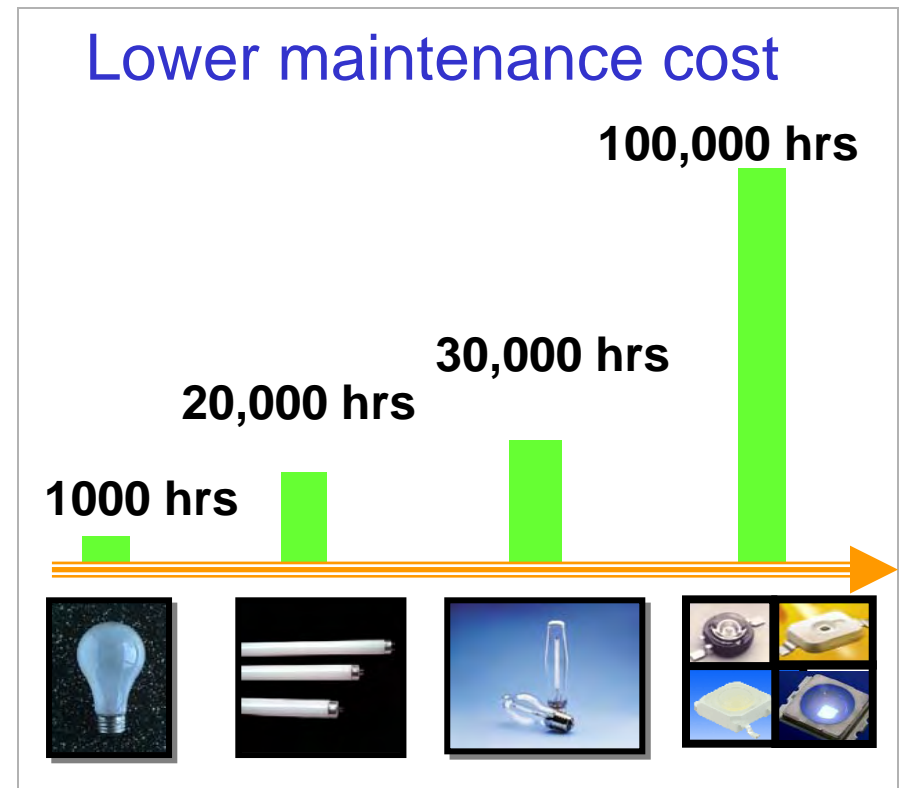
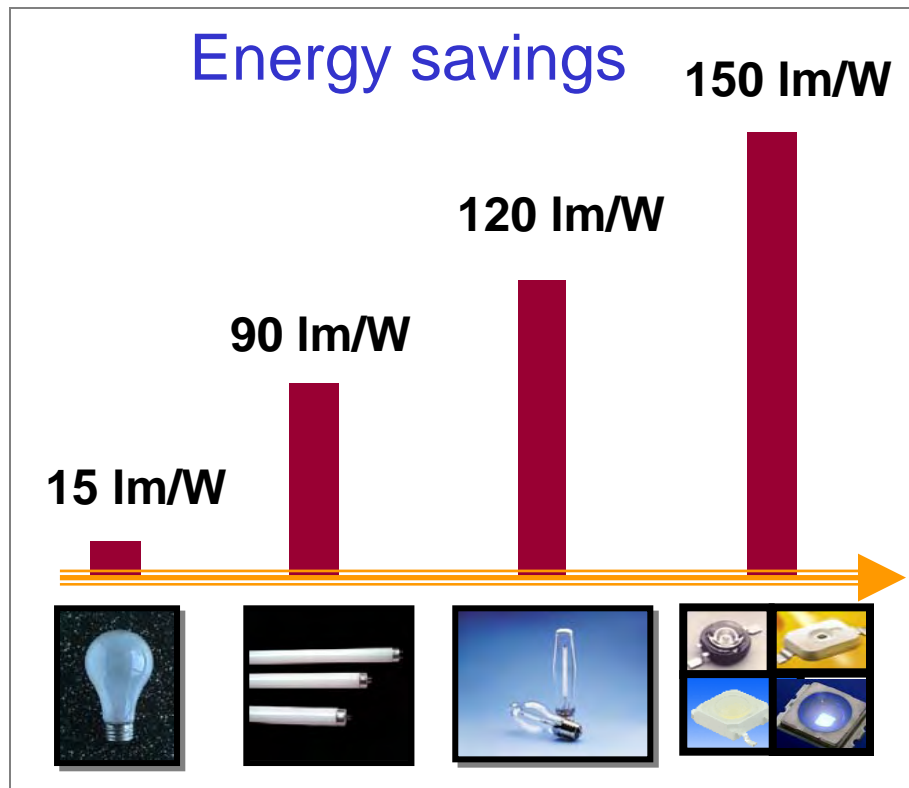
Are LEDs Ready for General Lighting? **- *Status and Issues***

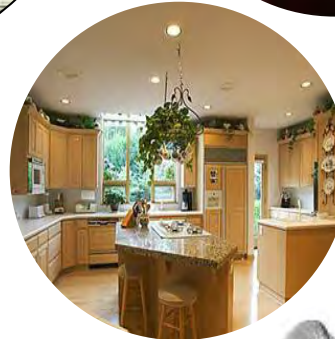
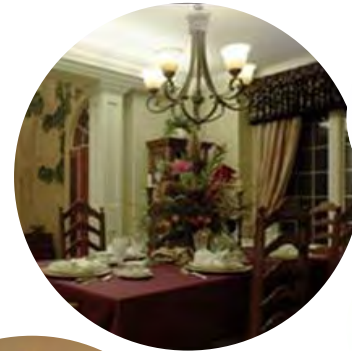
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Acknowledgments

- LRC Partners
- Sponsors of ASSIST Program
- LRC faculty and staff

SSL Promise: by 2012





 Rensselaer
Lighting
Research Center

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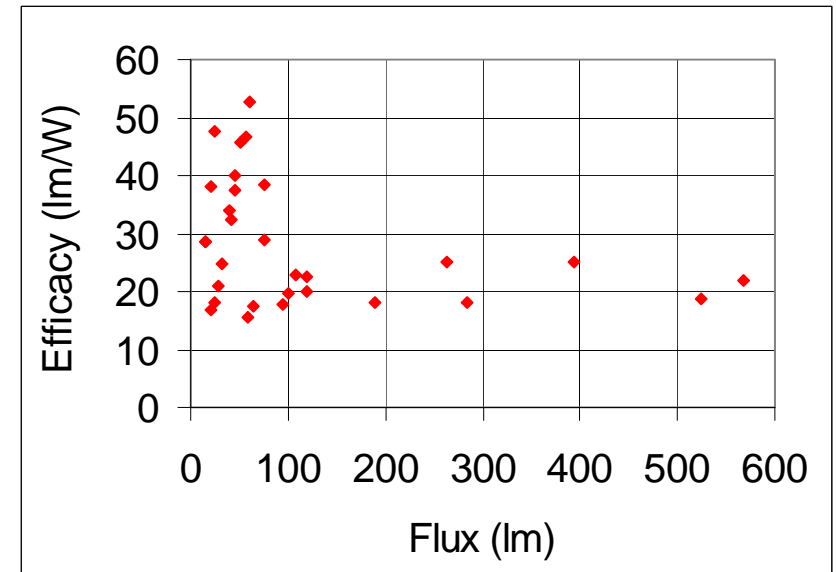
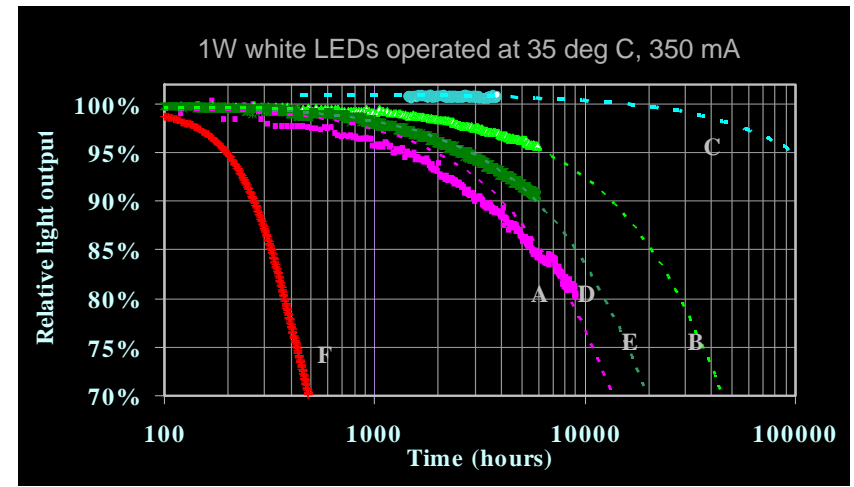
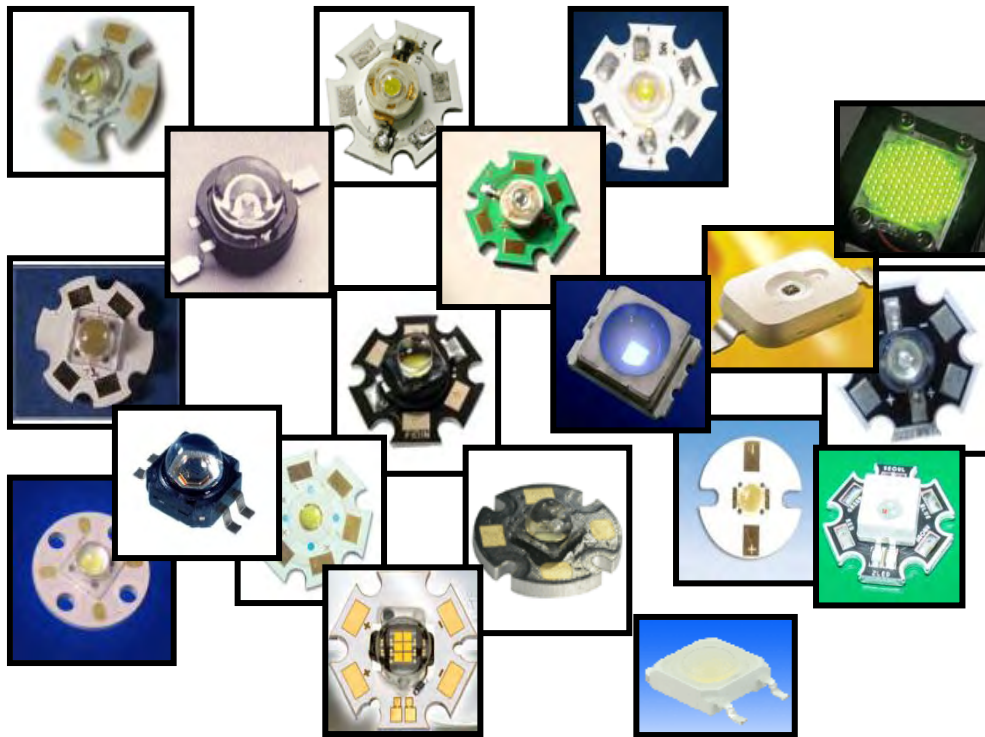

ASSOCIATION OF STATE ENERGY RESEARCH AND TECHNOLOGY TRANSFER INSTITUTIONS

LED: Present industry trend

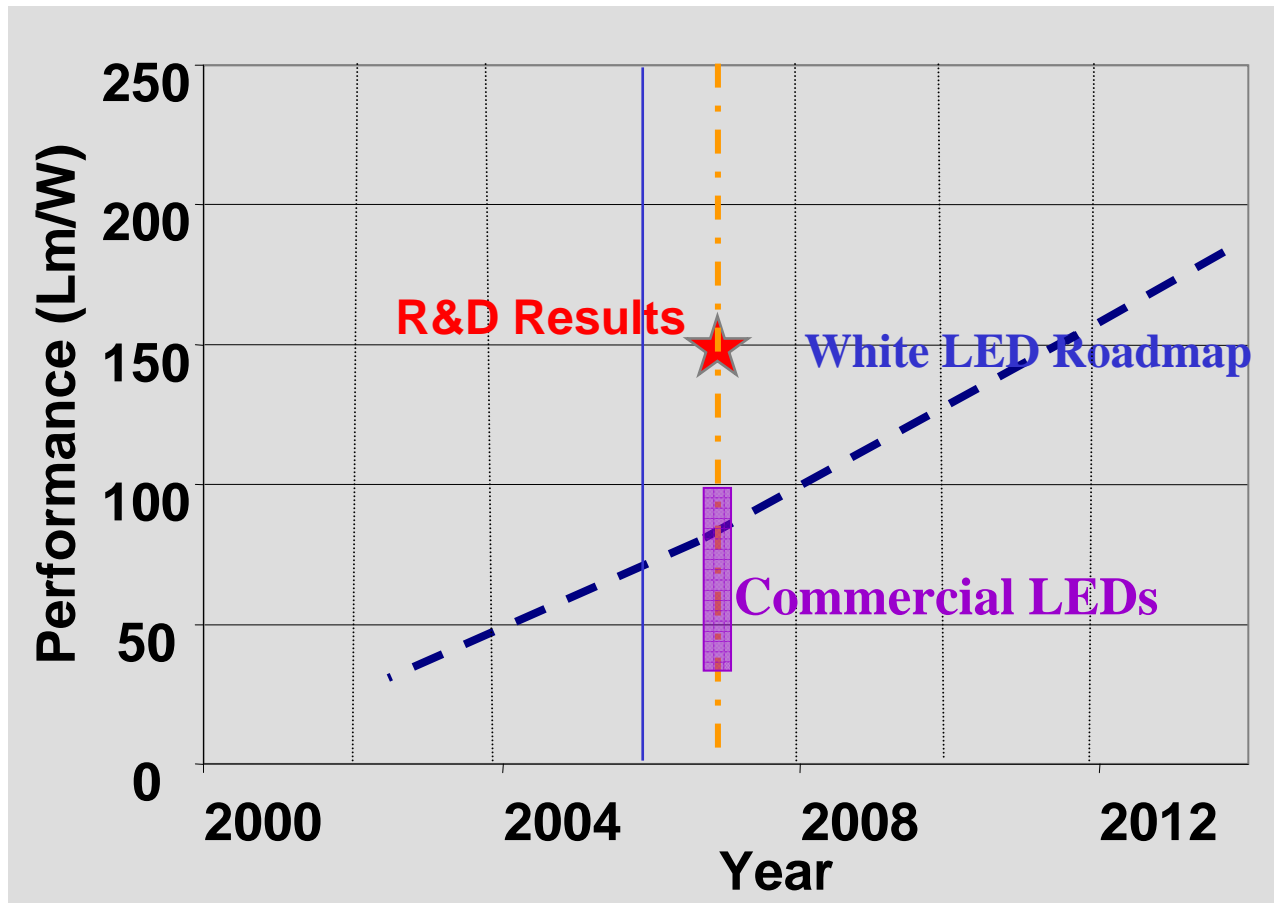
- Growing number of LEDs and LED fixtures



Many LED products in the market



LED efficacy growth



LED system

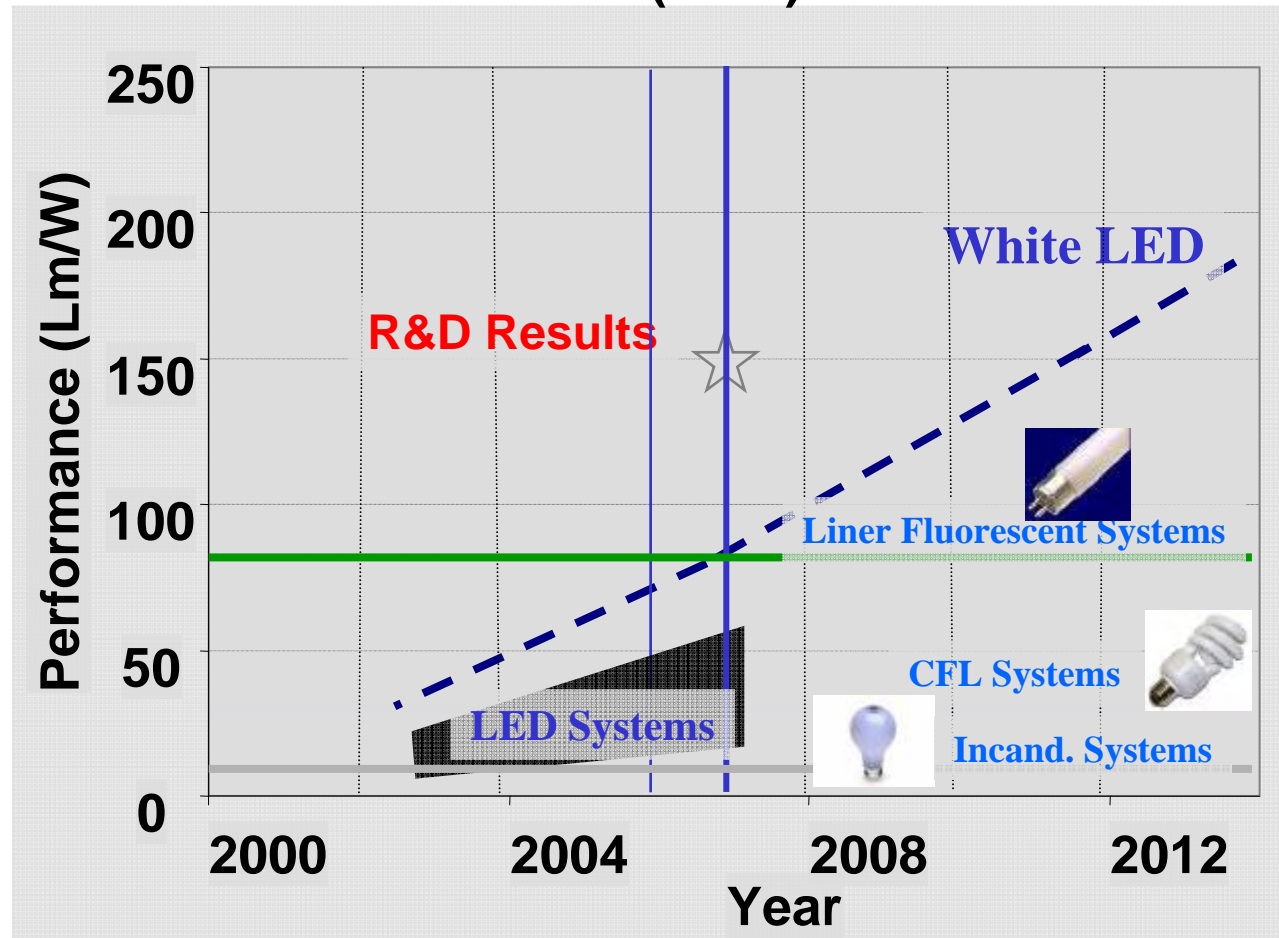
LED

- Electrical ~ 80%
- Optical ~ 80%
- Heat ~ 85%
- Final Efficiency ~ 54%

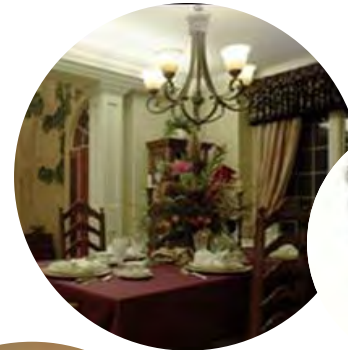
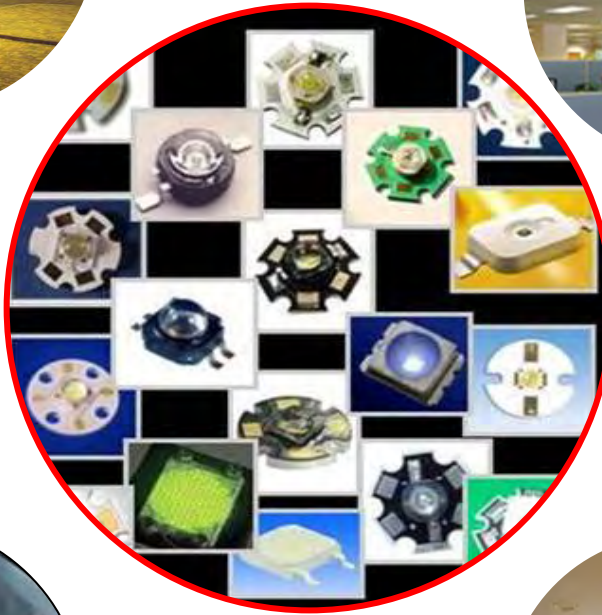
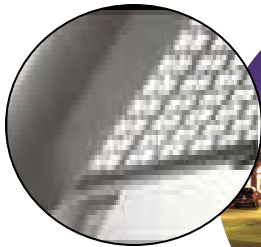


Luxeon

Lighting systems performance (2007)



To the end user, it is the system performance that matters, not source performance.



Illumination applications

- Two most-touted applications for white LEDs:
 - Downlights – interior applications
 - Street lights – outdoor

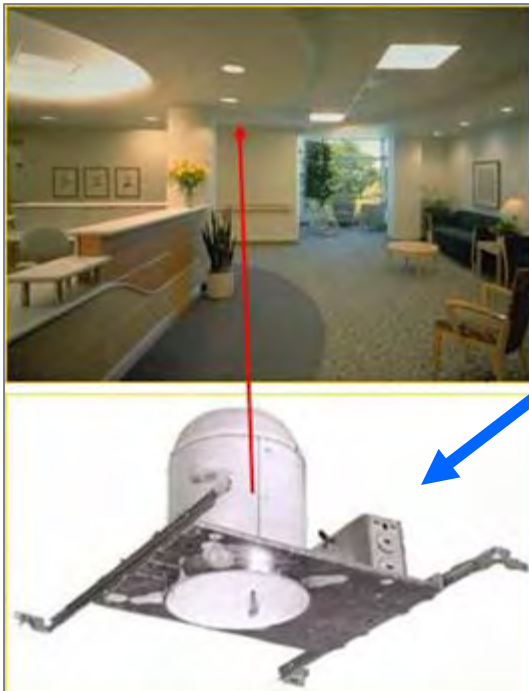
- Are LEDs ready for these applications?

Can LED systems compete in down lighting applications?



Downlighting

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



**Incandescent
Halogen**



CFL



LED



Commercial LED Downlight

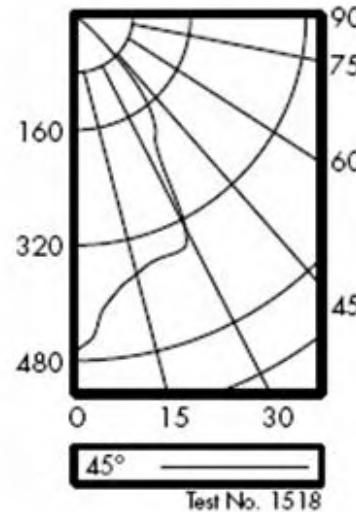


6" LED Downlight

D6LED

Wet Location
120V

prescolite
A Division of Hubbell Lighting, Inc.



CANDLEPOWER SUMMARY

Angle	45°
0	466
5	411
15	363
25	356
35	191
45	70
55	5
65	0
75	0
85	0
90	0

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP
0-30	299	52.4
0-40	416	73.0
0-60	477	83.7
0-90	477	83.7
90-180	0	0.0
0-180	477	83.7

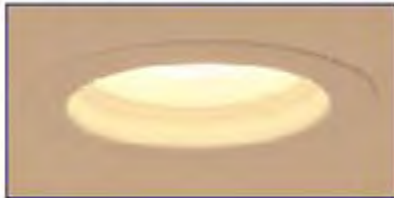
INPUT PARAMETER	VALUE	UNITS
Input Voltage range	120 ± 10%	V
Power	32	W
Current	0.266	A
Frequency	60	Hz

System efficacy = 15 lm/W

Commercial LED Downlight



LR6 6" Downlight Module



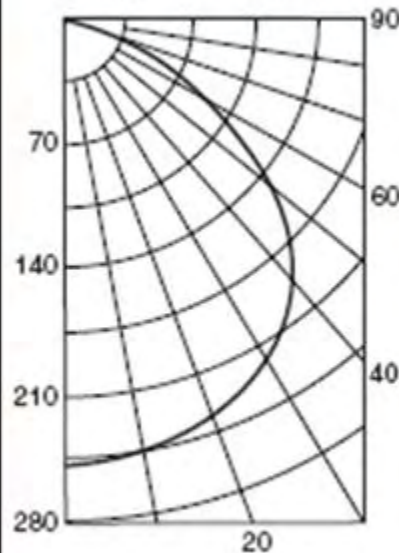
LR6



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 Summary

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


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

System efficacy = 54 lm/W

Commercial CFL Downlight



An Affiliate of Hubbell Lighting, Inc.



Featuring **VirtualSource** Reflectors

6" Vertical Quad Open & Wall Wash Downlights

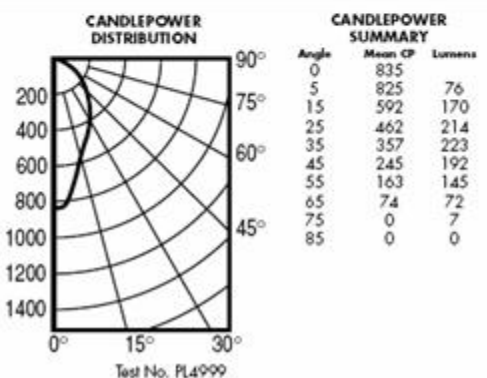
CFQ613EB
CFQ618EB
CFQ626EB

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 DISTRIBUTION

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

CANDLEPOWER SUMMARY

Test No. PL4999

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)

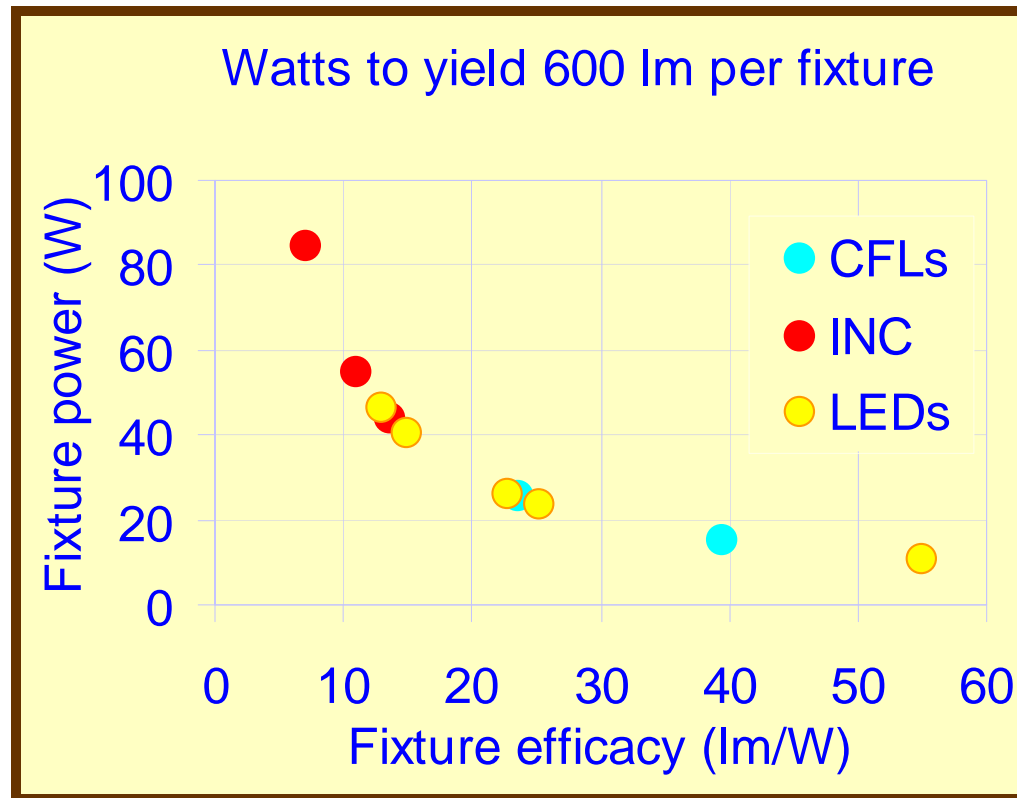
LAMP DATA

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

Watts to produce 600 lm per fixture

- Generally, downlight fixtures used in residential, office, and hospitality applications produce approximately 600 lumens per fixture.



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).

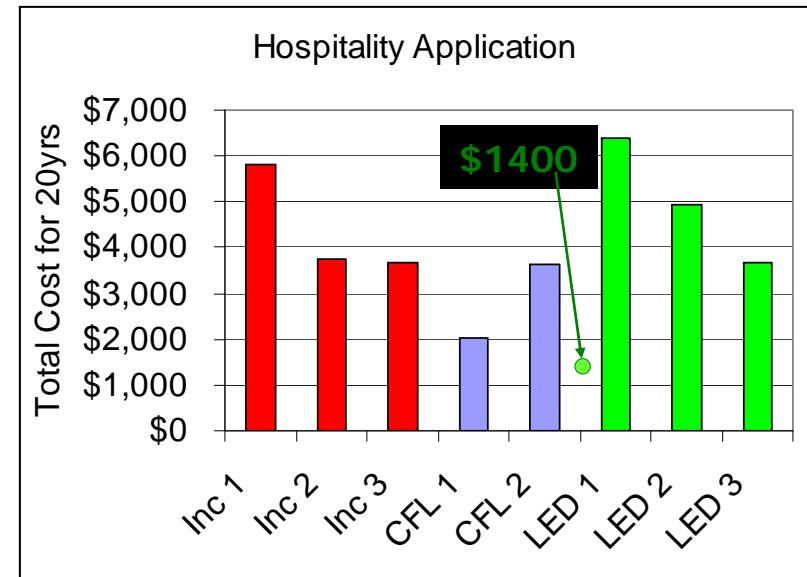
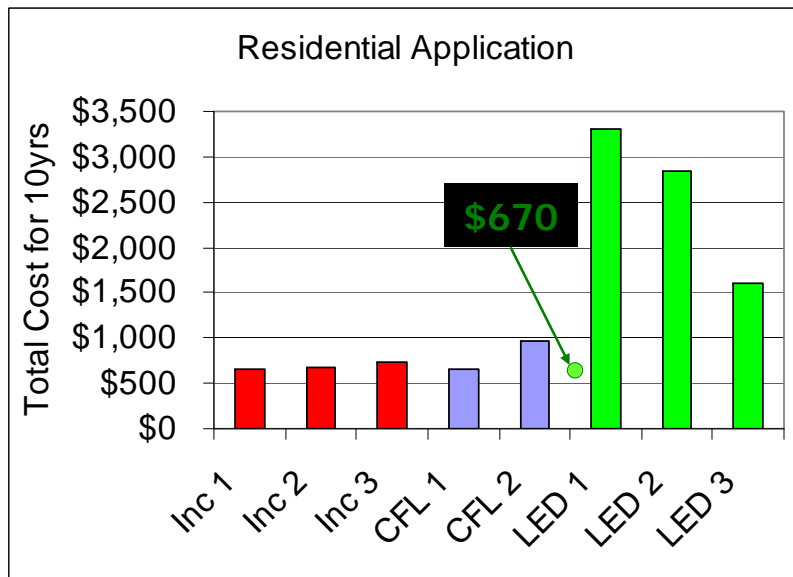
- Downlights:

■ Incandescent 75W	~\$50
■ CFL	~\$90 to \$140
■ LEDs (PC)	~\$300 to \$500

- (*LLF LED fixture under \$100)

Lifecycle cost

- In hospitality applications, the cost of using LED systems is approaching the cost of using traditional lighting systems.
 - The following cost estimates are based on the assumption that LED systems would last 50,000 hrs or longer.



(LLF was not considered in this calculation)

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.

Street lighting applications



LED fixture performance

150-W HPS
semi-cutoff cobra head



160 1-W white LEDs

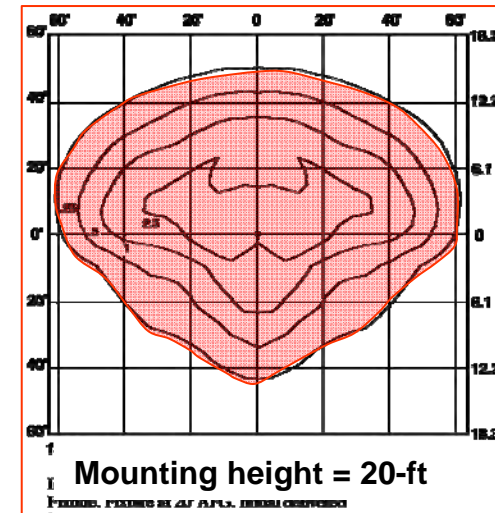
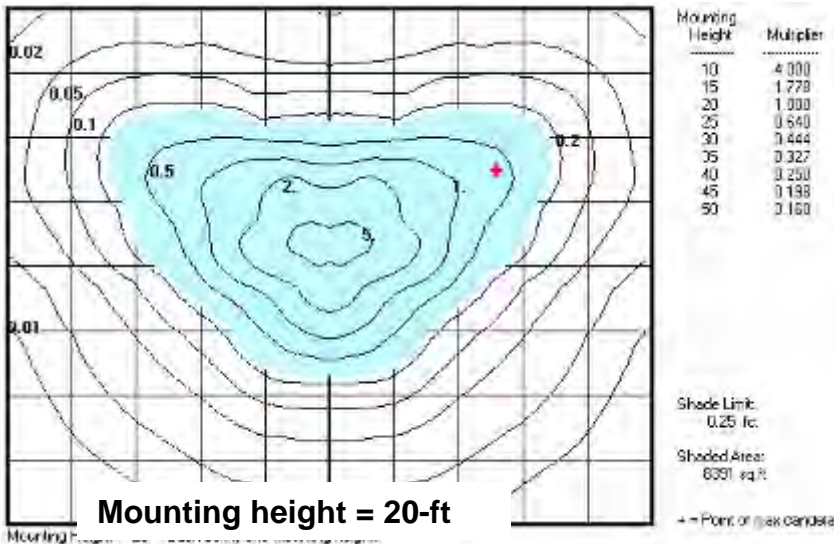


Lumens per lamp
Lumens per fixture
Fixture power

16000-lm (150-W)
12960-lm (150-W)
189-W (150-W)

Lumens per fixture
Fixture power

10,400-lm
189-W



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

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.

ASSIST Recommends

ASSIST recommends is sponsored by Cree, Federal Aviation Administration, Lite-On, GE Lumination (formerly known as GELcore), New York State Energy Research and Development Authority, Northwest Energy Efficiency Alliance, OSRAM SYLVANIA, Philips Lighting, Photonics Cluster (UK)/The Lighting Association, Seoul Semiconductor, and the U.S. Environmental Protection Agency.

ASSIST History & Background

- Established: In 2002
- Goal: To support the development and widespread application of LEDs for general illumination
 - Identify and reduce the major technical hurdles currently facing solid-state lighting
- Activities: Industry collaboration, research, demonstration, and education

ASSIST Program Sponsors



What is ASSIST Recommends?

- When standard definitions and metrics for LED technology are not available, ASSIST develops and publishes recommendations.
 - The recommendations are developed through research conducted by the LRC on behalf of ASSIST.
- ASSIST Recommends helps manufacturers present information to end-users in a consistent manner.
- ASSIST also publishes application guidelines to help end-users select and apply LED technology successfully.

ASSIST Recommends

- LED Life for General Lighting
 - Guideline for LED performance
 - Life definition: 70% lumen maintenance (50% for indicators or decoration)
 - Life reported by both LED and fixture manufacturers



<http://www.lrc.rpi.edu/programs/solidstate/assist/recommends.asp>

Additional ASSIST Recommends

- Two potential illumination applications in the near-term are:
 - Under-cabinet lighting
 - Directional lighting



ASSIST Recommends

■ Three parts

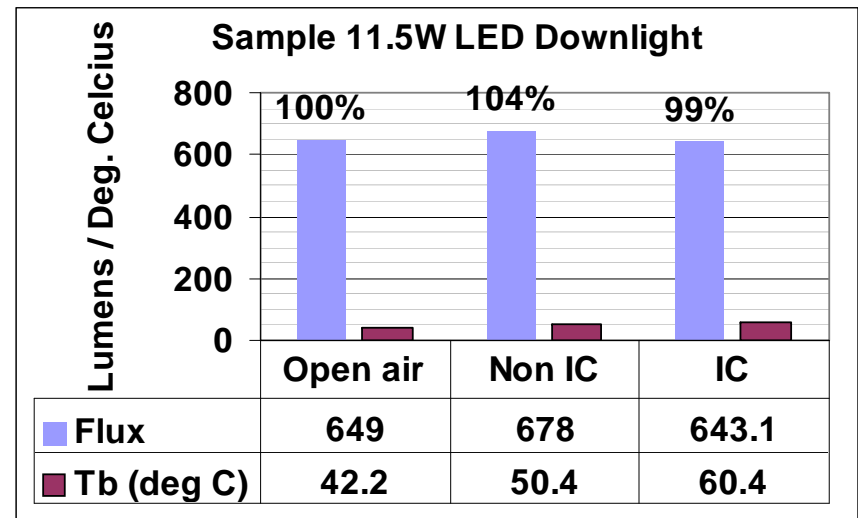
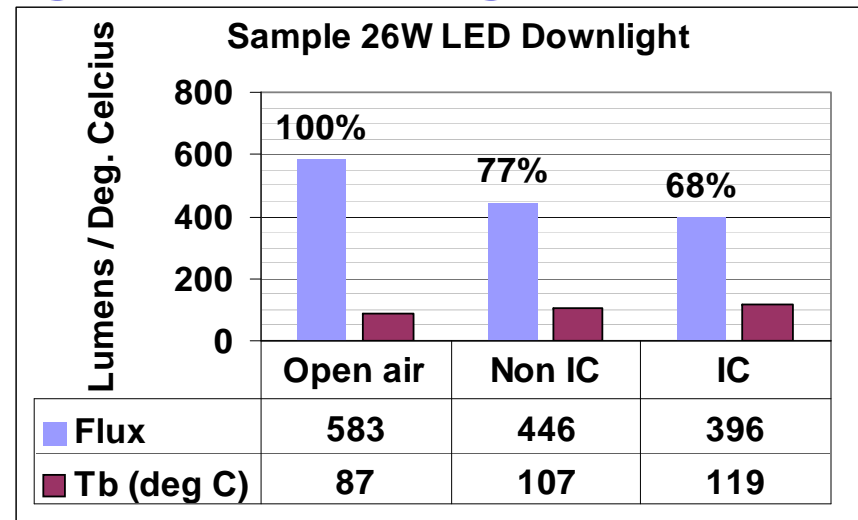
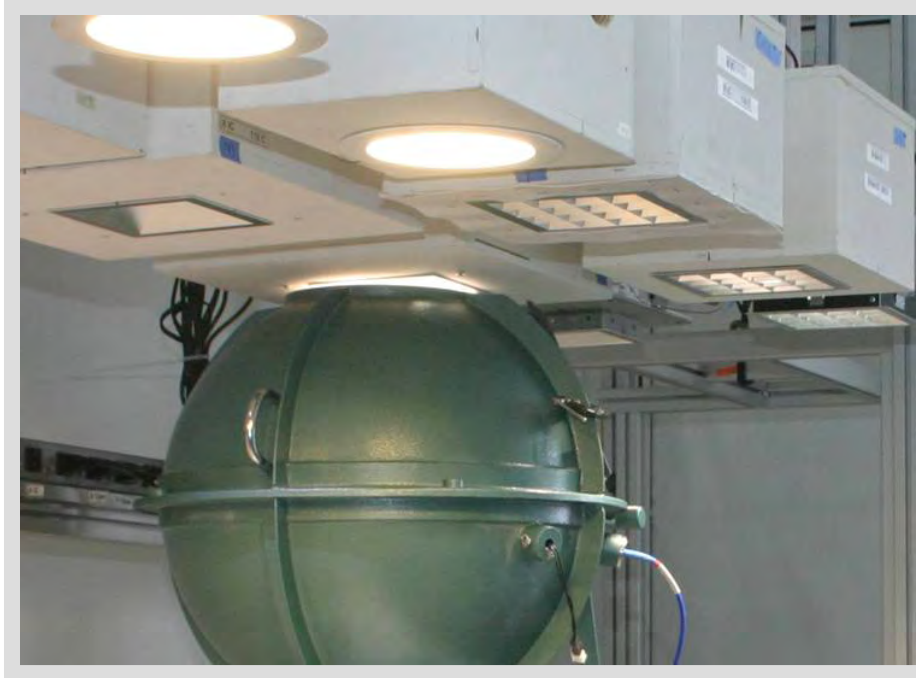
■ General guide to applications

■ Guide to selecting LED fixtures

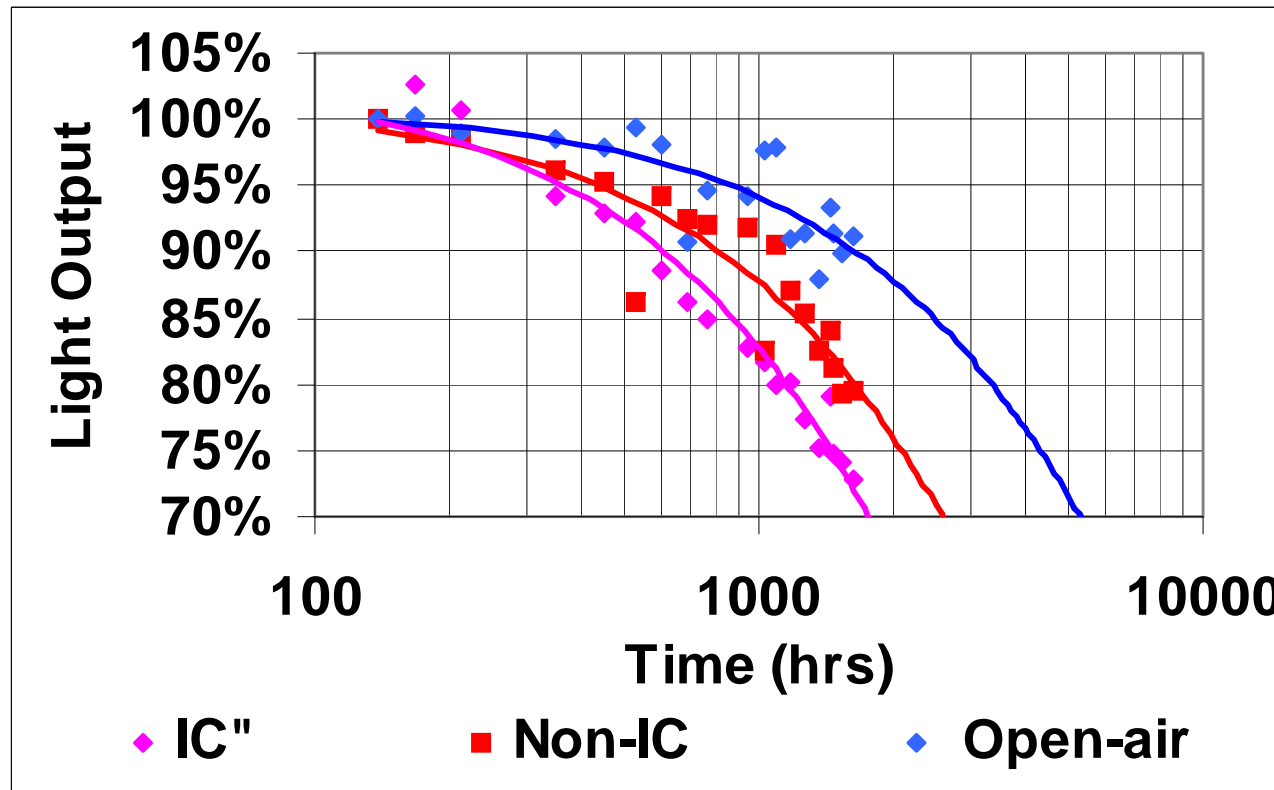
■ Testing and evaluation recommendations



LED Downlight testing



Downlight Fixture Life



Summary

- LEDs are rapidly advancing
 - Many commercial products
 - Significant performance variation
- LED fixture efficacy ~ 58% of LED efficacy
- Several, white LED fixtures in the marketplace
 - Many of them have very poor performance
 - Some downlights have performance much better than CFLs (as a system)
- ASSIST Recommends – a good way to identify good products