



LEDs: Getting to What's Real

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Technology Assessment Service

E SOURCE

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What's Coming

1. LED Attributes
2. Current Applications
3. Getting to general illumination:
 1. Avoiding CFL mistakes
 2. Energy Star Standards
 3. DOE Testing
 4. Lighting for Tomorrow
4. Utility programs



LED Attributes

- Long life
- Vibration resistance
- Small size
- Directional light output
- Efficiency is application dependent
- Heat is conducted away
- High performance at low temperatures
- Instant on, dimmable, controllable
- No IR or UV
- No mercury (but...)
- Expensive
- Rapidly improving



Early Applications

Replacing filtered incandescents

- exit signs, traffic signals, signage
- filtering makes low efficiency even lower





Expanding Niches

- Large Outdoor displays
- Holiday lights
- Retail accent lighting
- Airport runways
- Architectural lighting
- Marquis lighting
- Refrigerated display cases, walk-in freezers



LEDs for Cold Display Cases

- LEDs like the cold
- LED light is directional
- LED heat sink is outside the cooled case
- Customers like 'em
- Wal-mart application





General Illumination

What are the prospects?

Benefit from the lessons of the past



Avoiding mistakes

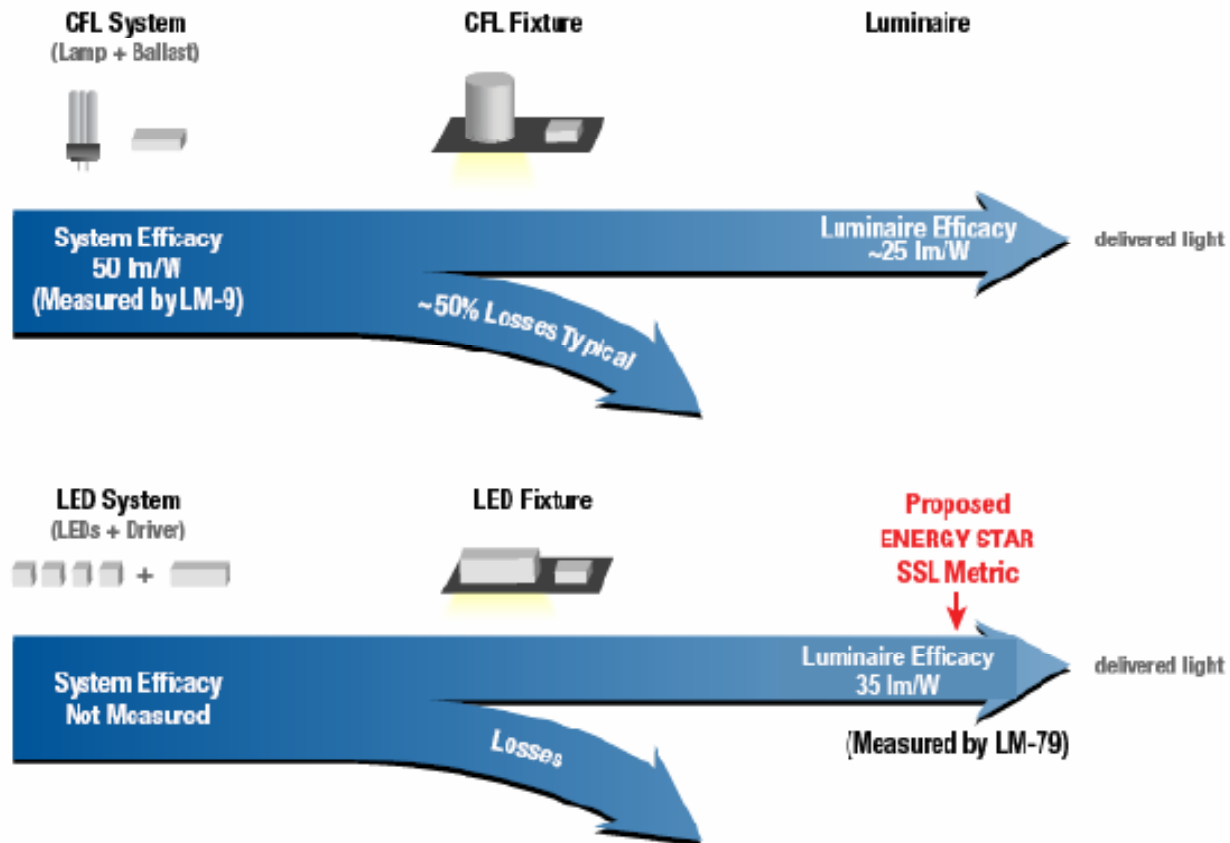
- CFL lessons learned
 - poor performance
 - exaggerated claims
 - high prices
- Early bad reputation has been hard to overcome

[see PNNL report: “Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market”]



Energy Star for LEDs

System Efficacy Vs. Luminaire Efficacy (Recessed Downlights Example)



Source: Pacific Northwest National Laboratory

1/30/08



Energy Star for LEDs

- Final Criteria released September 12, 2007
- Effective date set for September 30, 2008
- Two category approach



Energy Star for LEDs

Category A

- Near-term applications
- CRI at least 75
- PF of 0.7 for res; 0.9 for comm
- Thermal management
- Life: 35,000 hrs for most apps
- Efficacy: match CFL by application
 - eg $58.8 \text{ lu/W} \times 0.6 \text{ fixture eff} = 35 \text{ lu/W}$



Energy Star for LEDs

Applications

1. Undercabinet Kitchen
2. Undercabinet Shelf-mounted Task
3. Portable Desk/Task
4. Recessed Downlights (Res./Com.)
5. Outdoor Wall-mounted Porch
6. Outdoor Step
7. Outdoor Pathway



Energy Star for LEDs

Category B

- For longer term
- At least 70 lumens/watt



DOE Testing

CALiPER Program to track LED progress and share reliable data

- Wide range of performance (6 to 62 lm/W; 52 to 95 CRI)
- Some exaggerated claims (more than half were off by 70%)

<http://www.netl.doe.gov/ssl/>



Sample DOE Downlight Test Results

Product	Power (Watts)	Luminaire Efficacy (lumens/Watt)	Color Rendering Index (CRI)
LED Downlight Retrofit Lamp	12	60	95
LED Downlight Fixture	15	36	81
LED Downlight Fixture	31	12	76
CFL Downlight Fixture	12	42	82
<small>Source: Adapted from Brodrick, "LED Watch," LD+A November 2007.</small>			



LED Competition

Lighting for Tomorrow winners:

- Downlight
- Desk lamp
- Glare-free outdoor lighting
- see www.lightingfortomorrow.com/2007/ssl_winners07.shtml



LED Downlight



LR6 from LLF Inc.



LED Desklamp



PLS Desk lamp from Finelite; see [Integrated Office Lighting Systems: Making It Personal \(TB-33\)](#)



LED Outdoor light



Strata Outdoor by Progress Lighting



LED Cost Effectiveness

Dimmable downlights

Light source	Average initial cost (per 1,000 lm)	Expected lifetime (hours)	Product cost per 1,000 lm for 50,000 hours of use	Lifecycle cost (lamps +energy)
LED	\$175-600	50,000	\$175-600	\$260-840
Incandescent 65-W reflector lamp	\$2.50	2000	\$62.50	\$387.50
CFL, dimmable, 15 W lamp	\$13.50	6,000	\$112.5	\$187.50



Challenges

- Manufacturer's exaggerated claims
- Literature often does not include adequate info
- Misleading claims
 - eg lower power, but also lower light levels



Utility Programs

- Standard:

Exit signs	21
Traffic signals	15
Holiday Lights	7
Outdoor signs	4
Refrigerated cases	2
Pilots and demos	

- Cutting edge:



Utility Programs

- What about streetlighting
 - DOE demo: 36% energy saved; 18 yr payback
 - Lots of pilot programs, eg Ann Arbor, Toronto, Raleigh
 - Monitor the results
 - Participate in demos
- Examine:
 - Light levels
 - Energy savings compared to what





Avoid disappointments

- Check for DOE test data
- Look for luminaire data, not bare LED claims
- Look for performance numbers vs relative comparisons
- Look for performance data from independent laboratories
- Commission you own tests



For More Information

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