# Expanding Category A

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# Strategy

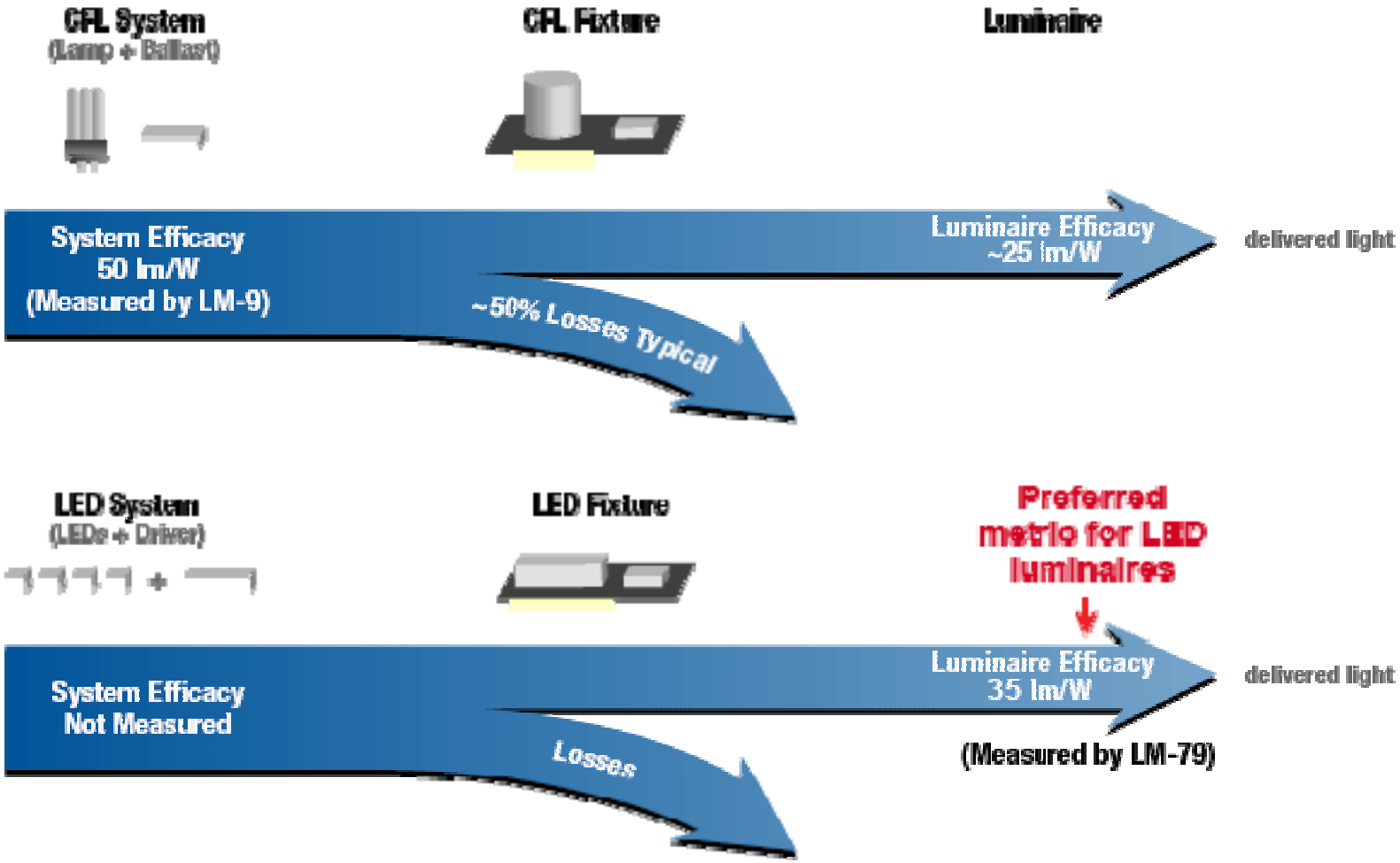
- Periodically add additional Category A applications as the technology improves
- No changes to major provisions
- Utilize information from CALiPER testing
- Establish minimum luminaire efficacy
  - Benchmark to prevailing technology
  - Use IES recommendations wherever possible: Handbook, RP-33-99, etc.

# Strategy (cont.)

- Release draft criteria for public review and comment
- DOE intends to release the draft of the first additions in July.

# System Efficacy Vs. Luminaire Efficacy

(Recessed Downlights Example)



# Assumptions for Establishing Luminaire Efficacy

| Application | CFL System Efficacy | Typical Fixture Efficiency | Calculated Luminaire Efficacy |
|---|---|---|---|
| **Under-cabinet Kitchen** | 58.8 | 40% | 24 |
| **Under-cabinet Shelf-mounted Task** | 58.8 | 50% | 29 |
| **Portable Task** | 58.8 | 50% | 29 |
| **Recessed Downlight (residential)** | 58.8 | 60% | 35 |
| **Recessed Downlight (commercial)** | 58.8 | 60% | 35 |
| **Outdoor Wall-mounted Porch** | 58.8 | 40% | 24 |
| **Outdoor Step** | 50 | 40% | 20 |
| **Outdoor Pathway** | 50 | 50% | 25 |

# Current Considerations

- DOE is considering adding the following to Category A:
  - Street and area lighting
  - Parking garage lighting
  - Cove lighting
  - Ceiling fan light kits
  - Replacement lamp applications
  - Display and accent lighting
  - Wall-wash applications

# Outdoor Area Lighting

- Street Lights
- Parking Lot Lights
- Parking Garage Lighting
- Wallpacks
- Efficacy should be on par with Metal Halide

# Cove Lighting

- Inverse of undercabinet
- Benchmark to fluorescent
- Efficacy likely to be similar to current undercabinet criteria

# Ceiling Fan Light Kits

- Benchmark to fluorescent
- May separate into two sub-categories
  - Dome
  - Mini-pendants

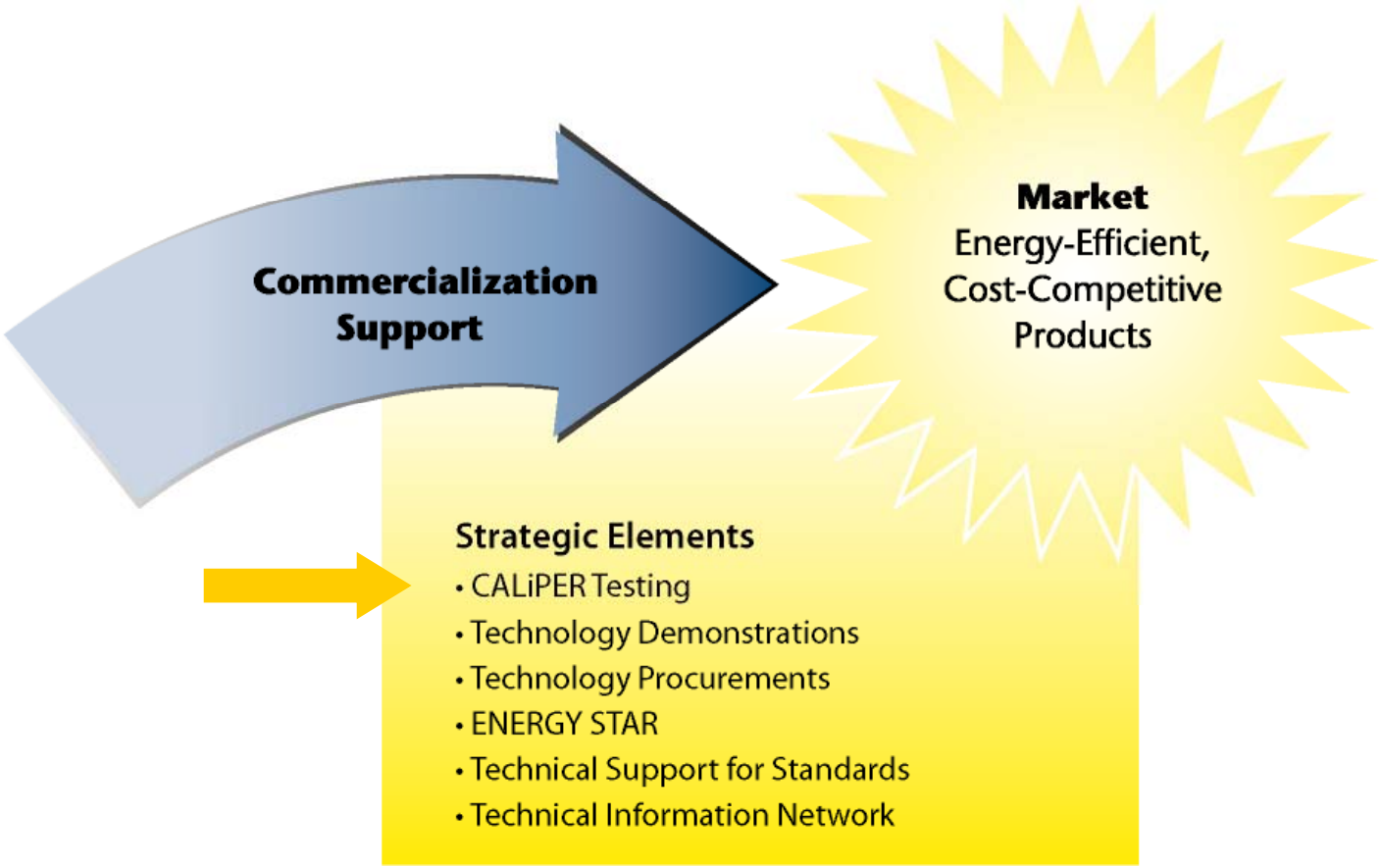
# Replacement Lamps

- MR-11/16
- PAR-38
- Due to integral design DOE is considering testing similar to what is currently used in the CFL program
- Efficacy should be on par with at least recessed downlights @ 35 lm/W

# Future Considerations

- Based on experience in the CALiPER Program
- Manufacturer supplied test reports (LM-79)

# DOE SSL Pathways to Market



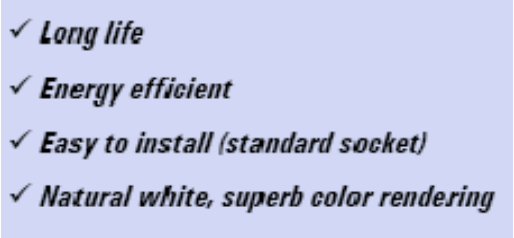
# CALiPER Program

- Purposes of CALiPER
- Testing program scope
- Testing methods & CALiPER process
- Rounds 1-4 results
- Where to go for more info

Photo credit: Luminaire Testing Laboratory

# Purposes of CALiPER

- Provide objective, high quality performance information
- Know performance of market available products
  - To support R & D planning
  - To support ENERGY STAR
- Inform industry test procedures and standards development
- Discourage low quality products
- Reduce SSL market risk due to buyer dissatisfaction from products that do not perform as claimed

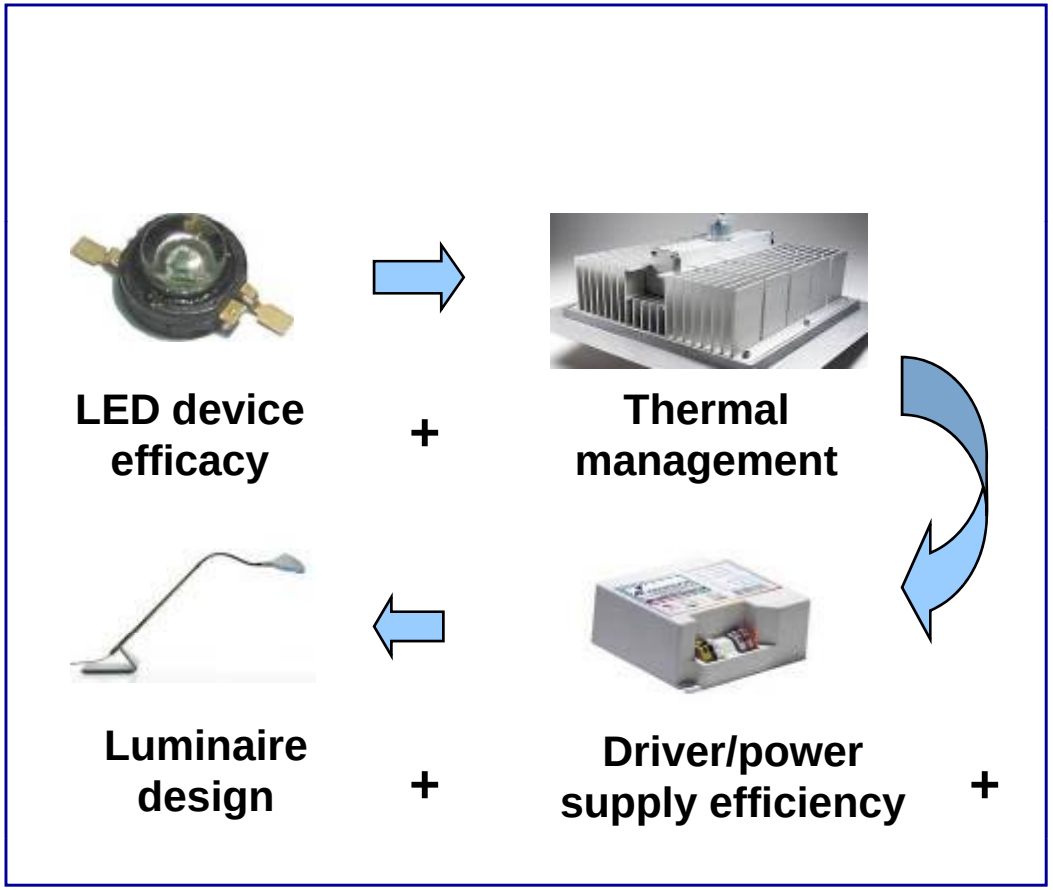


# Testing Program Scope

Commercially-available SSL products for the general illumination market

- Luminaires and replacement lamps (white light)
- Indoor and outdoor
- Residential and commercial

# SSL Luminaire Testing




- Must measure luminaire as a complete system
- Uses ‘absolute photometry’ rather than ‘relative photometry’
- Based on IESNA *draft* standard LM-79
  - Photometric testing methods under development
- Stakeholders are not all familiar with these new testing paradigms

# Types of CALiPER Testing

- Basic photometry (following IESNA LM-79 draft)
  - Integrating Sphere and Goniophotometry
    - Luminaire light output, efficacy
    - Color qualities (spectral power distribution, CCT, CRI)
    - Beam characteristics and intensity distributions
    - Electrical measurements, thermal characteristics
  - Benchmarking (other light sources)
- Other, non-standardized testing
  - "In Situ" Testing (relative measurements)
    - Environmental chamber
    - Insulated ceiling, recessed can
  - Lumen depreciation testing
    - Draws from IESNA LM-80 draft
  - Exploratory testing
    - Thermal imaging, dimming…

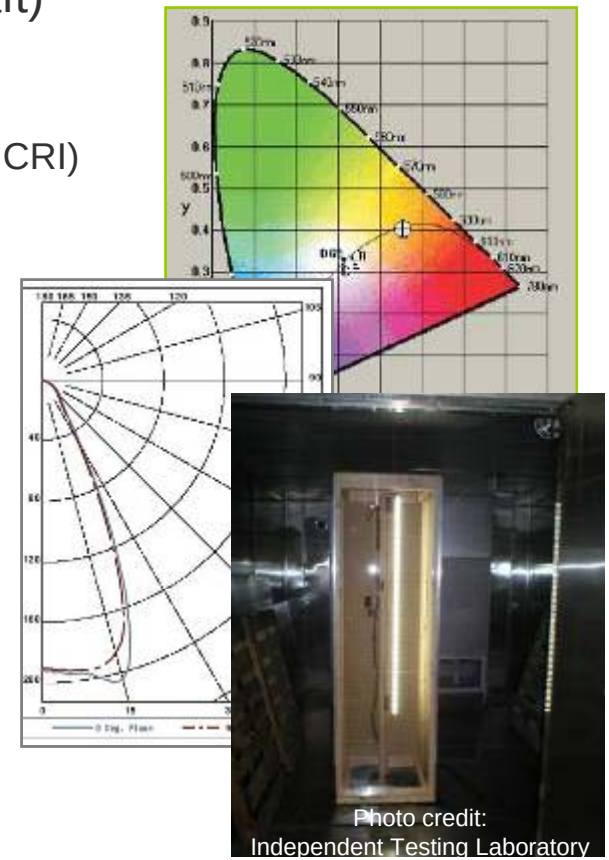


Photo credit:
Independent Testing Laboratory

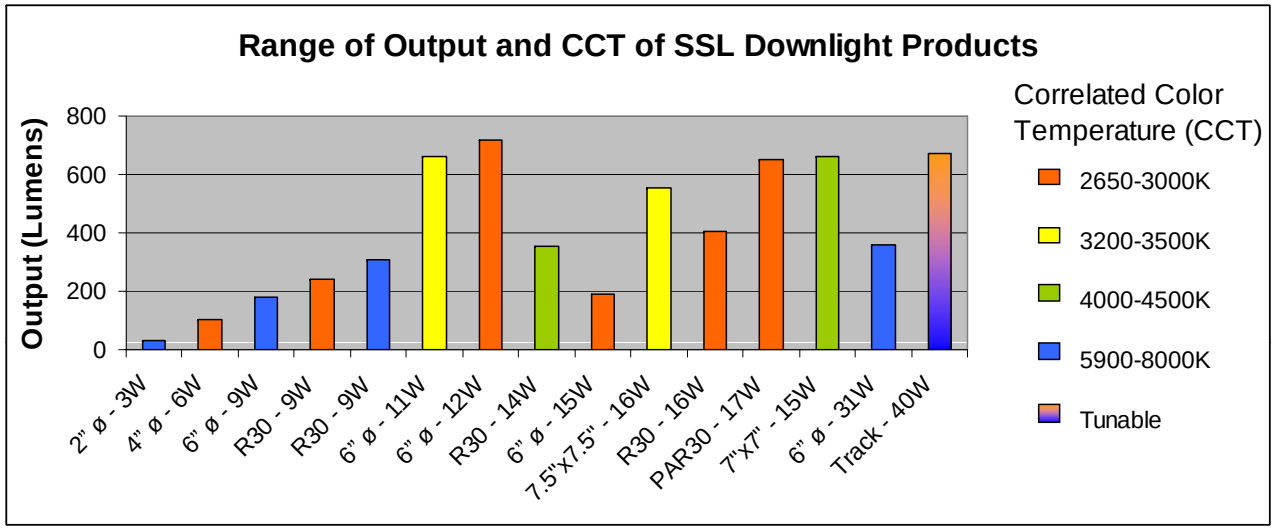
# Testing Program Quarterly Process

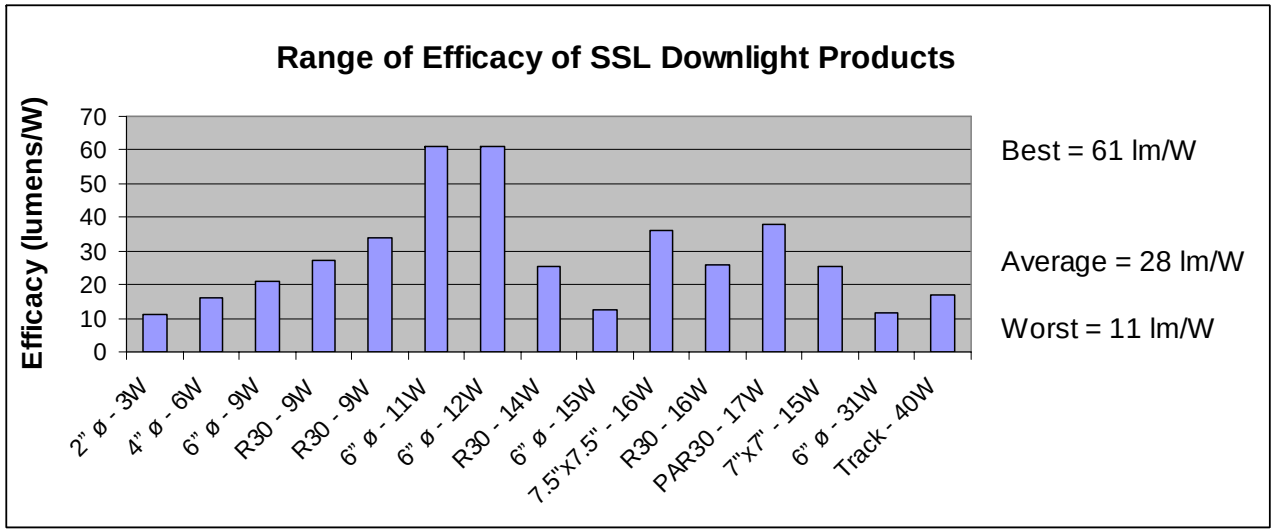
- Product selection & acquisition
- Multiple independent test labs
- Assembly and analysis of results
  - Courtesy sharing of results with manufacturers
  - Retesting options
- Publication of results
  - Summary reports
  - Detailed test reports
  - Analyses and studies
- “No Commercial Use” Policy

# Testing Rounds 1-4 Results

- 70+ products tested
- Focus: overall luminaire performance
- Wide range in products & results

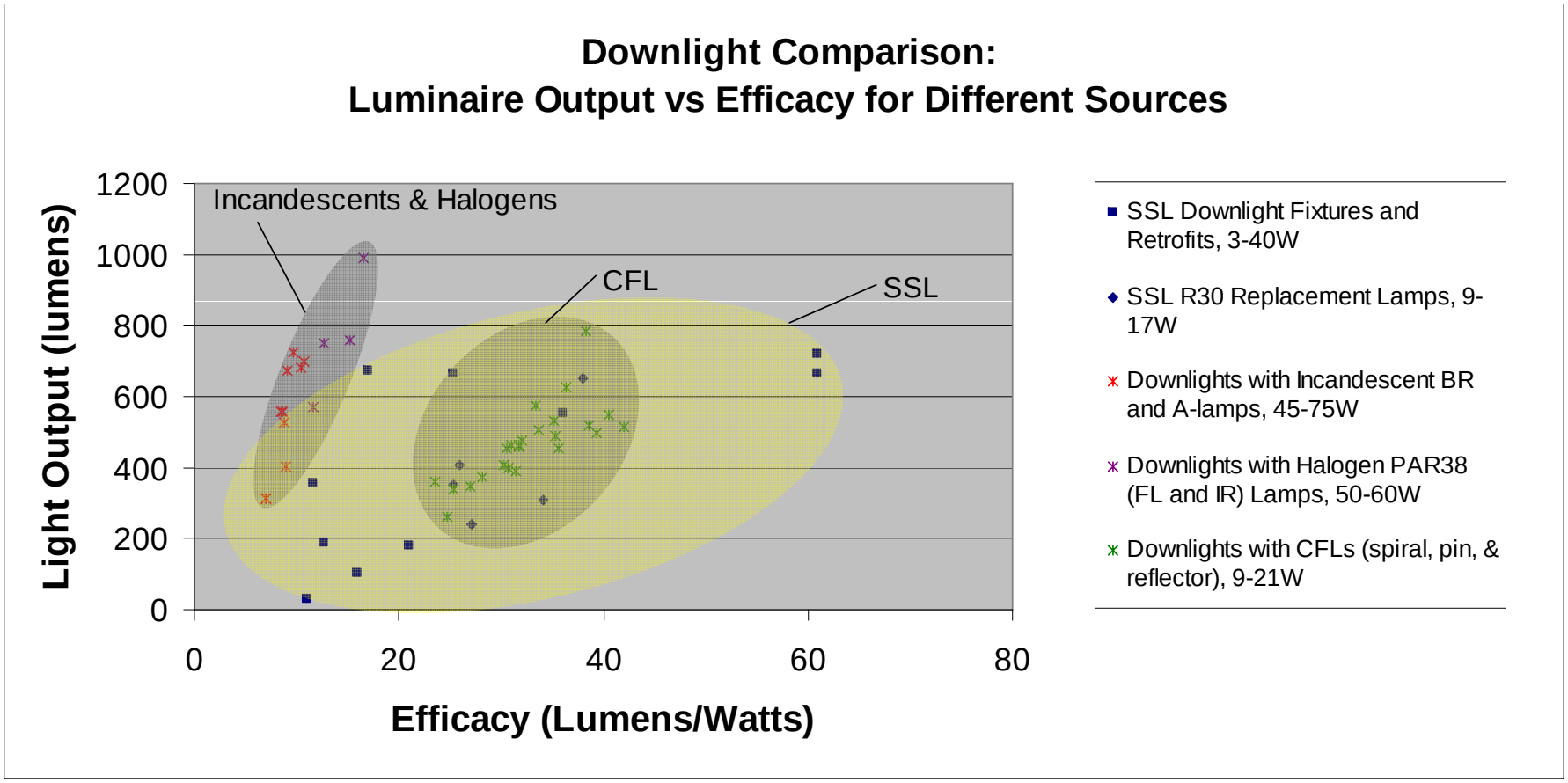
# SSL Downlight Performance




- Different sizes and configurations
- Different color temperatures
- Outputs
  - From 29 to 719 lumens
  - 389 lumens on average
- Efficacies
  - From 11 to 61 lm/W
  - 28 lm/W on average
- CRI
  - Maximum = 95
  - Average = 76
  - 3 RGB products

# Downlight Benchmarking



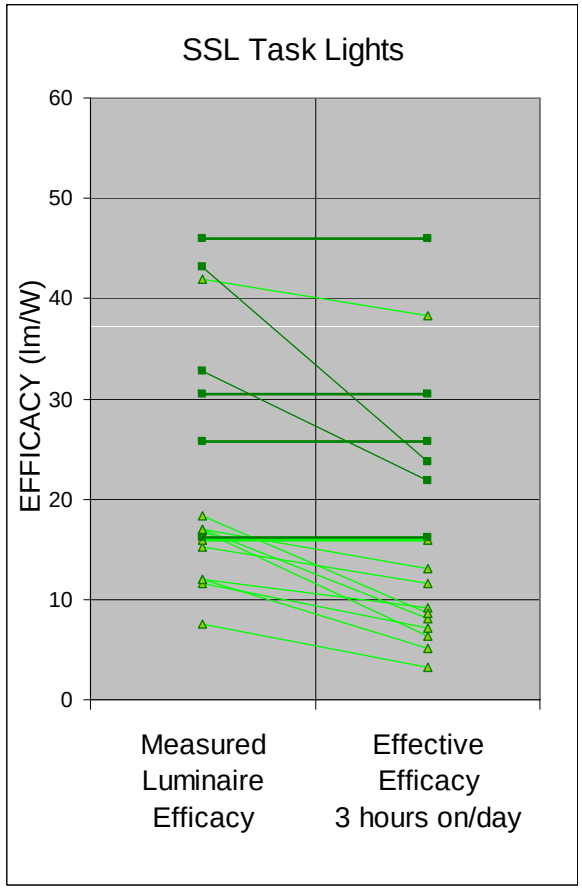

--Values for SSL downlight products are from CALiPER testing.
--Values for CFL and incandescents are assembled from CALiPER testing, earlier photometric testing and product catalogs.
--Fixture efficiencies are applied to replacement lamp values (factor depends on lamp type).

# Round 4 Replacement Lamps

- T8: Look for direct comparisons with fluorescents in troffers in Round 5
  - Respectable performance (42 lm/W), but misleading manufacturer literature
- MR16: not quite competing with 20W Halogen MR16 Flood (40° beam angle)
  - ↑ Efficacy: SSL-MR16 @ 16-27 lm/W **>** 20W Halogen flood @ 9-19 lm/W
  - ↓ Output: SSL-MR16 @ 75-133 lm **<** 20W Halogen flood @ 200-450 lm
  - ↓ CBCP: SSL-MR16 @ 59-283 cd **<<** 20W Halogen flood @ ~500 cd
- Candelabra: Low wattage level, advantage or disadvantage?
  - No comparably small wattage incandescent products
  - CFL 5W candelabra rated at 200 lm (40 lm/W), Halogen 25W rated at 280 lm (11 lm/W)

| Replacement Lamps | | Power | Output | Efficacy | CCT | CRI |
|---|---|---|---|---|---|---|
| SSL T8 | 07-56 | 25 | 1058 | 42 | 3494 | 75 |
| SSL MR16, *CBCP=283* | 07-53 | 3 | 82 | 27 | 3007 | 74 |
| SSL MR16, *CBCP=220* | 07-59 | 9 | 133 | 16 | 3338 | 89 |
| SSL MR16, *CBCP=59* | 07-64 | 3 | 75 | 26 | 3458 | 74 |
| SSL Candelabra | 07-57 | 2.2 | 28 | 13 | 2855 | 71 |

# SSL Task Lamp Performance




SSL Undercabinets

SSL Desk Lamps

## Task lamps tested

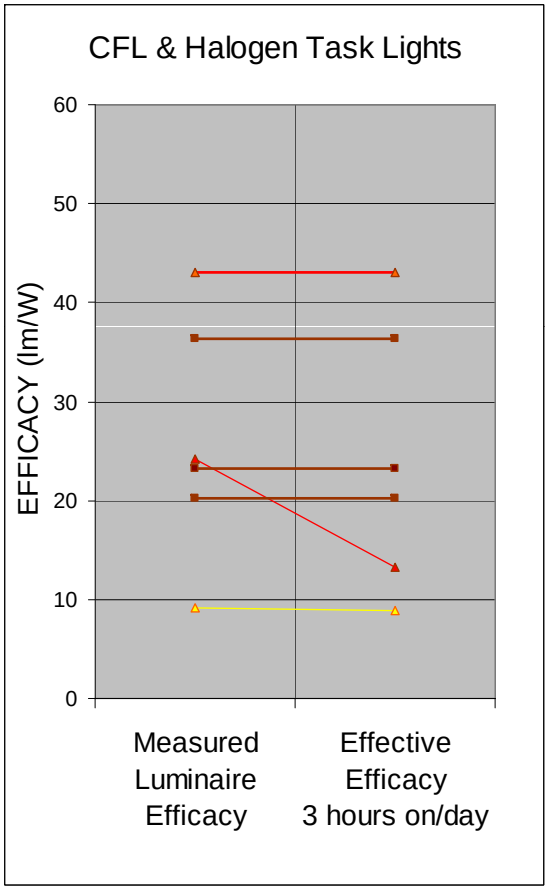
- 6 SSL undercabinets, 11 SSL desk lamps
- 3 fluorescent tube undercabinets, 2 CFL desk lamps
- 1 halogen desk lamp

## SSL undercabinets

- Perform as well or better than fluorescent undercabinets

## SSL desk lamps

- One SSL desk lamp rivals CFL energy star desk lamp
- Off-state power use ranges from 0 W to 2.6 W, reducing efficacy




Fluorescent Undercabinets

CFL Desk Lamps

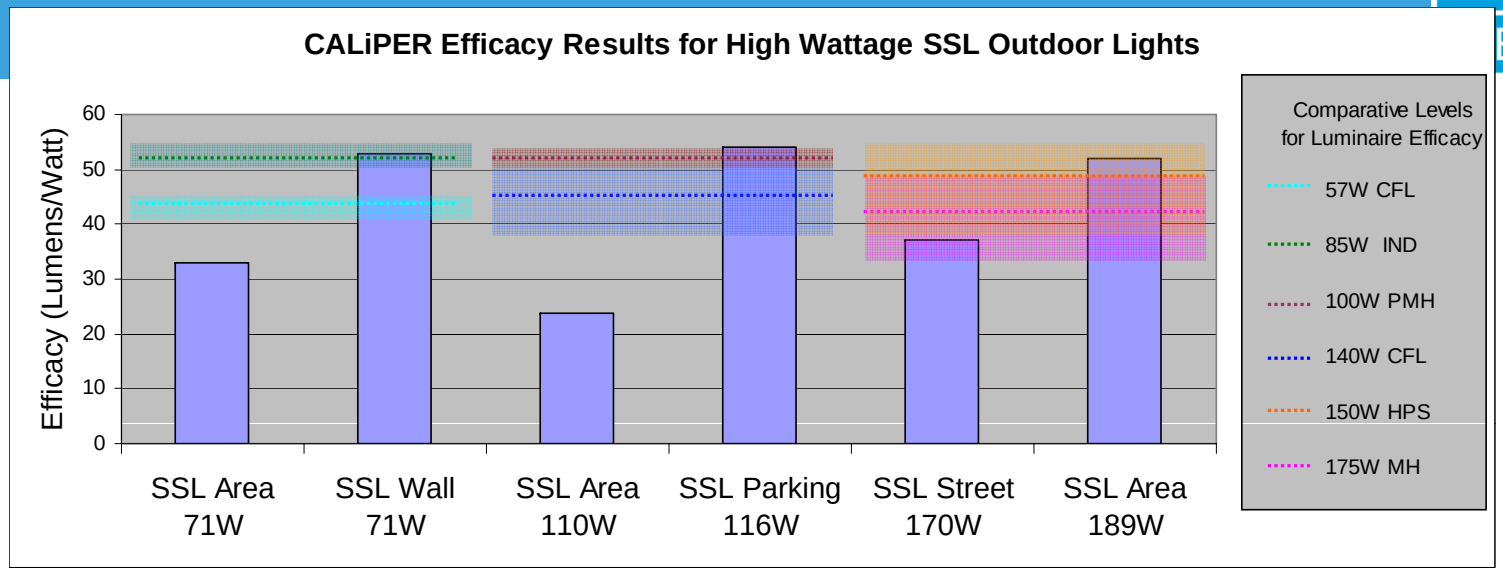
Halogen Desk Lamps

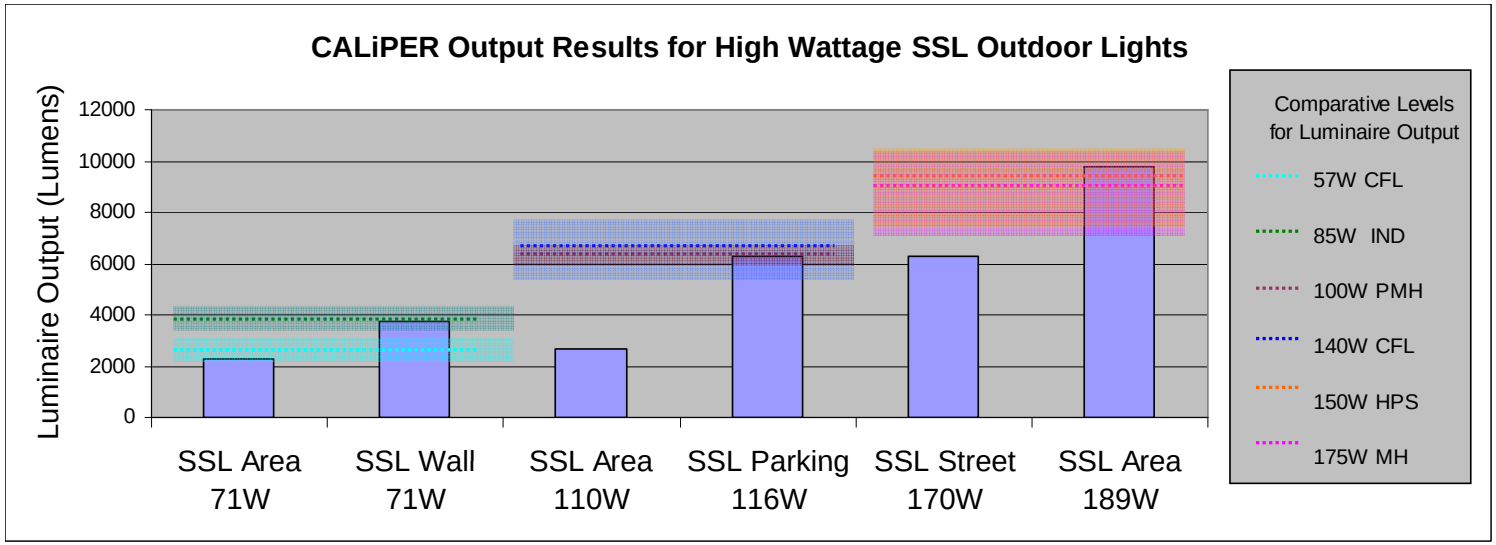
# Round 4 Direct Comparisons

| Same Recessed Wall Fixture, Different Sources | | | |
|---|---|---|---|
| | Halogen (20W) | CFL (13W) | LED (12W) |
| Luminaire Output (lm) | 174 | 199 | 154 |
| Luminaire Efficacy (lm/W) | 8 | 16 | 10 |
| CCT | 3085 | 3956 | 5166 |
| CRI | 98 | 77 | 73 |
| Power Factor | 0.99 | 0.97 | 0.97 |

| Manufacturer Published Values | | | |
|---|---|---|---|
| Recessed Wall Fixture | Manufacturer Brochure Output "Lumens" | Efficacy Calculated from Manufacturer IES files (lumens/W) | **CALiPER Measured Luminaire Efficacy (lumens/W)** |
| Halogen (20W) | 350 | 8 | **8** |
| CFL (13W) | 900 | 19 | **16** |
| LED (12W) | 195 | 5 | **10** |

# Outdoor Luminaires




Comparative levels are for initial luminaire efficacy and output, established using IES files and ballast factors for outdoor area lights, cobraheads, post-top, and pedestrian lights for CFL, induction, metal halide, pulse start metal halide, and high pressure sodium fixtures.

# Rounds 1-4 Key Conclusions

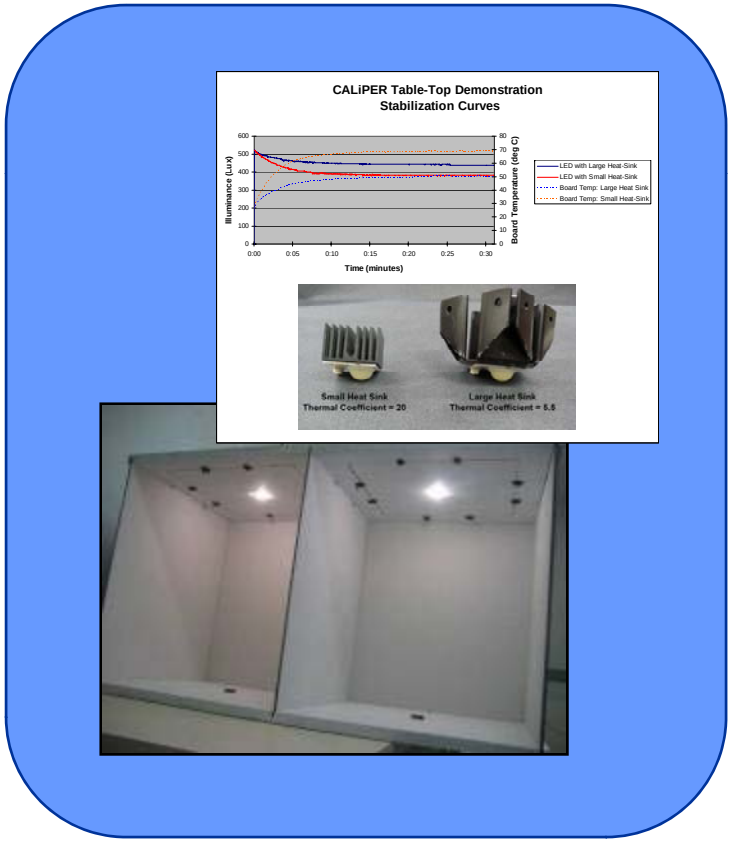
- Results include a wide range of products with a wide range of performance.
  - Be careful not to generalize.
- Product literature not always consistent, not always reliable
  - Be informed. Request luminaire testing results.

Round 1-4 products designed from 2005-2007, showing some now clearly rival traditional sources

Great promise for upcoming generation of SSL luminaires

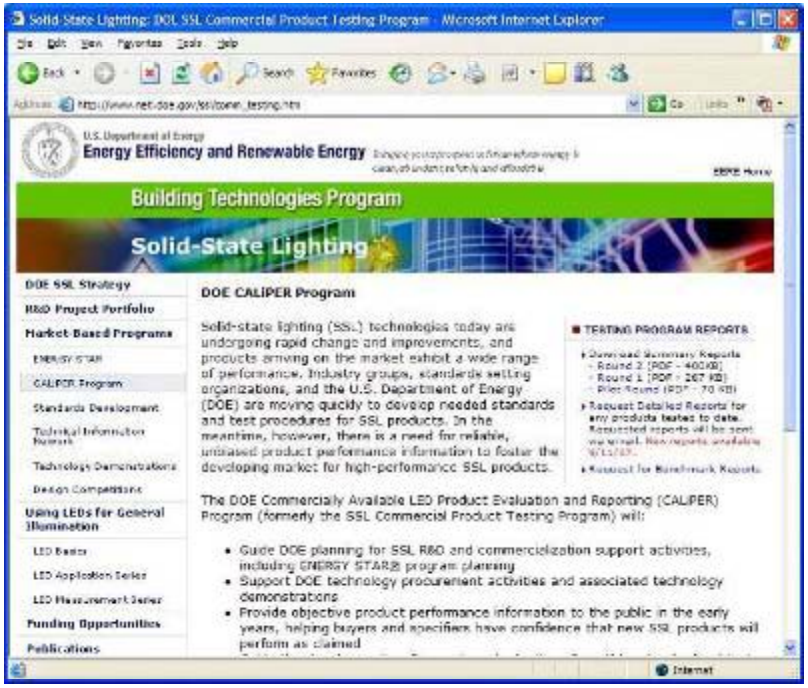
# CALiPER Positive Influences

- Testing standards validation & refinement
  - CALiPER Roundtable interactive meeting of experts (proceedings on-line)
- Market/industry awareness & involvement
  - Articles and discussions
  - Improvements in SSL product literature
  - CALiPER Booth



# More Info on CALiPER

- Via website
  - Summary reports
  - Detailed reports
    - Must be requested via web form
    - Requestor's contact information must be provided
    - Must agree to adhere to 'No Commercial Use Policy'




http://www.netl.doe.gov/ssl/comm_testing.htm

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# Questions?

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DOE SSL Website: www.netl.doe.gov/ssl/