Performance Insights on Solid State Lighting

USA DOE's CALiPER, NGL, and LED Lighting Facts Programs

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Outline

- The programs
- The trends
- Digging deeper
- Next steps

CALiPER

LED lighting facts®
A Program of the U.S. DOE

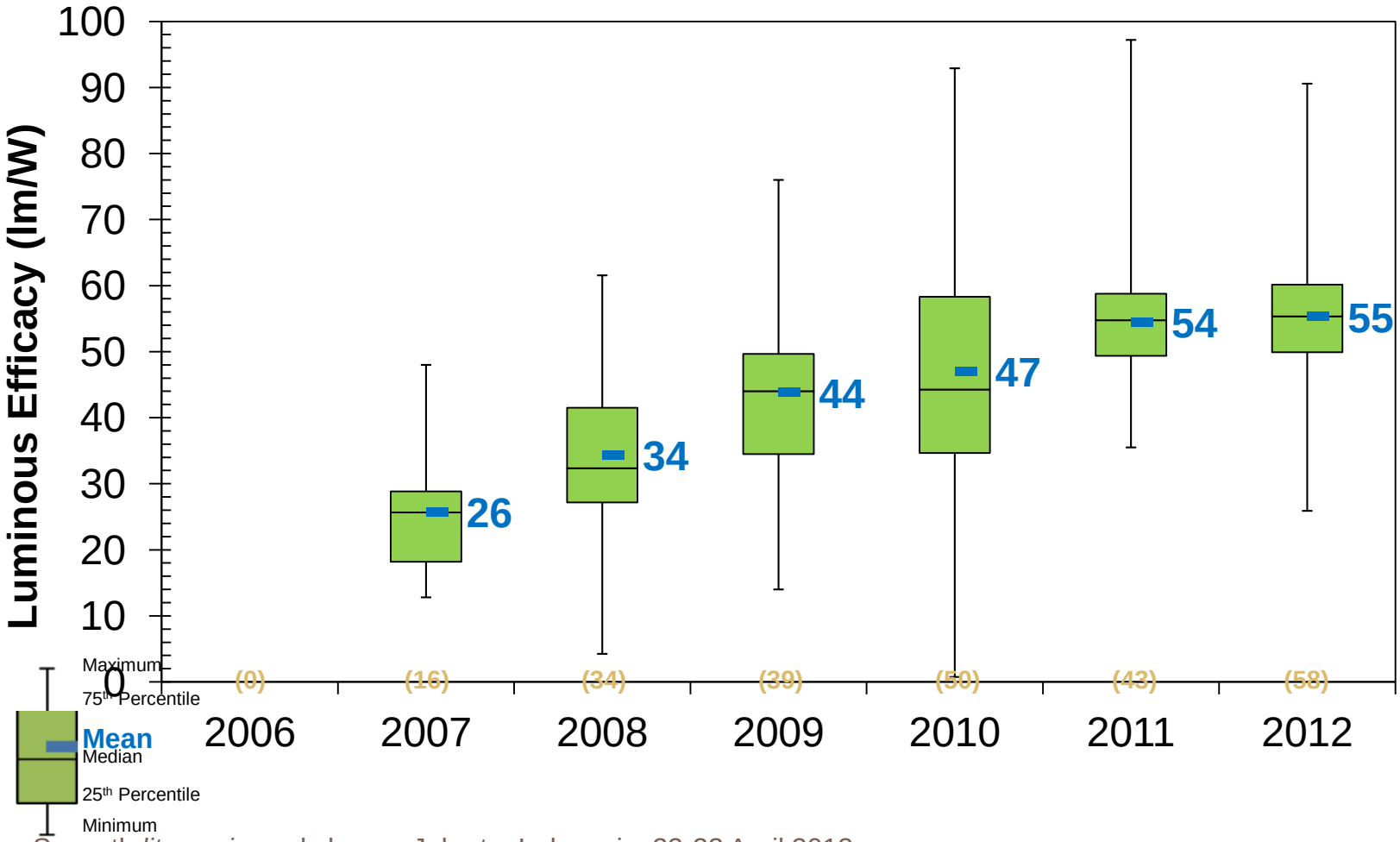
Next Generation LUMINAIRES

The DOE Programs

Understanding the Trends

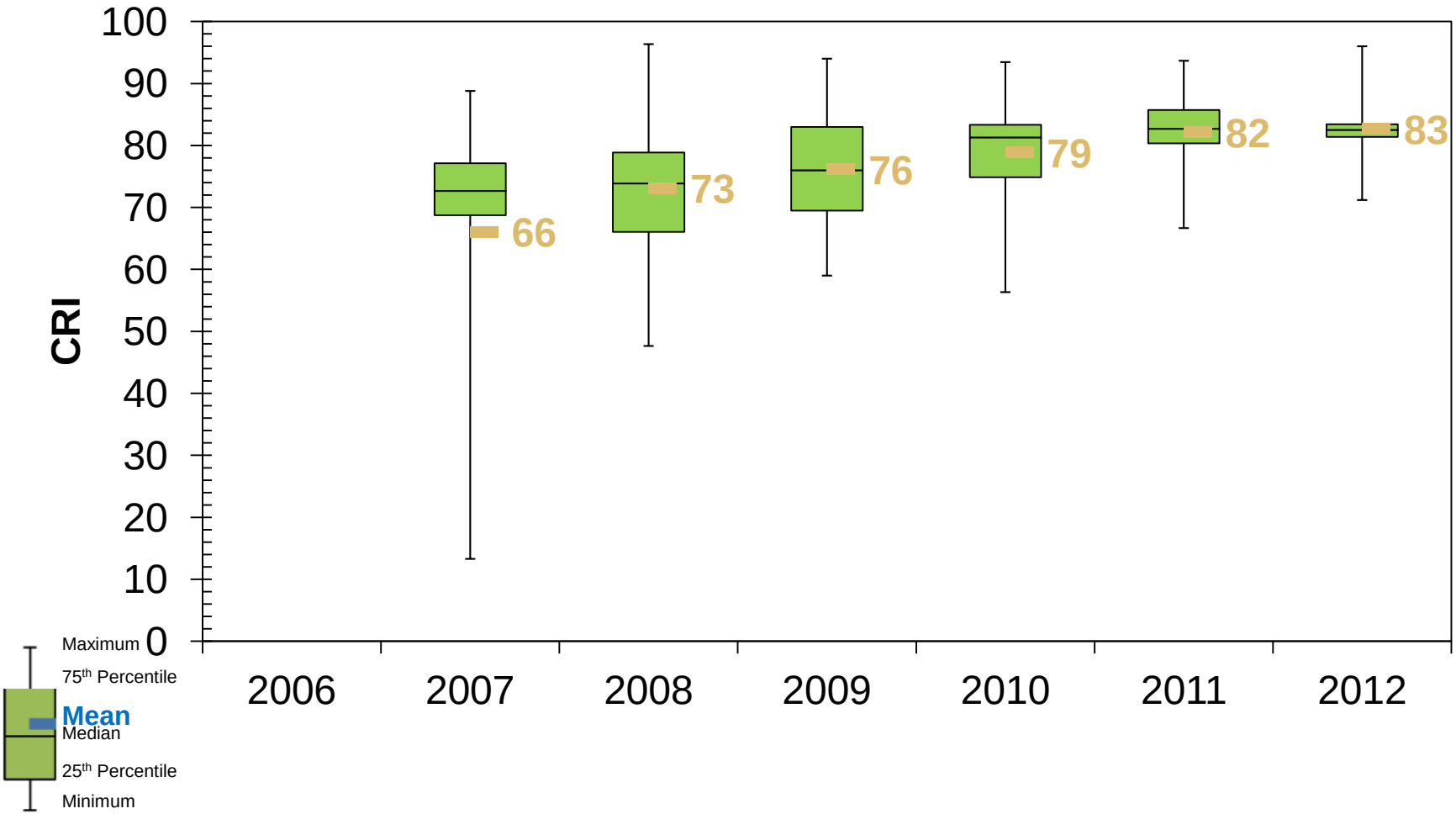
- CALiPER – significantly dependent on products tested in a given year
  - 600 tested since 2006 (around 60-150 year)
- LED Lighting Facts – best trend set
  - 7,000 products *listed*
- Next Generation Luminaire (NGL) – only products meeting strict competition requirements
  - Started 2008 – approximately 150 entries each year

CALiPER – Efficacy, Lamps



CALiPER – CRI, Lamps

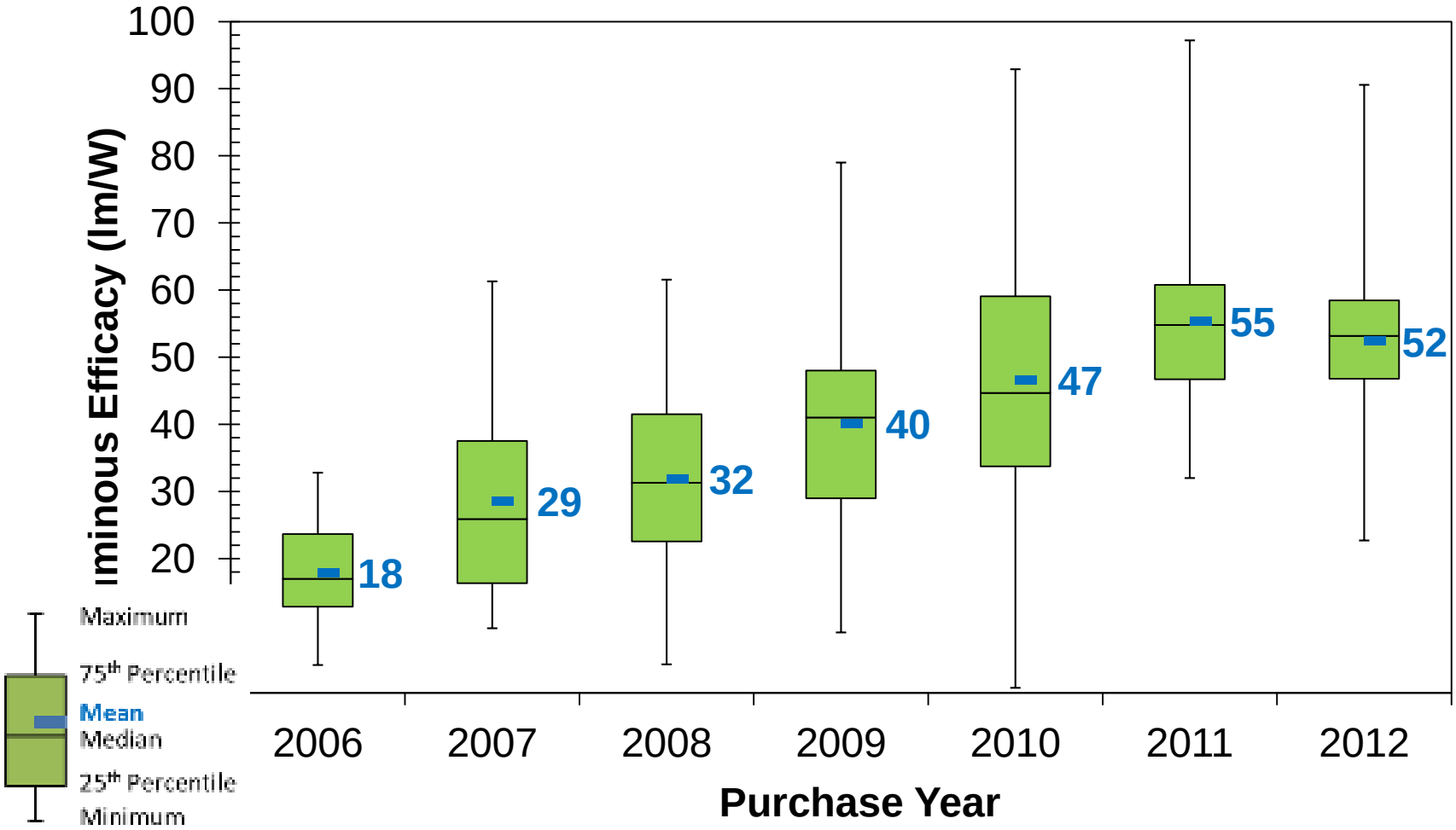
Color Rendering



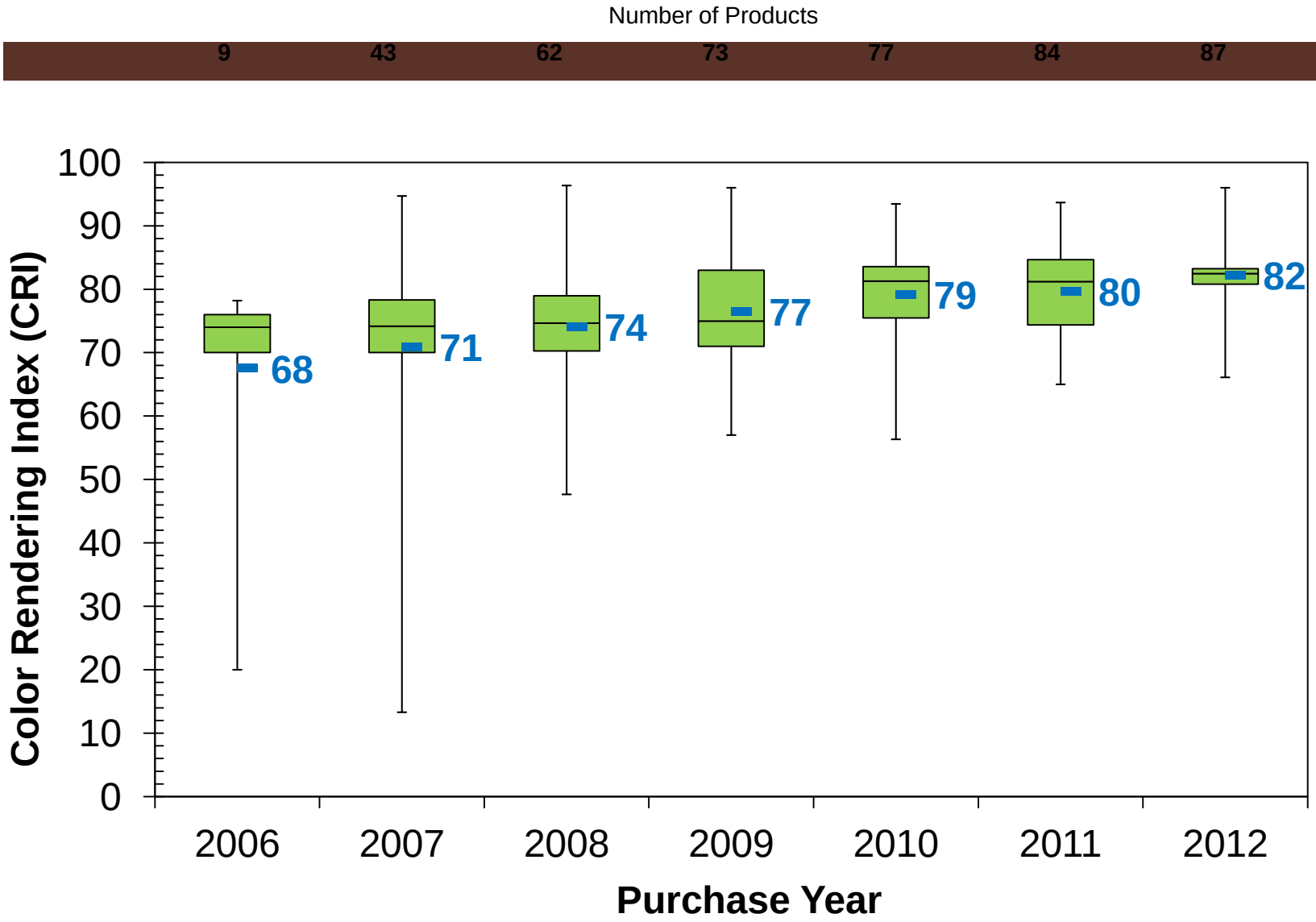
CALiPER – Efficacy, All Products

Number of Products

9 43 62 73 77 84 87



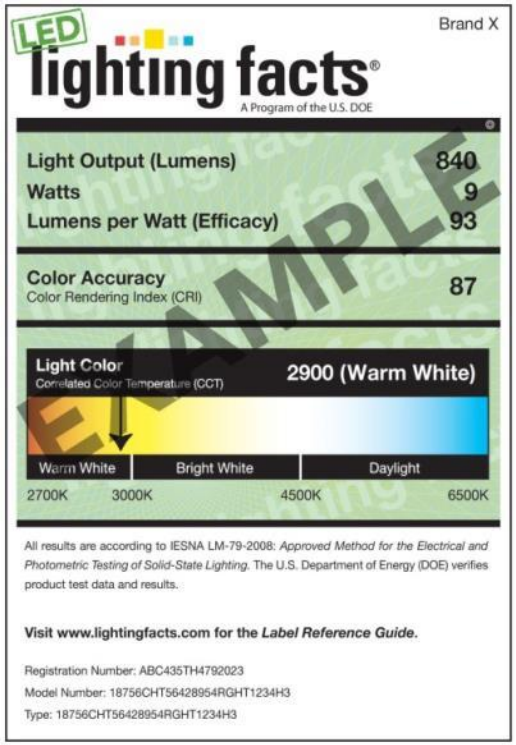
CALiPER – CRI, All Products

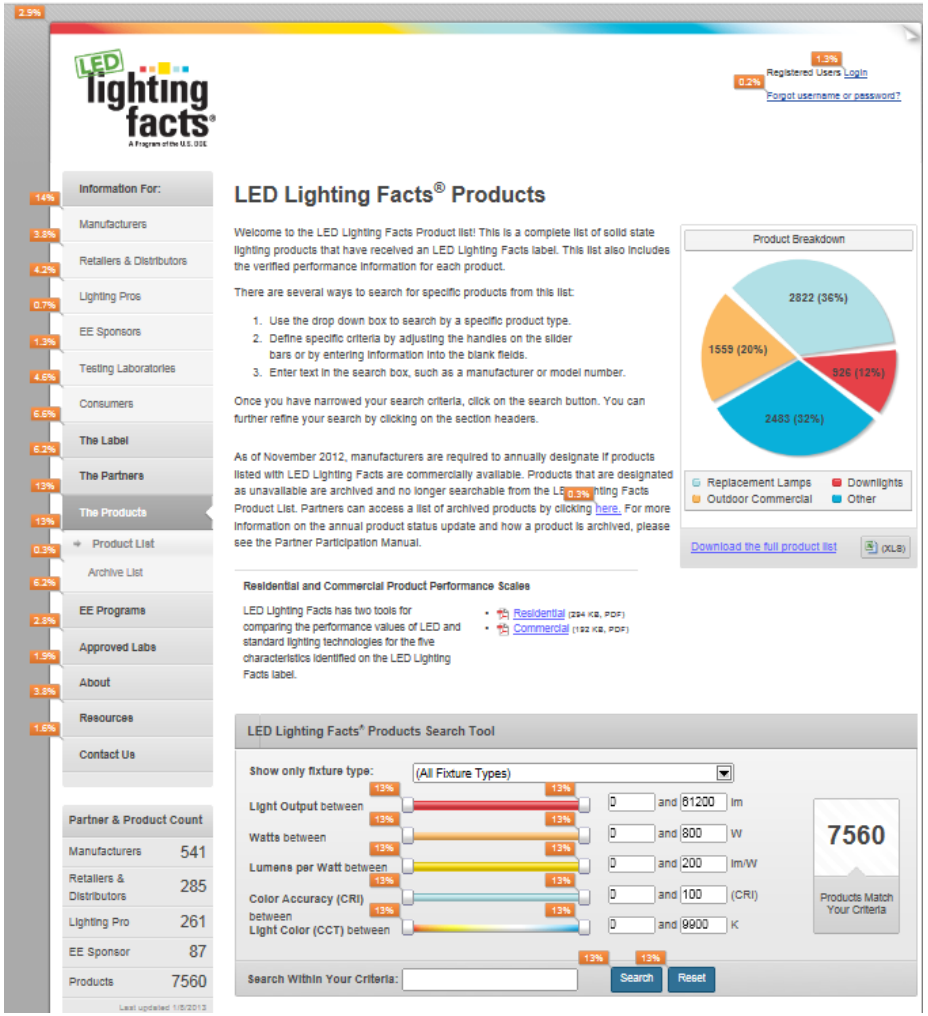


CALiPER 2012 Conclusions

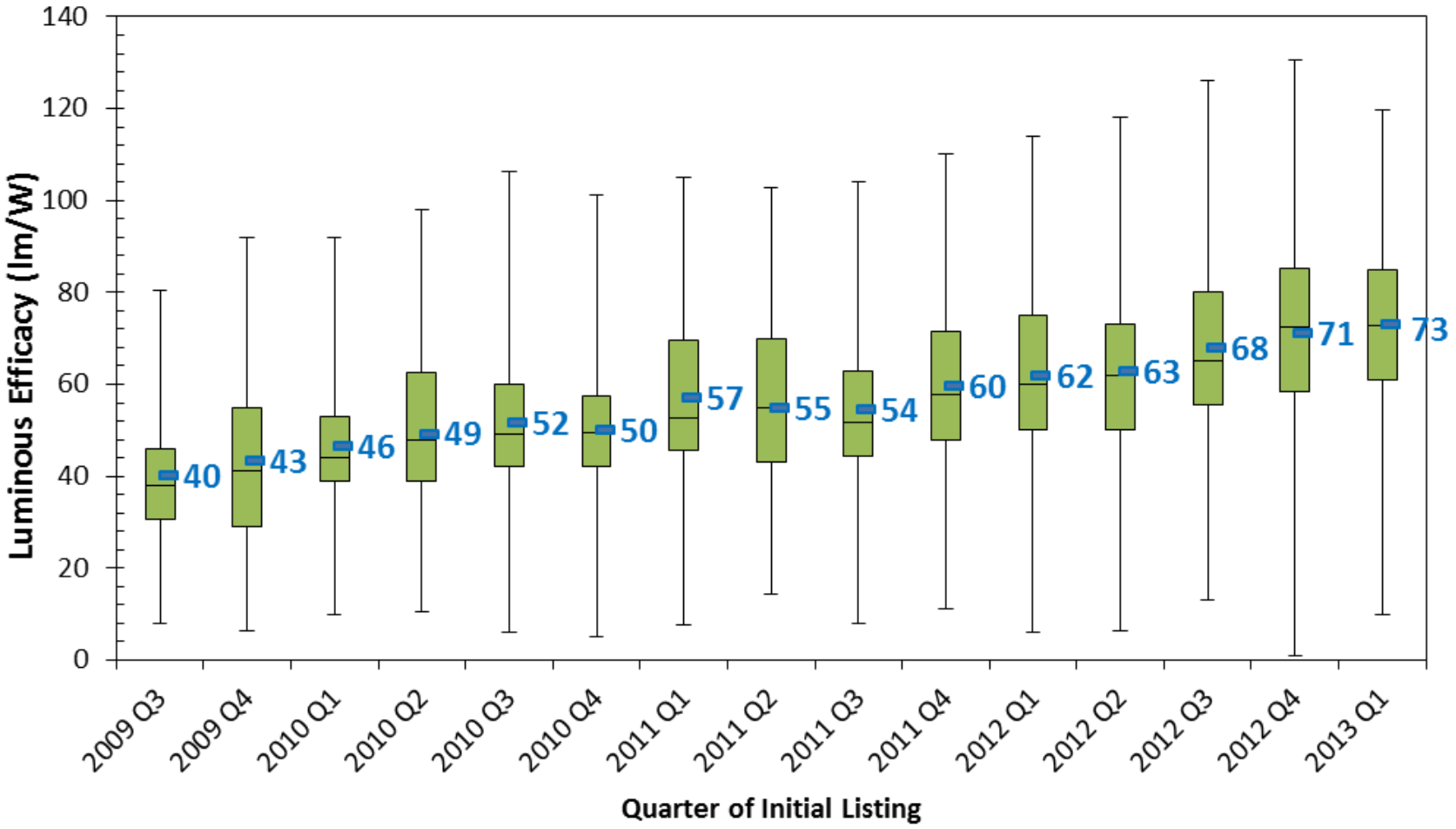
- Overall improvements in light output, efficacy, light distribution, power factor, color quality, etc.
- Manufacturer claims and equivalency claims are improving… but can still be a problem
- Suitability often depends on application
- Careful comparisons based on accurate performance data is an absolute necessity
- Be cognizant of “secondary” quality issues: glare, flicker, color tolerances, physical formats, reliability…

LED Lighting Facts

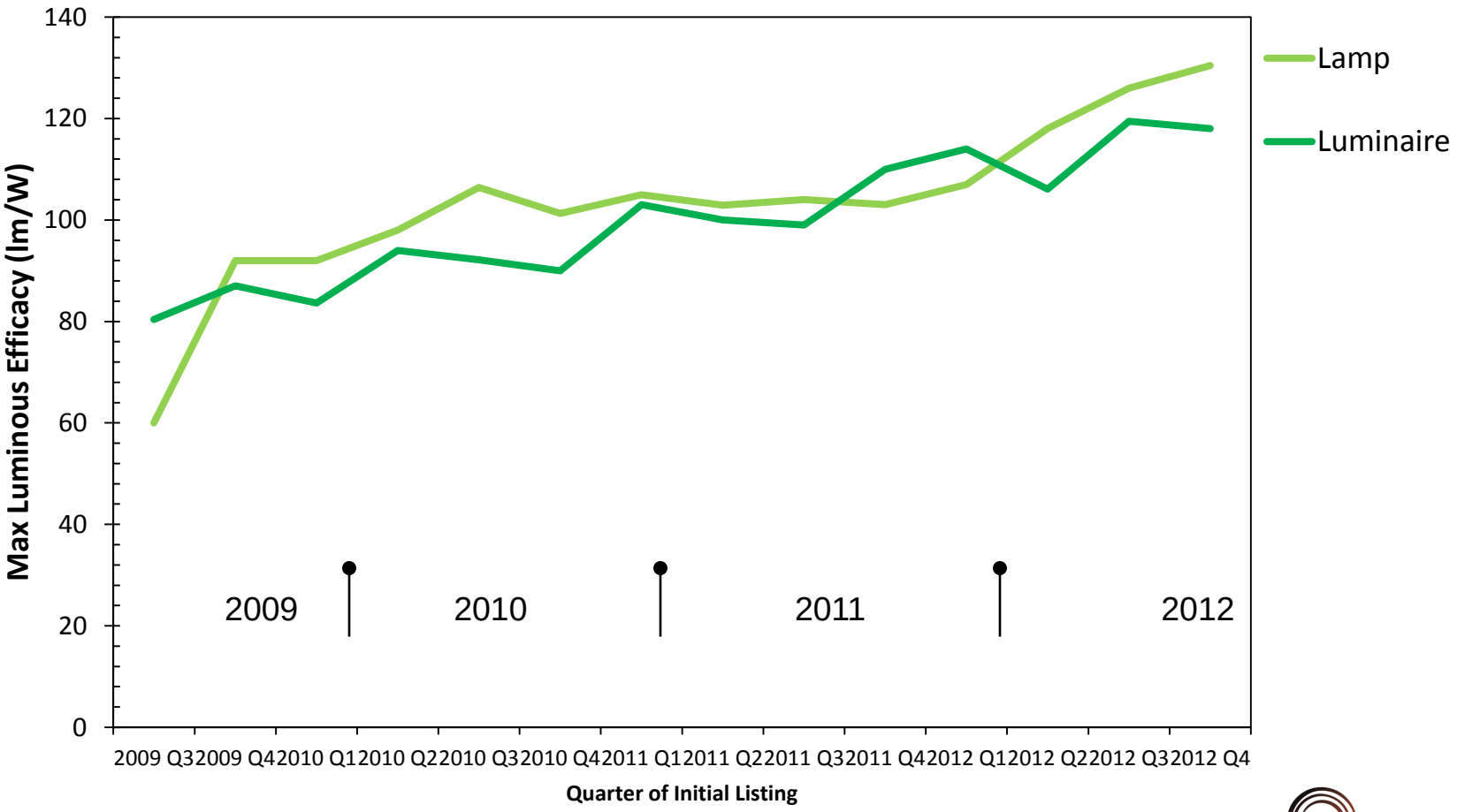




LED Lighting Facts - Efficacy



LED Lighting Facts – Maximum Efficacy



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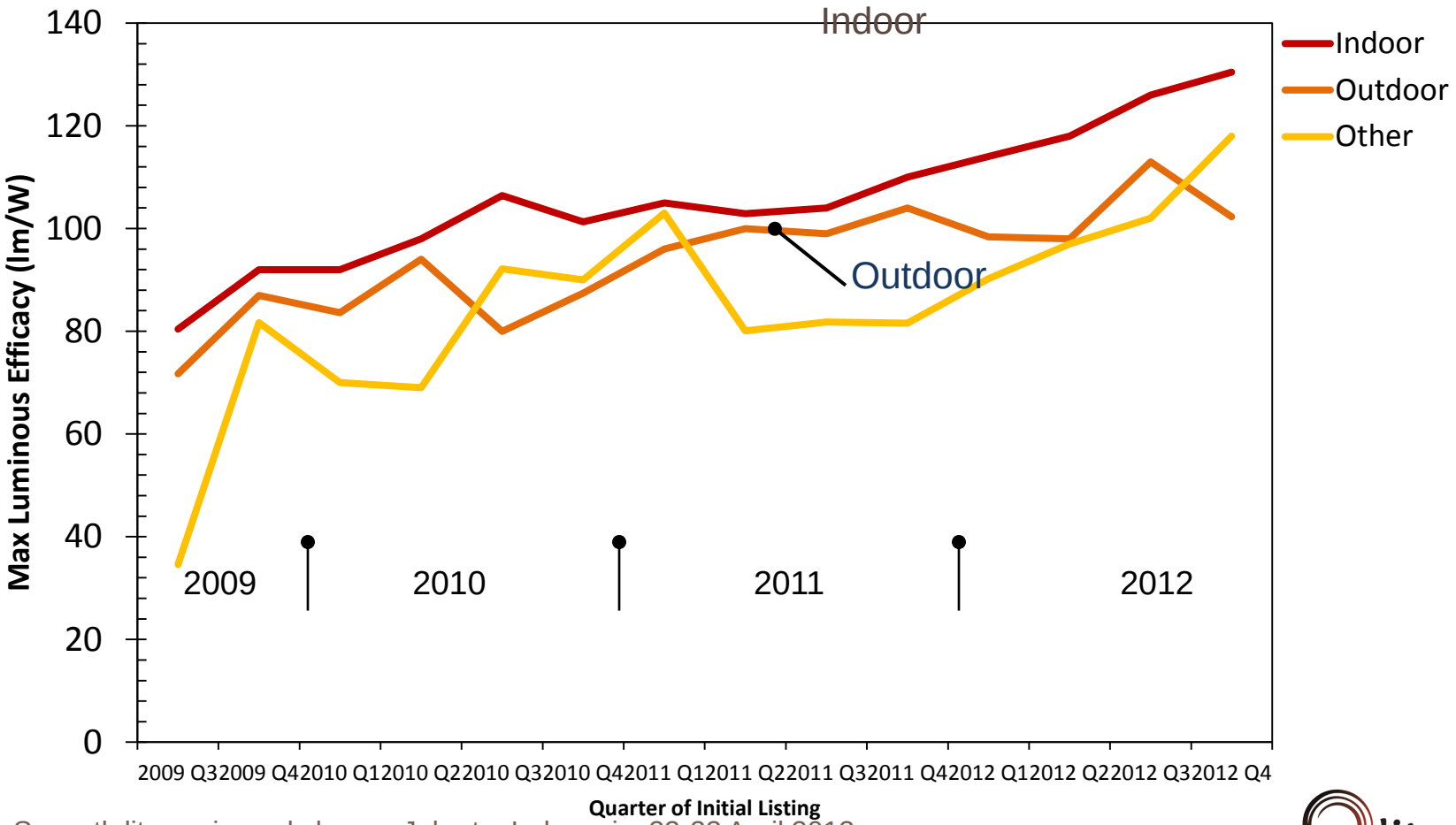
LED Lighting Facts – Maximum Efficacy



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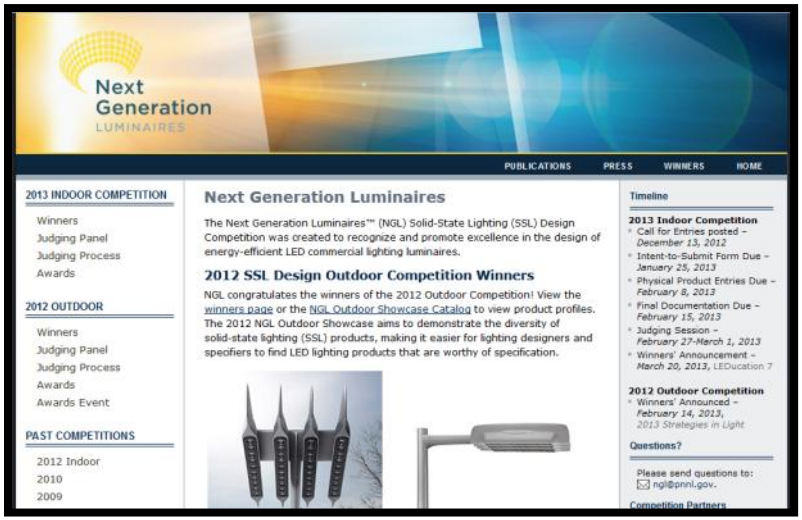
Next Generation Luminaires Design Competition



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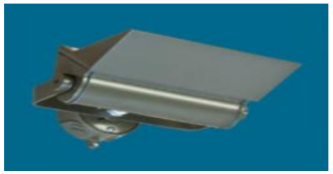
Best in Class Winners

Next Generation LUMINAIRES



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NGL Trends

- Efficacies continue to increase
- Significant documentation improvements
- Marked color improvements
- Increased dimming submissions
- Still waiting on emerging/innovative products
- Strong categories shift from year to year
  - Accent lighting always strong
  - Many downlight winners until 2013
  - Outdoor evaluation an issue until 2012
  - Troffers were prominent in 2012 along with high-bays
  - Linear pendants and track luminaires dominated 2013

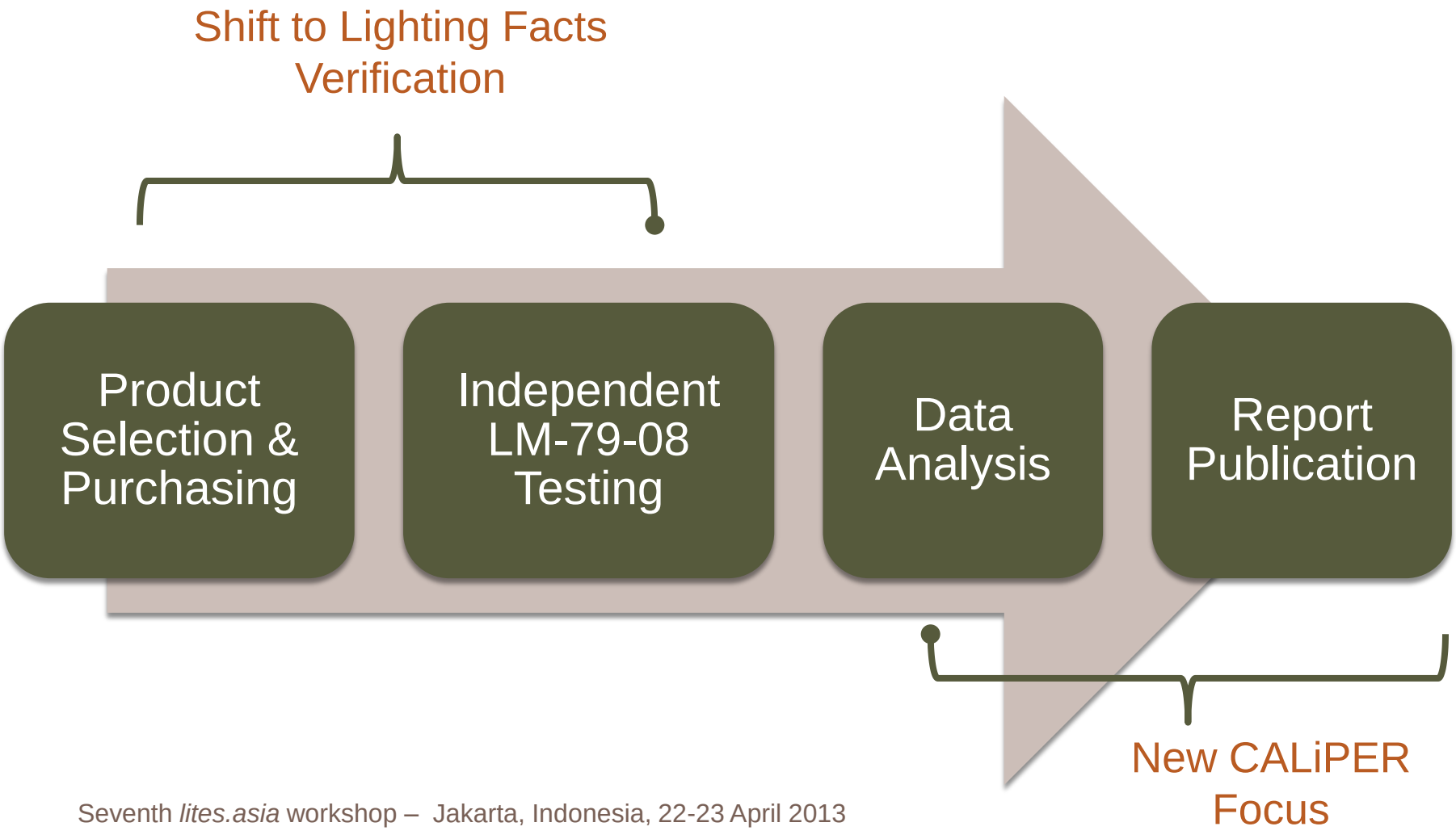
NGL Efficacy Advancements

All recognized (avg. efficacy)

- 2008 - 37 lm/W
- 2009 - 52 lm/W
- 2010 - 45 lm/W
- 2012 - 65 lm/W
- 2013 – 75 lm/W (indoor)

Remember, numbers are largely dependent on products recognized from year to year.

CALiPER Shift in Focus

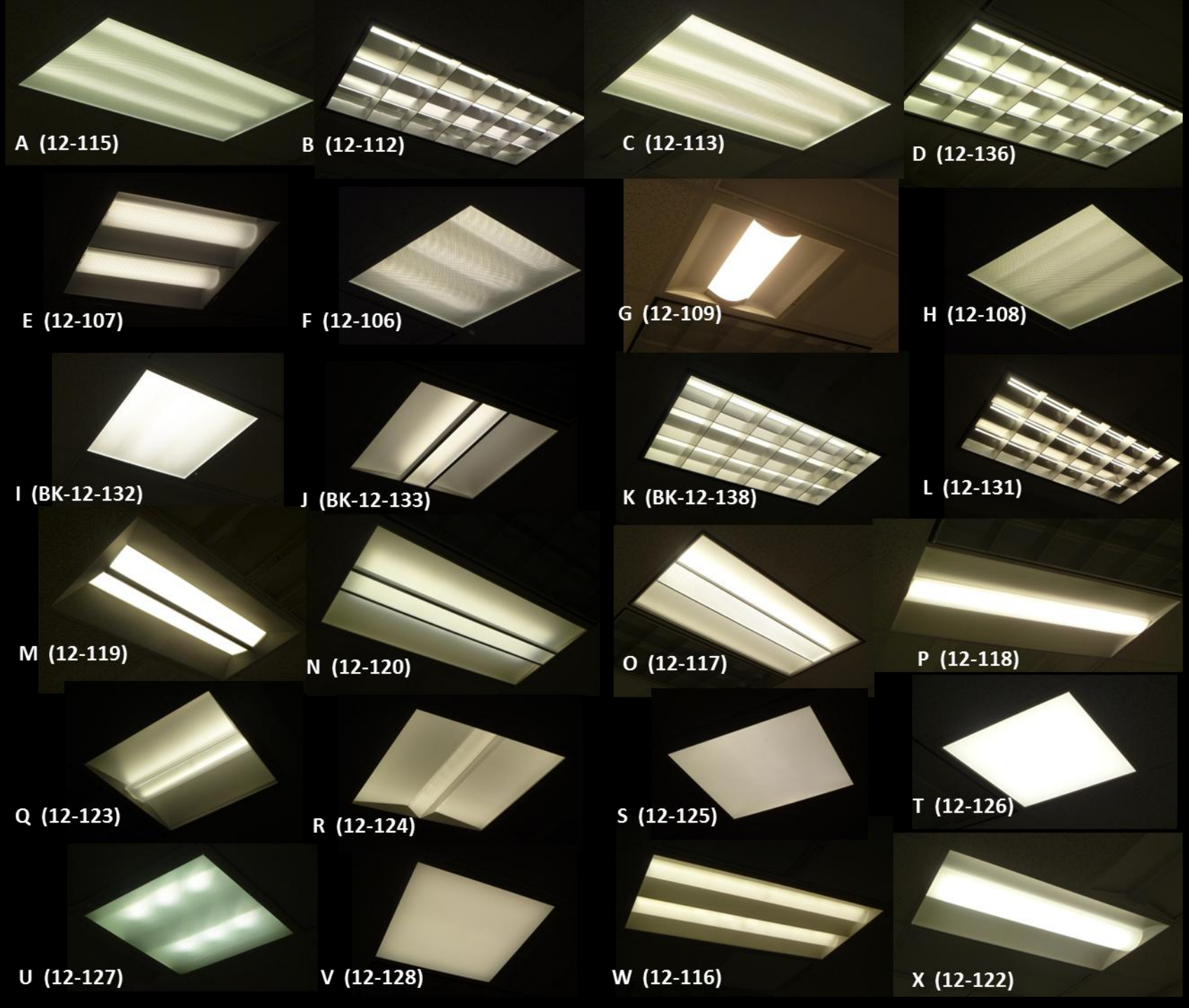


CALiPER Digging Deeper

- **Snapshot Reports** using data from LED Lighting Facts
- **Application Reports** focusing on specific product types and design scenarios, going beyond LM-79 testing
- **Exploratory Studies** that incorporate product installations and evaluations
- **Standards Support** for emerging areas such as flicker, dimming, power quality, long-term performance, etc.

Recessed Troffer Exploratory Study

- Install 24 pairs of similar performing recessed luminaires (2×2 and 2×4) and 0−10 V dimming controls in mock office space
- Show examples of fluorescent benchmarks, LED tubes, LED retrofit kits, and dedicated LED troffers
- Invite 18 designers/engineers to observe, brainstorm, and comment
- Get feedback from non-lighting experts as well


A (12-115)
B (12-112)
C (12-113)
D (12-136)
E (12-107)
F (12-106)
G (12-109)
H (12-108)
I (BK-12-132)
J (BK-12-133)
K (BK-12-138)
L (12-131)
M (12-119)
N (12-120)
O (12-117)
P (12-118)
Q (12-123)
R (12-124)
S (12-125)
T (12-126)
U (12-127)
V (12-128)
W (12-116)
X (12-122)

Energy efficiency – Luminaire efficacy

- All LED products did as well or better than the Fluorescent

	Min LPW	Max LPW	Average LPW
FL benchmark troffers (28W lamps)	54	72	65.3
Dedicated LED troffers	75	104	90.6
LED tube retrofits	55	76	68.8
LED retrofit kits	60	76	66.5

Energy consumption –Watts

- If you're not careful, LED retrofit tubes may not alter watts

	Min Watts	Max Watts	Average Watts
FL benchmark troffers (28W lamps)	49 (2x2)	83 (2x4)	63.5
Dedicated LED troffers (2x2 and 2x4)	34 (2x2)	58 (2x2)	43.6
LED tube retrofits	48 (2x4)	79 (2x4)	16 to 26W per tube
LED retrofit kits	35 (2x2)	51 (2x2)	41.2

What did we learn?

- Wide range of quality in LED troffers
- LED tubes produce some funky luminaire appearance
- Be careful in choosing the beam angle on these tubes, LED tubes can change the distribution of light from the luminaire
- LED tubes may have unexpected installation problems, especially concerning sockets
- Luminaire efficacy is very high. Holds great promised. Look for LPW of 90+
- Dedicated LED troffers are a good option for new installations

See it, mock it up before you buy a bunch of them!

What's Next?

- CALiPER – focus on deeper dives
- LED Lighting Facts – verification testing for QA
- NGL – discussions on separate competition for cutting edge, emerging products

Thanks!

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