

# CALiPER for New Technologies?

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U.S. DEPARTMENT OF  
**ENERGY**

**BATTELLE**

**Pacific  
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NATIONAL LABORATORY

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# What We'll Cover Today

- State of the Industry – Pre-CALiPER
- DOE's Initial Approach
- CALiPER – How it All Started
- CALiPER Impact
- Applying CALiPER Approach to Other Technologies
- Recommendations, Thoughts

# CALiPER Started in the SSL 'Wild Wild West'



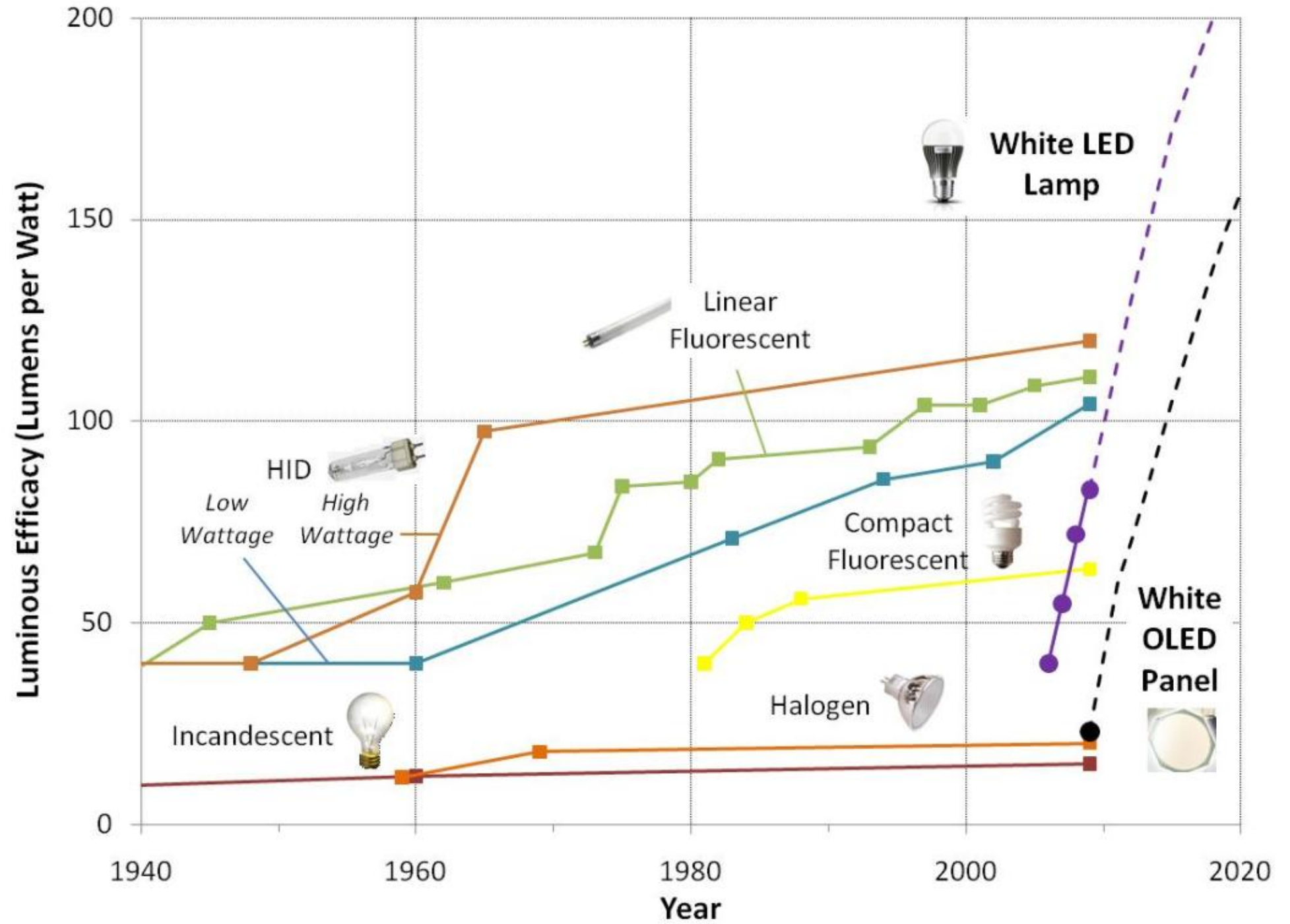
- No LM-79 test procedures
- Little understanding of how to compare products
- Many low efficacy products with even lower light output
- Virtually no industry accountability
- False equivalency claims by many
- Potential for great consumer disappointment



# DOE's Initial Approach

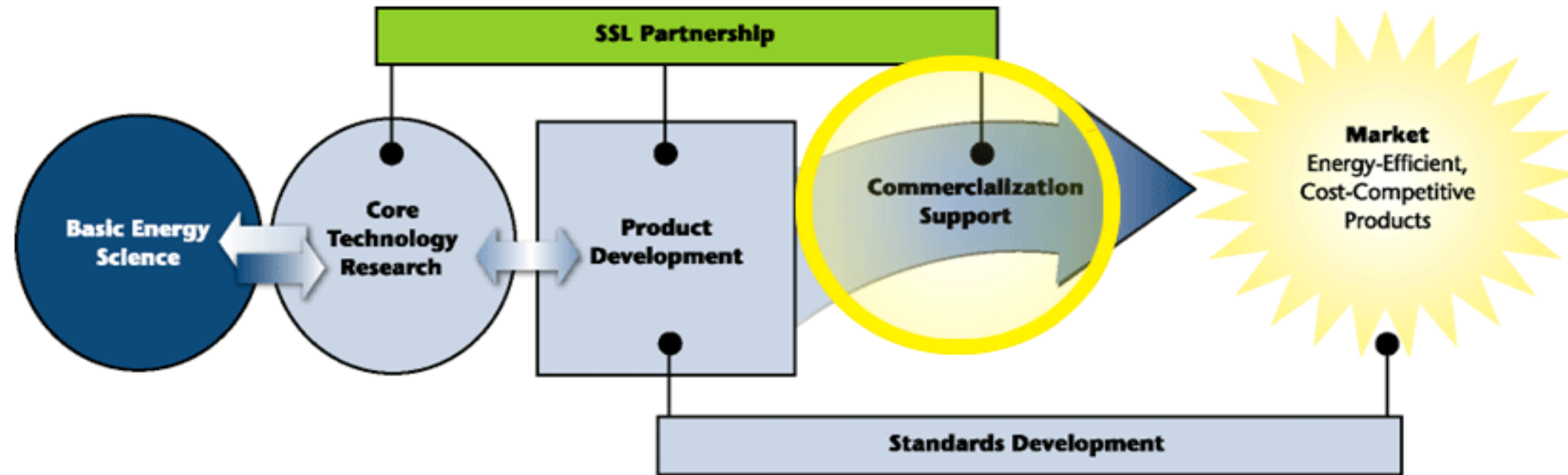


# DOE SSL Multi-Year Plan - 2010

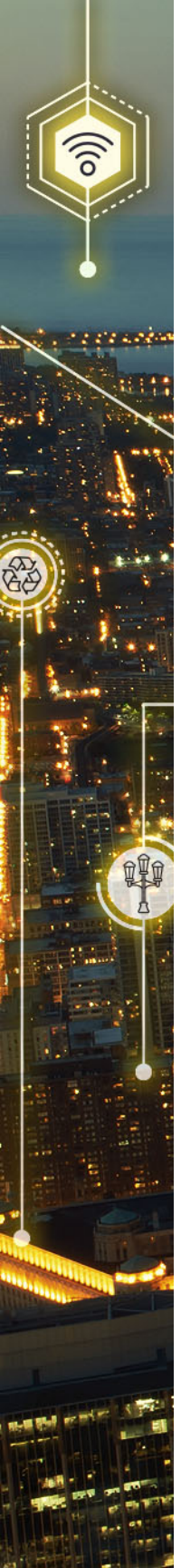


# DOE SSL Commercialization Support

## DOE SOLID-STATE LIGHTING PORTFOLIO



*Guiding technology advances from  
laboratory to marketplace*



# Initial SSL Programs



*SSL Quality Advocates*



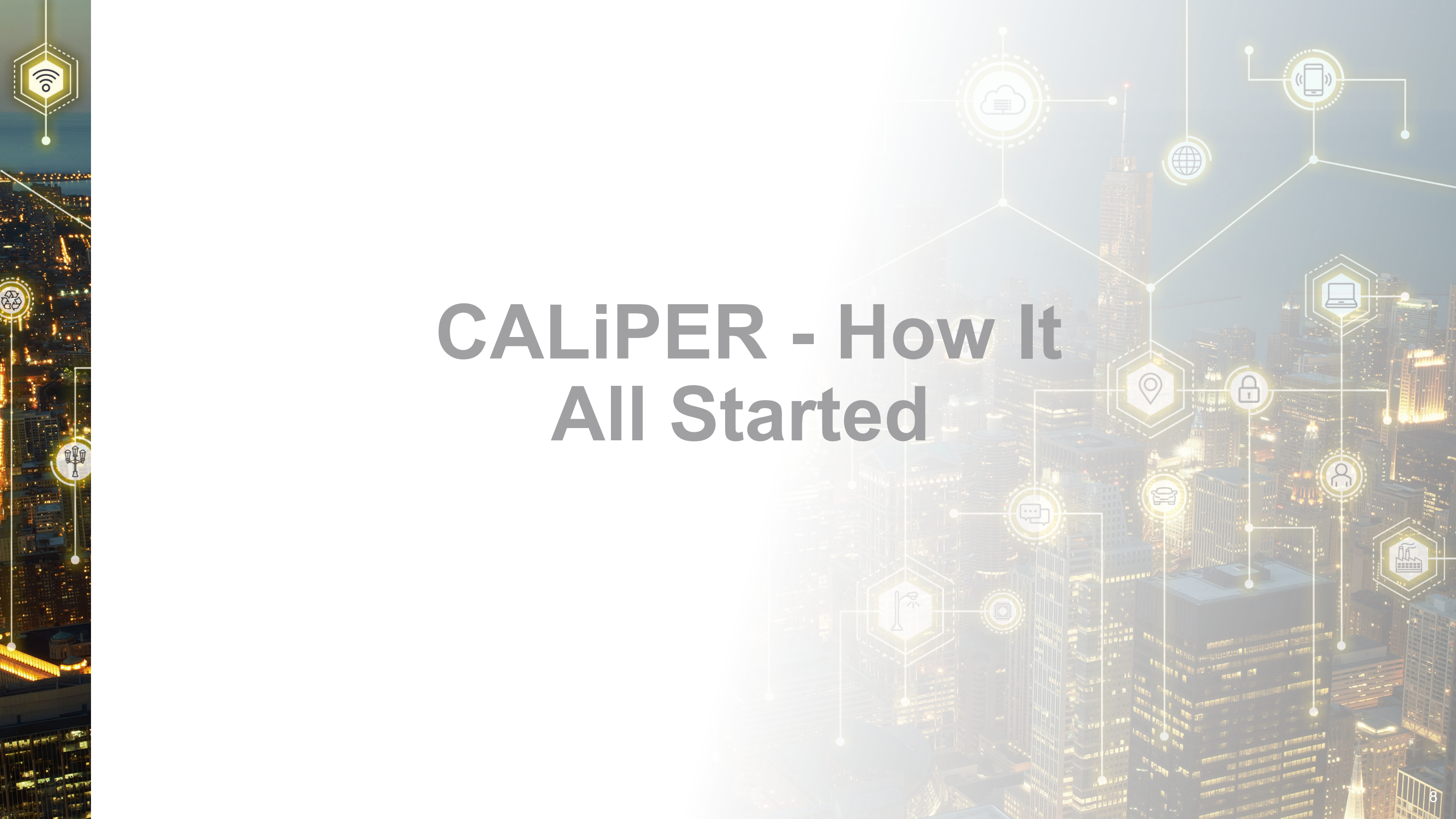
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**Retailer**  
Energy Alliance

**STANDARDS**



# CALiPER - How It All Started





# Original CALiPER Goals

- 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

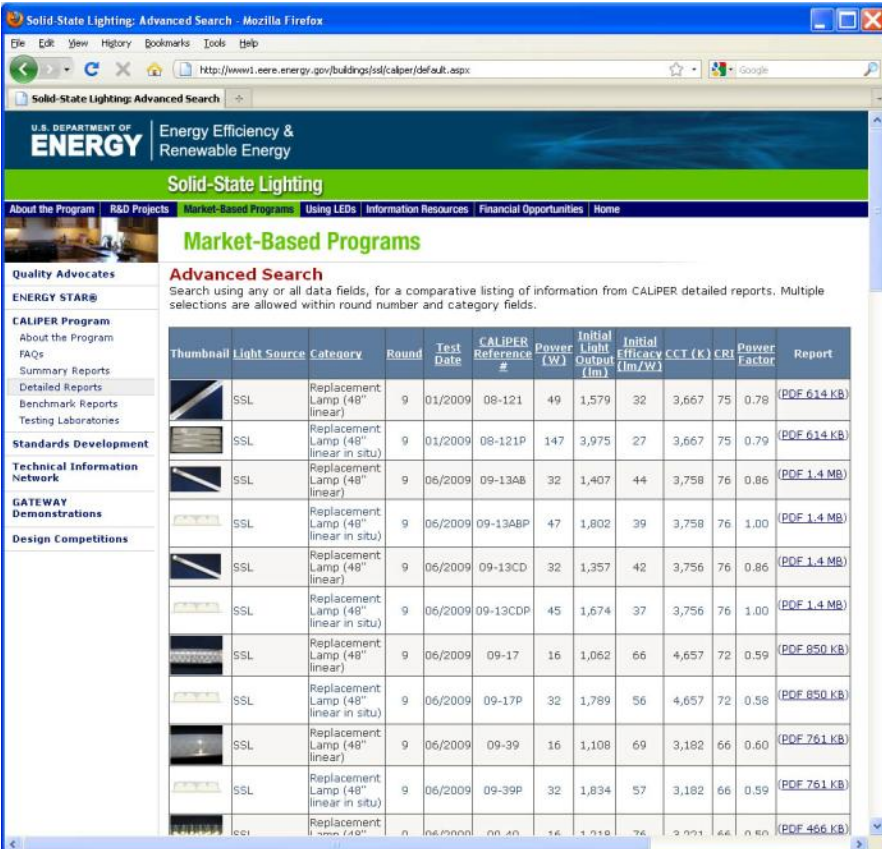


**YOU MAY NEVER CHANGE  
ANOTHER LIGHT BULB**

- ✓ *Long life*
- ✓ *Energy efficient*
- ✓ *Easy to install (standard socket)*
- ✓ *Natural white, superb color rendering*

# CALiPER Testing Process - 2008

- Quarterly 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



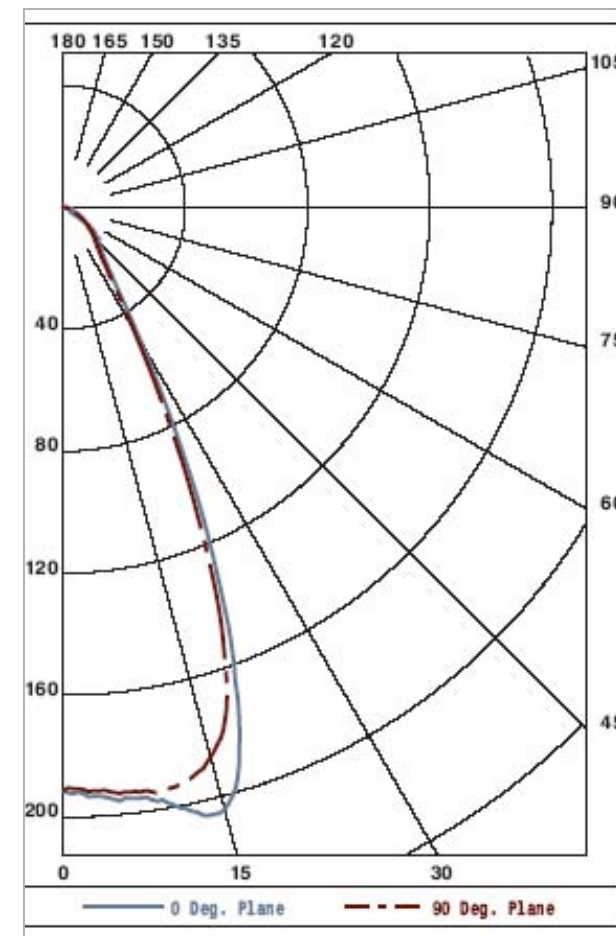
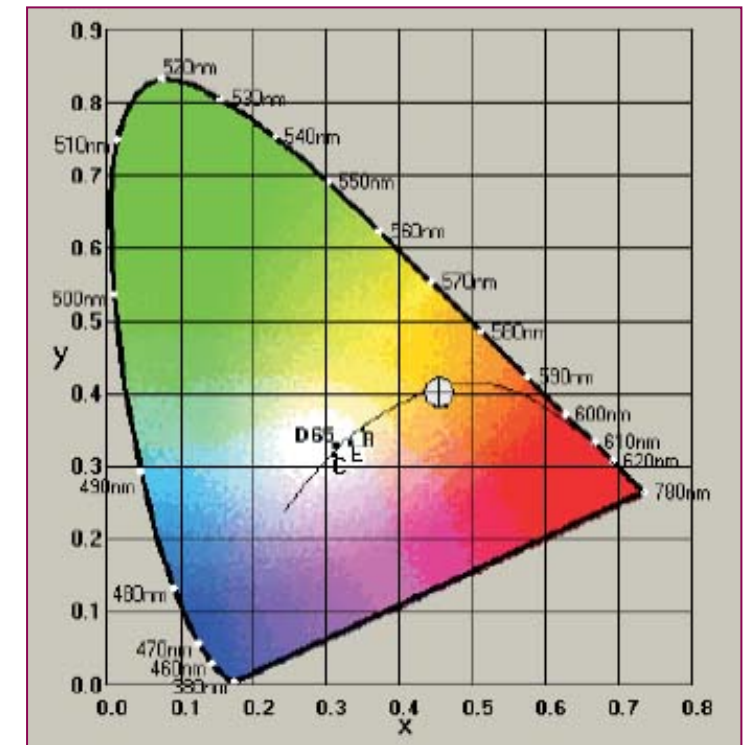
The screenshot shows the CALiPER website's advanced search results page. The page is titled "Solid State Lighting: Advanced Search" and is part of the U.S. Department of Energy's Energy Efficiency & Renewable Energy program. The main heading is "Market-Based Programs" and "Advanced Search". Below the heading is a table with the following columns: Thumbnail, Light Source, Category, Round, Test Date, CALiPER Reference #, Power [W], Initial Light Output [lm], Initial Efficacy [lm/W], CCT (K), CRI, Power Factor, and Report. The table lists several entries for "Replacement Lamp (48\" linear)" with various test dates and results.

Thumbnail	Light Source	Category	Round	Test Date	CALiPER Reference #	Power [W]	Initial Light Output [lm]	Initial Efficacy [lm/W]	CCT (K)	CRI	Power Factor	Report
	SSL	Replacement Lamp (48" linear)	9	01/2009	08-121	49	1,579	32	3,667	75	0.78	(PDF 614 KB)
	SSL	Replacement Lamp (48" linear in situ)	9	01/2009	08-121P	147	3,975	27	3,667	75	0.79	(PDF 614 KB)
	SSL	Replacement Lamp (48" linear)	9	06/2009	09-13AB	32	1,407	44	3,758	76	0.86	(PDF 1.4 MB)
	SSL	Replacement Lamp (48" linear in situ)	9	06/2009	09-13ABP	47	1,802	39	3,758	76	1.00	(PDF 1.4 MB)
	SSL	Replacement Lamp (48" linear)	9	06/2009	09-13CD	32	1,357	42	3,756	76	0.86	(PDF 1.4 MB)
	SSL	Replacement Lamp (48" linear in situ)	9	06/2009	09-13CDP	45	1,674	37	3,756	76	1.00	(PDF 1.4 MB)
	SSL	Replacement Lamp (48" linear)	9	06/2009	09-17	16	1,062	66	4,657	72	0.59	(PDF 850 KB)
	SSL	Replacement Lamp (48" linear in situ)	9	06/2009	09-17P	32	1,789	56	4,657	72	0.58	(PDF 850 KB)
	SSL	Replacement Lamp (48" linear)	9	06/2009	09-39	16	1,108	69	3,182	66	0.60	(PDF 761 KB)
	SSL	Replacement Lamp (48" linear in situ)	9	06/2009	09-39P	32	1,834	57	3,182	66	0.59	(PDF 761 KB)
	SSL	Replacement Lamp (48" linear)	9	06/2009	09-40	16	1,018	76	3,771	66	0.60	(PDF 466 KB)



# Types of CALiPER Testing

- Basic photometry (following ANSI/IES LM-79-19)
  - 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...



# Initial Testing



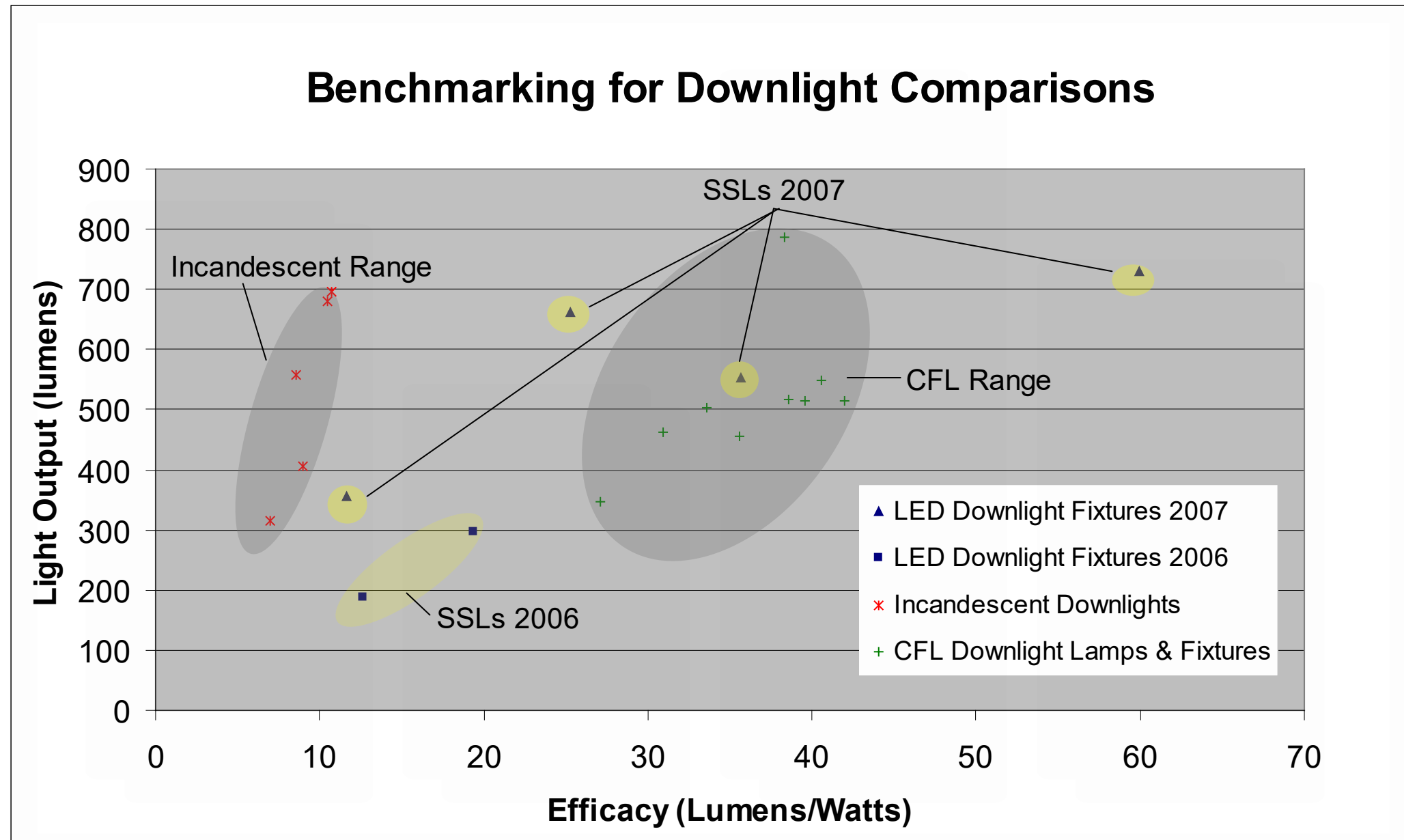
# CALiPER Early Testing Results (Rounds 1-5)

- Tests include a wide range of products
- Results show a very wide range of performance

	<i>from</i>		<i>to</i>
Power	0.6 W	↔	189 W
Output	10 lm	↔	6272 lm
Efficacy	4 lm/W	↔	62 lm/W
CCT	2600	↔	>7000
CRI	<50	↔	95



# CALiPER Benchmarking – 2006/2007



\* Values for LED downlights are from CALiPER testing.

\*\* Values for CFL and incandescents are assembled from CALiPER testing, earlier photometric testing and product catalogs.

\*\*\* A fixture efficiency of 0.9 is applied to all replacement lamps unless tested inside a fixture.

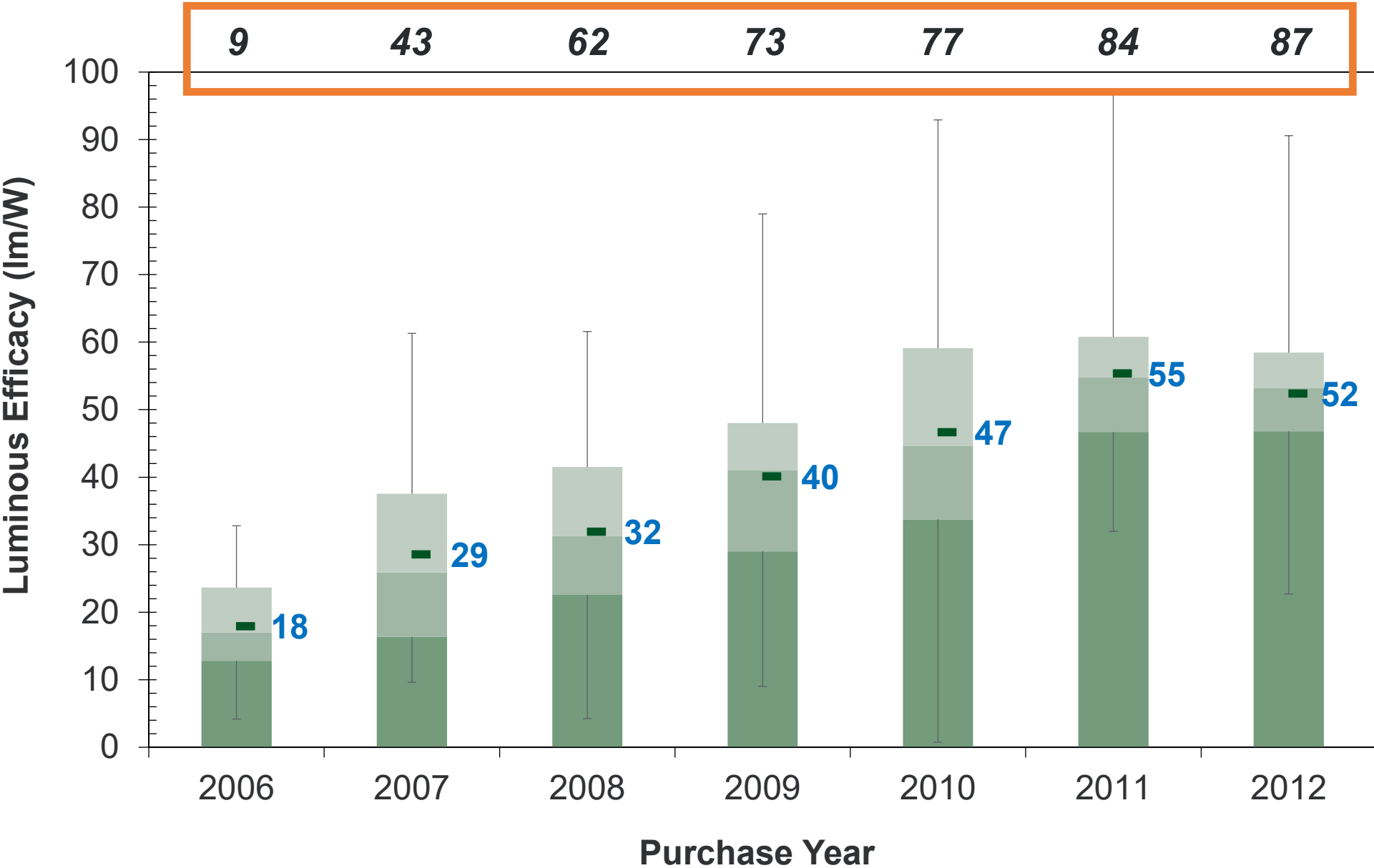


# Rapid Progress 2007-2009

- January 2007
  - Four (4) pilot tests were completed
  - LM-79 was under development
- January 2008
  - Finalizing LM-79
  - A few independent labs performing LM-79 testing
  - Manufacturers starting to listen to ‘absolute photometry’ concept
- 2009
  - Over 200 individual SSL products tested, many benchmarks
  - Loads of info, reports

# Product Trends - Efficacy

*Number of Products*

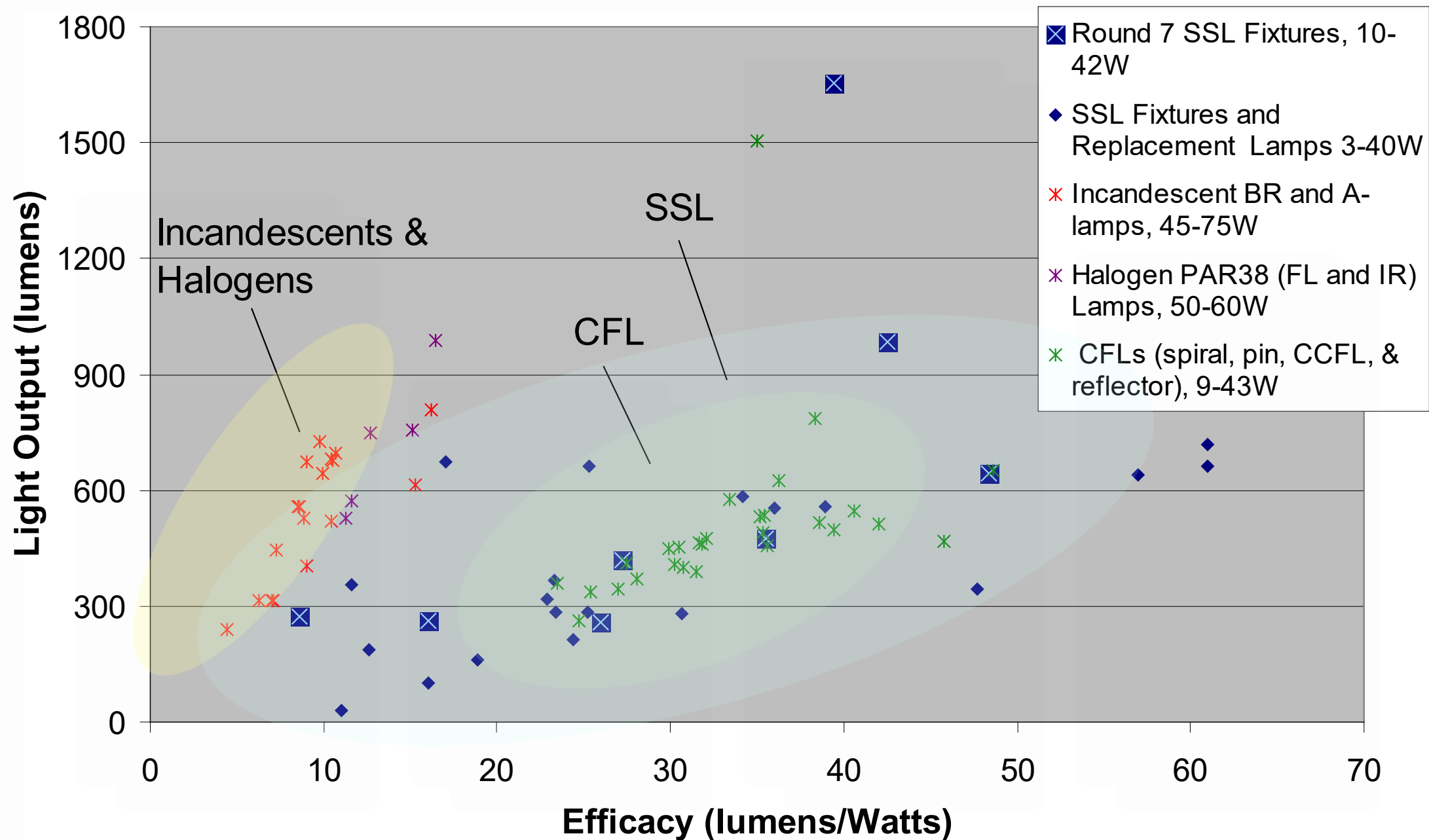




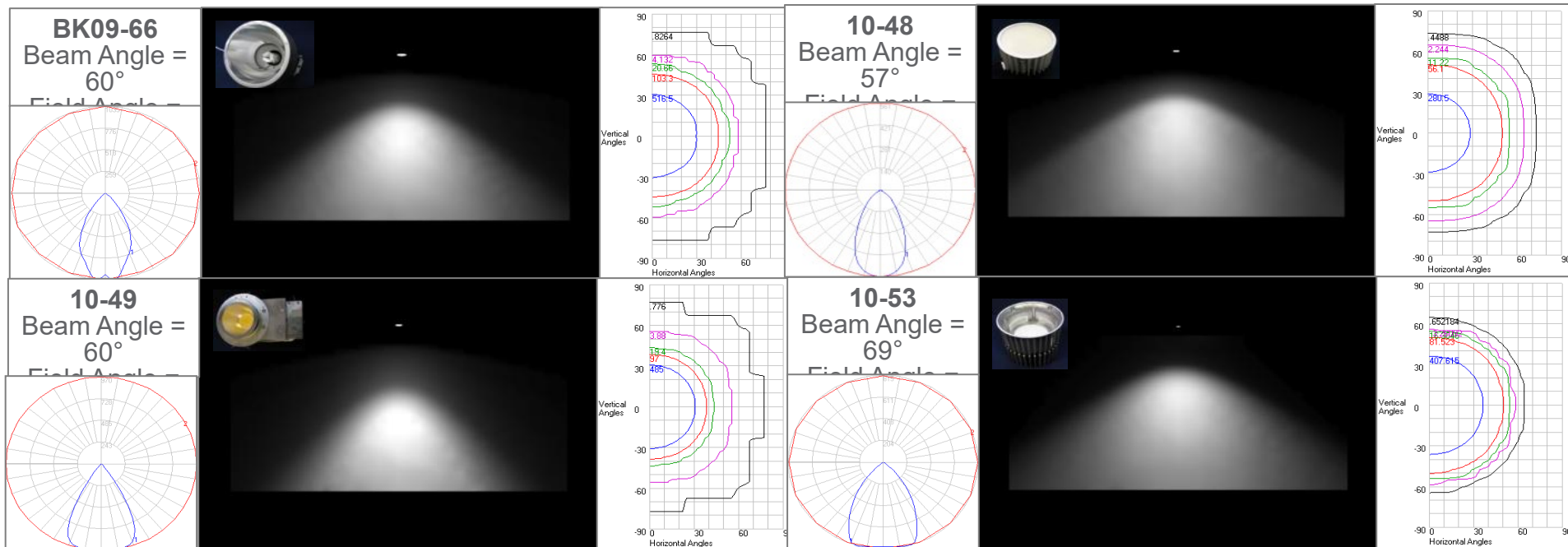
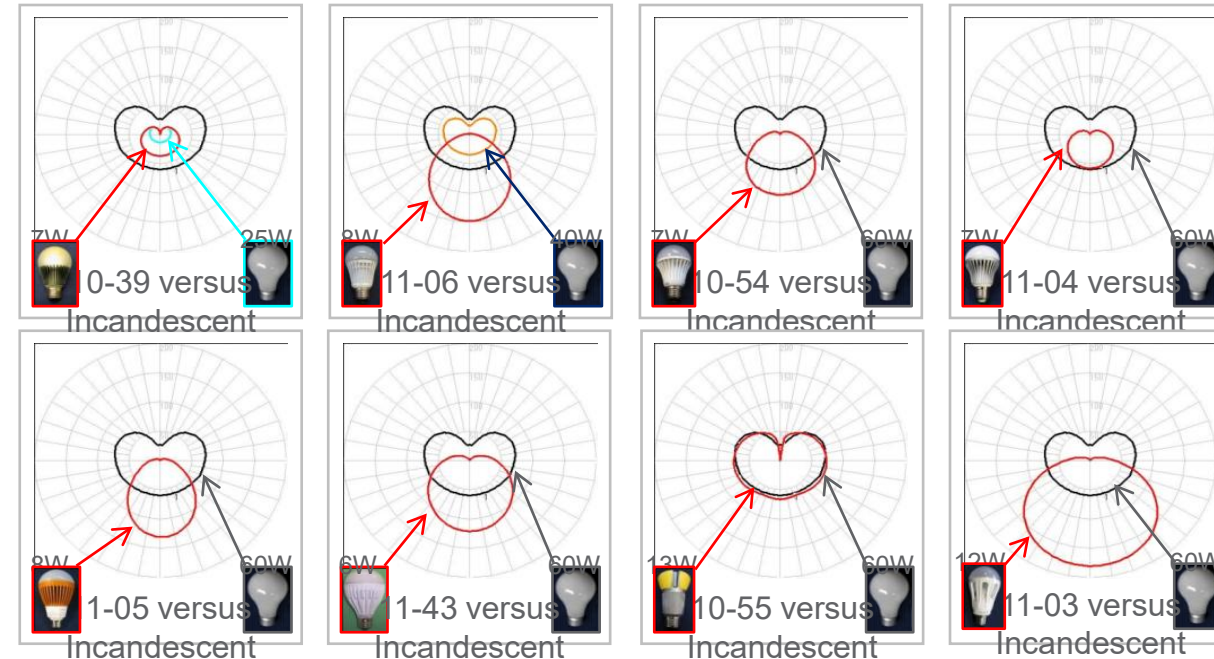
# Education was Key



# Education – Product Comparisons



# Education – Distribution Comparisons



# CALiPER Impact



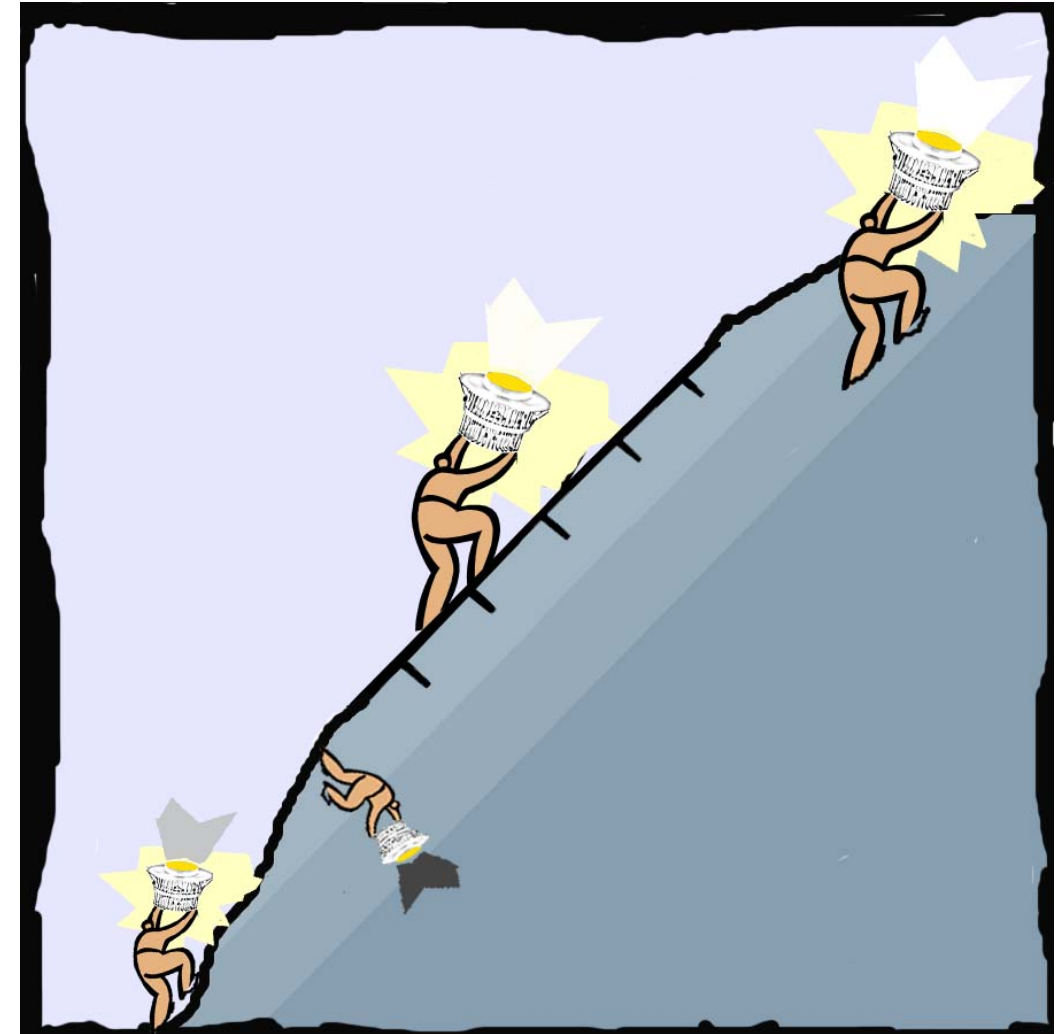
# CALiPER Early Positive Influences

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



# Early CALiPER Recommendations

- **Color**: some 'white' light products are quite 'bluish' or quite greenish
  - Both CCT and  $D_{uv}$  matter
- **Comparisons**: absolute  $\neq$  relative photometry
  - Compare performance at the luminaire level
- **Claims**: product literature is often erroneous or misleading
- **Lifetime performance**: true, *in situ*, long-term performance is still a great unknown
  - Initial lumen maintenance results are mixed
- **Learning curves**: some manufacturers are at the top, many still just setting foot on the slope

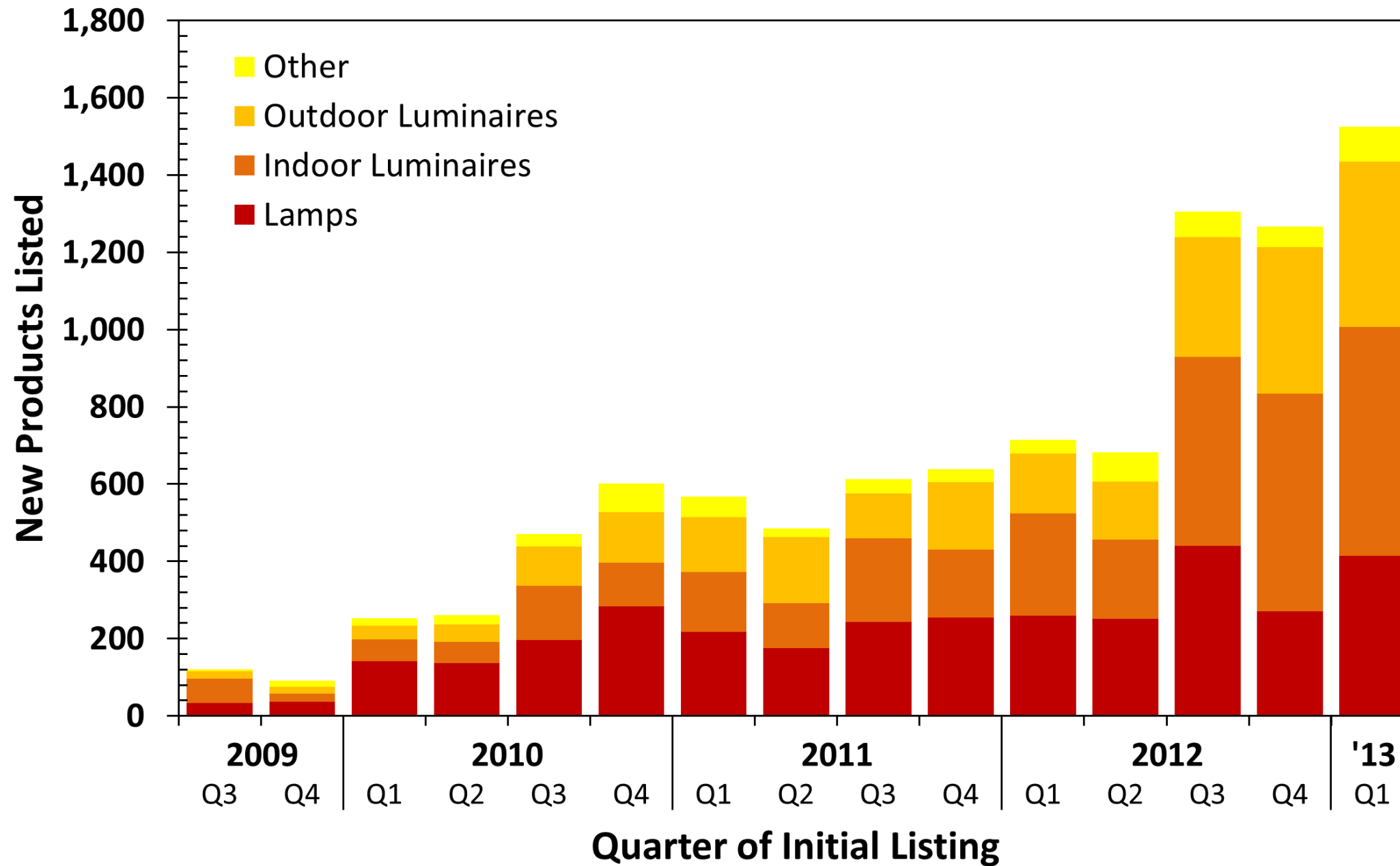


***Ascending the SSL  
Learning Curve***

The background features a night-time aerial view of a city with illuminated buildings. Overlaid on this is a network of white lines connecting various icons. The icons include a Wi-Fi symbol, a cloud with a server rack, a globe, a smartphone, a laptop, a location pin, a padlock, a person silhouette, a car, a factory, a lightbulb, and a microchip. The text is centered in a large, bold, grey font.

# CALiPER Shift – Changing with the Market

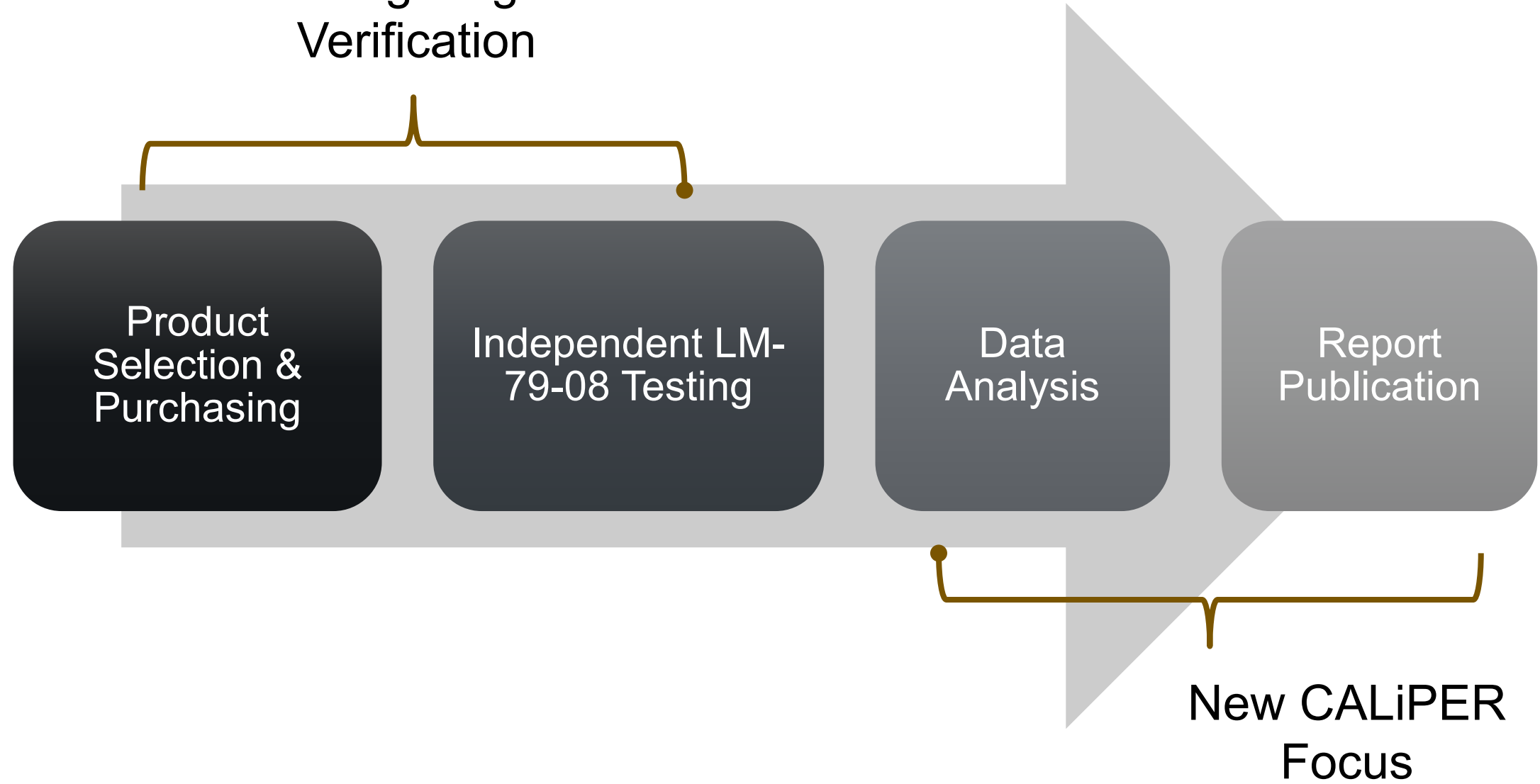
# SSL Product Growth – Lighting Facts Database





# CALiPER Shift in Focus

Shift to Lighting Facts  
Verification





# CALiPER Reports

## Snap Shot Reports

- High level summaries using LED Lighting Facts data
- 4 per year each on different product types

## Application Reports

- Focused on specific product types and design scenarios
- Go beyond LM-79 testing
- Include detailed testing reports online
- First in the series of deeper dive studies

## Deeper Dives

- Product installations and evaluations
- Dimming/flicker testing
- Stress testing
- Lumen maintenance testing

## Standards Support

- Testing/ analysis support as requested
- Roundtables to facilitate industry collaboration
- Participation in relevant standards committees



# CALiPER for Other Technologies?



# Applying CALiPER Approach to Other Technologies

- Standards development is critical
- Education is key
- Growth is important - be willing to change with the industry
  
- Simultaneous approaches might be warranted

# Simultaneous Approaches Might Be Warranted

- Standards development (round tables, committee involvement)
- Product testing and reporting (CALiPER style)
- In-situ mock-ups (CALiPER exploratory studies)
- User perceptions/acceptance (NGL style)
- Labeling program – eventually? (Lighting Facts)



CALiPER – think consumer reports  
LED Lighting Facts – think food labels  
NGL – think J.D. Powers



# Thank you

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