

# What Customers Want from Solid State Lighting

Jeff Quinlan

# Who is the customer?

- Owner / Operator
- Contractor
- Distributor
- Specifier
- Manufacturer
- Other Influences
  - Government
  - Professional Organizations
  - Trade Associations

- Application

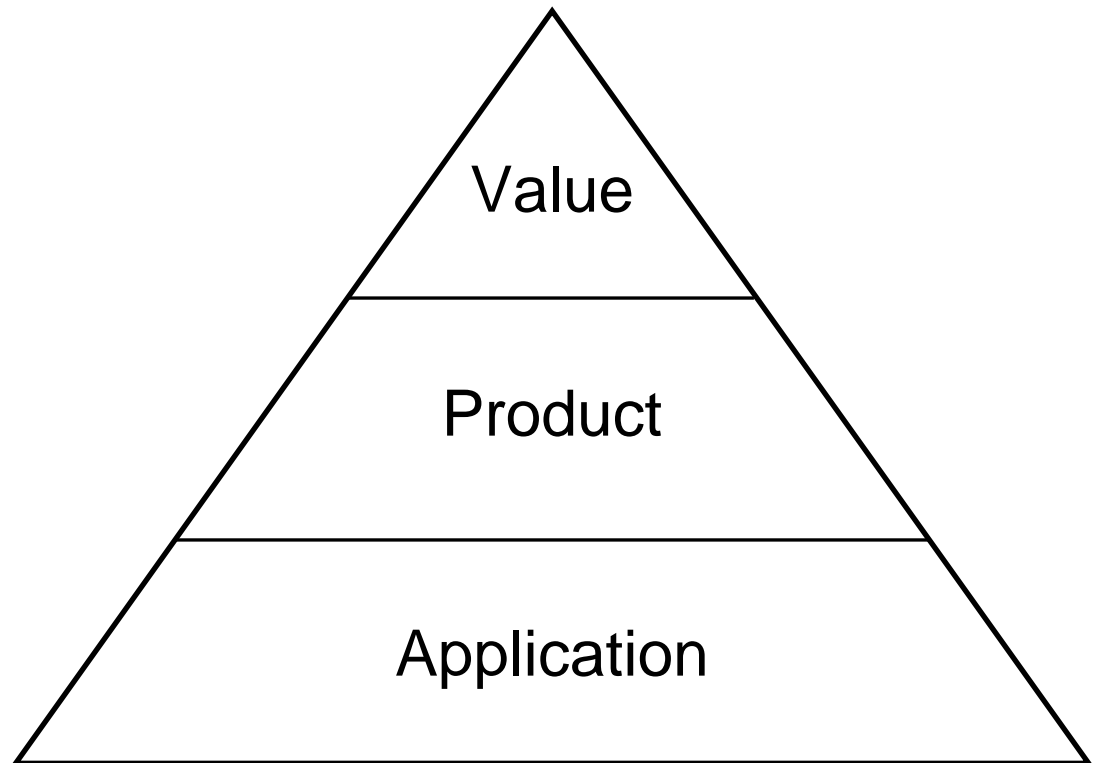
- Environment
- Performance
- Light level

- Product

- Consistency
- Performance
- Quality

- SSL Value

- Not just \$\$\$\$\$



# Environment - Indoor

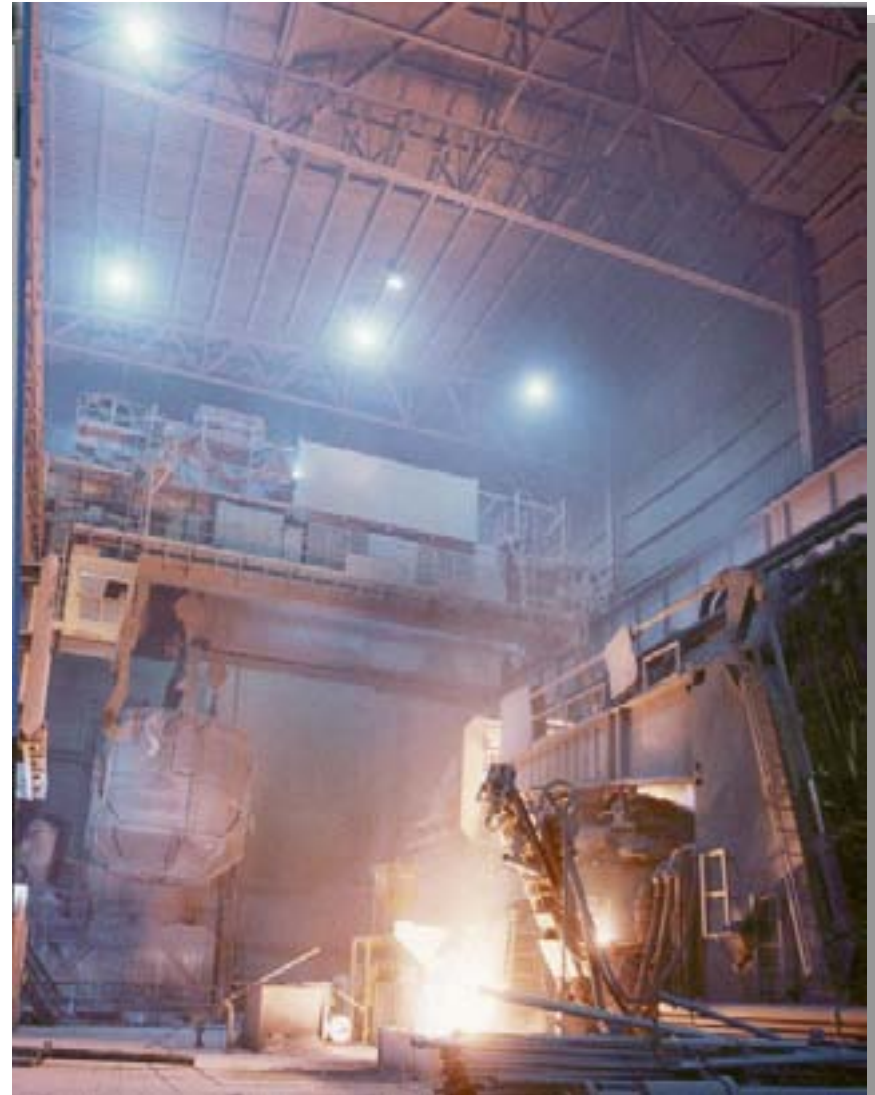


# Environment - Outdoor



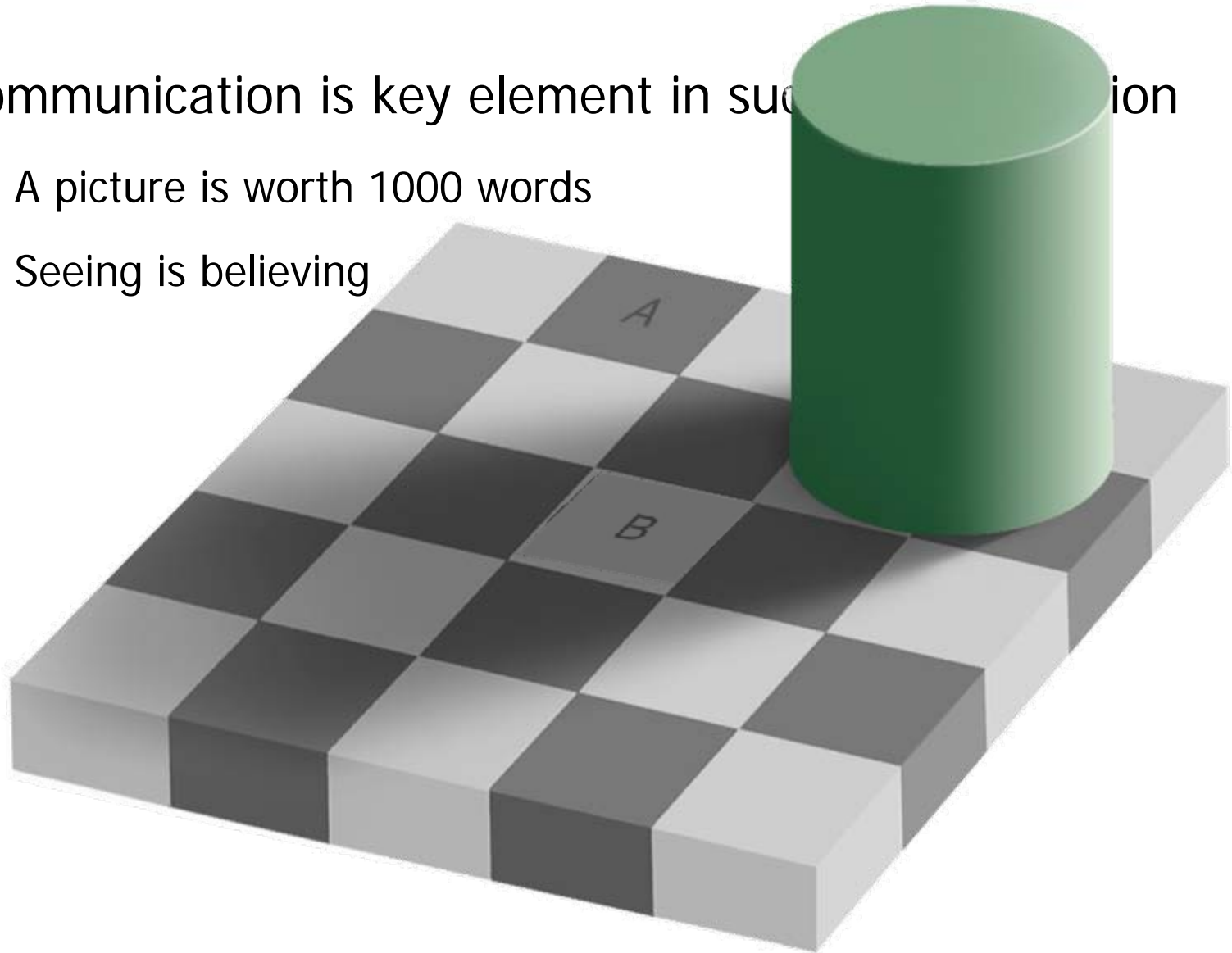
# Environment

- Temperature
- Humidity
- Ultra Violet
- Dust / Dirt
- Bugs
- Harmonics
- Voltage Spikes



# Perspective Effects Perception

- Communication is key element in successful negotiation
  - A picture is worth 1000 words
  - Seeing is believing



# Color & Cameras



# Customer Perception



U.S. Department of Energy – Technology Demonstration

HID Fixtures



LED Fixtures



# Quantity & Quality

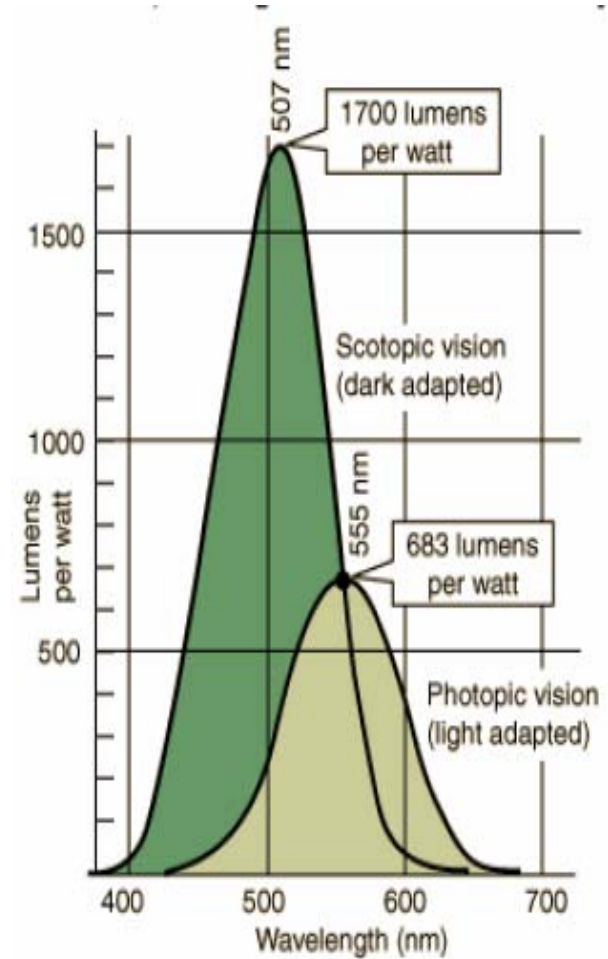
- Even small changes in color & illuminance can be used to attract attention.
  - The attraction is generally proportional to the variation
  - Can be used as a positive.
    - Strobing lights during an emergency
    - Color accents in architecture
  - Can be a negative
    - Distract a “retail customers” focus

# Perception



# Perception

- Scotopic vs. Photopic vs. Mesopic
- Color vs. Quantity
- Security & Cameras

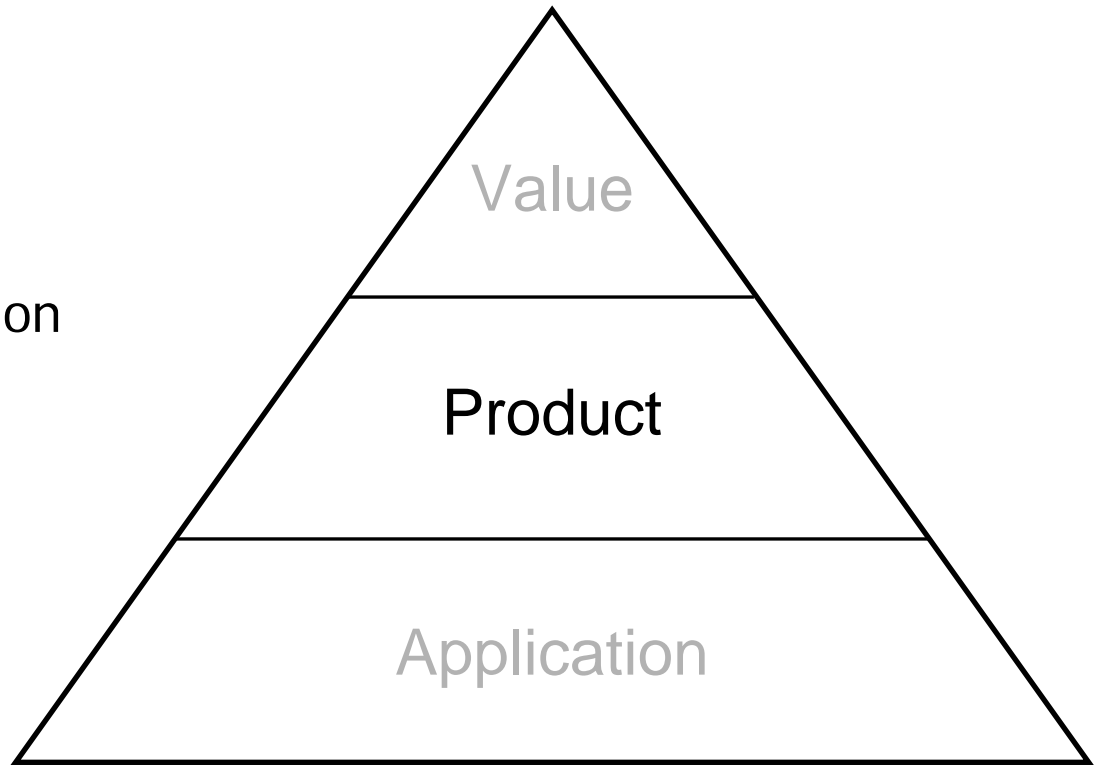


# Effective Lighting

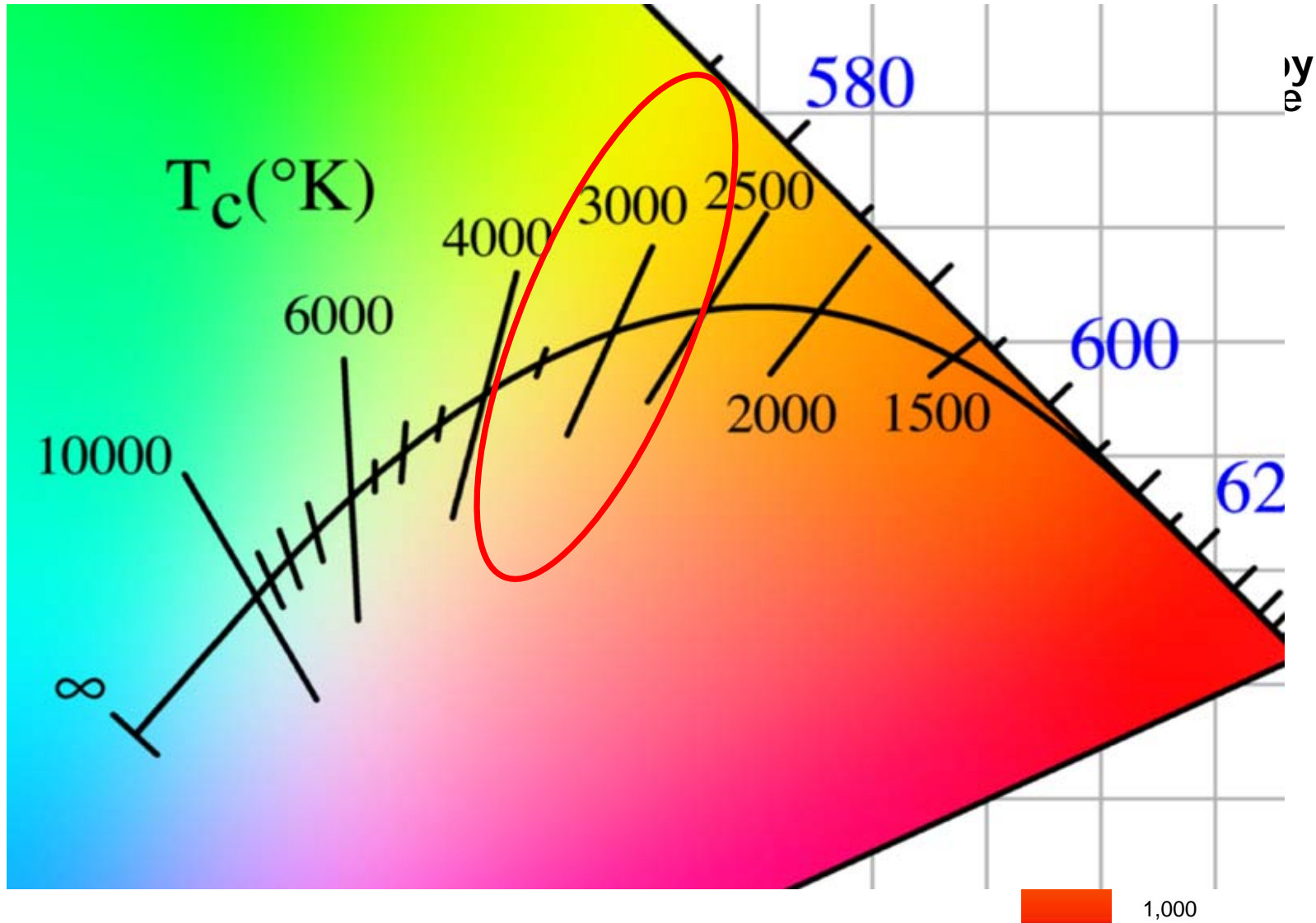


# Product

- Consistency
  - ANSI Binning
  - “Color “
- Performance
  - Meeting the Specification
  - CALiPER
  - L70 B10
- Quality
  - Thermal Management
  - Energy Balance



# Quantify Color



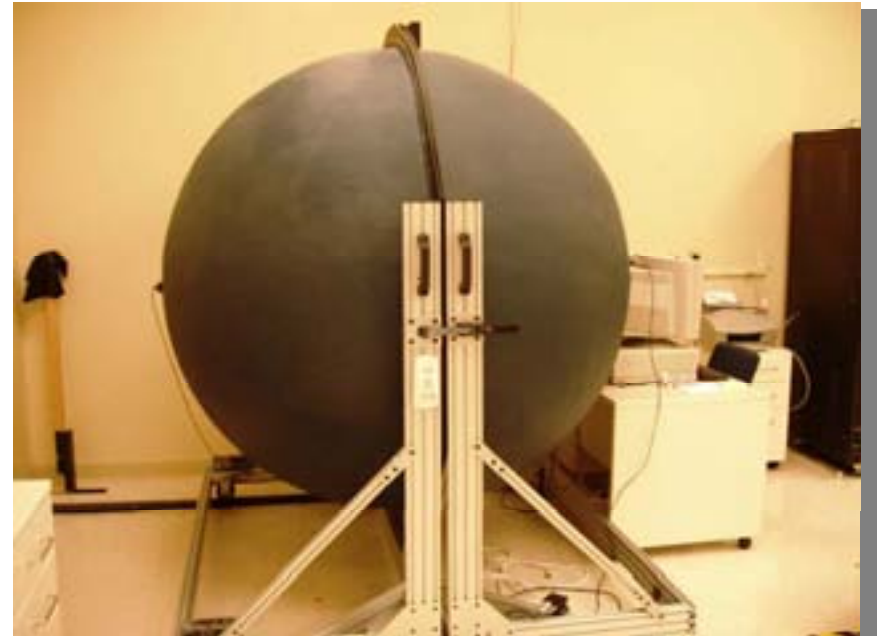
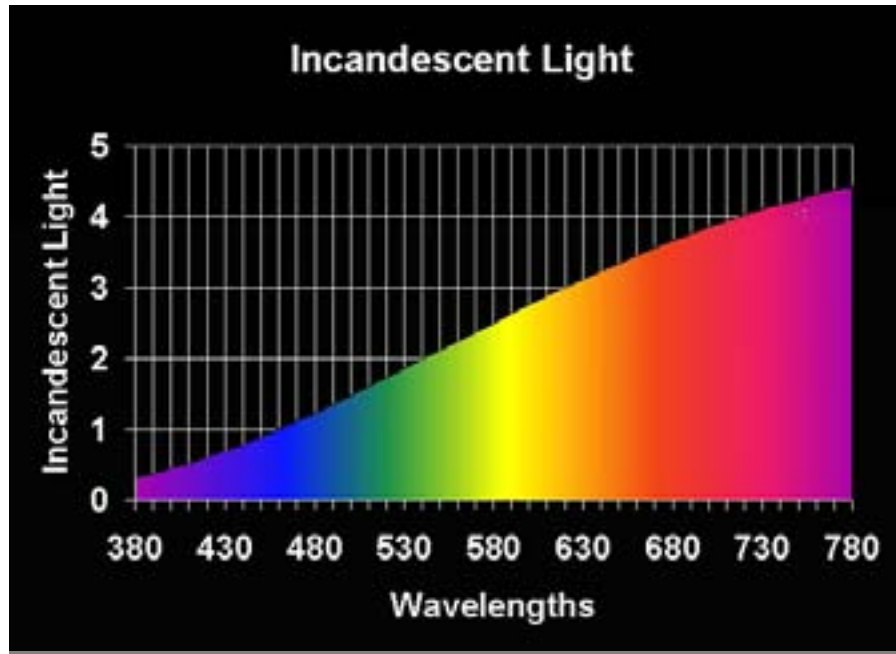
# Color Rendering Index

- Color Rendering Index
- How many swatches are needed to effectively

CIE Technical Report 177:2007, *Color Rendering of White LED Light Sources*, states, “The conclusion of the Technical Committee is that the CIE CRI is generally **not** applicable to predict the color rendering rank order of a set of light sources when white LED light sources are involved in this set.”

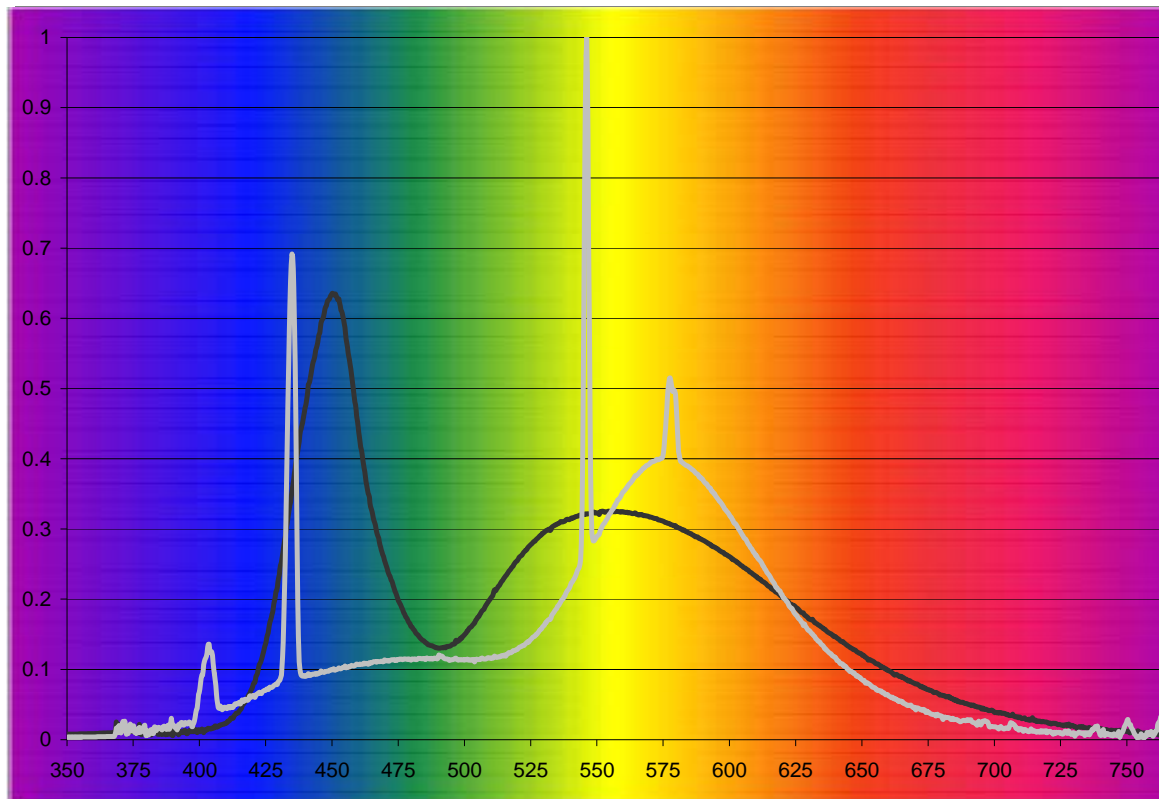
# SPDF (Spectral Power Distribution Func.)

- What do you need to know about Color

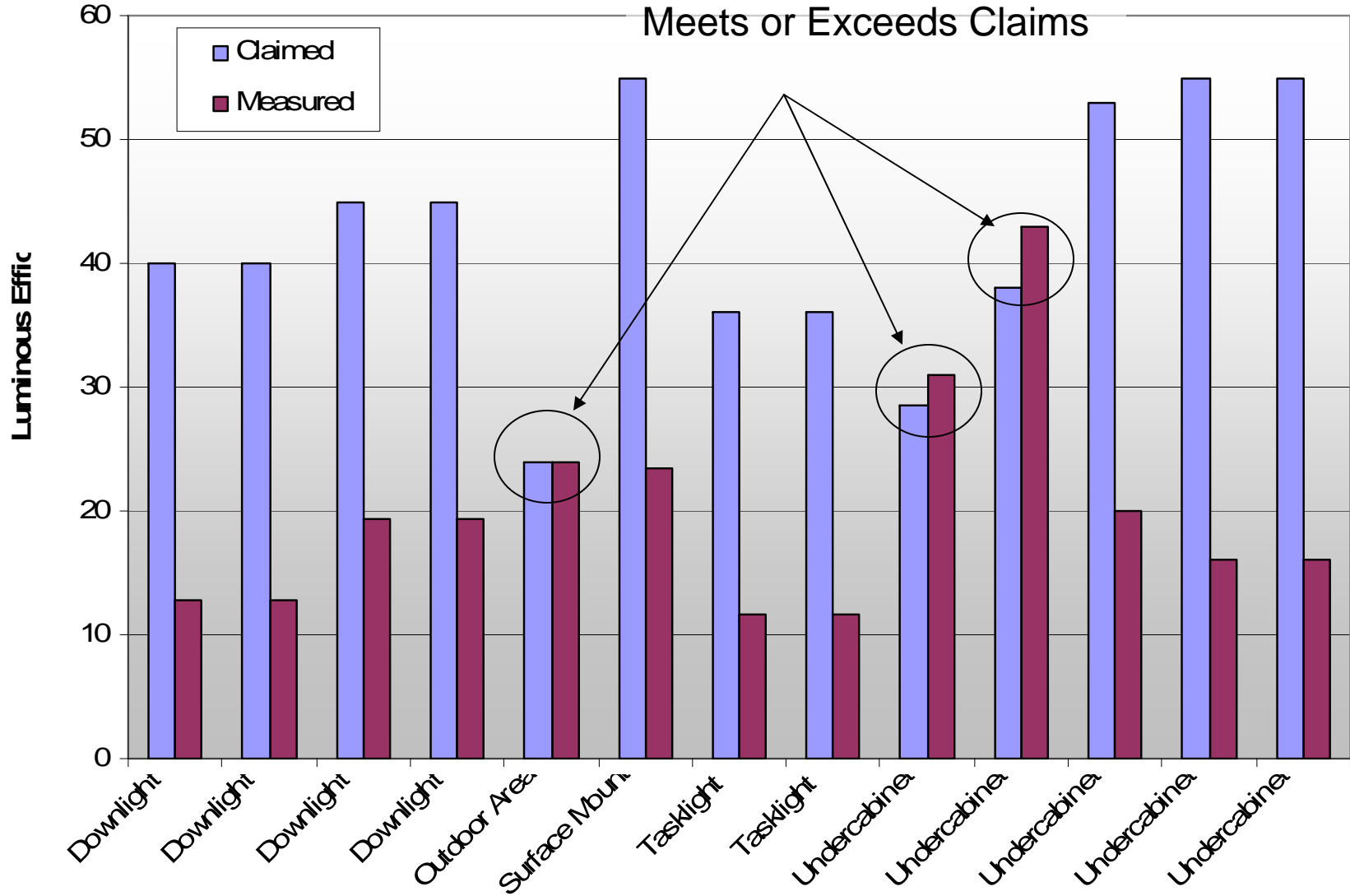


# SPDF

- What do you need to know about Color



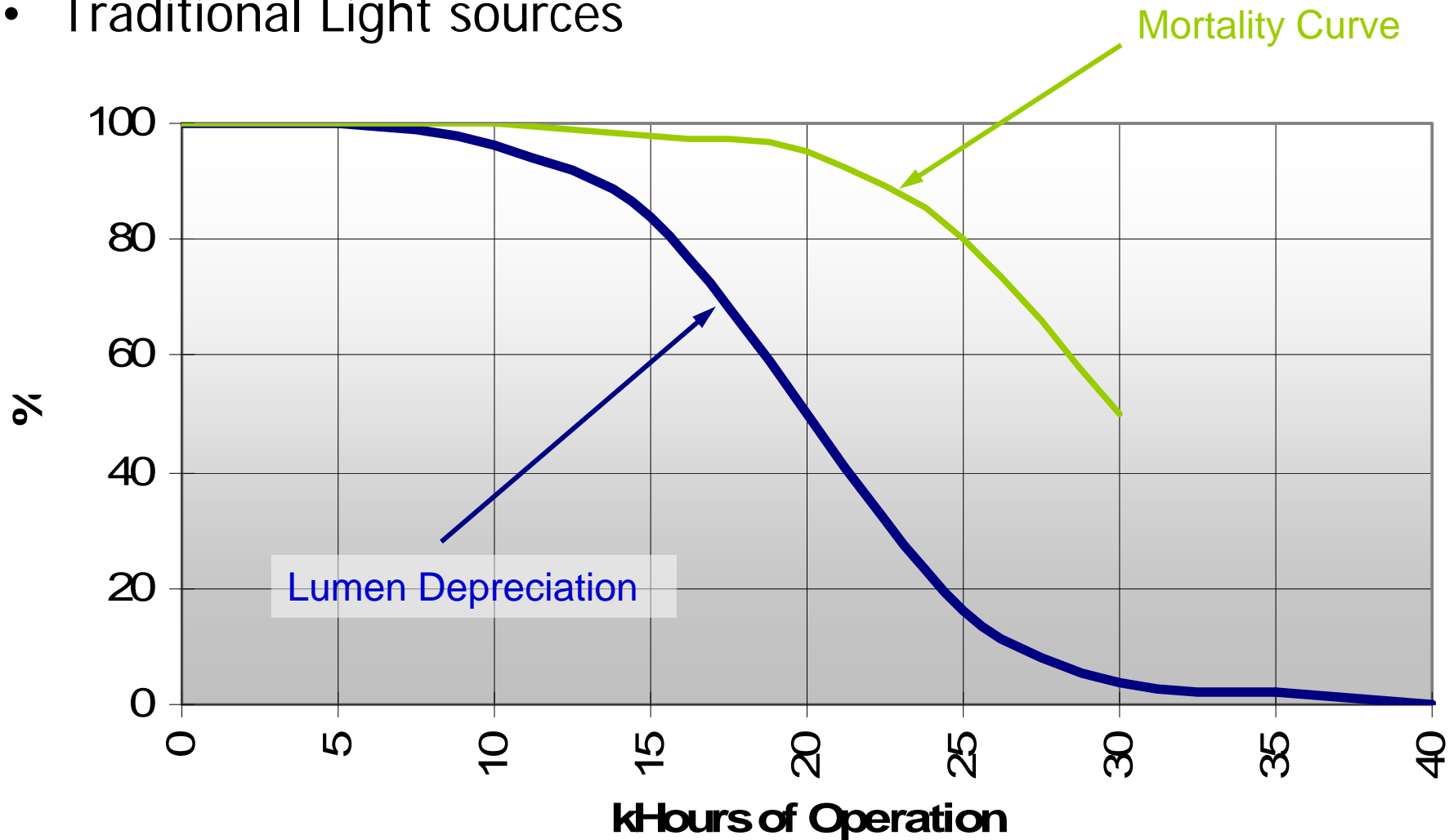
# DOE - CALIPER



Partial Summary of DOE Caliper Results

# L70 / B10

- Traditional Light sources

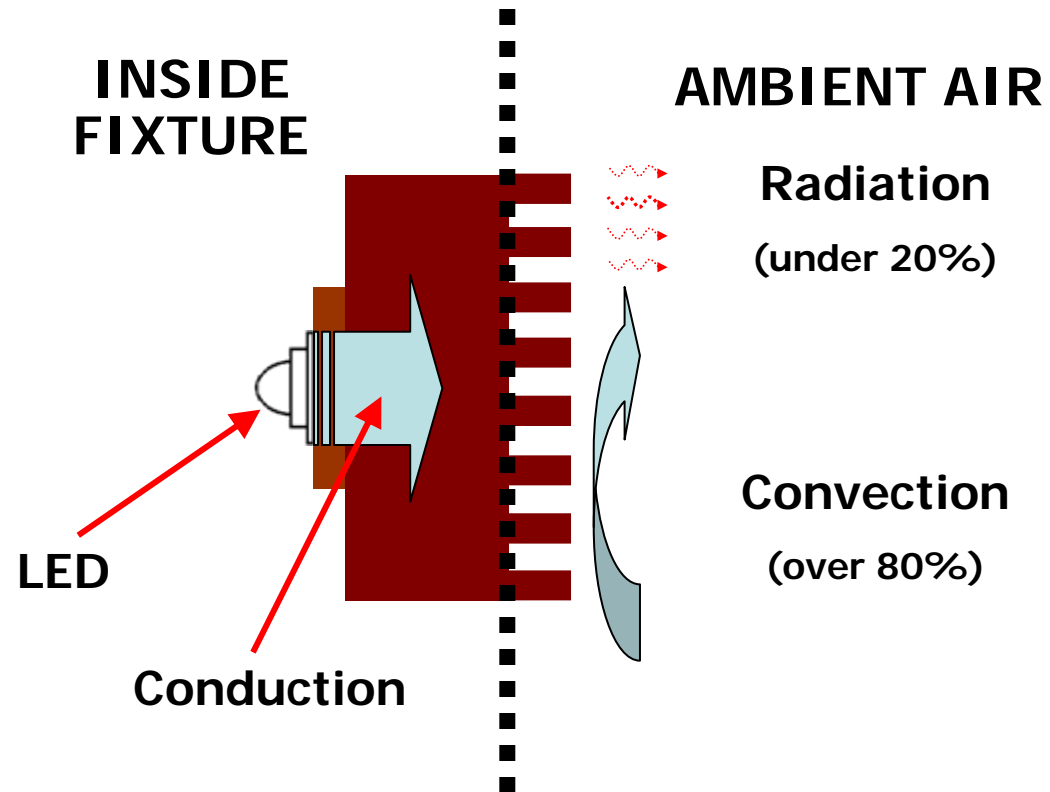


# Lamp Burnout



# Thermal Management

- What has changed?
  - All electronics power
  - Convective cooling is important
  - Components are more susceptible to ambient temperature.
- What do they need to know?
  - Less power?
  - Less Heat load



# Energy Balance

## Power Conversion for “White” Light Sources

	Incoandescent <sup>†</sup> (60W)	Fluorescent <sup>†</sup> (Typical linear CW)	Metal Halide <sup>‡</sup>	LED <sup>*</sup>
<b>Visible Light</b>	7.5%	21%	27%	15-25%
<b>IR</b>	73.3%	37%	17%	~ 0%
<b>UV</b>	0%	0%	19%	0%
<b>Total Radiant Energy</b>	80.8%	58%	63%	15-25%
<b>Heat (Conduction + Convection)</b>	19.2%	42%	37%	75-85%
<b>Total</b>	100%	100%	100%	100%

<sup>†</sup> IESNA Handbook

<sup>‡</sup> Osram Sylvania

\*Varies depending on LED efficacy. This range represents best currently available technology in color temperatures from warm to cool. DOE's SSL Multi-Year Program Plan (Mar 2006) calls for increasing extraction efficiency to more than 50% by 2012.

LED's produce more conducted heat than any other source.

# Quality

- Speak a common language
  - Energy Star (for SSL)
  - PQA
- Use industry standards
  - LM 79
  - LM 80
  - .....



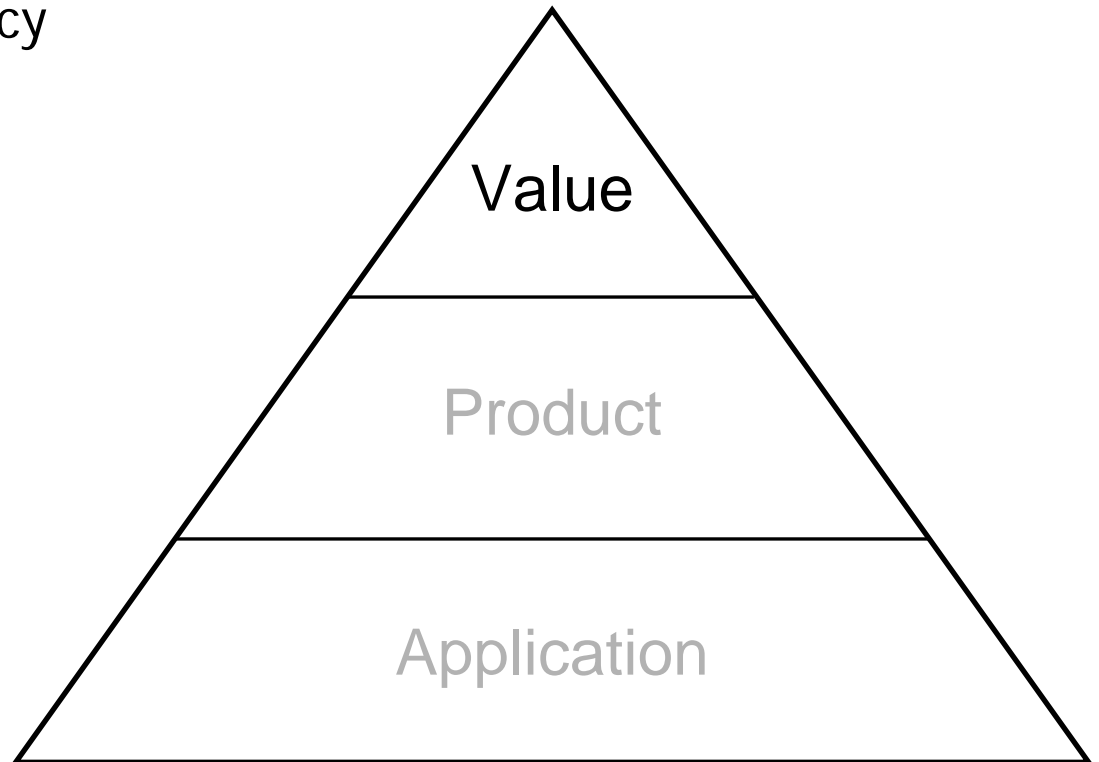
<b>Lighting Facts™</b>			
LED Product			
<b>Light Output (Lumens)</b>	840		
<b>Watts</b>	9		
<b>Lumens per Watt (Efficacy)</b>	93		
<b>Color Accuracy</b>	87		
Color Rendering Index (CRI)			
<b>Light Color</b>			
Combined Color Temperature (CCT) 3100 (Warm White)			
A horizontal color scale bar ranging from 2000K (dark red) to 6000K (blue). A yellow arrow points down to the 3100K mark, which is labeled "Warm White". The scale is divided into three sections: "Warm White" (2000K-3200K), "Bright White" (3200K-4000K), and "Daylight" (4000K-6000K).			
2000K	3200K	4000K	6000K
Visit <a href="http://www.lightingfacts.com">www.lightingfacts.com</a> for the Label Reference Guide.			
<small>Results are according to IESNA LM-79/2008 Approved Method for the Electrical and Photometric Testing of Solid State Lighting. Date: 6/18/2012 10:00:00 AM</small>			



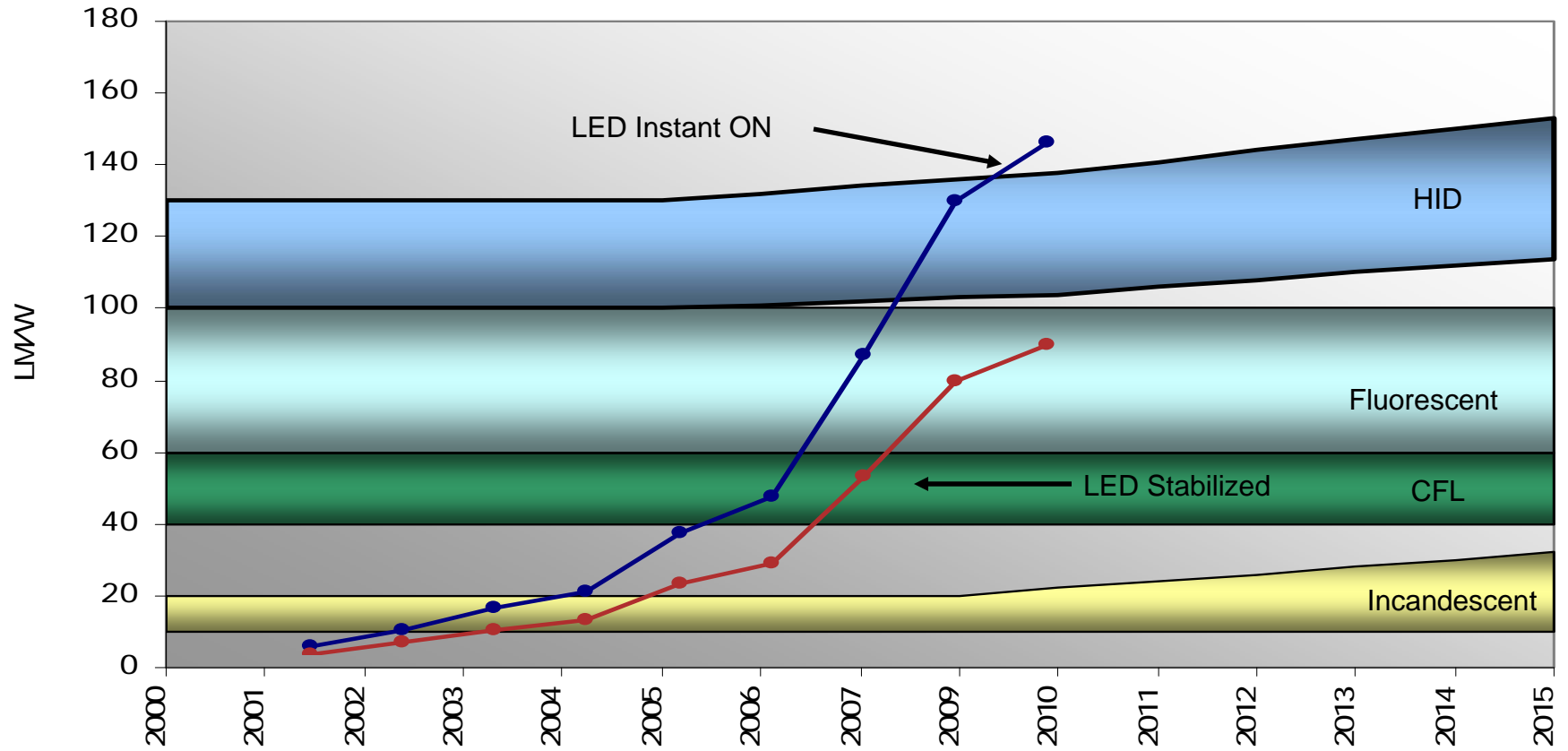
NGLIA & DOE – Lighting Facts

# SSL Value

- Not just about \$\$\$\$
  - Application level efficacy
  - Total Cost Ownership
  - Green
  - Emotion



# Efficacy Fixture



# System Efficacy

- Improved controls
- Better performing optical systems
  - Uniformity
  - Glare



# Being Green



LED luminaires can be made using Lead and Mercury free technology



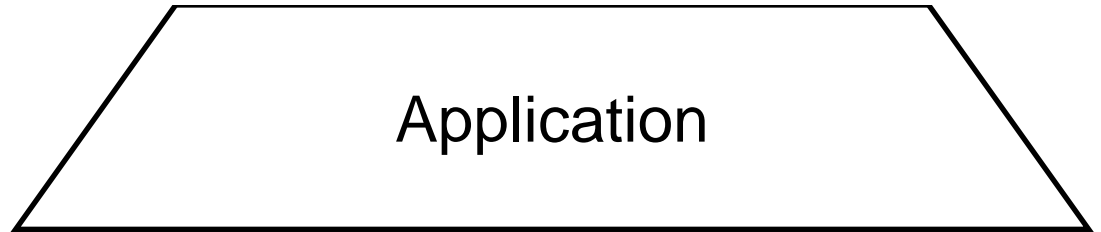
Increased Energy Efficiency will reduce the demand on fossil fuels.



No more hazardous disposal requirements.

# Conclusion

- We need to understand the application
- We need to develop quality products
- We need to drive value





Questions?