



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# Solid State Lighting State-of-the-art of for General Illumination

Jeff McCullough, LC

Pacific Northwest National Laboratory

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2007 ENERGY STAR® Lighting Partner Meeting



**BrightFeet**  
Lighted Slippers

**Lighted Slippers**  
That Let You See In The Dark!



**BRIGHTEN YOUR VALENTINE'S DAY WITH BRIGHTFEET LIGHTED SLIPPERS!**

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## Night Time Just Got a Little Brighter!

Now you can easily move handsfree around a darkened house reducing the risk of tripping over objects or running into doors, furniture or anything not easily seen in the dark.

Brightfeet™ Lighted Slippers are nightlights for your feet. They are ideal for night time trips to the bathroom, kitchen, kid's room or anywhere in your house! Power outage? Use Brightfeet™ to locate candles, flashlights and other emergency lighting sources.

Comfortable and convenient, Brightfeet Lighted Slippers make the perfect gift for any occasion!

Copyright Boston Ideas, LLC 2005  
Patent Pending

### BrightFeet News...

**THE MONTEL WILLIAMS SHOW** (Friday, December 30, 2005) features BrightFeet Lighted Slippers in a segment about amazing new gadgets hitting stores in 2006.

**FOX NEWS Channel's afternoon talk show, "Dayside"** with Mike Jerrick and Juliet Huddy, feature Brightfeet Lighted Slippers on December 14, 2005.

**BostonHerald.com's Holiday Gift Guide** reviews and features Brightfeet Lighted Slippers.



Order Now! \$39.95



See them  
in Action!







## Top 5 Reasons not to own BrightFeet™ Lighted Slippers

- #5. They're not machine washable which means they will never be cleaned during their useful life..... Ewuuuu!!!
- #4. Do they come with parental controls to prevent your children from using them as flashlights..... outside?
- #3. Gee.... that's neeeat..... but do they keep your feet warm?
- #2. Do they come with a strap so that they can be worn on your head for night reading?

.... and the #1 reason not to own BrightFeet Slippers:

Is it really a good idea to wake up your pet Doberman when all he can see are two "beadie" eyes staring him down???



## New Product Announcements

- *“Philips Lumileds shatters 350 mA performance records with 115 lm/W LED”*  
January 2007
- *“Seoul Semiconductor introduces world’s brightest LED, a 240 lumens single die light source” [100 lm/W]*  
December 2006
- *“Nichia delivers 92 lm/W at 350 mA”*  
November 2006
- *“Cree delivers first 160-lumen white power LED” [85 lm/W]*  
October 2006



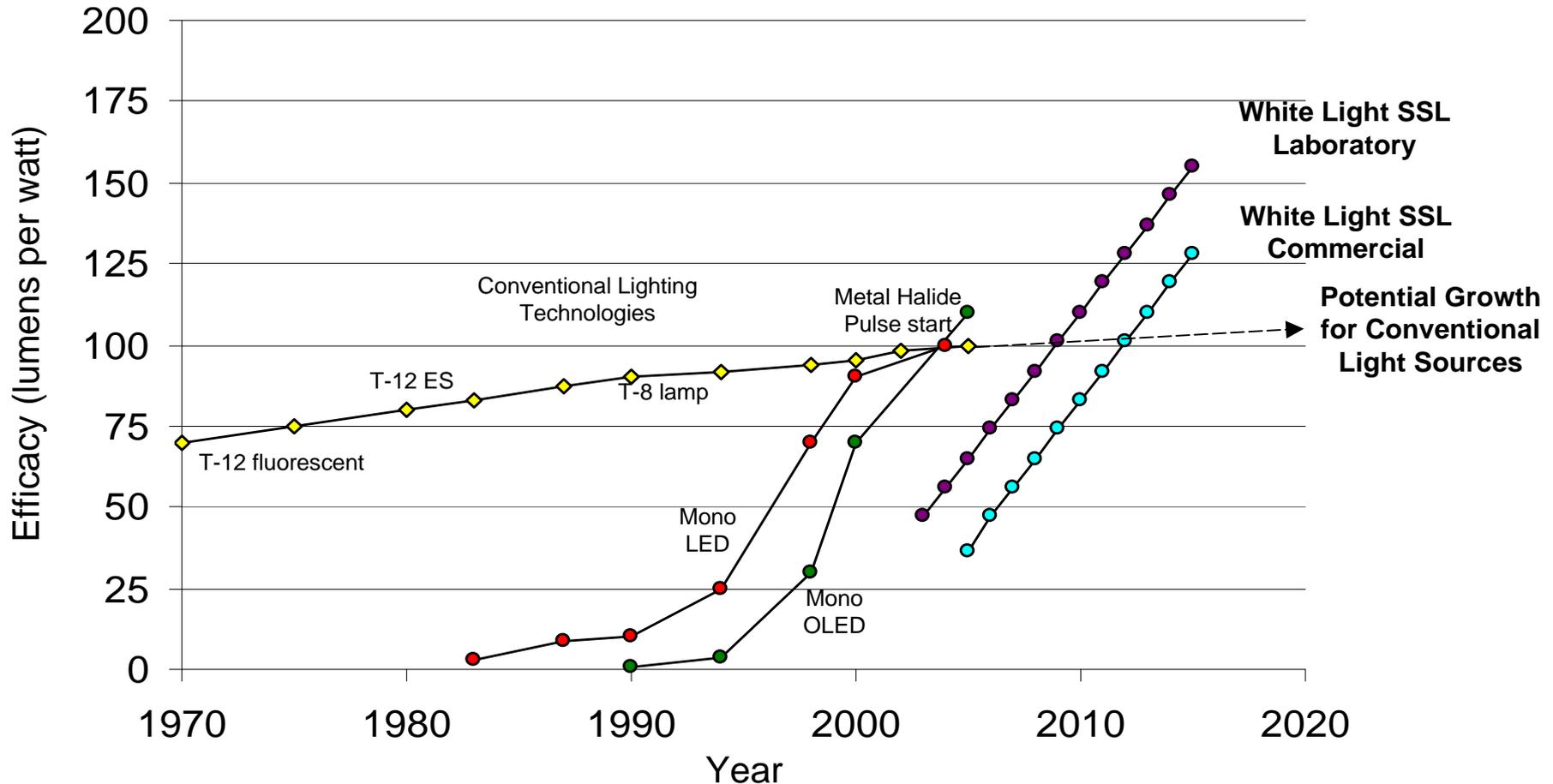
Seoul Semiconductor



Cree Inc.



# Accelerated R&D for White Light SSL

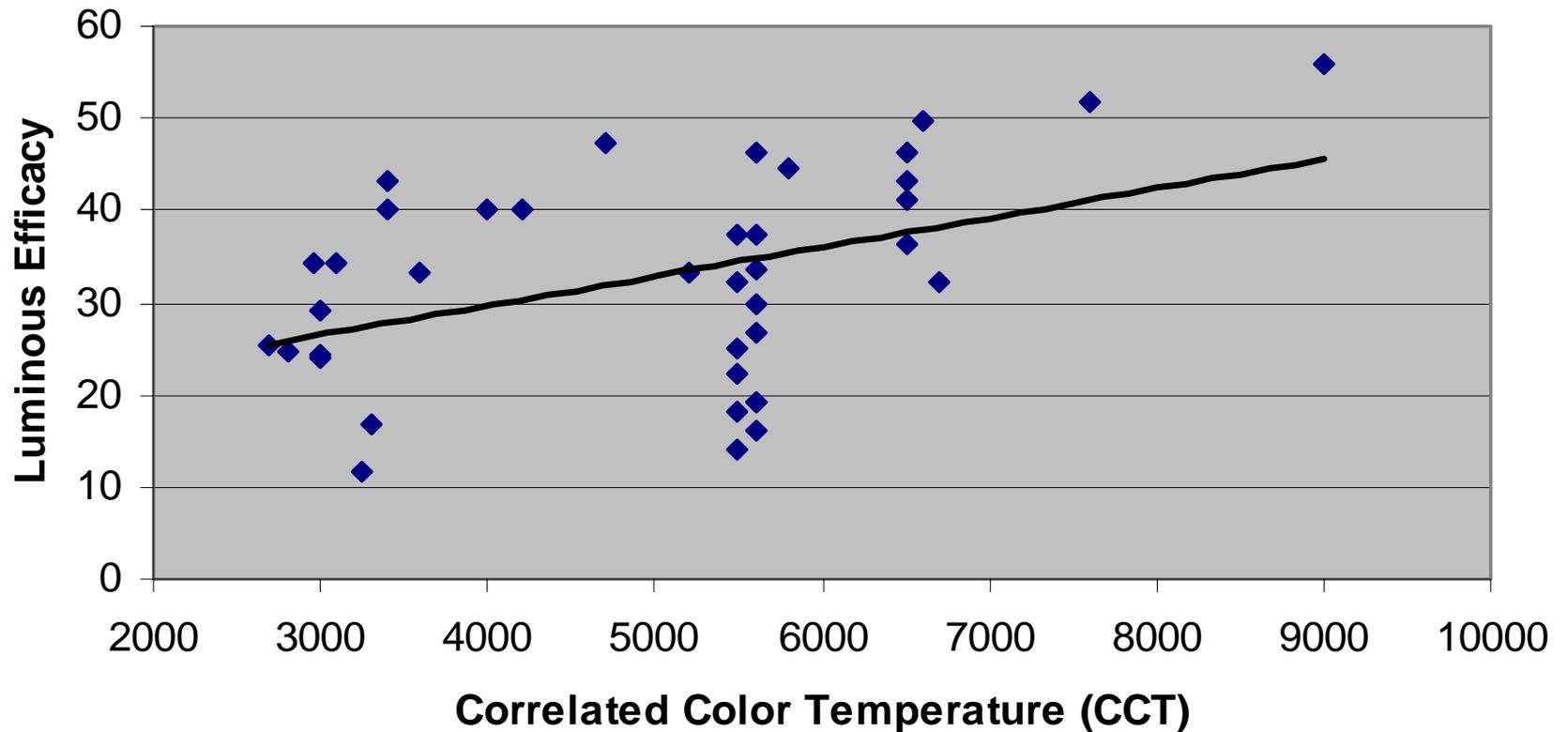


SSL Laboratory and Commercial Curves, revised May 2006



# Production LEDs

as of 7/06





## Terms

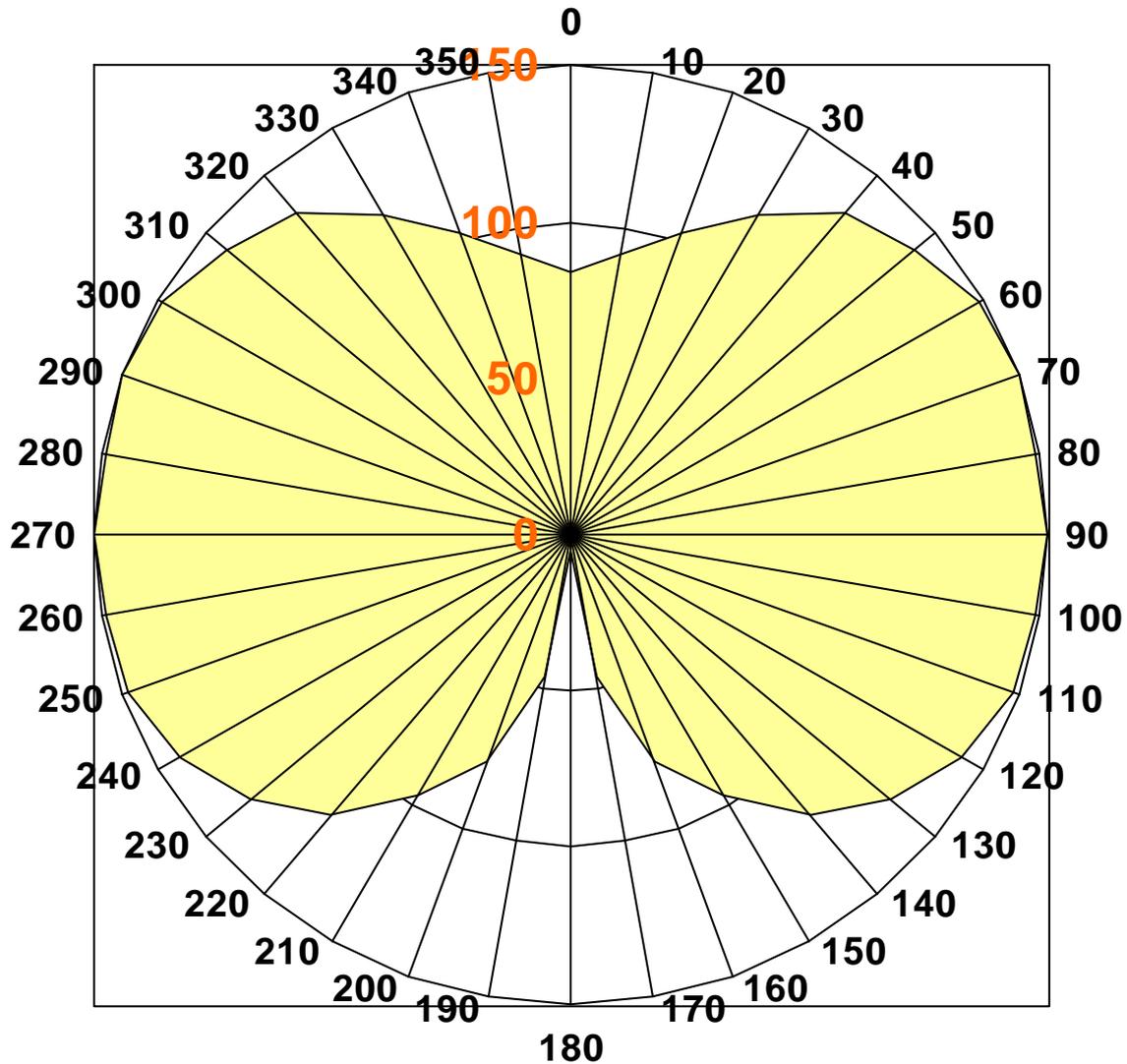
$$\text{Lamp Efficacy} = \frac{\text{Rated Lamp Lumens}}{\text{Lamp Input Power}}$$

$$\text{System Efficacy}_{\text{fluor}} = \frac{\text{Rated Lamp Lumens} \times \text{BF}}{\text{Ballast/Driver Input Power}}$$

$$\text{Luminaire Efficacy} = \frac{\text{Luminaire Light Output}}{\text{Ballast/Driver Input Power}}$$



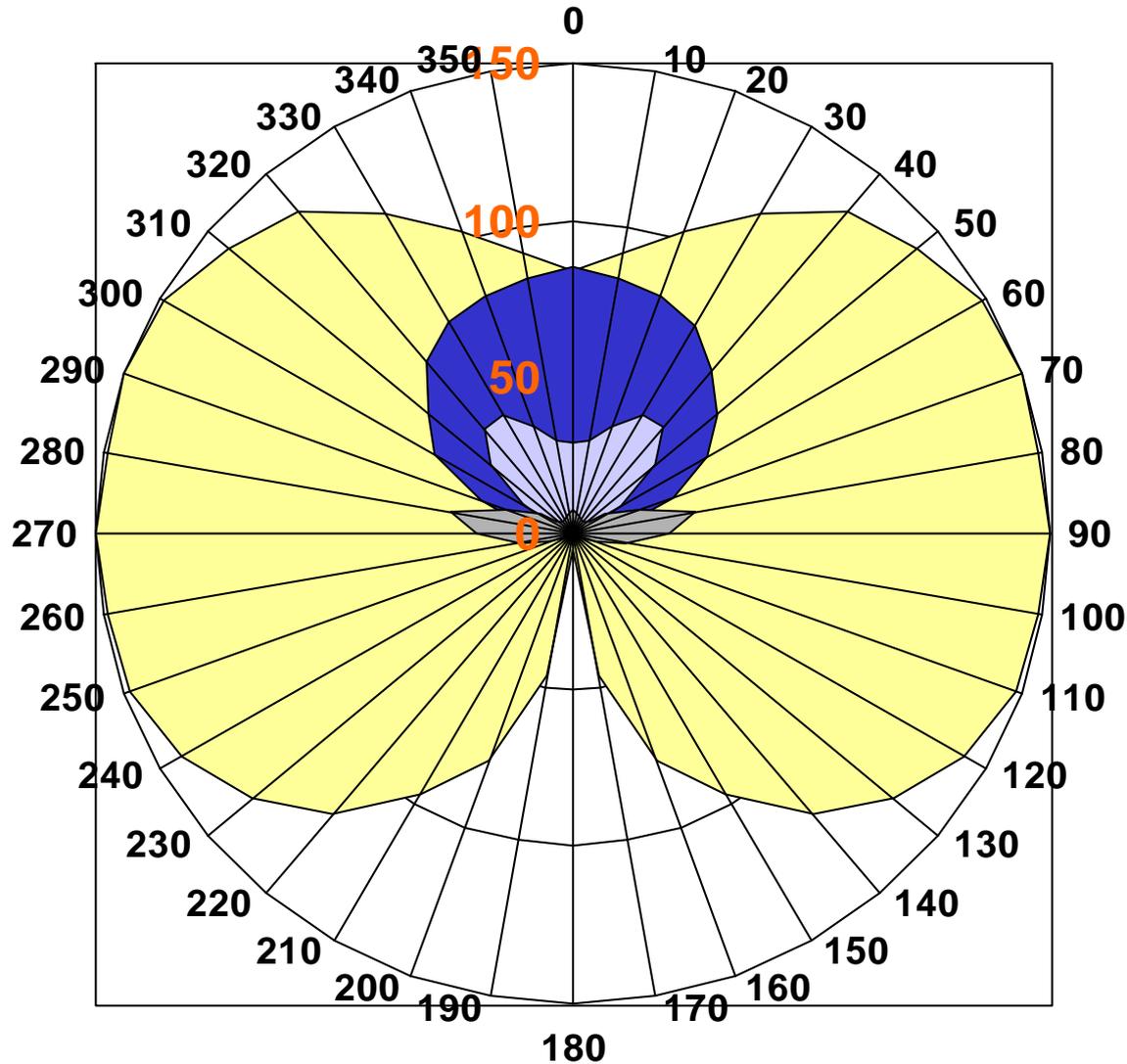
# Candela Curve



100 W Incandescent



# Candela Curve



- 100 W Incandescent
- Z-LED P4
- Luxeon Batwing
- Luxeon Side Emitting



**Myth #1:**

**LEDs create no heat**



# So you heard LEDs don't create heat?

## Power Conversion for "White" Light Sources

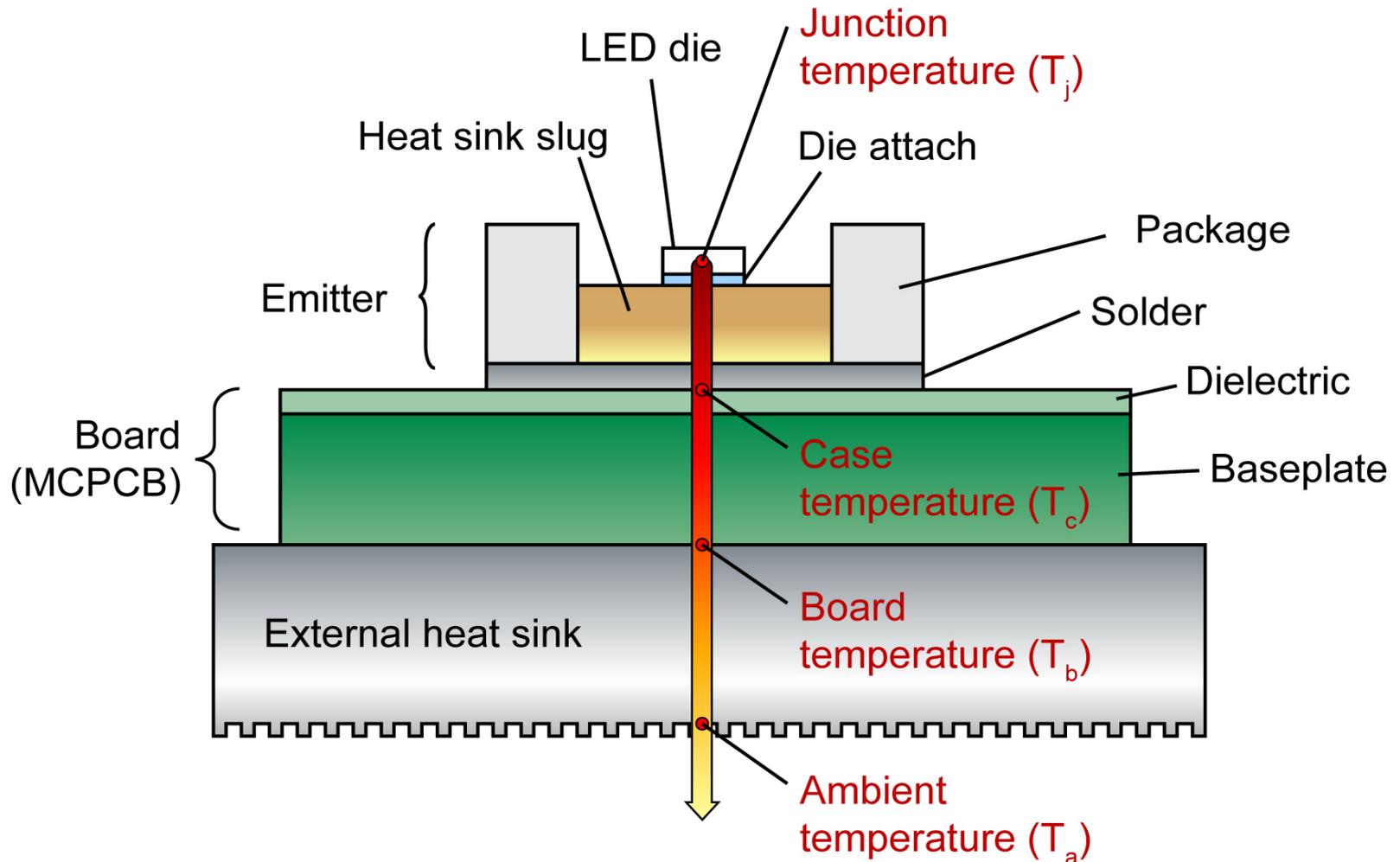
	<b>Incandescent†</b> (60W)	<b>Fluorescent†</b> (Typical linear CW)	<b>Metal Halide‡</b>	<b>LED</b>
Visible Light	7.5 %	21 %	27 %	10-15 %
Infrared	73.3 %	37 %	17 %	~ 0 %
Ultraviolet	0 %	0 %	19 %	0 %
Total Radiant Energy	80.8 %	58 %	63 %	10-15 %
Heat (Conduction + Convection)	19.2 %	42 %	37 %	85-90 %
Total	100 %	100 %	100 %	100 %

† IESNA Lighting Handbook – 9<sup>th</sup> Ed.

‡ Osram Sylvania

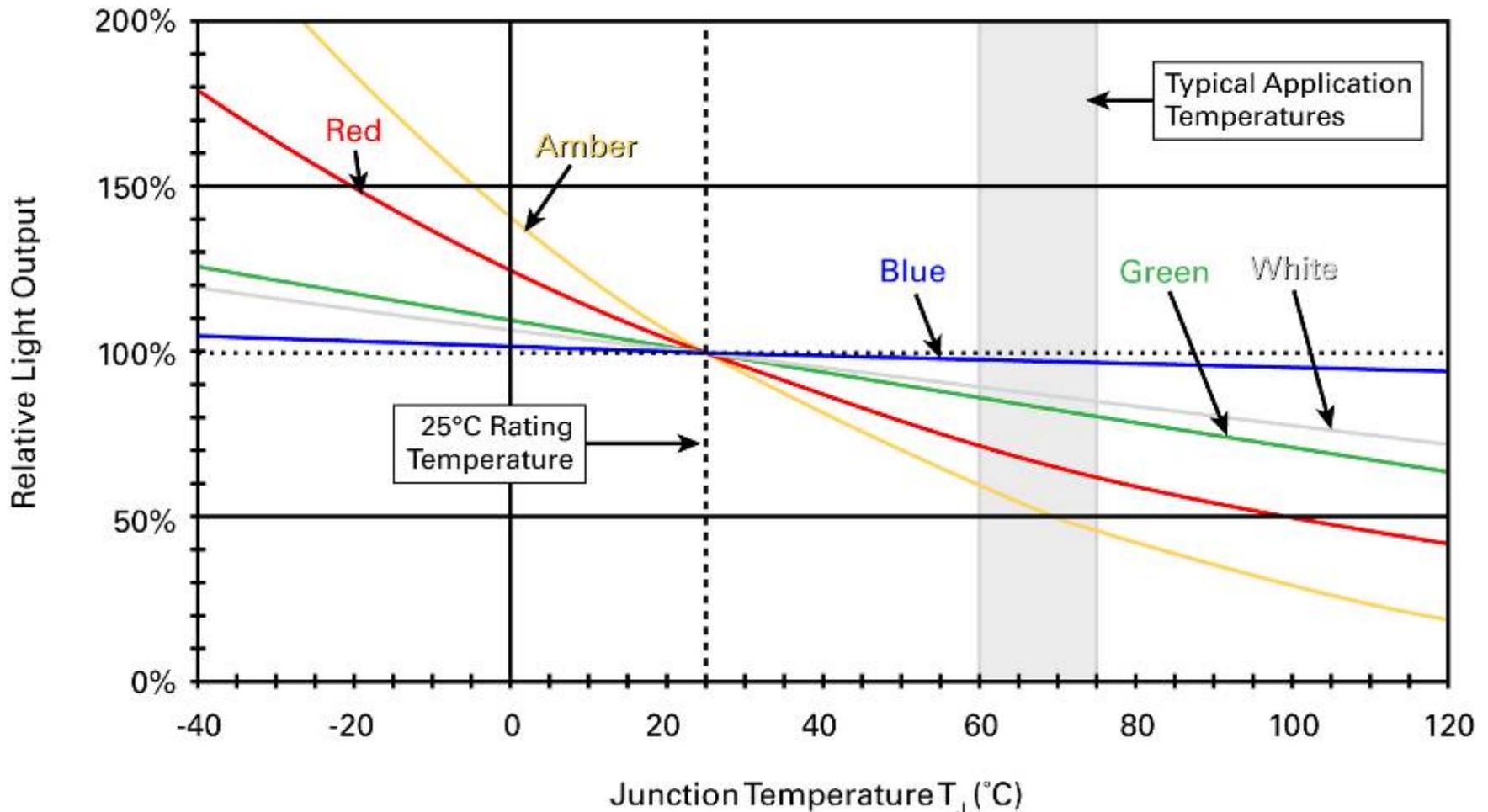


# Anatomy of an LED





# Light Output vs. Junction Temperature ( $T_j$ )





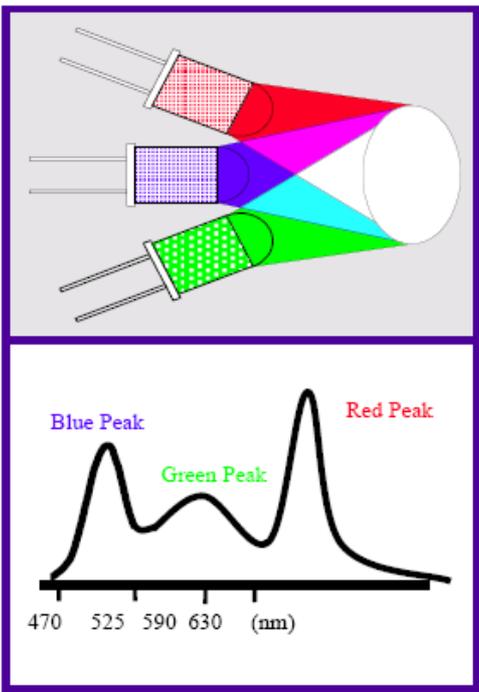
**Myth #2:**

**LEDs are “White Light ”  
Sources**



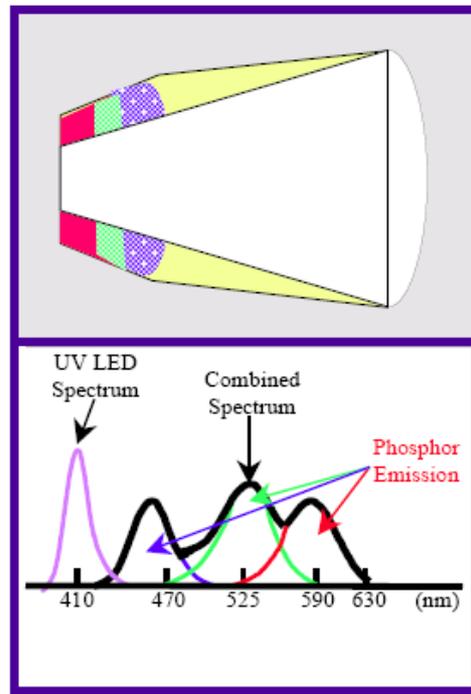
# How do we make white light?

### Red + Green + Blue LEDs



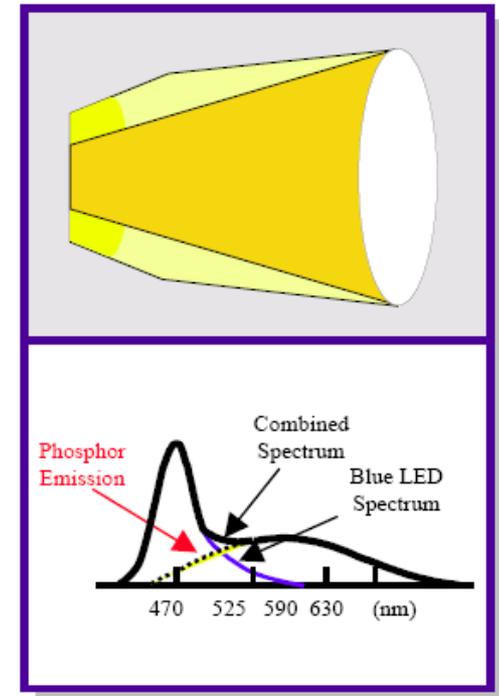
- Dynamic color tuning
- Excellent color rendering
- Large color gamut

### UV LED + RGB Phosphor



- White point tunable by phosphors
- Excellent color rendering
- Simple to create white

### Blue LED + Yellow Phosphor



- Simple to create white
- Good color rendering



## Myth #3:

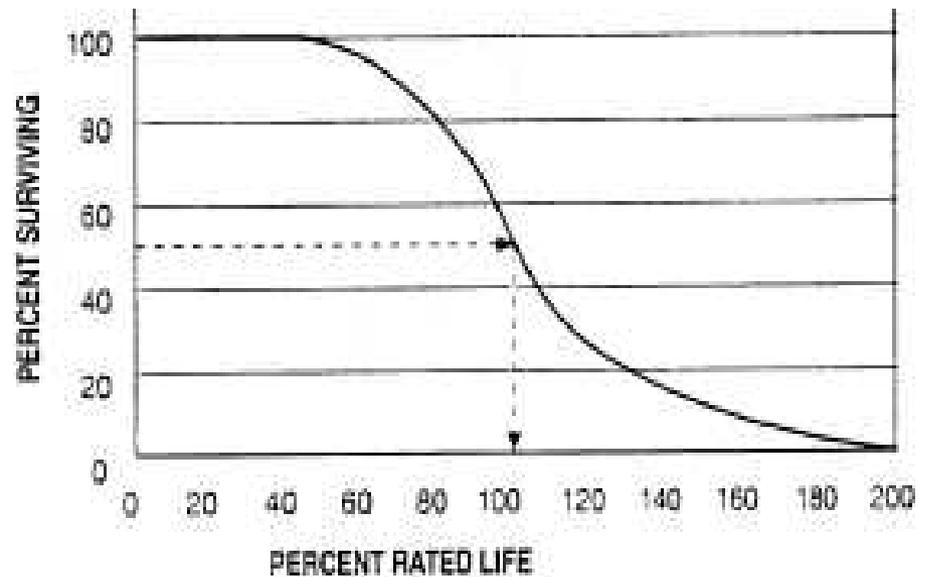
**LEDs last 100,000 hours  
(or forever depending who talk to!)**



# Traditional Lamp Life Rating

- **Lumen depreciation vs. failure**
- **LED life definition**
  - $L_{70}$  for general illumination
- **IESNA LM-80 in process**

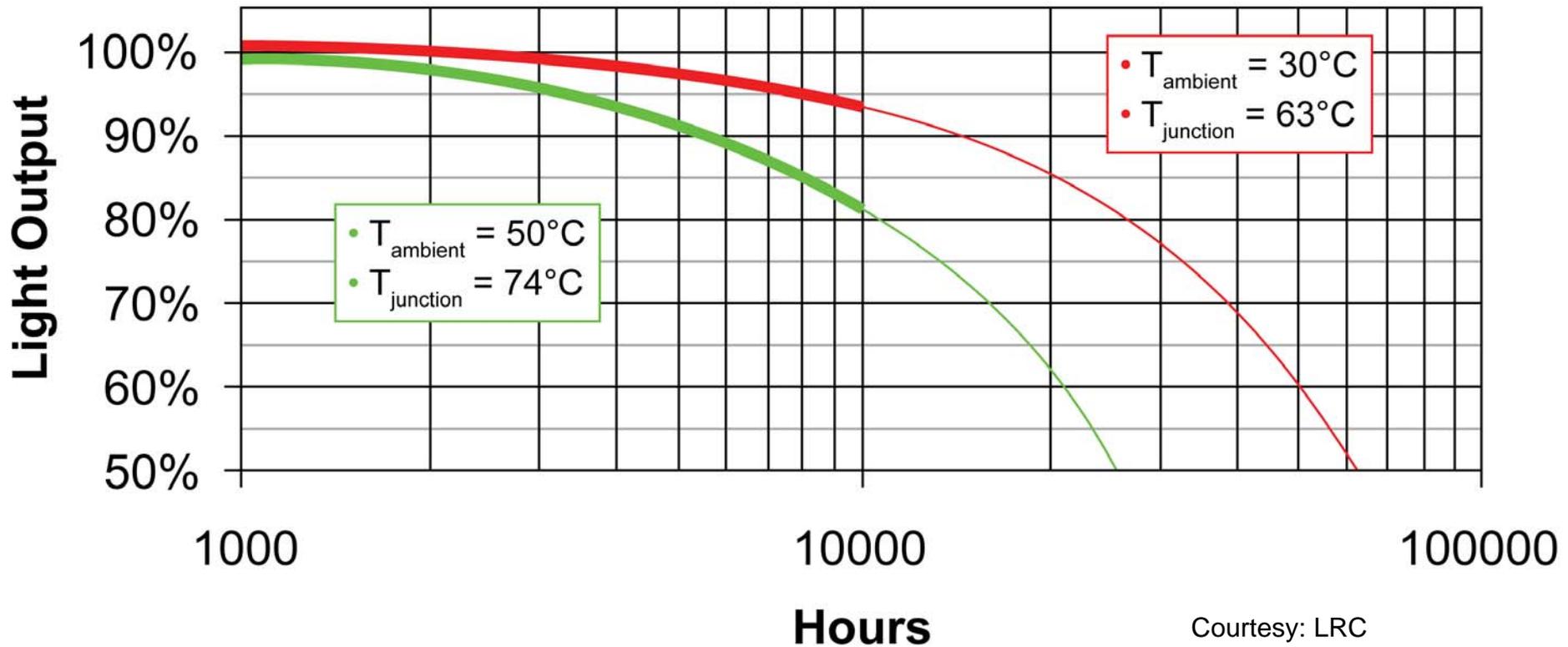
Typical lamp mortality curve





# Light Output over Time

## High Brightness White LED (350 mA)





# Significant Standard and Test Procedure Activity

- Photometric measurements (IESNA LM-79)
  - In second committee Review/Approval cycle
- Chromaticity (ANSI C78.377a)
  - In second committee Review/Approval cycle
- Lumen Depreciation (Life) (IESNA LM-80)
  - First draft under development
- Driver Standard (ANSI C82.XX1)
  - In first committee review
- Definitions (IESNA RP-16)
  - In second draft and currently in working group review



## Efficiency & Quality Trade-offs

Color Temperature*		Efficacy	
Color Temperature*		Efficacy	
CRI*		Efficacy	
Heat		Efficiency / Output	
Heat		Life / Durability	

\* Phosphor-converted LEDs



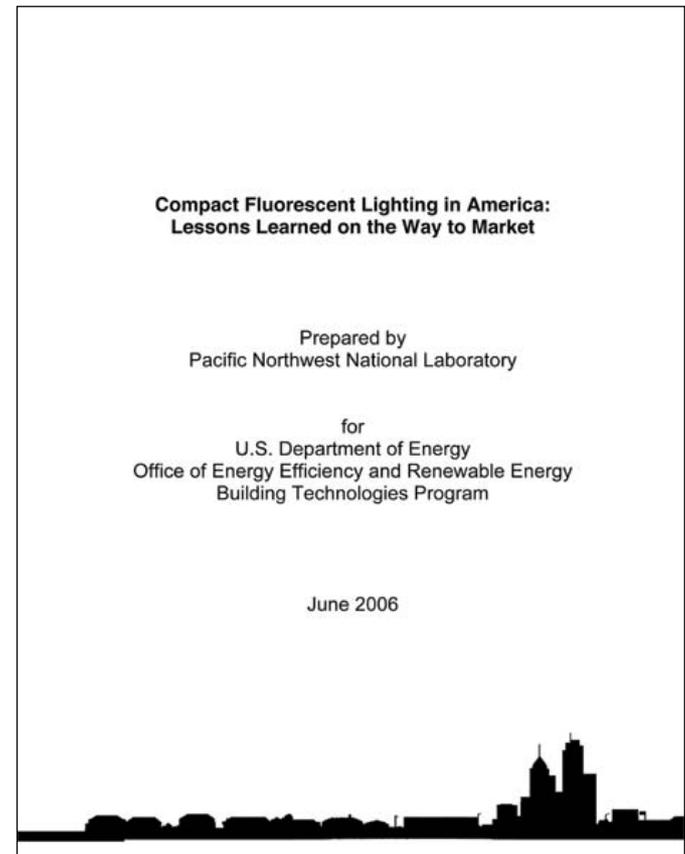
## Questions EEPS & Retailers Should Ask

- Show me the lumens!
- Ask for test reports (LM-79, LM-80, etc.)
- Is blue is the new white?
- Ask how they manage heat



# Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market

- Valuable lessons
  - Be aggressive about dealing with technology failures that affect main benefit claims
  - Know and admit technology limitations
  - Don't introduce inferior products; first impressions are long lasting
  - Accurate incandescent equivalency on packaging is critical
  - Manufacturers and energy-efficiency groups should coordinate to establish minimum performance requirements
- Use to avoid "CFL Part II"
- Apply to SSL commercialization path





# SSL Fact Sheet Series

- Written for efficiency program and facility managers
- Five completed in '06
- Five more coming in '07





## Q & A

For more information, fact sheets, etc.:

[www.netl.doe.gov/ssl/](http://www.netl.doe.gov/ssl/)

**Jeff McCullough**

**Pacific Northwest National Laboratory**

**[jeff.mccullough@pnl.gov](mailto:jeff.mccullough@pnl.gov)**