

# FEDERAL UTILITY PARTNERSHIP WORKING GROUP SEMINAR

May 18-19, 2016  
Cincinnati, OH

## FEMP Lighting Initiatives

Hosted by:

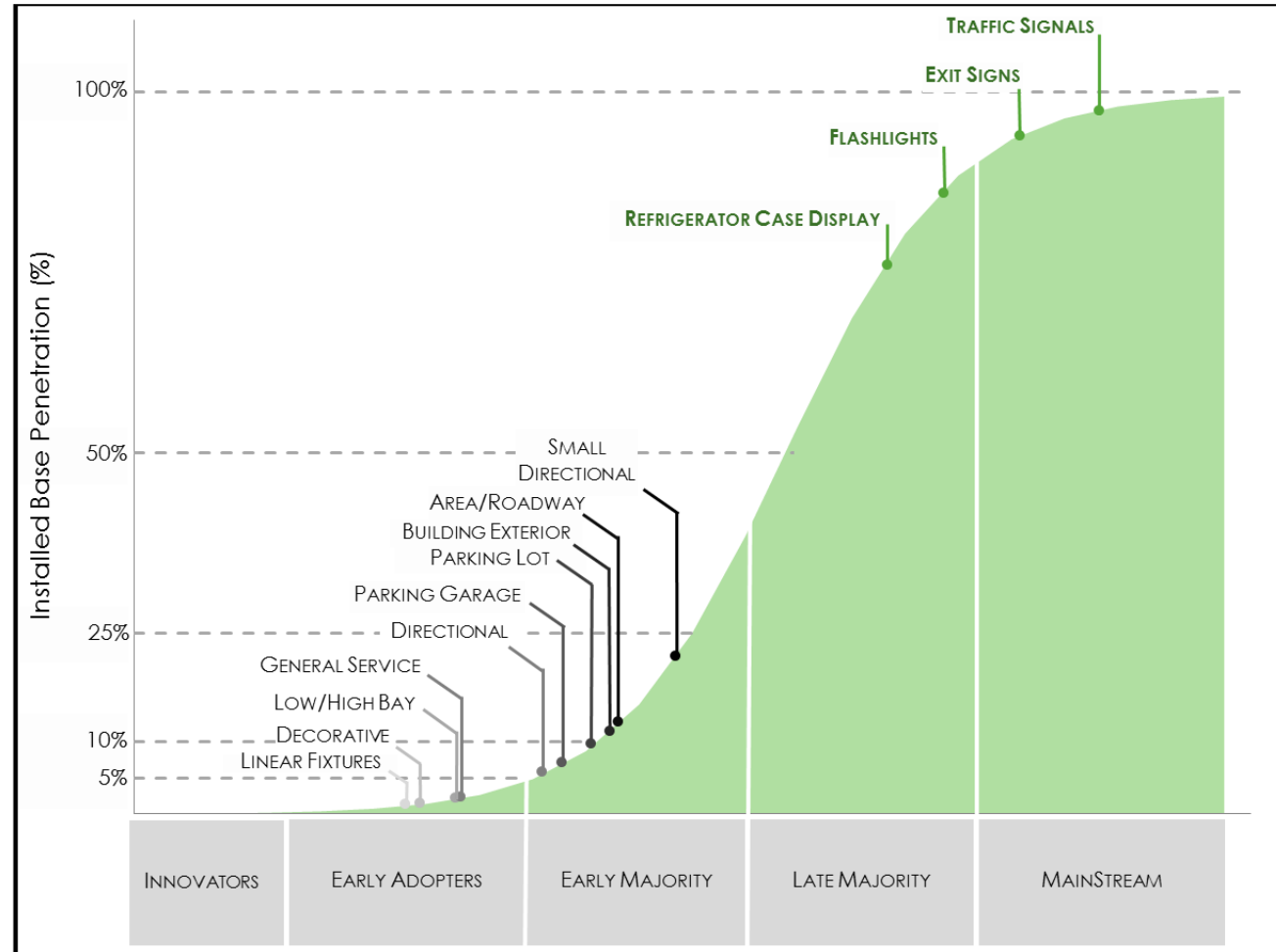


Jeff McCullough, LC  
Pacific Northwest National Laboratory

# Order of the Day...

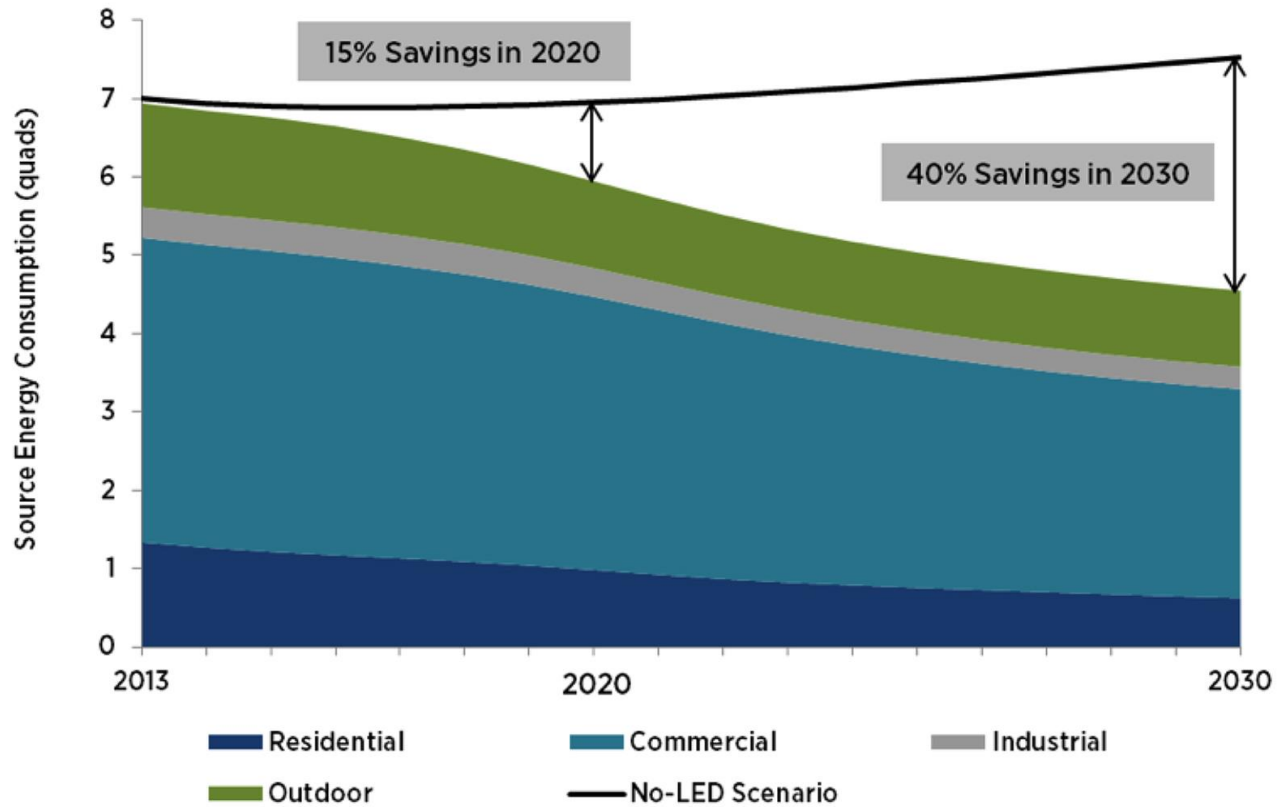
- Lighting industry trends and forecasts
- Federal sector lighting estimates
- Latest FEMP-designated lighting product categories
- The Interior Lighting Campaign (ILC)
- “The Troffer Conundrum”
- The “ABCs” ... of UL 1598
- Q&A

# Penetration Rates of LED Lighting Applications

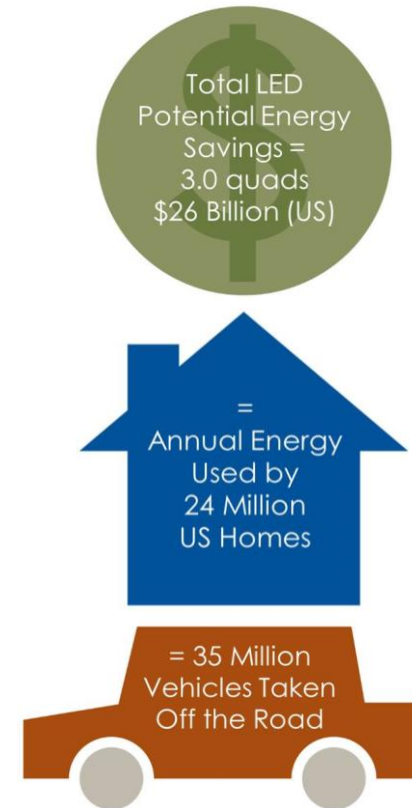


DOE 2015 Adoption of Light-Emitting Diodes in Common Lighting Applications

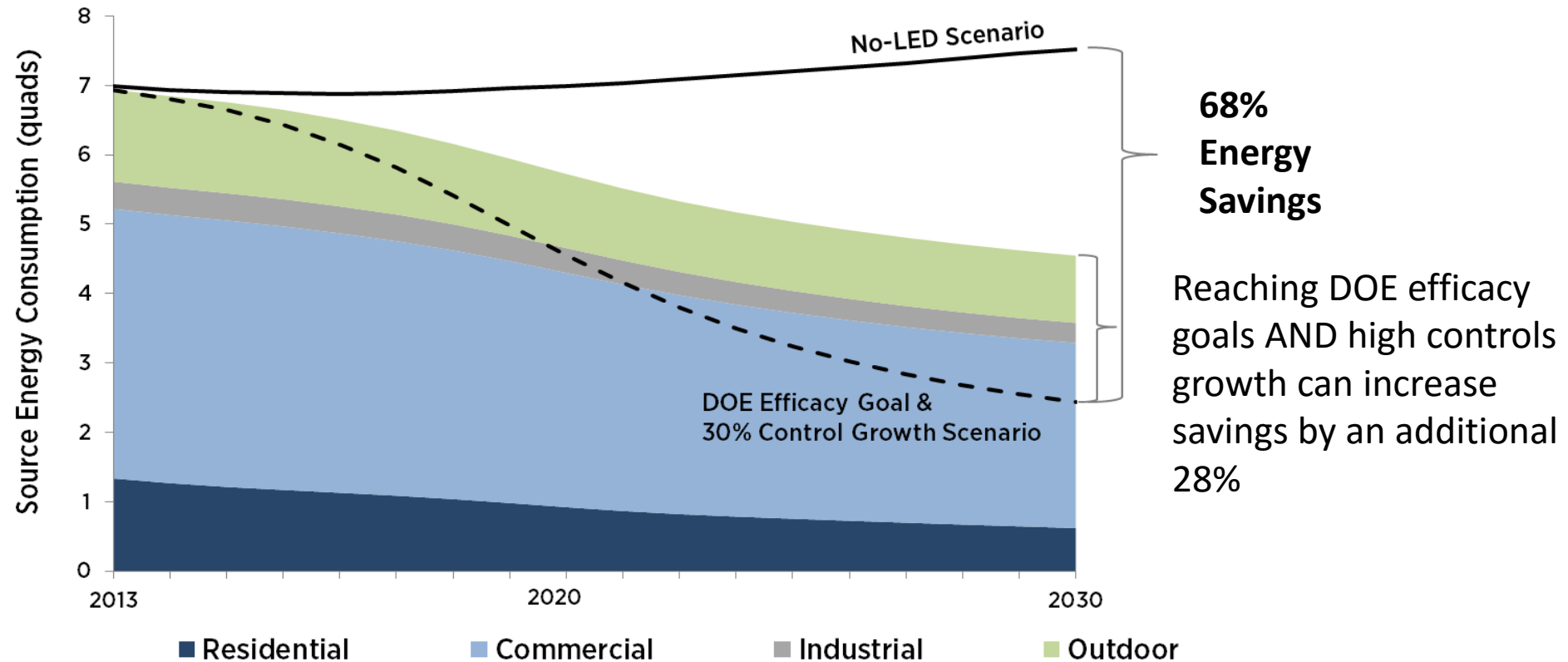
# Energy Savings Forecast



Source: Navigant



# Much Deeper Energy Savings Still Achievable

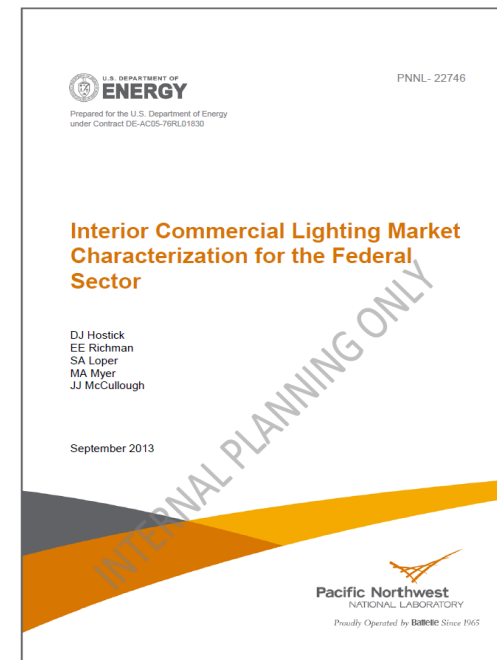
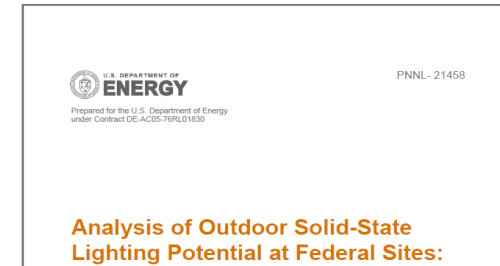


Source: <http://energy.gov/eere/ssl/market-studies>

# Federal Market Assessments

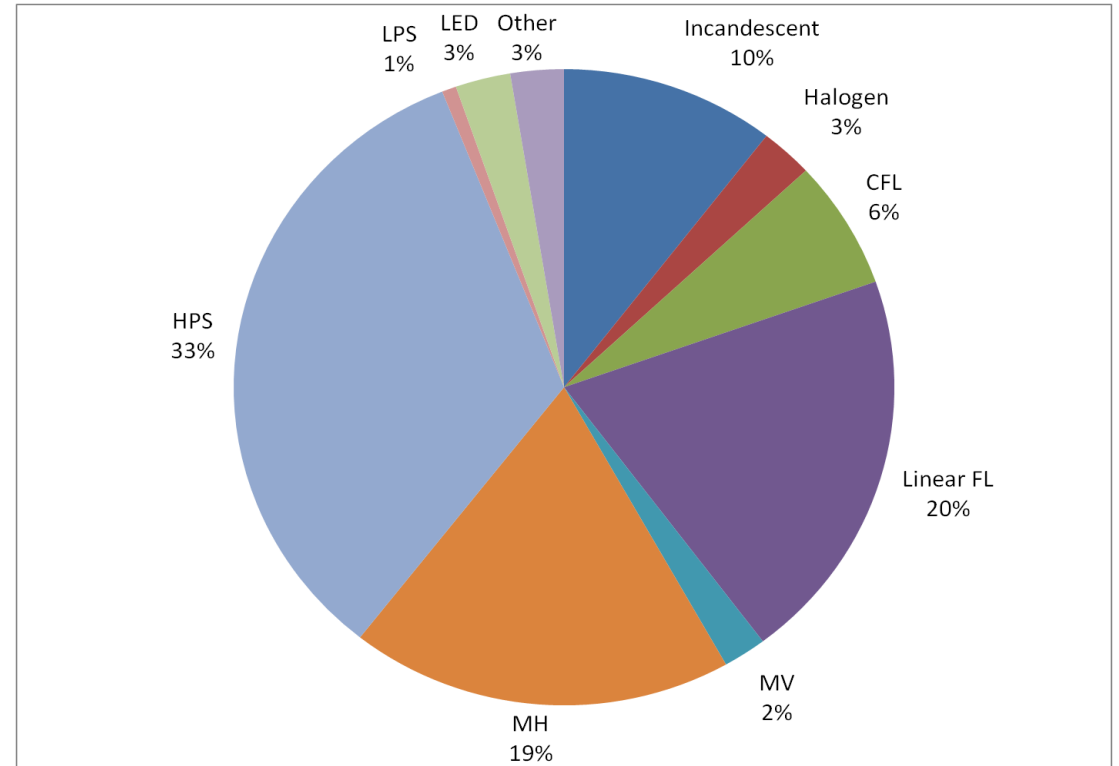
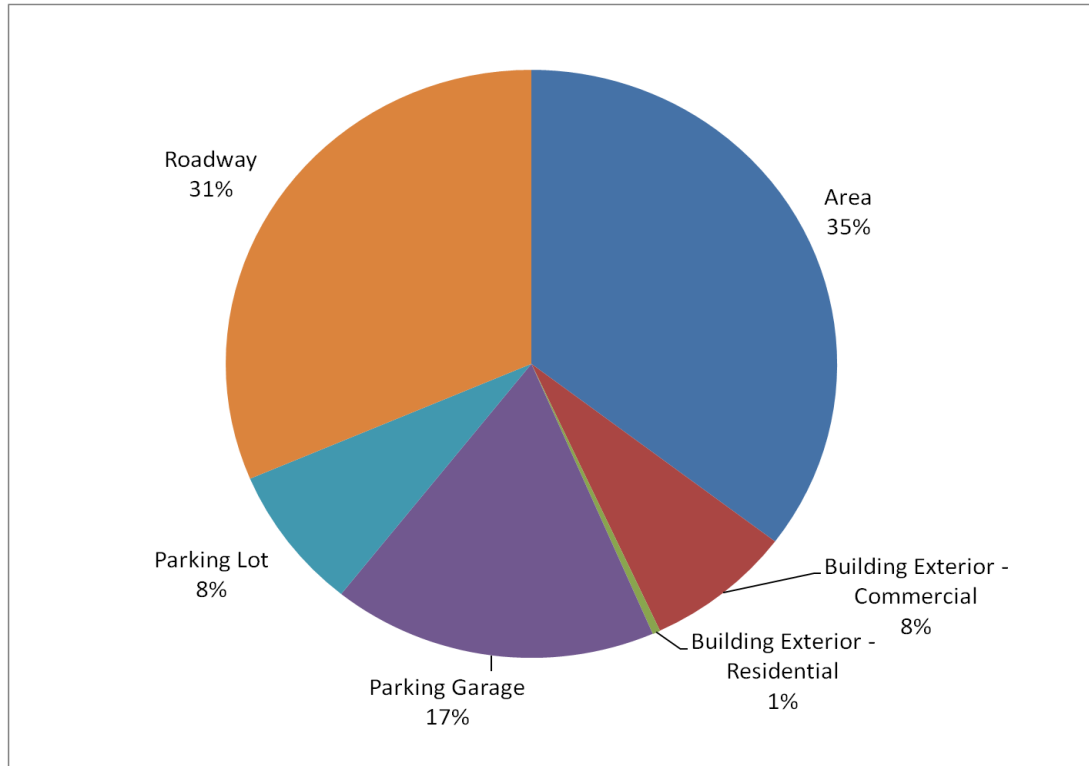
## Federal market assessments for indoor and outdoor lighting

- Energy savings potential of LEDs across portfolios
- Combines multiple databases/models
- Available to federal departments and agencies on a case-by-case basis



# Federal Outdoor Energy Use

- Estimated Federal Outdoor Lighting Energy Use by Application (Total 5.0 TWh)
- Federal Sector Outdoor Lamps by Technology (total 6.6 million lamps)



Source: Analysis of Outdoor Solid-State Lighting Potential at Federal Sites: Technical Support Document (PNNL-21458, August 2012)

# Federal Purchasers MUST Buy FEMP-designated Products



Multiple laws, Executive Orders, and the Federal Acquisition Regulations have established a robust set of requirements that:

**Federal purchasers MUST buy, specify, and contract for ENERGY STAR<sup>®</sup>, FEMP-designated, and low standby products**

Suppliers must provide only compliant products (look for FAR clause 52.223-15 in your contract)

References:

- Energy Independence and Security Act of 2007 (EISA)
- Energy Policy Act (EPA) of 1992 and 2005
- Executive Orders 13221, 13423 & 13514
- Federal Acquisition Regulation (FAR 23.2 and FAR 52.223-15)



# FEMP-designated Lighting Categories

PRODUCT CATEGORY	PRODUCT TYPE	★	△	○	◆	X
Fluorescent Ballasts	Lighting		△			
Fluorescent Lamps, General Service	Lighting		△			
Fluorescent Luminaires, Ceiling-Mounted	Lighting		△			
Fluorescent Luminaires, Suspended	Lighting		△			
Industrial Lighting (High/Low Bay)	Lighting		△			
LED Luminaires, Commercial and Industrial	Lighting		△			
Light Bulbs	Lighting	★				
Light Fixtures (Residential)	Lighting	★				
Light Fixtures, Luminaires (Commercial)	Lighting	★				
Exterior Lighting	Lighting		△			

# FEMP-designated Efficiency Requirements for Commercial and Industrial LED Luminaires

TABLE 1. EFFICIENCY REQUIREMENTS FOR COMMERCIAL AND INDUSTRIAL LED LUMINAIRES		
Luminaire Type	Light Output	Luminaire Efficiency (LE)
Commercial, linear ambient	≥375 lm/ft	≥103 lm/W
Commercial, 1-foot by 4-foot troffers	≥1,500 lm	≥99 lm/W
Commercial, 2-foot by 2-foot troffers	≥2,000 lm	≥100 lm/W
Commercial, 2-foot by 4-foot troffers	≥3,000 lm	≥103 lm/W
Industrial, low bay	≥5,000 to <10,000 lm	≥103 lm/W
Industrial, high bay	≥10,000 lm	≥100 lm/W

# Interior Lighting Campaign – Learn More



- Free resources
- Free to join
- Free technical assistance

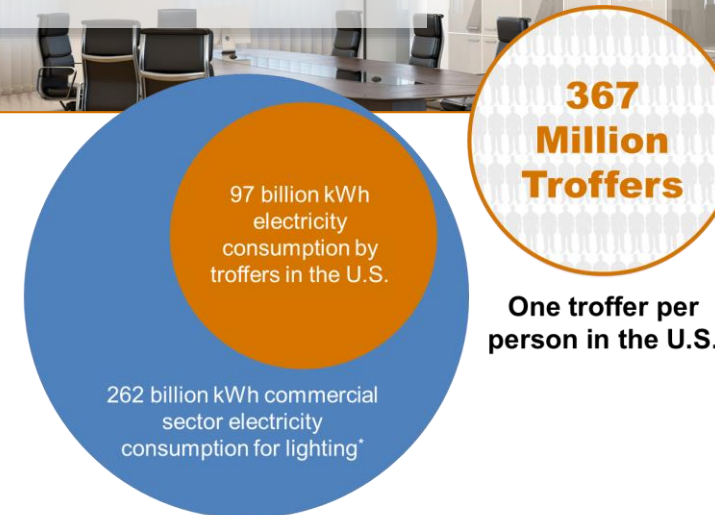
<http://www.interiorlightingcampaign.org>  
#IntLtgCampaign

# Interior Lighting Campaign – Overview

- Launched May 2015 by:



- First year focus
  - High-efficiency troffers and controls applications
- First year goal
  - Document by May 2016 – 1M high-efficiency troffers installed or planned for installation by May 2018
  - Retrofit and new construction
  - Includes TLEDs, LED retrofit kits, high-efficiency luminaires
  - Encourages use of controls for added energy savings



**Troffers consume the equivalent electricity use of 8.9 million homes**

\* U.S. Department of Energy–Energy Information Administration. Annual Energy Outlook 2014 with Projections to 2040. 2014.

# Interior Lighting Campaign – WIIFM



## Resources

- ✓ Incentive lists
- ✓ Technology reports
- ✓ Case studies
- ✓ Calculation tools
- ✓ Webinars



## Technical Assistance

- ✓ Site identification
- ✓ Technology option evaluation
- ✓ Application of specification
- ✓ Award entry content



## Be Recognized

- ✓ Listed/linked on Campaign website
- ✓ Case studies of recognized projects
- ✓ Newsletter articles and tweets
- ✓ Awards for exemplary projects – **2016 BOMA International Conference and Expo, June 27 plenary event**
  - New construction and retrofits awards
  - Small, medium, large project awards
  - Energy savings, portfolio adoption, and use of controls awards

## Join as a Participant

- ✓ Building owners
- ✓ Building managers
- ✓ Others end users including federal, state, and municipal buildings

## Join as a Supporter

- ✓ Energy efficiency groups
- ✓ Manufacturers
- ✓ Utilities
- ✓ ESCOs
- ✓ Lighting designers
- ✓ Others who influence but don't directly manage buildings



# Interior Lighting Campaign Resources

## High Efficiency Troffer Performance Specification

Version: 5.0  
17 APRIL 2015

Specifications

### Upgrading Troffer Luminaires to LED

Lighting accounts for roughly 20% of the electricity use in a typical commercial building. As the construction of new building applications has been the focus, fluorescent lamps in office lighting systems using linear fluorescent lamps (LFL) have been the primary source of commercial lighting. The most common LFL technology available for retrofit is T8, which provides the highest efficacy lighting. The high-efficiency class of recessed linear troffer luminaires in the United States is estimated to be over 500 million luminaires.

Although the installation of LED troffer-type luminaires represent an estimated \$120 to \$200 per troffer to nearly 500,000 units in 2012, LED luminaires still represent roughly 20% of the market and are expected to represent 50% of the market by 2015. The energy savings from retrofitting an additional 100,000 troffer luminaires to LED technology reaches 200,000 kWh of energy per troffer, or roughly \$200 per troffer per year. The energy savings on an individual troffer can be much greater than 20%. The related economic and environmental benefits are substantial.

**Introduction**  
This report provides information for upgrading lighting systems from fluorescent to LED technology. The report begins with an overview of the benefits of LED technology, including energy savings and reduced maintenance costs. It then provides a detailed overview of the current market for LED troffer luminaires, including the different types of LED troffer luminaires available and the factors that influence their performance. The report also provides information on the different types of LED troffer luminaires available and the factors that influence their performance. The report concludes with a list of system factors to consider when upgrading lighting systems to LED technology.

**System Factors to Consider**  
An analysis of LED upgrade options involves assessing the economic and technical benefits of the LED system and comparing it to the current system. The current lighting system is typically a T8 fluorescent troffer system. The LED system is typically a T8 LED troffer system. The factors that influence the performance of the LED system include the type of LED troffer luminaire, the type of LED troffer luminaire control, the type of LED troffer luminaire ballast, and the type of LED troffer luminaire driver. The report provides a list of system factors to consider when upgrading lighting systems to LED technology.

System Factor	Impact	LED	Fluorescent
Energy Savings	High	Green	Red
Maintenance Savings	High	Green	Red
Light Quality	Low	Yellow	Green
Compatibility	Low	Yellow	Green
Cost	Low	Yellow	Green
Reliability	Low	Yellow	Green
Flexibility	Low	Yellow	Green
Control	Low	Yellow	Green
Ballast	Low	Yellow	Green
Driver	Low	Yellow	Green

Reports  
Fact Sheets

## Lighting Project Evaluator

The Lighting Project Evaluator allows you to estimate the energy savings of a new lighting system against a specified energy code. This tool can also compare proposed lighting upgrades to your existing conditions.

This tool is the preferred method of data submission for the [Interior Lighting Campaign](#), which is a great place to go for troffer-specific lighting resources and to receive awards and recognition for implementing an energy saving lighting system using high-efficiency troffers and controls.

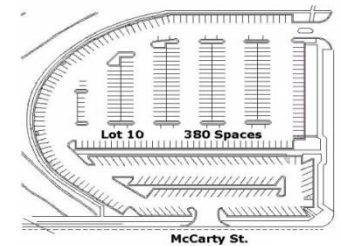
**Log In** Don't have an account? [Sign up now!](#)

email  password

Forgotten your password?

Energy Estimator to compare against code

Technical Assistance (limited)



## Standard Measurement and Verification Plan for Lighting Retrofit Projects for Buildings and Building Sites

EE Richman  
October 2012

M&V guidance

A Program of the U.S. DOE

### Indoor Lighting - Troffers (incl retrofit kits), Controls

Utility	State	Technology	Product
PPL Electric	PA	Controls	Occupancy S
PPL Electric	PA	Fluorescent	High Perform
PPL Electric	PA	LED	High Perform

List of utility incentives

# ILC Resources for Federal Users



## INTERIOR LIGHTING CAMPAIGN

Home

About ILC

News and Events

Resources

ILC Awards

Join ILC

[Home](#) » [Resources](#) » Information and Resources for Federal Users

### Information and Resources for Federal Users



Federal sites are encouraged by the Federal Energy Management Program (FEMP) to participate in the ILC

#### Benefits:

- **Save Money:** Significantly reduce your site's energy and maintenance costs. High efficiency troffer lighting technology with controls can cut lighting energy bills by 75% while delivering additional benefits including long life, reduced maintenance costs, and improved lighting uniformity.
- **Meet Federal Guidelines:** Help ensure that you are meeting federal requirements for energy efficiency.
- **Receive Technical Assistance:** Lighting engineers are available to provide technical assistance to help ensure that your site is designed in a manner to take full advantage of new high efficiency lighting and controls systems.
- **Get Recognized:** In addition to saving money and energy, ILC participants will be recognized on the campaign website and are eligible to receive awards for exemplary energy efficient lighting performance.

[JOIN YOUR FEDERAL COUNTERPARTS TODAY!](#)

[www.interiorlightingcampaign.org/information-and-resources-federal-users](http://www.interiorlightingcampaign.org/information-and-resources-federal-users)

Federal Utility Partnership Working Group  
May 18-19, 2016 Cincinnati, OH



# Top 10 reasons why everyone is interested in TLEDs?

1. They last longer (forever maybe) than fluorescent lamps
2. A TLED is perceived to be the lowest cost option to get the benefits of LED
3. Efficacy has been steadily increasing
4. Prices have been steadily decreasing
5. I get to keep my existing fixture that's been in my ceiling for 20 years... yippee!
6. They don't have any of that bad 'ol mercury
7. Many continue to cling to the old paradigm that... "a-lamp-is-a-lamp" and all lamps interchange "one-for-one"
8. I can potentially do away with my ballasts and get into the "lamps only" business
9. Installation is just a "point" and "click" away
10. They truly are shiniest damn thing in my ceiling!



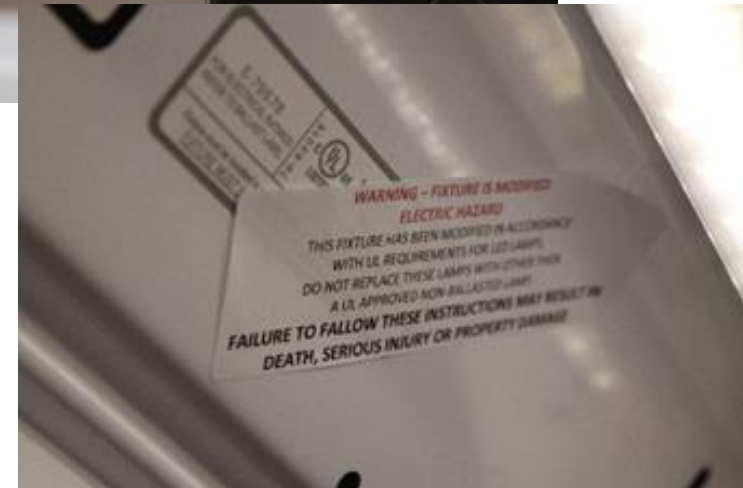
# A True Case Study from a 1<sup>st</sup> Generation TLED Installation

## 1<sup>st</sup> Generation System

- Installed circa 2010
- 16 W, 1400 lm, 87.5 lm/W
- 4200-4600K claimed “cool white”
- Reached  $< L_{70}$  in 6 years and is currently delivering 50% of initial fluorescent levels
- Warranty: 50,000 hour/5 year “life” claimed by manufacturer. No  $L_{70}$ !

## 2016 system

- 18 W, 1950lm, 108 lm/W
- 4100K (3000-6500K offered)
- $L_{70}$ : 50,000 hours
- Warranty: 5 years (with a 10-year option)
- **Resulted in increased energy usage!**



# Size of Market

Configuration	Mixture	Approx. # of Installations	Hours	Input Power (W)	Estimated Energy (TWh)
2'x4'	74%	~272,000,000	10.5	74	77.1
2'x2'	16%	~59,000,000	10.5	59	13.3
1'x4'	8%	~29,000,000	10.5	44	4.9
Total	100%	~367,000,000			95.3

## Notes:

- Quantities extrapolated from DOE SSL Niche Report & NEMA LE5-2001
- Power values assume a mixture of lamps, ballast factors, and ballast efficiencies
- TWh = 1,000,000,000,000 watt-hours

# Interior Lighting by the Numbers - Commercial Buildings

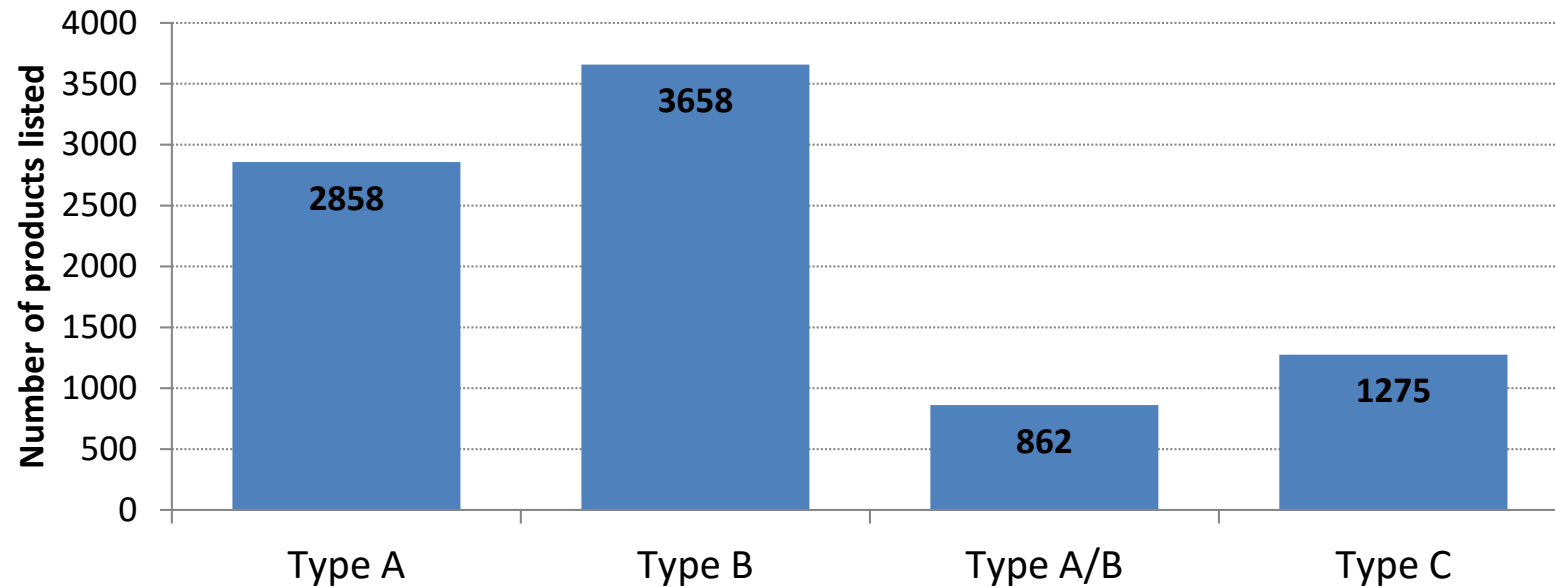


- Commercial lighting is  $\approx 2.6\%$  of **ALL** primary energy consumption in the U.S.
- Troffers  $\approx 1\%$  of **ALL** energy use
- $\approx 20\%$  of building energy is lighting and troffers are  $\approx 50\%$  of that energy

# TLEDs Today (2016)

## 4-foot LED linear replacements on DLC Qualified Products List by UL Type

4/20/16

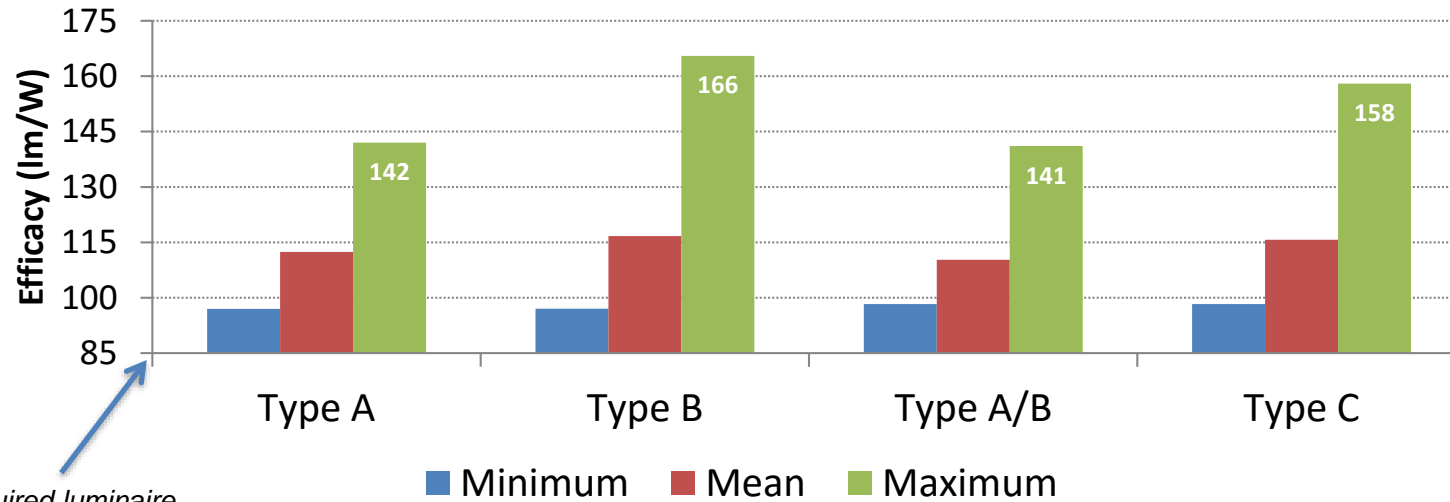


Note: Individual Product offerings and not shipments

# TLEDs Efficacy

## Measured luminaire efficacy of DLC-listed 4-foot LED linear replacement lamps by UL type

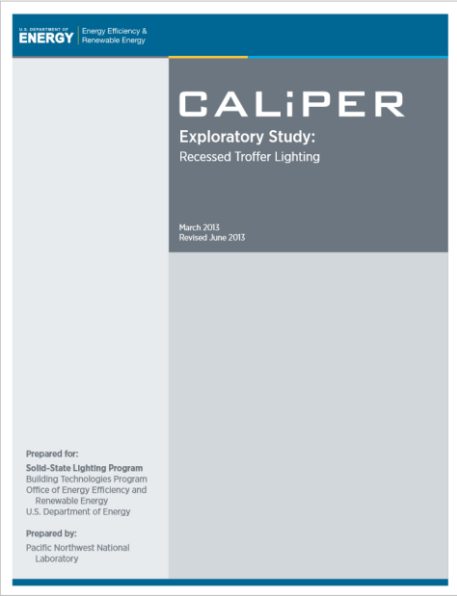
4/20/16



Min required luminaire efficacy is 85 lm/W

# Prior DOE Studies into TLEDs

## Reports



### Application Summary Report 21: Linear (T8) LED Lamps (March 2014)

- **Report 21.1:** Linear (T8) LED Lamps in a 2 × 4 K12-Lensed Troffer (April 2014)
- **Report 21.2:** Linear (T8) LED Lamp Performance in Five Types of Recessed Troffers (May 2104)
- **Report 21.3:** Cost-Effectiveness of Linear (T8) LED Lamps (May 2014)
- **Report 21.4:** Summary of Linear (T8) LED Lamp Testing (June 2014)
- “Only one product tested for this report could be installed without removing the existing fluorescent ballast, assuming the luminaire was equipped with an instant-start electronic ballast.”

### Exploratory Study: Recessed Troffer Lighting (May 2013)

## Fact Sheets

**Upgrading Troffer Luminaires to LED**

Lighting accounts for roughly 20% of the electricity use in a typical commercial building, and the workforce in these indoor applications has been the linear fluorescent lamp. In 2010, lighting systems using linear fluorescent lamps accounted for over 70% of the lighting service in commercial buildings. Recessed troffer luminaires, commonly available in 7' x 4', 2' x 4', and 2' x 2' sizes, provide the majority of this lighting. The total installed stock of common linear fluorescent luminaires in the United States is estimated to be over 960 million luminaires.<sup>1</sup>

Although the installation of LED troffer-style luminaires jumped from an estimated 40,000 units in 2010 to nearly 700,000 units in 2012, LED luminaires still represent less than 0.7% of the troffer luminaires installed in commercial buildings. It may be possible to achieve over 20% energy savings on a national level if LED technology reaches its projected market penetration in troffer luminaires of over 65% by 2020. The energy savings on an individual project can be much greater than 25%. The related economic and environmental benefits are significant.

**Introduction**

Three primary LED options exist for upgrading lighting systems that use fluorescent troffers: replacing the fluorescent lamps with LED replacement lamps, replacing the fluorescent lamps and other luminaire components with an LED retrofit kit, and replacing the fluorescent luminaires with new luminaires designed for LED light sources. Selecting the best option for an application depends on the current lamp and ballast type and the condition of the fluorescent troffer luminaires, the desired performance properties of the upgraded lighting system, the accessibility of the existing ceiling, and the initial and ongoing economic goals for the upgrade. This fact sheet provides guidance on the various factors to consider when deciding on an LED upgrade for a fluorescent system.

**System Factors to Consider**

An evaluation of LED upgrade options includes assessing the system costs and the impacts on the lighting system performance. Table 1 summarizes a number of key factors, and the accompanying text explains those factors. The column heading Lamps refers to LED replacement lamps, the heading Kits refers to LED retrofit kits, and the heading Luminaires refers to new LED luminaires. For each of the three LED upgrade options, the table provides a color-coded identification of whether a factor is favorable for the related LED option (green, circle), whether there may be reasons to exercise caution based on this factor (yellow triangle), or whether there may be significant barriers to implementing the related LED option based on this factor (red square). Note that the performance of the products available within each of the LED options varies and each individual product must be evaluated on its own merits.

<sup>1</sup> Energy savings potential of solid state lighting in general (Manufacturing Applications) - National Energy Labs, 2010. [http://www.energy.gov/buildings/publications/pdfs/ssl/energy\\_savings\\_potential\\_of\\_solid\\_state\\_lighting\\_applications.pdf](http://www.energy.gov/buildings/publications/pdfs/ssl/energy_savings_potential_of_solid_state_lighting_applications.pdf), energy savings report, Jan 2012.

<sup>2</sup> "Upgrading to light emitting diodes in common ceiling applications." Main Report, April 2011. [http://www.energy.gov/buildings/publications/pdfs/ssl/ssl-upgrade-report\\_2011.pdf](http://www.energy.gov/buildings/publications/pdfs/ssl/ssl-upgrade-report_2011.pdf).

**Table 1. System factors to consider for LED upgrades.**

SYSTEM FACTOR TO CONSIDER	DESCRIPTION	LAMPS	KITS	LUMINAIRES
Initial costs	Equipment purchase costs	Green circle	Yellow triangle	Red square
	Installation labor costs	Green circle	Yellow triangle	Red square
	Quality certification costs	Green circle	Yellow triangle	Red square
Operating costs	Energy costs for replacement lamps	Green circle	Yellow triangle	Red square
	Replacement costs over system life	Green circle	Yellow triangle	Red square
Current light levels	Accurate identification of luminaire type	Green circle	Yellow triangle	Red square
	Reduction of 10% or more in energy use	Green circle	Yellow triangle	Red square
Downing (repaired)	No emergency repair required	Green circle	Yellow triangle	Red square
	No emergency repair required	Green circle	Yellow triangle	Red square

[www.energy.gov/eere/ssl/led-linear-lamps-and-troffer-lighting](http://www.energy.gov/eere/ssl/led-linear-lamps-and-troffer-lighting)

# How Do TLEDs Save Energy and \$?

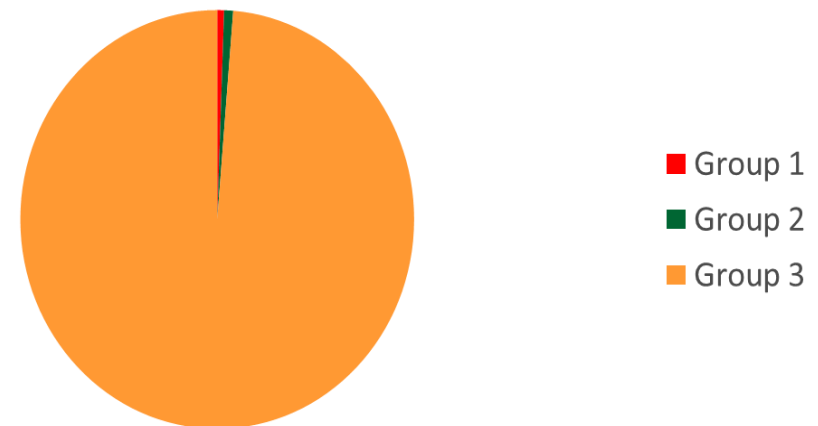
- Higher source (system) efficacy (lamp + driver) compared to fluorescent system efficacy (lamp + ballast) = reduced connected wattage.
- Greater fixture efficiency. Directionality of TLED allows for more light (useful lumens) out of the fixture.
- Energy savings of 20-30% are possible with similar light levels but ultimately is a function of the space and the existing fixture type.
- Potential for longer “lamp” life = reduced maintenance costs
- Potential to optimize existing lighting systems (reduce light levels) that are overlighted by current ASHRAE/IES standards

# Key Challenges with TLEDs

- There are NO standards for:
  - Wiring configurations. No guarantee that a replacement lamp 5 years from now will be wired the same way
  - Distribution from the lamps. Is beam angle a good surrogate? What about “batwing” distributions?
  - Light output. Fluorescent lamps are interchangeable and have standard lumen/wattage ranges
- How many manufacturers are in the market?

3 manufacturer groups for UL Type A products:  
Group 1: Cree, GE, OSRAM SYLVANIA, Philips  
Group 2: Lighting Science Group, Litetronics, Maxlite, Ushio, Universal Lighting Technologies, Venture, Westinghouse  
Group 3: All others (about 190 companies)

Number of Type A products listed by manufacturer group

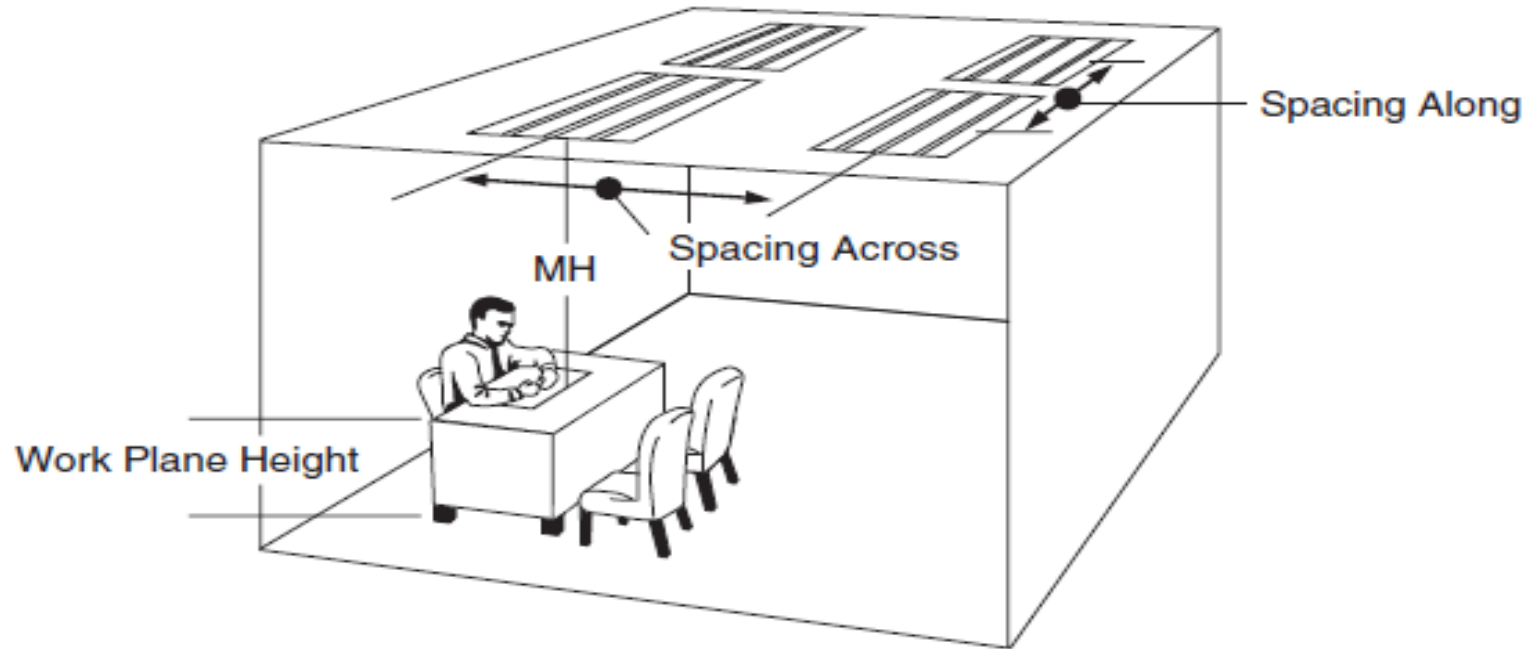




# How Do We Design Indoor Lighting Systems?

- Lighting designers “target” a sustained light level based on many factors:
  - The room geometry (e.g. ceiling height, location to work plane, etc.)
  - The reflectances of the room surfaces. You often see “80/50/20” used.
    - 80% for acoustic ceiling
    - 50% for light colored walls
    - 20% for dark carpet
  - Various light loss factors (LLFs)
    - Lamp lumen, dirt, temperature, fixture, ballast, voltage, etc.
    - Lamp lumen depreciation is specified at a point in time (typically 40% of rated life for fluorescents).
    - The lamp lumen depreciation for a “good” quality F32T8 85 CRI fluorescent lamp is ~0.91 or 91%. Some “premium” lamps are capable of up to 94-96% lumen maintenance all the way out to rated lamp life.
- The initial light levels are generally higher than the space needs so as to deliver  $\geq$  the target light levels at a point in time.
- As a practical matter light levels are generally allowed to fall about 10% below the target as the human eye will not notice the difference.
- Some building lease specifications may require a minimum light level at all times.

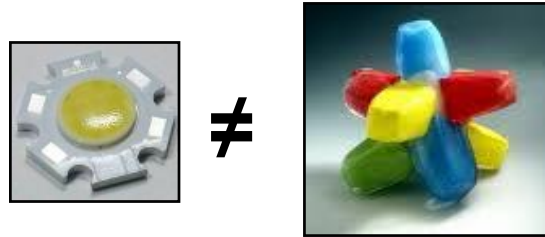
# Design Considerations – Spacing Criteria



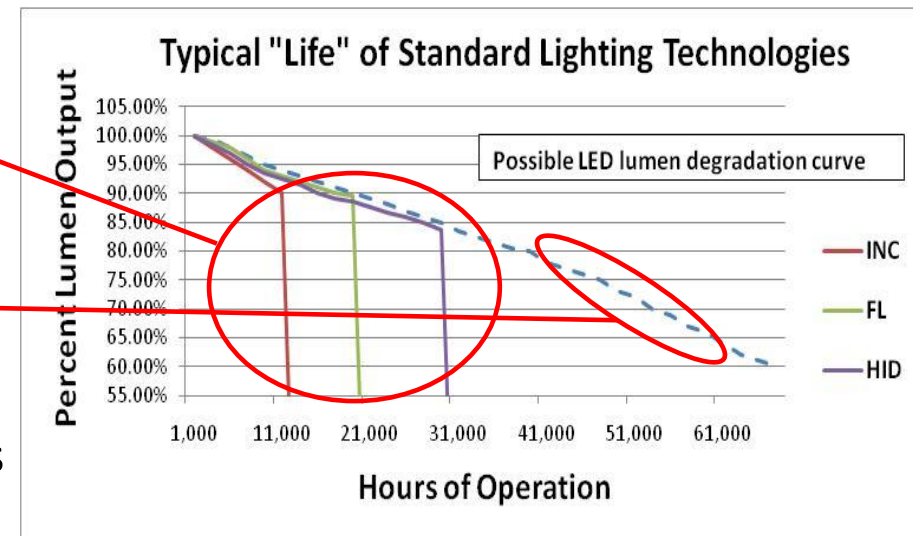
$$\text{Luminaire Spacing} = \text{Spacing Criterion} \times \text{mounting height above work plane (MH)}$$

Courtesy: Acuity Lighting Technical Considerations

# LEDs are not “Everlasting Gobstoppers”

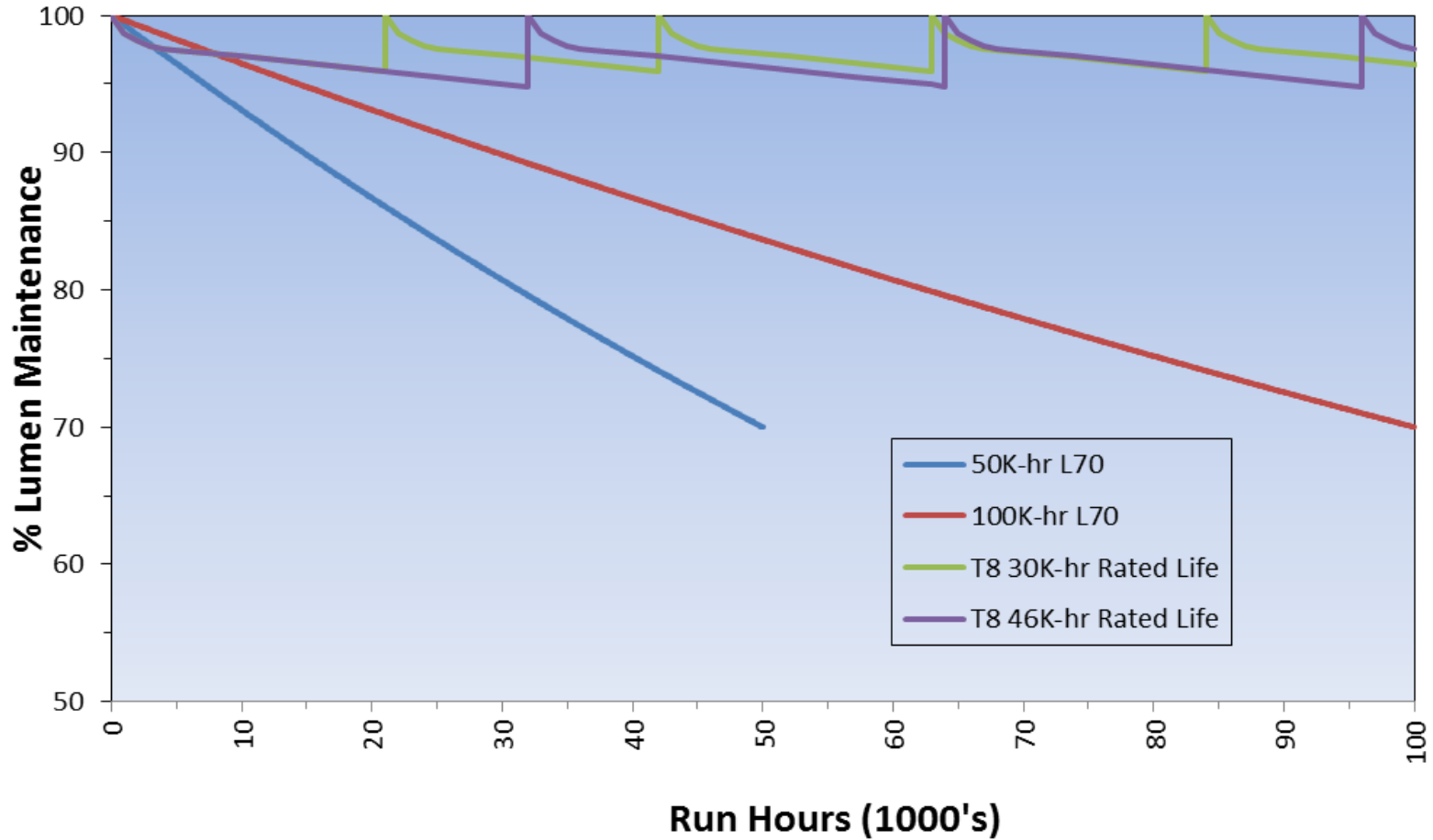


- **ALL** light sources degrade - most fail before critical light output level is reached
- LED diodes can survive but also degrade well beyond useful light levels
- Industry considers lumen output as one measure of the **useful life** of an LED diode. Commonly, 70% of initial output is used.



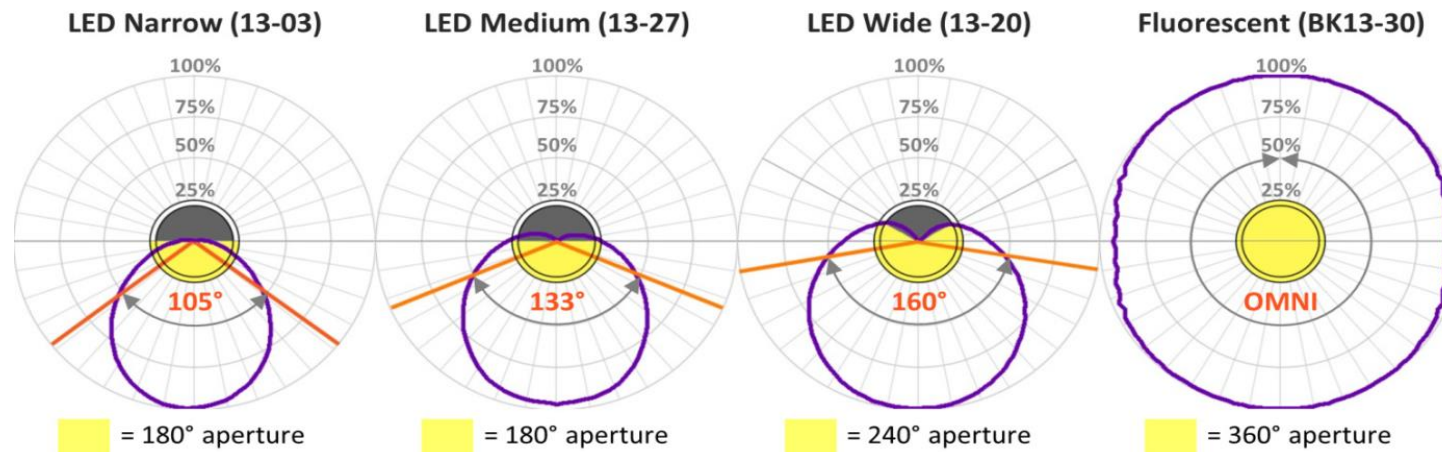
# Lumen Maintenance Comparisons

Lamp Replacement at 70% of Rated Life



# LED Replacement Tube Varieties

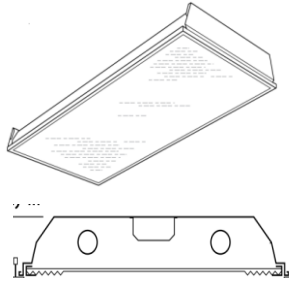
- LED replacement tubes come in a variety of distributions
- Directionality is efficacious – but can effect performance in fixtures designed for omnidirectional fluorescent tubes.



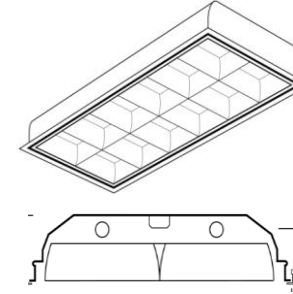
# Troffer Geometry

What happens when typical LED replacement tubes are retrofitted in various fluorescent fixture types?

**K12 Lens**



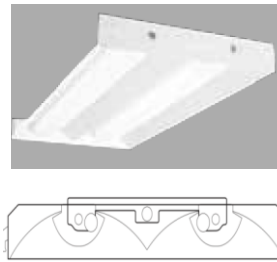
**Parabolic**



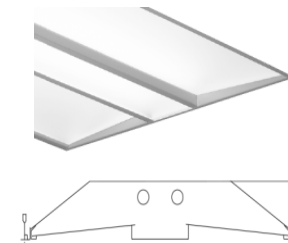
**Recessed Indirect**



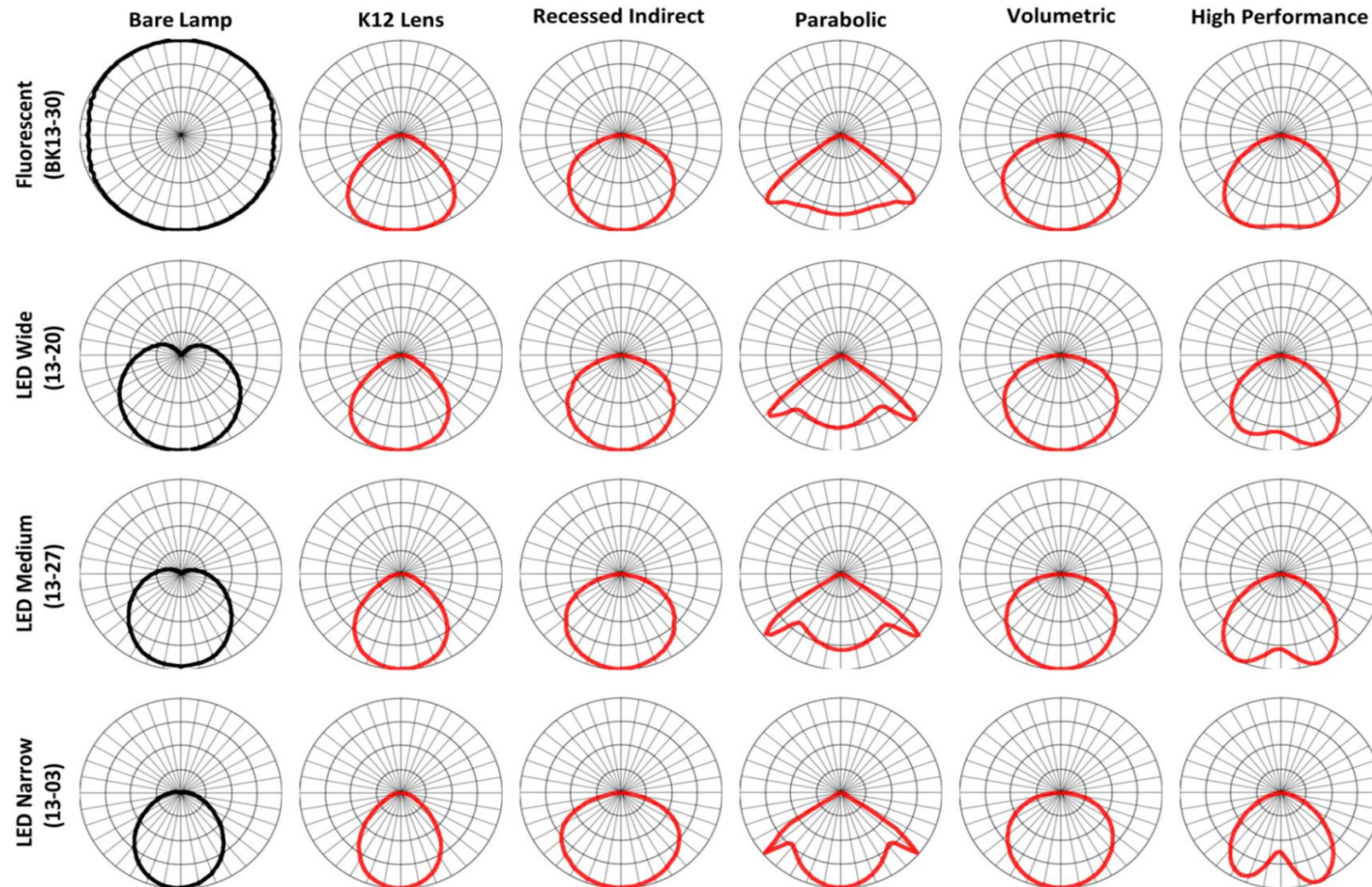
**Volumetric**



**High Performance**



# Fluorescent Tube vs. LED Tube Distribution Patterns





# The Troffer Conundrum – What do I do?



**Super T8 Fluorescent Lamp/Ballast**



**Tubular LED (TLED)**



**LED Retrofit Kit**



**New LED Fixture**



# As with most things... Life is about Choices... and Lighting is no different!

Category	Power Supply	Light Source Mounting	Dimming	Controls	Risk	Total Cost	Attributes
1. LED Replacement Lamp (Ballast)	Existing fluorescent ballast	Existing fluorescent socket	Unlikely	Shut-off only (switch or occupancy sensor)	?	\$	LED or LFL option, No electrician, matches lens configuration, need for future ballast replacement
2. LED Replacement Lamp (Mains)	"Mains" voltage	Existing fluorescent socket	Yes, with matching 0-10V system	Shut-off only (switch or occupancy sensor)	??	\$\$	Matches existing lens configuration
3. LED Replacement Lamp (Hybrid)	"Mains" voltage or existing fluorescent ballast	Existing fluorescent socket	Only likely if FL ballast removed	Shut-off only (switch or occupancy sensor)	?/??	\$\$	Matches existing lens configuration
4. LED Retrofit Kit (Lamp Socket)	Proprietary power supply	Existing fluorescent socket	Yes, with matching 0-10V system	Yes, with matching driver/control	??	\$\$\$	Matches existing lens configuration
5. LED Retrofit Kit (Free-form)	Proprietary power supply	Free-form	Yes, with matching 0-10V system	Yes, with matching driver/control	???	\$\$\$	Allows for light source relocation/re-alignment

# Key Considerations for a Successful TLED Installation

- Give thought to your long term goals for the space. Some choices commit you to certain technology... for a long time!
- A “role” for “control.” As luminaire efficacy increases the ability to add controls later becomes less cost-effective and a potential lost opportunity.
- Use the DesignLights® Consortium Qualified Products List and DOE LED Lighting Facts® to help find products that have been tested and meet your performance goals.
- Consider developing performance-based criteria for the intended application. Why not ask your vendor to deliver a system that meets your requirements (e.g., light levels when installed in your fixtures, maintained light levels at a period in time, etc.)?
- Target Facilities based on existing technology, light levels and energy costs.
- Do an honest life-cycle cost calculation or total cost of ownership.
- A mock-up is ALWAYS a good idea!

# The “A,” “B,” “A/B,” and “C”s of TLEDs

In 2013, the lines for troffer “kits” were blurry...

- Many lamps required bypass of the ballast
- Some were wired to line voltage
- Others required an external driver
- Some came with new sockets
- Some had new luminaire optics
- Others didn’t use the sockets at all
- Some you could install as simply as replacing the lamp
- Some you even had to aim!

... Since then, UL has helped bring clarity to some of the many options (UL 1598 certification)...

# UL 1598

## TYPE A

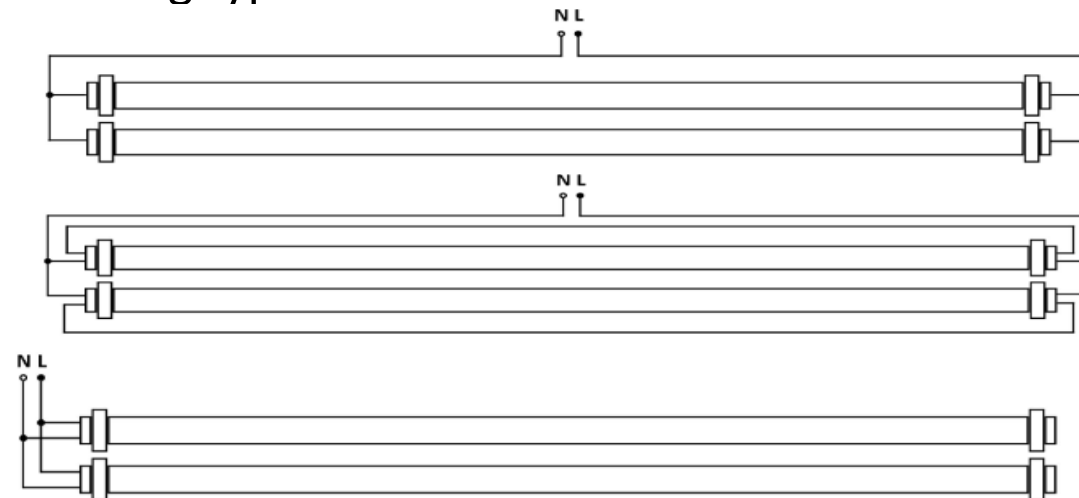
- Replacement Lamps... plug'n play!
- Does not require mechanical or electrical changes to the fixture
- Can operate off an existing fluorescent ballast however compatibility varies (may not work on rapid start/programmed rapid start ballasts)
- More and more products available
- Efficiency loses due to ballast
- Existing ballast life
- LED life + ballast life... something will fail first!



# UL 1598

## TYPE B

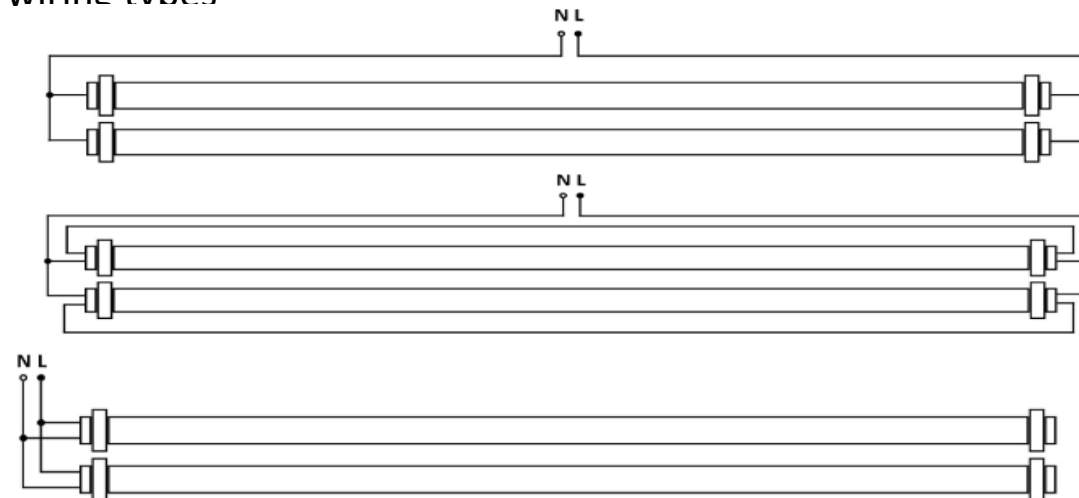
- Internal Driver/Line Voltage Lamp-Style Retrofit Kits
- Sockets are powered by line voltage, does **NOT** operate off the existing fluorescent ballast
- Requires rewiring of the existing fixture to bypass the ballast and send line voltage directly to the lamp holders
- Line-voltage sockets could prove dangerous for installer
- Still various wiring types



# UL 1598

## TYPE A/B (hybrid)

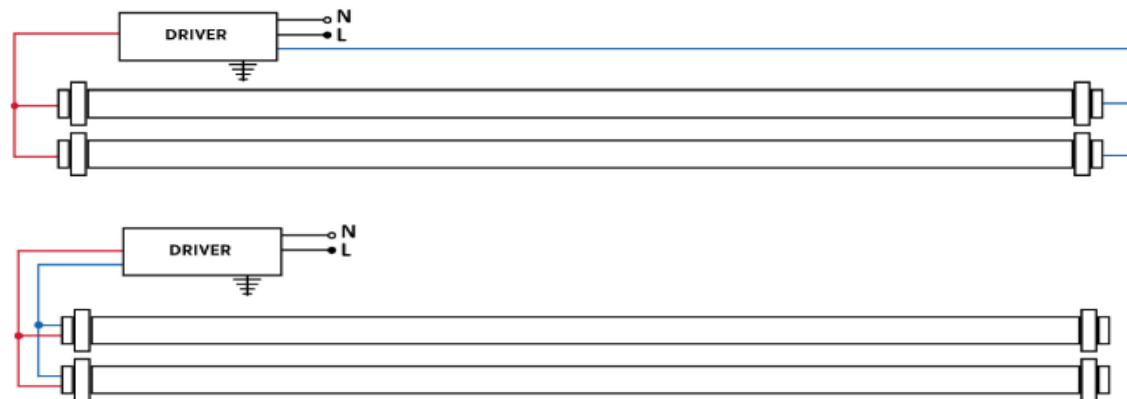
- Internal Driver/Line Voltage Lamp-Style Retrofit Kits
- Dual Mode Internal Driver (UL Type A and Type B):
  - operate off the existing fluorescent ballast
  - also have the ability to operate off of line voltage if the troffer is rewired to bypass the ballast
- Sockets are powered by line voltage, does **NOT** operate off the existing fluorescent ballast
- Requires rewiring of the existing fixture to bypass the ballast and send line voltage directly to the lamp holders
- Line-voltage sockets could prove dangerous for installer
- Still various wiring types



# UL 1598

## TYPE C

- External Driver Lamp-Style Retrofit Kits
- Sockets are powered by low-voltage drive current and does **NOT** operate off the existing fluorescent ballast
- Requires rewiring of the existing fixture to replace the ballast with an external driver
- Still variables within this category:
  - Form-factor,
  - wiring configuration



# Considerations - Are Retrofits a Good Idea?

EXISTING CONDITIONS TO CONSIDER	DESCRIPTION	LAMPS	KITS	LUMINAIRES
Condition of sockets	Look like new	●	●	●
	Some wear but no major cracks	▲	●	●
	Look old, blackened, cracks apparent	■	●	●
Condition of interior surfaces	Nice and white	●	●	●
	Slightly worn but no major scratches or peeling paint	▲	▲	●
	Very worn, scratches in paint, some peeling paint	■	▲	●
Condition of lens or louvers	Looks new; very little wear apparent	●	●	●
	Some minor color variations or scratches in surface	▲	▲	●
	Looks old, obvious cracks or yellowing	■	■	●
Ceiling access	No concerns with working above the ceiling; easy access	●	●	●
	Some concerns about working above the ceiling; limited access	●	●	▲
	Working above the ceiling should be avoided	●	▲	■

- There is no across-the-board one “best” option
- These are retrofit products. You need to know which system components are staying and compliment them.



# Navigating the Wiring Variables

## Existing: Instant Start Ballast

- Lampholders are shunted
  - Internally
  - Externally

## Existing: Programmed Start/Rapid Start/Magnetic Ballasts

- Lampholders are unshunted
- Unshunted lampholders can be easily shunted

- Products can be selected to reduce installation time
  - Type A- ballast compatibility
  - Type B- double ended power
  - Type C- double ended power
- Above recommendations will reduce installation time, but new ballasts/lampholders can be installed to accommodate any TLED

# Maintenance

- Re-lamping
  - Double-check manufacturer's wiring configuration (we have seen these change, even with the same model number!)
  - Clear documentation must be provided so the correct type and wiring can be purchased at time of re-lamping
  - Will the re-lamp work in the existing wiring configuration?
- Risks of Mis-lamping
  - Short Circuit at lamp holder
  - Re-installing fluorescent lamps leading to tube failure, socket damage, etc.

# Tons of Resources @ [www.ssl.energy.gov](http://www.ssl.energy.gov)

The screenshot shows a web browser window displaying the Energy.gov website. The address bar shows the URL <http://energy.gov/eere/ssl/solid-state-lighting>. The page features a green header with the Energy.gov logo and navigation menu. The main content area is titled "SOLID-STATE LIGHTING" and includes a sidebar with links, a central banner for "LIGHTFAIR International" with a photo of a booth, and a "SUBSCRIBE" section with news articles.

**ENERGY.GOV**  
Office of Energy Efficiency & Renewable Energy

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Emerging Technologies » Solid-State Lighting

## SOLID-STATE LIGHTING

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#### NEWS

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[DOE Booth Sessions at LIGHTFAIR International 2016](#)
- MARCH 23, 2016  
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- MARCH 16, 2016  
[New DOE Resources on Understanding IES TM-30](#)
- MARCH 8, 2016  
[Two SBIR Grants Awarded for SSI Technology](#)

<http://energy.gov/eere/ssl/articles/doe-booth-sessions-lightfair-international-2016>

# Questions and Answers

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