WHAT'S NEW IN LIGHTING?

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GE Lighting

Agenda

Lighting Legislation Update
LED Basics
LED Design Considerations
LED Modules
Zhaga
LED Applications
Fluorescent Ballasts

Lighting Legislation Update

Energy Policy & Conservation Act (EPCA)
Fluorescent Ballast
Energy Conservation Standards
Ballast Amendments Effective Nov 14, 2014

Ballast EPCA Standards

Summary

- Covers T8 and T5 ballasts in addition to T12 ballasts
- Includes previously exempt residential & sign ballasts
- Input voltage between 120V and 277V and 60 Hz.
- New rules create a new ballast efficiency metric Ballast Luminous Efficiency (BLE) and method of measurement
- Requires an efficiency improvement in a significant number of today's fluorescent ballasts
- Exempted:
  - Dimming ballasts that dim to 50 percent or lower
  - T8 magnetic ballasts for use in EMI-sensitive apps
  - Programmed-start ballasts operating 4-ft. medium bi-pin lamps below 140 mA (0.71 ballast factor).

Ballast EPCA Standards

Summary

- New rules create a new ballast efficiency metric Ballast Luminous Efficiency (BLE) and method of measurement,
- Requires an efficiency improvement in a significant number of today's fluorescent ballasts,
- Compliance and reporting requirements.

Ballast Luminous Efficiency (BLE)

Metric & Method of Measurement Advantages

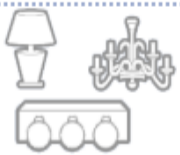
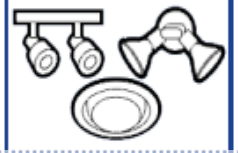
- Efficiency is the Performance parameter for NEMA Premium ballast program
- Removes lamp and photometric measurement variations and inaccuracies
- Allows accurate evaluation of high performance ballasts

ANSI/IES/ASHRAE 90.1 2010 Whole Building Ltg. Power Densities

•2007 Watts/Sq. Ft.:		•2010 Watts/Sq. Ft.:	
• Office Buildings: 1.0		• 0.9	-10%
		• 0.99	-17%
• Schools:	1.2	• 1.21	+0.8%
• Hospitals:	1.20	• 0.66	-17.5%
• Warehouses:	0.80	• 0.61	-39%
• Dormitories:	1.0		

Source: Willard Warren, PE, FIES, *LD+A,* June, 2010, p. 21

Legislation impact through 2014

	Effected Bulbs	Timing	Regulation	Primary Fixture	Example Eliminated Bulbs	Replacements Bulbs Available Now
Incandescent	100-Watt Medium Base (includes 95W)	Can no longer manufacture **1/1/2012*** inventory sellable until depleted	**New efficiency standards for all 100-Watt general service bulbs:** Maximum wattage 72-Watts; Lumens (brightness) 1,490-2,600**; Minimum life 1,000 hours			
Incandescent	75-Watt Medium Base (includes 71W)	Can no longer manufacture **1/1/2013*** inventory sellable until depleted	**New efficiency standards for all 75-Watt general service bulbs:** Maximum wattage 53-Watts; Lumens (brightness) 1,050-1,489**; Minimum life 1,000 hours			
Incandescent	60-Watt Medium & Intermediate Base (includes 57W)	Can no longer manufacture **1/1/2014*** inventory sellable until depleted	**New efficiency standards for all 60-Watt general service/deco bulbs:** Maximum wattage 43-Watts; Lumens (brightness) 750-1,049**; Minimum life 1,000 hours			
Incandescent	40-Watt Medium Base (includes 37W)	**Can no longer manufacture 1/1/2014*** inventory sellable until depleted	**40-Watt general service bulbs:** Maximum wattage 29-Watts; Lumens (brightness) 310-749**			
PAR	All PAR20 PAR30 PAR38 >39-Watt	Can no longer manufacture **7/14/2012** inventory sellable until depleted	**New lumen-per-Watt standards eliminate standard halogen bulbs. The legislation doesn't affect incandescent reflectors, PAR16, MR16 & GU10.**			
LFL	T12 F34 F40 F96; T8 F32 F96	Can on longer manufacture **7/14/2012** inventory sellable until depleted	**New lumen-per-Watt standards eliminate most F40 and F96 T12 bulbs and some F32 T8 lamps. Linear fluorescent lamps less than 4ft aren't affected.**			More options coming in 2012

* California will enact the new standards for general service bulbs 1 year earlier

** Lumen range is 25% lower for color-enhanced products like GE Reveal® light bulbs

Lighting Legislation

Department of Energy Regulations

July 14, 2012* – Linear Fluorescent Regulations

- 4' Fluorescent - T12, T8, T5
  - Exemptions for Plant, Cov-R-Guard, Colored, High CRI, etc....
- 8' Slimline – T12, T8
- 8' HO – 800 ma – T12, T8
  - Cold Temp. (CT) Exemption
  - (1500 ma NOT Regulated)
- U6, U3 – T12; U6, U-1/5/8 – T8

July 14, 2012* – Halogen PAR

- PAR38, PAR30, PAR20

*Last Date to Manufacture – Can Sell Inventory
CA – Same Date as Federal

2012 Standard – Linear Fluorescent Lamps

LAMP TYPE	CCT	LPW STANDARD
4’ Medium Bi-Pin ≥25W	≤ 4500K	89
4’ Medium Bi-Pin ≥25W	> 4500K and ≤7000K	88
2’ U-Shaped ≥25W	≤ 4500K	84
2’ U-Shaped ≥25W	> 4500K and ≤7000K	81
8’ Slimline ≥52W	≤ 4500K	97
8’ Slimline ≥52W	> 4500K and ≤7000K	93
8’ High Output	≤ 4500K	92
8’ High Output	> 4500K and ≤7000K	88
4’ Min Bi-Pin T5 ≥26W	≤ 4500K	86
4’ Min Bi-Pin T5 ≥26W	> 4500K and ≤7000K	81
4’ T5 HO ≥49W	≤ 4500K	76
4’ T5 HO ≥49W	> 4500K and ≤7000K	72

2012 Standard – Linear Fluorescent Lamps
Typical "4' " Lamp Types Covered

- F34T12, F40T12
- F28W/T5, F28/T5/WM, F54W/T5, F54/T5/WM
- F32T8, F32T8/HL, F32T8/WM, F28T8, F32T8/25W
- – 89 LPW
- - 32 Watts ➔ Min. 2850 Lumens
- - 30 Watts ➔ Min. 2679 Lumens
- - 28 Watts ➔ Min. 2500 Lumens
- - 25 Watts ➔ Min. 2225 Lumens

Note: 2', 3' and 5' lamps not covered.

High Lumen 8’ T12 High Output

Primary Application… Most Commercial Spaces

Customer Message… Energy efficient 8’ T12 high output lamp design that meets the DOE minimum standards & runs on existing T12 HO ballasts…

Product Performance…

Watts:	95W
Initial Lumens:	8,850
Mean Lumens:	7,920
CCT:	3000K & 4100K
CRI:	77
Rapid Start Life (3hrs):	12K
System Warranty:	None

High CRI 4’ T12

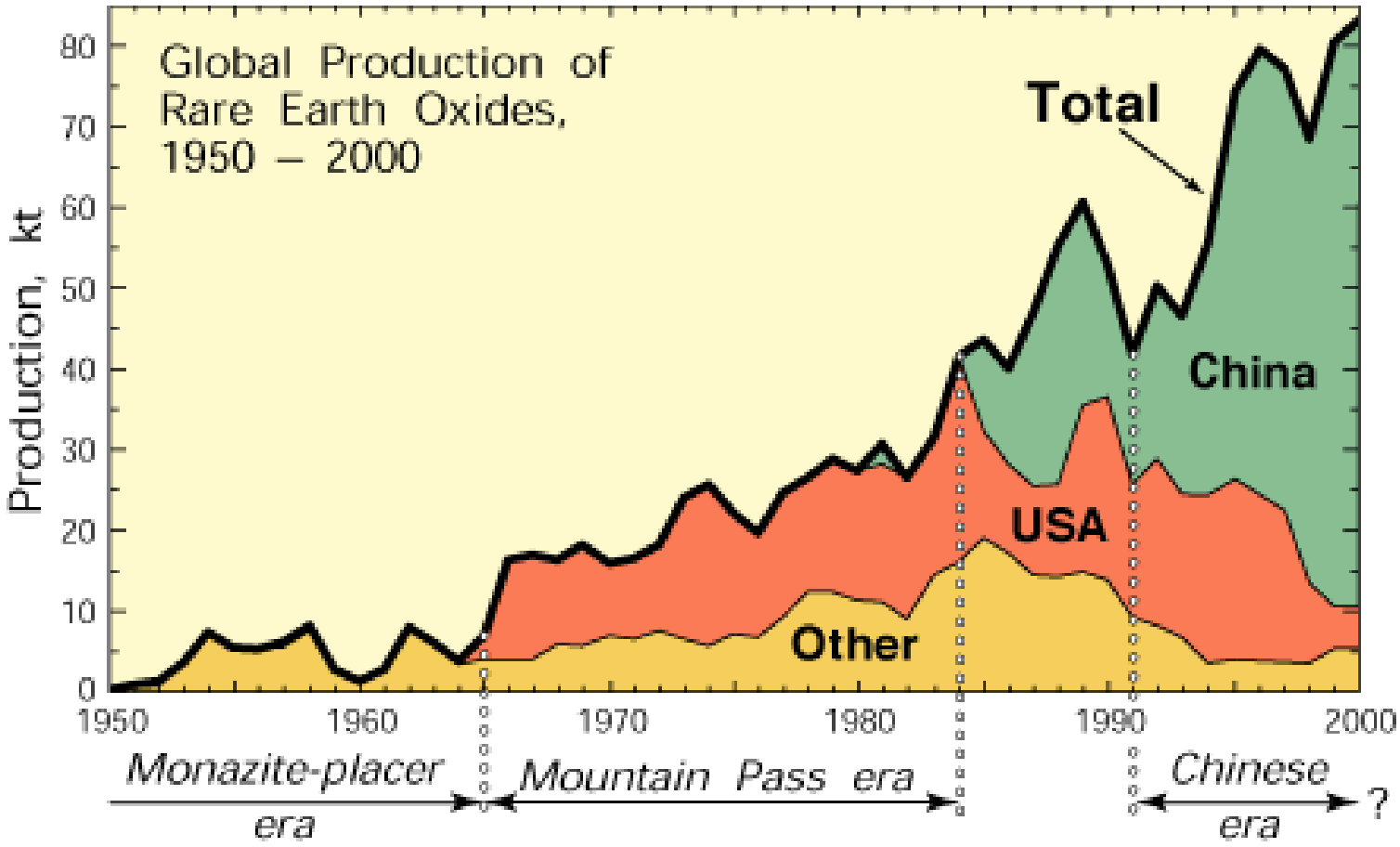
Primary Application… Most Commercial Spaces

Customer Message… High CRI F34 T12 lamp design that complies with DOE requirements & runs on existing T12 ballasts…

Product Performance…

	CW/C	CX
Watts:	34W	34W
Initial Lumens:	1,800	2,500
Mean Lumens:	1,500	2,200
CCT:	4100K	
CRI:	87	
Rapid Start Life (3hrs):	15K	20K
System Warranty:	None	

Rare Earth Phosphors Sources.



http://www.globalsecurity.org/military/world/china/rare-earth.htm

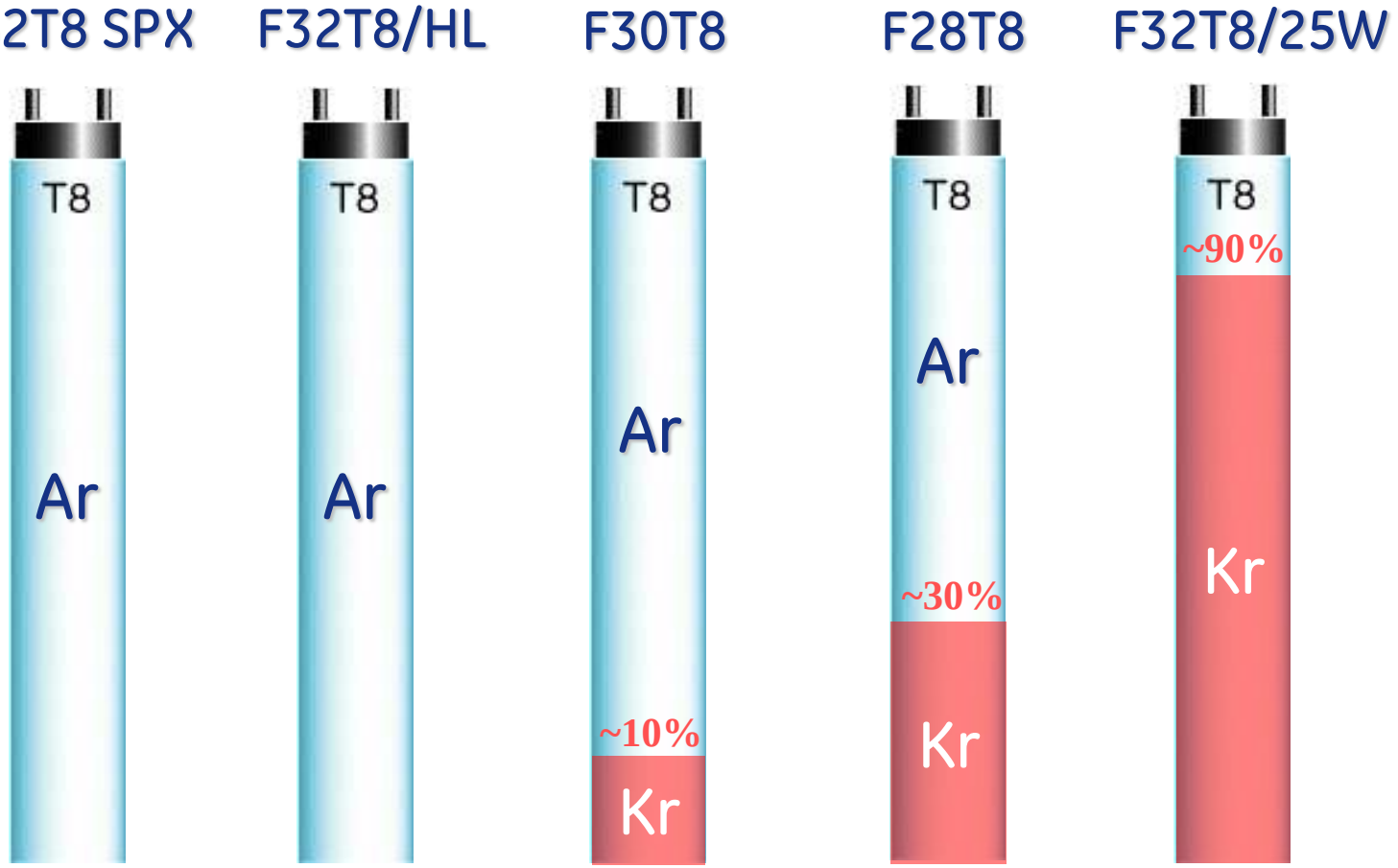
4’ T8 Options

Description	IS (12hr/Start)	PS (12hr/Start)	Initial Lumens	Mean Lumens	Color Temp K	CRI
F32T8 SP(700)	~30,000	~36,000	~2700	~2440	3500K	75-78
F32T8 XL(XP) SP(700)	~36,000	~45,000	~2850	~2700	3500K	78
F32T8 SPP(800XV)	~30,000	~36,000	~2900	~2725	3500K	80
	~40,000	~42,000	~2900	~2725	3500K	83
F32T8 SPX(800)	~30,000	~36,000	~2925	~2800	3500K	85
F32T8 XL(XP) SPX(800)	~40,000	~45,000	~2925	~2800	3500K	85
F32T8 SXL SPX(800)	~40,000	~60,000	~2850	~2700	3500K	83-85

4’ T8 Options

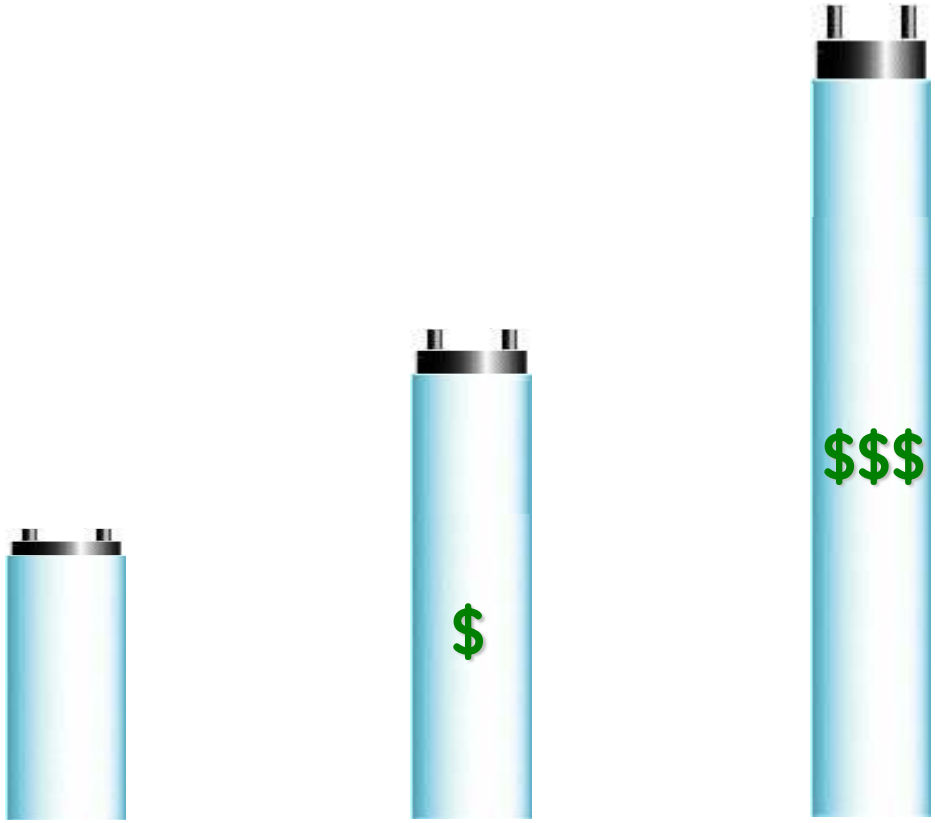
- Lamp Platforms:
- F32T8 HL “Super T8”
- F32T8 SP/700(78) & SPX/800(86)
- F28T8 = 28W
- F32/25T8 = 25W at 4’

Energy Saving 4’ T8 Fluorescent Lamps



	F32T8 SPX	F32T8/HL	F30T8	F28T8	F32T8/25W
Light Output:	100%	105%	95%	92%	89%
LPW:	92	97	93	97	100

T5 Energy Savings…



Watts:	54W	51W	47W/49W
Light Output:	5,000	5,000	4,800
Life (3hrs/12hrs):	30K/36K	30K/36K	30K/36K

Assumptions: $.10 kwh, 30,000 hrs burn, Savings per one 54W T5 lamp

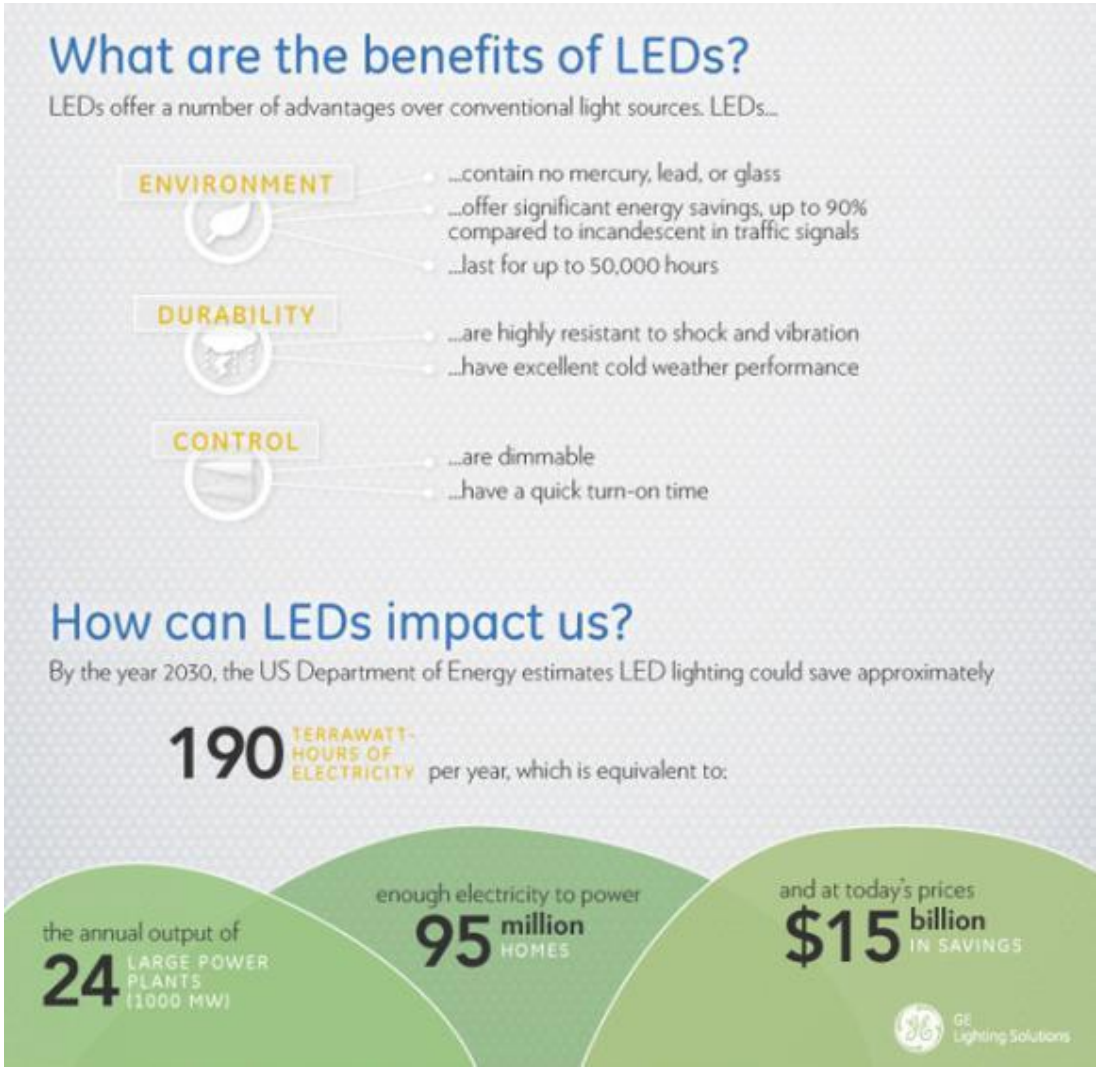
LED Basics

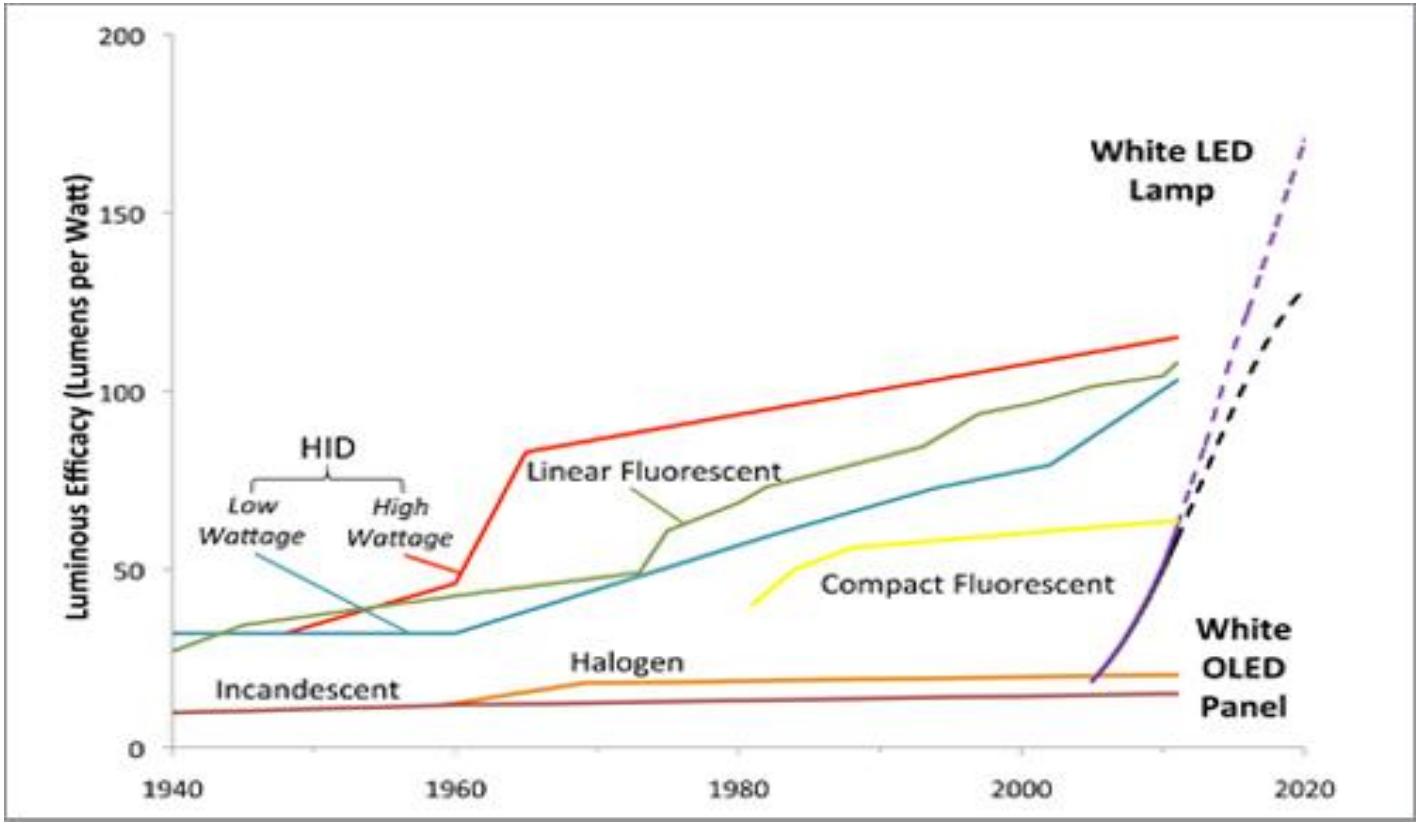
From DOE & NEMA

- In 2001, lighting ~765 TWh electricity consumption. Equal to 22% of U.S. total.
- In 2010, lighting ~700 TWh, 19% of total.
- In 2001, ~6,977 million permanent lamps in U.S.
- In 2010, ~8,203 million permanent lamps in U.S.

- LED lighting is expected to represent 36% of lumen-hour sales (general market) by 2020, and 74% by 2030

Benefits & Impacts





While traditional lighting technologies are relatively mature and offer less potential for improvement, SSL is still at a comparatively early stage and continues to achieve dramatic advances in efficacy.

Source: DOE SSL R&D Multi-Year Program Plan

DOE Life-Cycle Assessment

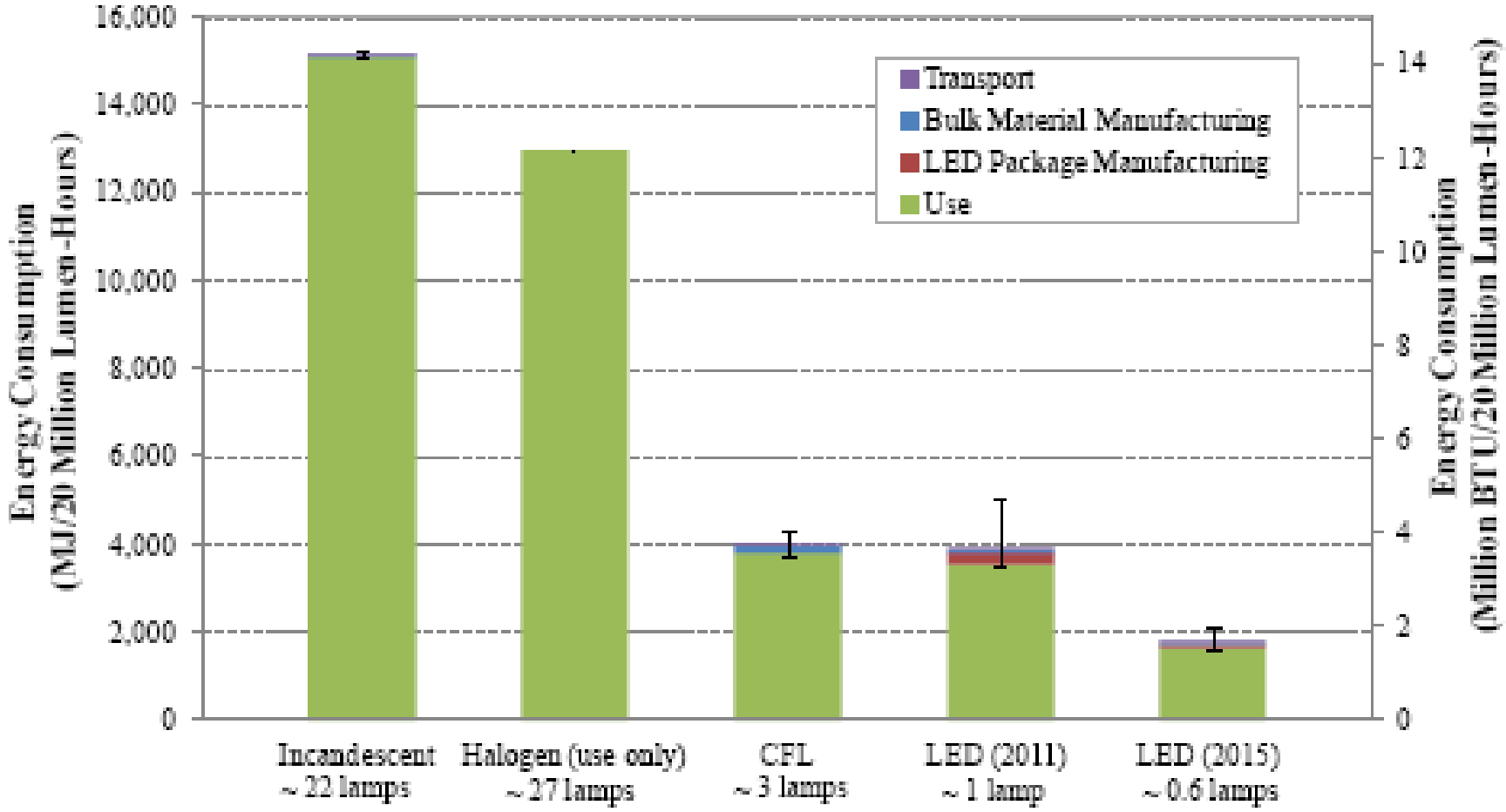


Figure ES. 1 Life-Cycle Energy of Incandescent Lamps, CFLs, and LED Lamps

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_LED_Lifecycle_Report.pdf

ENERGY STAR® Program
Start August 31, 2010

- **EPA now in charge of LED ENERGY STAR® Program**
  - **DOE sign MOU Sept 30, 2009**
  - **Expand and enhance energy efficiency programs for products and buildings**
  - **Re-align roles to best utilize expertise of each agency**

- **DOE completed ENERGY STAR® LED specification**
  - **Formally communicated program on Dec 3rd**
  - **Goes in effect August 31, 2010**

- **EPA will manage changes going forward with technical support of DOE**

Energy Star Qualification Summary Highlights

	Omnidirectional	Decorative	Directional	Non-Standard
Minimum Efficacy	< 10 watts: 50 LPW >or = 10 watts: 55 LPW	40 LPW	<or= PAR20: 40 LPW > PAR20: 45 LPW	< 10 watts: 50 LPW >or = 10 watts: 55 LPW
Minimum Light Output	If claiming it replaces: 25W -> 200 lumens 35W -> 325 lumens 40W -> 400 lumens 60W -> 800 lumens See PDF for higher levels	If claiming it replaces: 10W -> 70 lumens 15W -> 90 lumens 25W -> 150 lumens 40W -> 300 lumens 60W -> 500 lumens	BR, ER, K & R: Luminous flux = target wattage of the replaced lamp X10 PAR and MR16 : see tool http://www.drintl.com/htmlemail/Energystar/Dec09/ESIntLampCenterBeamTool.zip	200 lumens
Lumen Maintenance	>or = 70% (L70) at 25,000 hours	>or = 70% (L70) at 15,000 hours	>or = 70% (L70) at 25,000 hours	>or = 70% (L70) at 25,000 hours
Warranty	All types: 3 year minimum			
Packaging	All types: Manufacturer must use the Lighting Facts label			

ENERGY STAR® qualified LED lamp website

Commercial Products:
http://www.energystar.gov/index.cfm?fuseaction=ssl.display_products_com_pdf

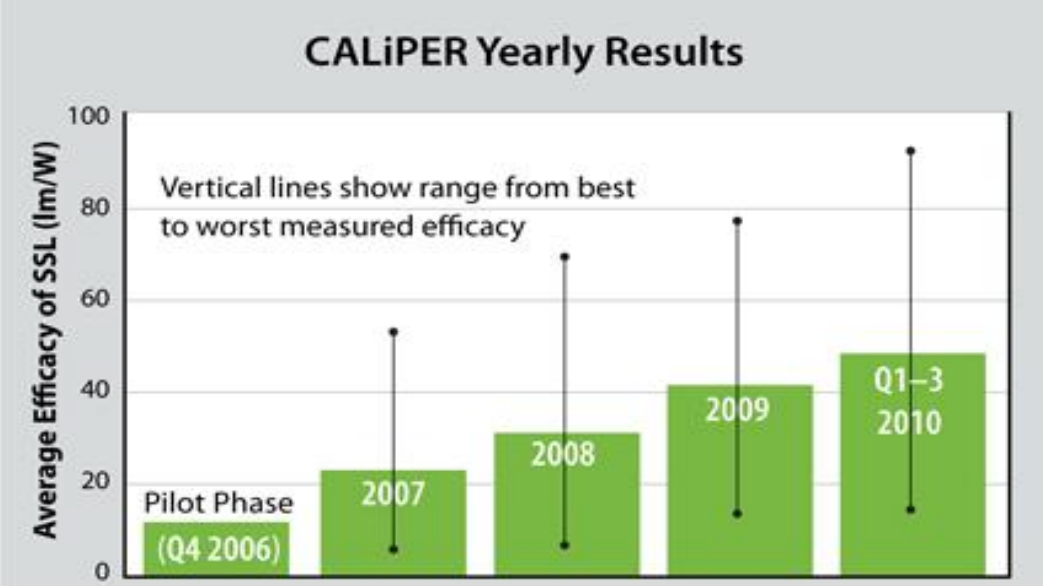
Residential Products:
http://www.energystar.gov/index.cfm?fuseaction=ledl.display_products_excel

FTC Lighting Facts Label - Mandatory

Front ^ Back >

- Lumens
- Energy Cost per Year

Based on $11.4 / KW-Hr.

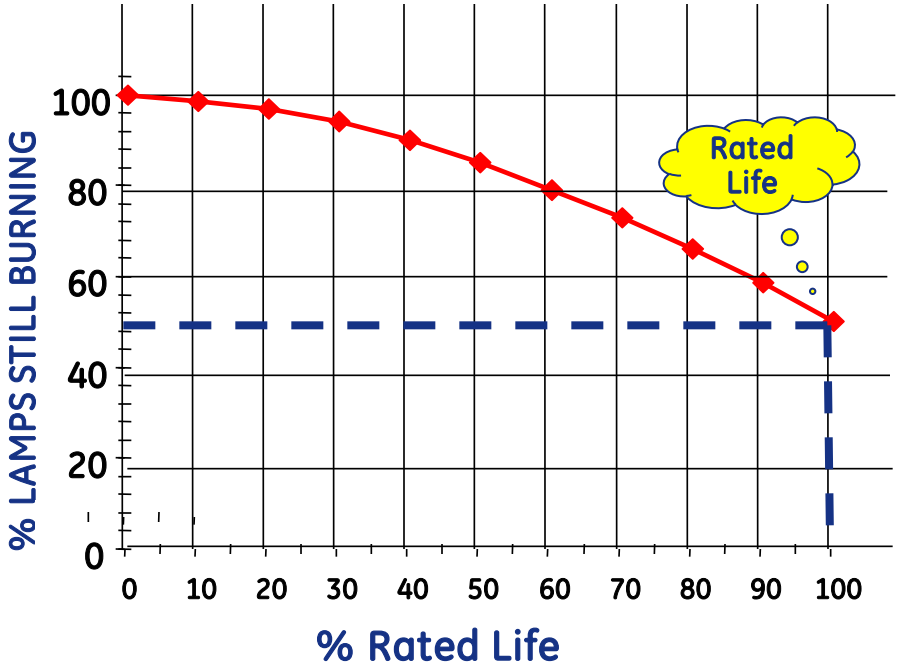


CALiPER testing from the Pilot Round through Round 11 shows a steady increase in average and maximum efficacy of market-available SSL luminaires and replacement lamps. The minimum efficacy seen in Round 11 is higher than the overall average efficacy observed in 2007.

Source: Caliper Round 11 Summary Report

LED Life Ratings

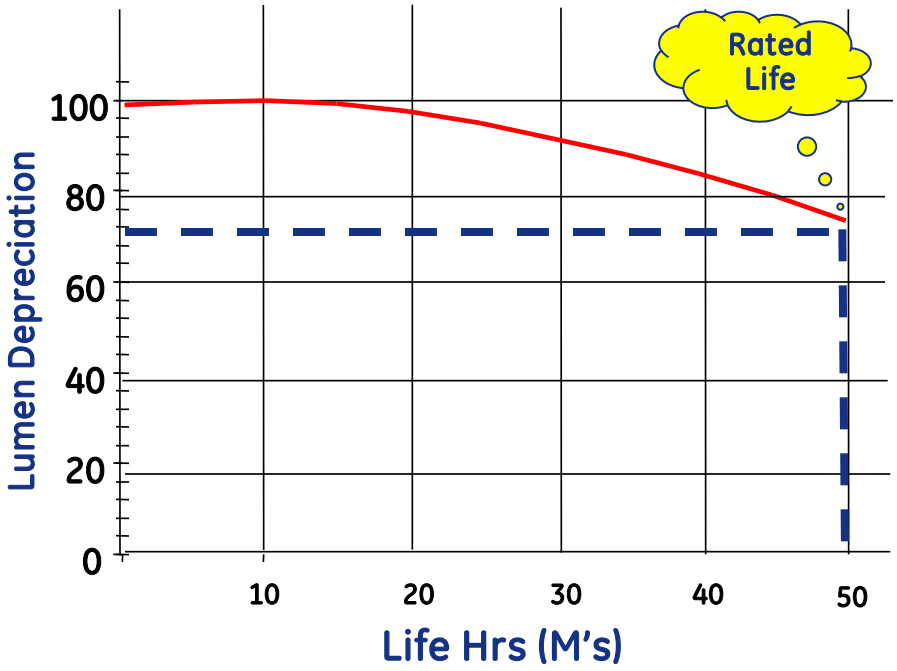
Traditional Lamps rated at B50 - 50% Mortality



B50 Life rated when 50% of a population has failed

B50 = Avg rated life

LEDS rated at 70% Lumen Maintenance



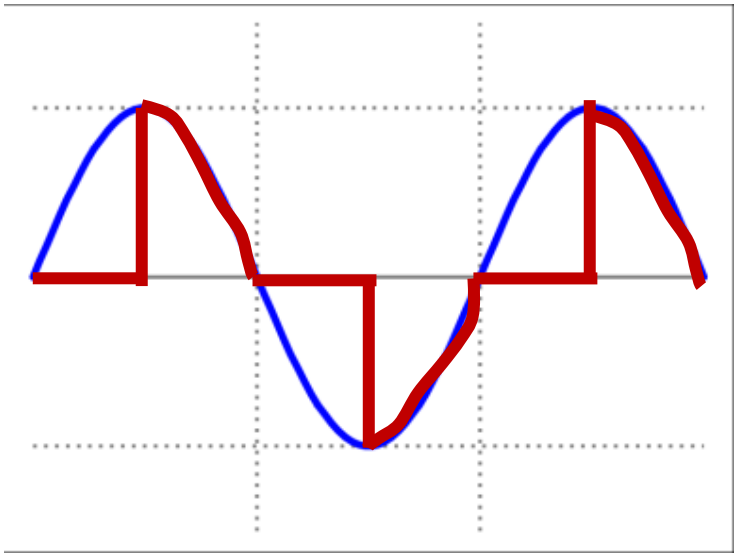
L70 Life defined as lumen depreciation to a particular point

L70 = Rated life @ 30% depreciation

LED Design Considerations

Dimming Considerations

Incandescent / Halogen Dimmers

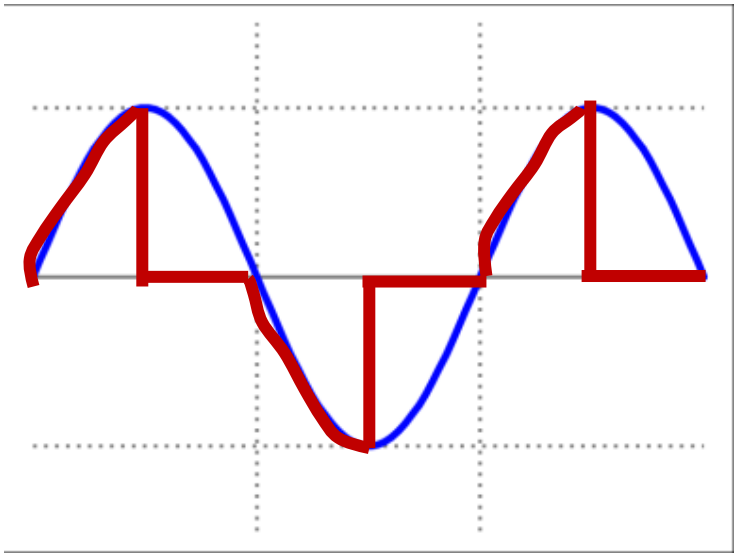


Line-voltage tungsten filament lamps, including line-voltage (120 V) halogen lamps. Resistive in nature.

Rated for cold filament inrush. The leading edge cut dimmer keeps voltage at zero until it turns on. Red Line.

Agenda

Reverse Phase Control Electronic Low-Voltage (



Electronic (solid-state) transformer-supplied low-voltage lighting. Capacitive in nature.
Neutral wire connection.

Very smooth turn on following the sine wave.
Red Line ramps up.

Agenda

Reverse Phase Control / Trailing Edge Cut Dimmers

Complex Design

- Trailing dimmers are more complex and costly, but are easier on lamp filaments, as there is no sharp current step.
- Trailing cut dimmer are less likely to generate noise mechanical noise in the lamp filament or noise into the electrical system.
- Trailing edge cut dimmers turn on at zero crossing with each line cycle then turn off at the desired level.

Dimming Compatibility

Only bulbs designed as dimmable should be used on a dimmer. Otherwise life & performance will suffer.

Actual performance of any LED or other lamp family will vary from bulb type to bulb type and among different manufacturers.

Check the bulb, or package, or call the manufacturer.

PER UL Standard 1472, manufacturers must test each bulb to ensure its compatibility with the dimmers.

Agenda

Reduce Dimming Range

Incandescent/halogen bulbs will typically dim lower than CFL or LED bulbs. Most dimmable CFLs will dim down to 10% to 30% measured light output. Early versions of dimmable LEDs on the market have the ability to dim lower than CFLs and can reach levels as low as 5% to 15% measured light. The actual dimming range is dictated by the bulb's circuitry.

Agenda

How to calculate wattage when mixing lamp types: (example only)

Total CFL/LED Wattage Installed

3 CFL bulbs x 16 W each = **48 W**

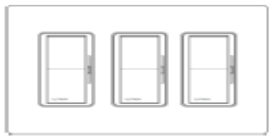
Maximum Allowable Incandescent/Halogen Wattage

6 Incandescent bulbs x 65 W each = **390 W**

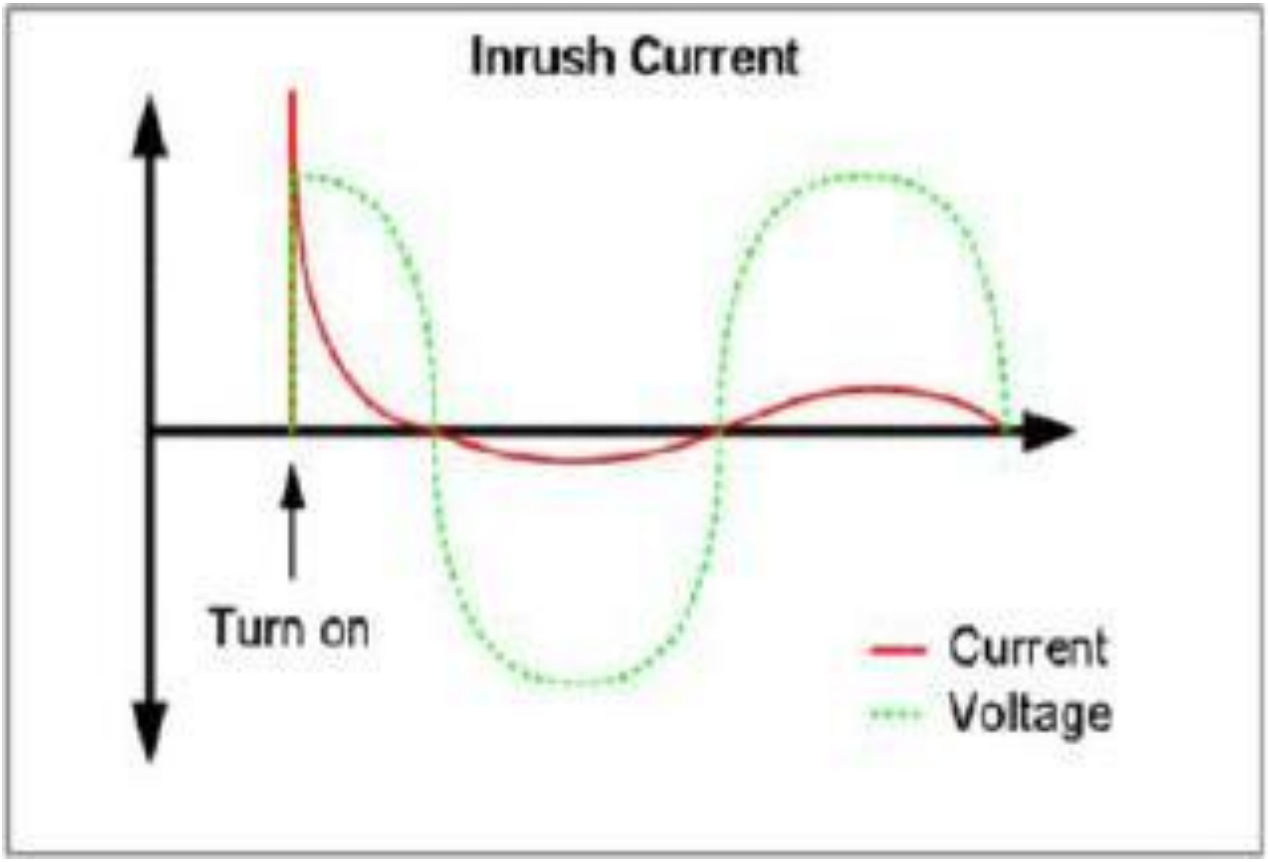
Example 1:

1. I have a single-gang dimmer and 3 CFL bulbs that are 16 W each, totaling 48 W.
2. Because I have 48 W of CFL bulbs installed, I can have up to 400 W of incandescent bulbs also controlled by this dimmer (6 incandescent bulbs that are 65 W each = 390 W)

(Please note this example applies to a single-gang dimmer only)

Single-Gang	Total CFL/LED Wattage Installed		Maximum Allowable Incandescent/Halogen Wattage
	0 W	+	600 W
	1-25 W	+	500 W
	26-50 W	+	400 W
	51-75 W	+	300 W
	76-100 W	+	200 W
	101-125 W	+	100 W
	126-150 W	+	0 W
2-Gang	**Total CFL/LED Wattage Installed**		**Maximum Allowable Incandescent/Halogen Wattage**
	0 W	+	500 W
	1-25 W	+	400 W
	26-50 W	+	300 W
	51-75 W	+	200 W
	76-100 W	+	100 W
	101-125 W	+	50 W
	126-150 W	+	0 W
3-Gang	**Total CFL/LED Wattage Installed**		**Maximum Allowable Incandescent/Halogen Wattage**
	0 W	+	400 W
	1-25 W	+	300 W
	26-50 W	+	200 W
	51-75 W	+	100 W
	76-100 W	+	50 W
	101-125 W	+	0 W
	126-150 W	+	0 W

In-Rush Current



Inrush current can be 10 times greater than steady-state current.

Agenda

LED Modules

GE Lighting

Infusion is a completely tool free, interchangeable modular system

Twist-in Optic

+

Twist-in LED Module

Assembled System

+

Holder

GE Lighting

Infusion Applications

Luminaire Flexibility


Recessed


Accent


Pendant

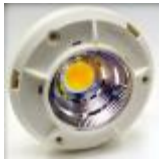

Multi-head


Track


Cylinder

GE Lighting

Competitive Comparison

Parameter	GE Infusion Gen2	Xicato XSM	Philips Fortimo SLM	Philips Fortimo TDLM	Cree LMH2	Osram PrevaLED HD	Bridgelux Helieon
Picture							
Installation	Twist-in	Screw down	Screw down	Twist-in	Screw down	Screw down	Twist-in
Lumens	Up to 3,500	Up to 2,000	Up to 3,000	Up to 2,000	Up to 1,250	Up to 3,000	Up to 1,200
Lm per watt	Up to 70	Up to 64	Up to 85 * @ 500 mA	Up to 62	Up to 80	Up to 84	Up to 59
Color Temps	27 / 30 / 40	27/30/35/ 40	27/30/35/ 40	27 / 30 / 40	27/30/35/ 40	27/30/35/ 40	30 / 41
CRI	Up to 87	Up to 95	Up to 95	Up to 80	90	Up to 90	Up to 82
Color Consistency	4 / 2-step	2-step	4 / 3-step	5 / 6-step	3-step	3-step	3-step
Size (dia.)	70 mm	45 mm	50 mm	75 mm	88.2 mm	50 mm	80 mm
L70 Life	50,000 hrs	50,000 hrs	50,000 hrs	25,000 hrs	50,000 hrs	50,000 hrs	50,000 hrs
Zhaga	Book 5	No	Book 3	Book 2	No	Book 3	No

GE Lighting

Zhaga

What is Zhaga?

- Zhaga is a consortium (group) of LED industry players, including : LED module manufacturers, LED luminaire manufacturers, and LED accessory component (i.e. heat sinks, optics) manufacturers.

Zhaga's role:

- Zhaga **promotes the interchangeability of LED modules** by specifying their interfaces and enabling easy identification of Zhaga compliant products.
    - Mechanical, Photometrical, Thermal, Electrical

Zhaga's purpose:

- Creates market confidence in LED lighting solutions which **stimulates the growth of the application of LED's**
    - *i.e. Speed up adoption and grow the market for LED modules quickly.*

Zhaga is a cooperation between companies

- 167 members
  - 55 members with voting rights
  - From Asia, North America, Europe
  - Companies you recognize such as:
  - Acuity, Cooper, Zumtobel, Iguzini, Ideal, Leviton, BJB, Lutron, GE, Osram, Philips, Panisonic, Ideal, Nuventix, Cree

Meeting every 6-8 weeks

GE Lighting

Zhaga

- Zhaga will create many light engine specifications
- Different lighting applications need different light engines
- Zhaga specifications are called “books”

Book No.	Book 1	Book 2	Book 3	Book 4	Book 5	Book 6	Book 7
Description	Overview and Common Information	Socketable module with integrated driver	Screw-down module with separate driver	Street light module	Socketable module with separate driver	Large socketable module with integrated driver	Office module with separate driver
Picture	N/A			N/A			N/A
Status	Complete	Complete	Complete	In preparation	Complete	Complete	In preparation

Defining an LED light engine

- An LED light engine is the combination of an LED module and its associated
  rol gear ('driver')

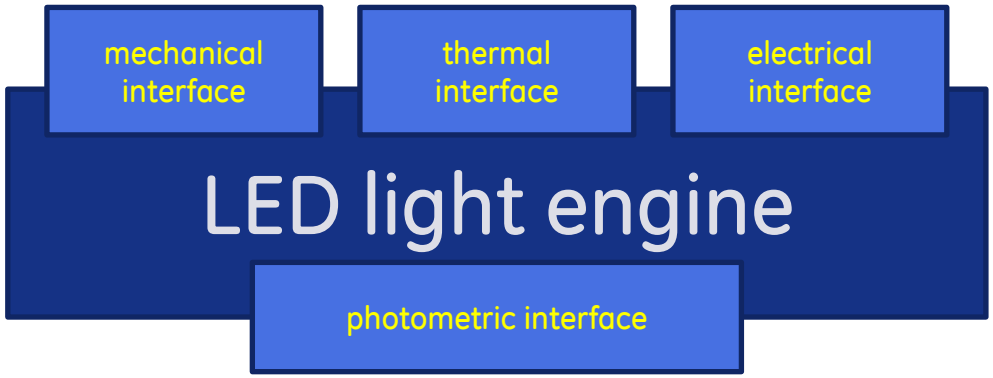
Light Engine with
Integrated Control Gear

Light Engine with
Separate Control Gear

Stable interfaces – Rapid innovation

- Zhaga specifies *only* what is necessary to enable the *interchangeability* of light engines from different manufacturers.

- The design freedom inside the light engines and in the luminaires is maximized.

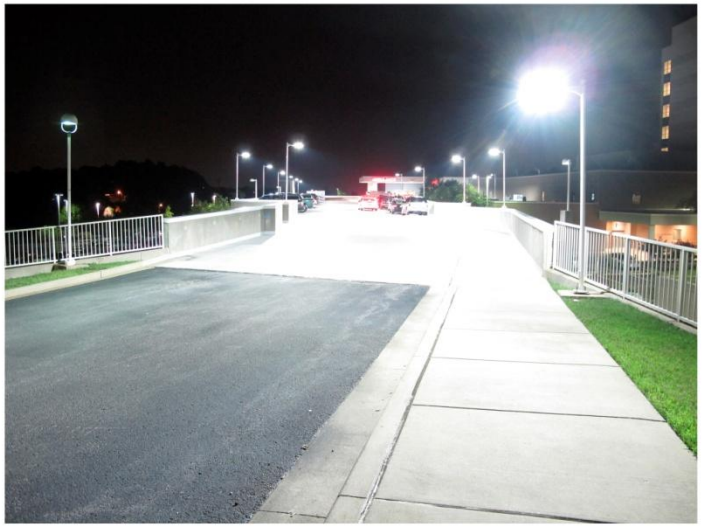


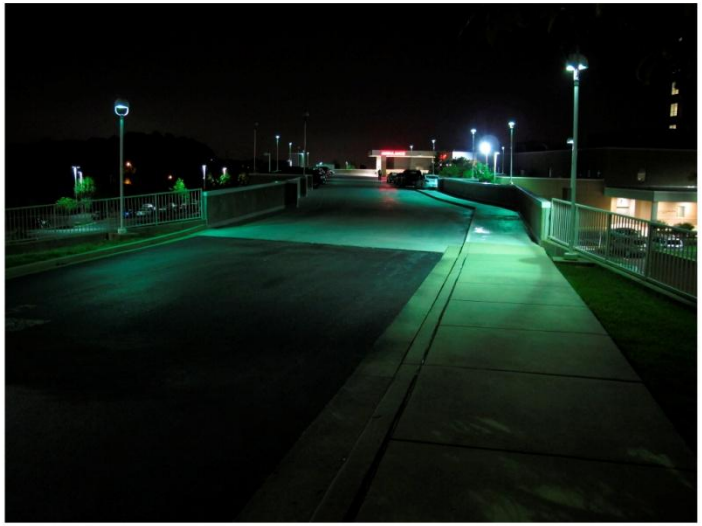
Zhaga treats the inside of a light engine as a 'black box'

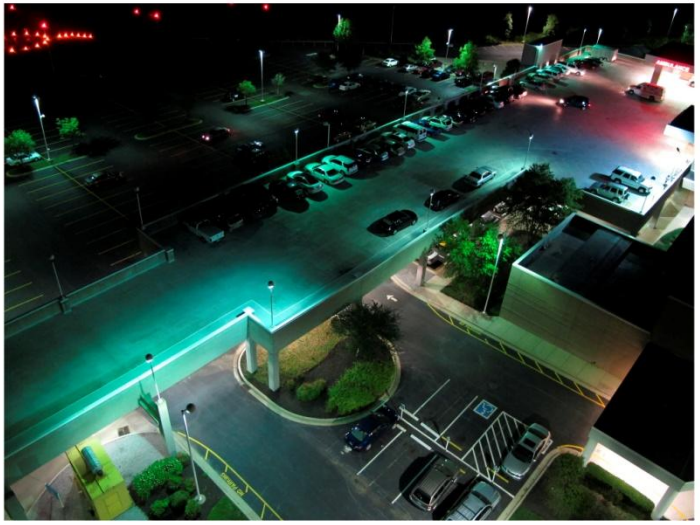
LED Applications


The Country Sampler
Floral
SALE
SALE
STOP


Before
After

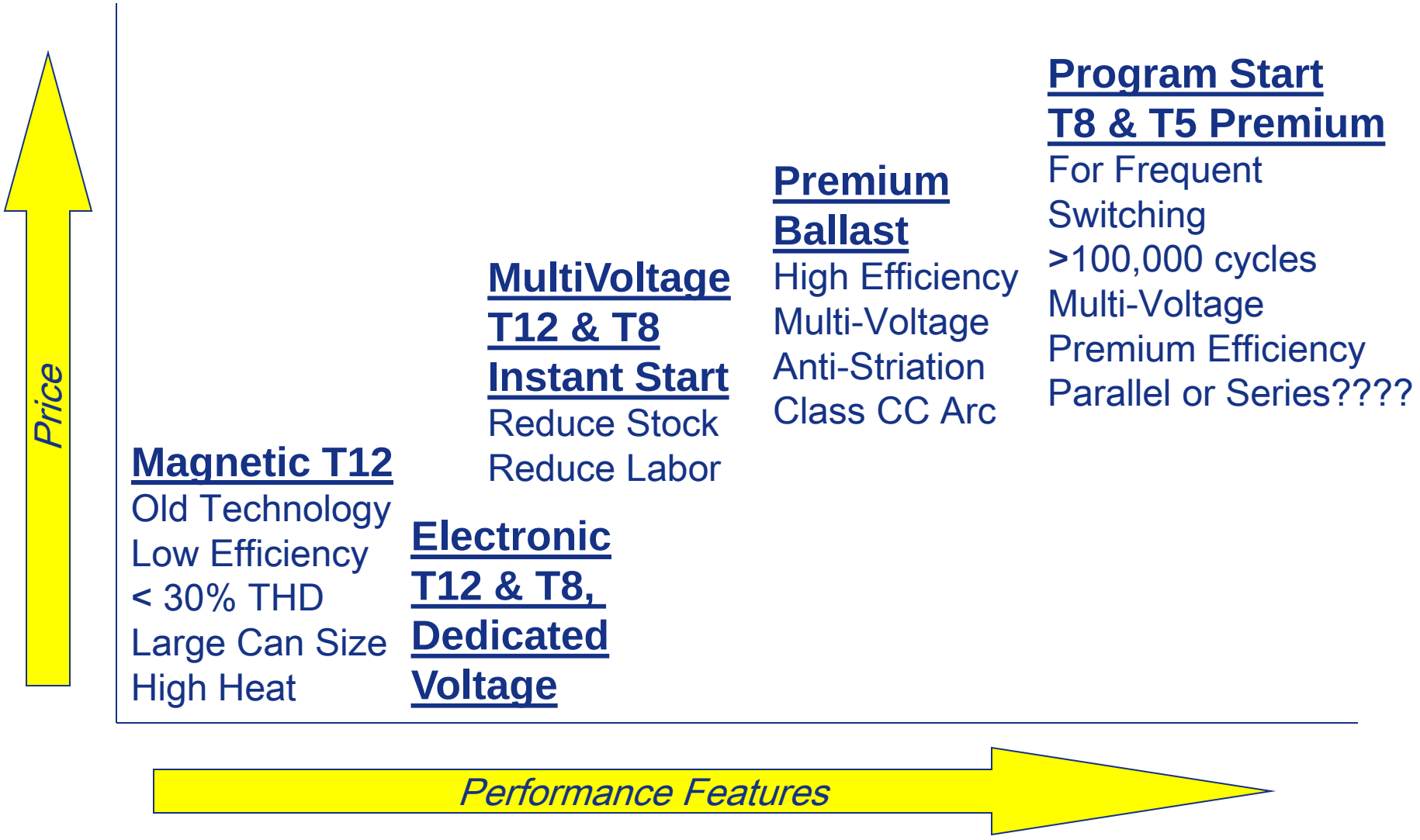




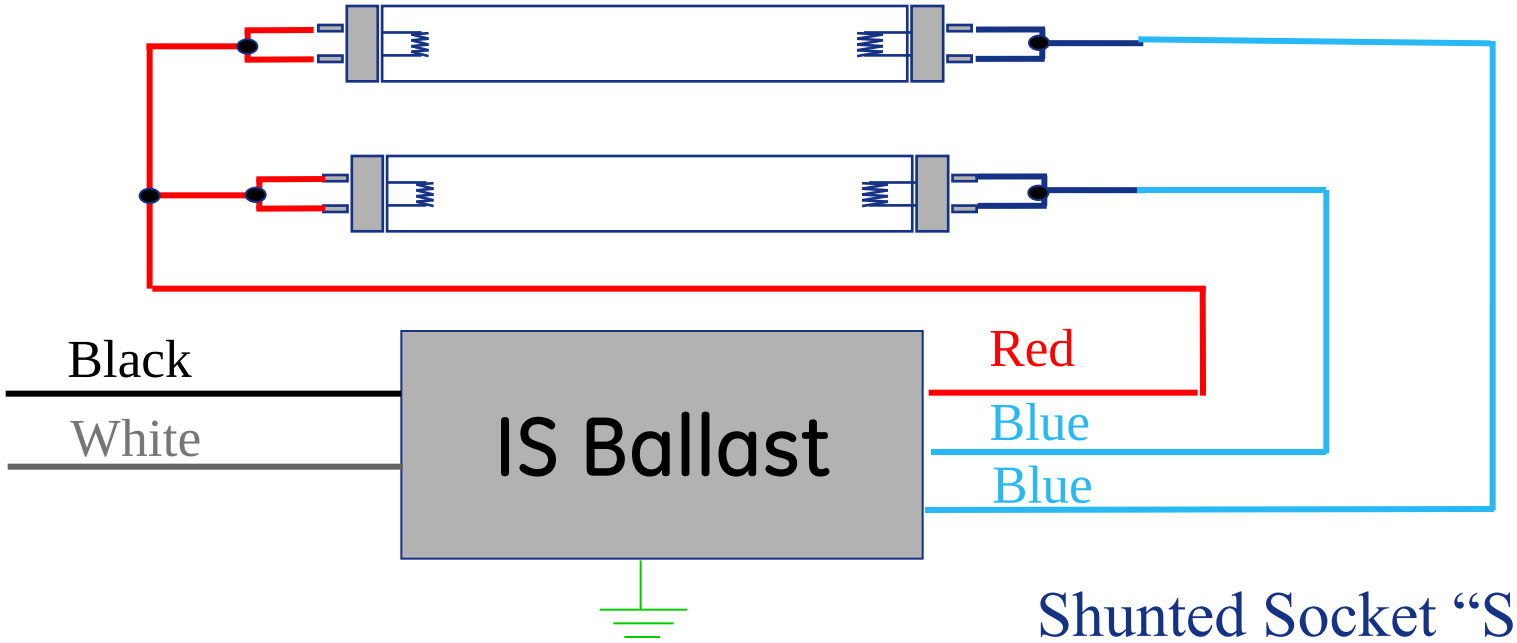


Fluorescent Ballasts

Fluorescent Ballast Products



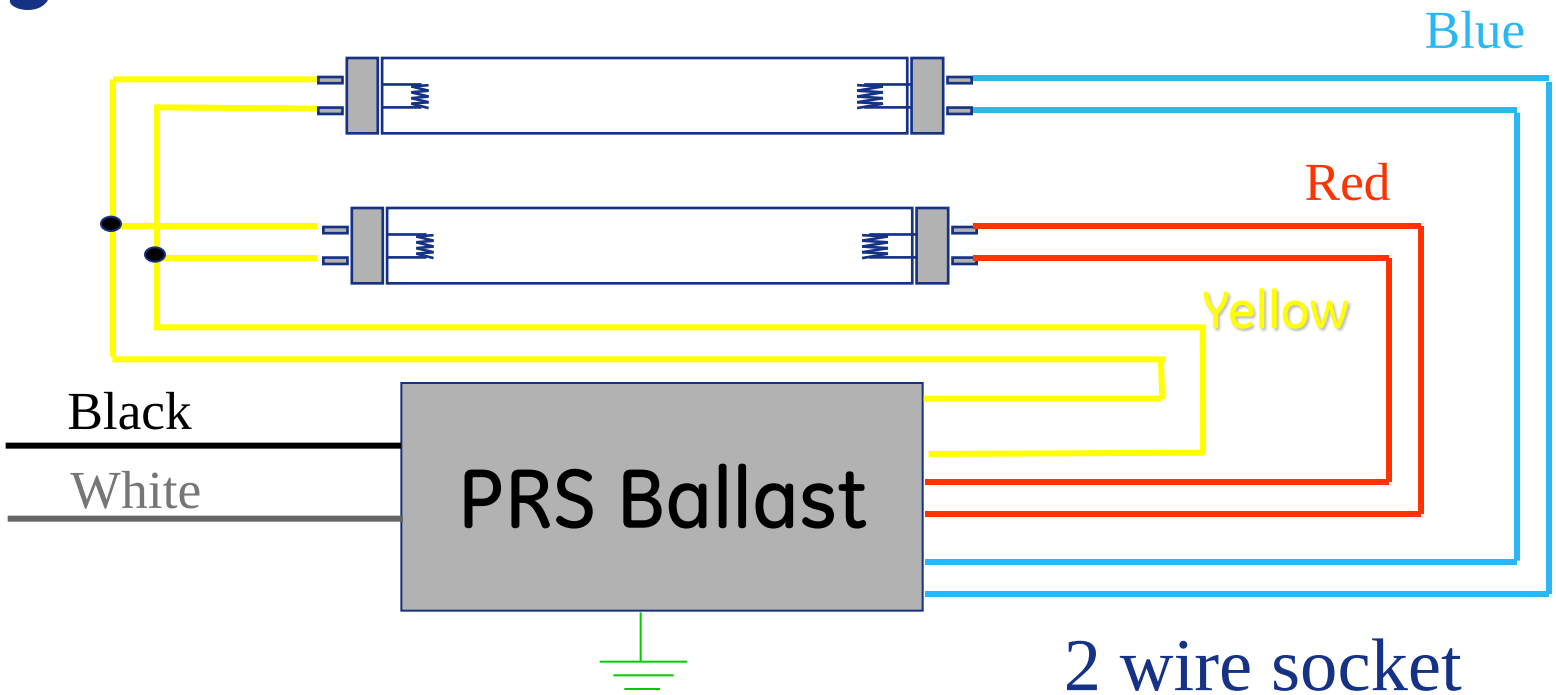
Instant Start Ballast NEMA LSD 2A-2007



Shunted Socket “S”

- **Parallel Wired, lamp goes out, the other stays on.**
- **One wire to Shunted sockets.**
- **550 Volts Open Circuit Voltage**
- **Cathodes Not heated. High OCV to start lamps.**
- **Good for long cycles of starting 1-2 times per day.**
- **Lamp types: F32T8, F28T8, F25T8, F96T8.**

Programmed Start Ballast



2 wire socket

- **Similar to Rapid Start, but Programmed Precise Control**
- **Cathodes heated without Arc Voltage**
- **Damaging "Glow Current" near Zero !**
- **Less damage during starting = Longer lamp life at short cycles**
- **Used with dimming technology**

Options for Reducing Lighting Loads

Options:

1. Switching
   - Fixture Switching (rows)
   - Fixture Switching (checkerboard)
   - Tandem Wiring (inboard/outboard)

2. Stepped Dimming ~50-60%
   - 2 hot leads/2 switches, switching logic)
   - 0-10V
   - Powerline Carrier

3. Load Shed Dimming 100 to 60%
   - 0-10V Analog
   - Powerline Carrier
   - DALI 0-16V Digital)

4. Full Range Dimming 100~3%
   - 0-10V Analog
   - Powerline Carrier or Phase Cut
   - DALI 0-16V Digital)

T8 vs T5 Efficacy For Office Environment

Luminaire	# Lamps	Initial Lumens	Maintained Lumens	BF	LLF	Watts	# Fixtures Required	Footcandles	Watts/Ft Sq	Mean Lum/Watt
T5 Perforated Basket	2-51W	5000	4600	1.00	0.76	107	10	53.6	**1.34**	85.98
T5 Perforated Basket	2-28W	2900	2660	0.96	0.73	59	15	47.0	**1.11**	86.56
T8 Perforated Basket	3-32W	2950	2800	0.89	0.78	84	12	48.6	**1.26**	89.00
T8 Perforated Basket	3-32W	2950	2800	1.15	1.00	108	10	53.0	**1.35**	89.44
T8 Perforated Basket	3-28W	2725	2562	1.10	0.96	91	12	55.2	**1.37**	92.91
T8 Perforated Basket	3-28W	2725	2562	1.10	0.96	91	10	47.0	**1.14**	92.91
T8 Perforated Basket	3-32W	3100	2915	0.89	0.77	84	10	53.6	**1.05**	92.66
T8 Parabolic	3-32W	2950	2800	0.89	0.78	84	10	58.3	**1.05**	89.00
T8 Parabolic	3-32W	3100	2915	0.89	0.77	84	8	49.0	**0.84**	92.66

Design based on the number of fixtures required to provide 50 footcandles at a 2.5' workplan. Room dimensions 40' x 20' x 9'.

Based on ambient temperature of 77 deg.

The Most Efficacious System?

Typically the T8 lamp is more efficient but it does depend on the lamp/ballast system.

As can be seen, the 3100 lumen 32W T8 and the 28W T8 are more efficient than the 2950 lumen 32W T8 and the 51W T5. The 28W T5 does very well but requires more luminaires.

If you consider the T8 in a parabolic luminare, the 3100 lumen 32W T8 really stands out.

Note 1: Many people simply look at the lumens/watt figure. I prefer to calculate the watts/ft sq because this really shows you how much energy is going to be required to get the desired results.

2: GE has a 51W T5 that has the same lumens as everyone's 54W lamp. This actually helps the T5 come closer to the T8.

THANK YOU!

QUESTIONS?