Make New Commercial Lighting Standards Work for You

March 28, 2012
Meet your panelists:

Kathy Schmitt, Sr. Business Lighting Program Manager, FPL

Jerry Braud, Director of Operations Broward Convention Center

Mark Farrell, Sr. Engineer, Business Energy Service

Mike Carter, Sr. Engineer, Business Energy Service

Jorge Lamelas, Account Manager, FPL
Agenda

• Understanding the impact of new federal standards
• Learning about FPL Business Lighting program
• Watching the new standards at work
  – Broward County Convention Center Case Study
• Making the new standards work for you
  – Bulb and fixture types
    -- Facts
    -- Options
    -- Benefits
  – Lighting controls, design and maintenance
• Getting started
Energy-efficient lighting systems provide immediate and long-term financial rewards while making a significant contribution to global carbon reduction.

**Efficient Lighting Benefits**

- Bottom line cost savings today!
- Improved employee productivity
- Increased property value

Depending on your business type, lighting can account for 20 to 50 percent of electricity consumption.
New federal lighting standards increase minimum standards for manufacturers and importers. Less efficient bulbs and lighting systems will no longer be available.

**Examples of Legislation at Work**


- Phases out 100, 75, 40 and 60 watt incandescent bulbs between now and 2014
- Better reflector lamps ≥ 40 watts


- No magnetic ballasts have been manufactured for replacement since June 2010
- New ballast luminous efficiency (BLE) standards in 2014

**Energy Conservation Program (ECP) 2009 Lamp Rule for Fluorescent Lamps**

- Effectively eliminates most 4 foot and 8 foot T12 lamps, as well as 700 series (first generation) T8 lamps in 2012
The FPL Business Lighting Program helps offset the cost of new bulbs and fixtures

The FPL Business Lighting Program

- Incentive based on dollars per lamp
  - Incentive on number of lamps installed only

- kWd reduction calculation based on tables

- Incentive based on 75 dollars per kWd and 100 dollars per kWd

- Requires installation by independent contractor
  - Independent contractors have signed FPL Demand Side Management contracts)

- Pre-approval required for qualification

- No pre-inspection required

<table>
<thead>
<tr>
<th>Lamp</th>
<th>Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8</td>
<td>$0.65 per lamp</td>
</tr>
<tr>
<td>T5HO</td>
<td>$2.00 per lamp</td>
</tr>
<tr>
<td>CFL (5-13 Watt)</td>
<td>$2.00 per lamp</td>
</tr>
<tr>
<td>CFL (14-26 Watt)</td>
<td>$5.00 per lamp</td>
</tr>
</tbody>
</table>
Upgrading to a more efficient system lowers operating costs and results in better quality lighting

**Sample Benefits**

- **Installation rebate**
  - Four lamp, 34-watt T12 with energy-efficient magnetic ballast retrofitted to a 4 lamp T8 with electronic ballast
  - 4 lamps x $0.65 per lamp = $2.60 incentive

- **Long-term savings**
  - A 23,000 square foot athletic club in Sarasota replaced 131 fluorescent fixtures with T8 lamps and electronic ballasts
  - Received a $294 FPL incentive
  - Decreased energy consumption by 26 percent
  - Resulted in $5,387 yearly savings!
The Broward County Convention Center received $23,246 in FPL incentives. The facility expects savings of approximately 25 percent of its annual electric charges.

**Lighting Retrofit Project**

The payback period is expected to be less than one year!
The convention center upgrades were based on the facility’s usage requirements

**Sample Upgrades**

- **Changed out** 244 – 400W HIDs to 8-lamp T5HO fixtures with step-down lighting levels from 100 to 25 percent, utilizing only 25 percent on during event move-in and move-out
  - Allows for only 108 watts per fixture to be used during these times versus 400 watts
- **Changed lights** in all meeting rooms from 2 x 4 4-lamp T-12 parabolic fixtures to 2 x 4 2-lamp T5HO direct/indirect fixtures
- **Changed all HID and/or incandescent down lights** in all pre-function areas to CFLs
- **Changed emergency stairwell lighting** from 1 x 4 2-lamp T-12 fixtures to a 1 x 4 2-lamp T-8 motion-sensor fixture that runs at 13 watts until motion is detected in the stairwell
Many different bulb and fixture types exist. We will review the facts and benefits of each type so you can determine which options best meet your business needs.

**Lighting Types**

- **Incandescent bulbs**
- **T12 fluorescent**
- **Metal halide or HPS high-bay**

**Halogen**
- CFL
- Metal halide
- LED

**T8/T5 fluorescent**
- LED troffers
- LED light guides

**T8/T5 fluorescent banks**
- Induction lighting
- Radio-frequency lighting
- LED
Federal regulations do not ban any technologies, they just establish higher performance standards

**Incandescent Bulb Standards**

- **90 percent heat and 10 percent light**
  - 10 to 17 lumens per watt
- **Energy Independence and Security Act (EISA) establishes higher minimum performance standards for manufacturers and importers**
  - Generally, a 25 percent energy reduction for equal light output
  - Incandescent bulbs with a medium screw base (E26)>2.25” diameter
    - Phased in starting 2012
    - Recent legislation has (temporarily?) eliminated enforcement budget

<table>
<thead>
<tr>
<th>Incandescent Bulb Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated Lumens</strong></td>
</tr>
<tr>
<td>1490-2600</td>
</tr>
<tr>
<td>1050-1489</td>
</tr>
<tr>
<td>750-1049</td>
</tr>
<tr>
<td>310-749</td>
</tr>
</tbody>
</table>
Many reflector lamps will no longer meet federal performance standards, but replacement options exist

**Reflector Lamp Replacement Options**

- **EISA 2007/Energy Conservation Program (ECP) 2009**
  - Reflector lamps ≥ 40 watts and diameter >2.25”
  - Begins 7/14/2012
  - Effectively eliminates standard PAR20, PAR30, and PAR38 lamps

### Reflector Lamps

<table>
<thead>
<tr>
<th>Type</th>
<th>Watts</th>
<th>Old LPW</th>
<th>New LPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>K19</td>
<td>60</td>
<td>12.8</td>
<td>15.1</td>
</tr>
<tr>
<td>R20</td>
<td>50</td>
<td>7.7</td>
<td>14.4</td>
</tr>
<tr>
<td>BR40</td>
<td>100</td>
<td>14.5</td>
<td>20.5</td>
</tr>
<tr>
<td>BR30</td>
<td>85</td>
<td>10.0</td>
<td>19.6</td>
</tr>
</tbody>
</table>

### Reflector Lamps

<table>
<thead>
<tr>
<th>Existing</th>
<th>Replacements</th>
</tr>
</thead>
<tbody>
<tr>
<td>K19</td>
<td>Halogen PAR16 or PAR20</td>
</tr>
<tr>
<td>R20 50W</td>
<td>R20 45W* or Halogen PAR20</td>
</tr>
<tr>
<td>65W&lt; BR40&lt;205W</td>
<td>BR40 65W* or Halogen PAR38</td>
</tr>
</tbody>
</table>
Metal halide bulbs are a good option in areas such as warehouses or retail stores if lights are consistently on or off for a prolonged period of time.

**Metal Halide Bulb Options**

- **Self-ballasted PAR30LN and PAR38**
  - 1,200 to 1,400 initial lumens @ 23W
  - Replaces 74W and 120W halogen bulbs

- **Smaller Size <150W HID Ballasts**
  - Generally 50% smaller in size (3" x 1.3" x 1.1")

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Lamp Watts</th>
<th>System Watts</th>
<th>Replaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylvania Quicktronic eHID Super Mini</td>
<td>15W, 20W, 39W</td>
<td>17.4W, 23W, 44W</td>
<td>12V 50W MR-16; 20W CMH</td>
</tr>
<tr>
<td>GE UltraMax micro eHID</td>
<td>20W, 39W</td>
<td>23W, 43W</td>
<td>75-100W Halogen</td>
</tr>
<tr>
<td>Universal Micro Series</td>
<td>20W, 22W, 39W</td>
<td>24.5W, 26.5W, 45W</td>
<td>75-100W Halogen</td>
</tr>
<tr>
<td>Philips e-Vision Mini MasterColor</td>
<td>20W</td>
<td>&lt;26W</td>
<td>60W+ Halogen</td>
</tr>
</tbody>
</table>
CALiPER tested seven different directional LEDs and found them to be much better than halogen bulbs, but not quite competitive with CMH.

### LED PAR and AR Product Options

<table>
<thead>
<tr>
<th>Type</th>
<th>Watts</th>
<th>Lumens</th>
<th>LPW</th>
<th>CCT (K)</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED PAR30</td>
<td>12</td>
<td>594</td>
<td>49</td>
<td>2,642</td>
<td>64</td>
</tr>
<tr>
<td>LED PAR38</td>
<td>18</td>
<td>959</td>
<td>52</td>
<td>4,056</td>
<td>87</td>
</tr>
<tr>
<td>CMH PAR38</td>
<td>25</td>
<td>1,504</td>
<td>60</td>
<td>3,012</td>
<td>86</td>
</tr>
<tr>
<td>HIR PAR38</td>
<td>75</td>
<td>1,060</td>
<td>14</td>
<td>3,500</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: Round 11, CALiPER*

http://www1.eere.energy.gov/buildings/ssl/caliper.html
New halogen bulbs offer several improvements with the same benefits of incandescents

**Incandescent Bulb Replacement Options**

- New halogen bulbs offer up to 30 percent energy savings, instant on, no mercury, 100 CRI, and compliance with EISA 2007
  - Philips Halogena® Energy Saver/Energy Advantage (3,000 hrs)
  - Sylvania Halogen SuperSaver® (1,000 hrs)
  - GE Edison™ (2,500 hrs)

- Hybrid halogen from GE

- Vu Electron Stimulated Luminescence
  - 1 ESL™ R-30 (11,000 hrs)

*Source: Philips Lighting*

*Source: GE*
Compact Fluorescent Lighting (CFL) is a good option for replacing obsolete incandescent and halogen bulbs

Benefits of Compact Fluorescent Lighting (CFL)

• **Equal light output (lumens)**
  – 75 percent energy reduction
  – Six times the rated life

• **Energy savings far outweigh difference in lamp prices**

• **Use reflector flood R-CFLs in recessed can lights**

• **Issue of mercury content can be addressed**

*Source: NREL*
Although expensive, LED replacement bulbs offer equal light output with lower energy consumption and longer life.

### Omnidirectional LED Options

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Wattage</th>
<th>Lumens</th>
<th>CCT</th>
<th>Life (Hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEDzworld Professional LED Bulb CTA</td>
<td>6.5W</td>
<td>250</td>
<td>2500K</td>
<td>35,000</td>
</tr>
<tr>
<td>GE Energy Smart™ LED</td>
<td>9W</td>
<td>450</td>
<td>3700K</td>
<td>25,000</td>
</tr>
<tr>
<td>Philips AmbientLED™</td>
<td>12.5W</td>
<td>800</td>
<td>2700K</td>
<td>25,000</td>
</tr>
<tr>
<td>Sylvania LED A-Line</td>
<td>12W</td>
<td>810</td>
<td>2700K</td>
<td>25,000</td>
</tr>
<tr>
<td>Switch 100</td>
<td>16W</td>
<td>1,700</td>
<td>4,200K</td>
<td>20,000</td>
</tr>
</tbody>
</table>

•Source: GE Lighting
•Source: Switch Bulb Co.
•Source: LEDzworld
The National Appliance Energy Conservation Amendments of 1988 are the regulatory driver for electronic ballasts (T8 and T5 lamps)

**Rulemaking Cycles for Electronic Ballasts**

1. **The 2000 Ballast Rule/EPAct 2005**
   - No magnetic ballasts manufactured for replacement after June 2010

2. **Energy Conservation Standards for Fluorescent Lamp Ballasts: Final Rule, November 2011**
   - Effective July 1, 2014
   - Measured in terms of ballast luminous efficiency (BLE), the ratio of total lamp arc power to ballast input power
   - For ballasts driving T12 lamps, minimum BLE increased
     - Old range of 0.711 to 0.888
     - New range of 0.841 to 0.918
Electronic ballasts consume much less energy than magnetic ballasts

**Types of Fluorescent Ballasts**

- **Magnetic (60 Hz)**
  - Core and coil
- **Electronic (20 to 60 kHz)**
  - 10 to 15 percent more efficient
  - NEMA Premium® ballasts even better
    -- Generally a 5-7 percent efficiency improvement (2-5 watts) and anti-striation control
- **All ballasts consume power even without lamps**

<table>
<thead>
<tr>
<th>Type</th>
<th>Rated Load</th>
<th>Open-Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic</td>
<td>18-20 w</td>
<td>6-10 w</td>
</tr>
<tr>
<td>Electronic</td>
<td>6-12 w</td>
<td>3-7 w</td>
</tr>
</tbody>
</table>

Two Lamp Example
The Energy Conservation Program (ECP) 2009 Lamp Rule for fluorescent lamps effectively eliminates most 4-ft 12, 8-ft (F96) T12 lamps, and 700 series (first generation) T8 lamps*

**T8 Lamp Types (Generations)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Watts</th>
<th>Lumens</th>
<th>CRI</th>
<th>Life (hrs, 000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>700 Series, Basic</td>
<td>32 W</td>
<td>2,800</td>
<td>75-78</td>
<td>15-20</td>
</tr>
<tr>
<td>2G</td>
<td>800 Series</td>
<td>32 W</td>
<td>2,850 - 3,000</td>
<td>82-86</td>
<td>24-30</td>
</tr>
<tr>
<td>3G</td>
<td>Super, HO</td>
<td>32 W</td>
<td>2,950 - 3,200</td>
<td>82-86</td>
<td>24-30</td>
</tr>
<tr>
<td>4G</td>
<td>Reduced Wattage, Energy Savers</td>
<td>23 W</td>
<td>2,000</td>
<td>82-86</td>
<td>Temp. sensitive, Instant start only</td>
</tr>
<tr>
<td></td>
<td>25 W</td>
<td>2,400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28 W</td>
<td>2,750</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 W</td>
<td>2,850</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Beginning July 14, 2012
T8 and T5 lamps with electronic ballasts are good replacements for T12 lamps with magnetic ballasts

**Fluorescent Lamp Upgrades**

<table>
<thead>
<tr>
<th>Four-lamp T12 versus T8 Fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp Type</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>F40T12</td>
</tr>
<tr>
<td>F34T12</td>
</tr>
<tr>
<td>F32T8</td>
</tr>
</tbody>
</table>

- **NEC Article 410.130(G) Disconnecting Means**
  - “At the time a ballast is replaced, a disconnecting means shall be installed.”
Super T8 lamps offer premium energy efficiency if lower ballast factors are used

**Fluorescent Lamp Options**

- **Super T8 lamps (3G), with high-efficiency ballasts**
  - High-lumen (>3000 versus 2,850 standard)
  - Extended life (>30,000 versus 24,000 hours standard)
  - Only saves energy when combined with a lower ballast factor ballast

- **T5 series (good for indirect lighting like suspended lighting)**

### Super T8 Lamps

<table>
<thead>
<tr>
<th>Type</th>
<th>Initial Lumens</th>
<th>Watts</th>
<th>Ballast Factor</th>
<th>Fixture Lumens</th>
<th>Fixture Watts</th>
<th>LPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8</td>
<td>2,950</td>
<td>33</td>
<td>0.85</td>
<td>2,496</td>
<td>28</td>
<td>89</td>
</tr>
<tr>
<td>Super T8</td>
<td>3,200</td>
<td>34</td>
<td>0.78</td>
<td>2,496</td>
<td>26</td>
<td>96</td>
</tr>
</tbody>
</table>

### T5 Series Lamps

<table>
<thead>
<tr>
<th>Type</th>
<th>Initial Lumens</th>
<th>Watts</th>
<th>LPW</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5</td>
<td>2,900</td>
<td>28 W</td>
<td>104</td>
<td>30,000 hours</td>
</tr>
<tr>
<td>T5HO</td>
<td>5,000</td>
<td>54 W</td>
<td>93</td>
<td>30,000 hours</td>
</tr>
</tbody>
</table>
Whether to choose a fixture that accommodates T8 or T5 lamps depends upon your application

Choosing the Right Lamp for Your Needs

• T5 not interchangeable with T8

• (4) F54T5HOs=(6) F32T8s

• Lower mercury content than T8

• T5 lumen maintenance
  – Better at higher ambient temperatures
  – Worse in cold temperatures

*Source: RPI Lighting Research Center*
Reduced wattage lamps may or may not result in reduced light output

### Reduced Wattage T5HO Lamps

- **Light output equal to standard 54W**
  - Philips Energy Advantage (49W)
  - GE Watt Miser (51W)
  - Sylvania Pentron® SuperSaver® Ecologic® (51W)

- **Slightly less light output (percentage)**
  - GE Watt Miser Plus 47W (4 percent)
  - Sylvania Pentron HO SuperSaver 47W (8 percent)
Tubeless LED troffers now offer equivalent performance to linear fluorescent troffers

**Purpose-built Linear LED Troffers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Watts</th>
<th>Lumens</th>
<th>LPW</th>
<th>CCT (K)</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8</td>
<td>32</td>
<td>3,300</td>
<td>100</td>
<td>3,300</td>
<td>82</td>
</tr>
<tr>
<td>Cree CR Series</td>
<td>44</td>
<td>4,000</td>
<td>90</td>
<td>3,500</td>
<td>90</td>
</tr>
<tr>
<td>Cooper Corelite</td>
<td>45</td>
<td>3,256</td>
<td>72</td>
<td>4,000</td>
<td>75</td>
</tr>
<tr>
<td>LED 2X2 (Rd 13)</td>
<td>43</td>
<td>3,469</td>
<td>80</td>
<td>3,152</td>
<td>94</td>
</tr>
</tbody>
</table>

Source: Cree

Source: Philips

Source: Cooper Corelite
Thin LED Light Guide products offer more design flexibility than traditional troffers

**LED Light Guide Products**

- **GE Edge Lighting**
- **Philips CoreView**
  - 3000 lumens @ 52 watts
- **LG ModulA Light Guide Plate (LGP)**
  - 14 mm thick; 3200 lumens @ 40 watts

Source: LG Innotek

Source: GE

Source: Philips Lighting

Source: LG Innotek
High intensity means lots of lumen output in a small package

Types of High Intensity Discharge Bulbs

• **Low Pressure Sodium**
  – Most energy efficient lighting source.
  – Not an arc source, so no glare.
  – 0 to 20 CRI

• **High Pressure Sodium**
  – Arc source with (20 to 65 CRI)
  – Replacements exist for 400 W
    -- 310 W and 360 W
  – Electronic ballasts 5 to 20 W
    -- Magnetic ballasts 50 to 70 W
Types of High Intensity Discharge Bulbs

- **Mercury Vapor**
  - EPAct 2005, Sec. 135 Energy Conservation Standards for Additional Products
  - Mercury vapor lamp ballasts shall not be manufactured or imported after January 1, 2008

- **Metal Halide**
  - Arc source with 60 to 95 CRI
  - Quartz or ceramic transparent tubes
    - Ceramic advantages
      - Lumen maintenance
      - Color rendering (95 versus 65 CRI)
      - Color stability
    - 3X lumens per watt and rated life compared to halogen

Source: Venture Lighting

Source: State of Illinois
HID lighting trades efficiency for light quality and does not support short burn times

**High Intensity Discharge**

**Sustained arc vs. fluorescent phosphor emission**

<table>
<thead>
<tr>
<th>Type</th>
<th>Watts</th>
<th>Lumens</th>
<th>Lumen Maintenance</th>
<th>LPW</th>
<th>CRI</th>
<th>Life (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury Vapor*</td>
<td>1,000 W</td>
<td>47,500</td>
<td>65%</td>
<td>30</td>
<td>40</td>
<td>24,000</td>
</tr>
<tr>
<td>Low Pressure Sodium</td>
<td>135 W</td>
<td>22,000</td>
<td>&gt;95%</td>
<td>150</td>
<td>10</td>
<td>18,000</td>
</tr>
<tr>
<td>High Pressure Sodium</td>
<td>400 W</td>
<td>45,000</td>
<td>75%</td>
<td>85</td>
<td>30</td>
<td>24,000+</td>
</tr>
<tr>
<td>Metal Halide**</td>
<td>452 W</td>
<td>40,000</td>
<td>70%</td>
<td>65</td>
<td>65</td>
<td>20,000</td>
</tr>
</tbody>
</table>

**Strike time (minutes)**

<table>
<thead>
<tr>
<th></th>
<th>MV</th>
<th>LPS</th>
<th>HPS</th>
<th>MH Probe</th>
<th>MH Pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm up</td>
<td>4-7</td>
<td>7-15</td>
<td>1-4</td>
<td>2-15</td>
<td>1-4</td>
</tr>
<tr>
<td>Restrike</td>
<td>3-6</td>
<td>1</td>
<td>0.5-1</td>
<td>5-20</td>
<td>2-8</td>
</tr>
</tbody>
</table>
HID Metal Halide Ballasts (pulse start) that are greater than 150 watts, offer improved efficiency.

**High Intensity Discharge**

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Type</th>
<th>Eff.</th>
<th>Glass</th>
<th>Watts</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylvania Quicktronic®</td>
<td>E</td>
<td>94%</td>
<td>MH, CMH</td>
<td>200–350</td>
<td></td>
</tr>
<tr>
<td>GE UltraMax®</td>
<td>E</td>
<td>93%</td>
<td>MH, CMH</td>
<td>250–400</td>
<td>Dims to 50%</td>
</tr>
<tr>
<td>Philips PS XEE</td>
<td>M</td>
<td>90%</td>
<td>MH</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Metrolight SmartHID®</td>
<td>E</td>
<td>&gt;90%</td>
<td>MH</td>
<td>175–450</td>
<td>HPS, Remote 50'</td>
</tr>
</tbody>
</table>

Source: Metrolight Ltd.

Low frequency square wave reduces lamp wear and tear.
Linear fluorescents are a good replacement for probe-start metal halide fixtures

**Metal Halide (MH) versus Fluorescent for High-bay**

- **EISA2007 imparts higher performance standards for Probe Start MH fixtures**
- **Probe start (PS) MH with low lumen maintenance (<65%) is best target for replacement.**
  - Lumen maintenance of fluorescents (90 to 95 percent)
- **Comparison**
  - One PS MH with 20,000 EOL lumens at 320 system watts
  - Six F32T8 with 18,000 EOL lumens at 220 system watts
- **High-temperature T5HO available.**
  - Holophane IntelliBay™ & IntelliVue™
  - Lithonia I-BEAM™ System
  - Amalgam mercury alloy
Induction lamps offer long life and cold temperature performance for a price

**Induction (Electrodeless) Lighting**

- **High-frequency magnetron microwave power generator, magnetic field coupling device (antenna), and phosphor coated tube**
- **Up to 100,000 hour rated lamp life**
  - Lumen maintenance 70% at 60,000 hours
  - Efficacy of 70 to 75 lumens per watt
- **Best applications have high labor cost**
  - Parking garages
  - Cold-storage rooms
  - Inaccessible roadway tunnels and underpasses
  - Illumination of roadway signs and inaccessible advertisement boards
  - Lighting over stairs or escalator wells
  - Open mall atriums or ceilings in "big box" retail areas
  - Pole-mounted luminaires for dusk-to-dawn
  - Industry, petrochemical, and offshore applications

Source: Osram Sylvania Icetron™

Source: Osram DURA-ONE
CALiPER testing found High-Bay LED products offer a narrow light beam pattern, suspect life claims and overall efficacy that still lags behind that of fluorescent lamps.
Radio Frequency Lighting offers longer life and lower dimming levels

**Radio Frequency Lighting**

- **Luxim LiFi™ or Light Emitting Plasma™ (LEP)**
  - An ac/dc converter generates an RF signal that is transmitted by a special cable to a quartz lamp embedded in a dielectric material

- **Pemco Lighting Products STA-41-01 luminaire**
  - 273/450 system watts
  - 23,000/45,000 initial lumens
  - 5,500K CCT/80 CRI
  - 50,000 hour rated life
  - Dimmable to 20 percent

Source: Luxim
Equivalent LED street lighting with reduced lumens but higher light quality and longer life

**HID Replacement Summary**

- **Lumen maintenance higher for LEDs versus HID lighting**
  - Minimum illuminance levels equal to HPS (perceived as better)
  - LEDs are *Dark Skies* compliant

- **Color rendering and uniformity for LEDs are better than HPS**
  - Minimum illuminance levels equal to HPS (perceived as better)
  - LEDs are *Dark Skies* compliant

- **Simple payback of 3 to 10 years minimum**
  - Capital cost of $850 for LED versus $250 for HPS or CMH cobra head.
  - Energy savings of 30 to 50 percent

*Data Source: EERE*
Compare LED lighting at 60 percent of the HPS lumen output

**HID Replacements**

Before (HPS)  
After (LED)  

Source: Progress Energy

<table>
<thead>
<tr>
<th>Type (tested)</th>
<th>Watts</th>
<th>Lumens</th>
<th>LPW</th>
<th>CCT (K)</th>
<th>CRI</th>
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</thead>
<tbody>
<tr>
<td>LED</td>
<td>44</td>
<td>3,994</td>
<td>90</td>
<td>4,947</td>
<td>66</td>
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<tr>
<td>HPS</td>
<td>117</td>
<td>6,540</td>
<td>56</td>
<td>2,042</td>
<td>21</td>
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<tr>
<td>Induction</td>
<td>67</td>
<td>3,960</td>
<td>59</td>
<td>3,906</td>
<td>75</td>
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</tbody>
</table>

Source: Round 11, CALiPER
Better light quality compensates for decreased lumen output

**HID Replacements**

Before (HPS)  
Source: Progress Energy  

After (LED)  
Source: Everlast Biolume

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<tbody>
<tr>
<td>LED</td>
<td>86</td>
<td>6,765</td>
<td>79</td>
<td>6,000</td>
<td>75</td>
</tr>
<tr>
<td>HPS</td>
<td>120</td>
<td>11,400</td>
<td>95</td>
<td>2,042</td>
<td>21</td>
</tr>
</tbody>
</table>
Turning off or dimming lights is a great way to further reduce energy consumption

**Occupancy Sensors**

- Ultrasonic, infrared, dual or high-bay
- Ideal when combined with ballast retrofits
- Ideal for classrooms, copy rooms, break rooms, hallways - anywhere with intermittent occupancy
- $30 to $150 cost plus installation
- Two-year payback is normal
- Vacancy sensors are a new technology that requires manual turn-on but shut-off when no movement is detected
  - Ideal for conference rooms
Daylight is free, but you have to know how to use it

**Lighting Controls**

- **Daylight is BIG!**
  - Foot-candles varies by 2X between summer and winter
  - Diffuse most of it
    - -- 5 to 10 percent direct sunlight maximum
  - Do not try to match daylight to electric light (confuses people)
  - About 3 to 4 percent of roof area is optimal
  - Photosensor layout is important

- **LightLouver™ Daylighting System**
  - Mini-light shelves
  - Redirects sunlight onto the ceiling from overhead windows
  - Creates an ambient source of natural light that reaches deep inside the building
Incandescents are easy to dim; HID dimming is also possible

**Dimming**

- A solid-state dimmer works by using silicon-controlled rectifiers (SCRs)
- Radio frequency interference (RFI) can be a problem
- Greatly increases bulb life for incandescent/halogen bulbs
  - Requires special dimming ballast for fluorescents
    - 3-wire, 2-wire, or 4-wire
    - Energy savings fairly linear with fluorescents.
    - Continuous or bi-level dimming
- **HID lighting limited to 50 to 60 percent dimming**
  - Two-level for magnetic ballasts (non-linear energy savings)
  - Continuous for electronic ballasts (energy savings linear)
  - Lamp life degrades if dimming to less than 60 percent level
Check with the LED lamp manufacturer for compatibility with your existing dimming system

**LED Dimming**

- **Bulbs and Lamps**
  - Silicon Controlled Rectifiers (SCR)
- **Solid State LEDs**
  - Pulse Width Modulated (PWM)
  - Constant Current Reduction (CCR)
The DOE offers retail stores a great tool for lighting design

**DOE Commercial Lighting Solutions Tool**

- All commercial building types
  - Retail
    - Sales Area - Retail
- Optional control strategies
  - Manual Dimming
  - Demand Response
  - Multilevel Switching
  - Daylight Harvesting
  - Scheduling
- Energy savings bar displays percentage savings below baseline
The best lighting technology will not perform without regular maintenance

9 Components of a Good Lighting Maintenance Program*

1. Group relamping
2. Know your equipment
3. Focusing and adjustment
4. Verify lamp types and wattage
5. Verify color temperature
6. Confirm that everything is in working order
7. Watch for compatibility issues
8. Get rid of dirt
9. Do not forget exterior lighting

*"Everything You Need to Know About Maintaining Your Lighting System," by Jean Sundin, founder of Office for Visual Interaction, Inc.
You can save dollars by replacing lamps before end of life

**Lighting Maintenance**

- **Group relamping recommended at 60 to 80 percent of rated life**
  - Every 3 to 4 years for 30,000 hour fluorescents
  - Can be 30% to 40% cheaper to group relamp due to labor savings
  - Easier to schedule and outsource than spot relamping
  - Reduces improper mixing of different types of lamps
  - Normally done outside working hours

- **Lighting Failure Modes**
  - Heat
  - Voltage transients
  - Vibration
  - Bad electrical connection
  - Improper cycling
Identify lighting savings opportunities for your business by contacting FPL for a Business Energy Evaluation

Next Steps

- **Business Energy Evaluation**
  - Look at your energy profile and identify key focus areas
  - Call 1-877-748-4BEE or contact your FPL account manager if you have one

- **FPL Business Lighting Program**