Lighting - Past, Present and Future

Yazi Fletcher, LC MIES
Vice President Engineering
Phoenix Products Company
Lamp Technology Update

- Incandescent
- Fluorescent
- HID
- Ballast
- LED
- Lighting controls
- New Sources – Plasma etc
Exterior Factors

- RoHS (Restriction of Hazardous Substances)
- EISA (Energy Independence & Security act 2007)
- IDA (International Dark-Sky Association)
- MLO (Municipal Lighting Ordinance)
- LEED (Leadership In Energy and Environmental Design)
- USGBC (U.S. Green Building Council)
- EPAct (Energy Policy Act)
Exterior Influences

Energy/ Material/ Economic Crisis
Global Desire to “Go Green”
Cost of a Barrel of Oil
<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Efficiency</th>
<th>Lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>17 LPW</td>
<td>2K hrs</td>
</tr>
<tr>
<td>Halogen</td>
<td>15-24 LPW</td>
<td>2K hrs</td>
</tr>
<tr>
<td>Compact Fluorescent</td>
<td>40-60 LPW</td>
<td>12K hrs</td>
</tr>
<tr>
<td>Induction</td>
<td>&gt;60 LPW</td>
<td>120K hrs</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>80-90 LPW</td>
<td>30K hrs</td>
</tr>
<tr>
<td>Metal Halide</td>
<td>100-120 LPW</td>
<td>20-30K hrs</td>
</tr>
<tr>
<td>LED</td>
<td>&gt;99 LPW</td>
<td>50K-100K hrs</td>
</tr>
<tr>
<td>High Pressure Sodium</td>
<td>110 LPW</td>
<td>18K hrs</td>
</tr>
<tr>
<td>Plasma</td>
<td>120 LPW</td>
<td>20K hrs</td>
</tr>
<tr>
<td>Low Pressure Sodium</td>
<td>140 LPW</td>
<td>16K hrs</td>
</tr>
</tbody>
</table>
Where it all started.....

Sir Joseph Swan

Thomas Edison
Incandescent Lamps

**Goodbye old “A” lamps**
Will be banned in Europe, Australia and USA etc

**New incandescent A lamp**
Efforts to design better halogen lamps
No mercury, recyclable
30-50% better performance than standard incandescent
Meets 2009 EISA
Fully dimmable
Same shapes and 100% CRI

PHOENIX® Durability by Design
Also goodbye to……

- Mercury lamps and ballasts
- Probe start metal halide 150-500w
- T12 Fluorescent  July 2010
Fluorescent lamps

Reduced Wattage T8 Lamps

New 25w replacement of old 32w = Energy Savings
At 30°C the 25w performs better than 32w
Fluorescent Lamps

VHO - Very High Output

Designed for unconditioned areas
High bay lighting T5 and T8
Lumen output >90% in 10°C -70°C
Fluorescent Lamps

Fluorescent Ballast Technology

- High efficiency electronic ballasts (<W, >LPW)
- Higher case temperatures 90°C
- Universal ballasts 120-277V
- Multiple lamp types and quantities
- Bi-level switching
- Occupancy sensors (without loss of lamp life)
- Load shedding
- Dimming 100%-1%
HID Lamps

No More Mercury
January 2008 ballasts can no longer be manufactured or imported

No More Probe Start
EISA
150w-500w no probe start and efficiency >88%
Nationally January 1, 2009
HID Lamps

**Pulse Start Technology**
- Higher wattage and greater acceptance
- More universal lamps

**Ballasts**
- Dimming
- Square wave
- High frequency >150w
HID Lamps

**Low Wattage Metal Halide**

- Up to 90 CRI
- 20w-70w
- 3K-5K (less color shift)
- Better red
- Long life
- Cosmo (street lighting)
Light color mixing is an *additive* system.

Pigment color mixing is a *subtractive* system.
LED’s

Optics/reflectors needed to control LED light distribution
LED’s

**High Flux**
Modular systems
Better binning
Heat management
Realistic life
Relative lower cost

**Total Cost Per Lumen**
LED $0.022, Fl $0.0008, Inc $0.0005
LEDs...Cool
LED’s

82% of lighting energy is lost as heat.
Why LED’s

- 100,000hrs depends on environment
- One of the most efficient light sources
- LED’s will save money? (Possibly)
- LED’s are not like other sources (suitable for unique environments, color changing, smaller fixtures and long life at a price)
- If properly designed great for harsh areas such as vibration.
- No mercury or Environmental disposal problems
LED – What to ask………

- Is the manufacturer using a reputable LED company?
- What operating temperature is the fixture designed for?
- Is the LED fixture tested to LM-79 photometric testing by a 3rd party laboratory?
LED – What to ask........

- Is the fixture tested to IESNA LM-80?
  - Measure of lumen maintenance
  - Fixture compared to L70 lifetime curve
  - Maximum Tj at various and worst-case ambient temperatures

- What is the fixture’s actual power factor? Does it consume power during “off” periods.
LED – What to ask……

- What is the fixtures actual delivered lumens and lumens per watt (LPW)?
- Does the fixture meet DOE energy star guidelines?
- What is the product warranty and can the supplier stand behind it?
LED – What to ask

- Are replacement parts available?
- Is the fixture designed and tested for the environment it is going in?
- Has the fixture been tested by the DOE CALiPER program?
Upcoming Light Sources

Induction: >60 LPW, 120,000 hrs, replace components

Plasma: Not yet proven, appears good on paper

Nano technology – Quantum dots

OLEDs – Organic LEDS
Working to improve mining efficiency?
LED Installation Examples
Mosaic Phosphate Mine

Before

After

PHOENIX® Durability by Design
How do we see colors?
Bringing out the Blue via light color mixing an additive system
Mosaic Phosphate Mine
"FRONT" FIXTURES AT 250W

Phoenix Products Company, Inc.

6731 W. Port Avenue
Milwaukee, WI 53224
Voice Number: (414) 773-3969
email: cghamblin@phoenixproducts.com

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PHOENIX® Durability by Design
Shovel
Crusher/Conveyor
Beyond Lighting

How do we see?
IS 1000 Thermal Imaging

Near Infrared (active)

Long Wave Infrared (passive)
Good image quality is maintained over a wide range of environments.
IS1000 Thermal Imaging
Thank you