Comparison of Traditional Street Lighting Technologies and LED

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Representing

Our Experience

• 5th Street Pedestrian Crossing – Rapid City, SD
• Brandon Street Lighting – Brandon, SD
• Central City Streetscape – Central City, IA
• Center Street Lighting – Madison, SD
• Brookings Downtown Streetscape – Brookings, SD
• Brown Deer/Fast Avenue Lighting – Coralville, IA
• Cedar Rapids Streetscape Lighting – Cedar Rapids, IA
• Center & Wocott Street Lighting – Casper, WY
• Coralville Aquatic Center Lot Lighting – Coralville, IA
• Downtown Streetscape – Sheridan, WY
• Ellis Crossing Street Lighting Phase II – Rapid City, SD
• Hartford Street Lighting – Hartford, SD
• Harlan Boulevard Street Lighting – Harlan, WY
• Holly Boulevard Street Lighting – Brandon, SD
• Iowa City Gilbert Street Lighting – Iowa City, IA
• Laramie Downtown Street Lighting – Laramie, WY
• Liberty Boulevard Street Lighting – Box Elder, SD
• Lincoln High School Parking Lot Lighting – Sioux Falls, SD

• Marion North 35th Street Extension – Marion, IA
• Melgaard Road Street Lighting – Aberdeen, SD
• Mobridge Street Lighting – Mobridge, SD
• Memorial Park Promenade Lighting – Rapid City, SD
• Moon Meadows & Hwy 16 Intersection Street Lighting – Rapid City, SD
• North Street Extension – Rapid City, SD
• Orchard Meadows & Hwy 14 Intersection Signal Design – Rapid City, SD
• Rock Bluff Parking Lot Lighting – Spearfish, SD
• Roosevelt Street Lighting – Aberdeen, SD
• Roosevelt High School Parking Lot Lighting – Sioux Falls, SD
• Salem Street Lighting Replacement – Salem, SD
• Seger Drive Reconstruction – Rapid City, SD
• Spirit Lake Highway Street Lighting – Spirit Lake, IA
• Spirit Lake Residential Street Lighting – Spirit Lake, IA
• Springville Street Lighting – Springville, IA
• UNI 22nd Street Lighting – Cedar Falls, IA
• UNI Missouri Street Lighting – Cedar Falls, IA
• Washington High School Parking Lot Lighting – Sioux Falls, SD
• Waterloo Street Lighting – Waterloo, SD
• Wells Fargo 39th and 42nd Street Remodels – Cedar Rapids, IA
• West Chicago Street Reconstruction – Rapid City, SD
• Williston 42nd Street & 15th Avenue – Williston, ND
A comparison of Traditional Street Lighting Technologies and LED

- Terminology
- Street Light Fixture Components
- Correlated Color Temperature – CCT
- Light Sources
- LED Street Lighting
- Photopic/Scotopic/Mesopic Vision
- Street Lighting Design
- Q&A

Common Lighting Terms

- Watts
- Correlated Color Temperature – CCT
- Color Rendering Index – CRI
Common Lighting Terms

- Average Rated Life
- Lumens
- Efficacy
- Illuminance
- Foot-candle and Lux

Common Lighting Terms

- BUG Rating-Backlight – Uplight – Glare
Correlated Color Temperature

- **Appearance**
  - 2700K-3000K “Warm”
  - 6500K “Daylight” Lamping Terminology
  - 14,000K Actual Daylight on a Cloudless day

- **Impact**
  - Color intensity and purity to visual feedback.

- **Preferences – Recommendations**
  - Application dependent - street lighting 4000-5000K typically

Street Light Fixture Components

- **POLE**
- **LAMP OR LIGHT SOURCE**
- **REFLECTOR**
- **LENS OR OPTICS**
- **BALLAST OR DRIVER**
- **LED**
- **LED ARRAY**
- **DRIVER**
- **HEATSINK**
- **MOTION SENSOR**
Light Sources

- **Mercury Vapor (MV)**
  - **Characteristics**
    - 75-1000 Watt lamps
    - CCT 4000K-5900K
    - CRI 20-45
    - Average Rated Life 16,000-24,000 hrs
    - 25-60 Lumens/Watt
  - **Advantages**
    - Long life
    - Good CRI as compared to high pressure sodium
  - **Disadvantages**
    - Disposal of Mercury when replaced
    - Green Skin Tones
    - Poor Light for Photography
    - Requires Warm-up Times up to 10 minutes
    - Obsolete due to government mandates for efficiency

- **High Pressure Sodium (HPS)**
  - **Characteristics**
    - 50-1000 Watt lamps
    - CCT 1900K-2100K
    - CRI 20-30
    - Average Rated Life 16,000-24,000 hrs
    - 40-140 Lumens/Watt
  - **Advantages**
    - Good Efficiency
    - Smaller Lamp Size than MV
    - Can be used to retrofit MV
  - **Disadvantages**
    - Poor Color Rendering Index
    - Require 3-4 minutes warm-up time
    - Inefficient Ballasts Reducing overall efficiency of the light fixture
    - Yellow light
    - Restrike limitations
    - On-off-on cycling at end of life
Light Sources

- Metal Halide (MH)
  - Characteristics
    - 20-1500 Watt lamps
    - CCT 3000K-20,000K (depending on Halide type)
    - CRI 60-90
    - Average Rated Life 3,000 - 20,000 hrs
  - Advantages
    - Better Efficiency 65-115 Lumens/Watt
    - Longer Life than MV
  - Disadvantages
    - Blue Color
    - Lamp orientation must match installation – horizontal vs. vertical
    - More expensive to product than HPS and MV
    - More Light Pollution
    - Warm up times up to 10 minutes
    - Restrike limitations

- Light Emitting Diodes (LED)
  - Characteristics
    - 0.01-3 Watt lamps
    - CCT 2540K-10,000K
    - CRI 70-90+
    - Average Rated Life 25,000 - 100,000 hrs
  - Advantages
    - Most energy efficient
    - Durable and Shock and Vibration Resistant
    - Directional Nature
    - Wide Variety of Colors
    - Controllable and Dimmable
    - Instant on
  - Disadvantages
    - Heat Sensitive
    - More expensive to product than traditional light sources
    - More advanced technology so more opportunity for failure
Comparison of Light Sources

<table>
<thead>
<tr>
<th>Wattages</th>
<th>Mercury Vapor</th>
<th>High Pressure Sodium</th>
<th>Metal Halide</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-1000</td>
<td>35-1000</td>
<td>20-1000</td>
<td>0.01-3/LED</td>
<td></td>
</tr>
<tr>
<td>CCT</td>
<td>4000K-5900K</td>
<td>1900K-2800K</td>
<td>3000K-20,000K</td>
<td>2540K-10,000K</td>
</tr>
<tr>
<td>CRI</td>
<td>20-45</td>
<td>20-80</td>
<td>60-90</td>
<td>70-90+</td>
</tr>
<tr>
<td>Average Rated Life (hrs)</td>
<td>16,000-24,000</td>
<td>10,000-24,000</td>
<td>3,000-20,000</td>
<td>25,000-100,000</td>
</tr>
<tr>
<td>Lumens/Watt</td>
<td>25-60</td>
<td>40-140</td>
<td>65-115</td>
<td>28-150</td>
</tr>
<tr>
<td>Instant Full Power</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

LED Street Lighting

- Advantages over Traditional Light Sources
  - Less energy cost
  - Better control of light
  - Less maintenance costs
  - Improved light quality

- Disadvantages
  - More initial cost
  - Heat Sensitivity
LED Street Lighting

- Los Angeles is working on a city-wide conversion to LED

BEFORE
200W HPS (240 W)
FC: 4.31
Ave/Min: 2.40
Max/Min: 5.4

AFTER
180W LED (180W)
FC: 3.48
Ave/Min: 1.63
Max/Min: 2.67

BEFORE
150W HPS (190W)
FC: 1.46
Ave/Min: 6.63
Max/Min: 18.3

AFTER
72W LED (72W)
FC: 1.90
Ave/Min: 3.29
Max/Min: 7.44

Results

Statistics from the Los Angeles LED lighting upgrade.

- Convert 140,000 streetlights to LED over 4 years beginning in 2009.
- Energy savings was expected to be 40% - actual energy savings 63%.
- Maintenance Savings $2.5 million/year
- Less inventory costs for repair components.
- Failure rate of HID – 10% vs LED - 0.2%
- Decrease in crime rate of 10.5% during the hours of 7pm-7am over first 2 years.
Photopic/Scotopic/Mesopic Vision

Human vision is enabled by three primary modes:

- **Photopic vision**: Vision under well-lit conditions, which provides for color perception, and which functions primarily due to cone cells in the eye.
- **Scotopic vision**: Monochromatic vision in very low light, which functions primarily due to rod cells in the eye.
- **Mesopic vision**: A combination of photopic vision and scotopic vision in low lighting, which functions due to a combination of rod and cone cells in the eye.

<table>
<thead>
<tr>
<th>250W HPS</th>
<th>295W/head</th>
<th>16,800 Lumens</th>
<th>2100K</th>
</tr>
</thead>
<tbody>
<tr>
<td>137W LED</td>
<td>137W/head</td>
<td>10,191 Lumens</td>
<td>4500K</td>
</tr>
<tr>
<td>137W LED</td>
<td>Dimmed to 33W/head</td>
<td>3,934 Lumens</td>
<td>4500K</td>
</tr>
</tbody>
</table>
### Life Cycle Cost Comparison

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Watts</th>
<th>Cost (Install)</th>
<th>Lamp Life (Hours)</th>
<th>Cost to Re-lamp</th>
<th>Cost over Life (27 years)</th>
<th>Cost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>400W HPS Hubbell Roadway RL</td>
<td>465</td>
<td>$895</td>
<td>30,000</td>
<td>$180</td>
<td>$6014</td>
<td>$222.75</td>
</tr>
<tr>
<td>400W MH Hubbell Roadway RL</td>
<td>460</td>
<td>$920</td>
<td>20,000</td>
<td>$190</td>
<td>$6412</td>
<td>$237.48</td>
</tr>
<tr>
<td>140W LED Hubbell Roadway RL</td>
<td>140</td>
<td>$1000</td>
<td>70,000</td>
<td>??</td>
<td>($1000)</td>
<td>$123.13</td>
</tr>
<tr>
<td>140W LED Hubbell Roadway RL</td>
<td>140</td>
<td>$1000</td>
<td>120,000</td>
<td>0</td>
<td>$2324</td>
<td>$86.09</td>
</tr>
</tbody>
</table>

4380 hours of operation per year  
Energy Cost $.08/KWH  
Life span of 27 years was selected based on 120,000 hours LED

Typical warranties of traditional light fixtures: 1-5 years  
Typical warranties of LED light fixtures: 5-10 years

### Additional Terminology for LED Lighting

- **LM-79**
- **LM-80**
DOT Acceptance

- LEDs not currently used. HPS is the current standard.
  - No ASHTO standard
- Used when specifically requested.
  - The city pays for the additional cost.
- Designed with a 0.7 LLF
- DOT projects with LED
  - Philip
  - Beresford
  - Madison
  - Groton

Street Lighting Design
What the designer needs to know-

- New Systems
  - Function or Usage of the Project
  - Desired Lighting Levels & IESNA Recommendations
  - Light Trespass Concerns
  - Dark Sky Compliance Concerns
  - Accessories to be included in the project such as planter baskets, banner arms, etc.
  - Need for Traffic Signal lights
  - Desire for lighting controls such as photo cells, time clocks, motion sensors and dimming
  - Need for receptacles on bases and expected usage of receptacles
  - Decorative or more utilitarian poles and bases
  - Cameras or provisions for future cameras
  - Powered signage

- Retrofit
  - Function or Usage of the Project
  - Desired Lighting Levels & IESNA Recommendations
  - Light Trespass Concerns
  - Dark Sky Compliance Concerns
  - Accessories to be included in the project such as planter baskets, banner arms, etc.
  - Need for Traffic Signal lights
  - Desire for lighting controls such as photo cells, time clocks, motion sensors and dimming
  - Need for receptacles on bases and expected usage of receptacles
  - Cameras or provisions for future cameras
  - Powered signage
  - Existing Conditions
  - Reuse of poles and bases or replacement
  - Shortfalls of the existing system
  - Strengths of the existing system
Street Lighting Design
What the owner should expect

- **New Systems**
  - Layout of fixtures
  - Routing of conduit & wire
  - Sizing of wire
  - Location of power supply
  - Specifications for light fixtures, poles, bases and accessories
  - Details and wiring diagram as needed
  - That the designer has done light distribution calculations
  - The designer has done voltage drop calculations

- **Retrofit**
  - Demolition drawings
  - Layout of fixtures
  - Routing of conduit & wire
  - Sizing of wire
  - Specifications for light fixtures, poles, bases and accessories
  - Details and wiring diagrams as needed
  - That the designer has done light distribution calculations
  - The designer has done voltage drop calculations

Questions??
References