Energy Open House
Building a sustainable future for MSU
The Physical Plant is helping meet MSU’s Energy Transition Plan goals.

Energy-conscious lighting

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Lighting Systems 101
Important keys to lighting systems

• Foot candles-light measurement
• Lumens per watt—efficiency of lighting system
• Color temperature (k)—lamp
• Color rendering index (CRI)—lamp
• Fixture efficiency—light output
• Ballast factor-light output of ballast
• Lighting control—wide variety
Foot-candle

One foot-candle is equal to the amount of light provided by an ordinary wax candle on a spherical surface with an area equal to one square foot one foot away from the flame.
## Lumens/Watt

<table>
<thead>
<tr>
<th>Lamp type</th>
<th>Luminous efficacy (lumens/watt)</th>
<th>Luminous output (lumens)</th>
<th>Wattage</th>
<th>CCT&lt;sup&gt;(a)&lt;/sup&gt; (typical/dominant wavelength)</th>
<th>CRI&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED white package (cool)</td>
<td>132 lm/W</td>
<td>139 lm</td>
<td>1.05 W</td>
<td>6500 K</td>
<td>75</td>
<td>50k hours</td>
</tr>
<tr>
<td>LED white package (warm)</td>
<td>78 lm/W</td>
<td>87.4 lm</td>
<td>1.12 W</td>
<td>3150 K</td>
<td>80</td>
<td>50k hours</td>
</tr>
<tr>
<td>LED lamp (warm)</td>
<td>62 lm/W</td>
<td>650 lm</td>
<td>10.5 W</td>
<td>3000 K</td>
<td>92</td>
<td>50k hours</td>
</tr>
<tr>
<td>OLED panel</td>
<td>23 lm/W</td>
<td>15 lm</td>
<td>0.65 W</td>
<td>2800 K</td>
<td>75</td>
<td>5k hours</td>
</tr>
<tr>
<td><strong>HID&lt;sup&gt;(c)&lt;/sup&gt; (high watt) lamp system</strong></td>
<td>120 lm/W</td>
<td>37800 lm</td>
<td>315 W</td>
<td>3000 K</td>
<td>90</td>
<td>20k hours</td>
</tr>
<tr>
<td>Linear fluorescent lamp system</td>
<td>111 lm/W</td>
<td>2890 lm</td>
<td>26 W</td>
<td>4100 K</td>
<td>85</td>
<td>25k hours</td>
</tr>
<tr>
<td>HID (low watt) lamp system</td>
<td>104 lm/W</td>
<td>7300 lm</td>
<td>70 W</td>
<td>3000 K</td>
<td>90</td>
<td>12k hours</td>
</tr>
<tr>
<td>CFL</td>
<td>63 lm/W</td>
<td>950 lm</td>
<td>15 W</td>
<td>2700 K</td>
<td>82</td>
<td>12k hours</td>
</tr>
<tr>
<td>Halogen</td>
<td>20 lm/W</td>
<td>970 lm</td>
<td>48 W</td>
<td>2750 K</td>
<td>N/A</td>
<td>4k hours</td>
</tr>
<tr>
<td>Incandescent</td>
<td>15 lm/W</td>
<td>900 lm</td>
<td>60 W</td>
<td>3300 K</td>
<td>100</td>
<td>1k hours</td>
</tr>
</tbody>
</table>
Energy efficient lighting fixtures such as LED are provide twice the lumens per watt of electricity than legacy metal halide fixtures.
April 12, 2012

Cree sets new research and development performance record with 254 lumen-per-watt power LED
CRI in different lamps

**Color Rendering Index (CRI)**

- **Incandescent & Halogen**: 100
- **Triphosphor Fluorescent**: 85
- **Metal Halide**: 85
- **Fluorescent**: 70-50
- **Coated Mercury**: 49
- **High Pressure Sodium**: 24
- **Clear Mercury**: 17
- **Low Pressure Sodium**: 5

*MSU Physical Plant Division* *Energy Open House*
Color Rendering Index (CRI)

- **Warm White**
  - 3000k - 52 CRI
- **SPX 30**
  - 3000k - 82 CRI
- **SPX 65**
  - 6500k - 82 CRI
Lighting efficiency

PHOTOMETRICS

2EP3GX-232S28I
Electronic Ballast
F32T8/35K Lamps
3100 Lumens

Spacing criterion:
(II) 1.2 x mounting height,
(⊥) 1.5 x mounting height

Efficiency 69.7%

Test Report:
220P209
LER = FP-

Yearly Cost of 1000
lumens, 3000 hrs at
.08 KWH = $
Lighting control

- Occupancy motion sensing
  Infrared/ultrasonic/microphonic
- Wireless 0-10 volt control
- Daylight harvesting
- Step-down dimming
- Central control automation
- Astronomical time clocks
Ballast factor

Rated Lumens: 3000
Ballast Factor: 0.79
Actual Lumens: 2370
Ballast factor

Rated Lumens: 3000
Ballast Factor: 1.15
Actual Lumens: 3450
<table>
<thead>
<tr>
<th>Color Temperature</th>
<th>Avg Rated Life</th>
<th>Maintained Lumens/Watt</th>
<th>Contains Mercury</th>
<th>Visual Flicker</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>Neutral</td>
<td>50,000 HOURS</td>
<td>60</td>
<td>NO</td>
</tr>
<tr>
<td>CFL</td>
<td>Cool</td>
<td>20,000 HOURS</td>
<td>50</td>
<td>YES</td>
</tr>
<tr>
<td>Inc</td>
<td>Warm</td>
<td>2,000 HOURS</td>
<td>10</td>
<td>NO</td>
</tr>
</tbody>
</table>
Lighting systems upgrade 2011

• T-9 ceramic metal halide
• Induction fluorescents
• Occupancy motion sensors
• Daylight harvesting
• Central Control automation
• LED recessed lighting
2011 Consumers Energy incentives lighting projects

- IM East
- IM West
- Spartan Stadium
- Jenison Field House
- AG Livestock Pavilion
- Biomedical Physical Science
- Crop Science Field Lab
2011 Consumers Energy Incentive Projects- Savings/Payback

- Total annual kWh savings = 871,206
- Total light fixtures controlled = 2300
- Total money saved per year = $78,408
- Total cost for lighting projects = $528,198
- Consumers incentive = $74,344
- Payback on investment = 5.8 years
Invest today, less coal tomorrow

We will continue to use the most advance lighting technologies in the industries to reduce our lighting demand. MSU is focusing to become one of the most energy-efficient universities today and tomorrow.
Radiology Patient Entrance
Questions?
Thank you!