SSL Pricing and Efficacy Trend Analysis for Utility Program Planning

Northwest Power and Conservation Council
Conservation Resources Advisory Committee meeting
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Background

• April 2012 TINSSL Utility Planning Roundtable
  ▪ Roadmap needed to forecast when important SSL product applications will become cost-effective, looking 2-3 years out
  ▪ Price and performance projections
    ➢ Provide time for planning
    ➢ Enable prioritization by application or product category
    ➢ Inform delivery and education approaches
    ➢ Allow estimation of energy savings potential and appropriate incentive levels to overcome price barriers
  ▪ DOE viewed as a credible source of such data for regulatory review
Background

• October 2013 report
  ▪ Informed by additional input from Advisory Task Force
    ➢ Appropriate type/timing/magnitude of energy efficiency activities will vary from organization to organization
    ➢ Price is a primary barrier
  ▪ Focused on category-specific projections of pricing and efficacy
    ➢ Cost-effectiveness beyond scope
  ▪ Historical data from
    ➢ CALiPER
    ➢ LED Lighting Facts (LF)
    ➢ ENERGY STAR (ES)
    ➢ DesignLights Consortium (DLC)
  ▪ To serve as a starting point...
## LED market penetration and savings potential in key categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Savings potential in 2012 (TWh)</th>
<th>Penetration in 2012 (%)</th>
<th>Installed base in 2012 (million units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troffers et al.</td>
<td>110.4</td>
<td>&lt; 0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>A lamps</td>
<td>79.1</td>
<td>&lt; 1</td>
<td>19.9</td>
</tr>
<tr>
<td>High-bay luminaires</td>
<td>46.5</td>
<td>&lt; 1</td>
<td>0.3</td>
</tr>
<tr>
<td>Decorative lamps</td>
<td>28.7</td>
<td>&lt; 1</td>
<td>4.7</td>
</tr>
<tr>
<td>Downlights</td>
<td>26.8</td>
<td>&lt; 1</td>
<td>5.5</td>
</tr>
<tr>
<td>Parking lot luminaires</td>
<td>20.4</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Parking garage luminaires</td>
<td>15.3</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Streetlight luminaires</td>
<td>22.9</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Directional lamps (PAR, BR, R)</td>
<td>16.7</td>
<td>4.6</td>
<td>11.4</td>
</tr>
<tr>
<td>MR16 lamps</td>
<td>6.2</td>
<td>10</td>
<td>4.8</td>
</tr>
</tbody>
</table>

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*Adoption of Light-Emitting Diodes in Common Lighting Applications (April 2013)*

[www.ssl.energy.gov/tech_reports.html](http://www.ssl.energy.gov/tech_reports.html)
LED efficacy trends: Omnidirectional lamps

**Graph Description**
- **Data Points and Trends:**
  - LF A lamp
  - Modeled avg. LF A lamp
  - CALiPER A lamp
  - Modeled avg. CALiPER A lamp
  - ES A lamp
  - Modeled avg. ES A lamp
- **Notations:**
  - + Current criterion and date effective for ES omni. lamps < 10 W
  - × New criterion and date effective for ES omni. lamps < 15 W
- **Regression Lines:**
  - $y = 72.82 \ln(x) - 116.30$
  - $R^2 = 0.21$
  - $y = 46.36 \ln(x) - 60.05$
  - $R^2 = 0.29$
  - $y = 14.63 \ln(x) + 28.27$
  - $R^2 = 0.00$
LED efficacy trends: Directional lamps (PAR-BR-R)
LED efficacy trends: Troffer luminaires

![Graph showing LED efficacy trends for troffer luminaires. The graph compares various types of troffer luminaires, including modeled average and Caliper troffer luminaires, and includes data points for high and low performance. The graph also highlights the trend lines and labels for different criteria and target luminaires.]

- **LF troffer luminaire**
- **Modeled avg. LF troffer luminaire**
- **CALiPER troffer luminaire**
- **Modeled avg. CALiPER troffer luminaire**
- **DLC troffer luminaire**
- **Modeled avg. DLC troffer luminaire**
- **Old criterion and date effective for DLC 2x2 troffers**
- **Current criterion and date effective for DLC 2x2 troffers**
- **MYPP luminaire target for 2017**

Equations:

- \( y = 108.16 \ln(x) - 187.19 \)
  \( R^2 = 0.57 \)

- \( y = 112.13 \ln(x) - 201.01 \)
  \( R^2 = 0.15 \)

- \( R^2 = 0.01 \)
LED efficacy trends: Streetlight luminaires

![Graph showing LED efficacy trends for streetlight luminaires. The graph includes data points and lines representing different luminaire types and criteria, along with their respective models and R-squared values.](image)

- LF street/area luminaire
- Modeled avg. LF street/area luminaire
- DLC street/area luminaire
- Modeled avg. DLC street/area luminaire
- Old DLC area/roadway criterion and date effective
- Current DLC area/roadway criterion and date effective
- MYPP luminaire target for 2017

Equations and R-squared values:

1. \( y = 83.37 \ln(x) - 134.04 \)
   \[ R^2 = 0.19 \]

2. \( y = 66.27 \ln(x) - 91.87 \)
   \[ R^2 = 0.15 \]
LED pricing trends

• Scoured CALiPER data for product categories meeting criteria
  ▪ Substantial number of models for which purchase date, purchase price, and measured lumens could be determined
    ➢ Rated life was not considered in this analysis
  ▪ Purchases dispersed fairly well over time
  ▪ Substantial span between oldest and most recent

• CALiPER datasets meeting criteria
  ▪ Omnidirectional lamps
  ▪ Decorative lamps
  ▪ Directional lamps (PAR-BR-R and MR16)
  ▪ Troffer luminaires

• Supplemented by Seattle City Light (SCL) streetlight luminaires

• Projections using least-squares regression fits to power mathematical models based on historical product data
LED pricing trends: Omnidirectional lamps

![Graph showing LED pricing trends with key points and regression line. The R² value is 0.43.]

- MYPP luminaire target for 2017
- CALiPER LED A lamps
- CALiPER LED A lamps (power model)
- 95% confidence band for predicted avg.
LED pricing trends: Directional lamps (PAR-BR-R)
LED pricing trends: Troffer luminaires
LED pricing trends: Streetlight luminaires
LED pricing trends—normalized to January 1, 2008
LED pricing trends—normalized to October 1, 2013
LED pricing trends: Example projection

• September 2013 LED directional lamp pricing from major retailers
  ▪ Ace Hardware, Best Buy, The Home Depot, Lowe’s, Sears, True Value
    ➢ No adjustment for possible upstream incentives
  ▪ Cree, EcoSmart, Feit, GE, Insignia, LSGC, Philips, Samsung, Sylvania, Utilitech, and TCP
  ▪ CCT of 2700-3000 K
  ▪ CRI and ENERGY STAR certification not consistently indicated
  ▪ Strong relationship between price and output—and diameter
    ➢ Similar relationship observed for omnidirectional and decorative
LED pricing trends: Example projection
LED pricing trends: Example projection

<table>
<thead>
<tr>
<th>Brand</th>
<th>&lt; 3” diameter</th>
<th>&gt; 3” diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest pricing ($/klm)</td>
<td>Efficacy (lm/W)</td>
</tr>
<tr>
<td>A</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>B</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>C</td>
<td>69</td>
<td>57</td>
</tr>
<tr>
<td>D</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>49</td>
<td>56</td>
</tr>
<tr>
<td>F</td>
<td>57</td>
<td>67</td>
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<tr>
<td>G</td>
<td>*</td>
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<td>H</td>
<td>50</td>
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<td>I</td>
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<td>J</td>
<td>46</td>
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<td>K</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>L</td>
<td>56</td>
<td>49</td>
</tr>
<tr>
<td>Mean</td>
<td>50</td>
<td>56</td>
</tr>
</tbody>
</table>

* No model available for this brand at these retailers.
LED pricing trends: Example projection

- Applied current values to normalized lamp curve for projections

<table>
<thead>
<tr>
<th>Lamp diameter</th>
<th>$/klm pricing at beginning of year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
</tr>
<tr>
<td>&lt; 3 inch</td>
<td>47</td>
</tr>
<tr>
<td>&gt; 3 inch</td>
<td>28</td>
</tr>
</tbody>
</table>
Key findings

- Projected average efficacies are below 2017 targets, but leading products might still reach these goals on or ahead of schedule.
- In several key LED product categories, projected efficacies based on LED Lighting Facts listings are substantially higher than projections based on the corresponding ENERGY STAR or DLC listings.
- Historical data indicates two distinct normalized curves—one for LED lamps, and one for LED luminaires—can be used to make projections from current $/klm pricing for a given product category.
- LED lamp $/klm pricing is expected to decrease roughly 55% by 2017, relative to current pricing—a more modest decrease of 30% is projected for LED luminaires over this same period.
End of slides

Thank you!