Prospects for Residential Lighting Programs in Light of Federal Lamp Standards

Chris Calwell
Senior Research Fellow and Founder

November 10, 2009
SWEEP Conference
Lighting Remains One of the Biggest Pieces of Residential Electricity Use

So if lighting is 16% of residential electricity use, why is it 30 to 80% of total energy savings in many utilities’ efficiency programs?

• very cheap savings
• everybody needs light bulbs
• CFLs are an iconic symbol of efficiency
Our Perspective Comes from 12 Years of Working on the Front Lines of Light Bulb Policy & Program Development Around the World

- Designed and implemented manufacturer buydown CFL programs for tens of millions of CFLs & hundreds of utilities (1997 to 2009)
- Supported PG&E advocacy of world’s first incandescent lamp standards - CEC Tier 1 and 2 (2003 to 2006)
- Addressed International Energy Agency meeting in Paris on the prospects of global phaseout of conventional incandescent lamps (March 2007)
- Supported NRDC & PG&E in U.S. legislative negotiations for EISA (2007)
- Assisted Australian counterparts during their parallel stds effort (2007)
- Supported NRCan in development of Canada’s standards (2007 to 2008)
- Supported UK government and eceee with EU lamp stds (2008 to 2009)
- Assisted NRDC in its FTC advocacy for better mandatory federal light bulb labeling of energy efficiency (summer 2008 to present)
- Assisted PG&E in its advocacy for DOE reflector lamp stds (2009)
- Addressed ENERGY STAR Partner Meeting (March 2009) & ACEEE conference (October 2009) on post-EISA lighting program approaches
- Addressed conference in Dehli, India on national incandescent lamp phaseout (April 2009)
Is the Residential Lighting Market Already Transformed?

Word on the street:
Utilities have done enough CFL promotions to transform the market +
Federal standards take care of the rest: Congress bans incandescent lamps after 2012 in the Energy Independence & Security Act (EISA) =
Mission Accomplished!

Reality:
- CFL socket share still low
- Many utilities still in early stages of CFL promotion
- EISA is weaker, slower, and less comprehensive than most people think; incandescents will be with us for many years to come

Image source: www.lighterfootstep.com
Remember Where We Started? Typical CFLs from the 1990s
1999: A Mid-Course Correction
<table>
<thead>
<tr>
<th>1999 Recommendation</th>
<th>2009 Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make new construction a priority</td>
<td>Title 24 &amp; ENERGY STAR homes include efficient lights</td>
</tr>
<tr>
<td>Use common specifications and improve them over time</td>
<td>ENERGY STAR has improved test procedure, updates spec more frequently; greatly increased sales</td>
</tr>
<tr>
<td>Develop a testing program for residential lighting products and act decisively on its findings</td>
<td>PEARL established, but has only tested 130 of the thousands of CFL models sold; some products delisted, test data not released to public</td>
</tr>
<tr>
<td>Target untapped regions of the country</td>
<td>Major CFL programs now in SW; small programs in SE</td>
</tr>
<tr>
<td>Research and pilot-test promising emerging technologies (white LEDs, better incandescent technologies)</td>
<td>DOE heavily supporting LED research and giving small support to incandescent research; EPA encouraging universal CFL ballasts and bases</td>
</tr>
<tr>
<td>Change consumer preferences</td>
<td>Change a Light; EISA; FTC lamp label changes</td>
</tr>
<tr>
<td>Design multi-year utility programs around the lighting season</td>
<td>Utility programs now synchronized with lighting sales cycle and sales territories</td>
</tr>
<tr>
<td>Leverage retailer and manufacturer capabilities</td>
<td>Less reliance on bill stuffers; better point of purchase materials; wide use of manufacturer buy-downs</td>
</tr>
<tr>
<td>Target specific product categories &amp; markets (dimmable/sub/reflector CFLs)</td>
<td>PNNL effort on sub-CFLs a big success, now dominant lamp type; dimmable/reflector CFLs still struggling</td>
</tr>
</tbody>
</table>
Signs of Progress – New CFLs Smaller *and* Brighter
CFLs and Incandescents Cheaper than They’ve Ever Been

$1.34 apiece (8,000 hours)  $0.22 apiece (1,000 hours)

Still about 12.5 billion incandescents sold worldwide each year and only 2.5 billion CFLs. Nearly ¾ of the light bulbs installed worldwide are still incandescents.
Products Better & Cheaper, But Market is Not Transformed; Only 10-15% Socket Saturation Nationally by 2007

- Highest CFL saturation in West, upper Midwest, and New England (roughly 6-7 CFLs per home)
- The leading utilities had managed about 10-12 per home.
- US average was 4.4 CFLs per home
- With 40-50 sockets in the average home, we still have a long way to go.

A Little More Progress by 2009, But We Have Still Captured Only a Fraction of CFLs’ Savings Potential

Sources: California - “Residential Lighting Metering Study – Preliminary Results,” KEMA, February 2009
National – D&R International. (slide by Steve Bickel, D&R International)
11% of the Homes Have 51% of the CFLs; 30% of the Homes Still Have None

<table>
<thead>
<tr>
<th>10% saturation =~ 4 CFLs</th>
<th>Distribution by % Socket Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>National Households</td>
<td>30%</td>
</tr>
<tr>
<td>CFLs</td>
<td>0%</td>
</tr>
<tr>
<td>Vermont Households</td>
<td>15%</td>
</tr>
<tr>
<td>CFLs</td>
<td>0%</td>
</tr>
<tr>
<td>California Households</td>
<td>9%</td>
</tr>
<tr>
<td>CFLs</td>
<td>0%</td>
</tr>
<tr>
<td>Puget Sound Households</td>
<td>31%</td>
</tr>
<tr>
<td>CFLs</td>
<td>0%</td>
</tr>
<tr>
<td>Tacoma Households</td>
<td>19%</td>
</tr>
<tr>
<td>CFLs</td>
<td>0%</td>
</tr>
</tbody>
</table>

Even in mature markets

| 60-70% homes Have less than 8 CFLs | ~80% of installed CFLs are in 30%-40% of homes |

Slide from Steve Bickel, D&R International
California Is Leading the Nation, But Its Homes Have More Incandescents In Use Today Than They Did in 2000

<table>
<thead>
<tr>
<th>CLASS</th>
<th>Metering Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td><strong>CFL Socket Penetration</strong></td>
<td></td>
</tr>
<tr>
<td>Average Number of Sockets</td>
<td>na</td>
</tr>
<tr>
<td>Average Number of Lamps</td>
<td>33.8</td>
</tr>
<tr>
<td>Average Number of Sockets Using CFLs</td>
<td>0.3</td>
</tr>
<tr>
<td>CFL Socket Penetration</td>
<td>1%</td>
</tr>
<tr>
<td><strong>CFL Saturation</strong></td>
<td></td>
</tr>
<tr>
<td>Percentage of Households with 1+ CFLs</td>
<td>12%</td>
</tr>
<tr>
<td>Percentage of Households with No CFLs</td>
<td>88%</td>
</tr>
<tr>
<td>Percentage of Households with 1-5 CFLs</td>
<td>na</td>
</tr>
<tr>
<td>Percentage of Households with 6-10 CFLs</td>
<td>na</td>
</tr>
<tr>
<td>Percentage of Households with 11-20 CFLs</td>
<td>na</td>
</tr>
<tr>
<td>Percentage of Households with &gt;20 CFLs</td>
<td>na</td>
</tr>
</tbody>
</table>

**Average Number of CFLs Installed**

| Among Households with 1+ CFLs | na   | na   | 11.3 |
| Among All Households          | na   | na   | 10.3 |

Source: Kathleen Gaffney, KEMA
CFL Sales and Market Share Peaked in 2007; Dropping about 15% per Year Since Then

US Screw-based CFL Imports

<table>
<thead>
<tr>
<th>Year</th>
<th>Monthly CFL Imports (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>20.7 M</td>
</tr>
<tr>
<td>2001</td>
<td>69.1 M</td>
</tr>
<tr>
<td>2002</td>
<td>51.6 M</td>
</tr>
<tr>
<td>2003</td>
<td>65.8 M</td>
</tr>
<tr>
<td>2004</td>
<td>93.5 M</td>
</tr>
<tr>
<td>2005</td>
<td>101.7 M</td>
</tr>
<tr>
<td>2006</td>
<td>184.7 M</td>
</tr>
<tr>
<td>2007</td>
<td>397.1 M</td>
</tr>
<tr>
<td>2008</td>
<td>337.5 M</td>
</tr>
<tr>
<td>2009</td>
<td>107.8 M</td>
</tr>
</tbody>
</table>
Why?

- **Market Reasons**
  - Long product life – years before replacements needed
  - Cheap enough to be worth buying without utility rebates
  - Becoming an undifferentiated commodity – why buy *this* one?

- **Technology Reasons**
  - Product still behaves differently than incandescent in certain ways: warm up times, dimming, lighting intensity, directionality
  - Products frequently do not last as long or provide as much light as claimed
  - Cooler operation a large benefit for some climate zones and a smaller benefit or drawback for others

- **Human Behavior Reasons**
  - Not the “new new” thing anymore – LEDs capturing more attention
  - Mercury fears give the skeptical another reason not to buy
  - Other lingering health fears or aesthetic concerns
CFL Quality Has Improved, But Not All Consumers Are Sold

Tacoma Power 2008 CFL Survey

- Not as good as incandescent bulbs: 31%
- Equal to incandescent bulbs: 33%
- Better than incandescent bulbs: 16%
- Don’t know: 20%
### Customers’ Stated Reasons for Not Buying CFLs

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enough light</td>
<td>35%</td>
</tr>
<tr>
<td>Too expensive</td>
<td>34%</td>
</tr>
<tr>
<td>Does not fit</td>
<td>28%</td>
</tr>
<tr>
<td>Does not turn on instantly</td>
<td>20%</td>
</tr>
<tr>
<td>Don’t like the color</td>
<td>14%</td>
</tr>
<tr>
<td>Don’t like how they look</td>
<td>13%</td>
</tr>
<tr>
<td>Don’t know where to buy</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>23%</td>
</tr>
</tbody>
</table>

*Multiple response: columns total to more than 100%*

N = 228

Tacoma Power 2008 CFL Survey
What about Incandescents?
Technology and Efficiency Changes Over Time

Modified from original in Wiley Encyclopedia of Electrical and Electronics Engineering, 1999
The Least Efficient Incandescent Bulbs Increasingly Get the Best Retail Shelf Space
Ecos Lab Tests: Standard Vs. Modified Spectrum Bulbs

California’s 2006 & 2008 Standards Give Us a Preview of What Will Happen Federally; Nevada’s 2012 Standards Are Much Better

Nevada Standards: 25 Lumens/Watt across the board

- Standard Incandescent Lamps
- New Philips Halogena
- New Sylvania E-Logic
- New GE Energy Saver
- New Philips Econ-o-watt

CEC Tier 2 (2008)
CFLs now getting more prominent placement

New bulbs with 5% lower wattage now reaching retail shelves in California.

Most of the new bulbs reduce light output by 8 to 10%, and are less efficient than the old bulbs they replace.

Modified spectrum bulbs and G lamps at standard wattages offered for sale right next to the new bulbs at unfamiliar wattages.
What Will EISA Really Do?

- EISA does *not* ban incandescent lamps; it sets minimum efficiency requirements for light bulbs
- EISA doesn’t mean that only CFLs will be available after 2012
  - Tier 1, phased in from 2012 to 2014, cuts allowable power use but allows lamps to get much dimmer, so *efficiency* gains could be quite small
  - Also offers weaker requirements for modified spectrum lamps and exemptions for special purpose lamps
- Manufacturers are already bringing products to market at the lowest efficiency and light output levels allowed under EISA
- Minimum required lamp efficiencies in 2014 will be much lower than many people think, and nowhere near today’s CFL efficiency levels
- Likely to create market confusion; also creates an opportunity for utility savings from new and better lighting products
EISA Requires a Power Reduction of about 28%

<table>
<thead>
<tr>
<th>Rated Lumen Ranges</th>
<th>Maximum Rate Wattage</th>
<th>Minimum Rate Lifetime</th>
<th>Effective Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1490–2600</td>
<td>72</td>
<td>1,000 hrs</td>
<td>1/1/2012</td>
</tr>
<tr>
<td>1050–1489</td>
<td>53</td>
<td>1,000 hrs</td>
<td>1/1/2013</td>
</tr>
<tr>
<td>750–1049</td>
<td>43</td>
<td>1,000 hrs</td>
<td>1/1/2014</td>
</tr>
<tr>
<td>310–749</td>
<td>29</td>
<td>1,000 hrs</td>
<td>1/1/2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rated Lumen Ranges</th>
<th>Maximum Rate Wattage</th>
<th>Minimum Rate Lifetime</th>
<th>Effective Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1118–1950</td>
<td>72</td>
<td>1,000 hrs</td>
<td>1/1/2012</td>
</tr>
<tr>
<td>788–1117</td>
<td>53</td>
<td>1,000 hrs</td>
<td>1/1/2013</td>
</tr>
<tr>
<td>563–787</td>
<td>43</td>
<td>1,000 hrs</td>
<td>1/1/2014</td>
</tr>
<tr>
<td>232–562</td>
<td>29</td>
<td>1,000 hrs</td>
<td>1/1/2014</td>
</tr>
</tbody>
</table>
Comparing US, Canada and Nevada Standards
EISA Federal Standards and the First New Incandescents

![Graph showing lumens per watt for different light bulbs.]
Corner Bulbs and Loophole Lamps

- **Philips Halogena ES**
- **EISA (Modified Spectrum)**
- **EISA (Standard Spectrum)**
- **Philips EcoVantage (MS)**
- **Osram Syl SUPERSAVER**
Cutaway of Philips Energy Saver Halogena

Halogen capsule with Infrared Reflective (HIR) coating
Approx. 20 lm/W
Steady Progression of Better Halogen IR Lamps

Efficiency of General Service Lamps can be Significantly Improved

100 Watts, 1500 Lumens, 15 Lm/W, 1000 Hours
40 Watts, 1500 Lumens, 37 Lm/W, 1000 Hours

100W = 40W

Standard Incandescent Lamp
Hybrid Electric Lamp
# ENERGY STAR’s Current CFL Efficiency Requirements: We Can Aim Even Higher

<table>
<thead>
<tr>
<th>Criteria Item</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lamp Power (Watts) &amp; Configuration</strong>¹</td>
<td>Minimum Efficacy: Lumens/watt (Based on initial lumen data²)</td>
</tr>
<tr>
<td><strong>Bare lamp (fixed light output)</strong>:</td>
<td></td>
</tr>
<tr>
<td>Lamp power &lt; 10</td>
<td>50</td>
</tr>
<tr>
<td>10 ≤ Lamp power &lt; 15</td>
<td>55</td>
</tr>
<tr>
<td>Lamp power ≥ 15</td>
<td>65</td>
</tr>
<tr>
<td><strong>Bare lamp (Dimmable/2-way/3-way)</strong>:</td>
<td></td>
</tr>
<tr>
<td>Lamp power &lt; 15</td>
<td>50</td>
</tr>
<tr>
<td>Lamp power ≥ 15</td>
<td>60</td>
</tr>
<tr>
<td><strong>Covered lamp (no reflector)</strong>:</td>
<td></td>
</tr>
<tr>
<td>Lamp power ≤ 7</td>
<td>40</td>
</tr>
<tr>
<td>7 &lt; Lamp power ≤ 15</td>
<td>45</td>
</tr>
<tr>
<td>15 ≤ lamp power &lt; 25</td>
<td>50</td>
</tr>
<tr>
<td>Lamp power ≥ 25</td>
<td>60</td>
</tr>
<tr>
<td><strong>Outdoor Reflectors</strong></td>
<td></td>
</tr>
<tr>
<td>Lamp power &lt; 20</td>
<td>33</td>
</tr>
<tr>
<td>Lamp power ≥ 20</td>
<td>40</td>
</tr>
</tbody>
</table>

¹ Based on initial lumen data

² For Candelabra screw-base, efficacy requirements are not applicable.
How Much Better Could LEDs Get?
How Can We Fill the Open Jaw?
Better Incandescents and Brighter, Less Expensive LEDs

- Better Incandescents
- Brighter, Less Expensive LEDs

<table>
<thead>
<tr>
<th>Wattage</th>
<th>Lumens/Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 W</td>
<td>60 W</td>
</tr>
<tr>
<td>75 W</td>
<td>100 W</td>
</tr>
</tbody>
</table>

[Graph showing lumens per watt for various light bulb types]
Options for Replacing Today’s 60 Watt Incandescent Bulbs

<table>
<thead>
<tr>
<th>LUMENS</th>
<th>630</th>
<th>840</th>
<th>750</th>
<th>785</th>
<th>800</th>
<th>&gt;800</th>
<th>&gt;800</th>
<th>750</th>
<th>900</th>
<th>&gt;800</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATTS</td>
<td>60</td>
<td>60</td>
<td>43</td>
<td>43</td>
<td>40</td>
<td>29</td>
<td>20</td>
<td>15</td>
<td>13</td>
<td>&lt;12</td>
</tr>
<tr>
<td>LUMENS PER WATT</td>
<td>10.5</td>
<td>14</td>
<td>17.4</td>
<td>18</td>
<td>20</td>
<td>28</td>
<td>40</td>
<td>45</td>
<td>55</td>
<td>65</td>
</tr>
</tbody>
</table>

- **Today’s incandescent bulbs**: inefficient but inexpensive
- **EISA compliant bulbs**: already on the market, but dimmer than standard incandescents
- **Super-efficient incandescent lamps**: bright incandescents could fill the gap between CFLs and lamps that just barely meet EISA
- **Today’s CFLs**: more efficient than incandescent bulbs, but behave differently and cannot substitute for all lighting applications
- **Improved CFLs and LEDs**: could yield even greater savings

**Table**:

- **Modified Spectrum Bulb**
- **Standard Bulb**
- **EISA TIER 1 Osram Supersaver**
- **Philips Halogen**
- **Energy Saver**
- **Super-Efficient Incandescent**
  - Lumens: >800
  - Watts: <30
  - Lm/W: >28
- **ENERGY STAR CFLs**
  - Covered
  - Bare

**Diagram**:

- Comparison of lumens, watts, and lumens per watt for different bulb types.
- Visual representation of bulb efficiency and cost effectiveness.

**Note**: The table and diagram illustrate the efficiency and cost implications of different bulb types, highlighting the advantages of EISA compliant bulbs and the potential for improved CFLs and LEDs to yield greater savings.
How Would Consumers Know Which Bulbs to Buy? NRDC/Ecos Proposal for Mandatory Categorical Labeling

<table>
<thead>
<tr>
<th>ENERGY EFFICIENCY RATING</th>
<th>5-star bulbs are the most energy efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTRICITY COST</td>
<td>$2.30 PER YEAR</td>
</tr>
<tr>
<td>POWER</td>
<td>23 WATTS</td>
</tr>
<tr>
<td>LIFE</td>
<td>10,000 HOURS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIGHT OUTPUT</th>
<th>1600 LUMENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUMENS</td>
<td>450  800  1110 1600  2600  3000</td>
</tr>
<tr>
<td>INCANDESCENT EQUIVALENT</td>
<td>40W  60W  75W  100W  150W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENERGY EFFICIENCY RATING</th>
<th>5-star bulbs are the most energy efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTRICITY COST</td>
<td>$10.00 PER YEAR</td>
</tr>
<tr>
<td>POWER</td>
<td>100 WATTS</td>
</tr>
<tr>
<td>LIFE</td>
<td>750 HOURS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIGHT OUTPUT</th>
<th>1600 LUMENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUMENS</td>
<td>450  800  1110 1600  2600  3000</td>
</tr>
<tr>
<td>INCANDESCENT EQUIVALENT</td>
<td>40W  60W  75W  100W  150W</td>
</tr>
</tbody>
</table>
Conclusions

- EISA will reduce savings opportunities from utility residential lighting programs by 2012-2014, but not as much as many people think.
- Continue promoting CFLs until EISA takes effect, but include fair consideration of free ridership and lower net savings.
- Steadily shift emphasis toward better-than-ENERGY STAR CFL and LED models.
- Offer a rebated, energy-saving option for every buyer of screw-based lighting products, including super efficient incandescents for those customers that don’t like or want CFLs.
- Fund random testing of the product models you are rebating and publicly disclose the results; help ensure your customers get what they pay for.
- Support mandatory categorical labeling of light bulb efficiency to help your consumers buy the right products (comments due to FTC in December).
- **Costs per saved lifetime kWh are going up, but residential lighting will continue to be one of the largest, cheapest sources of energy & CO$_2$ savings for years to come.**
Thank You

Chris Calwell
Durango, CO
ccalwell@ecosconsulting.com
(970) 259-6801 x301

Ecos delivers proven results for clients looking to reduce their energy use, manage their carbon emissions and make their operations more environmentally sustainable. With over a decade of experience designing innovative ways to couple the power of ecology with the engine of our economy, Ecos performs the research, develops the plans and carries out the projects that make the most significant impact on the vitality of both our clients and our planet.