# Linear Fluorescent Fixtures

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# Background

- PG&E submitted a Preliminary CASE Report in January 2008--PG&E Withheld it during April 1st submittals due to changes planned.
- It recommended a linear fluorescent fixture standard based on BEF
- Estimated energy savings:
  - 78 GWh and 22 MW for first year sales
  - 1,959 GWh and 561 MW upon stock turnover

# Alternate Concept Proposal

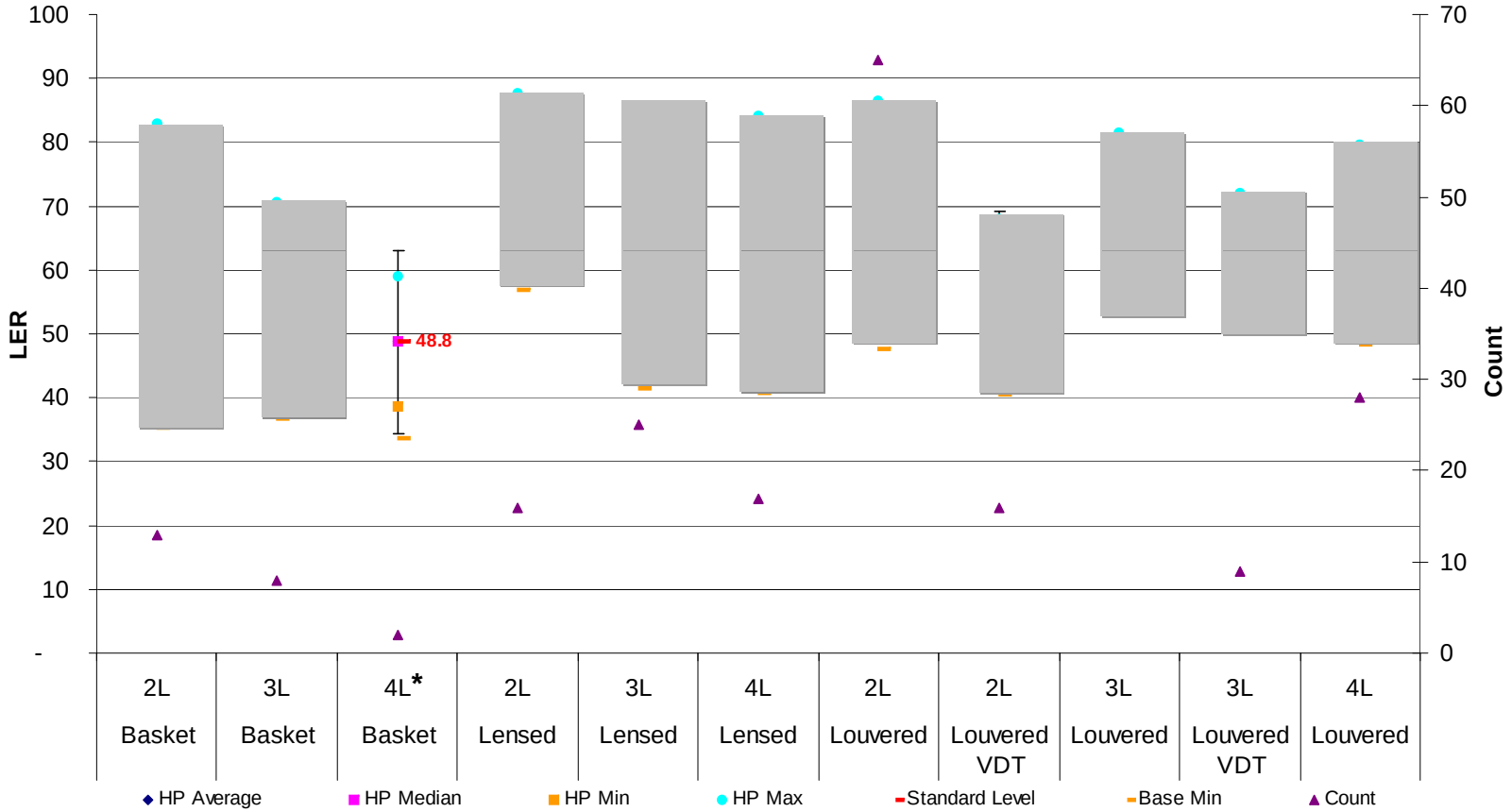
- Identified an alternate standards approach concept appended as Appendix D to the CASE Report.
- Alternate approach more directly regulates overall fixture performance using Luminaire Efficacy Rating (LER), a metric proposed by DOE in 1992, but not yet used in standards

  LER =Total rated lamp lumens x ballast factor x fixture efficiency /Luminaire input watts
- Industry is working on TER, but that isn't ready for implementation.

# Alternate Approach Methodology

- 500 product records including published fixture efficiency data and design characteristics for major fluorescent fixture types
- Out of 250 records for 2x4 recessed and surface-mount fixtures,
  - Examined fixture efficiency variation across different fixture types
  - Three basic product classes –
    - fixtures with wide-cell louvers,
    - those with prismatic lenses,
    - those with basket diffusers (usually perforated metal).
  - Differentiated these into 11 total sub-categories based on:
    - Number of lamps, and
    - Glare control ( VDT).
  - These categories seem to appropriately control for application- and design-based factors (i.e., distinct product utility) that may impact fixture efficiency.

# LER Range for 2x4 Fixtures with High Performance Lamps and Ballast




Note: Grey bars indicate the range of all possible LER in each fixture category. Error bars show standard deviation.
* More data is needed

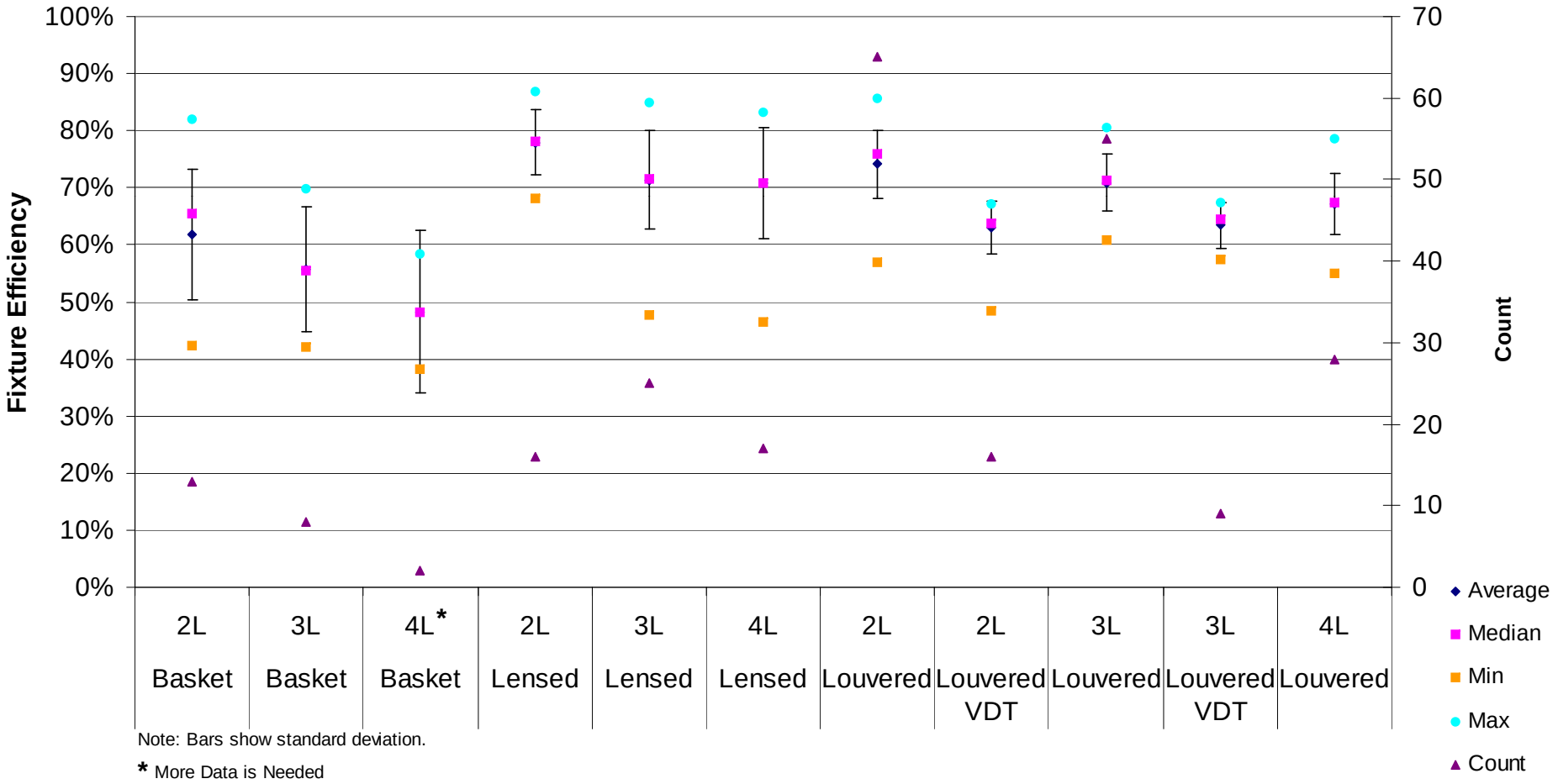
# California Statewide Energy Savings Extrapolated from Single Product Category Analysis

| California Annual Sales (millions) | Average watts saved per fixture | Percent on at Peak | For First-Year Sales | | After Entire Stock Turnover | |
|---|---|---|---|---|---|---|
| | | | Coincident Peak Demand Reduction (MW) | Annual Electricity Savings (GWh/yr) | Coincident Peak Demand Reduction (MW) | Annual Electricity Savings (GWh) |
| 5.1 | 7 | 78% | 27 | 103 | 669 | 2,567 |

Notes: For the source of sales data and peak coincidence assumption, see Table 7 in main body of the report.
Average watts saved per fixture is based on a 11% average reduction for 2-lamp and 3-lamp fixtures given market shares of 60% and 30%, respectively (Brook, 2006; no savings is assumed for 1-lamp fixtures). The 20% pre-standards compliance is factored in to the savings estimates.

# Additional Detail Slides

# Baseline Analysis




Note: Bars show standard deviation.

* More Data is Needed

# Alternate Approach Methodology

- Examined LER under three lamp-ballast scenarios to determine what minimum LER would offer valuable savings without limiting design flexibility or forcing the use of efficient lamps and ballasts.
- Base case fixture assumes standard 700-series T8s and generic instant-start ballasts because--new T12 fixtures with electronic ballasts can be sold, but vast majority of fixtures sold are T8s.
- The fixtures with the highest LERs are those that use high-performance T8 systems, including 3100-lumen lamps and extra-efficient electronic ballasts.
- Many fixtures are not shipped with lamps included, evaluated how a fixture's LER is impacted by the use of base lamps and an extra-efficient ballast only.

# Establishing Levels

- Set minimum LER at the base maximum (fixture with "base lamp and ballast").
  - This allows only the most efficient fixtures to be used with a generic T8 system.
- In some fixture classes however, the base maximum LER falls above the median LER for fixtures using high-performance lamps and ballasts.
- In order for at least half of all available products to comply using efficient lamps and ballasts, we would propose a standard based on the *lower* of either the "base" maximum LER or the "high performance" median LER.

# Implications of Conceptual Levels

- For most lensed and louvered fixtures, the proposed minimum LER level would be around 70. For “basket” and “VDT” fixtures, lower LER’s are recommended.
  - All but the very least efficient two-lamp fixtures using high-performance lamps and ballasts, and
  - it would allow about half of 2-lamp fixtures using only the extra-efficient ballast. The proposal results in more stringent standards for 3- and 4-lamp fixtures, which carries the added benefit of encouraging the use of fixtures with fewer lamps.
- It has a similar affect on fixtures with basket diffusers, to encourage more efficient designs that incorporate direct and indirect light. It may be
- Possible to simplify the standard by grouping lensed and louvered fixtures, making exceptions for those with glare control designs (VDT).

# Key Assumptions

- For our savings analysis, we made assumptions about which methods would be used to meet a new LER standard. Our estimate was that 90% of new fixtures will utilize extra-efficient ballasts to improve LER, as this is a very low-cost option that requires merely a supply shift.
- We assume 10% of new fixtures will be installed with revised fixture spacing based on higher lumen lamps and higher efficiency fixtures, as a result of manufacturers' promotion of increased fixture spacing with new high-performance lighting.
- We also assume about one third of fixtures will use a ballast with a lower ballast factor to compensate for higher lumen lamps and/or higher efficiency fixtures.
- We project the standard will shift about two thirds of lamps into higher-efficiency categories. Since 700-series T8 is the basecase, the improved category includes 800-series and high-lumen T8s, as well as reduced-wattage T8s.
- Because not all fixtures are shipped with lamps installed, it is possible that manufacturers could claim higher LER from high-lumen lamps without ensuring they are used with the fixture. Although probably not a significant loophole since downgrading lamps would affect lighting design, a final standards proposal should address this issue.
- In our detailed analysis, reduced-wattage lamps were treated as a 30/70 blend of 25WT8 and 28WT8 lamps

# Possible Impact of Fixture Standards on Market

| Parameter | | Current Share | Post-Standard Share |
|---|---|---|---|
| Ballast Efficiency | GEB | 90 % | 10 % |
| | Extra Eff | 10% | 90 % |
| Ballast Factor | Normal | 87 % | 70 % |
| | Reduced | 13 % | 30 % |
| Lamp Type | 700-series | 49 % | 15 % |
| | 800-series | 45 % | 20 % |
| | Reduced | 1 % | 15 % |
| | High-Lumen | 5% | 50% |
| Revised Spacing | | 0 % | 10 % |

Note: This is one possible outcome that we model for illustrative purposes.

# Demand Scenarios

| Lamp-Ballast System | Lumens per Lamp | Ballast Factor | Watts | |
|---|---|---|---|---|
| **"Base" Lamp and Ballast** (700-series T8, generic instant-start electronic ballast) | 2800 | 0.88 | 2 Lamps<br>3 Lamps<br>4 Lamps | 59<br>85<br>112 |
| **Extra-Efficient Ballast** (With 700-series T8) | 2800 | 0.88 | 2 Lamps<br>3 Lamps<br>4 Lamps | 54<br>81<br>108 |
| **High Performance System** (High-lumen T8 and extra-efficient instant start ballast) | 3100 | 0.88 | 2 Lamps<br>3 Lamps<br>4 Lamps | 54<br>81<br>108 |

# Illustrative Efficiency Options for 2x4 Recessed Louvered 3-Lamp Fixtures

| Design Options | LER | Fixture Efficiency | Rated Lumens per lamp | Ballast Factor | System Watts | Relative Light Output | Annual Operating Hours | Unit Electricity Consumption (kWh/yr) | % Savings |
|---|---|---|---|---|---|---|---|---|---|
| ***Base Case*** | | | | | | | | | |
| 700 series T8 lamps<br>Generic electronic IS ballast<br>Normal ballast factor | 62 | 71% | 2800 | 0.88 | 85 | 100% | 3,740 | 318 | - |
| ***Efficiency Options*** | | | | | | | | | |
| Higher Fixture Efficiency | 70 | 81% | 2800 | 0.88 | 85 | 116% | 3,740 | 318 | 0% |
| High-lumen lamps | 70 | 74% | 3100 | 0.88 | 85 | 116% | 3,740 | 318 | 0% |
| High-lumen T8 lamps<br>Extra-efficient electronic IS ballast | 70 | 71% | 3100 | 0.88 | 81 | 111% | 3,740 | 304 | 4% |
| Extra-efficient electronic IS ballast | 70 | 76% | 2800 | 0.88 | 81 | 108% | 3,740 | 304 | 4% |
| Higher Fixture Efficiency<br>Low ballast factor[1] | 70 | 82% | 2800 | 0.77 | 76 | 104% | 3,740 | 284 | 11% |
| High-lumen T8 lamps<br>Low ballast factor[1] | 70 | 74% | 3100 | 0.77 | 74 | 104% | 3,740 | 280 | 12% |
| High-lumen T8 lamps<br>Extra-efficient electronic IS ballast<br>Low ballast factor[1] | 70 | 71% | 3100 | 0.77 | 72 | 99% | 3,740 | 269 | 15% |

[1]An alternative to lowering the ballast factor is to use reduced wattage (25W, 28W, or 30W) T8s.