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Lighting Quality Considerations in Energy Regulations

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Huffman Bill (AB 1109) - Oct 12, 2007

- “**Reduce** average statewide **electrical energy** consumption by
 - not less than **50%** from the 2007 levels
for **indoor residential lighting**
- and
 - not less than **25%** from the 2007 levels
for **indoor commercial & outdoor lighting**
- **by 2018”**

Key Focus: Replace Incandescent Lamps

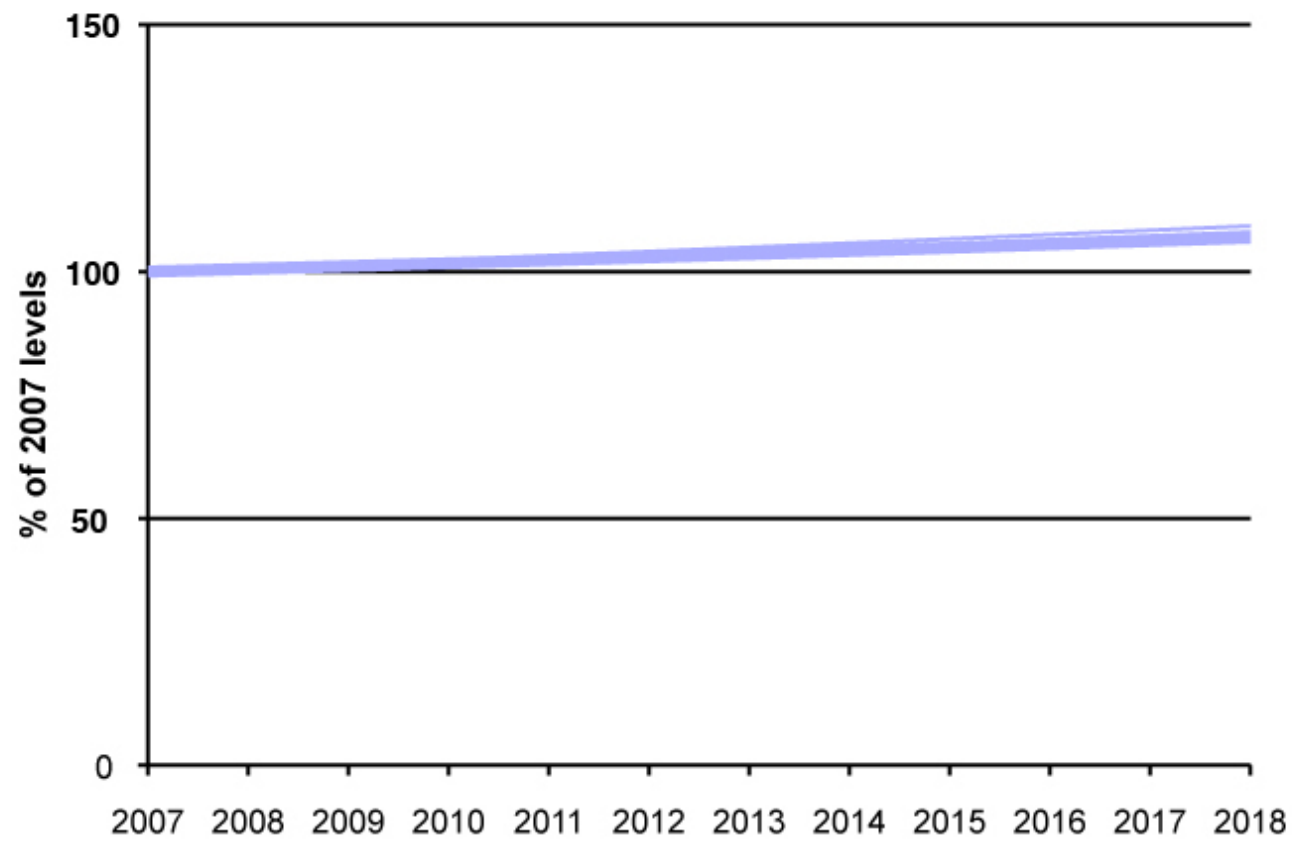
Key Problem



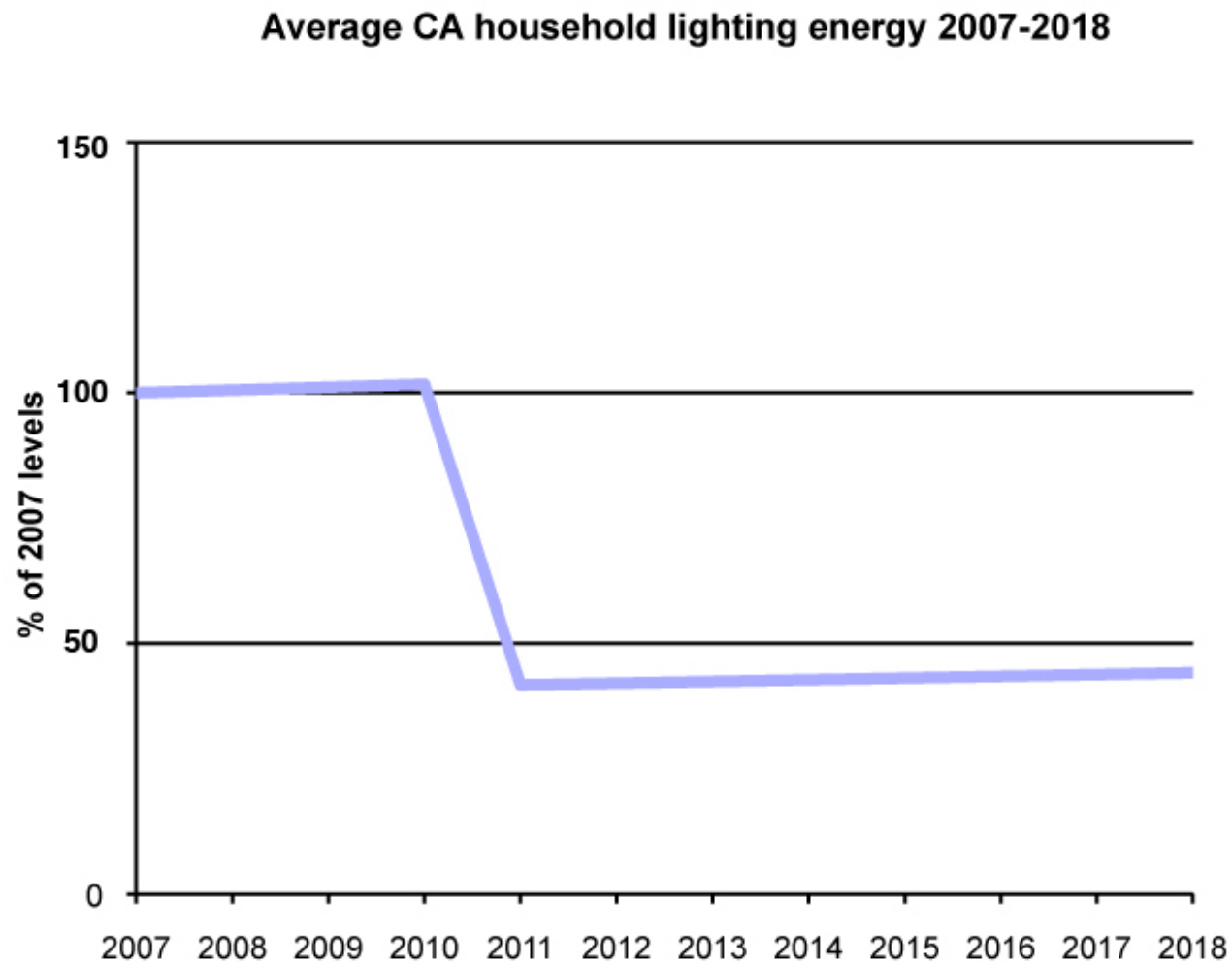
15 LPW System Efficacy

Do Nothing

Average CA household lighting energy 2007-2018
No Action



Replace incandescent with 40+ LPW



Road to Huffman in 2007: CFLs!

- Halogen incandescent isn't going to get us there...
 - Marginal increase in efficacy
 - Slow entry / phasing in the market
- **Only practical method: dramatically increase penetration of CFLs**



2007 Residential CFL use: ~15%

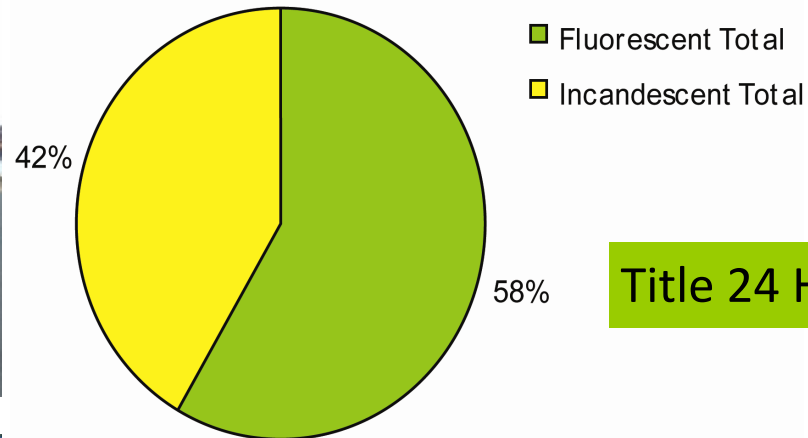
- **Two Main Strategies**
 - T24 & T20 Efficacy Requirements
 - Utility Incentive & Rebate Programs
- **Two Main Performance Considerations**
 - Luminous Efficacy
 - Cost
- **Results**
 - Very low cost, high efficacy CFLs
 - Failed in almost every quality aspect...



CA Residential Market Today



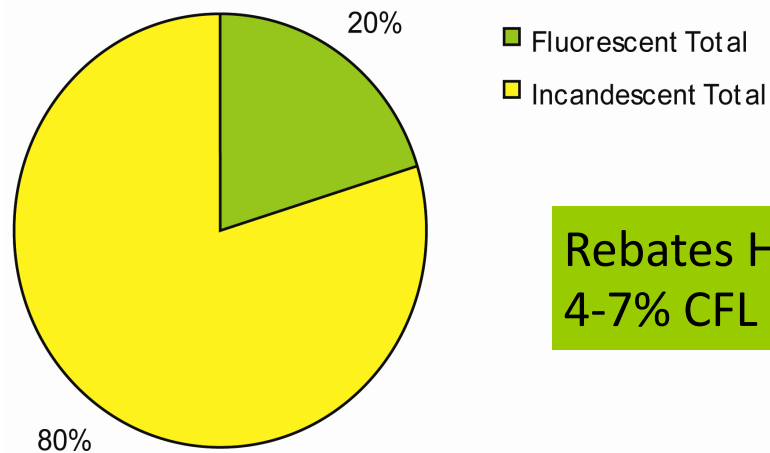
California New Construction Stock



Title 24 Highly Successful!



California Installed Housing Stock



Rebates Highly Unsuccessful...
4-7% CFL increase from 2007

CFL Issues & Shortcomings

- Size
- Shape
- CCT
- Consistency
- Cost
- Reliability
- Time to full brightness
- CRI
- Dimming
- Drama
- Safety
- Health
- Longevity
- ...

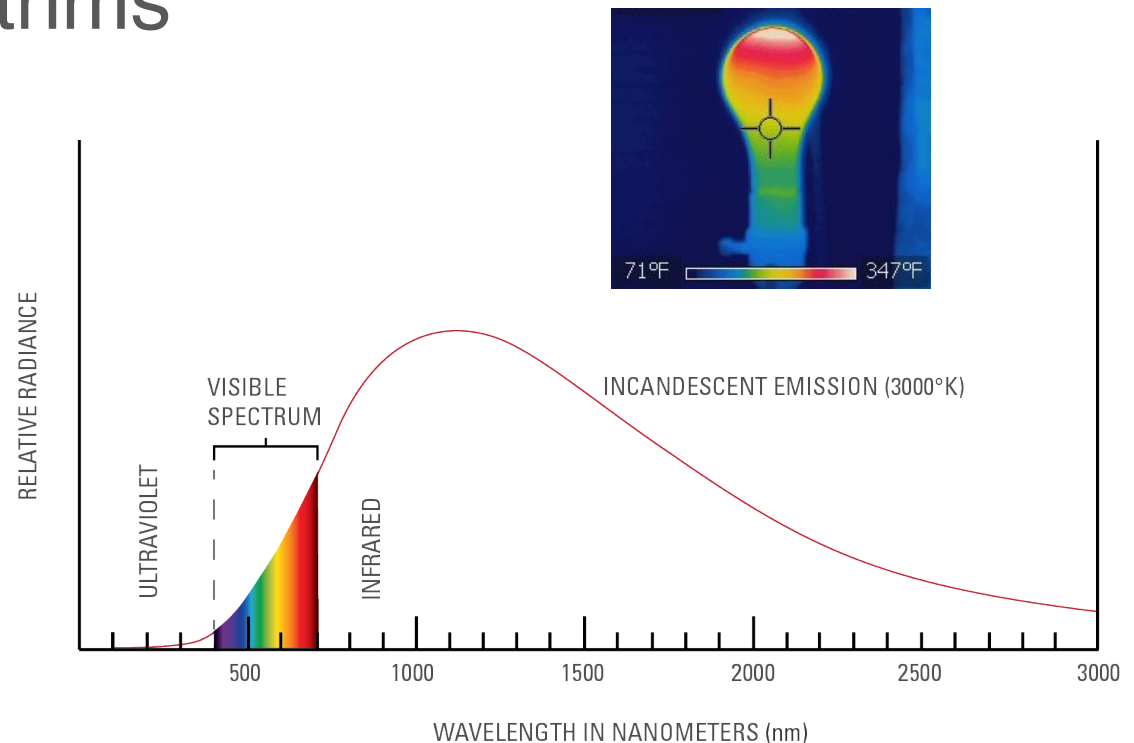
Incandescent Lighting

- **Pros**

- ★ Color Rendering
- ★ Color Temperature
- ★ Circadian Rhythms
- ★ Dimming
- ★ Drama
- ★ No flicker
- ★ No noise
- ★ Low cost

- **Cons**

- ★ Low efficacy...
- ★ Thermal comfort



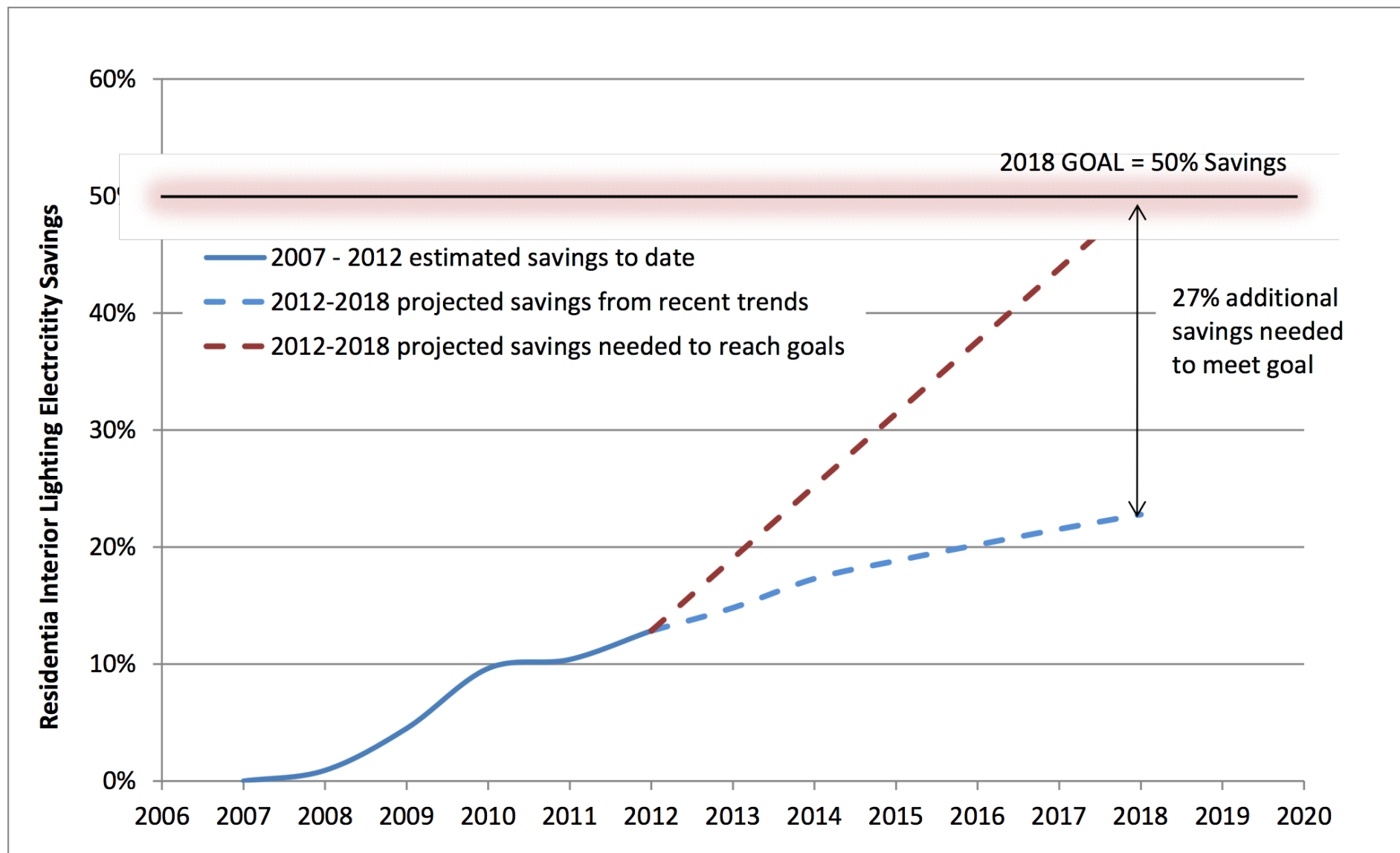
Road To Huffman Today: LEDs

- Small size
- Directed light
- Optics
- Dimming
- Longevity



Electricity Savings Estimates

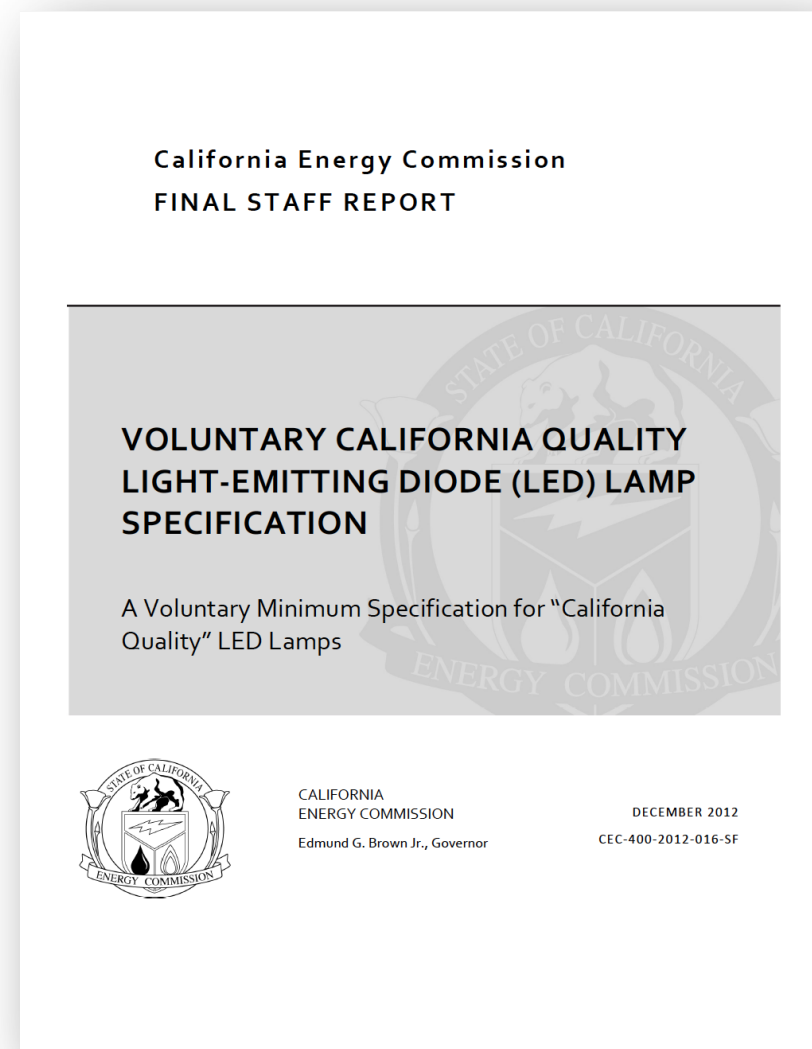
Residential Interior Lighting



Source: CLTC calculations

CA LED Lighting Quality Specification

- Developed by the **California Energy Commission** at the request of the **California Public Utilities Commission**
- Voluntary standard, required only for LED lamps in **utility incentive & rebate programs**
- **Energy Star Plus** approach
- In Effect since **January 2013**

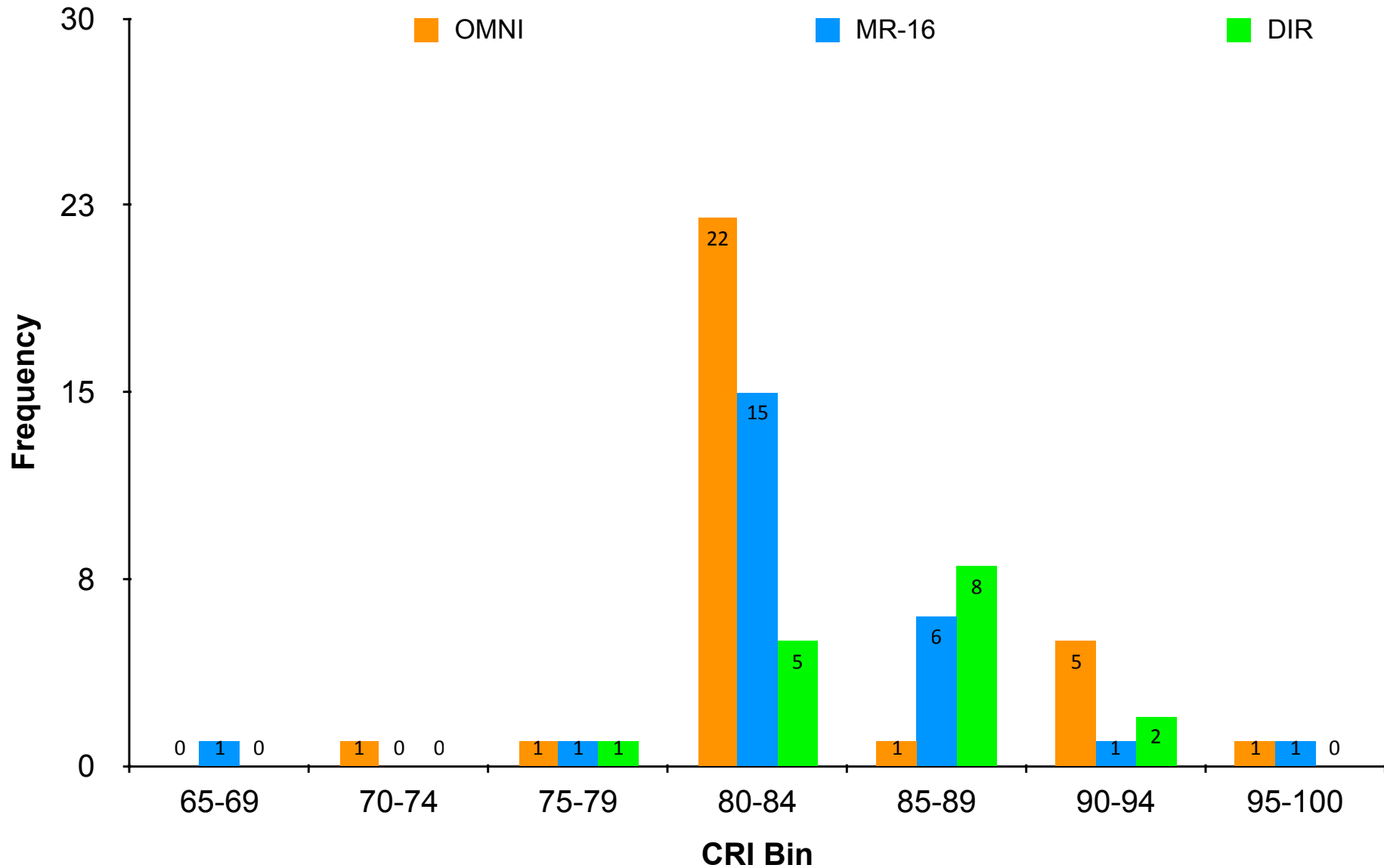


LED Quality Specification Comparison

LED Lamp Specifications	California Quality	Energy Star Version 1.0, Solid-State Lamps
Color Rendering	$\text{CRI} \geq 90$, $\text{R9} > 50$	$\text{CRI} \geq 80$, $\text{R9} > 0$
Color Temperature (CCT) & Consistency	2700K or 3000K within a 4-step MacAdam ellipse	2700K, 3000K, 3500K, 4000/4100K, 5000K or 6500K within a 7-step MacAdam ellipse
Dimming Performance without Flicker or Noise	10–100% continuous	20–100% (only required of those lamps marketed as dimmable)
Power Factor (PF)	$\text{PF} \geq 0.9$	$\text{PF} \geq 0.7$
Minimum Warranty	5 years with free replacement	3 years

The CA LED Lighting Quality specification aims to improve on certain Energy Star key lighting quality requirements

LED Replacement Lamp CRI Distribution



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LED Performance Database

- **Comprehensive Characterization**

- Photometric
- Power

- **Lamp Selection Criteria**

- Total Flux: > 600 Lumens
- CRI: > 80
- CCT: 2700 – 3000
- Shape: A19 – A21
- Base: E26 (medium)



Current Status of CA Energy Standards

- **CA Title 24 - New Building Construction Requirements**
 - **2013** Title 24, Part 6 Joint Appendix JA8
 - **CRI** ≥ 90
 - **CCT** between 2700K & 4000K
 - **2016** Title 24 **Proposals**
 - California Commission Staff
 - California Utilities
- **CA Title 20 - Light Sources Allowed for Sale in the State**
 - Proposals for Next Version
 - California Commission Staff
 - California Utilities

CA Title 20 Issues

- **Color Rendering**
 - **Utilities:** $R_a \geq 90$, $R_9 > 50$
 - **Manufacturers:** $R_a \geq 80$, $R_9 > 0$ (Energy Star)
 - **CEC Staff:** $3 \cdot R_a + LPW \geq 335$ (1/1/2015) & 350 (1/1/2017)
- **Dimmability**
 - No industry-approved measurement method
 - Backward/forward compatibility with dimmers
- **Flicker**
 - No industry-approved measurement method
- **Noise**
 - No industry-approved measurement method

Key Stakeholders Influencing Process



Thank You!

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