

LED Panel Fixtures and Retrofit Kits



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Presentation Overview



Objective: Seeking TF approval of final workpaper

- Measure Description
- Previous Issues and Concerns
- Measure Details
- Workpaper Methodology & Kilolumen Unit
- Results
- Questions or Comments

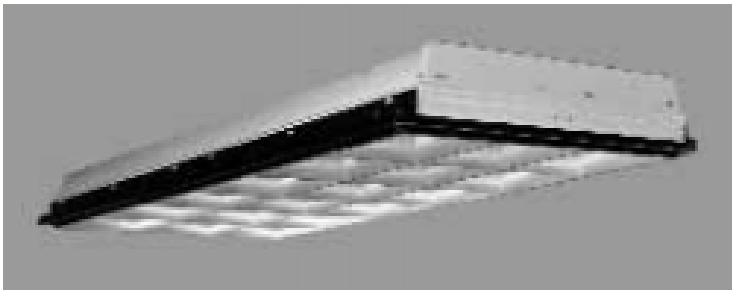
Measure Description

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Base Case

Linear fluorescent recessed fixture or retrofit kit

- 2x4, 2x2 or 1x4 size
- Meeting Federal lamp and ballast standards
- Meets Title 24 LPD



Measure Case

LED Panel fixture or retrofit kit

- DLC-listed (min. 85 LPW)
- Lens required between LED chips and target



LED Incentive Options



Product	Features	Pros	Challenges
Linear Replacement Lamps	<ul style="list-style-type: none"> • Plug-and-play • Uses existing ballast 	<ul style="list-style-type: none"> • Lowest cost • Easy to install; no rewiring 	<ul style="list-style-type: none"> • Persistence • Ballast life • Compatibility
Retrofit Kits	<ul style="list-style-type: none"> • Uses existing housing • Replaces lamp & ballast • New Optics 	<ul style="list-style-type: none"> • Versatility • Better Savings 	<ul style="list-style-type: none"> • Requires electrician
Luminaires (troffers/panels)	<ul style="list-style-type: none"> • Replaces entire fixture • New Optics 	<ul style="list-style-type: none"> • Most efficient • Designed for LEDs 	<ul style="list-style-type: none"> • Higher 1st cost

These two bottom options represent these measures:

- These measures avoid concerns around replacement lamps:
 - ❑ Completely remove existing ballast, mitigating safety concern
 - ❑ LED chips directly visible to occupants are ineligible

DLC Technical Requirements



Eligible fixtures must meet DLC requirements for efficacy, light output, light distribution, Color Temperature, Color Rendering, Lumen Maintenance, and Warranty period.

DesignLights Consortium Qualified Products List - Technical Requirements For Luminaires & Retrofit Kits for Ambient Lighting of Interior Commercial Spaces

Fixture Size	Minimum Light Output	Zonal Lumen Density	Minimum Luminaire Efficacy	Allowable CCTs (Color Temp)	Minimum CRI	L70 Lumen Maintenance Minimum	Warranty
2x2	2,000 lm	Spacing Criteria: 0°-180°: 1.0-2.0 90°-270°: 1.0-2.0 ≥75%: 0-60°	85 lm/W	≤ 5000K	80	50,000 hrs	5 years
1x4	1,500 lm	Spacing Criteria: 0-180°: 1.0-2.0 90-270°: 1.0-2.0 ≥75%: 0-60°	85 lm/W	≤ 5000K	80	50,000 hrs	5 years
2x4	3,000 lm	Spacing Criteria: 0°-180°: 1.0-2.0 90°-270°: 1.0-2.0 ≥75%: 0-60°	85 lm/W	≤ 5000K	80	50,000 hrs	5 years

CalTF history with this workpaper

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- Brief methodological discussions at summer 2014 meetings
- Discussion of Savings Methods at October 2014 CalTF:
 - CalTF approved use of single maintained-LPW performance based on interior commercial lighting model from Title24-2013 CASE Report on Indoor Lighting Controls as baseline
 - Workpaper approved abstract contingent on suggestions
- Follow-up advice & suggestions from Jon McHugh and Mary Matteson Bryan
 - Mary: Lumen Depreciation reference: LightingFacts and TM-21
 - Jon: use maintained illuminances for both measure and baseline fixtures
 - Adding lumen maintenance for both measure and baseline case allows savings to be calculated from light output
 - ✦ Fluorescent fixture baseline is 58.8 LPW; LED fixtures start at 76.5 LPW
 - ✦ For equivalent lumens between the two, there is a delta wattage

Issues and Concerns

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Abstract Review Comments from the Cal TF

- ✓ Revisit the assumption for maintained lumens. Resource suggestions include the LightingFacts website, and the TM-21 lighting calculator
 - The Lumen equivalence was reconfigured to use Maintained Lumens. For LEDs, maintenance data on LightingFacts was used, plus the DOE's lumen maintenance equation. For fluorescent, the CASE Report's modeled 90.3% lumen maintenance figure was used.

- ✓ Lumen depreciation is greater for LEDs than fluorescent. Accounting for LED L70 rated life in the calculation of incentives is one approach.
 - LED lumen depreciation was factored in not based on the L70 lifetimes but only on the amount of depreciation that will be experienced in the 50,000 hours claimed measure life: 13.2% depreciation

Measure Details

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- **Units:** per kilolumen (1000 lumens of LED initial light output)
- **Measure Application and Delivery Type**
 - Downstream Deemed (ROB)
- **Eligibility**
 - Climate Zones: All
 - Building Types: All
- **Target Market**
 - Commercial Office
 - Retail & Grocery
 - Schools & Universities
 - Medical Office & Hospital
- **Market Potential**
 - 8% penetration of linear LED Luminaires in 2015 per NLB's Energy Savings Forecast of Solid-State Lighting in General Illumination Applications
 - LED potential savings nationally through 2030 for linear fixture submarket (additionally includes suspended and direct/indirect fixtures) is 642 TWh, approximately 50 TWh in CA IOU territories.
 - <http://www.nlb.org/index.cfm?cdid=11067&pid=10225>

Measure Details

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- **Measure Costs per kilolumen**

- Costs are given per kilolumen, not per fixture. LED fixture costs largely depend on output, but fluorescents do not (4-lamp fixtures do not cost double 2-lamp)

LED Panel LPW	Measure Cost (\$/Kilolumen)	Baseline Cost (\$/Kilolumen)	Incremental Measure Cost (\$/Kilolumen)
85 to 95 LPW	\$41.79	\$15.63	\$26.16
95 to 105 LPW	\$43.83	\$15.63	\$28.20
> 105 LPW	\$49.44	\$15.63	\$33.81

- **EUL**

- 50,000 hours in accordance with DLC minimum requirements;
- Capped at 20 years (DEER EUL maximum)

- **NTG**

- 0.7 (DEER EUL ID: All-Default<=2yrs)

- **Savings Potential**

- Based on CEUS commercial floor stock of 4,920,114 statewide and 1,969,884 in PG&E.
 - ✦ 420 MW and 1.78 TWh statewide;
 - ✦ 170 MW and 710 GWh in PG&E territory

Workpaper Methodology: kilolumen- new impact unit

- Define lighting fixtures by the service provided: illumination of tasks
 - Task illumination will be defined by room geometry, but fixture light output will, for general lighting applications, be closely related
 - Grouping fixtures by wattages ignores important differences in efficacy and can penalize or reward new products based on where they fall in a range
- Measure defined by kilolumen of initial LED light output
 - Easy to use as a reference basis - published by DLC
 - Kilolumens are used instead of lumens because savings of delta watts per lumen might be zeroed out in rounding
- Kilolumen unit has been presented to ED, and followed up with product calculation examples

kilolumen unit Outcomes

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The kilolumen unit offers:

- Greatly simplified set of measures for customers to use
 - 1 measure code per tier of efficacy
 - 3 MCs instead of 21 MCs
- Closer estimation of actual savings:
 - Higher lumen output will correspond to higher savings and higher rebate
 - ✦ e.g. DLC-listed 35W fixtures can perform at 2975 or 4865 Lumens: significant difference not reflected in a wattage-based grouping.
 - Allows workpapers to be based on 1-to-1 equivalence of light output: maintained fixture lumens
- Measure & baseline costs are given per kilolumen
 - Already common for LED products (DOE, Navigant studies), but new for fluorescent fixtures

Workpaper Methodology: Baseline

- Baseline data collection (previously presented October 2014)
 - Since the measure application type is ROB and this is a downstream measure above code savings are considered
 - Variations in fluorescent troffers are so numerous (# lamps, ballast factors, lenses & reflectors, etc.) that a model was built to meet all applicable codes with a typical baseline fixture type
 - The model was taken from the Title24-2013 Codes and Standards Enhancement (CASE) Report on [Indoor Lighting Controls](#)
 - ✦ A mixed of open-plan, medium and small rooms, typical of an office
 - ✦ Recessed [3-lamp F32T8 fixtures](#)
 - ✦ 74.7% Fixture Efficiency
 - The model was adjusted to reflect:
 - ✦ Federal fluorescent lamp standards (2950 lumens/F32T8) and CEE HPT8 ballast
 - ✦ T24-2013 reduction in LPDs from 0.9 W/sf to 0.8 W/sf
 - Maintained average illuminance of 39 footcandles at 8' x 10' spacing
- Baseline methodology
 - Initial Fixture lumens = $2950 \text{ lm/lamp} \times 3 \text{ lamps} \times 0.63 \text{ BF} \times 74.7\% \text{ fixt eff} = 4170 \text{ lm}$
 - Maintained fixture efficacy = $4170 \text{ lm} \times 90.3\% \text{ lumen maintenance} / 64 \text{ W} = \mathbf{58.8 \text{ LPW}}$

Workpaper Methodology: Measure

- Measure data collection
 - The full DLC Panels & Kits lists provide Lumens, Watts, LPW
 - ✦ 1762 fixture families, 6840 fixtures represented
 - Lumen Maintenance data taken from full LightingFacts.com list of Panel Fixtures
- Measure methodology
 - LED Watts per kilolumen = $1000 \text{ lumens} \div 85 \text{ LPW} = \mathbf{11.8 \text{ W}}$
 - LED Lumen Maintenance modeled on DOE equation =
 $e^{[EUL \text{ hours} \times \ln(\text{Lumen Maintenance percent @ } 25,000 \text{ hours}) \div 25,000 \text{ hours}]}$
= 87% for Com blended building type
 - LED lumen maintenance used to provide base case equivalent fluorescent wattage per kilolumen = $1000 \text{ lm} \times$
 $87\% \text{ LED maintenance} \div 58.8 \text{ Fluorescent LPW} = \mathbf{14.8 \text{ W}}$
 - ✦ Note: base case equivalent wattage varies with DEER building type

Results

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Measure Code	Measure Description	LED LPW Minimum	Equivalent Basecase Wattage per kilolumen (COM building type)	LED Watts per 1000 lumens	Delta Watts per 1000 lumens (COM)
1	New DLC-listed LED recessed fixture or kit rated greater than or equal to 85 LPW and less than 95 LPW	85	14.8	11.8	3.0
2	New DLC-listed LED recessed fixture or kit rated greater than or equal to 95 LPW and less than 105 LPW	95	14.8	10.5	4.2
3	New DLC-listed LED recessed fixture or kit rated greater than or equal to 105 LPW	105	14.8	9.5	5.2

Additional Data Needs

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- None Identified

Questions or Comments?

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- EUL cap 20 years?
- Energy Savings calculation reasonable? Any other assumptions should be considered?
- Any comments on cost calculation per kilolumen?