Lighting Subcommittee Meeting #1

CALIFORNIA
TECHNICAL FORUM

TIM MELLOCH
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NOVEMBER 2017

Subcommittee Schedule

	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	6-Nov	13-Nov	20-Nov	27-Nov	4-Dec	11-Dec	18-Dec	25-Dec	1-Jan	8-Jan	15-Jan	22-Jan	29-Jan	5-Feb	12-Feb	19-Feb	2017	2018
Cal TF Meeting			9/28				10/26			11/16				12/14						1/25				2/21-2/22		
Governance / TPP														2a												
Commercial Refrigeration			1																	2					20	0
Food Service			1				2a			2															15	0
Agriculture / Pumps							1																	2	5	1
Lighting		T0	TC											1						2					11	42
HVAC														1										2	2	50
Water Heating														1										2	22	0
Appliance / Plug Load										1										2					10	12
Building Envelope																									0	4
Pools							1																	2	1	5
Process																									0	7
Miscellaneous							1																	2	2	4

Future HVAC Meetings will be held on Thursdays, but from 3 – 5 pm

2017 Lighting Measures

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No.	Description	Energy (kWh/yr)	% of Total
4.01	CFL, Interior Fixture	1,639,129	0.3%
4.02	CFL, Exterior Fixture	2,472,772	0.4%
4.03	CFL, BiLevel Fixture	15,128	0.0%
4.04	CFL, Integral/Screw-in	164,363,359	26.7%
4.05	CFL, Integral/Screw-in, Multip	12,639,624	2.1%
4.06	CFL, 3-Way	14,063,950	2.3%
4.07	CFL, Spiral	82,874	0.0%
4.08	CFL, Pin-Based		
4.09	CFL, Plug-In	3,806	0.0%
★ 4.10	LF, 4' Replace Lamp	11,245,144	1.8%
4.11	LF, Dimming Ballast		
4.12	LF, Ballast Retrofit		
4.13	LF, Replacement Fixture	23,561,653	3.8%
4.14	LF, HP Fixture	7,312,149	1.2%
4.15	LF, Delamping Fixture		
★ 4.16	LED, Interior Downlight	9,762,830	1.6%
4.17	LED, Exterior Wallpack	4,612,086	0.7%
4.18	LED, High/Low Bay	23,523,635	3.8%
4.19	LED, Troffer (2x4, 1x4, 2x2)	46,380,364	7.5%
4.20	LED, Street Light	16,266,823	2.6%
4.21	LED, Interior Common, Res	2,506,851	0.4%
4.22	LED, Landscape	270,207	0.0%
4.23	LED, Exterior with Motion	3,422,230	0.6%
4.24	LED, Exterior, Res	1,687,353	0.3%
4.25	LED, Exterior, Pole		
★ 4.26	LED, MR-16	3,639,850	0.6%

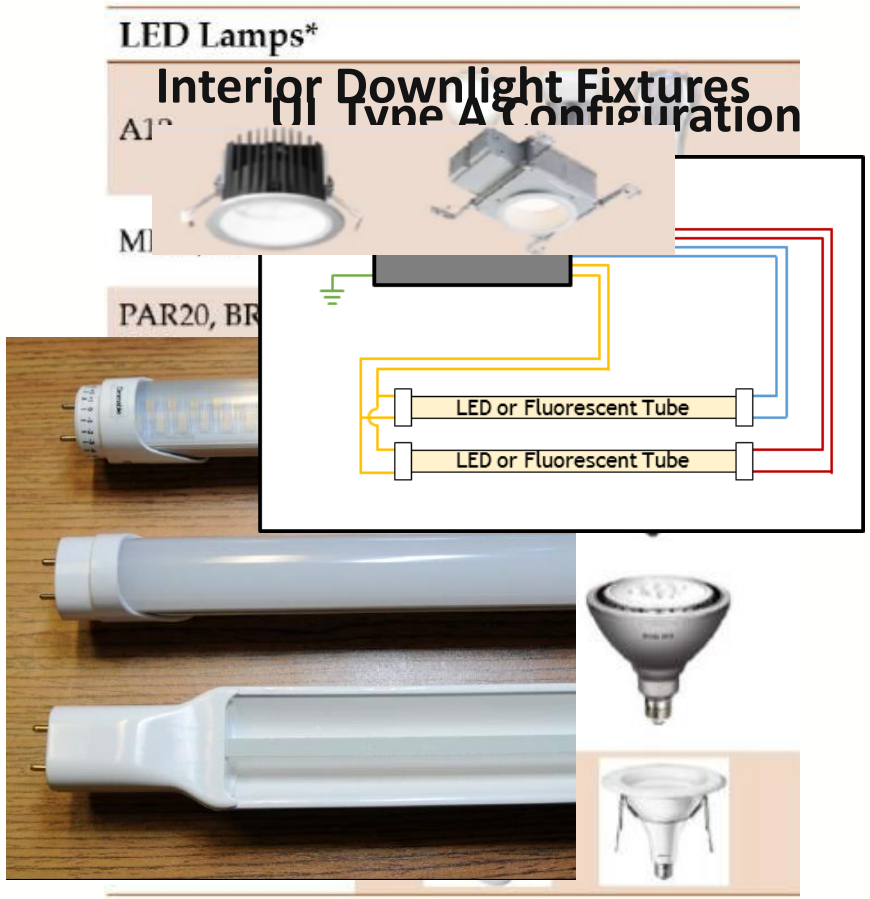
No.	Description	Energy (kWh/yr)	% of Total
★ 4.27	LED, PAR20, 30, 38,	77,757,805	12.6%
★ 4.28	LED, Candelabra	4,150,347	0.7%
★ 4.29	LED, Globe	236,283	0.0%
★ 4.30	LED, A-Lamp	112,402,706	18.2%
★ 4.31	LED, Recessed Downlight	13,090,543	2.1%
★ 4.32	LED, R-BR	40,386,227	6.6%
★ 4.33	LED, GU-24		
4.34	LED, Various Lamps		
4.35	LED, Exterior Lamps	1,194,663	0.2%
★ 4.36	LED, Tube LED	423,546	0.1%
4.37	HID, Interior Fixture	22,981	0.0%
4.38	HID, Exterior Fixture	20,173	0.0%
4.39	HID, Interior Lamp		
4.40	Sensor, Residential Occ	57,408	0.0%
4.41	Sensor, Wall or Ceiling Occ	889,086	0.1%
4.42	Sensor, Integrated Fixture	154,002	0.0%
4.43	Sensor, Photocell		
4.44	Open Sign	130,576	0.0%
4.45	Menu Board		
4.46	Channel Letter Sign		
4.47	Refrig, Case Door	12,515,846	2.0%
4.48	Refrig, Walk-in	15,982	0.0%
4.49	Refrig, Reach-in	2,732,405	0.4%
4.50	Cold Cathode		
4.51	LED, Pool		
4.52	CFL, Ceiling Fan		
4.53	LED, Sports or Athletic Fields	398,406	0.1%

Lighting Measures for 2017

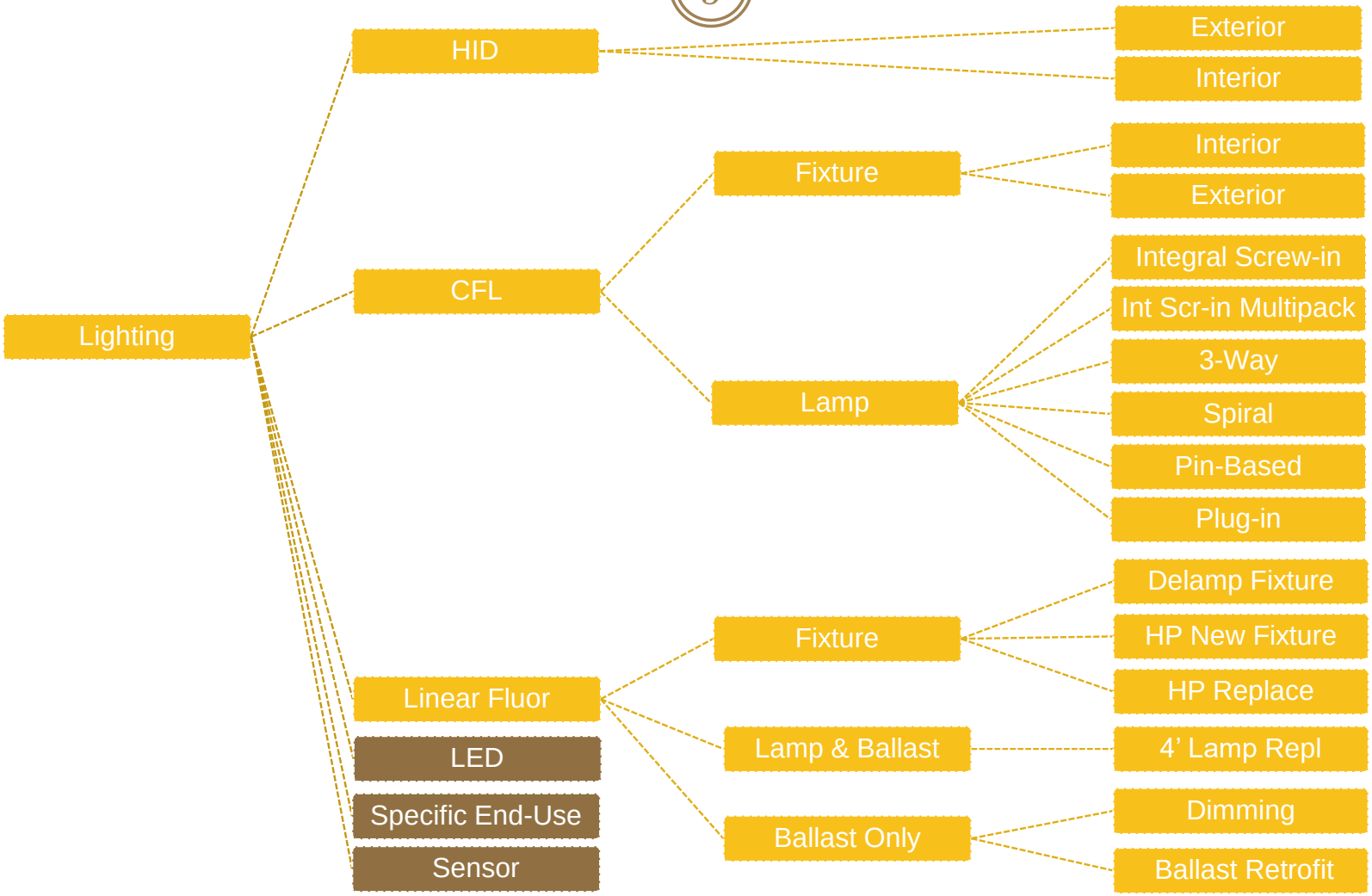
Lighting Measures for 2017

- LF, 4' Replace Lamp
- LED, Interior Downlight
- LED, Tube LED

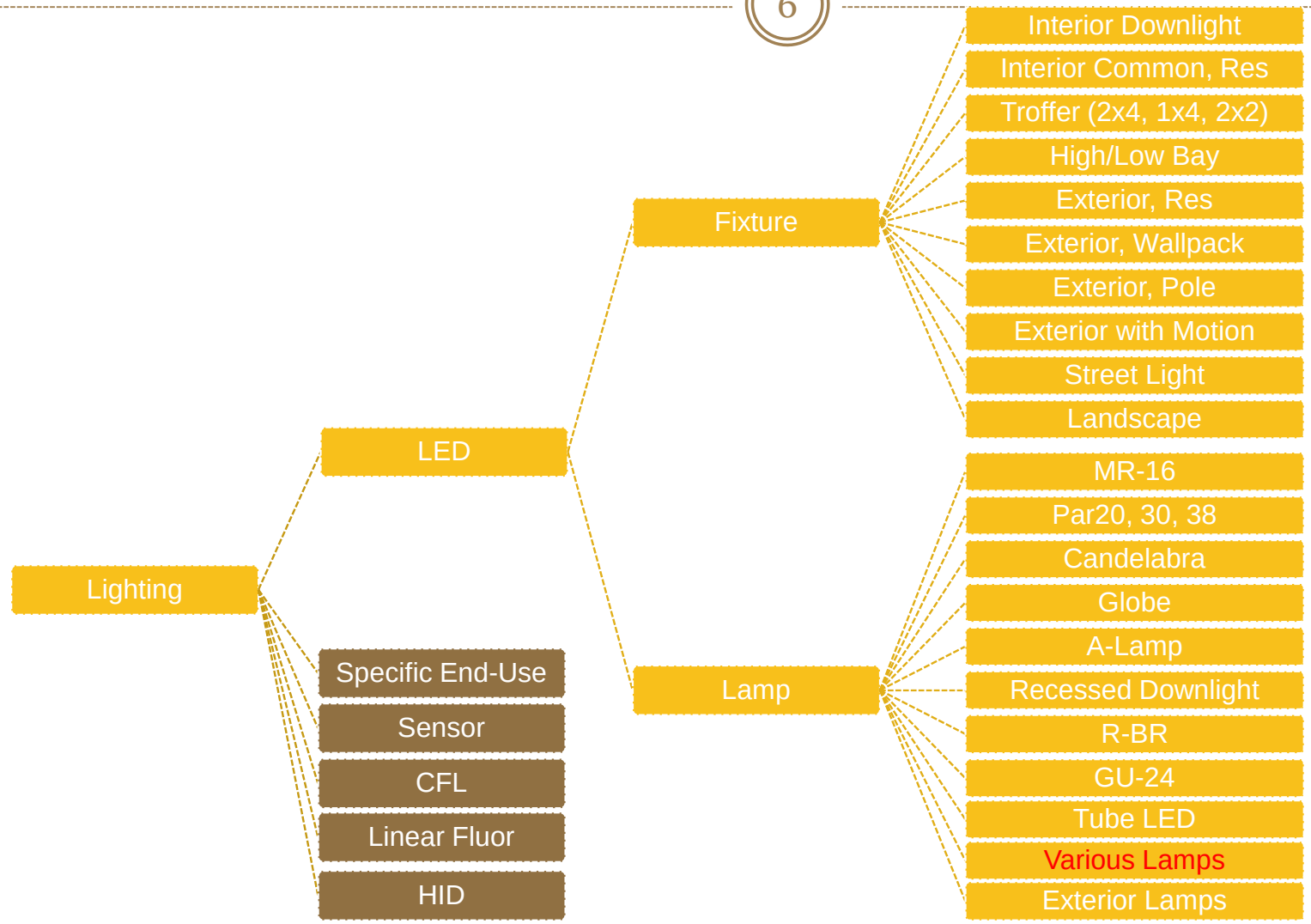
- LED, A-Lamp
- LED, Candelabra
- LED, MR-16
- LED, PAR20, 30, 38,
- LED, R-BR
- LED, Globe
- LED, GU-24
- LED, Recessed Downlight



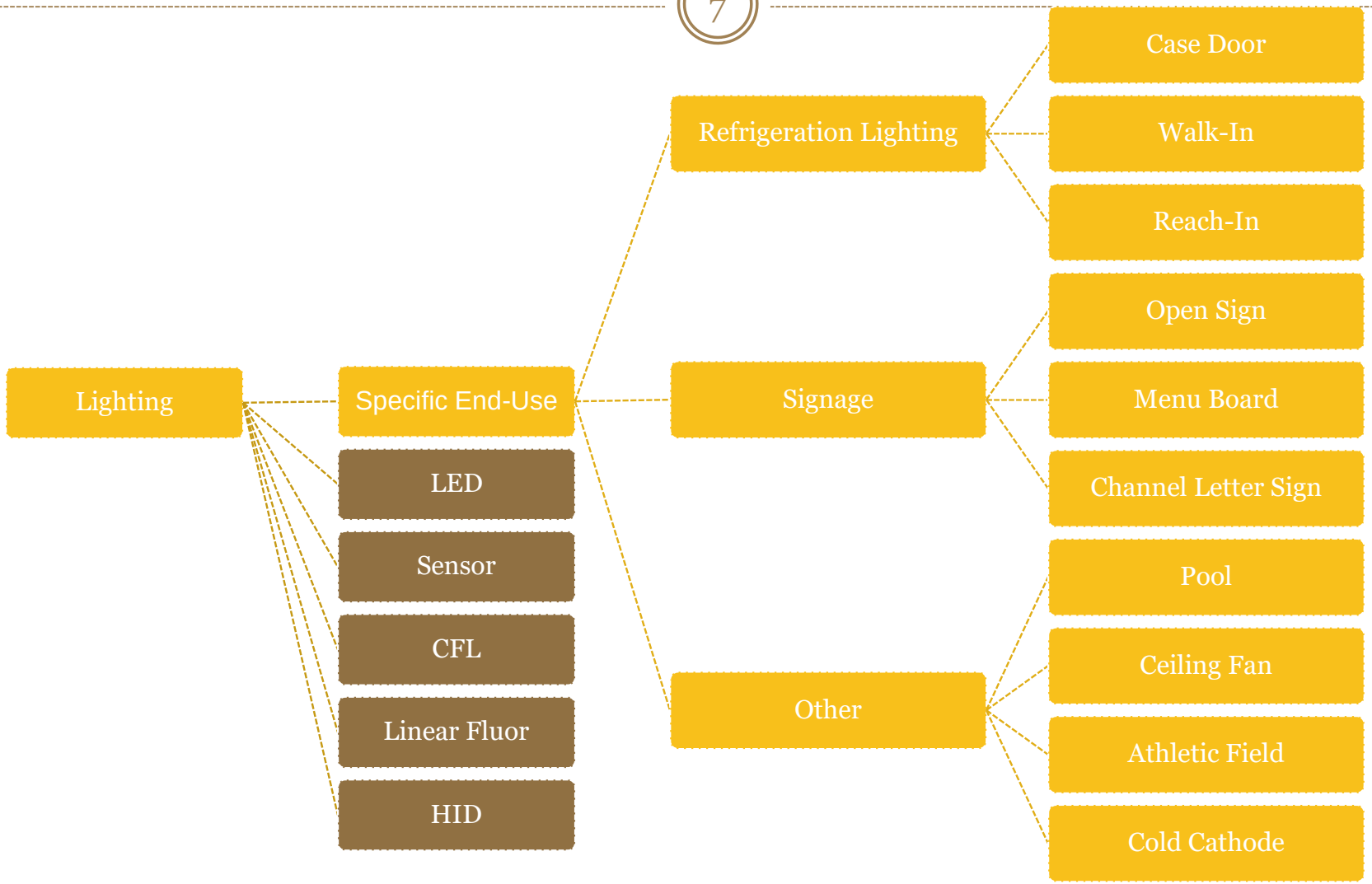
Lighting Measure Tree



Lighting Measure Tree



Lighting Measure Tree



4.10, LF 4' Replacement

PA	Date Updated	Meas Appl Type	Offerings	Desc	Sectors	Bldg Loc
SCE	11/12/16	ROB	Comm x3 Res x3	- Lamp & ballast replacement, from T8 32W to T8 28W or 25W. - T5 standard efficiency lamp & ballast (54W) to Energy Saver T5 lamp & ballast (49W).	Res and Non-Res	CZ - specific
PG&E	11/17/16	REA	Interior x2 Exterior x2	Lamp only replacement from 32W to either 28W or 25W T8.	Non-Res only	IOU
SDG&E	6/30/14	ROB	x2	Lamp only replacement from 32W to either 28W or 25W T8.	Non-Res only	CZ - specific
Recommended	4.10a	REA / AOE	Interior x2 Exterior x2	Lamp only	Non-Res only	Tbd
Recommended	4.10b	ROB	Comm x3 Res x3	Lamp and Ballast	Res and Non-Res	Tbd

4.16, LED, Interior Downlight
4.31, LED, Recessed Downlight

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PA / Date	Measure Appl. Type	Offering	Description	Baseline	Sectors	Life	Cost
SCE 11/1/16	ROBNC and ER (for DI)	<=15W Res Non-Res Common Area Dwelling Area	Replacement of pendant and recessed incandescent or halogen lamps between 40 and 100 watts with LED downlight modules that are less than 15 watts	Uses WRR of 3.42 (stated in wp)	Res / Comm	20,000 hrs	Nav. Study for base and measure; RS Means for labor
PG&E (LTG139) 11/28/16	ROBNC	<7W to >25W (20 categories)	Replacing incandescent BR30, R30, BR40, MR16, R40 or halogen PAR30, PAR38 with fully integrated LED retrofit kit	Uses WRR of 2.42 from July 22, 2016 Disposition for LED Fixtures	Res / Comm	20,000 hrs (res) 50,000 hrs (comm)	Webscraping – base and measure; Nav. Study
SDG&E 5/21/15	ROBNC	<7W to >25W (19 categories) Not 9W-10W	Replacing incandescent BR30, R30, BR40, MR16, R40 or halogen PAR30, PAR38 with fully integrated LED retrofit kit	Uses WRR of 2.96 (represents type A-lamp WRR for all fixtures in the WP). Used factors from the DEER 2014 Lighting HVAC IE Workbook	Non-Res only	20,000 hrs (res) 50,000 hrs (comm)	RS Means - base; EA d/b – measure
PG&E (LTG175)	ROB	<10W >=10W to 12W >12W to 25W	Replacing R20, BR20, ER20 incandescent or R30, BR30, ER30, R40, BR40 or ER40 incandescent or integral CFL lamps in recessed can fixtures with fully integrated LED downlight retrofit kits	Uses a WRR of 3.42 based on Energy Division Dec 14, 2013 lighting retrofit disposition; Not covered by Title 24	Res only	20,000 hrs	READi/ WO017 – base; webscraping = measure; 25% CFL/75% Inc – base

4.30, LED, A-Lamp

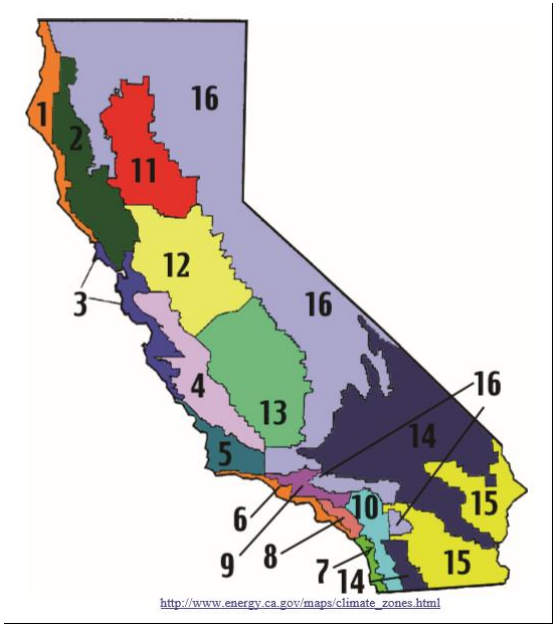
PA / Date	Measure Appl. Type	Offering	Baseline	Sectors	Life	Cost
PG&E (LTG165) 8/10/17	ROB	4 EISA Wattage with 4 Efficacy Thresholds	EISA bin based measure definition with an adjustment for savings based on 4 LPW thresholds in each EISA bin States HOU & IE's based on most recent DEER values.	Res and Comm	20,000 hrs	Webscraping
SCE (LG133) 6/30/17		Adds dwelling areas & common areas for MF dwelling areas and residential mobile homes.	The operating hours for Commercial and Residential were taken from DEER 2016.			Base and measure case costs refers to attached calculation templates
SDG&E (L10106) 6/30/17		Addressed LED reflector lamps (BR/R) Lower LPW group added for each EISA Wattage	Adds long list of requirements (including PF, CRI, standby power, etc)			Measure cost - utilizes its own MSRP's costs from its contracted manufacturer/distributor for both A-lamps and reflectors

Lighting – Cross Cutting Issues

- Savings methodology
  - Wattage Reduction Ratio vs Wattage Range vs Lumen Bins
  - Interactive effects
  - Hours of Use support
  - Baseline
  - Existing Conditions – AB802
- Cost variation due to Climate Zone
- Permutation collapse
- Categorization

Climate Zone vs IOU

- To claim lighting savings, there are two methods used today:
  - Specify Climate Zone (SCE / SDG&E)
  - Use Weighted Average Approach = “IOU” (PG&E)
- Climate Zone impacts savings and cost:
  - Savings through the DEER Interactive Effects Table
    - Energy Interactive Effects (kWh/kWh)
    - Demand Interactive Effects (kW/kW)
    - Coincident Demand Factor (CDF) (%)
    - Gas Interactive Effects (Therms/kWh)
    - Hours of Use (hours/year)
    - Revised in 2016
  - Cost through DEER Cost Adjustment Tables
    - Material Cost
    - Labor Cost



- Energy Savings (kWh) = Wattage * HOU * Energy IE (kWh/kWh)
- Demand Savings (kW) = Wattage * CDF * Demand IE (kW/kW)
- Gas Savings (therms) = Wattage * HOU * Gas IE (th/kWh)

Climate Zone vs IOU

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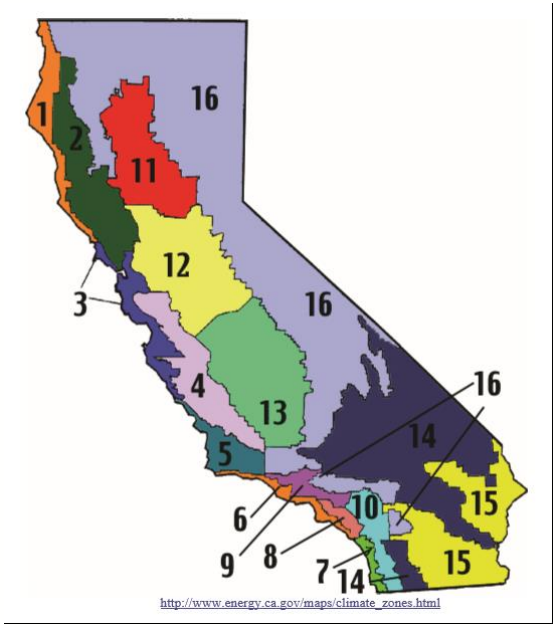
    - Gas Interactive Effects (Therms/kWh)
    - Hours of Use (hours/year)
    - Revised in 2016
  - Cost through DEER Cost Adjustment Tables
    - Material Cost
    - Labor Cost
- Plan
  - Explain the Interactive Effects Table (and variation)
  - Try to quantify the difference between the methods
- Goal
  - Choose the best path forward for the eTRM



Interactive Effects Table – DEER 2016

- Large table
  - 16,000+ combinations by PA, Bldg Type, Vintage, CZ, Ltg Type, OS

Lookup Index	IOU	BldgTyp	BldgVint	BldgLoc	Ltg Type	OS	Hours of Use and Coincident demand Code and Msr Cases HOU	CDF	Calculate IE from WB/EU impacts Energy kWh/kWh	Demand kW/kW	Gas therm/kWh
CFLB	PGE	Asm	Ex	CZ01	CFL	Bldg	1160	0.221	0.948	1.16	-0.0178
CFLB							1160	0.221	1.03	1.17	-0.0103
CFLB							1160	0.221	1.03	1.17	-0.0113
CFLB							1160	0.221	1.05	1.17	-0.00835
CFLB							1160	0.221	1.05	1.2	-0.00974
CFLB							1160	0.221	1.05	1.17	-0.00888
CFLB							1160	0.221	1.04	1.18	-0.00931
CFLB							1160	0.221	1.08	1.21	-0.0086
CFLB							1160	0.221	0.983	1.19	-0.0134
CFLB							1160	0.221	1.04	1.18	-0.00991
CFLB							1160	0.221	1.05	1.2	-0.00974
CFLB							1160	0.221	1.09	1.24	-0.00522
CFLB							1160	0.221	1.1	1.2	-0.00456
CFLB							1160	0.221	1.11	1.24	-0.00499
CFLB							1160	0.221	1.09	1.22	-0.0058
CFLB							1160	0.221	1.08	1.21	-0.0086
CFLB							1160	0.221	1.07	1.14	-0.00914
CFLB							1160	0.221	1.25	1.18	-0.00255
CFLB							1160	0.221	0.983	1.19	-0.0134
CFLB							1160	0.221	1.1	1.22	-0.00533

IOU	BldgType		BldgVint	BldgLoc	Ltg Type	OS
PGE	Asm	RSD	Ex	CZ01	CFL	Bldg
SCG	Com	Rt3	New	CZ02	HB	None
SCE	ECC	RtL		CZ03	LF	AllSpc
SDG	EPr	RtS		CZ04	Exit	
	ERC	s_Agr		CZ05		
	ESe	s_Cli		CZ06		
	EUn	s_FSt		CZ07		
	Gro	s_Ind		CZ08		
	Hsp	s_MiC		CZ09		
	Htl	s_TCU		CZ10		
	MBT	SCn		CZ11		
	MLI	SUn		CZ12		
	Mtl	WRf		CZ13		
	Nrs	DMo		CZ14		
	OfL	MFm		CZ15		
	OfS	Res		CZ16		
	RFF	SFm		IOU		

Interactive Effects Table – DEER 2016 Variation across Climate Zones

- Large table
  - ~400+ combinations by PA, Bldg Type, Vintage, Ltg Type, OS
  - (see spreadsheet – "Summary of SD" worksheet)
  - Observations – Across *one IOU's* Climate Zones
    - HOU – varies only slightly
    - CDF – varies only slightly (except for schools)
      - Likely because DEER peak changes with CZ (not confirmed)
    - kW and kWh varies only by less than 4-7% SD
    - Therms vary can vary by more than 100% SD
    - Res – has more variation in kW and kWh; less variation in therms
    - New is very similar to Ex
  - Take-away
    - Potential concern for therm variation and CDF/kW for schools

Interactive Effects Table – DEER 2016 Variation across IOU

- Larger table
  - 16,000+ combinations by PA, Bldg Type, Vintage, CZ, Ltg Type, OS
  - (see spreadsheet – "Pivot between IOUs" worksheet)
  - Zoom out to see similar pattern – for "New"
    - Little variation for HOU, CDF'; more variation between energy/demand
    - Question: Why different between New and Ex?
  - Zoom in to Office Large
  - Observations – Across IOUs
    - For Existing Bldg (Ex), minimal variation across CZ except COM
      - Except "Exit"
      - Minimal Residential
      - No variation for A-Lamp choices (CFL / Bldg or None)
  - Take-away:
    - We should ask some deeper questions long-term about where the differences come from.
    - Are the differences still valid / significant?

Climate Zone vs IOU

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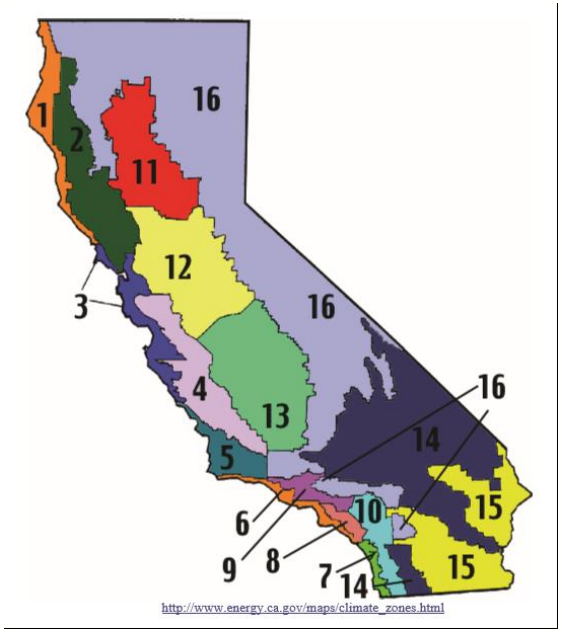


Climate Zone vs IOU

Averaged Climate Zone	Climate Zone Specific

• Existing PG&E methodology
• Approach
• Benefits
• Concerns
• Quantitative Comparison
  ○ A-Lamp Example
	• Existing SCE/SDG&E methodology
	• Approach
	• Benefits
	• Concerns
	• Quantitative Comparison
	  ○ A-Lamp Example

Want feedback along the way to add to this list, so that we can make decision on how to move forward. I will come back to the list after talking through the analysis to let you add more (now or after the meeting).

Climate Zone vs IOU

Averaged Climate Zone

- Existing PG&E methodology
- Approach:
  - Stage 1:
    - IOUs would use weighted value for each CZ
    - POUs would use actual CZ
      - *OR*
    - POUs would use closest IOU weighted average

Climate Zone Specific

- Existing SCE/SDG&E methodology
- Approach:
  - Stage 1:
    - CZ specific values
    - May vary by PA due to interactive effects
    - POUs would use average interactive effect values
  - Stage 2:
    - All use average IE values

Climate Zone vs IOU

Averaged Climate Zone

- Existing PG&E methodology
- Benefits:
  - Simplifies permutations in Stage 1
  - Error in other parameters (ie, HOU) likely greater than IE effects
  - Upstream programs may have difficulty identifying actual CZ

Climate Zone Specific

- Existing SCE/SDG&E methodology
- Benefits :
  - One set of values by Climate Zone for all to use (IOU/POU) in Stage 2
  - More accurate savings values
    - Some IE effects like Therms can vary significantly

Climate Zone vs IOU

Averaged Climate Zone

- Existing PG&E methodology
- Concerns:
  - ~~POU approach may not be the same as IOU long term~~
  - Not clear how weighted average is done.
  - Gas interactive effects look significantly different across climate zones

Climate Zone Specific

- Existing SCE/SDG&E methodology
- Concerns:
  - More permutations than IOU approach short term until IE effects can be averaged per climate zone
  - Allows for cost complexity
  - May not be possible for Upstream Programs

Climate Zone vs IOU

- Energy Savings (kWh) = Wattage * HOU * Energy IE (kWh/kWh)
- Demand Savings (kW) = Wattage * CDF * Demand IE (kW/kW)
- Gas Savings (therms) = Wattage * HOU * Gas IE (th/kWh)
- Comparison:
  - Using 2016 claims data (from IOUs)
  - Using 2016 DEER Interactive Effects table
  - A-Lamp Measure looked at specifically due to volume of products implemented
  - Case 1:
    - Changed SCE data to claim savings based upon IOU approach (SCE weighted average)
    - Changed SDG&E data to claim savings based upon IOU approach (SDG&E weighted average)
    - PG&E claims remain unchanged (currently using PG&E weighted average)
  - Case 2:
    - SCE and SDG&E claims remain unchanged
    - Changed PG&E claims data to claim savings based upon CZ-Specific approach
      - Note – 25% of PG&E claims included CZ data; same percentage used to distribute other 75% of PG&E claims data

IE = Interactive Effects
HOU = Hours of Use
CDF = Coincident Demand Factor

Climate Zone vs IOU

Averaged Climate Zone

- Existing PG&E methodology
- Quantitative Comparison
  - SCE / SDG&E:
    - kW (+0.1% / -3.4%)
    - kWh (+0.2% / -3.2%)
    - Therms (+4.4% / -5.4%)
  - Notes:
    - Updated hours for Com Areas
    - Updated Res data with Com savings (not based upon BT)

Climate Zone Specific

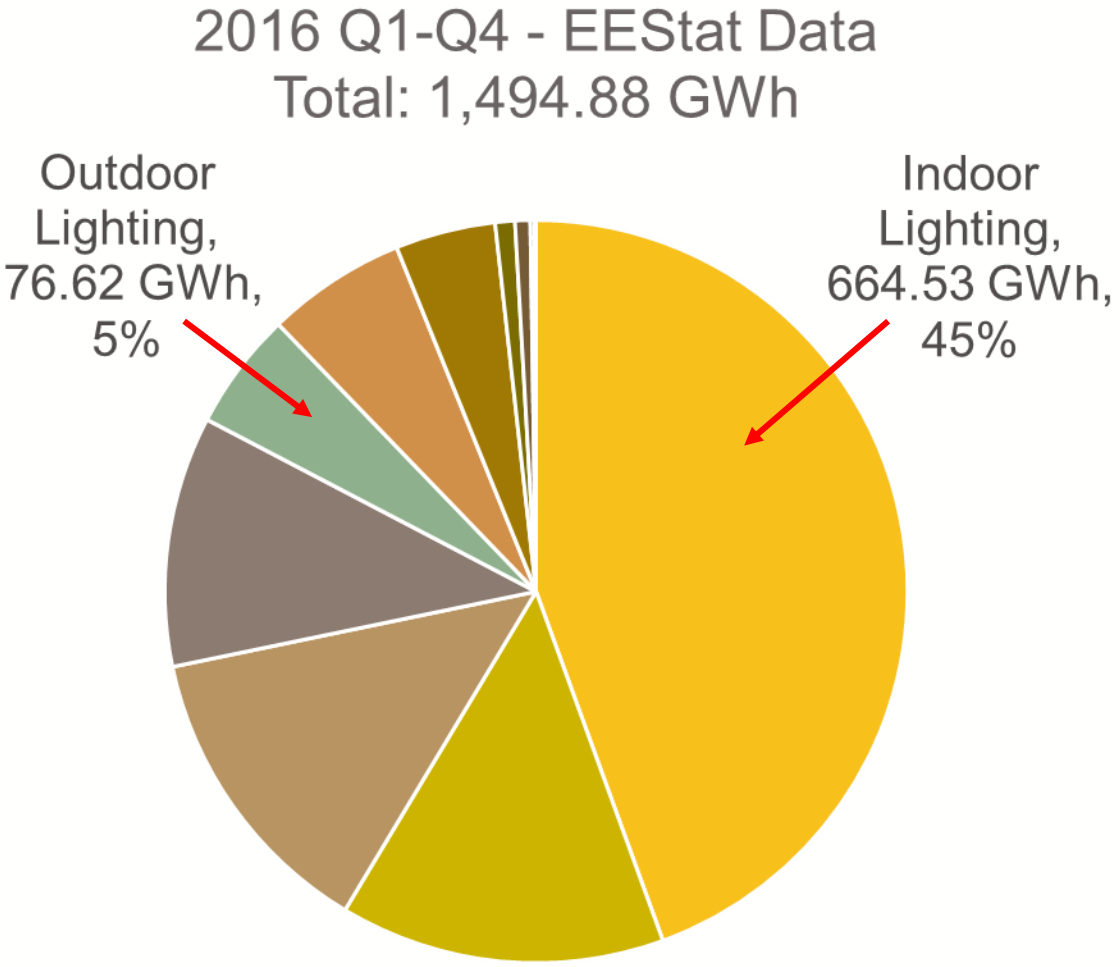
- Existing SCE/SDG&E methodology
- Quantitative Comparison
  - PG&E:
    - kW (-0.2%)
    - kWh (-0.6%)
    - Therms (+1.8%)
  - Notes:
    - Assumed breakdown of CZs

Backup Slides

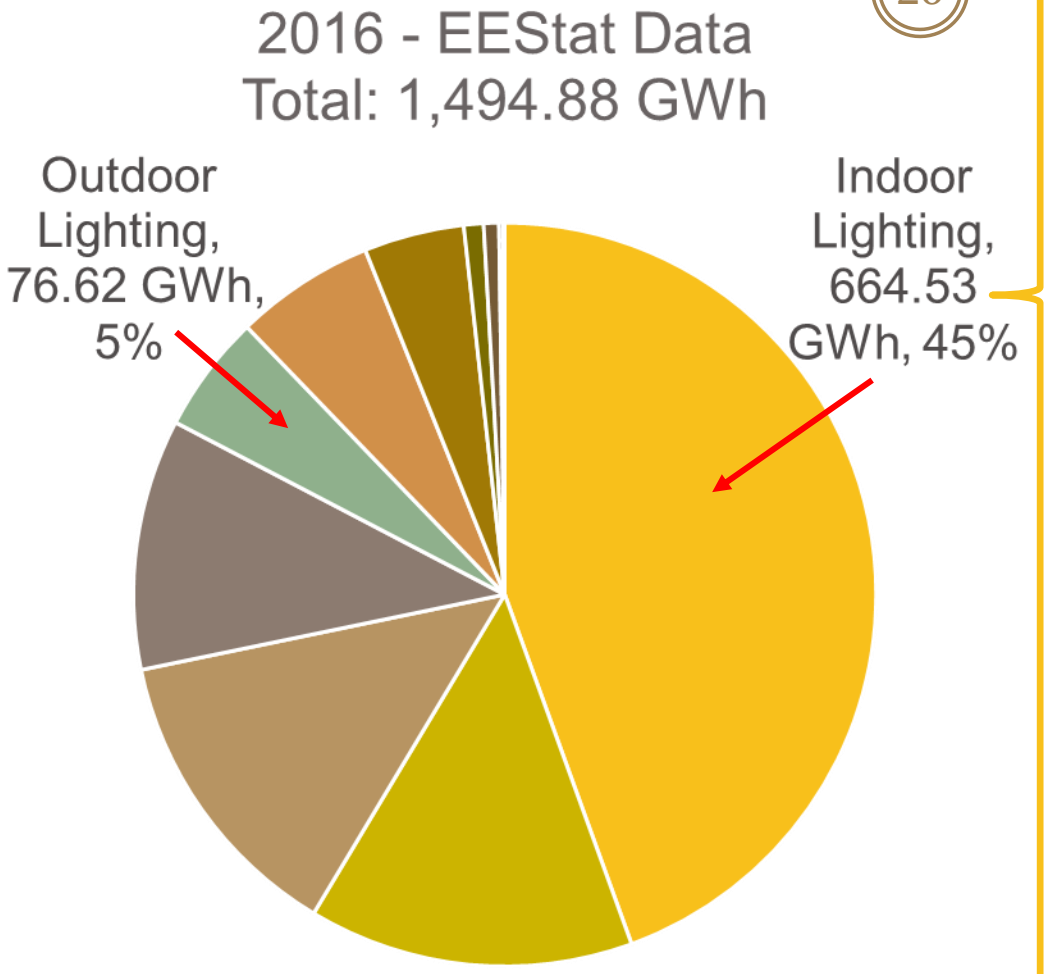
- Climate Zone breakdown based upon 25% of PG&E claims for A-Lamps that did specify Climate Zone.

CZ01	2%
CZ02	7%
CZ03	38%
CZ04	12%
CZ05	5%
CZ11	6%
CZ12	22%
CZ13	8%
CZ16	0%

2016: Lighting Savings Perspective



Indoor Lighting



Indoor Lighting	
Lighting Indoor CFL > 30 Watts	2.58
Lighting Indoor CFL 3 Way	13.54
Lighting Indoor CFL A Lamp	31.46
Lighting Indoor CFL Basic	138.87
Lighting Indoor CFL Fixture	1.76
Lighting Indoor CFL Globe	0.00
Lighting Indoor CFL Other	0.00
Lighting Indoor CFL Reflector	4.65
Lighting Indoor Controls Daylighting	0.17
Lighting Indoor Controls Other	1.40
Lighting Indoor Controls Wall Or Ceiling	1.30
Lighting Indoor Fixture Integrated Occu	0.17
Lighting Indoor HID	0.18
Lighting Indoor High Bay Fluorescent	2.21
Lighting Indoor Induction	0.02
Lighting Indoor LED Fixture	125.80
Lighting Indoor LED Lamp	123.43
Lighting Indoor LED Night Light	0.20
Lighting Indoor LED Other	19.97
Lighting Indoor LED Reflector Lamp	124.17
Lighting Indoor LED Signage	0.13
Lighting Indoor Linear Fluorescent	42.10
Lighting Indoor Linear Fluorescent Dela	3.96
Lighting Indoor Other	26.09
Lighting Outdoor LED Fixture	0.03
Lighting Outdoor LED Streetlight	0.28
Other	-
Retrocommissioning Lighting	0.06
Indoor Lighting Total	**664.53**

Lighting Savings Perspective

2016 CA Deemed Electric Savings
(Total = 912 GWh/yr)