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Proposal Information Template for:
Fluorescent Dimming Ballasts

Submitted to:
California Energy Commission
In consideration for the 2011 Rulemaking Proceeding on Appliance Efficiency Regulations, Docket number 11-AAER-1

Prepared for:
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San Diego Gas & Electric
Southern California Edison
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Last Modified: September 30, 2011

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Please note: all savings estimates and information in this document are preliminary and are based on data available to the authors at the time of the report. If the CEC moves forward with this topic, we anticipate updating our estimates and recommendations based upon additional input from stakeholders.

Proposal Information Template – Fluorescent Dimming Ballasts

2011 Appliance Efficiency Standards

Prepared for: Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison, Southern California Gas Company

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Purpose

This document is a report template to be used by researchers who are evaluating proposed changes to the California Energy Commission's (Commission) appliance efficiency regulations (Title 20, Cal. Code Regulations, §§ 1601 – 1608) This report specifically covers Fluorescent Dimming Ballasts.

Background

All fluorescent fixtures require a ballast to operate. The ballast provides a high initial voltage to initiate the discharge to start the lamp, and then rapidly limits the lamp current to safely sustain the discharge. Fluorescent lamps driven by standard ("fixed output") ballasts cannot be properly dimmed with a dimmer control such as those used for incandescent lamps. For a fluorescent lamp to be dimmed, it must be driven by a dimming ballast. Dimming ballasts are capable of dimming the lamp to at least one intermediate light level between 100% full output and off mode. These ballasts, shown in the figure below, with the appropriate controls, can save significant energy relative to non-dimming ballasts by raising and reducing light levels to adaptively meet the specific lighting needs in different conditions and activity levels.

Figure 1. Typical dimming ballasts. Source: Google Images

Dimming ballasts are used primarily when indoor spaces are lighted using natural outdoor light. Common scenarios include office spaces with windows, big box retail stores with

skylights as well as other similar situations. Dimming ballasts can be controlled in a variety of ways, including light sensors that automatically dim lights in response to ambient light conditions and user-operated, wall-mounted controls. Dimming systems are generally more expensive than non-dimming systems both in terms of hardware and installation.
There are two main methods of controlling ballast dimming level: analog and digital. Analog control makes use of the wires that deliver power to the ballast to set the dimming level, while digital systems typically use two additional wires to send a signal to the ballast to indicate the dimming level. The Consortium for Energy Efficiency (CEE) maintains a list of "High-Performance Dimming Ballasts," which represent ballasts that meet the programmed-rapid start requirements of the "High Performance T8 Specification" at full light output. This list is provided in Appendix A.

Currently, sales and existing stock of dimming ballasts in CA are relatively small compared to fixed output ballasts. However, there are proposed changes to the CA building energy code (Title 24) that have been vetted and developed over the past two years, and which are likely to be adopted in 2012, to take effect in 2014. These code changes will likely result in a very large increase in dimmable ballast sales in CA. However, no minimum efficiency standards exist for these dimmable fluorescent ballasts. The efficiency gap between high efficiency and low efficiency dimmable ballasts is substantial; therefore, savings from an efficiency standard for dimmable fluorescent ballasts will likely be significant.

Overview

Description of Standards Proposal	Linear fluorescent fixtures require ballasts to start and operate the lamps. In 2014, Title 24 regulations will likely require the lighting in most non-residential spaces (new construction and retrofits) to either be capable of dimming or to have a lighting power density of 0.7W/sq ft or better. In response to this expected increase in dimming ballast sales, this standards proposal sets minimum efficiency levels for fluorescent dimming ballasts based on Ballast Luminous Efficiency (BLE), a new metric used by the US Department of Energy (DOE) to determine the energy efficiency of fluorescent ballasts. DOE defines BLE as follows: $$Ballast\ Luminous\ Efficiency\ (\%) = \frac{Total\ Lamp\ Arc\ Power}{Ballast\ Input\ Power} \times 100 \times \beta$$ Where β is an adjustment factor to account for different frequency ballasts.
California Stock and Sales	We based our 1st year shipments estimates on DOE analyses provided in support of federal ballast rulemakings. Applying assumptions regarding the fraction of national ballast shipments in California and the impact of Title 24 on the market penetration of dimming ballasts results in annual 1st year shipments of 3.0 million units in California in 2014. For this measure, we estimate the installed stock to be on the order of 3.7 million at the start of 2014; however, this value is not critical to our analysis, because shipments are expected to grow dramatically in 2014 with the implementation of the new controllable lighting and retrofit alterations requirements in Title 24. We estimate the total stock of fluorescent ballasts (including both dimming and non-dimming) to be over 90 million, which represents the upper bound of the potential impact of this standard.
Energy Savings and Demand Reduction	Based on very preliminary research, we estimate per unit wattage reduction to be on the order of 5W, leading to annual per unit savings of 17.6 kWh. We estimate first year savings of 43 GWh and savings after full stock turnover of 547 GWh (without including expected growth in annual shipments) statewide. This corresponds to a peak demand reduction of 121 MW in California.

Economic Analysis	Incremental costs for high efficiency dimming ballasts are expected to be minimal. We assume a range of $0-10 per ballast, based on today's prices, but expect to refine this estimate with further market research and manufacturer outreach. Please note that this estimated incremental cost does not include the possible additional cost of advanced optional features, such as occupancy sensors, daylight harvesting controls, etc. Product offerings within the dimming ballast product class are not differentiated strongly along "high price, high efficiency" and "low price, low efficiency" distinctions. Moreover, there are a range of different options that are not correlated to efficiency that have a significant impact on purchasing decisions within the market. It is reasonable to assume that the market would not face significant obstacles in the adoption of higher efficiency options. Lifecycle energy savings will vary by fixture type and application and will scale according to actual dimming profiles. We initially estimate that on average, a high efficiency dimming ballast will lead to $44 in avoided energy costs over the lifetime of the ballast. We plan to refine this estimate as we continue to conduct market research and collect test data specific to dimming ballasts.
Non-Energy Benefits	Our proposal will reduce greenhouse gas emissions at the power generation source, helping California to meet its AB 32 goals (1990 levels by 2020).
Environmental Impacts	TBD.
Acceptance Issues	TBD.
Federal Preemption or other Regulatory or Legislative Considerations	There is currently no industry accepted test procedure specifically designed for dimming ballasts to measure energy consumption at different levels of light output. We propose to apply DOE's recently adopted BLE test procedure (for non-dimming ballasts) to rate the energy efficiency of dimming ballasts. This test procedure has proven to be applicable to all ballasts, including dimming ballasts when operated at 100% power, and it is our understanding from conversation with ballast manufacturers that they would have no difficulty using the BLE test procedure to rate dimming ballasts.

Methodology and Modeling used in the Development of the proposal
Significant savings can be achieved by setting energy efficiency standards for dimming ballasts, which are currently exempt from federal standards. There is a range of efficiencies among dimming ballasts on the market today, and by ensuring that all products are able to meet a minimum level of efficiency, we can greatly enhance savings expected from the Title 24 controllable lighting measures.

Baseline Stock and Shipments

DOE analysis for the 2011 federal rulemaking to update efficiency standards for fluorescent ballasts estimated the total baseline stock and shipments of non-residential fluorescent ballasts in the US to be 82.9 million in 2014. Based on the percentage of national commercial floor area in the Pacific West census region (EIA 2003) and the portion of the Pacific West population that resides in California (U.S. Census Bureau 2002), California represents 9.06% of total US commercial sales, or 7.5 million units per year in 2014.

We expect sales of dimming ballasts, currently a small fraction of the total ballast market, to increase dramatically as a result of Title 24 standards effective in 2014. Based on DOE analysis, 40% of ballast sales in California in 2014 will be for new construction or retrofit. We assume Title 24 will require all of these ballasts to be dimmable.

Baseline and Standards Case Energy Use

We are still in the process of building a comprehensive dataset representative of the stock of available dimming ballasts from major manufacturers, and expect to conduct testing to measure the BLE of dimming ballasts (since this metric is new and this data does not yet exist). In lieu of more precise data, we currently estimate the base case and standards case energy consumption of dimming ballasts by examining the Consortium of Energy Efficiency's (CEE) list of high-performance T8 dimming ballasts. From this list, we are able to approximate the difference in relative efficiencies of higher and lower efficiency dimming ballasts (~5 watts). Since this list is meant to include only the best performing ballasts on the market, we believe that solely looking at the upper and lower bound of this list represents a conservative estimate of the actual efficiency gains that a Title 20 standard could achieve. Preliminary research found ballasts some that are not CEE listed with much higher power requirements, providing further indication that our initial savings estimates are conservative.

We assume that the average annual operating hours for fluorescent ballasts in commercial buildings is 3,184 hours, based on utility best estimates, shown in Appendix C. In both the base case and standards case, we assume that ballasts are dimmed, resulting in decreased annual energy consumption. The following table was developed through Title 24 research to determine the estimated annual savings from different dimming scenarios. We have preliminarily used an average of these savings percentages to calculate base and standards case annual energy use of dimming ballasts.

Table 1. Savings from dimming for non-residential fluorescent ballasts

Scenario	% Savings
Base Case	---
Tuning + Dimming	15%
Tuning + Tri-Level	0%
Tuning + Bi-Level	0%
Tuning, Daylighting + Dimming	29%
Daylighting + Dimming	16%
Daylighting + Tri-Level	12%
Daylighting + Bi-Level	11%
Tuning, Personal Controls + Dimming	19%
Personal Controls + Dimming	4%
Personal Controls + Tri-Level	4%
Personal Controls + Bi-Level	4%
Tuning, Occ/Vacancy + Dimming	17%
Occ/Vacancy + Dimming	3%
Occ/Vacancy + Tri-Level	3%
Occ/Vacancy + Bi-Level	3%
Average	9%

Note: Tuning refers to a dimmable fixture’s ability to downward adjust light levels in previously over-lit areas in order to minimally meet desired light levels.

To determine the peak demand associated with fluorescent ballasts, we used the coincident diversity factors reported by the Energy Division to utilities in BaseCamp on January 26, 2011 shown in Appendix C. We preliminarily used the average value across all building types of 0.64; we expect to refine this estimate by acquiring more comprehensive data on relative lighting usage among different building types, but do not expect a significant change from this value.

Incremental Cost

We are still in the process of collecting information on the incremental cost of high efficiency dimming ballasts. Initial conversations with industry experts indicated that incremental costs are expected to be very low, if not negligible in many cases. For now, when considering the ballast only, we assume an incremental cost of $0-10, but expect to refine this estimate as we continue our market research.

Data, Analysis, and Results

Our preliminary analysis indicates that standards to regulate efficiency of dimming ballasts will generate significant energy savings. Based on the assumed impact of Title 24 requirements on total ballast shipments in 2014, we leverage DOE market analyses to estimate the total shipments and stock of dimming ballasts in California. The table below presents the estimated shipments and stock of dimming ballasts in 2014.

Table 2. Stock and shipments of dimming fluorescent ballasts in California in 2014.

2014 stock in CA (million units)	2014 shipments in CA (million units)
3.79	3.00

Multiplying estimated per unit energy savings, operating hours, and the expected percent reduction in baseline energy consumption as a result of the inherent dimming capability of both base case and standards case ballasts, we calculated annual, standards case per unit energy savings to be approximately 18 kWh.

We then determined first year savings by multiplying annual energy savings per unit by total shipments in 2014. To determine total savings after stock turnover, we multiplied first year savings by the assumed lifetime of the ballast. This simplified savings model does not yet account for potential increases in annual shipments beyond 2014, which could lead to greater savings opportunities. Demand savings were calculated assuming a 64% peak coincidence factor. The table below presents preliminary estimates for per unit annual energy and demand savings, 1st year energy and demand savings, as well as after stock turnover energy and demand savings.

Table 3. Savings resulting from proposed standards for dimming ballasts in California

	Annual energy savings	Peak demand savings
Per unit	14 kWh	3 W
1st year	43 GWh	10 MW
After stock turnover	547 GWh	121 MW

Life-cycle cost savings were determined to be on the order of $44 per unit, according to CEC methodology (Energy Solutions 2011), based on electricity price trends. As more ballast energy use data becomes available, we expect to refine this estimate.

Proposed Standards and Recommendations

We recommend that California set minimum BLE requirements for dimming ballasts. Similar to federal BLE requirements being set for non-dimming fluorescent ballasts, for this standard, we recommend that BLE levels be set according to the measured lamp arc power of the ballast. Each ballast would be tested at 100% power mode. California also should adopt the test procedure and compliance and reporting requirements used in the federal fluorescent ballast rulemaking.

Final BLE standard levels TBD, pending additional data on measured performance of dimming ballasts.

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References and Appendices

Appendix A: CEE High Performance Dimming Ballasts

Manufacturer	Product Name	Model Number	NEMA[4] Premium®	Lamp Wattag	Voltage (V)	Ballast Type [2]	Ballast Factor Rang	Ballast Fact	Input Watts (W)	BEF[3]	
HP T8 Qualified Ballasts with 1 Lamp											1 Lamp
Fifth Light Technology	DALI	FLT-120-1x32WT8HBF-DALI	no	32	120	PD	Normal	1.00	35	2.86	
		FLT-277-1x32WT8HBF-DALI	no	32	277	PD	Normal	1.00	35	2.86	
General Electric Company	UltraStart T8 100-3% Dimming	GE132MVPS-N-VO3	no	32	120/277	PD	Normal	0.88	30/29	2.93/3.03	
Leviton	Sector	SD1F8-32M	no	32	120/277	PD	High	1.15	39	2.95	
		SD1J8-32M	no	32	120/277	PD	High	1.15	39	2.95	
LUMEnergi	LUMEnergi	LUM-LD-IB100	no	32	120/277	PD	High	1.20	40	3.00	
Lutron	Hi-Lume3D	H3D T832 C UNV 1 10	no	32	120/277	PD	Normal	1.00	35.1 / 34.8	2.85/2.87	
		H3D T832 C UNV 1 17	no	32	120/277	PD	High	1.17	39.7	2.95	
	EcoSystem	EHD T832 C U 1 10	no	32	120/277	PD	Normal	1.00	35.1 / 34.8	2.85/2.87	
		EHD T832 C U 1 17	no	32	277	PD	High	1.17	39.7	2.95	
OSRAM SYLVANIA	Quicktronic	QTP1X32T8/UNVDIM-TC	yes	32	120/277	PD	Normal	0.88	30	2.93	
		QHES2X32T8/UNVPSN-SC	yes	32	120/277	PD	Normal	0.87	28/29	3.00/3.11	
Philips - Advance	Mark 10 Powerline	REZ-132-SC	yes	32	120	PD	Normal	1.00	35	2.86	
		VEZ-132-SC	yes	32	277	PD	Normal	1.00	35	2.86	
	Mark 7	IZT-132-SC	yes	32	120/277	PD	Normal	1.00	35	2.86	
	ROVR	IDA-132-SC	yes	32	120/277	PD	Normal	1.00	27/35	3.70/2.86	
Robertson Worldwide	Sterling Series	PSL132T8MV3D	yes	32	120/277	PD	Normal	1.00	34	2.94	
Universal Lighting Technologies	DemandFlex	B232PUNVDRL-A	yes	32	120/277	PD	Low	.83/.84	23.7/23.8	2.88/2.87	
		B232PUNVDR-A	yes	32	120/277	PD	Normal	0.88	29/30	3.03/2.93	
	Ballastar	B232PUS50-A	yes	32	120/277	PD	Normal	0.88	29	3.03	
	SuperDim	B132PUNVSV3-A	yes	32	120/277	PD	Normal	0.88	30	2.93	
HP T8 Qualified Ballasts with 2 Lamps											2 Lamp
ELB Electronics, Inc.	ELB Plus Dimming Ballast 0-10VDC	ELB-2L32 EA10ES120-277	no	32	277	PD	Normal	0.88	58.3	1.51	
		ELB-2L32 EA10E120-277	no	32	277	PD	Normal	1.00	67.5	1.48	
		ELB-2L32 EA10EH120-277	no	32	120/277	PD	High	1.18	74.2/72.3	1.59/1.63	
General Electric Company	UltraMax Bi-Level Switching	GE232MAX90-S60	yes	32	120/277	PD	High	1.18	75/74	1.57/1.59	
	UltraMax LoadShed Dimming	GE232MAX90-V60	yes	32	120/277	PD	High	1.18	75/74	1.57/1.59	
	UltraStart T8 100-3% Dimming	GE232MVPS-N-VO3	no	32	120/277	PD	Normal	0.88	58/56	1.52/1.57	
		GE232MVPS-H-VO3	no	32	120/277	PD	High	1.18	76/74	1.55/1.59	
Leviton	Sector	SD2F8-32M	no	32	120/277	PD	High	1.15	76	1.51	
		SD2J8-32M	no	32	120/277	PD	High	1.15	76	1.51	
LUMEnergi	LUMEnergi	LUM-LD-IB100	no	32	120/277	PD	High	1.20	76/75	1.58/1.60	
Lutron	Hi-Lume3D	H3D T832 C UNV 2 10	no	32	120/277	PD	Normal	1.00	66.5/65.7	1.50/1.52	
		H3D T832 C UNV 2 17	no	32	120/277	PD	High	1.17	76.9/75.4	1.52/1.55	
		EC5 T832 G UNV 2L	no	32	120/277	PD	Low	0.85	56.9	1.49	
	EcoSystem	EC5 T832 J UNV 2	no	32	120/277	PD	Low	0.85	59.1/57.4	1.44/1.48	
		EHD T832 C U 2 10	no	32	120/277	PD	Normal	1.00	66.5 / 65.7	1.50 / 1.52	
		EHD T832 C U 2 17	no	32	120/277	PD	Normal	1.17	76.9 / 75.4	1.52 / 1.55	
OSRAM SYLVANIA	Quicktronic	QHES2X32T8/UNVPSN-SC	yes	32	120/277	PD	Normal	0.87	55/54	1.58/1.61	
		QTP2X32T8/UNV DIM TC	yes	32	120/277	PD	Normal	0.88	60/58	1.47/1.52	
		QHELS2X32T8/UNV-ISN-SC	yes	32	277	ID	Normal	0.88	56/55	1.60	
		QHES2X32T8/UNVPSL-SC	yes	32	120/277	PD	Low	0.77	48	1.60	
Philips - Advance	Mark 10 Powerline	REZ-2S32-SC	yes	32	120	PD	Normal	1.00	68	1.47	
		VEZ-2S32-SC	yes	32	277	PD	Normal	1.00	68	1.47	
	Mark 7	IZT-2S32-SC	yes	32	120/277	PD	Normal	1.00	67	1.49	
	EssentiaLine	ILV-2S32-SC	yes	32	120/277	PD	Normal	0.88	59	1.49	
	ROVR	IDA-2S32-SC	yes	32	120/277	PD	Normal	1.00	68.0	1.47	
Pure Spectrum Lighting	PureSpectrum	PST232PNS3	no	32	277	PD	Normal	1.00	68	1.47	
Robertson Worldwide	Sterling Series	PSL232T8MV3D	no	32	120/277	PD	Normal	1.00	68	1.47	
Sage Lighting Ltd	Sage	NU232T8D-ROHS	no	32	120/277	PD	Normal	0.88	60	1.47	
Sunpark Electronics Corp.	Ultra Lumen	U-232PS3	no	32	277	PD	Normal	1.00	68	1.47	
		U-232PS3-HBF	no	32	277	PD	High	1.20	79	1.52	
Ultrasave Lighting Ltd.	-	PR232120M-D	no	32	120/277	PD	Normal	1.00	67	1.49	
Universal Lighting Technologies	Demand Flex	B232PUNVDR-A	yes	32	120/277	PD	Normal	0.88	56/55	1.57/1.6	
		B232PUNVDRL-A	yes	32	120/277	PD	Low	0.71	47	1.51	
		B232PUNVDRH-A	yes	32	120/277	PD	High	1.18	74/72	1.59/1.64	
		B232PUNVDFH-A	yes	32	120/277	PD	High	1.15	76/75	1.51/1.53	
		B232PUNVDYL-A	yes	32	277	PD	Low	0.69	46	1.50	
		B232PUNVDY-A	yes	32	120/277	PD	Normal	0.87	58/57	1.50/1.53	
		B232PUNVDYH-A	yes	32	120/277	PD	High	1.15	76/74	1.51/1.55	
	Ballastar	B232PU104S50-A	yes	32	120/277	PD	High	1.04	65	1.60	
		B232PUS50-A	yes	32	120/277	PD	Normal	0.88	57/56	1.54/1.57	
	SuperDim	B232PUNVSV3-A	yes	32	120/277	PD	Normal	0.88	57/56	1.54/1.57	

HP T8 Qualified Ballasts with 3 Lamps											
ELB Electronics, Inc.	ELB Plus Dimming Ballast 0-10VDC	ELB-3L32 EA10ES120-277	no	32	120/277	PD	Normal	0.88	84/82.5	1.51	**3 Lamp**
		ELB-3L32 EA10E120-277	no	32	277	PD	Normal	1.00	98.8	1.48	
		ELB-3L32 EA10EH120-277	no	32	120/277	PD	High	1.18	118.4/115.9	1.59/1.63	
General Electric Company	UltraMax Bi-Level Switching	GE332MAX90-S60	yes	32	120/277	PD	High	1.18	113/110	1.04/1.07	
	UltraMax LoadShed Dimming	GE332MAX90-V60	yes	32	120/277	PD	High	1.18	113/110	1.04/1.07	
	UltraStart T8 100-3% Dimming	GE332MVPS-N-VO3	no	32	120/277	PD	Normal	0.88	87/85	1.01/1.04	
		GE332MVPS-H-VO3	no	32	120/277	PD	High	1.18	116/113	1.02/1.04	
LUMEnergi	LUMEnergi	LUM-LD-IB100	no	32	120/277	PD	High	1.20	113/112	1.06/1.07	
Lutron	Hi-Lume3D	H3D T832 C UNV 3 17	no	32	120/277	PD	High	1.17	106.8/105.7	1.10/1.11	
		H3D T832 G UNV 3 10	no	32	120/277	PD	Normal	1.00	95.4/93.5	1.05/1.07	
	EcoSystem	EC5 T832 G UNV 317	no	32	120/277	PD	High	1.17	106.8/105.7	1.10/1.11	
		EC5 T832 G UNV 3L	no	32	120/277	PD	Low	0.85	85.9/86.5	.99/.98	
		EHD T832 C U 3 10	no	32	120/277	PD	Normal	1.00	95.4 / 93.5	1.05 / 1.07	
	Eco-10	EC3 T832 G U 3 10	no	32	120/277	PD	Normal	1.00	95.4 / 93.5	1.05 / 1.07	
OSRAM SYLVANIA	Quicktronic	QHELS3X32T8/UNV ISN-SC	yes	32	120/277	ID	Normal	0.88	83/82	1.06/1.07	
		QTP3X32T8/UNVDIM-TC	yes	32	120/277	PD	Normal	0.88	87/84	1.01/1.05	
Philips - Advance	Mark 7	IZT-3S32-SC	yes	32	120/277	PD	Normal	1.00	93	1.08	
	Mark 10 Powerline	REZ-3S32-SC	yes	32	120	PD	Normal	0.97	96.0	1.01	
		VEZ-3S32-SC	yes	32	277	PD	Normal	0.97	96.0	1.01	
	ROVR	IDA-3S32-G	yes	32	120/277	PD	Normal	1.00	99.0	1.01	
Robertson Worldwide	Sterling Series	PSL332T8MV3D	yes	32	120/277	PD	Normal	1.00	100	1.00	
Sunpark Electronics Corp.	Ultra Lumen	U-332PS3	no	32	277	PD	Normal	1.00	100	1.00	
		U-332PS3-HBF	no	32	120/277	PD	High	1.15	115/111	1.00/1.04	
Universal Lighting Technologies	Demand Flex	B332PUNVDR-A	yes	32	120/277	PD	Normal	0.87	85/83	1.02/1.05	
		B332PUNVDRL-A	yes	32	120/277	PD	Low	0.71	72	0.99	
		B332PUNVDRH-E	yes	32	120/277	PD	High	1.15	115/111	1.00/1.04	
HP T8 Qualified Ballasts with 4 Lamps											
General Electric Company	UltraMax Bi-Level Switching	GE432MAX90-S60	yes	32	120/277	PD	High	1.18	149/146	0.79/.81	**4 Lamp**
	UltraMax LoadShed Dimming	GE432MAX90-V60	yes	32	120/277	PD	High	1.18	149/146	.79/.81	
	UltraStart T8 100-3% Dimming	GE432MVPS-N-VO3	no	32	120/277	PD	Normal	0.88	114/111	.77/.79	
		GE432MVPS-H-VO3	no	32	120/277	PD	High	1.18	150/148	.79/.80	
OSRAM SYLVANIA	Quicktronic	QTP4X32T8/UNV DIM-TC	yes	32	120/277	PD	Normal	0.88	114/110	.77/.80	
Philips - Advance	Mark 7	IZT-4S32	yes	32	120/277	PD	Normal	0.88	116	0.76	
		VZT-4S32-G	yes	32	277	PD	Normal	0.88	116	0.76	
		VZT-4S32-HL	yes	32	277	PD	High	1.18	149	0.79	
		VZT-4PSP32-G	no	32	277	PD	Normal	0.88	112	0.79	
	ROVR	IDA-4S32	yes	32	120/277	PD	Normal	0.88	116	0.76	
Universal Lighting Technologies	Demand Flex	B432PUNVDR-E	yes	32	120/277	PD	Normal	0.88	116/112	0.76/0.79	
		B432PUNVDRL-E	yes	32	120/277	PD	Low	0.71	93	0.76	
	Ballastar	B432P277V5-E	yes	32	277	PD	Normal	0.88	115	0.77	
		B432P277V5H-E	yes	32	277	PD	High	1.18	150	0.79	
HP T8 Qualified Ballasts with 6 Lamps											
General Electric Company	UltraMax	GE632MAX-H90-S60	yes	32	120/277	ID	High	1.18	221/215	.53/.55	**6 Lamp**
		GE632MAX-H90-V60	yes	32	120/277	ID	High	1.18	221/215	.53/.55	

The source dataset can be found at the following address:
http://www.cee1.org/com/com-lt/lamps-ballasts.xls

Appendix B: DOE spreadsheet for fluorescent ballasts rulemaking

Commercial sector growth rates			Source: AEO, Table 5.		Commercial Sector Indicators and Consumption				Updated for 2010 release		
Total Floorspace (billion squa	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Surviving	72.2	73.5	74.9	76.4	77.9	79.2	80.1	80.7	81.4	82.1	83.0
New Additions	2.2	2.3	2.4	2.4	2.2	1.8	1.6	1.6	1.7	1.9	2.0
Total	74.3	75.8	77.3	78.8	80.1	81.0	81.7	82.3	83.1	84.0	85.1
Growth in surviving		1.8%	2.0%	2.0%	2.0%	1.7%	1.1%	0.8%	0.8%	0.9%	1.1%
New construction as percentage of survivi		3.2%	3.2%	3.2%	3.1%	2.8%	2.3%	1.9%	2.0%	2.1%	2.3%
Growth in total		2.0%	2.0%	2.0%	1.7%	1.2%	0.8%	0.8%	0.9%	1.1%	1.3%

The full spreadsheet can be found at the following address:
http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/flb_nopr_ch10_nia.nes.xlsx

Appendix C: Table of Coincident Diversity Factors for Non-CFL Lighting

Non-CFL Energy Impacts for: Pacific Gas & Electric

Location: IOU Territory, Building Vintage: Existing

				Lighting	Energy Impacts per ΔWatt Lighting					HVAC Factors		
Measure	Building	Building	Lighting	Coincident	Direct (End-Use)		Whole Building			Energy	Demand	Gas
Type	Type	Vintage	EFLH	Demand	kWh/ΔW	Watt/ΔW	kWh/ΔW	Watt/ΔW	kBTU/ΔW	kWh/kWh	kW/kW	therm/kWh
Non-CFL	Asm	Existing	2614	0.53	2.61	0.53	2.73	0.62	-2.35	1.05	1.16	-0.0090
Non-CFL	EPr	Existing	2140	0.04	2.14	0.04	2.31	0.04	-1.86	1.08	1.10	-0.0087
Non-CFL	ESe	Existing	2285	0.04	2.28	0.04	2.45	0.04	-2.44	1.07	1.10	-0.0107
Non-CFL	ECC	Existing	2423	0.45	2.42	0.45	2.68	0.57	-2.61	1.11	1.25	-0.0108
Non-CFL	EUn	Existing	2353	0.41	2.35	0.41	2.62	0.50	-1.77	1.12	1.22	-0.0075
Non-CFL	ERC	Existing	2475	0.04	2.48	0.04	2.56	0.05	-2.41	1.03	1.11	-0.0097
Non-CFL	Gro	Existing	4907	0.69	4.91	0.69	4.58	0.88	-6.24	0.93	1.27	-0.0127
Non-CFL	Hsp	Existing	5258	0.83	5.26	0.83	5.85	1.02	-3.23	1.11	1.23	-0.0061
Non-CFL	Nrs	Existing	4158	0.68	4.16	0.68	4.38	0.85	-5.42	1.05	1.26	-0.0130
Non-CFL	Htl	Existing	1947	0.24	1.95	0.24	2.00	0.30	-1.08	1.03	1.25	-0.0055
Non-CFL	Mtl	Existing	1550	0.17	1.55	0.17	1.61	0.21	-0.91	1.04	1.23	-0.0059
Non-CFL	MBT	Existing	3528	0.85	3.53	0.85	3.96	1.03	-0.20	1.12	1.21	-0.0006
Non-CFL	MLI	Existing	3216	0.92	3.22	0.92	3.38	1.08	-1.70	1.05	1.17	-0.0053
Non-CFL	OfL	Existing	2641	0.71	2.64	0.71	2.97	0.93	-1.67	1.12	1.32	-0.0063
Non-CFL	OfS	Existing	2594	0.69	2.59	0.69	2.79	0.85	-0.92	1.08	1.22	-0.0036
Non-CFL	RSD	Existing	4826	0.80	4.83	0.80	4.95	0.93	-4.12	1.03	1.17	-0.0085
Non-CFL	RFF	Existing	4835	0.81	4.84	0.81	5.02	0.95	-3.62	1.04	1.17	-0.0075
Non-CFL	Rt3	Existing	3375	0.76	3.38	0.76	3.66	0.90	-1.65	1.08	1.18	-0.0049
Non-CFL	RtL	Existing	4269	0.85	4.27	0.85	4.59	1.01	-2.54	1.08	1.20	-0.0060
Non-CFL	RtS	Existing	3376	0.88	3.38	0.88	3.62	1.04	-1.74	1.07	1.18	-0.0052
Non-CFL	SCn	Existing	3422	0.70	3.42	0.70	3.31	0.89	-2.81	0.97	1.27	-0.0082
Non-CFL	SUn	Existing	3422	0.70	3.42	0.70	3.42	0.70	0.00	1.00	1.00	0.0000
Non-CFL	WRf	Existing	4766	0.56	4.77	0.56	4.77	0.56	0.00	1.00	1.00	0.0000
Non-CFL	Wtd-Com	Existing	3184	0.64	3.18	0.64	3.38	0.76	-1.93	1.06	1.20	-0.0061
Non-CFL	SFM	Existing	na	na	na	na	na	na	na	na	na	na
Non-CFL	MFM	Existing	na	na	na	na	na	na	na	na	na	na
Non-CFL	DMO	Existing	na	na	na	na	na	na	na	na	na	na
Non-CFL	Wtd-Res	Existing	na	na	na	na	na	na	na	na	na	na