

February 26, 2010

Title 24 Controllable Lighting
Cost-Benefit Analysis Summary

Introduction

The intent of this analysis was to examine the potential costs and benefits of three available control technologies (dimming, tri-level and bi-level ballasts) with respect to the proposed Title 24 requirements for controllable lighting.

Methodology

Base Case

To establish a base case against which proposed scenarios could be compared, we used data from the 2002 California Commercial End-Use Survey (CEUS), which provides electricity usage profiles for the major commercial building segments in California. We structured our analysis around the six segments with highest lighting energy use statewide, ranked as follows:

Segment/Building Type	Lighting Energy Use (GWh)
Office	4331
Retail	4246
Warehouse	1485
School	1281
Food Store	1233
Restaurant	961

Our base case for the cost-benefit analysis is intended to represent a current 2008 Title 24-compliant building or premise within each of these segments. We assume that the base case includes manual control and automatic shutoff controls only (from a practical standpoint, this implies the use of occupancy sensors in most buildings). We created a theoretical lighting load profile for typical new construction by assuming a percentage reduction from the 2002 CEUS data for each hour of the day to account for the reduced lighting power allowances and increased controls requirements in the 2008 Title 24 code.

Because many lighting control strategies are applicable only to specific space types, we created an architectural profile for each building type by assuming a percentage breakdown of space types within the building. The contribution of each space type to the total building load is weighted by relating the space types to the allowed power densities from the Area Category Method in 2008 Title 24 (Table 146-F).

Control Scenarios

For each building type, we developed a list of control scenarios or test cases that combine each of four lighting control strategies (tuning, daylighting, personal controls, and occupancy/vacancy control where applicable) with the three evaluated ballast types (dimming, tri-level and bi-level). The estimated load profile for each control scenario is derived from the base case either by applying an initial base load adjustment factor (i.e. for tuning) or a percentage of energy savings by space type and hour of the day (i.e. for daylighting), or by a combination of the two approaches (i.e. when layering tuning with other control strategies). By comparing the controlled lighting load profile to the base case, we can determine the potential energy savings for each proposed scenario.

Daylight Availability Analysis

To estimate the potential energy savings from daylighting control for each of the six segments, we first developed a projected energy savings curve for daylight-optimized spaces based on average statewide climate and astronomical data and the anticipated performance of each of the three ballast types under daylighting control.

We created this curve based on data from three representative locations within California: Los Angeles, Oakland, and Sacramento. For each location, we developed four estimated seasonal energy savings curves by time of day using sunrise/sunset data and the average percentage of clear and partly cloudy days for the season. The projected savings were estimated by multiplying the estimated energy savings performance of each ballast type by time of day under optimal daylight conditions by a daylight availability factor that varied with the season. For tri-level and bi-level switching systems, this factor represents the percentage of clear days by season. For dimming systems, this factor also includes 50% of the percentage of partly cloudy days to account for the increased sensitivity of this control strategy.

The seasonal curves were averaged first to create an estimated energy savings curve for daylighting for each location. The three location curves were then averaged to create a representative statewide curve that would be used as the basis for further analysis.

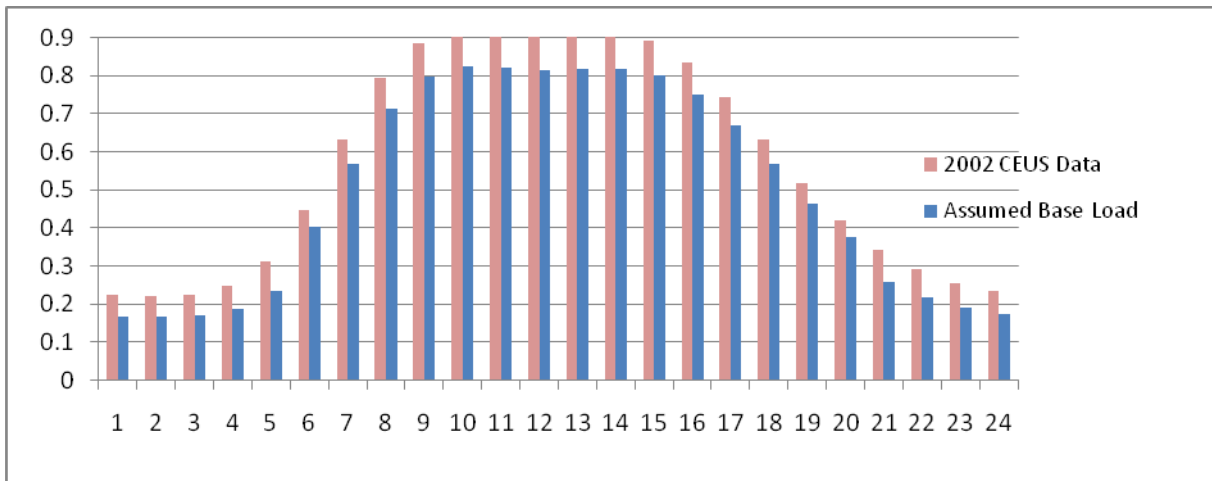
To create the range of energy savings by time of day for each space type within a building, we multiplied this curve by the estimated percentage of floor space for which daylighting control would be applicable. The analysis assumptions for each building type are presented in the results section below. The full daylight availability analysis is presented at the end of this report.

Results

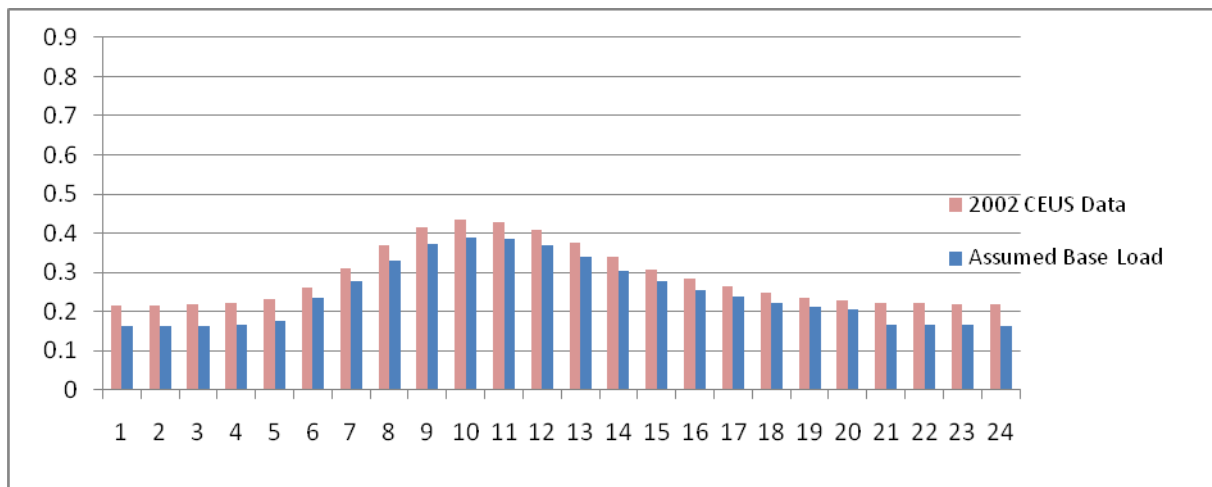
1. Office

Base Case Assumptions

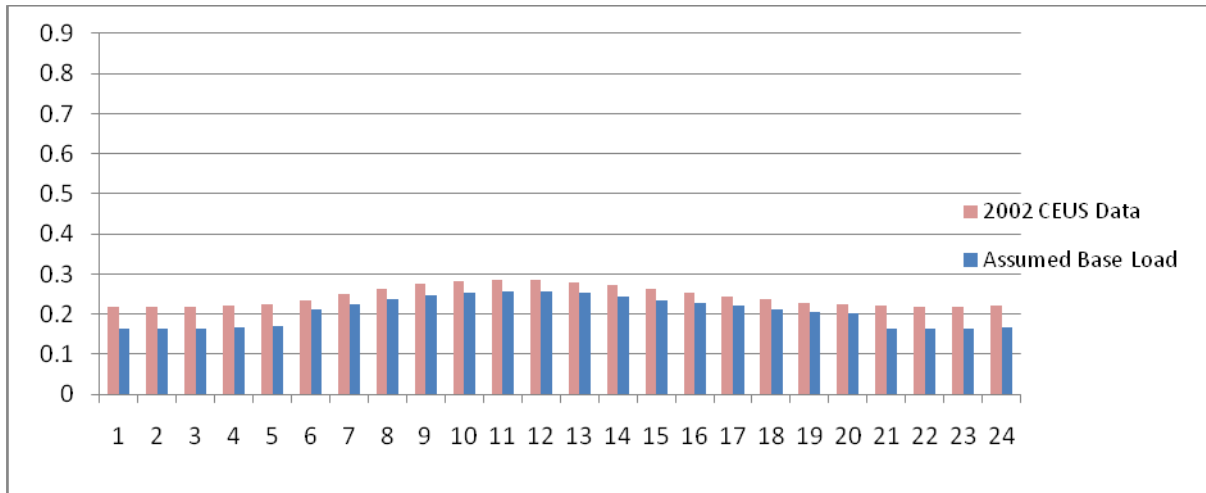
To create the base load profile for a 2008 Title 24-compliant office building, we assumed a 10% reduction from 2002 CEUS levels between 5AM and 8PM, and a 25% reduction between 8PM and 5AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for offices (Monday- Friday)



Base case lighting load (W/ft²) by hour for offices (Saturday)



Base case lighting load (W/ft²) by hour for offices (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	5%	3%
Corridor	0.6	10%	7%
Toilet	0.6	4%	3%
Service	0.7	5%	4%
Open Office	0.9	50%	49%
Private Office	1.1	15%	18%
Conference	1.4	9%	14%
Lobby	1.5	2%	3%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	20% average savings between 7AM and 8PM (assume daylighting in 75% of open and private offices and 40% of conference rooms)
Daylighting + Dimming	0.00	20% average savings between 7AM and 8PM (assume daylighting in 75% of open and private offices and 40% of conference rooms)
Daylighting + Tri-Level	0.00	17% average savings between 7AM and 8PM (assume daylighting in 75% of open and private offices and 40% of conference rooms)

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Daylighting + Bi-Level	0.00	16% average savings between 7AM and 8PM (assume daylighting in 75% of open and private offices and 40% of conference rooms)
Tuning, Personal Controls + Dimming	0.15	20% average savings in private offices and 10% in open offices and conference rooms between 10AM and 5PM
Personal Controls + Dimming	0.00	20% average savings in private offices and 10% in open offices and conference rooms between 10AM and 5PM
Personal Controls + Tri-Level	0.00	16% average savings in private offices and 10% in open offices and conference rooms between 10AM and 5PM
Personal Controls + Bi-Level	0.00	15% average savings in private offices and 10% in open offices and conference rooms between 10AM and 5PM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Tuning + Tri-Level		\$0.40		\$ -		\$0.40	
Tuning + Bi-Level		\$0.40		\$ -		\$0.40	
Tuning, Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.08	\$0.58	\$0.73	\$0.88
Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.03	\$0.53	\$0.68	\$0.83
Daylighting + Tri-Level		\$0.40		\$0.03		\$0.43	
Daylighting + Bi-Level		\$0.40		\$0.03		\$0.43	
Tuning, Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.09	\$0.59	\$0.74	\$0.89
Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.04	\$0.54	\$0.69	\$0.84
Personal Controls + Tri-Level		\$0.40		\$0.04		\$0.44	
Personal Controls + Bi-Level		\$0.40		\$0.04		\$0.44	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	3.114	0.307	0.263	3.684	---
Tuning + Dimming	2.647	0.261	0.224	3.131	15%
Tuning + Tri-Level	3.114	0.307	0.263	3.684	0%
Tuning + Bi-Level	3.114	0.307	0.263	3.684	0%
Tuning, Daylighting + Dimming	2.199	0.225	0.195	2.619	29%
Daylighting + Dimming	2.587	0.265	0.229	3.081	16%
Daylighting + Tri-Level	2.733	0.277	0.239	3.248	12%
Daylighting + Bi-Level	2.752	0.278	0.240	3.271	11%
Tuning, Personal Controls + Dimming	2.532	0.252	0.216	3.001	19%
Personal Controls + Dimming	2.979	0.297	0.255	3.530	4%
Personal Controls + Tri-Level	2.987	0.297	0.255	3.539	4%
Personal Controls + Bi-Level	2.976	0.296	0.254	3.527	4%

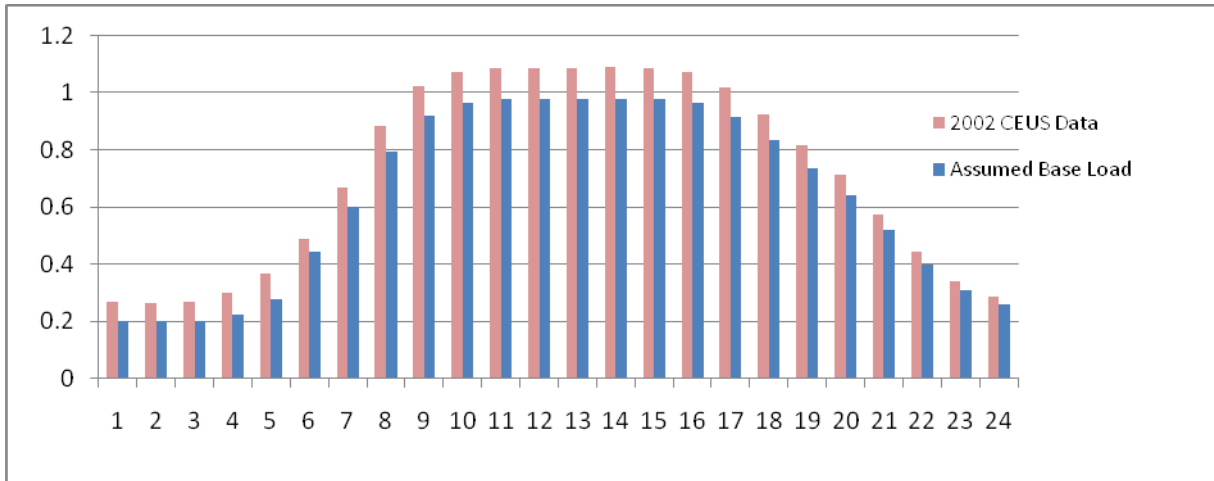
Cost-Benefit Analysis Summary (OFFICE)

Control Scenario Description	Size	Savings	Savings	Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	1	15	\$1.31	-\$0.24	\$1.07	\$0.55	\$0.70	\$0.85	1.9	1.5	1.3
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning, Daylighting + Dimming Ballast	1 ft ²	1	24	\$1.24	-\$0.28	\$1.77	\$0.58	\$0.73	\$0.88	3.1	2.4	2.0
Daylighting + Dimming Ballast	1 ft ²	1	15	\$1.24	-\$0.20	\$1.04	\$0.53	\$0.68	\$0.83	2.0	1.5	1.3
Daylighting + Tri-Level Ballast	1 ft ²	0	11	\$0.90	-\$0.20	\$0.70		\$0.43			1.6	
Daylighting + Bi-Level Ballast	1 ft ²	0	10	\$0.86	-\$0.20	\$0.66		\$0.43			1.5	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	1	15	\$1.28	-\$0.30	\$0.98	\$0.59	\$0.74	\$0.89	1.7	1.3	1.1
Personal Controls + Dimming Ballast	1 ft ²	0	4	\$0.33	-\$0.22	\$0.11	\$0.54	\$0.69	\$0.84	0.2	0.2	0.1
Personal Controls + Tri-Level Ballast	1 ft ²	0	4	\$0.31	-\$0.22	\$0.09		\$0.44			0.2	
Personal Controls + Bi-Level Ballast	1 ft ²	0	4	\$0.33	-\$0.22	\$0.11		\$0.44			0.3	

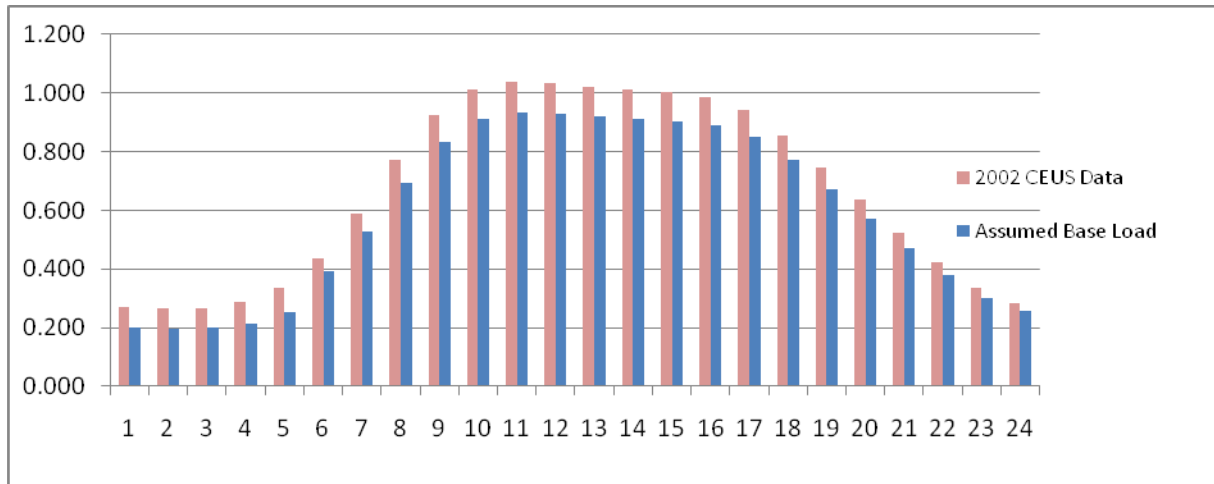
2. Retail

Base Case Assumptions

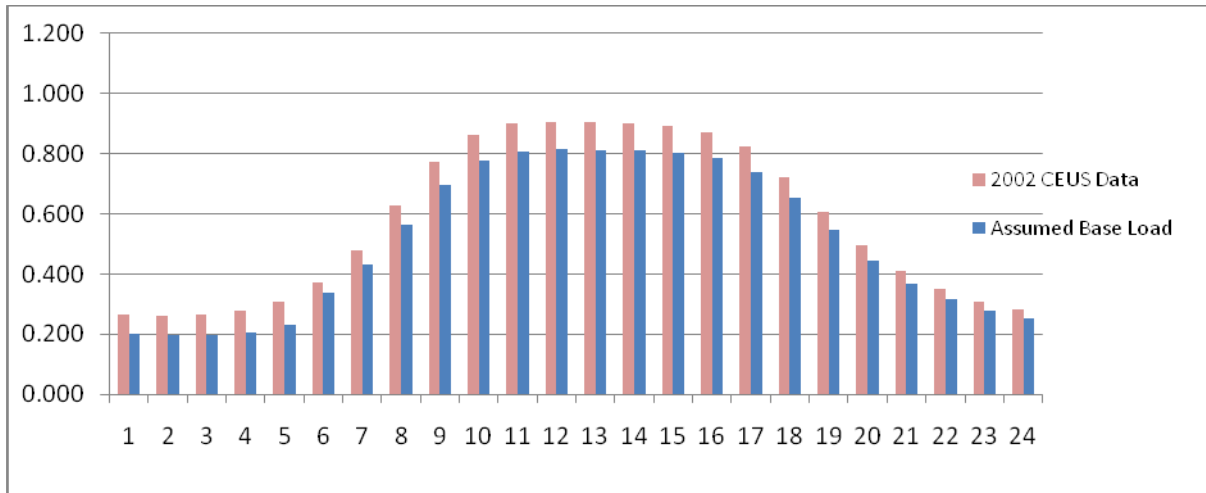
To create the base load profile for a 2008 Title 24-compliant retail building, we assumed a 10% reduction from 2002 CEUS levels between 5AM and 12AM, and a 25% reduction between 12AM and 5AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for retail (Monday- Friday)



Base case lighting load (W/ft²) by hour for retail (Saturday)



Base case lighting load (W/ft²) by hour for retail (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	15%	7%
Corridor	0.6	5%	2%
Toilet	0.6	3%	1%
Service	0.7	4%	2%
Malls/Atria	1.2	5%	5%
Sales	1.6	64%	79%
Dressing Room	0.8	1%	1%
Office	1.1	3%	3%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	9% average savings between 7AM and 8PM (assume daylighting in 25% of retail sales and 75% of malls and atria)
Daylighting + Dimming	0.00	9% average savings between 7AM and 8PM (assume daylighting in 25% of retail sales and 75% of malls and atria)
Daylighting + Tri-Level	0.00	7% average savings between 7AM and 8PM (assume daylighting in 25% of retail sales and 75% of malls and atria)
Daylighting + Bi-Level	0.00	7% average savings between 7AM and 8PM (assume daylighting in 25% of retail sales and 75% of malls and atria)
Tuning, Personal Controls + Dimming	0.15	20% average savings in retail office spaces between 8AM and 8PM

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Personal Controls + Dimming	0.00	20% average savings in retail office spaces between 8AM and 8PM
Personal Controls + Tri-Level	0.00	16% average savings in retail office spaces between 8AM and 8PM
Personal Controls + Bi-Level	0.00	15% average savings in retail office spaces between 8AM and 8PM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Tuning + Tri-Level		\$0.40		\$ -		\$0.40	
Tuning + Bi-Level		\$0.40		\$ -		\$0.40	
Tuning, Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.06	\$0.56	\$0.71	\$0.86
Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.01	\$0.51	\$0.66	\$0.81
Daylighting + Tri-Level		\$0.40		\$0.01		\$0.41	
Daylighting + Bi-Level		\$0.40		\$0.01		\$0.41	
Tuning, Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.00	\$0.50	\$0.65	\$0.80
Personal Controls + Tri-Level		\$0.40		\$0.00		\$0.40	
Personal Controls + Bi-Level		\$0.40		\$0.00		\$0.40	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	3.973	0.737	0.650	5.361	---
Tuning + Dimming	3.377	0.627	0.553	4.556	15%
Tuning + Tri-Level	3.973	0.737	0.650	5.361	0%
Tuning + Bi-Level	3.973	0.737	0.650	5.361	0%
Tuning, Daylighting + Dimming	3.145	0.583	0.514	4.242	21%
Daylighting + Dimming	3.700	0.686	0.605	4.990	7%
Daylighting + Tri-Level	3.776	0.700	0.617	5.094	5%
Daylighting + Bi-Level	3.786	0.702	0.619	5.107	5%
Tuning, Personal Controls + Dimming	3.365	0.624	0.551	4.540	15%
Personal Controls + Dimming	3.959	0.735	0.648	5.341	0%
Personal Controls + Tri-Level	3.962	0.735	0.648	5.345	0%
Personal Controls + Bi-Level	3.962	0.735	0.648	5.345	0%

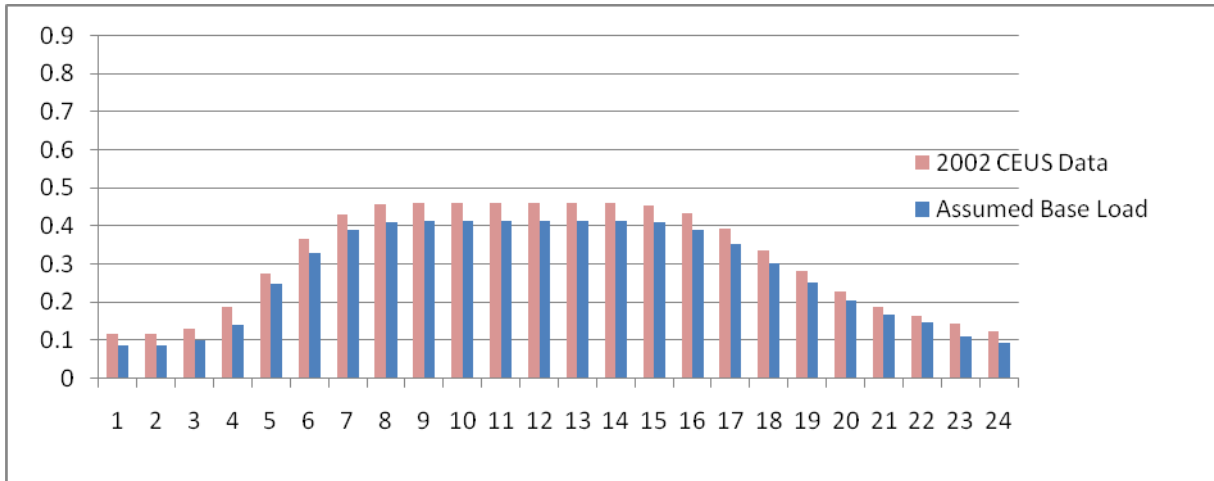
Cost-Benefit Analysis Summary (RETAIL)

Control Scenario Description	Size	Savings	Savings	Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	1	17	\$1.42	-\$0.24	\$1.18	\$0.55	\$0.70	\$0.85	2.1	1.7	1.4
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning, Daylighting + Dimming Ballast	1 ft ²	1	24	\$0.73	-\$0.26	\$1.79	\$0.56	\$0.71	\$0.86	3.2	2.5	2.1
Daylighting + Dimming Ballast	1 ft ²	0	9	\$0.73	-\$0.18	\$0.55	\$0.51	\$0.66	\$0.81	1.1	0.8	0.7
Daylighting + Tri-Level Ballast	1 ft ²	0	6	\$0.53	-\$0.18	\$0.35		\$0.41			0.9	
Daylighting + Bi-Level Ballast	1 ft ²	0	6	\$0.50	-\$0.18	\$0.33		\$0.41			0.8	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	1	17	\$1.45	-\$0.24	\$1.21	\$0.55	\$0.70	\$0.85	2.2	1.7	1.4
Personal Controls + Dimming Ballast	1 ft ²	0	0	\$0.04	-\$0.16	-\$0.13	\$0.50	\$0.65	\$0.80	-0.3	-0.2	-0.2
Personal Controls + Tri-Level Ballast	1 ft ²	0	0	\$0.03	-\$0.16	-\$0.13		\$0.40			-0.3	
Personal Controls + Bi-Level Ballast	1 ft ²	0	0	\$0.03	-\$0.16	-\$0.13		\$0.40			-0.3	

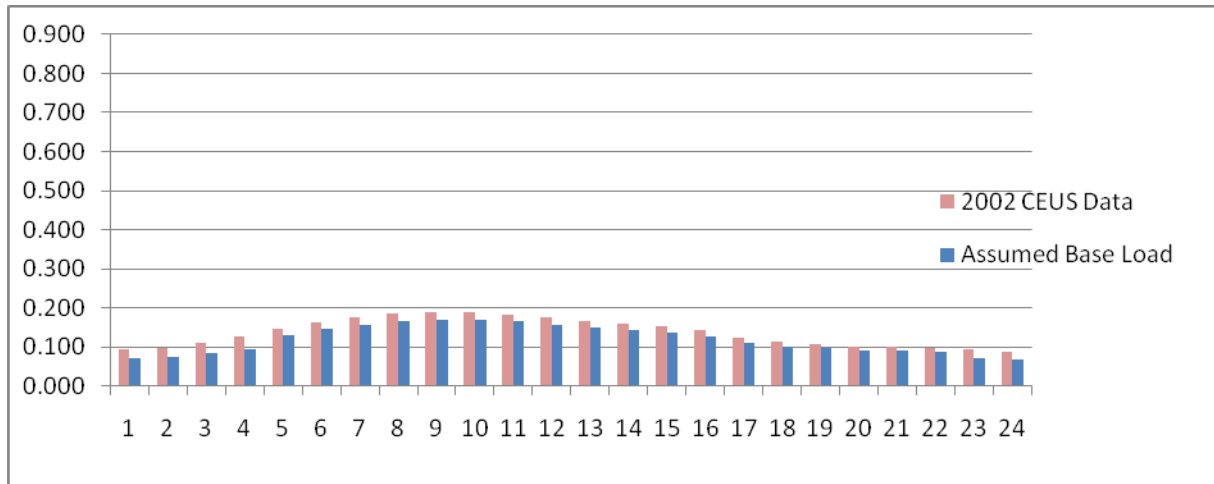
3. Warehouse

Base Case Assumptions

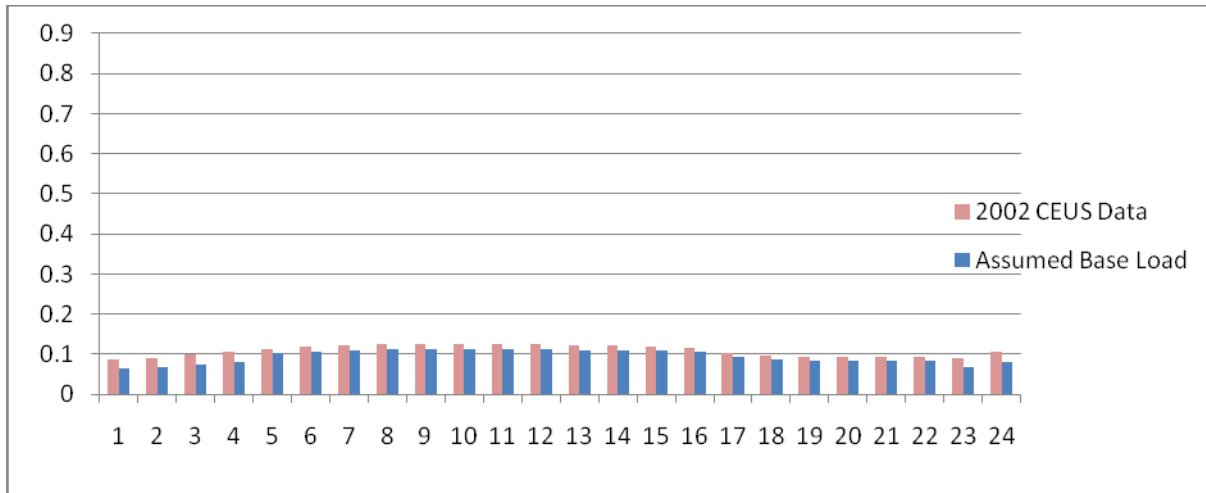
To create the base load profile for a 2008 Title 24-compliant warehouse, we assumed a 10% reduction from 2002 CEUS levels between 4AM and 10PM, and a 25% reduction between 10PM and 4AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for warehouses (Monday- Friday)



Base case lighting load (W/ft²) by hour for warehouses (Saturday)



Base case lighting load (W/ft²) by hour for warehouses (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	85%	80%
Corridor	0.6	2%	2%
Toilet	0.6	1%	1%
Service	0.7	4%	4%
Office	1.1	2%	3%
Low Bay	0.9	3%	4%
High Bay	1.0	2%	3%
Precision	1.2	1%	2%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	18% average savings between 7AM and 8PM (assume daylighting in 60% of storage spaces and 25% of high bay, low bay and precision work areas)
Daylighting + Dimming	0.00	18% average savings between 7AM and 8PM (assume daylighting in 60% of storage spaces and 25% of high bay, low bay and precision work areas)
Daylighting + Tri-Level	0.00	16% average savings between 7AM and 8PM (assume daylighting in 60% of storage spaces and 25% of high bay, low bay and precision work areas)
Daylighting + Bi-Level	0.00	15% average savings between 7AM and 8PM (assume

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
		daylighting in 60% of storage spaces and 25% of high bay, low bay and precision work areas)
Tuning, Personal Controls + Dimming	0.15	No energy savings assumed from personal controls (not applicable to warehouses)
Personal Controls + Dimming	0.00	No energy savings assumed from personal controls (not applicable to warehouses)
Personal Controls + Tri-Level	0.00	No energy savings assumed from personal controls (not applicable to warehouses)
Personal Controls + Bi-Level	0.00	No energy savings assumed from personal controls (not applicable to warehouses)
Tuning, Occupancy/Vacancy + Dimming	0.15	23% average savings (70% savings during 30% of the day) in storage spaces between 5AM and 10PM
Occupancy/Vacancy + Dimming	0.00	23% average savings (70% savings during 30% of the day) in storage spaces between 5AM and 10PM
Occupancy/Vacancy + Tri-Level	0.00	18% average savings (55% savings during 30% of the day) in storage spaces between 5AM and 10PM
Occupancy/Vacancy + Bi-Level	0.00	15% average savings (45% savings during 30% of the day) in storage spaces between 5AM and 10PM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.30	\$0.45	\$0.60	\$0.05	\$0.35	\$0.50	\$0.65
Tuning + Tri-Level		\$0.25		\$ -		\$0.25	
Tuning + Bi-Level		\$0.25		\$ -		\$0.25	
Tuning, Daylighting + Dimming	\$0.30	\$0.45	\$0.60	\$0.08	\$0.38	\$0.53	\$0.68
Daylighting + Dimming	\$0.30	\$0.45	\$0.60	\$0.03	\$0.33	\$0.48	\$0.63
Daylighting + Tri-Level		\$0.25		\$0.03		\$0.28	
Daylighting + Bi-Level		\$0.25		\$0.03		\$0.28	
Tuning, Personal Controls + Dimming	\$0.30	\$0.45	\$0.60	\$0.05	\$0.35	\$0.50	\$0.65
Personal Controls + Dimming	\$0.30	\$0.45	\$0.60	\$ -	\$0.30	\$0.45	\$0.60
Personal Controls + Tri-Level		\$0.25		\$ -		\$0.25	
Personal Controls + Bi-Level		\$0.25		\$ -		\$0.25	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	1.742	0.149	0.120	2.011	---
Tuning + Dimming	1.481	0.127	0.102	1.710	15%
Tuning + Tri-Level	1.742	0.149	0.120	2.011	0%
Tuning + Bi-Level	1.742	0.149	0.120	2.011	0%
Tuning, Daylighting + Dimming	1.273	0.112	0.090	1.475	27%
Daylighting + Dimming	1.498	0.131	0.106	1.735	14%
Daylighting + Tri-Level	1.566	0.136	0.110	1.812	10%
Daylighting + Bi-Level	1.575	0.137	0.111	1.823	9%
Tuning, Personal Controls + Dimming	1.481	0.127	0.102	1.710	15%
Personal Controls + Dimming	1.742	0.149	0.120	2.011	0%
Personal Controls + Tri-Level	1.742	0.149	0.120	2.011	0%
Personal Controls + Bi-Level	1.742	0.149	0.120	2.011	0%
Tuning, Occ/Vacancy + Dimming	1.243	0.108	0.088	1.439	28%
Occ/Vacancy + Dimming	1.463	0.127	0.103	1.693	16%
Occ/Vacancy + Tri-Level	1.523	0.132	0.107	1.762	12%
Occ/Vacancy + Bi-Level	1.523	0.132	0.107	1.762	12%

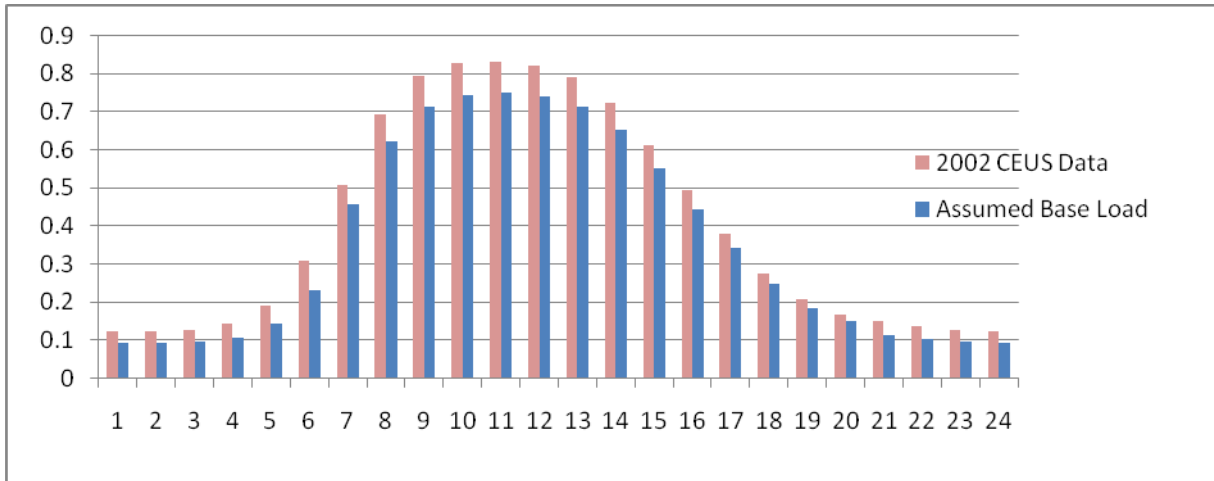
Cost-Benefit Analysis Summary (WAREHOUSE)

Control Scenario Description	Size	Savings		Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	0	9	\$0.80	-\$0.24	\$0.56	\$0.35	\$0.50	\$0.65	1.6	1.1	0.9
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Tuning, Daylighting + Dimming Ballast	1 ft ²	1	12	\$0.57	-\$0.28	\$0.74	\$0.38	\$0.53	\$0.68	2.0	1.4	1.1
Daylighting + Dimming Ballast	1 ft ²	0	7	\$0.57	-\$0.20	\$0.37	\$0.33	\$0.48	\$0.63	1.1	0.8	0.6
Daylighting + Tri-Level Ballast	1 ft ²	0	5	\$0.41	-\$0.20	\$0.21		\$0.28			0.8	
Daylighting + Bi-Level Ballast	1 ft ²	0	5	\$0.39	-\$0.20	\$0.19		\$0.28			0.7	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	0	6	\$0.54	-\$0.24	\$0.30	\$0.35	\$0.50	\$0.65	0.9	0.6	0.5
Personal Controls + Dimming Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16	\$0.30	\$0.45	\$0.60	-0.5	-0.4	-0.3
Personal Controls + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Personal Controls + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Tuning, Occupancy/Vacancy + Dimming Ballast	1 ft ²	1	12	\$1.04	-\$0.31	\$0.73	\$0.39	\$0.54	\$0.69	1.9	1.4	1.1
Occupancy/Vacancy + Dimming Ballast	1 ft ²	0	7	\$0.59	-\$0.23	\$0.36	\$0.34	\$0.49	\$0.64	1.1	0.7	0.6
Occupancy/Vacancy + Tri-Level Ballast	1 ft ²	0	6	\$0.46	-\$0.23	\$0.24		\$0.29			0.8	
Occupancy/Vacancy + Bi-Level Ballast	1 ft ²	0	6	\$0.46	-\$0.23	\$0.24		\$0.29			0.8	

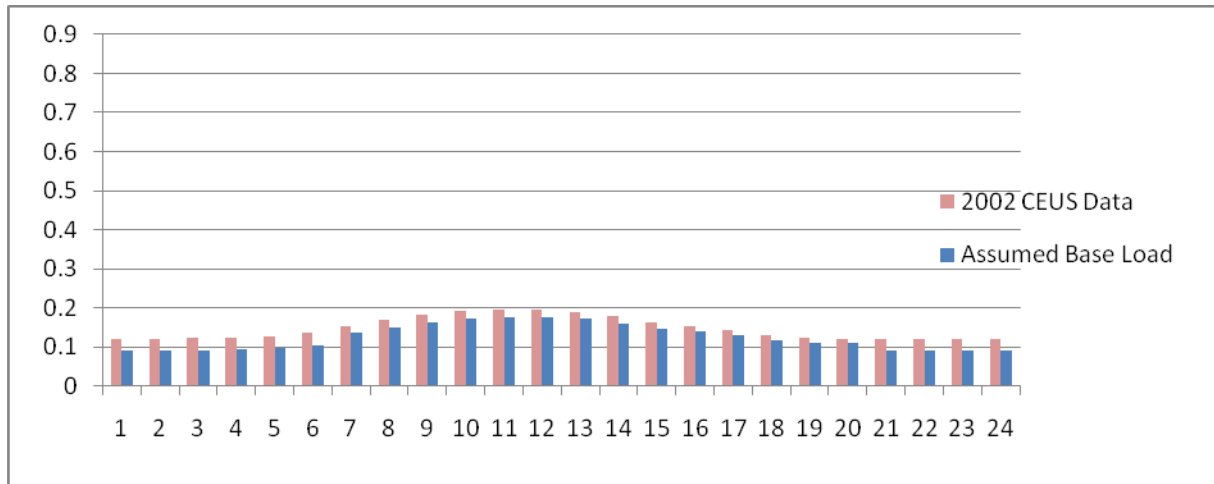
4. School

Base Case Assumptions

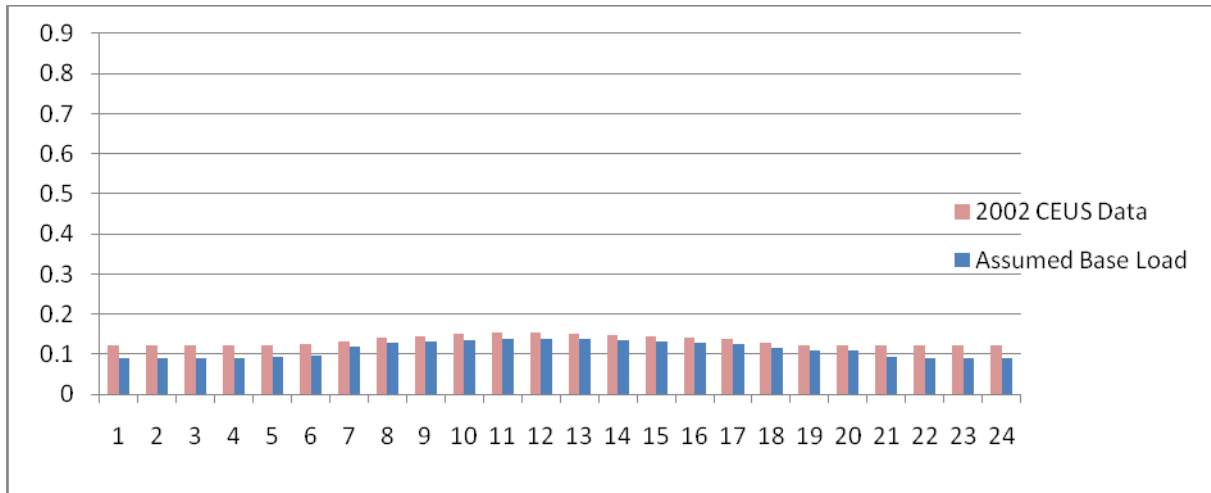
To create the base load profile for a 2008 Title 24-compliant school, we assumed a 10% reduction from 2002 CEUS levels between 6AM and 8PM, and a 25% reduction between 8PM and 6AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for schools (Monday- Friday)



Base case lighting load (W/ft²) by hour for schools (Saturday)



Base case lighting load (W/ft²) by hour for schools (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	5%	3%
Corridor	0.6	4%	2%
Toilet	0.6	3%	2%
Service	0.7	5%	3%
Auditorium	1.5	4%	5%
Classroom	1.2	46%	50%
Library - Read	1.2	2%	2%
Library - Stacks	1.5	4%	5%
Office	1.1	6%	6%
Dining	1.1	4%	4%
Gymnasium	1.0	8%	7%
Kitchen	1.6	2%	3%
Laboratory	1.4	4%	5%
Locker Room	0.8	3%	2%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	10% average savings between 7AM and 8PM (assume daylighting in 50% of classrooms and 20% of educational offices)
Daylighting + Dimming	0.00	10% average savings between 7AM and 8PM (assume

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
		daylighting in 50% of classrooms and 20% of educational offices)
Daylighting + Tri-Level	0.00	8% average savings between 7AM and 8PM (assume daylighting in 50% of classrooms and 20% of educational offices)
Daylighting + Bi-Level	0.00	8% average savings between 7AM and 8PM (assume daylighting in 50% of classrooms and 20% of educational offices)
Tuning, Personal Controls + Dimming	0.15	20% average savings in classrooms and educational offices between 8AM and 5PM
Personal Controls + Dimming	0.00	20% average savings in classrooms and educational offices between 8AM and 5PM
Personal Controls + Tri-Level	0.00	16% average savings in classrooms and educational offices between 8AM and 5PM
Personal Controls + Bi-Level	0.00	15% average savings in classrooms and educational offices between 8AM and 5PM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.35	\$0.50	\$0.65	\$0.05	\$0.40	\$0.55	\$0.70
Tuning + Tri-Level		\$0.25		\$ -		\$0.25	
Tuning + Bi-Level		\$0.25		\$ -		\$0.25	
Tuning, Daylighting + Dimming	\$0.35	\$0.50	\$0.65	\$0.06	\$0.41	\$0.56	\$0.71
Daylighting + Dimming	\$0.35	\$0.50	\$0.65	\$0.01	\$0.36	\$0.51	\$0.66
Daylighting + Tri-Level		\$0.25		\$0.01		\$0.26	
Daylighting + Bi-Level		\$0.25		\$0.01		\$0.26	
Tuning, Personal Controls + Dimming	\$0.35	\$0.50	\$0.65	\$0.08	\$0.43	\$0.58	\$0.73
Personal Controls + Dimming	\$0.35	\$0.50	\$0.65	\$0.03	\$0.38	\$0.53	\$0.68
Personal Controls + Tri-Level		\$0.25		\$0.03		\$0.28	
Personal Controls + Bi-Level		\$0.25		\$0.03		\$0.28	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	2.204	0.156	0.143	2.503	---
Tuning + Dimming	1.874	0.133	0.121	2.128	15%
Tuning + Tri-Level	2.204	0.156	0.143	2.503	0%
Tuning + Bi-Level	2.204	0.156	0.143	2.503	0%
Tuning, Daylighting + Dimming	1.713	0.124	0.114	1.951	22%
Daylighting + Dimming	2.015	0.146	0.134	2.295	8%
Daylighting + Tri-Level	2.067	0.149	0.137	2.352	6%
Daylighting + Bi-Level	2.074	0.149	0.137	2.360	6%
Tuning, Personal Controls + Dimming	1.734	0.126	0.115	1.975	21%
Personal Controls + Dimming	2.040	0.148	0.136	2.324	7%
Personal Controls + Tri-Level	2.073	0.149	0.137	2.359	6%
Personal Controls + Bi-Level	2.081	0.150	0.138	2.368	5%

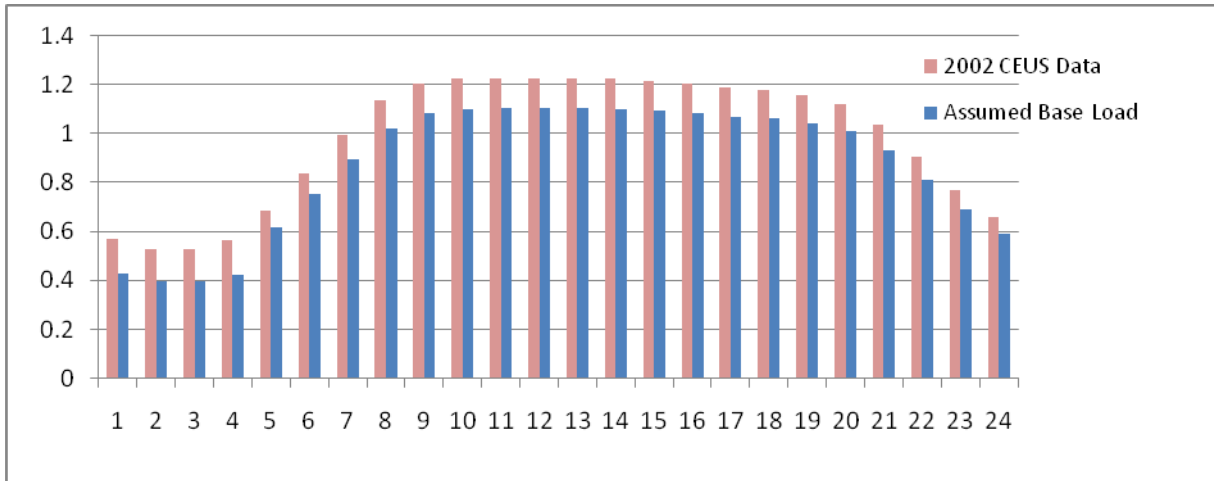
Cost-Benefit Analysis Summary (SCHOOL)

Control Scenario Description	Size	Savings	Savings	Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	0	8	\$0.69	-\$0.24	\$0.45	\$0.40	\$0.55	\$0.70	1.1	0.8	0.6
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.25			-0.6	
Tuning, Daylighting + Dimming Ballast	1 ft ²	1	12	\$0.43	-\$0.26	\$0.79	\$0.41	\$0.56	\$0.71	1.9	1.4	1.1
Daylighting + Dimming Ballast	1 ft ²	0	5	\$0.43	-\$0.18	\$0.25	\$0.36	\$0.51	\$0.66	0.7	0.5	0.4
Daylighting + Tri-Level Ballast	1 ft ²	0	4	\$0.31	-\$0.18	\$0.13		\$0.26			0.5	
Daylighting + Bi-Level Ballast	1 ft ²	0	4	\$0.30	-\$0.18	\$0.12		\$0.26			0.5	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	1	12	\$0.99	-\$0.28	\$0.71	\$0.43	\$0.58	\$0.73	1.7	1.2	1.0
Personal Controls + Dimming Ballast	1 ft ²	0	4	\$0.36	-\$0.20	\$0.16	\$0.38	\$0.53	\$0.68	0.4	0.3	0.2
Personal Controls + Tri-Level Ballast	1 ft ²	0	3	\$0.29	-\$0.20	\$0.09		\$0.28			0.3	
Personal Controls + Bi-Level Ballast	1 ft ²	0	3	\$0.27	-\$0.20	\$0.07		\$0.28			0.2	

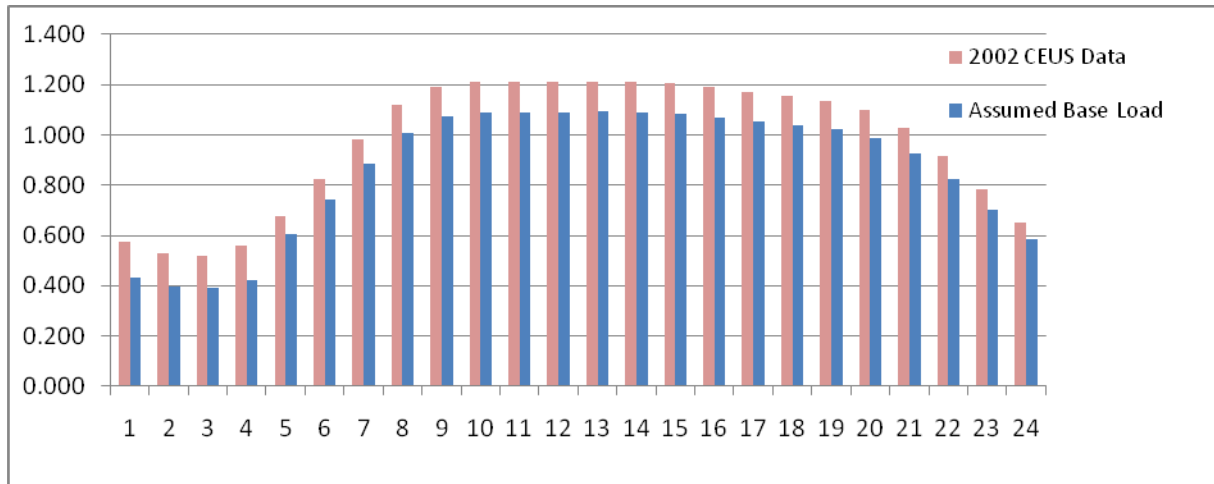
5. Food Store

Base Case Assumptions

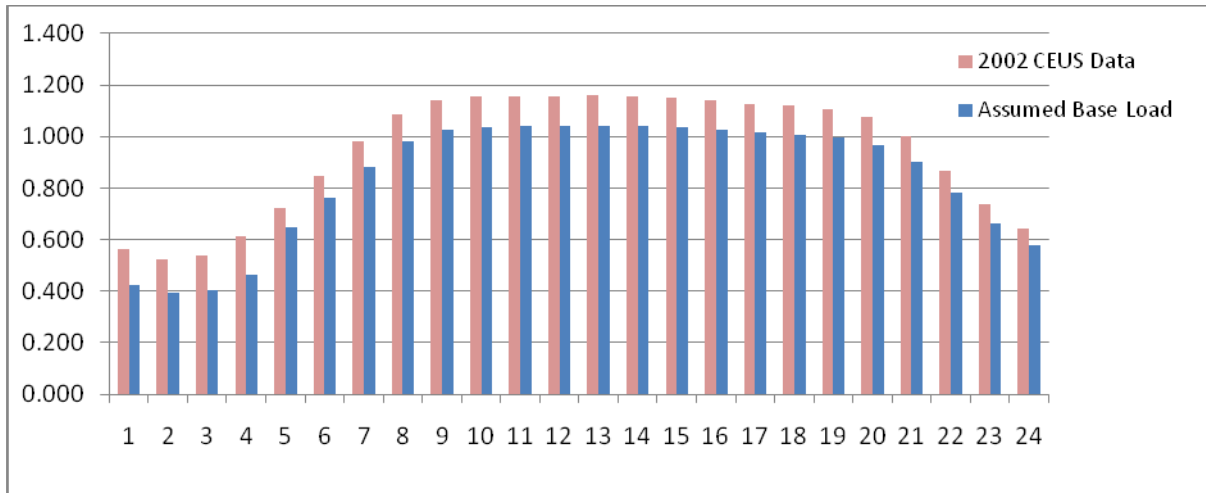
To create the base load profile for a 2008 Title 24-compliant food store, we assumed a 10% reduction from 2002 CEUS levels between 4AM and 12AM, and a 25% reduction between 12AM and 4AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for food stores (Monday- Friday)



Base case lighting load (W/ft²) by hour for food stores (Saturday)



Base case lighting load (W/ft²) by hour for food stores (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	22%	10%
Corridor	0.6	1%	0%
Toilet	0.6	2%	1%
Service	0.7	6%	3%
Grocery Sales	1.6	65%	81%
Office	1.1	2%	2%
Kitchen	1.6	2%	2%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	16% average savings between 7AM and 8PM (assume daylighting in 30% of grocery sales and 50% of storage)
Daylighting + Dimming	0.00	16% average savings between 7AM and 8PM (assume daylighting in 30% of grocery sales and 50% of storage)
Daylighting + Tri-Level	0.00	13% average savings between 7AM and 8PM (assume daylighting in 30% of grocery sales and 50% of storage)
Daylighting + Bi-Level	0.00	13% average savings between 7AM and 8PM (assume daylighting in 30% of grocery sales and 50% of storage)
Tuning, Personal Controls + Dimming	0.15	20% average savings in grocery offices between 8AM and 8PM
Personal Controls +	0.00	20% average savings in grocery offices between 8AM and 8PM

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Dimming		
Personal Controls + Tri-Level	0.00	16% average savings in grocery offices between 8AM and 8PM
Personal Controls + Bi-Level	0.00	15% average savings in grocery offices between 8AM and 8PM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Tuning + Tri-Level		\$0.40		\$ -		\$0.40	
Tuning + Bi-Level		\$0.40		\$ -		\$0.40	
Tuning, Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.07	\$0.57	\$0.72	\$0.87
Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.02	\$0.52	\$0.67	\$0.82
Daylighting + Tri-Level		\$0.40		\$0.02		\$0.42	
Daylighting + Bi-Level		\$0.40		\$0.02		\$0.42	
Tuning, Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.00	\$ 0.50	\$0.65	\$0.80
Personal Controls + Tri-Level		\$0.40		\$0.00		\$0.40	
Personal Controls + Bi-Level		\$0.40		\$0.00		\$0.40	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	5.431	1.077	1.068	7.576	---
Tuning + Dimming	4.617	0.915	0.908	6.440	15%
Tuning + Tri-Level	5.431	1.077	1.068	7.576	0%
Tuning + Bi-Level	5.431	1.077	1.068	7.576	0%
Tuning, Daylighting + Dimming	4.118	0.817	0.811	5.746	24%
Daylighting + Dimming	4.844	0.961	0.955	6.759	11%
Daylighting + Tri-Level	5.011	0.994	0.987	6.991	8%
Daylighting + Bi-Level	5.033	0.998	0.991	7.022	7%
Tuning, Personal Controls + Dimming	4.607	0.913	0.906	6.426	15%
Personal Controls + Dimming	5.420	1.075	1.066	7.560	0%
Personal Controls + Tri-Level	5.422	1.075	1.066	7.563	0%
Personal Controls + Bi-Level	5.423	1.075	1.066	7.564	0%

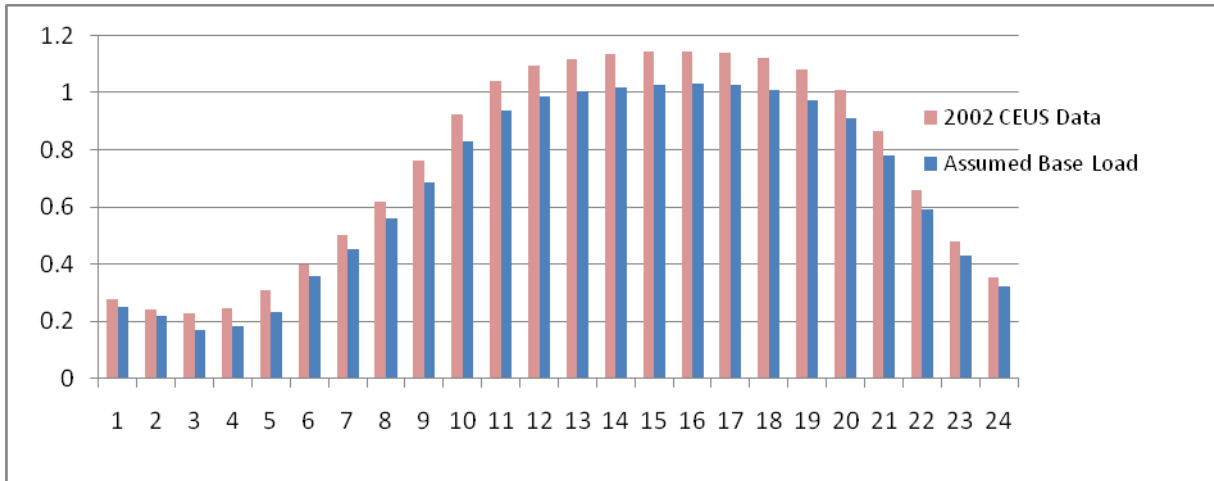
Cost-Benefit Analysis Summary (FOOD STORE)

Control Scenario Description	Size	Savings	Savings	Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	2	38	\$3.18	-\$0.24	\$2.94	\$0.55	\$0.70	\$0.85	5.3	4.2	3.5
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning, Daylighting + Dimming Ballast	1 ft ²	2	39	\$1.59	-\$0.27	\$3.02	\$0.57	\$0.72	\$0.87	5.3	4.2	3.5
Daylighting + Dimming Ballast	1 ft ²	1	19	\$1.59	-\$0.19	\$1.40	\$0.52	\$0.67	\$0.82	2.7	2.1	1.7
Daylighting + Tri-Level Ballast	1 ft ²	1	14	\$1.15	-\$0.19	\$0.96		\$0.42			2.3	
Daylighting + Bi-Level Ballast	1 ft ²	1	13	\$1.09	-\$0.19	\$0.90		\$0.42			2.2	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	1	23	\$1.97	-\$0.24	\$1.72	\$0.55	\$0.70	\$0.85	3.1	2.5	2.0
Personal Controls + Dimming Ballast	1 ft ²	0	0	\$0.03	-\$0.16	-\$0.13	\$0.50	\$0.65	\$0.80	-0.3	-0.2	-0.2
Personal Controls + Tri-Level Ballast	1 ft ²	0	0	\$0.02	-\$0.16	-\$0.14		\$0.40			-0.3	
Personal Controls + Bi-Level Ballast	1 ft ²	0	0	\$0.02	-\$0.16	-\$0.14		\$0.40			-0.3	

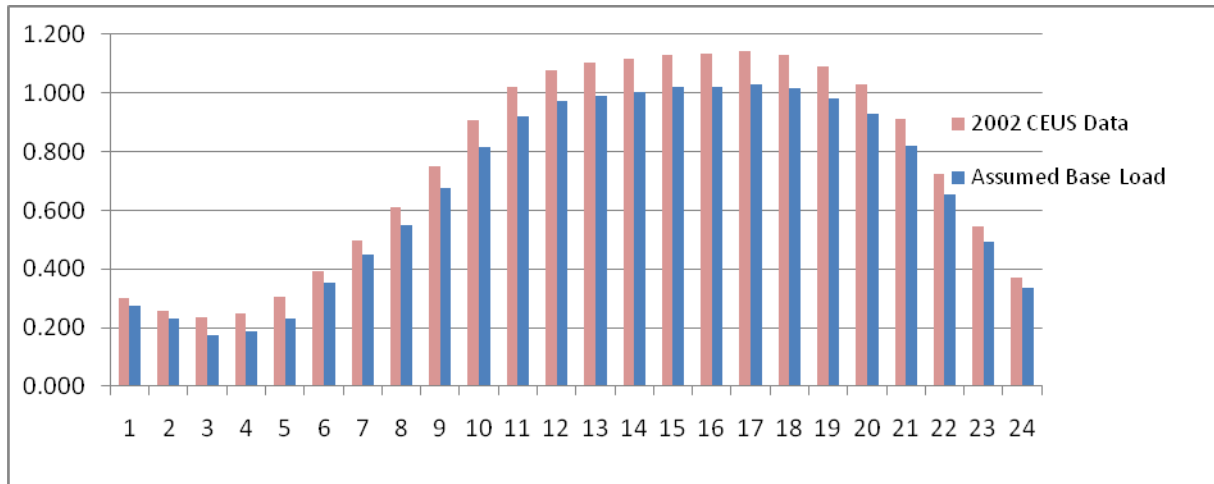
6. Restaurant

Base Case Assumptions

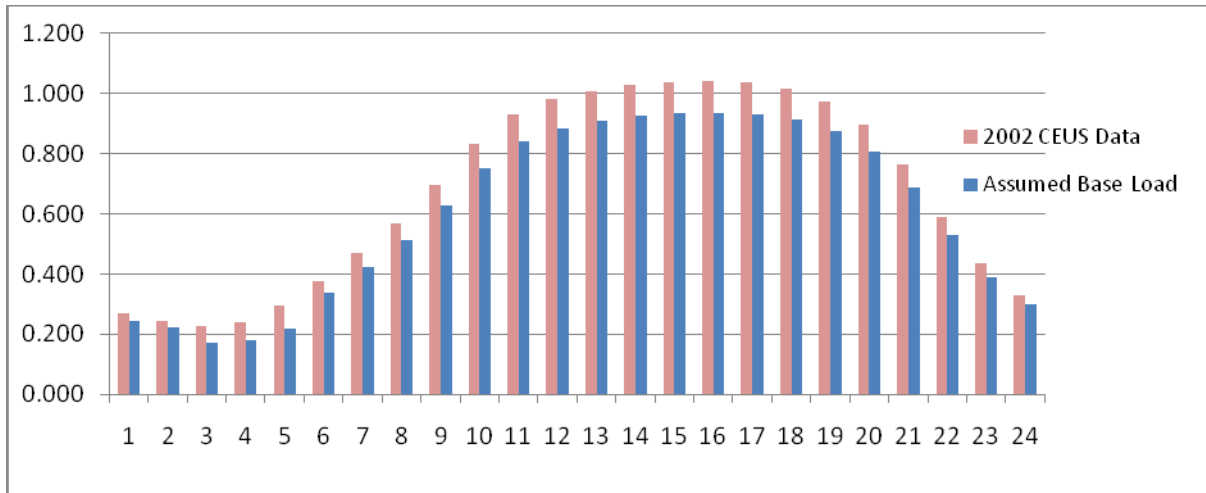
To create the base load profile for a 2008 Title 24-compliant restaurant, we assumed a 10% reduction from 2002 CEUS levels between 5AM and 2AM, and a 25% reduction between 2AM and 5AM (due to mandatory automatic shutoff requirements). The resulting load profiles for Monday-Friday, Saturday, and Sunday are presented below.



Base case lighting load (W/ft²) by hour for restaurants (Monday- Friday)



Base case lighting load (W/ft²) by hour for restaurants (Saturday)



Base case lighting load (W/ft²) by hour for restaurants (Sunday)

Assumed Breakdown of Space Types

Space Type	Allowed Ltg Pwr (W/ft ²)	% of Floor Space	Weighted Load Contribution
Storage	0.6	10%	5%
Corridor	0.6	2%	1%
Toilet	0.6	7%	4%
Service	0.7	6%	4%
Dining	1.1	50%	50%
Kitchen	1.6	25%	36%

Energy Savings Assumptions by Control Scenario

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Tuning + Dimming	0.15	N/A
Tuning + Tri-Level	0.00	N/A
Tuning + Bi-Level	0.00	N/A
Tuning, Daylighting + Dimming	0.15	2% average savings between 7AM and 8PM (assume daylighting in 10% of dining areas)
Daylighting + Dimming	0.00	2% average savings between 7AM and 8PM (assume daylighting in 10% of dining areas)
Daylighting + Tri-Level	0.00	1% average savings between 7AM and 8PM (assume daylighting in 10% of dining areas)
Daylighting + Bi-Level	0.00	1% average savings between 7AM and 8PM (assume daylighting in 10% of dining areas)
Tuning, Personal Controls + Dimming	0.15	20% average savings in dining areas between 10AM and 2AM
Personal Controls + Dimming	0.00	20% average savings in dining areas between 10AM and 2AM

Scenario	Base Load Adjustment Factor	Assumed % Savings from Controls by Space Type and Time of Day
Personal Controls + Tri-Level	0.00	16% average savings in dining areas between 10AM and 2AM
Personal Controls + Bi-Level	0.00	15% average savings in dining areas between 10AM and 2AM

Cost Assumptions by Control Scenario

Scenario	Incremental Ballast Cost (per ft ²)			Incremental Commissioning Cost (per ft ²)	Total Incremental Cost (per ft ²)		
	Low	Avg	High		Low	Avg	High
Tuning + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Tuning + Tri-Level		\$0.40		\$ -		\$0.40	
Tuning + Bi-Level		\$0.40		\$ -		\$0.40	
Tuning, Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.05	\$0.55	\$0.70	\$0.85
Daylighting + Dimming	\$0.50	\$0.65	\$0.80	\$0.00	\$0.50	\$0.65	\$0.80
Daylighting + Tri-Level		\$0.40		\$0.00		\$0.40	
Daylighting + Bi-Level		\$0.40		\$0.00		\$0.40	
Tuning, Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.08	\$0.58	\$0.73	\$0.88
Personal Controls + Dimming	\$0.50	\$0.65	\$0.80	\$0.03	\$0.53	\$0.68	\$0.83
Personal Controls + Tri-Level		\$0.40		\$0.03		\$0.43	
Personal Controls + Bi-Level		\$0.40		\$0.03		\$0.43	

Summary of Energy Savings by Control Scenario

Estimated Energy Intensities (kWh/ft²/yr) for Base Case and Proposed Scenarios

Scenario	M-F	Sat	Sun	Total	% Savings
Base Case	4.155	0.838	0.771	5.764	---
Tuning + Dimming	3.532	0.712	0.656	4.900	15%
Tuning + Tri-Level	4.155	0.838	0.771	5.764	0%
Tuning + Bi-Level	4.155	0.838	0.771	5.764	0%
Tuning, Daylighting + Dimming	3.481	0.702	0.646	4.829	16%
Daylighting + Dimming	4.095	0.826	0.760	5.681	1%
Daylighting + Tri-Level	4.111	0.829	0.763	5.704	1%
Daylighting + Bi-Level	4.114	0.830	0.764	5.707	1%
Tuning, Personal Controls + Dimming	3.257	0.657	0.605	4.518	22%
Personal Controls + Dimming	3.831	0.772	0.712	5.315	8%
Personal Controls + Tri-Level	3.896	0.786	0.723	5.405	6%
Personal Controls + Bi-Level	3.912	0.789	0.726	5.428	6%

Cost-Benefit Analysis Summary (RESTAURANT)

Control Scenario Description	Size	Savings	Savings	Savings	PV Savings	Cost Savings	Incremental Cost \$			B/C ratio		
		Total kWh	TDV kBtu	Energy Cost PV \$	Maint. PV \$	Total PV \$	Low	Average	High	Low \$	Average \$	High \$
Tuning + Dimming Ballast	1 ft ²	2	31	\$2.61	-\$0.24	\$2.37	\$0.55	\$0.70	\$0.85	4.3	3.4	2.8
Tuning + Tri-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning + Bi-Level Ballast	1 ft ²	0	0	\$0.00	-\$0.16	-\$0.16		\$0.40			-0.4	
Tuning, Daylighting + Dimming Ballast	1 ft ²	1	20	\$0.16	-\$0.24	\$1.43	\$0.55	\$0.70	\$0.85	2.6	2.0	1.7
Daylighting + Dimming Ballast	1 ft ²	0	2	\$0.16	-\$0.16	\$0.00	\$0.50	\$0.65	\$0.80	0.0	0.0	0.0
Daylighting + Tri-Level Ballast	1 ft ²	0	1	\$0.12	-\$0.16	-\$0.05		\$0.40			-0.1	
Daylighting + Bi-Level Ballast	1 ft ²	0	1	\$0.11	-\$0.16	-\$0.05		\$0.40			-0.1	
Tuning, Personal Controls + Dimming Ballast	1 ft ²	1	27	\$2.25	-\$0.28	\$1.97	\$0.58	\$0.73	\$0.88	3.4	2.7	2.2
Personal Controls + Dimming Ballast	1 ft ²	0	10	\$0.84	-\$0.20	\$0.64	\$0.53	\$0.68	\$0.83	1.2	0.9	0.8
Personal Controls + Tri-Level Ballast	1 ft ²	0	8	\$0.67	-\$0.20	\$0.47		\$0.43			1.1	
Personal Controls + Bi-Level Ballast	1 ft ²	0	7	\$0.63	-\$0.20	\$0.43		\$0.43			1.0	

7. Daylight Availability Analysis

Percent of clear days by season and location (Western Regional Climate Center)

City	Spring	Summer	Fall	Winter
Los Angeles	38%	37%	44%	44%
Oakland	32%	49%	50%	32%
Sacramento	33%	73%	77%	28%

Percent of partly cloudy days by season and location (Western Regional Climate Center)

City	Spring	Summer	Fall	Winter
Los Angeles	27%	39%	37%	26%
Oakland	29%	36%	36%	26%
Sacramento	30%	20%	16%	21%

Daylight period by season (from astronomical data)*

Date	Los Angeles			Oakland			Sacramento		
	Start	End	Total Hrs	Start	End	Total Hrs	Start	End	Total Hrs
22-Mar	7:54:00 AM	6:07:00 PM	10.22	8:09:00 AM	6:23:00 PM	10.23	8:06:00 AM	6:20:00 PM	10.23
21-Jun	6:42:00 AM	7:08:00 PM	12.43	6:47:00 AM	7:34:00 PM	12.78	6:42:00 AM	7:34:00 PM	12.87
22-Sep	7:52:00 AM	5:50:00 PM	9.97	7:57:00 AM	6:06:00 PM	10.15	7:54:00 AM	6:03:00 PM	10.15
21-Dec	7:55:00 AM	3:48:00 PM	7.88	8:21:00 AM	3:53:00 PM	7.53	8:20:00 AM	3:48:00 PM	7.47

*Assume daylight period is one hour after sunrise to one hour before sunset

Assumed Percentage of Energy Savings During Optimal Daylighting Conditions (SPRING)

	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0%	0%	0%	0%	0%	0%	0%	0%	25%	50%	70%	100%	100%	100%	100%	100%	70%	50%	25%	0%	0%	0%	0%	0%
Tri-Level	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	70%	100%	100%	100%	100%	100%	70%	50%	0%	0%	0%	0%	0%	0%
Bi-Level	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	100%	100%	100%	100%	100%	50%	50%	0%	0%	0%	0%	0%	0%

Derived Energy Savings (factoring for seasonal weather conditions: DAF = Daylight Availability Factor)

Los Angeles

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.51	0%	0%	0%	0%	0%	0%	0%	0%	13%	26%	36%	51%	51%	51%	51%	51%	36%	26%	13%	0%	0%	0%	0%	0%
Tri-Level	0.38	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	26%	38%	38%	38%	38%	38%	26%	19%	0%	0%	0%	0%	0%	0%
Bi-Level	0.38	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	19%	38%	38%	38%	38%	38%	19%	19%	0%	0%	0%	0%	0%	0%

Oakland

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.47	0%	0%	0%	0%	0%	0%	0%	0%	12%	23%	33%	47%	47%	47%	47%	47%	33%	23%	12%	0%	0%	0%	0%	0%
Tri-Level	0.32	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	23%	32%	32%	32%	32%	32%	23%	16%	0%	0%	0%	0%	0%	0%
Bi-Level	0.32	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	16%	32%	32%	32%	32%	32%	16%	16%	0%	0%	0%	0%	0%	0%

Sacramento

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.48	0%	0%	0%	0%	0%	0%	0%	0%	12%	24%	34%	48%	48%	48%	48%	48%	34%	24%	12%	0%	0%	0%	0%	0%
Tri-Level	0.33	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	23%	33%	33%	33%	33%	33%	23%	17%	0%	0%	0%	0%	0%	0%
Bi-Level	0.33	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	17%	33%	33%	33%	33%	33%	17%	17%	0%	0%	0%	0%	0%	0%

Assumed Percentage of Energy Savings During Optimal Daylighting Conditions (SUMMER)

	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0%	0%	0%	0%	0%	0%	0%	25%	50%	70%	100%	100%	100%	100%	100%	100%	100%	70%	50%	25%	0%	0%	0%	0%
Tri-Level	0%	0%	0%	0%	0%	0%	0%	0%	50%	70%	100%	100%	100%	100%	100%	100%	100%	70%	50%	0%	0%	0%	0%	0%
Bi-Level	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	100%	100%	100%	100%	100%	100%	100%	50%	50%	0%	0%	0%	0%	0%

Derived Energy Savings (factoring for seasonal weather conditions: DAF = Daylight Availability Factor)

Los Angeles

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.56	0%	0%	0%	0%	0%	0%	0%	14%	28%	39%	56%	56%	56%	56%	56%	56%	56%	39%	28%	14%	0%	0%	0%	0%
Tri-Level	0.37	0%	0%	0%	0%	0%	0%	0%	0%	18%	26%	37%	37%	37%	37%	37%	37%	37%	26%	18%	0%	0%	0%	0%	0%
Bi-Level	0.37	0%	0%	0%	0%	0%	0%	0%	0%	18%	18%	37%	37%	37%	37%	37%	37%	37%	18%	18%	0%	0%	0%	0%	0%

Oakland

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.67	0%	0%	0%	0%	0%	0%	0%	17%	33%	47%	67%	67%	67%	67%	67%	67%	67%	47%	33%	17%	0%	0%	0%	0%
Tri-Level	0.49	0%	0%	0%	0%	0%	0%	0%	0%	24%	34%	49%	49%	49%	49%	49%	49%	49%	34%	24%	0%	0%	0%	0%	0%
Bi-Level	0.49	0%	0%	0%	0%	0%	0%	0%	0%	24%	24%	49%	49%	49%	49%	49%	49%	49%	24%	24%	0%	0%	0%	0%	0%

Sacramento

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.83	0%	0%	0%	0%	0%	0%	0%	21%	42%	58%	83%	83%	83%	83%	83%	83%	83%	58%	42%	21%	0%	0%	0%	0%
Tri-Level	0.73	0%	0%	0%	0%	0%	0%	0%	0%	37%	51%	73%	73%	73%	73%	73%	73%	73%	51%	37%	0%	0%	0%	0%	0%
Bi-Level	0.73	0%	0%	0%	0%	0%	0%	0%	0%	37%	37%	73%	73%	73%	73%	73%	73%	73%	37%	37%	0%	0%	0%	0%	0%

Assumed Percentage of Energy Savings During Optimal Daylighting Conditions (FALL)

	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0%	0%	0%	0%	0%	0%	0%	0%	25%	50%	70%	100%	100%	100%	100%	100%	70%	50%	25%	0%	0%	0%	0%	0%
Tri-Level	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	70%	100%	100%	100%	100%	100%	70%	50%	0%	0%	0%	0%	0%	0%
Bi-Level	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	100%	100%	100%	100%	100%	50%	50%	0%	0%	0%	0%	0%	0%

Derived Energy Savings (factoring for seasonal weather conditions: DAF = Daylight Availability Factor)

Los Angeles

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.63	0%	0%	0%	0%	0%	0%	0%	0%	16%	31%	44%	63%	63%	63%	63%	63%	44%	31%	16%	0%	0%	0%	0%	0%
Tri-Level	0.44	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	31%	44%	44%	44%	44%	44%	31%	22%	0%	0%	0%	0%	0%	0%
Bi-Level	0.44	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	22%	44%	44%	44%	44%	44%	22%	22%	0%	0%	0%	0%	0%	0%

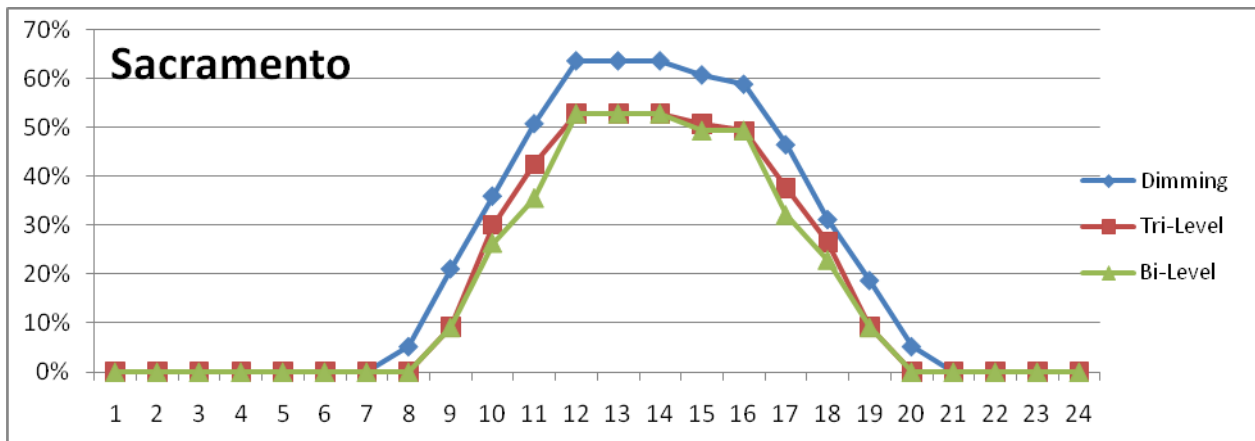
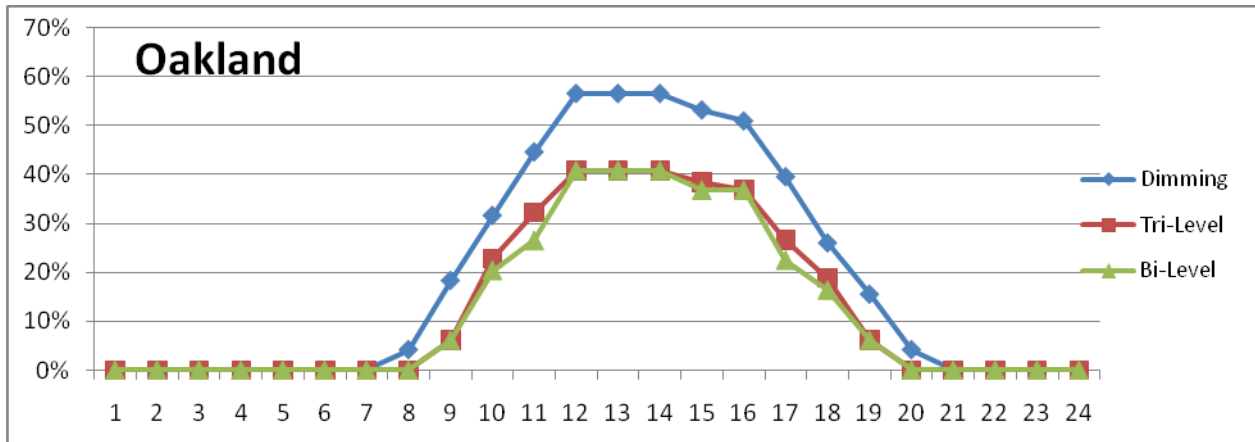
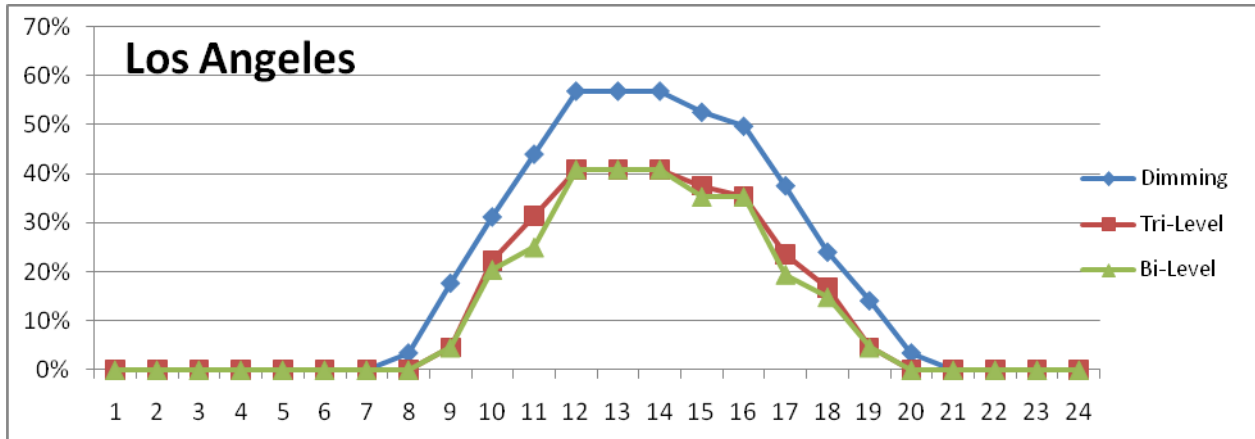
Oakland

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.68	0%	0%	0%	0%	0%	0%	0%	0%	17%	34%	47%	68%	68%	68%	68%	68%	47%	34%	17%	0%	0%	0%	0%	0%
Tri-Level	0.50	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	35%	50%	50%	50%	50%	50%	35%	25%	0%	0%	0%	0%	0%	0%
Bi-Level	0.50	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	25%	50%	50%	50%	50%	50%	25%	25%	0%	0%	0%	0%	0%	0%

Sacramento

	DAF	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Dimming	0.84	0%	0%	0%	0%	0%	0%	0%	0%	21%	42%	59%	84%	84%	84%	84%	84%	59%	42%	21%	0%	0%	0%	0%	0%
Tri-Level	0.77	0%	0%	0%	0%	0%	0%	0%	0%	0%	38%	54%	77%	77%	77%	77%	77%	54%	38%	0%	0%	0%	0%	0%	0%
Bi-Level	0.77	0%	0%	0%	0%	0%	0%	0%	0%	0%	38%	38%	77%	77%	77%	77%	77%	38%	38%	0%	0%	0%	0%	0%	0%

Average Energy Savings by Location and Time of Day



Average Estimated Statewide Energy Savings from Daylighting Control by Time of Day

