

# **Consortium for Energy Efficiency Commercial Lighting Systems Initiative**

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## 1 Background

Lighting represents roughly 26% of the energy consumption in the commercial building sector. However, the diversity of this sector as well as continuous changes in lighting technologies present some challenges to effectively mining energy saving opportunities. Due to these complexities, CEE has developed a Commercial Lighting Initiative.

Commercial buildings such as schools, hospitals and office buildings have varying lighting requirements based upon the workspace in question. Also, efficiency considerations regarding a new construction versus retrofit situation differ greatly based upon the design scheme. Furthermore, over the past decade, technology that has been promoted as high efficiency is becoming the mainstream. As a result, national, state and regional programs encourage the use of energy-efficient lighting technologies through a multitude of program approaches and measures to attain energy savings.

The purpose of this initiative is to

1. Provide clear and credible definitions in the marketplace for energy efficient T8 systems, including defining “high performance” T8 systems.
2. Provide consensus guidance for other systems and program approaches, as prioritized by the Commercial Lighting Committee.
3. Streamline identification and selection of products that adhere to the defining parameters of these systems and program approaches as specified by the Commercial Lighting Committee.

## 2 Initiative Overview

The commercial lighting market offers a variety of innovative technologies. In order to effectively define performance in this market, CEE will develop performance specifications for those lighting technologies with verified savings and impact. CEE intends to capture the value of nationally consistent energy efficiency definitions in each specified technology.

The initial effort of CEE is to nationally align definitions around efficient T-8 lighting technologies. The current Initiative addresses higher lumen T-8 systems and reduced wattage systems. The scope of this Initiative may extend in the future to include 8’ T8 lamps, and controls such as dimming ballasts and smart sensors. As performance specifications are adopted for additional technologies they will be added to the Initiative.

CEE members are also exploring ways to emphasize whole-system approaches in many types of program offerings, including commercial lighting. Future Initiative efforts may focus not only on technologies, but also on the role of commercial lighting in the context of other building systems (such as HVAC).

Recent US inventory statistics indicate that of the fluorescent lighting installed (including linear lamps, compact pin- and screw based, and circline), 58% are T-12s and 28% are T-8s. With 70% of the lighting in commercial facilities as fluorescent<sup>1</sup>, energy efficiency programs encourage the installation of technologies such as T-8s. T-8s have evolved over time with significant performance advancements including higher lumens, improved color rendering, longer system life and reduced nominal wattage.

### 3 Initiative Goal and Strategy

The focus of the Commercial Lighting Systems Initiative is to enhance energy savings by improving the effectiveness of the marketplace in delivering energy efficient lighting products. CEE's broad strategies proposed to accomplish this include:

- Evaluate opportunities to support efficient lighting technologies and practices,
- Encourage the adoption and promotion of common specifications for energy efficient lighting systems by program efficiency administrators,
- Highlight effective program approaches to increase market share of energy efficient lighting systems and practices.

The immediate strategy is to nationally align definitions around efficient T-8 lighting technologies. With varying types of T-8s in the market, CEE first addressed the higher initial lumen, 4', 32W T-8 system through a performance specification, referred henceforth as High Performance T-8s. Some of the key benefits of this system include:

- High efficacy (lumens/watt)
- Long lamp life (2400+ hours)
- Control capability (dimmable)
- Ease of retrofit
- Reduced initial costs since fewer lamps are required
- Enhanced visibility with high CRI
- Reduced maintenance, disposal costs

In January of 2007, CEE's board adopted a specification for reduced wattage (28 and 25 W) T8 systems. The Commercial Lighting Committee agreed that reduced wattage systems are important to include in CEE's Commercial Lighting Initiative for the following reasons:

1. They can deliver significant savings in appropriate situations, especially in lamp switchout/retrofit applications.
2. These products continue to develop and provide more choices (e.g., 25 W lamps). Therefore, their importance in the market is expected to grow.
3. CEE can provide clarification (through specification and a qualifying products list) on which reduced wattage systems are the most energy efficient. Consumers and contractors currently have insufficient information on how to make an effective, energy-saving choice in differing applications (retrofit versus new construction) and with increasing T8 technology choices.

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<sup>1</sup> US DOE Lighting Market Characterization Volume 1: National Lighting Inventory and Energy Consumption Estimate, prepared by Navigant Consulting and Xenergy, 2002

## 4 Market Overview

### 4.1 Market Trends

T-8s have evolved over time with significant performance advancements. The first generation of T-8s, also known as the 700 series is rated at 32 watts, 20,000 hours, and has color rendering index (CRI) ratings in the 70’s. They are available in a variety of color temperature ratings. These products are used in the majority of T-8 applications. These T-8 lamps are rated at 84 initial lumens per watt (LPW) or greater. The second generation of T-8 technology, known as the 800 series, includes 32-watt lamps rated at 20,000 hours with CRIs in the 80’s and initial lumens per watt around 87-92. The third generation of T-8s, often referred to as “super” includes 32-watt lamps with extended life to 24,000 hours or more on rapid start circuits, and higher lumen products of at least 3,100 initial lumens, plus CRIs in the 80’s. The CEE High Performance T-8 specification is based upon a specific performance threshold for this generation of T-8 technology.

Manufacturers have also developed fourth and fifth generation lamp technologies with reduced wattages and similar or increased lumens per watt compared to third generation lamps. Fourth generation technologies are 30-watt T-8 lamps and fifth generation technologies are rated at less than 30 watts.

In spite of the performance advancements made over time with the T-8 technology, the majority of lighting systems sold in the US are instant start electronic ballasts with standard 700 series performance levels. Manufacturers indicate that roughly 85-90% of the sales of ballasts are instant start electronic ballasts.

DOE research indicates that in 2001, T12 systems captured 60% of the fluorescent market, while T8 systems captured 30%. More recent research, based upon conversations with manufacturers, indicates that High Performance T8s comprise 5% of the T8 market while reduced wattage T8 systems comprise another 10%. Figure 1 captures this market breakdown by technology.

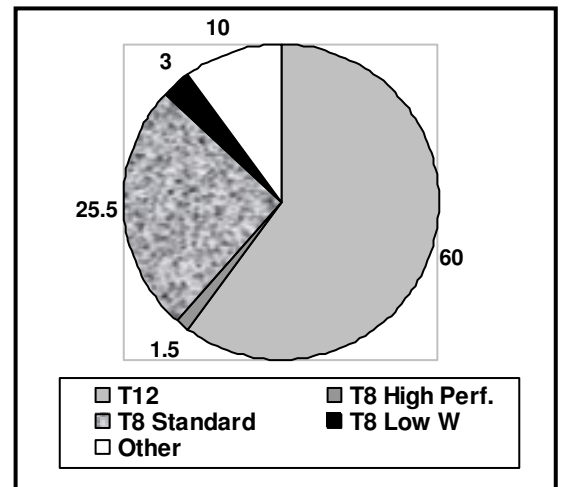


Figure 1: Commercial lighting technology market breakdown

### 4.2 Market Availability

The T8 market is evolving rapidly. CEE first developed a High Performance qualifying products list in September of 2005. By January of 2008 that list had grown to more than 75 lamps and 350 ballasts, illustrating that more lighting manufacturers are adding more High Performance lamps and high efficiency ballasts to their product lines. At the same time, manufacturers developed additional products in their reduced wattage T8 lines, and have been promoting those heavily.

The most recent generations of T8 technology (High Performance and reduced wattage T-8 systems) are currently available under unique, manufacturer specific, lamp and ballast family names. Table 1 provides a list of some manufacturer’s that provide CEE specified T-8 products.

**Table 1 - Sample of manufacturer’s that provide CEE specified T-8 Lamps and/or Ballasts.**

Manufacturer	Lamp Family Name	Ballast Family Name
Advance	---	Optanium
General Electric	EcoLux	UltraMax
Howard Industries	---	HEX Electronic
Osram Sylvania	Octron XPS	Quicktronic
Philips Lighting	Advantage	---
Universal Lighting Technologies	---	ULTim

Conversations with lighting designers and program administrators indicate that more efficient T-8 products can be difficult to specify. In addition, the delivery lead time has been found to be longer than a standard T-8 system. CEE has provided a qualifying product list for High Performance lamps and ballasts that meet the specification. CEE has also endorsed the NEMA Premium label for meeting CEE’s performance specifications for ballasts. This collaboration is expected to accelerate market transformation by easing procurement of high performance products and decreasing delivery lead time.

### 4.3 Market Structure

The total number of fluorescent lamps installed in the commercial sector is roughly 1.5 billion. In fact, nearly 30% of the total US lighting electricity is consumed in commercial fluorescent fixtures.

The US DOE shares in their Vision 2020 - Lighting Technology Roadmap that the distribution channels for commercial lighting is “unusually” complex. Depending upon a new construction or retrofit situation, the building owner tasks either a design team or a construction team for building improvements and/or design. Lighting designs are typically made at the architect or lighting designer level; however contractors can be the ones that often make the purchasing decisions. These decisions are dominated by first cost, rather than life-cycle cost, which inhibits advanced technology purchases.

Figure 2 illustrates the various entities that are involved in a design or construction project for commercial buildings.

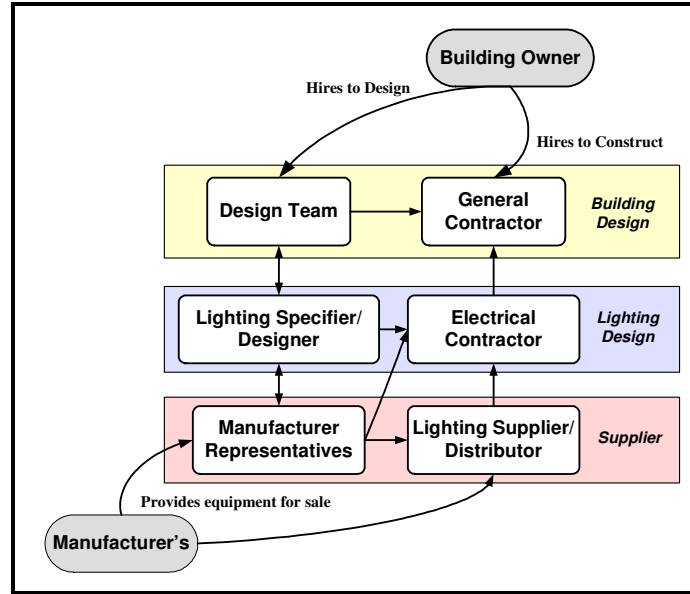


Figure 1 - Distribution channel for commercial lighting.

## 5 Energy Savings Potential

### 5.1 Energy Usage and Cost Information – High Performance T8

High Performance T-8s can attain a considerable amount of energy savings. Upgrading to this system from a traditional 40W T-12 system yields roughly 40% energy savings. To upgrade from a standard T-8 system, the savings are roughly 20%. Figure 3 compares the annual energy use between different technologies in a 2-lamp configuration operating at 3650 hours a year. The High Performance T-8 system consumes 40% less energy than the T-12 system, 20% less than the standard 700 series T-8 system and 10% less than the 800

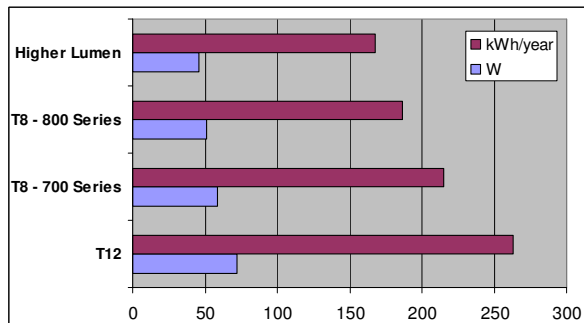


Figure 3 - Annual energy usage comparison.

series T-8. In addition, the demand savings potential (kW) in a 2-lamp system operating during peak load times can be seen to be roughly 20% with a High Performance lighting system compared to a 700 series T-8.

CEE’s specification for High Performance T8 lighting is especially well suited for new construction and major renovations – situations where designers can work to maximize

their effect. These systems provide more lumens, therefore requiring fewer fixtures and delivering more energy efficiency than reduced wattage systems.

When originally introduced into the market, the costs associated with the High Performance T-8 systems were significantly higher than the standard, 700 Series T-8. However, these costs have come down over time possibly due to increased demand and production economics. Still, the cost of a High Performance T-8 system is roughly 40-50% greater than that of a T-12 system. Compared to a standard 700 series T-8 system, the High Performance T-8 system is 25-30% greater. Incremental cost information on the lamps and ballasts can be seen in Table 2 as compared to a base of T-12 or standard T-8s.

Table 2 - Incremental cost information for High Performance lamps and ballasts.

	Base: T-12 Energy Saver		Base: 700 Series T-8	
	T-8: 800 Series	T-8: High Performance	T-8: 800 Series	T-8: High Performance
<b>Lamp</b>	\$1.50-2.00	\$2.00-2.50	\$1.00-1.50	\$1.50-2.00
<b>Ballast</b>	\$4-5	\$7-8	\$2-3	\$5-6

## 5.2 Energy Usage and Cost Comparison – Reduced Wattage Systems

High Performance T8 lighting systems are generally superior in the class of T8 lighting, but reduced wattage systems save energy in applications where customers are unlikely to use High Performance systems. Due to lower light levels reduced wattage systems are better suited for retrofit projects. In new construction, efficient design would call for fewer High Performance T8 fixtures with higher light output from each fixture.

CEE estimates that reduced wattage systems may generate significant national energy savings in retrofit/relamping applications. Because these lamps use krypton gas technology, they require less wattage to deliver light. In addition, they can be used easily without altering fixture arrangements. Twenty-eight watt systems can save approximately 25% more energy than standard 700 series T8s, and 40% over T12s. Twenty-five watt systems can save 37% and 50%, respectively. As displayed in Figure 4, 72% of the annual lighting projects in commercial facilities are either lamp replacements or retrofits. CEE’s proposed Reduced Wattage T8 specification is designed to address this portion of the nation’s yearly lighting needs.

Incremental costs for both 28 and 25 W systems fall within a six-month payback period, with 25 W systems being slightly less expensive.

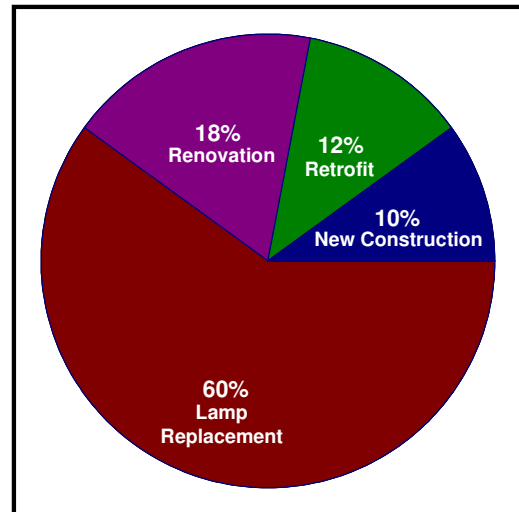


Figure 4: Approximate breakdown of lighting needs in commercial facilities

### 5.3 Energy Analysis

Volume I of the The US Lighting Market Characterization study (2002) indicates that 34,500,000 kWh/yr is consumed by T-12s and 14,800,000 kWh/yr by T-8s. We know that the potential savings for upgrading to a High Performance T-8 system from a traditional T-12 system is roughly 40% and to upgrade from a standard T-8 system, the savings are roughly 20%. Assuming that all T-12's and standard T-8's were replaced with the High Performance T-8 system the annual savings potential in the US could be 16.5 TWh or 16,500,000 kWh. In order to see the potential payback from the High Performance T-8 system, an analysis was performed looking at a base case of a T12 system and a base case of a standard 700 series T-8. Table 3 illustrates the results from this analysis. The calculation does not take into consideration key benefits of the advanced lighting systems. Retrofit #2 with the High Performance T-8 system results in a longer life lamp that would reduce the frequency of lamp replacement. In a new construction application, the High Performance T-8 system with a greater efficacy may result in fixtures being more widely spaced. This may reduce the number of fixtures required and increase the financial attractiveness of a High Performance T-8 system.

Table 3 – Energy analysis for 2-lamp system assuming operation at 10hrs/day (3650 hours/yr) and an energy rate of \$0.08/kWh.<sup>2</sup>

	Base Case	Retrofit #1	Retrofit #2	Base Case	Retrofit #1	Retrofit #2
<b>Lamp</b>	T12	T8 800 Series	HP T8	T8 700 Series	T8 800 Series	HP T8
<b>Ballast</b>	ES Magnetic	Instant Start	Program Start	Instant Start	Instant Start	Program Start
<b>Wattage (kW)</b>	0.072	0.051	0.046	0.056	0.051	0.046
<b>Ballast Factor (BF)</b>	0.88	0.77	0.71	0.88	0.77	0.71
<b>Energy Use (kWh/yr)</b>	263	186	168	212	186	168
<b>Lamp + Ballast Cost (\$)</b>	\$14	\$20	\$26	\$16	\$20	\$26
<b>Incremental Cost (\$)</b>	---	\$6.00	\$12.00		\$4.00	\$10.00
<b>Annual Energy Cost per Fixture (\$)</b>	\$21.04	\$14.88	\$13.44	\$16.96	\$14.88	\$13.44
<b>Annual Energy Savings Potential (\$)</b>	---	\$6.16	\$7.60	---	\$2.08	\$3.52
<b>Payback Period (yrs)</b>	---	0.97	1.57	---	1.92	2.84

<sup>2</sup> Costs associated with labor and installation not included here.

From analysis performed for the High Performance 32 W T8 specification, CEE learned that T12 lighting consumes approximately 34,500,000 kWh/yr and T8 lighting accounts for 14,800,000 kWh/yr. CEE developed two scenarios to predict potential energy savings from reduced wattage systems. In scenario 1, the nation converts the entire T12 portion of the market into 25 W reduced wattage systems and generates savings of 17,250,000 kWh (17.25 tera-Watt hours, TWh). In scenario 2, in addition to the T12 to reduced wattage conversion, the portion of the Standard T8 market not currently in HP T8 or reduced wattage systems is also converted to 25 W systems. Scenario 2 achieves total energy savings of 24,650,000 kWh/yr, or 24.65 TWh. Table 4 summarizes these two energy savings scenarios.

**Table 4: Energy Savings Scenarios with Reduced Wattage Systems**

		Current Picture Energy Use (TWh/year)	Scenario 1 Energy Use (TWh/year)	Scenario 2 Energy Use (TWh/year)
Technology	T12	34.5	---	---
	T8 - 700 series	12.58	12.58	---
	T8 - High Performance	.74	.74	.74
	T8 Reduced W (25W)	1.48	18.73	23.91
<b>Total Lighting Energy (TWh)</b>		49.3	32.05	24.65
<b>Savings Potential (%)</b>		0%	35%	50%

## 6 Initiative Approach

The approach advocated by this Initiative consists of identifying and encouraging the purchase of energy efficient products that are relevant to key lighting market segments and distribution channels. By encouraging programs to commonly address a finite set of products, the manufacturing and distribution players are more likely to respond consistently and favorably to our community’s objectives.

Recent activities such as the adoption of stringent state energy codes, the growing awareness of the US Green Building Council (USGBC) LEED certification as well as the CHPS standard for high performance schools provide the opportunity to engage motivated end user groups to accelerate the penetration of high performance lighting in both new and existing construction.

Finally, the 2005 National Energy Policy Act targets commercial building retrofits and new construction. The law allows a tax deduction for 25 percent lighting savings relative to the ASHRAE 90.1 – 2001 lighting power density requirements (but excluding ASHRAE’s additional lighting power allowances). This credit increases progressively as lighting savings reach 40 percent. Newer lighting technologies like the “high performance” lighting systems provide an option to meet these levels with an added incentive.

## 7 Performance Specifications

Both the High Performance T8 systems and the Reduced Wattage T8 systems specification have been reviewed and modified as appropriate based upon industry review and comment. Industry is supportive of the resulting specifications and encourages the pursuit of additional application specific specifications.

## 8 Participation

As with all Initiatives of CEE, participation in the Commercial Lighting System Initiative is voluntary. To be considered an Initiative participant, the following are required:

1. Support the CEE COMMERCIAL LIGHTING SYSTEMS initiative.
2. Incorporate one or both of the CEE specifications in an educational or incentive based regional/local program. Members are required to make explicit in their own literature which part(s) of the initiative they are promoting.
3. Communicate the scope, duration, and key aspects of their respective regional/local programs.
4. Allow the use of their organization’s name and program information for the purpose of achieving the initiative’s goals.

## 9 CEE Role

CEE will support the ongoing Initiative efforts, develop and manage a compliant products list, promote and encourage specification adoption within voluntary programs, correspond with industry and investigate the merits of additional lighting system specifications. Additional efforts of CEE in this initiative include:

- Secure support for the Initiative by utilities, retailers, manufacturers and others
- Facilitate development of common specifications
- Provide program updates to manufacturers and retailers on initiative participation
- Facilitate information exchange for initiative participants
- Promotion of initiative
- Maintain and distribute qualifying products lists
- Continued discernment of mature opportunities for national program strategies in commercial lighting