

SNAPSHOT

Linear Luminaires, Troffer Luminaires, & Troffer Retrofit Kits

This Snapshot report includes data for linear luminaires, troffer luminaires, and troffer retrofit kits. Linear luminaires can include wraparound, slot, and suspended luminaires. As of December 2017, 87% of the 8,100+ linear listed products are suspended linear luminaires, which are further characterized by distribution of light emitted: direct, indirect, direct/indirect, and indirect/direct (direct = down to workplane; indirect = up to ceiling). Linear luminaires are typically mounted to or suspended 4" to 18" from the ceiling. Linear retrofit kits comprised 11% of all listed retrofit kits.

Troffers are a staple of the lighting industry, providing economical ambient lighting in offices, schools, and other commercial spaces. Roughly 50% of all light fixtures in commercial spaces (e.g., education, retail, hospital, government, etc.) are troffers. In terms of frequency of installation, 2x4s are by far the most common type. Fluorescent troffers utilize a variety of optical systems (e.g., lenses, louvers, perforated metal) to meet different needs or simply provide a different appearance. However, virtually all LED troffer luminaires and troffer retrofit kits use a lens (flat or countered) for light distribution and aesthetic needs.

The LED Lighting Facts® database contains information about size, but



information on optical systems and distribution of light is more limited.

As a result, distribution of light is not discussed in this report, although it can be a key factor that influences the application efficacy of products. Luminaires and retrofit kits should be evaluated for light distribution as well as light control, glare, construction, and appearance separately from the results presented.

Notably, troffer retrofit kits may or may not reuse the existing luminaire's optical system (e.g., lens), which will affect the performance of the complete system. A product using the existing luminaire's optical system will have a lower efficacy than when it is tested by itself. This introduces a confounding factor when making comparisons using aggregate data in the LED Lighting Facts database.

LED Lighting Facts

2,920 Partners | 67,759 Total Active Products (December 8, 2017)

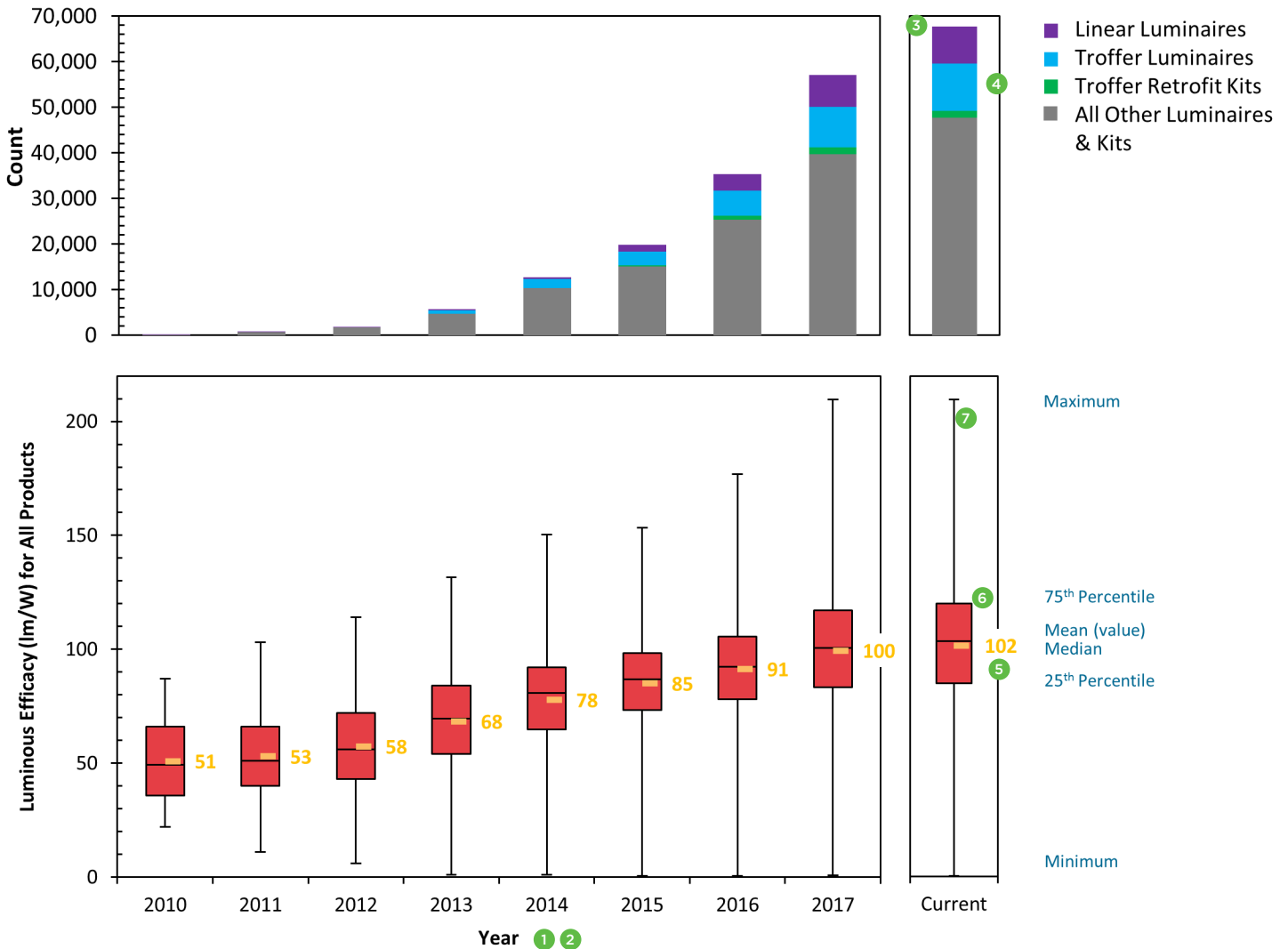
News and Notes

- LED Lighting Facts has played a pivotal role in the early adoption of SSL technology and products.
- After nearly a decade, the program is scheduled to end; the LED Lighting Facts website will close down on June 1.
- This Snapshot report is the final Snapshot report to be published, analyzing data drawn from the LED Lighting Facts product database.

Report Highlights

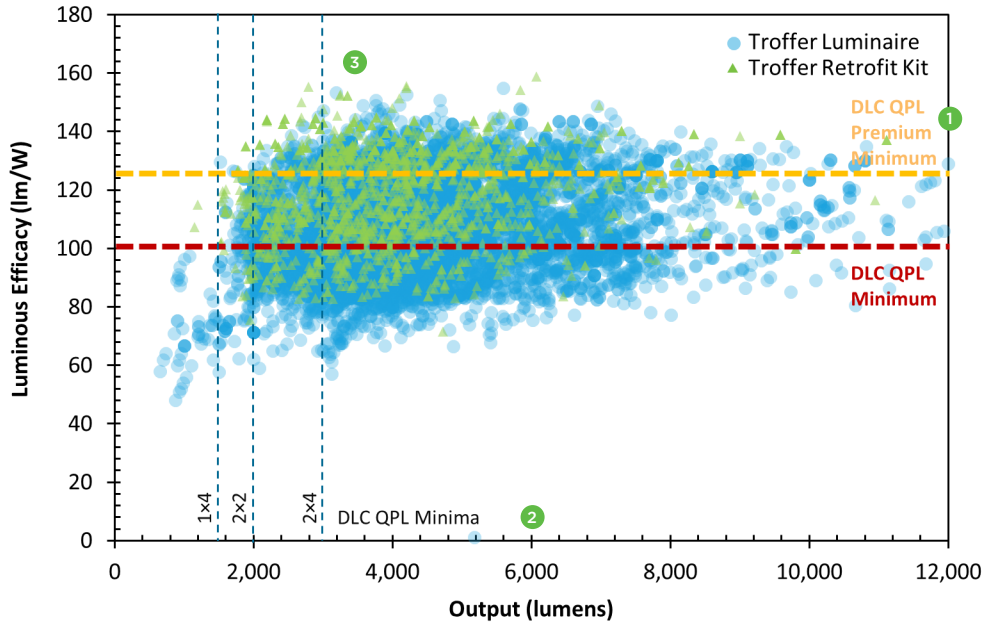
- Linear luminaires ranged in lumen output. However, a majority of the LED linear luminaires had lumen output that was on the low end compared to the incumbent fluorescent linear systems.
- Listed troffers had similar efficacy performance compared to other luminaires used for ambient lighting.
- A majority of troffer retrofit kits had an initial lumen output between 3,500 and 5,400 lumens. This is comparable to the lumen output range of louvered troffers with two or three standard-output T8 fluorescent lamps operating on a normal ballast factor ballast.

ALL PRODUCTS Listings & Efficacy Over Time



- 1 All yearly data corresponds to the status of the LED Lighting Facts database in June of that year.
- 2 As of December 2016, lamps are no longer listed by LED Lighting Facts. This includes screw-base lamps (e.g., A-lamps, PAR lamps), as well as pin-base lamps (e.g., MR16, TLED). To properly display trends, all lamps have been removed from the historical dataset. This results in small changes in average and maximum efficacy values compared to past CALiPER Snapshot reports.
- 3 As of December 8, 2017, there were 67,700+ products listed by LED Lighting Facts, 92% of which are luminaires and 8% of which are retrofit kits. The growth in number of listed products continues to be strong.
- 4 On the date of capture, there were 10,300+ products classified as troffer/grid ceiling luminaires and 8,100+ products classified as linear luminaires. Linear luminaires and troffer luminaires represent 13% and 17%, respectively, of all the luminaires in the LED Lighting Facts database. Also on the date of capture, there were 1,500+ troffer retrofit kits (29% of all retrofit kits) in the LED Lighting Facts database.
- 5 The mean initial efficacy of currently listed products is 102 lm/W, which is an increase of 2 lm/W compared to the June 2017 dataset.
- 6 As it has since the inception of LED Lighting Facts, the efficacy for the middle 50% of products covers a relatively small range (85 to 120 lm/W). The range has grown somewhat in the last year.
- 7 Of the three focus categories for this Snapshot (linear luminaires, troffer luminaires, and troffer retrofit kits), the highest efficacy value is 177 lm/W. There are roughly 50 products of the entire 67,700+ products with efficacy values greater than 177 lm/W. All of these products are industrial luminaires. One has a listed efficacy of 210 lm/W.

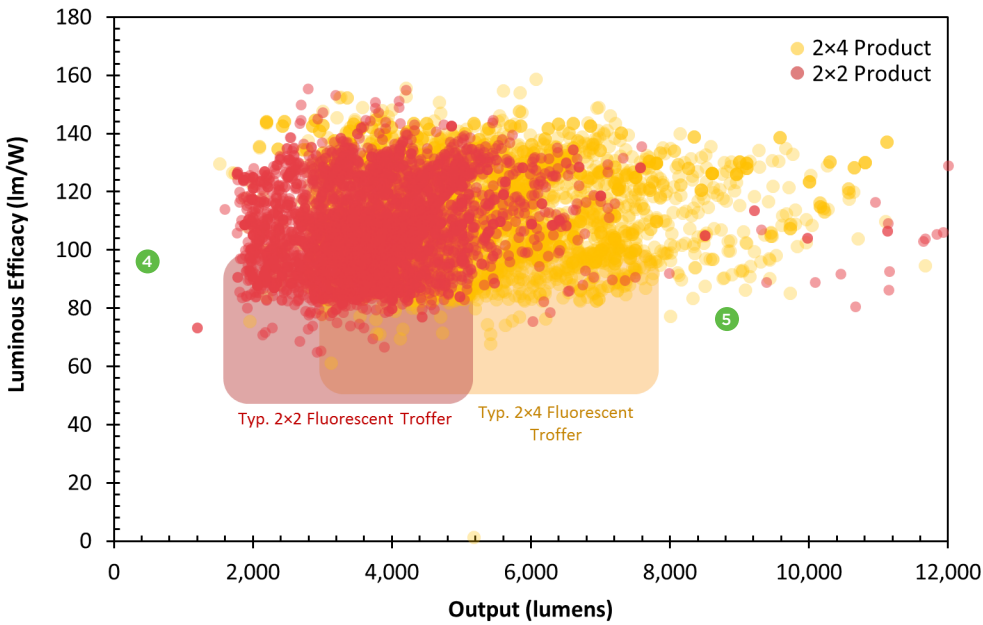
TROFFERS Efficacy & Output



1 66% of the listed troffer luminaires and 86% of the listed troffer retrofit kits had a luminous efficacy equal to or greater than 100 lm/W, which is greater than the maximum for fluorescent troffers and the minimum of the DesignLights Consortium® Qualified Products List (DLC QPL) Technical Requirements V4.2. 17% of the troffer luminaires and 40% of the troffer retrofit kits met the DLC Premium minimum value of 125 lm/W.

2 A vast majority of the listed troffer products exceed the DLC QPL Technical Requirements V4.2 for minimum lumen output. Specific shape designations are not available for all products listed by LED Lighting Facts.

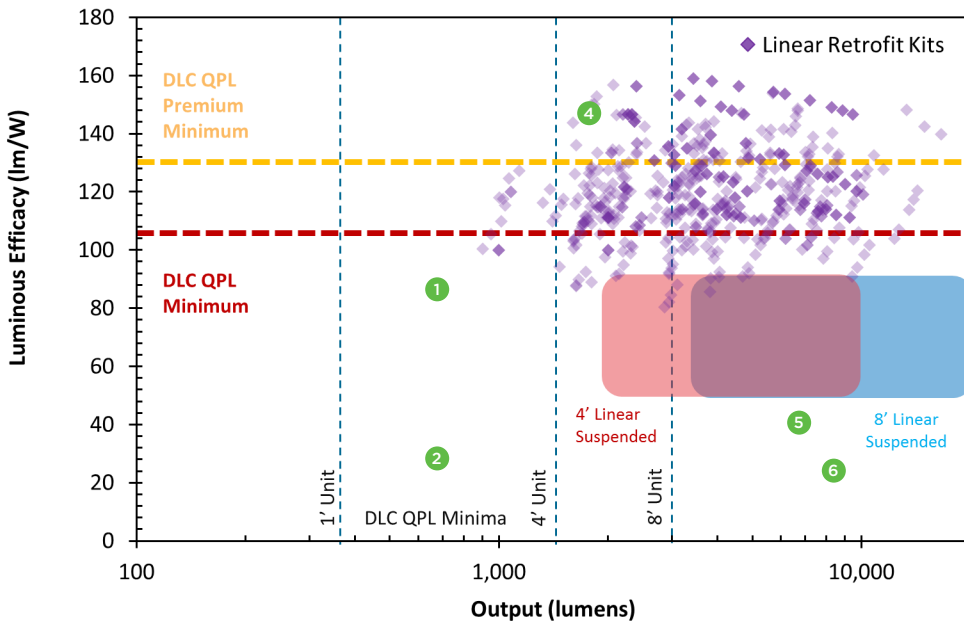
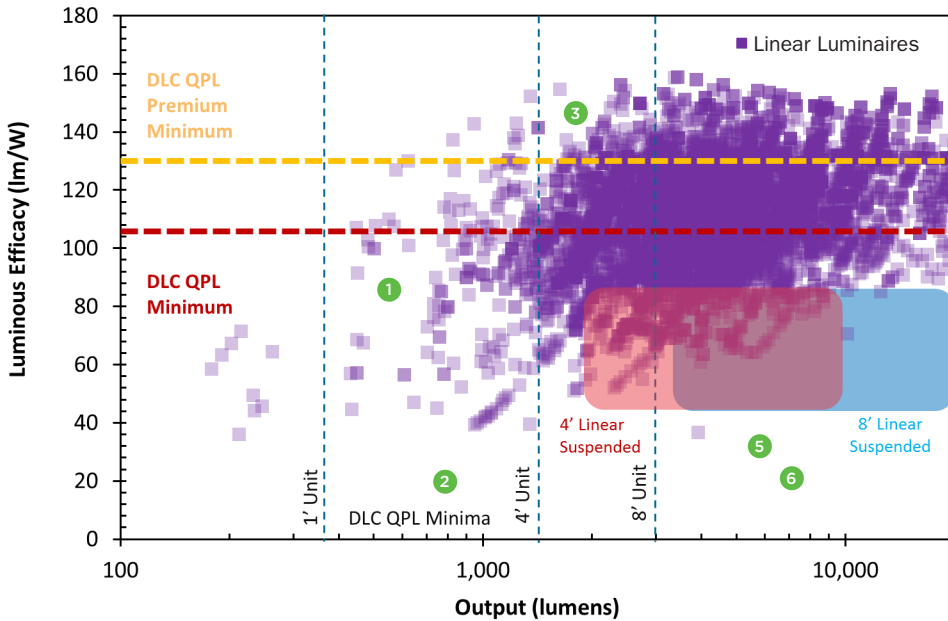
3 Overall, both the range in efficacy and lumen output is very similar between the troffer retrofit kits and troffer luminaires.



4 Of those products that list a specific size (2x2 or 2x4), it is clear that the majority of products have appropriate lumen output with higher luminous efficacy compared to competing fluorescent products. LED troffers are approaching twice the efficacy of the fluorescent incumbent products.

5 For both sizes of troffers, there are some outliers with lumen packages exceeding 8,000 lumens. Although the physical size is either 4 or 8 sq. ft., the luminous surface is smaller. With the low mounting heights of troffers (typically 8'–12'), a high lumen package and small luminous surface could be perceived as glare. Some very high lumen troffers may be used for clean rooms and other specialty applications where very high light levels might be needed.

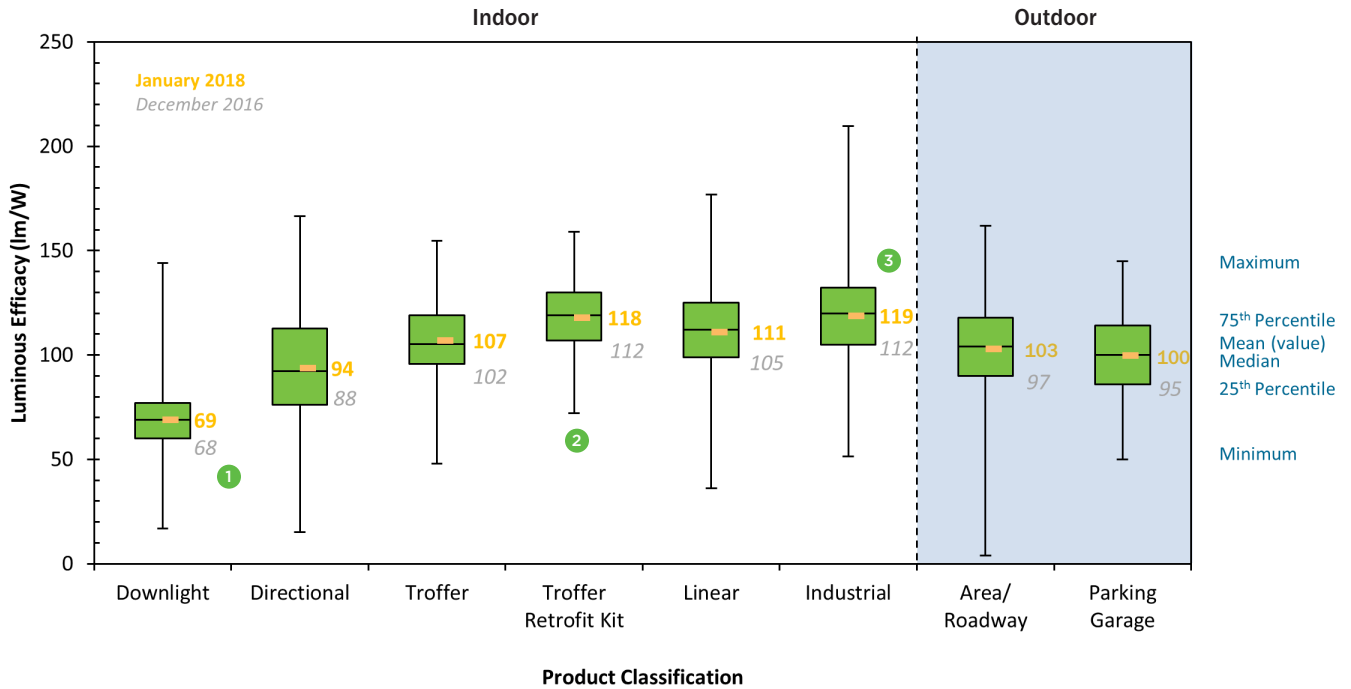
LINEAR Efficacy & Output



- 1 Compared to December 2016, the number of linear luminaires listed in the LED Lighting Facts database increased by 60%. In contrast, linear retrofit kits only increased by 28%.
- 2 The DLC QPL Technical Requirements V4.2 minimum light output for indoor linear ambient products is 375 lm/ft. The dashed lines represent 1 ft. (375 lumens), 4 ft. (1,500 lumens), and 8 ft. (3,000 lumens). 96% of the linear luminaires and retrofit kits meet the minimum for a 4 ft. and more than 65% meet the minimum requirement for an 8 ft.
- 3 In contrast to the lumen output, fewer of the linear luminaires listed in the LED Lighting Facts database met the DLC QPL Technical Requirements V4.2 minimum efficacy requirements. Only 65% of the linear luminaires met the minimum efficacy of 105 lm/W and only 16% met the premium efficacy requirement of 130 lm/W.
- 4 87% of linear retrofit kits listed in LED Lighting Facts met the minimum efficacy of 105 lm/W and 28% met the premium efficacy requirement of 130 lm/W per DLC QPL Technical Requirements V4.2.
- 5 Fluorescent linear suspended luminaires typically use between one and three T8 or T5 lamps in cross section. Linear suspended fluorescent luminaires range in efficacy between 49 and 87 lm/W.
- 6 The linear category within LED Lighting Facts contains many subcategories including direct, indirect, direct/indirect, slot, striplight, wraparound and various combinations of these categories. Further, LED Lighting Facts allows for manufacturers to input fixture size; however, there was insufficient data to analyze the dataset by length.

A significant portion of the listed LED linear luminaires and retrofit kits have a lumen output between 3,000 and 4,500 lumens.

TROFFERS & LINEAR Current Efficacy Versus Other Product Types



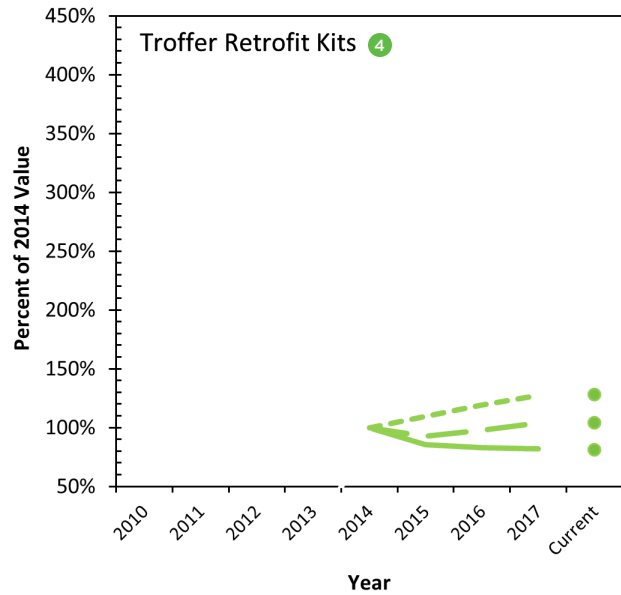
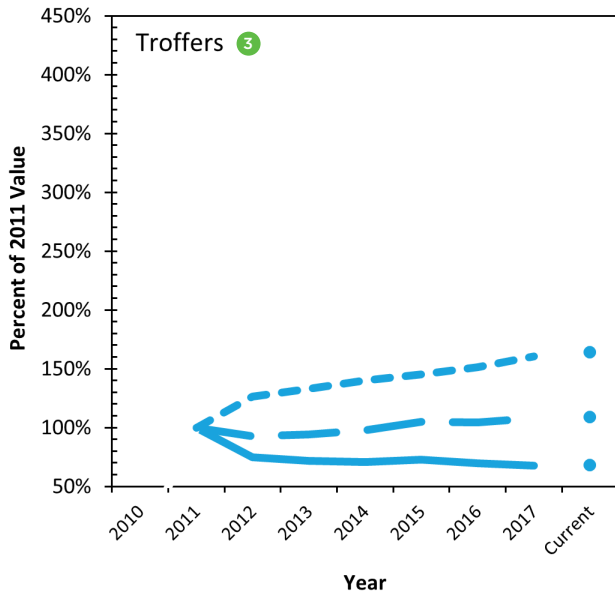
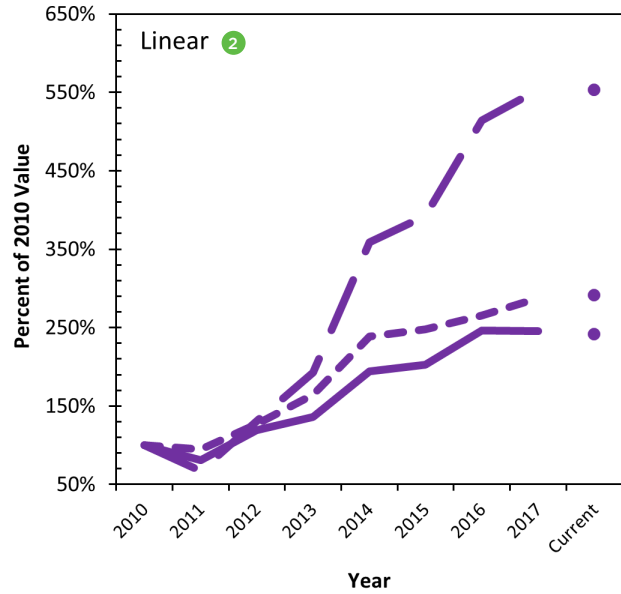
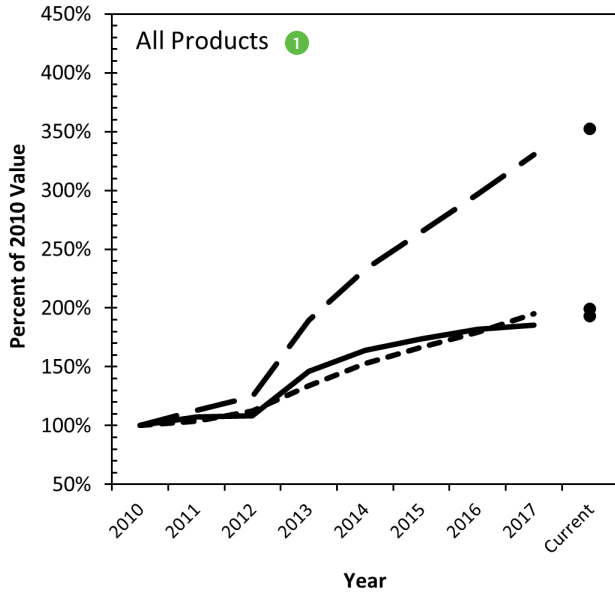
1 This chart compares the efficacy for a variety of indoor luminaires and troffer retrofit kits (left of dashed line) with two types of outdoor luminaires. The light gray italicized text is the mean efficacy value for the lighting product category from December 2016. Other than downlights, the initial efficacy for all of the lighting equipment increased by 5% or more.

2 According to the LED Lighting Facts database, troffer retrofit kits tend to have higher efficacy than troffer luminaires. This occurs in part because more than 2,000 of the listed troffer products were listed prior to 2014, when the retrofit designation first became available. If only the 8,200 troffer luminaires entered in the LED Lighting Facts database since the start of 2015 are considered, the mean initial efficacy of troffer luminaires is 109 lm/W.

One reason troffer retrofit kits might be slightly greater in efficacy than troffer luminaires, is that some retrofit kits reuse luminaire optical systems, and therefore the efficacy values for the listed products do not reflect the entire system.

3 Troffer retrofit kits and industrial luminaires are the products with the greatest initial efficacy values, followed by linear and troffer luminaires. The mean efficacy of these four indoor lighting product types exceeds traditional outdoor luminaires (area/roadway and parking garage luminaires).

TROFFERS & LINEAR Trends Versus All Other Products



— Input Power (W) - - - Luminous Efficacy (lm/W) - · - Output (lm)

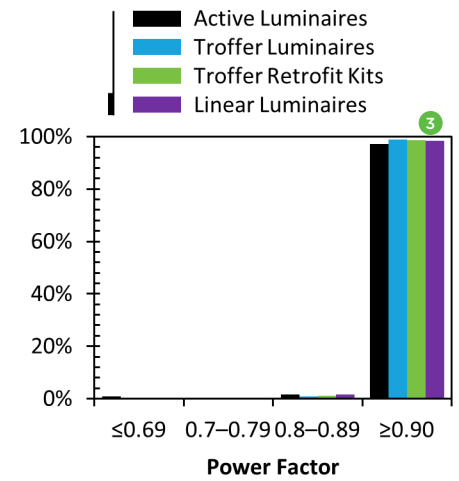
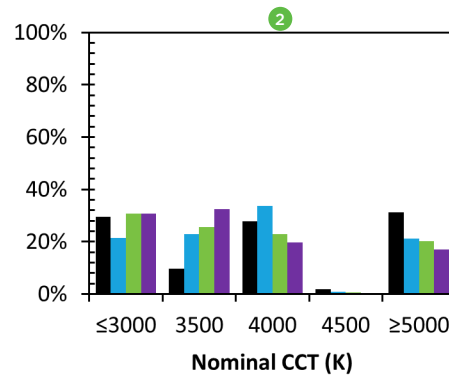
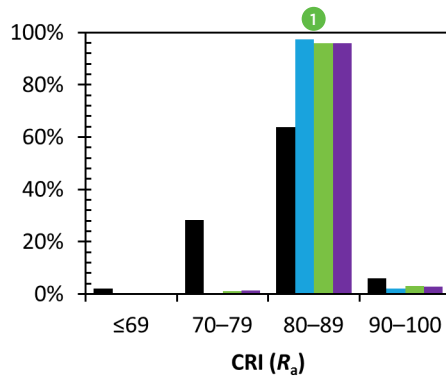
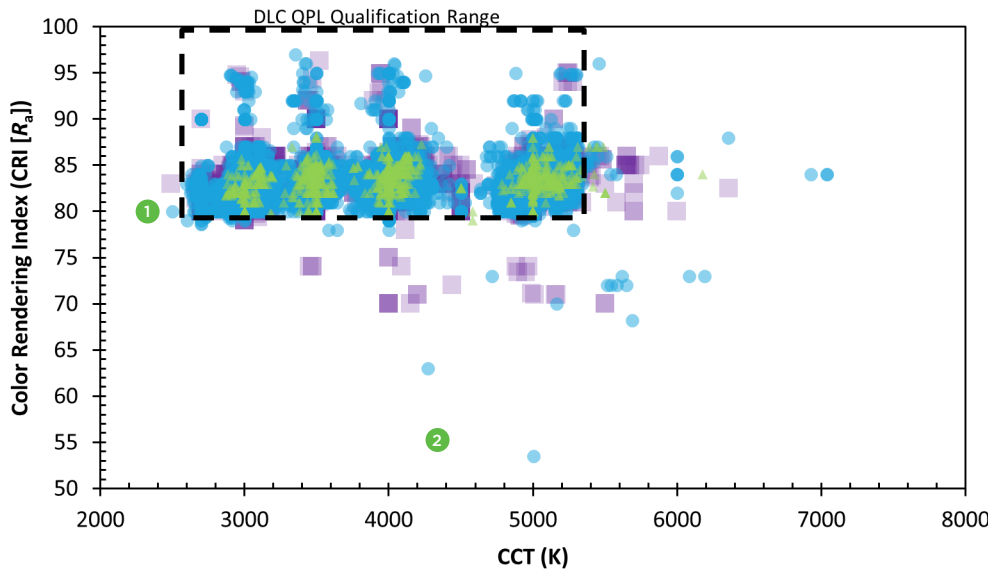
1 For all products listed by LED Lighting Facts, lumen output has been increasing faster than either input power or luminous efficacy, especially since 2012. If luminous efficacy continues to increase in the future, then input power should decrease, given that it is not necessary to continually increase lumen output.

2 Compared to troffer luminaires and troffer retrofit kits, linear luminaires have had more growth in input power, luminous efficacy, and lumen output compared to the original 2010 values. Since 2016, mean input power values for linear luminaires appears to have leveled at 50 W.

3 Since 2015, the mean input power for troffer luminaires has been between 43 and 46 W. Troffer luminous efficacy increased from 91 to 107 lm/W between 2014 and December 2017. In contrast, fluorescent lamp efficacy, fluorescent ballast efficiency, and troffer optical efficiency had little gains in that same time period.

4 The mean input power for troffer retrofit kits has been between 34 and 36 W since 2015. A two-lamp T8 troffer with normal ballast factor would draw 56 to 60 W. The mean lumen output for troffer retrofit kits has been between 3,600 and 4,000 lumens since 2015, which is generally comparable to fluorescent troffers.

TROFFERS & LINEAR Color Quality & Power Quality



1 Only 1% of the troffer luminaires, troffer retrofit kits, and linear luminaires have a CRI R_a less than 80.

Compared to December 2016, slightly more troffer luminaires, troffer retrofit kits, and linear luminaires have CRI R_a values of 90 or greater.

Although average color fidelity (e.g., CIE R_a) is not a good measure of color quality, this homogenous performance leaves little choice for specifiers. Not enough IES TM-30-15 data (which is optional) has been submitted to LED Lighting Facts to allow for meaningful comparisons. However, R_f values submitted were in the 80s and the R_g values submitted were in the 90s.

2 Common nominal CCT values of fluorescent interior lighting are 3000 K, 3500 K, and 4000 K. It is not surprising that troffer luminaires, troffer retrofit kits, and linear luminaires have more options at these nominal CCTs.

4500 K is not a standard offering for fluorescent lamps, which explains the similar lack of LED products at that CCT.

3 All of the luminaires and retrofit kits that provided the value had a high power factor (equal to or greater than 0.90). 35% or more of active luminaires, troffer luminaires, troffer retrofit kits, and linear troffers include power factor information in their LED Lighting Facts data.

TROFFERS & LINEAR

Discussion

The last time a Snapshot report included linear luminaires was in May 2014 (14,200+ total products), and troffers was in December 2016 (46,100 total products). Since the December 2016 report, the number of products listed by LED Lighting Facts has increased by 45%, adding 21,000 more total products including 3,000 linear luminaires, 3,000 troffer luminaires, and 600 troffer retrofit kits.

In December 2016, the mean initial efficacy for listed products was 105 lm/W for linear luminaires, 102 lm/W for troffer luminaires, and 112 lm/W for troffer retrofit kits; today they are 111 lm/W, 107 lm/W, and 118 lm/W respectively. In contrast, the incumbent fluorescent luminaires have efficacy values between 50 and 100 lm/W with luminaires in the 65 to 75 lm/W range being the most common. More than 65% of the linear luminaires, troffer luminaires, and troffer retrofit kits meet the minimum efficacy of the DLC QPL Technical Requirements V4.2.

The typical initial output of a 4 ft. T8 fluorescent lamp is 2,900 lumens. Normal ballast factor is in the range of 0.87 to 0.89, and fixture efficiency of fluorescent troffers varies from 45% to 90%. Therefore, a two-lamp generic troffer produces roughly 3,500 initial lumens and a three-lamp generic troffer produces 5,400 lumens. Roughly 50% of the troffer luminaires and troffer retrofit kits listed in the LED Lighting Facts database produce between 3,500 and 5,400 initial lumens. Almost 15% of the troffer luminaires and troffer retrofit kits produce more than 6,000 initial lumens. This is a significant lumen package and should be selectively used. It is important to evaluate the desired illuminance, the initial light output, and expected lumen depreciation when selecting equipment.

In terms of color quality and power quality, LED linear luminaires, troffer luminaires, and troffer retrofit kits almost all offer the same performance as their fluorescent counterparts. If CRI is the chosen color metric, the troffers and troffer retrofit kits meet the typical

quality bar of 80. However, more data from manufacturers is needed to comprehensively evaluate color rendition. All of the troffer luminaires and troffer retrofit kits that provided the data had high power factor, but only 35% reported a power factor value.

The data captured by LED Lighting Facts and reported here indicates that LED linear luminaires, troffer luminaires, and troffer retrofit kits offer a compelling alternative to fluorescent luminaires. Although this report focuses on basic photometric characteristics, choosing a product for a specific installation requires a more comprehensive analysis. ■

The Fine Print About LED Lighting Facts Snapshot Reports

Snapshot reports analyze the dataset—or subsets—from DOE's LED Lighting Facts product list. They are designed to help lighting retailers, distributors, designers, utilities, energy-efficiency program sponsors, and other industry stakeholders understand the current state and trajectory of the solid-state lighting market. Product classifications are at the discretion of the manufacturer, and Snapshot reports generally reflect the raw data listed in the LED Lighting Facts database. Minimal action is taken to adjust for inconsistencies.

The LED Lighting Facts database is not a statistical sample of the overall market. LED Lighting Facts is a voluntary reporting program in which manufacturers submit data for products tested in accordance with IES LM-79-08. Within any category, the data may be skewed not only by what is submitted, but also by the reporting practices of different manufacturers (e.g., reporting each small variation of

a product). Given the broad nature of some of the predetermined categories, not all individual products may be directly comparable (i.e., the form factor may be substantially different). Despite these limitations, the LED Lighting Facts database is the largest of its kind, and is generally considered indicative of market trends. The product list includes a wide variety of product types, from manufacturers large and small, lighting industry veterans and brand new companies alike.

LED Lighting Facts and Snapshot reports focus on five core metrics: lumen output, input power, luminous efficacy, color rendering index, and correlated color temperature. Data for other performance metrics can be voluntarily submitted, and all data are available on the LED Lighting Facts website until June 1, 2018. Specifiers should thoroughly consider all aspects of performance when evaluating different products.

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For more information, visit:

energy.gov/eere/ssl/led-lighting-facts

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