

CALiPER

Snapshot Indoor LED Luminaires

Featuring **Downlights, Industrial Luminaires,
Track Heads, Troffers, Linear Fixtures**

The LED Lighting Facts™ program is a primary repository for LED product data, and as of April 1, 2014, catalogued nearly 15,000 products. The number of listed products is growing rapidly, with about as many products added in the first quarter of 2014 as in the first two years of the program's existence. Importantly, not only is the quantity of products increasing, but the performance of newly listed products is also better than ever. Products listed in the first quarter of 2014 had a mean efficacy of 86 lm/W, with a maximum of 139 lm/W. In fact, the mean efficacy for newly listed products has increased by more than 16% in the past year alone.

LED replacement lamps get a lot of attention, but complete luminaires designed especially for LEDs may offer better overall performance. In fact, luminaires make up more than 70% of all products currently listed by LED Lighting Facts. This report, based on data through the first quarter of 2014, focuses on five types of luminaires intended for use indoors: downlights, industrial ambient luminaires (e.g., high-bay and low-bay), track heads, troffers (e.g., 2x4, 2x2, 1x4), and linear fixtures (e.g., linear pendants, strip lights).¹ Together, these five product types represent the bulk of all indoor luminaires listed by LED Lighting Facts, and about one-third of the total products listed. They are all typically used in applications with long hours of use, and thus consume substantial amounts of energy.

For industrial, troffer, and linear luminaires, LED products must compete with conventional technologies, such as linear fluorescent and high-intensity discharge systems, which are both low-cost and relatively efficacious. In contrast, LED downlights and track heads generally compete with less energy-efficient conventional products; track lighting is primarily accomplished using halogen lamps housed in basic luminaires, whereas downlights in commercial spaces typically use compact fluorescent lamps and have inefficient optical systems. The different benchmark technologies likely contribute to differences in the efficacy, output, and color quality of the five product types, as demonstrated throughout this Snapshot Report. For some categories where inefficient benchmark systems are commonplace, comparing LEDs to conventional lamps and luminaires may actually be limiting LEDs in their ability to fulfill the energy savings potential of the technology.

¹ Manufacturers that submit data to LED Lighting Facts are responsible for proper categorization of their products.



April 1, 2014

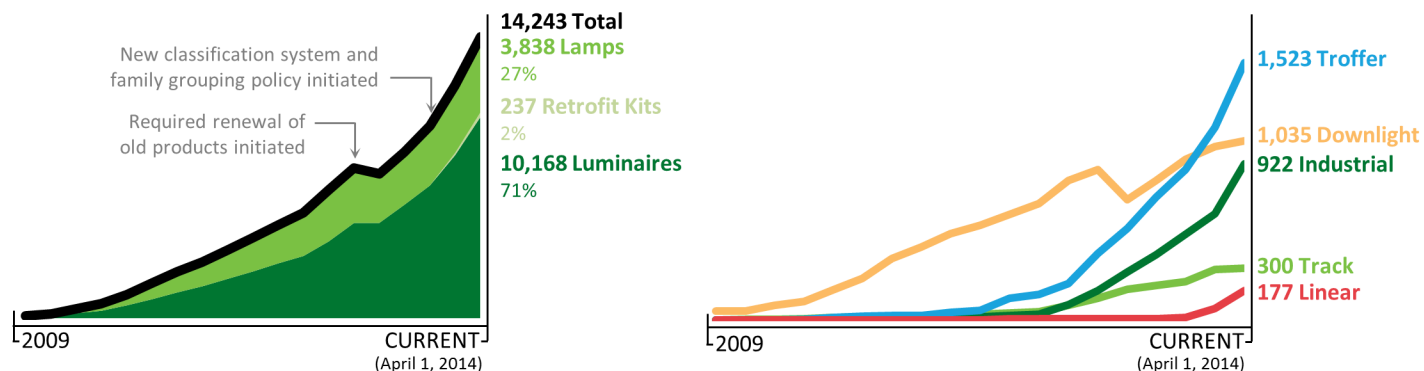
1,609 Partners

14,243 Total Active Products

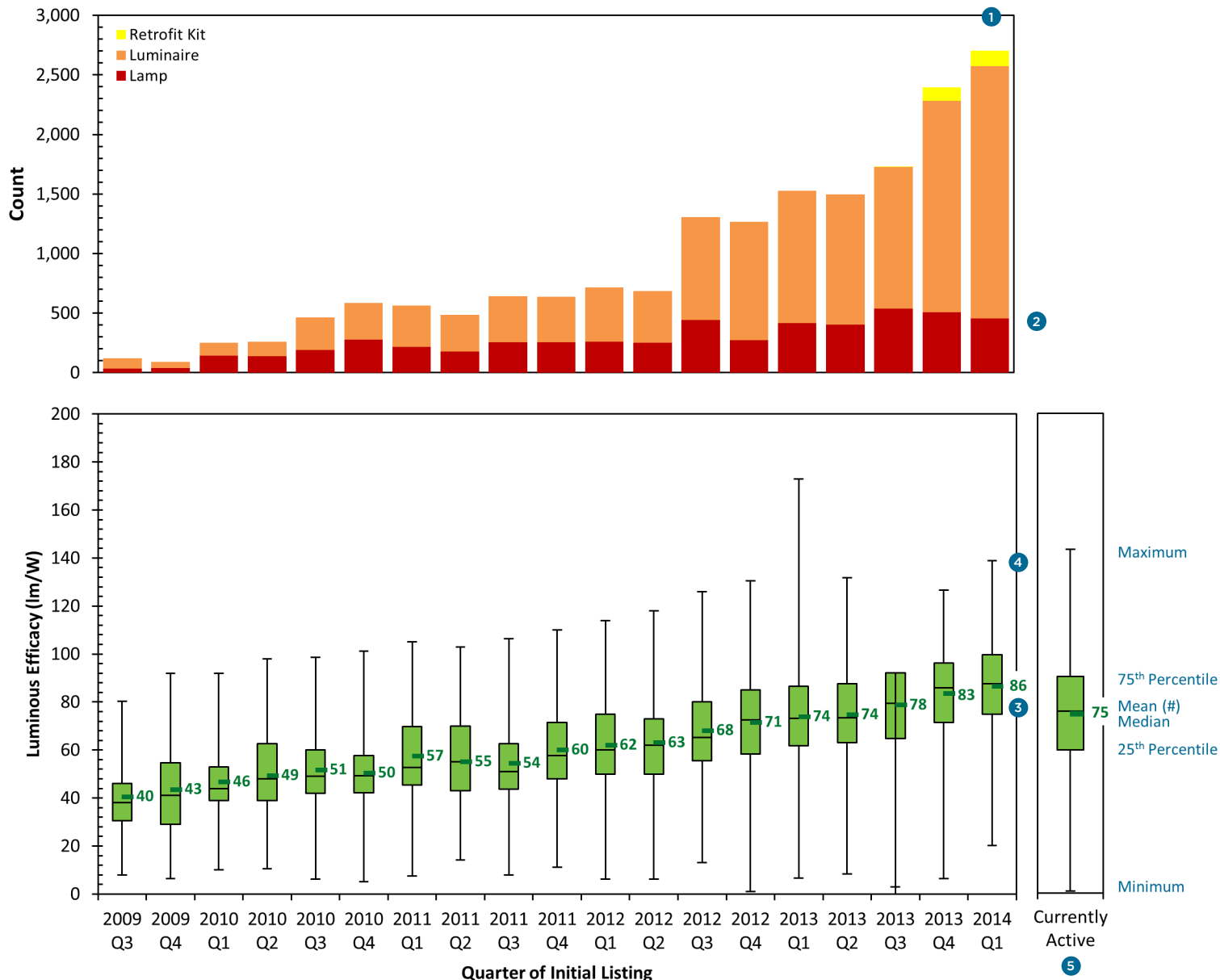
Report Highlights

- For the 11th consecutive quarter, the mean efficacy of newly listed products has increased, and is now at 86 lm/W.
- In all five categories, over 70% of the products meet relevant efficacy qualification criteria from energy efficiency programs.
- Although performance was highly variable, the lumen output of LED luminaires was often similar to that of typical conventional luminaires of the same type (where applicable). That is, at least 50% of the products had lumen output within a range considered typical for a conventionally lamped luminaire.
- Efficacy performance was divided into two groups: troffers/industrial/linear and downlight/track. Factors contributing to the divide may include form factor, intended use, or qualification thresholds.
- The dataset shows little correlation between color quality and luminaire efficacy.

AT A GLANCE NUMBER OF PRODUCTS LISTED BY LED LIGHTING FACTS



All Products New Listings & Efficacy Performance by Quarter



1 The growth of the LED Lighting Facts database continues to accelerate, with more than 2,700 new products added in the first quarter of 2014 alone. That is nearly as many products as were listed in the first two years of the program.

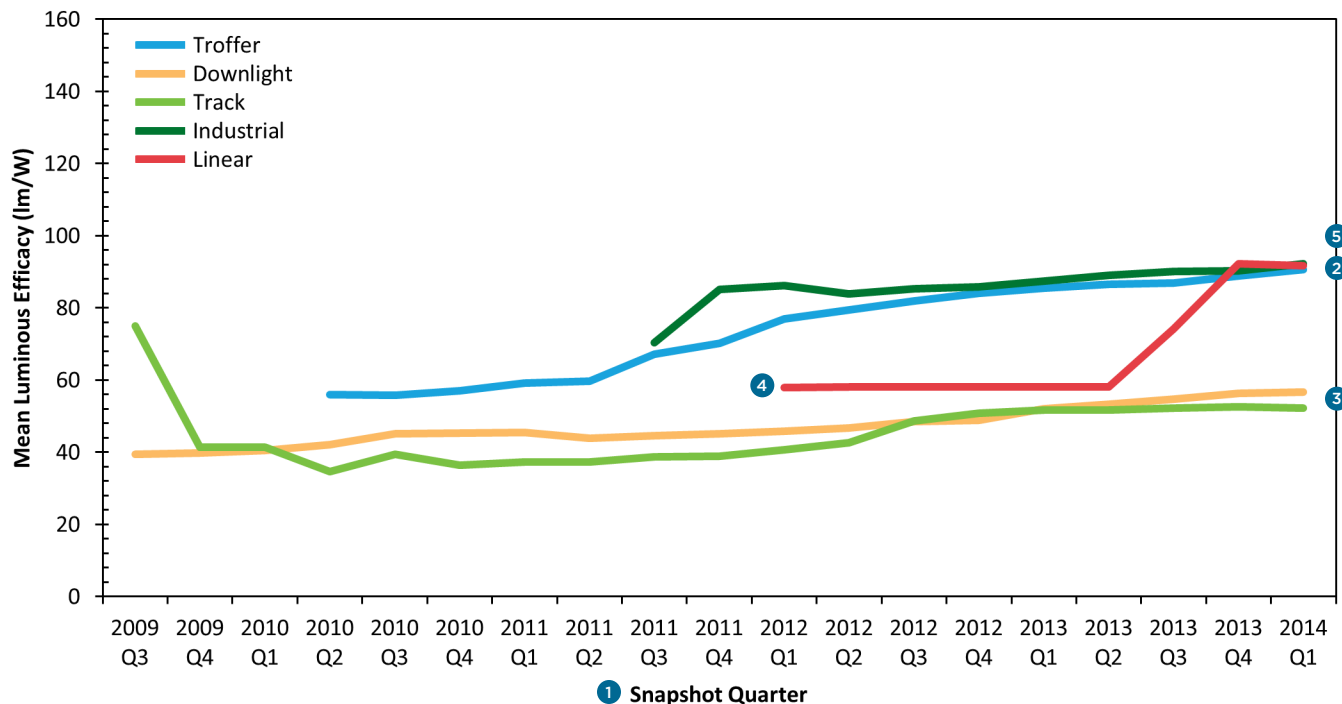
2 While the number of luminaires being listed each quarter has increased, the number of new lamps listed has remained fairly consistent over the past two years. That is, the increasing growth rate of the LED Lighting Facts database has been due almost entirely to the addition of LED luminaires.

3 The mean efficacy for products initially listed in the first quarter of 2014 (86 lm/W) is the highest to date. The efficacy of newly listed products has more than doubled since the inception of the LED Lighting Facts program, with an average increase of about 10 lm/W per year. In fact, the mean efficacy for products listed in the past quarter is higher than the maximum efficacy for products listed in LED Lighting Facts' first quarter.

4 With the exception of one anomalous product listed in the first quarter of 2013 (now delisted), increases in maximum efficacy have slowed over the past year. This will be an important trend to watch going forward.

5 As would be expected given the age of some of the products that remain active in the database, the overall mean efficacy of currently active products (75 lm/W) remains slightly below the performance from recent quarters. However, it is higher than the mean efficacy for all products ever listed (72 lm/W), which indicates that lower efficacy products are being deactivated, and it has risen every quarter since DOE began issuing Snapshot Reports.

Indoor Luminaires Efficacy Trends



1 This “Snapshot” chart documents the performance of products active in the LED Lighting Facts database at any given time. It is different from charts that show the performance for products newly listed in any given quarter. Under the scheme depicted here, old products that remain listed will partially mask increases for newly listed products, but it may be a better representation of what was on the market at a given point in time.

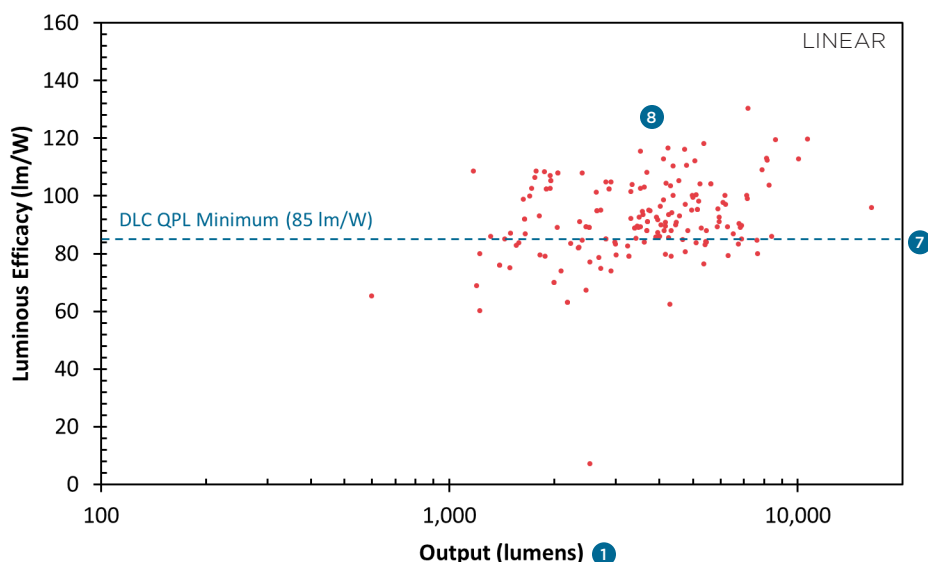
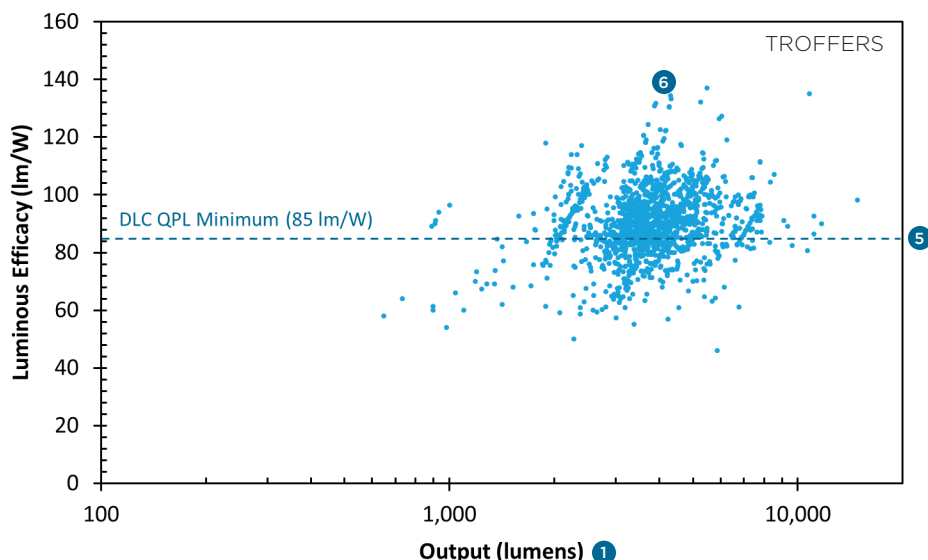
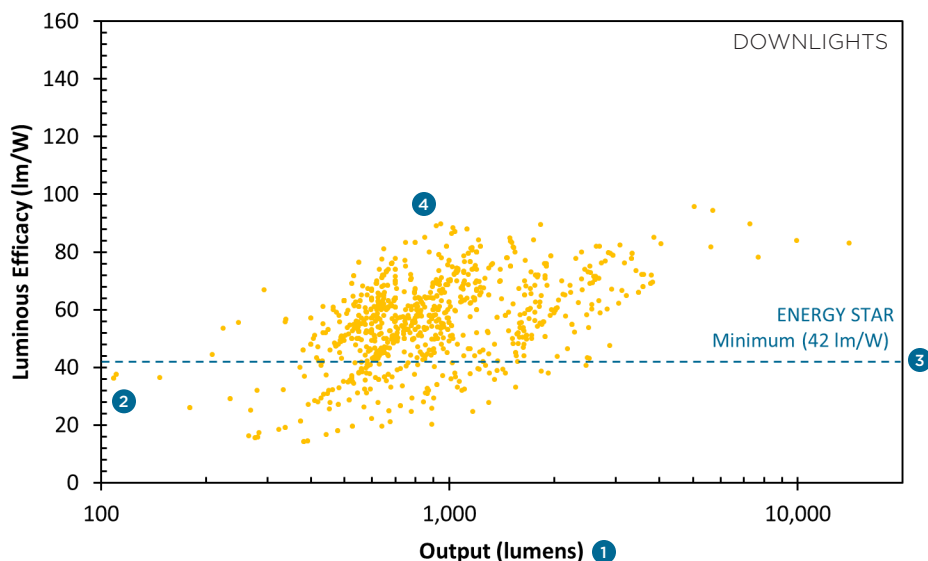
2 The five luminaire types covered in this report divide into two groups when examining their mean efficacies. The troffer, industrial, and linear luminaires listed by LED Lighting Facts all currently have a mean efficacy just above 90 lm/W.

3 The downlight and track luminaires have much lower mean efficacies of 57 lm/W and 52 lm/W, respectively. Compared to other product types, there has been less increase in efficacy over the past four years. In fact, the few track heads listed in the third quarter of 2009 had a higher efficacy than those listed in the most recent quarter. Along with higher reported efficacy for some individual products, this demonstrates that the lower average efficacy of this group of products is not entirely due to a technical limitation.

4 Less than 10 products listed prior to the third quarter of 2013 were retroactively given the linear luminaire designation, which was only added when the classification system expanded in August 2013. Thus, older data for linear luminaires is not representative of broader trends.

5 As a point of comparison, the mean efficacy for the nearly 1,000 currently listed linear LED lamps is 103 lm/W, which is higher than for any of the five indoor luminaire product types. However, when used in a luminaire, the total system efficacy will typically be between 60% and 90% of the lamp efficacy.

Indoor Luminaires Current Efficacy & Output



① Note that four of the five charts shown in this section are shown with a logarithmic scale. The three charts on this page have the same range, whereas the two plots on the next page have different ranges.

② A small number of downlights currently listed by LED Lighting Facts emit less than 100 lumens (not shown). These, and other downlights emitting less than 300 lumens, are likely specialty products, such as small-aperture accent luminaires.

③ The ENERGY STAR™ or DesignLights Consortium® Qualified Product List (DLC QPL) qualification criteria vary for the five different categories featured in this Snapshot report. For downlights, the minimum efficacy for ENERGY STAR qualification is 42 lm/W, which is exceeded by 85% of the downlights listed by LED Lighting Facts as of April 1, 2014.

④ Many of the listed downlights emit between 500 and 1,000 lumens. However, there are also some (manufacturer-classified) downlights listed that exceed 10,000 lumens—although they would be used in very different applications than the others.

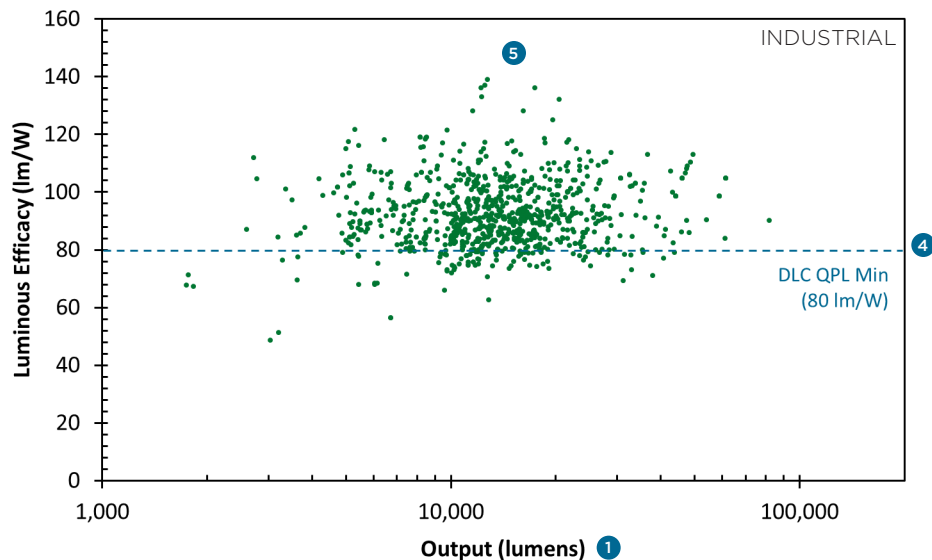
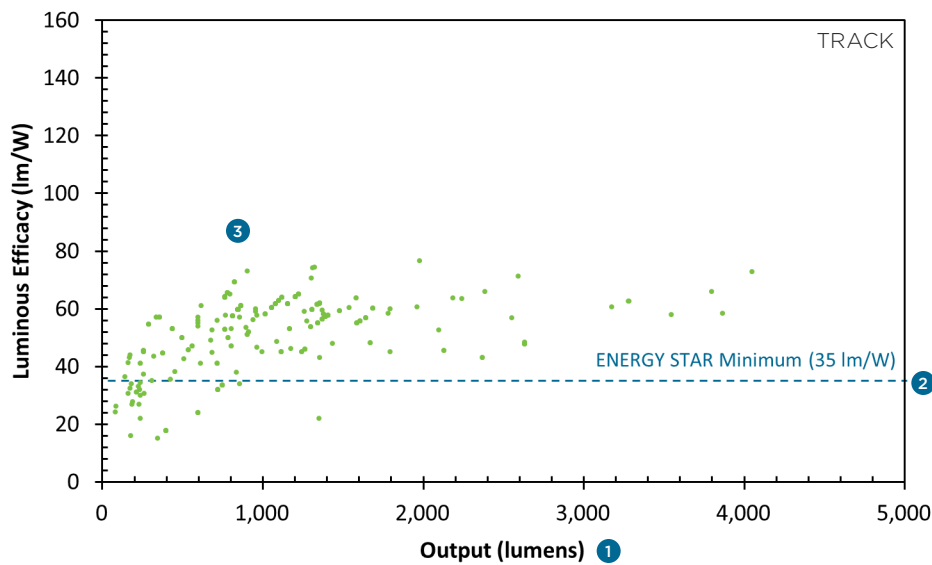
⑤ Over 71% of the listed LED troffers exceed 85 lm/W, the minimum efficacy criterion of the DLC QPL. Nine products exceed 130 lm/W, including products with a CRI above 90 and a CCT less than 4000 K.

⑥ About 57% of the LED troffers emit between 2,000 and 4,000 lumens. This is approximately the range for different types of two-lamp fluorescent troffers.

⑦ About 73% of the linear LED luminaires exceed 85 lm/W, the minimum efficacy criterion of the DLC QPL. One product exceeds 130 lm/W (5087 K, 83 CRI).

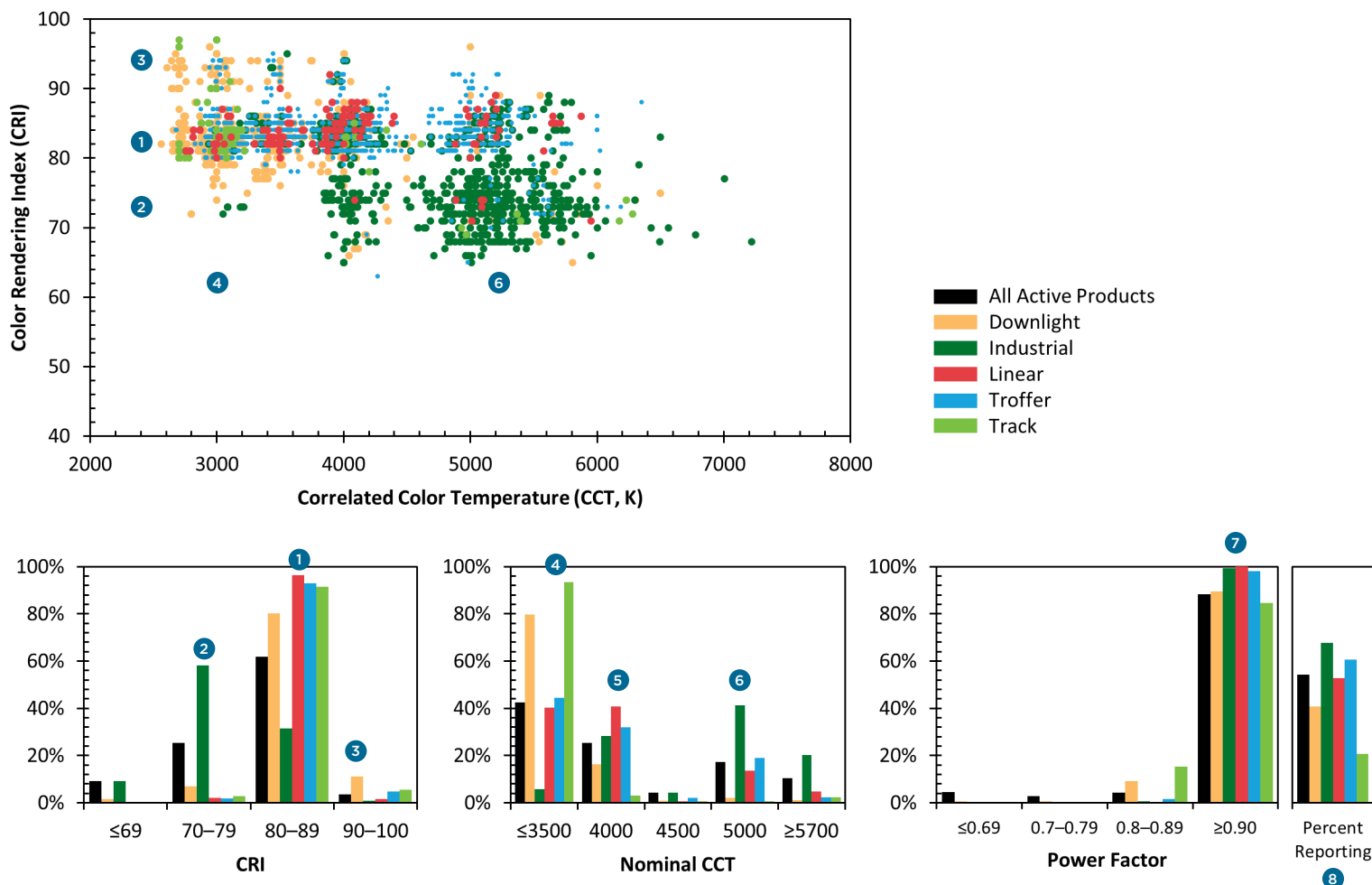
⑧ The output of linear LED luminaires ranges from about 600 to more than 10,000 lumens, with values scattered throughout that range rather than being clustered at particular output levels. Nearly three-quarters of the listed products exceed 2,500 lumens, which is approximately the maximum for a typical one-lamp fluorescent luminaire.

Indoor Luminaires Current Efficacy & Output



- ① Note that four of the five charts shown in this section are shown with a logarithmic scale. The two plots on this page have different ranges.
- ② Track-mounted luminaires have the lowest efficacy criterion (35 lm/W) of the five product types included in this report. Of the 300 products listed, 262 (87%) are over 35 lm/W.
- ③ As with linear luminaires, there is not a distinct range in track luminaire lumen output that includes a majority of the products. The track luminaires range from less than 100 to about 4,000 lumens.
- ④ Nearly 89% of the industrial luminaires listed by LED Lighting Facts meet the DLC QPL criterion of 80 lm/W.
- ⑤ As with track heads, the industrial luminaires do not tend to fall within a clear output range. However, there are more products toward the mean of the distribution (i.e., an approximately normal distribution), emitting between 10,000 and 20,000 lumens.

Indoor Luminaires Current Color Quality & Power Quality



1 For each of the five categories other than industrial luminaires, a vast majority of the products listed by LED Lighting Facts have a CRI in the 80s, with a majority of those falling between 80 and 85. In fact, more than 90% of downlights, troffers, track heads, and linear luminaires have a CRI of 80 or higher.

2 For industrial luminaires, a majority of the listed products have a CRI in the 70s. This is likely adequate for most industrial applications.

3 About 11% of the listed LED downlights have a CRI above 90. This is one of the highest numbers of any LED Lighting Facts product category. It is likely that these products are targeted for residential, hospitality, or retail use.

4 A vast majority of downlights and track luminaires have a nominal CCT of 3500 K or less. Nearly half of all listed troffers and many linear luminaires fall into the same category.

5 Linear and troffer luminaires show the greatest diversity of color appearance, with many warm, neutral, and cool products included in the LED Lighting Facts database.

6 According to the LED Lighting Facts database, industrial luminaires tend to have the highest CCTs, with a majority having a CCT of 5000 K or higher. In addition, a substantial amount have a nominal CCT of 4000 K.

7 A vast majority (more than 85%) of currently listed products in each of the five luminaire categories have a power factor of 0.90 or greater, if the value is reported at all. Only a very small percentage of products reporting the metric have a power factor less than 0.80.

8 Power factor is an optional metric for listing with LED Lighting Facts. As such, not all products include the value. The five luminaire categories that are the focus of this Snapshot have reporting rates between 21% and 68%.

Discussion Comparing Types of LED Luminaires

The five types of luminaires discussed in detail in this Snapshot Report are used in a broad range of interior lighting applications. The specific lighting products are intended to meet a variety of needs in different applications, which contributes to the diversity of performance. LED Lighting Facts relies on manufacturers to accurately categorize products using a predetermined set of criteria. CALiPER does not independently verify product classifications or attempt to identify specialty products that may be included in a given category.

The dataset obtained using the currently active products as of April 1, 2014, reveals that in many cases the performance of LED luminaires is similar to the products they are replacing, in terms of lumen output and color quality. For example, the LED troffers are generally comparable to two-lamp fluorescent troffers. While it is clear that the performance of conventional technologies is helping to drive the performance and energy-efficiency of LED luminaires, less obvious is the role that qualification programs may play. For all five luminaire categories, a strong majority of listed products met the relevant ENERGY STAR or DLC QPL efficacy criteria. However, the products tend to cluster just above the threshold. That is, the mean efficacy for downlights and track luminaires, which have lower efficacy criteria than the other three categories, are much lower than for linear, troffer, and industrial luminaires. To some degree, the discrepancy can be attributed to market-driven factors and the restrictions associated with smaller form factors and specialized optics, but there are downlights with efficacies over 100 lm/W and track luminaires with efficacies as high as 76 lm/W. From an energy-use perspective, higher efficacy may be more beneficial to product competitiveness, but once substantial energy savings are attained, lower cost and increased adoption may provide more immediate energy savings than further increases in efficiency.

Tradeoffs between lighting quality and energy efficiency are commonplace with LED luminaires. For otherwise identical products using the same type of LEDs, those with a higher CCT will be more efficient than those with a lower CCT; however, as demonstrated by the LED Lighting Facts data, this rule of thumb does not apply to a market-wide sample of products. For instance, the 11% of listed downlights with a CRI of 90 or greater have a higher mean efficacy (58 lm/W) than the entire group of downlights (57 lm/W). Similarly, one might expect luminaires in the industrial category, which tend to have higher CCTs and lower CRIs, to have higher efficacies; whereas in fact, the mean efficacy of products in that category is similar to the mean efficacy for the troffer and linear luminaires categories.

Another interesting result of this analysis is that the power factor for the luminaires is generally excellent. With 90% of the products reporting the metric having a power factor above 0.90, the LED products seem to compare favorably to conventional lighting systems. For example, many residential linear and compact fluorescent products have a power factor around 0.50. Given the incomplete data, however, such conclusions should be interpreted cautiously.

Overall, the performance of LED luminaires offers a compelling option for specifiers of interior lighting. LED Lighting Facts does not capture cost data, however, which is often a critical consideration in the decision-making process. Superior performance is not universal to all LED products, so specifiers must understand the needs of their application and the desired performance levels.

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, and from lighting-industry veterans and brand-new companies alike.

LED Lighting Facts and the 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 is available on the LED Lighting Facts website. Specifiers should thoroughly consider all aspects of performance when evaluating different products.

