

# Lighting Emitting Diode (LED) General Lighting

## 1. Development of LED Lighting

- (a) LED is one of the emerging lighting technologies in recent years. Before the release of internationally recognized performance standards for LED lamps, individual manufacturers adopt their own standards to test the key properties of LED lighting, including the light output, light intensity distribution, maintenance of light output, light intensity over time, energy performance, and colour rendering. The quality of LED lighting products on the market varies widely and many of this performance are manufacturer's claimed performance.
- (b) Standard development is essential for successful market introduction. The International Electro-technical Commission (IEC) has published performance standards on LED lightings (please kindly see Annex 1 for LED terms and definitions and its standards):-

Self-ballasted LED lamps:

- i. IEC 62612 (2013): Self-ballasted LED-lamps for general lighting services – Performance requirements for low wattage<sup>1</sup> LED lamps;

LED luminaires:

- ii. IEC 62722-1 (2014): Luminaire performance – Part 1: General requirements
  - iii. IEC 62722-2-1 (2014): Luminaire performance – Part 2-1: Particular requirements for LED luminaires
- (c) With reference to the CALiPER Snapshot Report<sup>2</sup> on Indoor LED Luminaires, products listed in early 2014 had a mean efficacy of 86 lumen per watt. Although quality of LED products vary widely, in many cases the performance of LED luminaires (low wattage for general lighting application) is similar to the products they are replacing, in terms of lumen output and color quality. The performance of LED luminaires offers a compelling option for specifiers of interior lighting. However, the Report does not capture cost data, however, which is often a critical consideration in the decision-making process.

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<sup>1</sup> For LED lamps with rated power up to 60W at rated voltage of >50V up to 250V a.c.

<sup>2</sup> [https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/snapshot2014\\_indoor-luminaires.pdf](https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/snapshot2014_indoor-luminaires.pdf), Department of Energy (DOE), US

- (d) The table<sup>3</sup> below shows a comparison between the price and performance of SSL products typically purchased during 2015 and the best-in-class conventional lighting technologies with which they are competing. The table shows that LED products (e.g. LED T8 tube, 107lm/W) are already as efficient as, or more efficient than, most incumbent technologies (e.g., linear fluorescent tube, 108lm/W), but still have higher purchase prices.

2015 Product Type	Luminous Efficacy (lm/W)	Correlated Color Temperature (CCT) (K)	Usable Life <sup>1</sup> (hours)	Price (\$/klm)
LED A19 Lamp (Dimmable, Warm White) <sup>2</sup>	78	2700	25,000	\$10
LED PAR38 Lamp (Warm White) <sup>2</sup>	70	3000	28,000	\$19
LED T8 Tube (Neutral White) <sup>2</sup>	107	4100	50,000	\$10
LED 6" Downlight (Warm White) <sup>2</sup>	64	3000	40,000	\$29
LED Troffer 2' x 4' (Warm White) <sup>2</sup>	94	3500	56,000	\$29
LED High/Low-Bay Fixture (Warm White) <sup>2</sup>	102	4000	90,000	\$23
LED Street Light <sup>2</sup>	96	5000	50,000	\$49
OLED Luminaire <sup>3</sup>	43	3000	40,000	\$870
HID (High Watt) System <sup>4</sup>	115	3100	15,000	\$3
Linear Fluorescent System <sup>4</sup>	108	4100	25,000	\$4
HID (Low Watt) System <sup>4</sup>	104	3000	15,000	\$4
CFL A19 Replacement	70	2700	12,000	\$2
CFL (Dimmable) A19 Replacement	70	2700	12,000	\$10
Halogen A19	20	2750	8,400	\$2.50
Incandescent A19	15	2760	1,000	\$0.63

- (e) Section C9 of the latest version of General Specification for Electrical Specification<sup>4</sup> published by ArchSD also covers the procurement of LED lighting including LED tubes.

## 2. LED for General Lighting Applications

- (a) To promote wider use of LED for general lighting applications, EEO of EMSD published pamphlet<sup>5</sup> and procurement guidelines<sup>6</sup>. Moreover, the use of LED lamps is also

<sup>3</sup> [http://energy.gov/sites/prod/files/2016/06/f32/ssl\\_rd-plan\\_%20jun2016\\_2.pdf](http://energy.gov/sites/prod/files/2016/06/f32/ssl_rd-plan_%20jun2016_2.pdf), Solid-State Lighting R&D Plan, June 2016 from US DOE, Table 2.1

<sup>4</sup> [http://www.archsd.gov.hk/media/119117/gsee02-2012\\_w\\_corr.pdf](http://www.archsd.gov.hk/media/119117/gsee02-2012_w_corr.pdf), Section C9

<sup>5</sup> Promotion pamphlet on "LED General Lighting Application" published by EEO of EMSD, [http://www.emsd.gov.hk/filemanager/en/content\\_764/LED\\_Gnrl\\_Lghtng\\_Aplctn.pdf](http://www.emsd.gov.hk/filemanager/en/content_764/LED_Gnrl_Lghtng_Aplctn.pdf)

<sup>6</sup> [http://www.emsd.gov.hk/filemanager/en/content\\_764/LED\\_lighting\\_procurement\\_issued.pdf](http://www.emsd.gov.hk/filemanager/en/content_764/LED_lighting_procurement_issued.pdf)

promoted in various publications and online website, trade seminars and school visits. Despite a wide range in performance, top-quality LED replacements are emerging for some existing general service lamp types such as LED linear lamp. Some examples of LED for general lighting applications are discussed in following paragraphs.

### **LED linear lamp**<sup>7</sup>

- (b) More than half of all the light sources in commercial applications are linear fluorescent lamps, which are used in a wide range of fixtures, including 600mm x 1200mm and 600mm x 600mm. With reference to US DOE's report<sup>8</sup> on linear LED (T8) lamps, more LED products are being offered as energy-efficient alternatives, such as integral LED luminaires, T8 LED replacement lamps, and retrofit kits to upgrade fluorescent troffers<sup>9</sup> to an LED option.
- (c) CALiPER's study<sup>10</sup> by US DOE revealed that integral LED luminaires provided the highest level of performance for LED troffer products although this may not necessarily be the best choice for all situations owing to higher retrofitting cost. LED T8 lamps and LED retrofit kits had a similar level of performance, with LED T8 lamps experiencing more difficulty in producing acceptable distributions and color quality given their interaction with existing optical systems. The application summary report<sup>11</sup> also indicated that none of the linear LED lamps tested had a luminous intensity distribution similar to that of a linear fluorescent lamp they are intended to replace. In order to save energy and achieve equal task plane illuminance, the linear LED lamps must rely on the directionality of the emission increasing the efficiency of the luminaire or changing its distribution to focus more light on the workplane.

### **LED General Lighting Application in Hong Kong**

- (d) LED lighting as general lighting application was commonly found in Hong Kong. The government and some public organizations such as Hong Kong International Airport and Mass Transit Railway Corporation of Hong Kong have adopted LED lighting at their premises. Some examples of the applications were presented in the pamphlet "LED General Lighting Application"<sup>12</sup>. LED lamps for general lighting are commonly

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<sup>7</sup> Linear LED lamps often have a similar form factor to T8 fluorescent lamps, but usually about half of the volume is dedicated to thermal management and/or an integral driver (others have an external drive). Some lamps can operate on an existing ballast, but others require rewiring.

<sup>8</sup> [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper\\_21-4\\_t8.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_21-4_t8.pdf), US DOE

<sup>9</sup> [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led\\_troffer-upgrades\\_fs.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_troffer-upgrades_fs.pdf), US DOE

<sup>10</sup> [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper\\_recessed-troffer\\_2013.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_recessed-troffer_2013.pdf), US DOE

<sup>11</sup> [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper\\_21\\_t8.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_21_t8.pdf), CALiPER Application Summary Report 21, US DOE, page 20

<sup>12</sup> [http://www.emsd.gov.hk/filemanager/en/content\\_764/LED\\_Gnrl\\_Lghtng\\_Aplctn.pdf](http://www.emsd.gov.hk/filemanager/en/content_764/LED_Gnrl_Lghtng_Aplctn.pdf), (Page 13 – 19)

available in Hong Kong's retail market. A survey on the LED lamps available in Hong Kong's retail market was conducted in September 2016. It reviewed the type of lamp, wattage rating range and market price by visiting the major chain stores and some retail shops. Findings of the survey was summarized below:-

- Different brands of LED lamps are available for customers in shops;
- The common types of LED lamps were globe lamp, candle bulb, spotlight; and
- Wattage ranging 1.5W to 24W among the surveyed LED lamps with price ranging HK\$30 to HK\$130 for each lamp.

The retail price was found generally 20-30% lower when compared with 3 years before and there were several choices for the customer to find a suitable lamp for replacement with the existing general lighting.

### **3. Energy Efficiency Label for LED lamps**

- (a) Household Lamp (LED self-ballasted lamps) – A Voluntary Energy Efficiency Labelling Scheme (VEELS) for LED Lamps<sup>13</sup> was launched on 14 June 2011. The VEELS aims to help consumers select more energy-efficient products, increase public awareness of the importance of using energy-efficient products, encourage manufacturers and product suppliers to market more energy-efficient products and achieve actual energy savings. With the energy label, consumers can make informed choices to help the environment by choosing energy-efficient products.
- (b) The VEELS for LED lamps is developed with reference to currently available, relevant international standards, regional/national standards and performance requirements in the labelling schemes of other countries such as China, Singapore and the United States. This scheme will assess the energy performance and operating life up to 6,000 hours.
- (c) For lighting testing in Hong Kong, local agencies such as Intertek, KEMA and SGS are potential service providers. Intertek has already set up additional testing facilities in 2010 for testing of various lighting products including LED lamps. For certification, local LED manufacturers are keen to see testing agencies in Hong Kong being capable of testing/certifying their products for export to the US and EU markets.
- (d) LED lighting technology is still under development stage. We will close monitor the development of LED lighting for extending the coverage of the Mandatory Energy Efficiency Labelling Scheme (MEELS) to include LED lighting.

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<sup>13</sup> [http://www.emsd.gov.hk/filemanager/en/content\\_358/veels\\_led\\_lamp.pdf](http://www.emsd.gov.hk/filemanager/en/content_358/veels_led_lamp.pdf), The revision of the scheme has been implemented from 1 January 2014

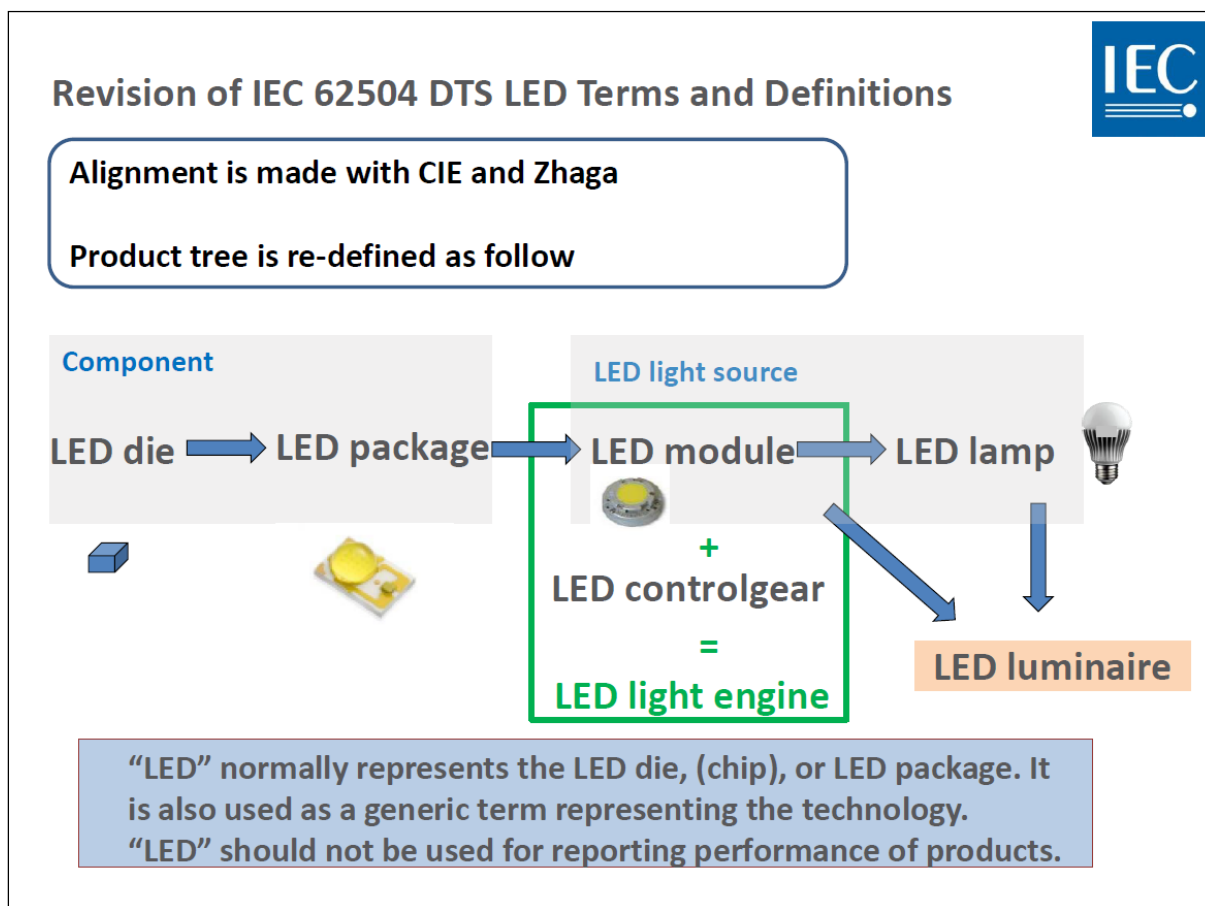
#### **4. Other Applications of LED apart from General Lighting**

- (a) LEDs were first deployed as indicator lights and digital display for watches many years ago. As the technology developed with improved power output and variety of colour, LEDs are also used for signboards, light-boxes, traffic lights, facade lighting and feature lighting applications.
- (b) With the fast development of LED technology, LED display applications for advertising, stadium and stage becomes more and more popular.
- (c) There is another kind of solid-state light sources, the organic light-emitting diode (OLED) which is still at research and development stage and currently not ready for illumination applications. The efficacy is about 40 lm/W at this moment.






#### **Reference Documents**

1. CALiPER Snapshot Reports, US DOE, <http://energy.gov/eere/ssl/caliper-snapshot-reports>
2. LED Linear Lamps and Troffer Lighting by US DOE, <http://energy.gov/eere/ssl/led-linear-lamps-and-troffer-lighting>
3. “LED for Illumination – Review of the Technology and Current Status in Hong Kong” by Ir. Dr. T.M. Chung, Department of Building Services Engineering, HKPU, [http://bs.hkie.org.hk/en\\_it\\_news\\_details.aspx?ID=364&&TypeName=What's+new](http://bs.hkie.org.hk/en_it_news_details.aspx?ID=364&&TypeName=What's+new)
4. “LED for Illumination – A Survey in Hong Kong” by Ir. Dr. T.M. Chung, Department of Building Services Engineering, HKPU, [http://bs.hkie.org.hk/en\\_it\\_news\\_details.aspx?ID=376&&TypeName=What%27s+new](http://bs.hkie.org.hk/en_it_news_details.aspx?ID=376&&TypeName=What%27s+new)

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### Safety standards and performance standards of different LED products:

Product Type	Safety Standard	Performance Standard
LED Control gear 	IEC61347-2-13:2014	IEC 62384:2006/ AMD1:2009
LED Connectors 	IEC 60838-2-2:2006/ AMD1:2012	-
LED Lamps Self ballasted 	IEC 62560:2011/ AMD1:2015	IEC 62612:2013/ AMD1:2015
LED Modules 	IEC 62031:2008/ AMD1:2012/AMD2:2014	IEC 62717:2014/ AMD1:2015
LED Luminaires 	IEC 60598-1:2014 IEC 60598-2-1:1987 IEC 60598-2-2:2011	IEC 62722-1:2014 and 62722-2-1:2014