

LED LIGHTING MARKET

GLOBAL FORECAST TO 2022

BY INSTALLATION TYPE (NEW INSTALLATION, AND RETROFIT INSTALLATION),
END USE APPLICATION (INDOOR LIGHTING, AND OUTDOOR LIGHTING),
PRODUCT TYPE (LAMPS, AND LUMINAIRES), AND GEOGRAPHY

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LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
APAC	Asia-Pacific
ASP	Average Selling Price
CAGR	Compound Annual Growth Rate
CMOS	Complementary-Metal-Oxide Semiconductor
DLP	Data Light Processing
EDA	Electronic Design Automation
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HID	High Intensity Discharge
IDMs	Integrated Device Manufacturers
LCoS	Liquid Crystal on Silicon
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
MEMS	Microelectromechanical Systems
MRI	Magnetic Resonance Imaging
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
OLED	Organic Light-Emitting Diode
POC	Point-of-Care
R&D	Research & Development
RoW	Rest of the World
U.K.	United Kingdom
USD	United States Dollar
U.S.	United States
Y-o-Y	Year-on-Year Growth

1 INTRODUCTION

1.1 OBJECTIVES OF THE STUDY

- To define, describe, and forecast the global LED lighting market, in terms of value and volume, segmented on the basis of installation type, product type, end-use application, and geography.
- To forecast the market size, in terms of value and volume, for various segments with regard to four main regions, namely, North America, Europe, Asia-Pacific, and RoW
- To provide detailed information regarding the major factors influencing the growth of the market (drivers, restraints, opportunities, and industry-specific challenges)
- To provide a detailed overview of the value chain in the LED lighting market and analyze the impact of Porter's five forces on the market
- To strategically analyze the micromarkets¹ with respect to the individual growth trends, future prospects, and contribution to the total market
- To analyze the opportunities in the market for various stakeholders by identifying the high-growth segments of the LED lighting market
- To strategically profile the key players and comprehensively analyze their market position in terms of ranking and core competencies² along with the detailed competitive landscape for the key market leaders
- To analyze competitive developments such as joint ventures, mergers and acquisitions, new product launches and developments, and research and development in the LED lighting market

1.2 MARKET DEFINITION

A light-emitting diode (LED) is a semiconductor light source formed from a p-n junction diode. It emits light when a suitable voltage is applied across its leads. An LED lamp is formed by assembling LED devices into a lamp to be used as a light bulb or light source in a lighting fixture.

Compared with incandescent lamps, LED lamps are several times electrically efficient and have a longer lifespan. They are also significantly more efficient than fluorescent lamps, and unlike fluorescent lamps, LEDs do not require warm-up time to come to full brightness. An LED lighting system's essential component is an LED driver. An LED driver is an electrical device which monitors the power to an LED or a series of LEDs. LED driver responds according to the changing needs of the diode or LED circuit by providing it a constant quantity of power.

1. Micromarkets are defined as the further segments and subsegments of the LED lighting market included in the report.

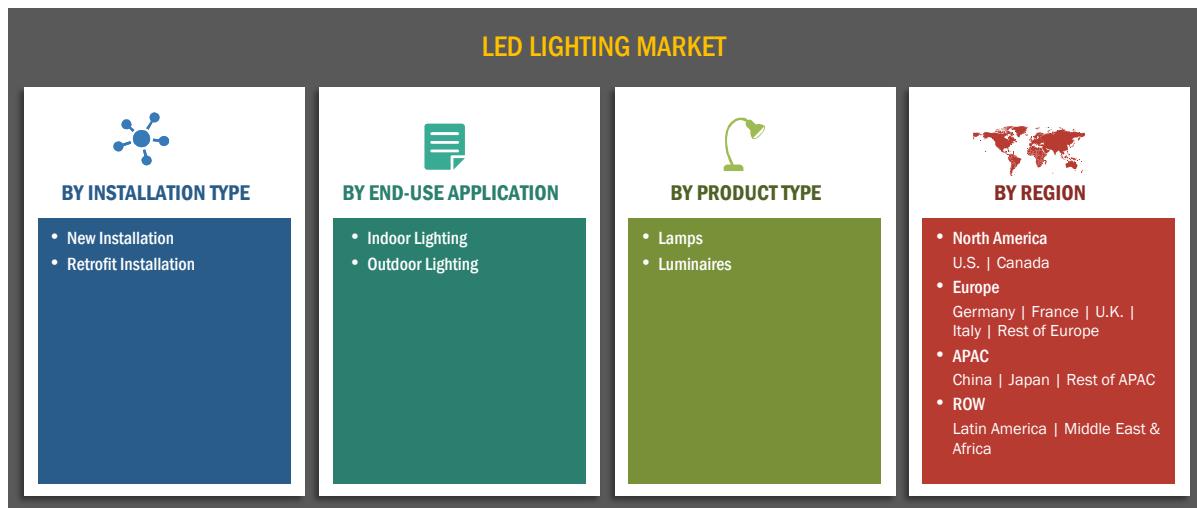
2. Core competencies of companies are defined in terms of their key developments, SWOT analysis, and key strategies adopted by them to sustain their position in the market.

1.3 STUDY SCOPE

1.3.1 MARKETS COVERED

The report covers both the demand and supply sides of the LED lighting market. The supply-side market segmentation includes installation type and product type, while the demand-side segmentation includes end-use application and geographical regions. The following diagram gives an overview of the segments covered in the report.

FIGURE 1 MARKET SEGMENTATION



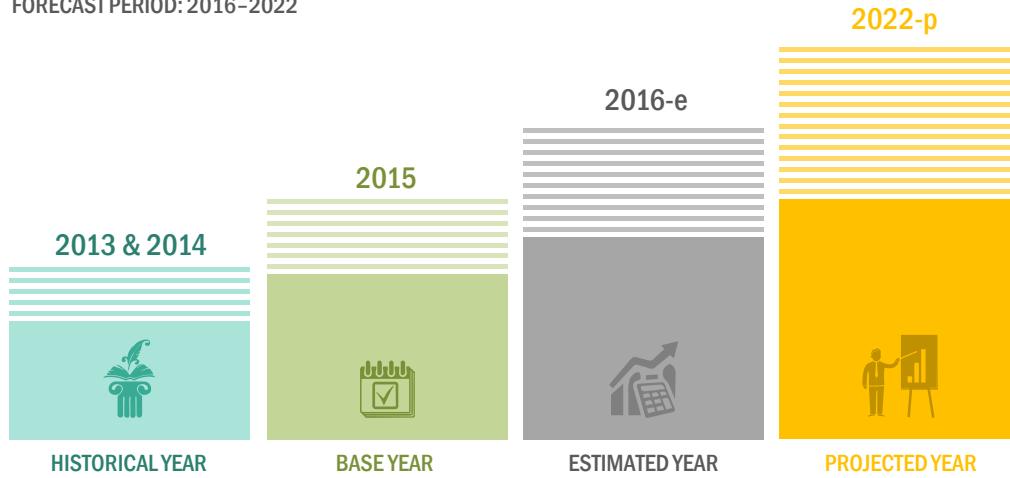
Note 1: Rest of Europe includes Spain, Russia, Netherlands, Switzerland, Belgium, and Scandinavian countries among others

Note 2: Rest of APAC includes South Korea, India, Australia, Indonesia, Thailand, Vietnam, and Singapore among others

Source: Experts' Interviews and MarketsandMarkets Analysis

1.3.2 YEARS CONSIDERED FOR THE STUDY

FORECAST PERIOD: 2016–2022



Note 1: The base year considered for the company profiles is 2015. Wherever the information for the base year was not available, the year prior to the base year has been considered.

Note 2: e = estimated; p = projected.

1.4 CURRENCY

The currency used in the report is U.S. dollars, with market size indicated in USD million.

- For companies reporting their revenue in U.S. dollars, the revenue has been sourced from their annual reports.
- For companies reporting their revenue in other currencies, the average annual currency exchange rate has been used for that particular year to convert the value into U.S. dollars.

1.5 PACKAGE SIZE

The market size in terms of volume has been indicated in million units.

- 1 million units = 1,000,000 units

1.6 LIMITATIONS

- Recent financials have been provided for publicly listed companies; financials for privately held companies have not been provided in the report.
- This report does not cover the LED lighting market in terms of raw materials used for making die, packaging technologies, and luminaries.
- Lighting controls have not been taken into consideration for the LED lighting market.
- The report covers the LED lighting market only in the general lighting industry and not automotive lighting and backlighting sectors.

1.7 STAKEHOLDERS

The intended audience for this report includes:

- Original equipment manufacturers (OEMs)
- OEM technology solution providers
- Research institutes
- Market research and consulting firms
- Lighting manufacturers
- Lighting control system manufacturers
- Forums, alliances, and associations
- Technology investors
- Governments and financial institutions
- Analysts and strategic business planners
- End users who want to know more about the technology and the latest technological developments in the industry

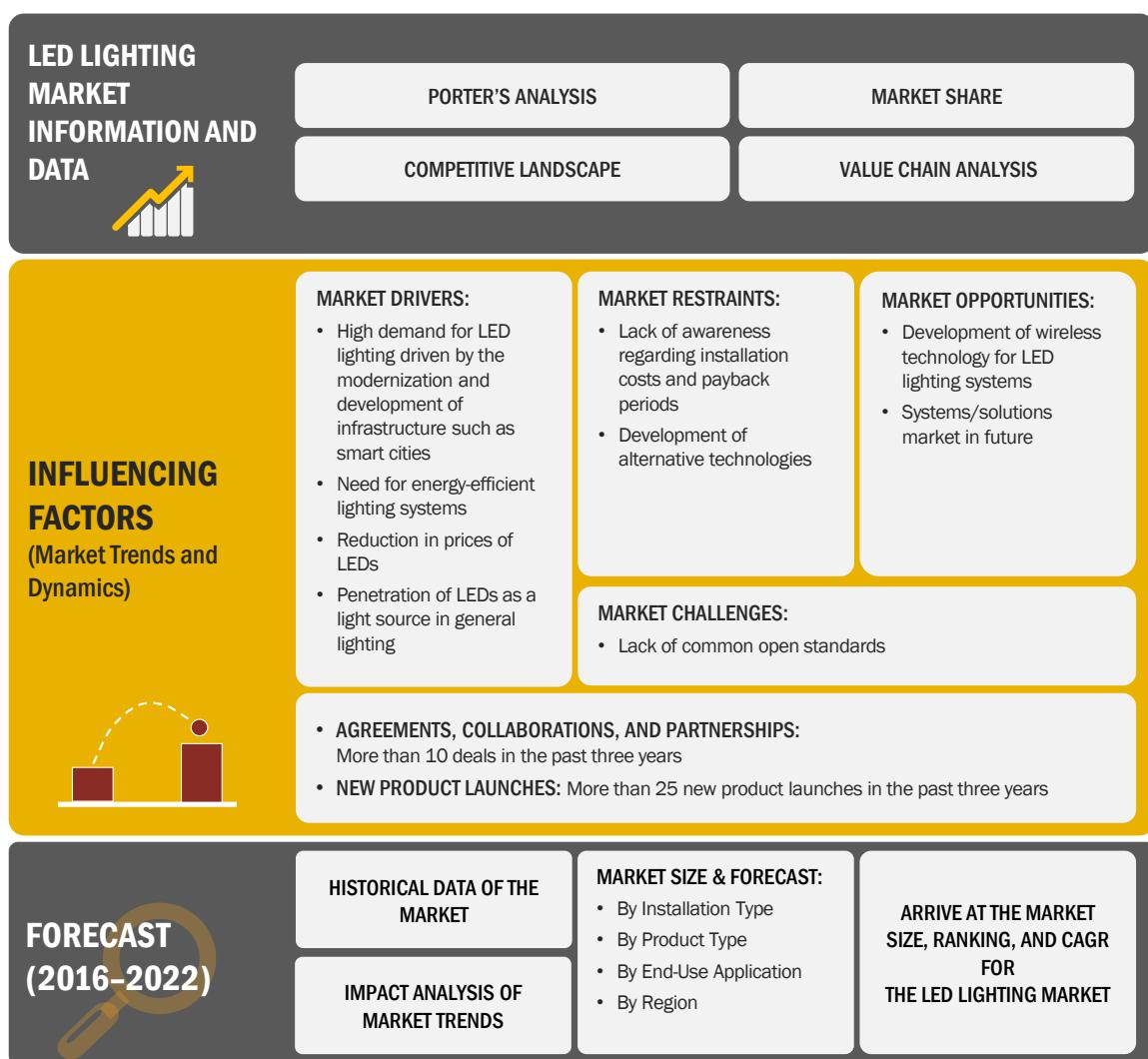
2 RESEARCH METHODOLOGY

2.1 RESEARCH DATA

This section of the report helps in understanding the methodology implemented during the development of the LED lighting market report. There are two basic sources of information—secondary and primary—that have been used to identify and collect information for an extensive technical and commercial study of the LED lighting market. Secondary sources include company websites, magazines, associations, and databases (OneSource, Factiva, and Bloomberg). Primary sources which include key opinion leaders from various industry verticals such as lighting, electronics and semiconductor manufacturing, and others have been interviewed to understand, obtain, and verify critical information as well as assess future market trends and prospects. The key players in the LED lighting market have been identified through secondary research and their market share has been determined through primary and secondary research. This research includes interviews with key opinion leaders such as CEOs, directors, and marketing personnel and the study of annual reports of market players to identify the top players.

The following illustrative figure shows the market research methodology applied in the making of this report.

FIGURE 2 LED LIGHTING MARKET: RESEARCH DESIGN



In the secondary research process, various secondary sources have been referred to for identifying and collecting information relevant to this study. The secondary sources include annual reports, press releases, and investor presentations of companies; white papers, certified publications, and articles from recognized authors; directories; and databases. Secondary research has been conducted to obtain key information about the industry's supply chain, market's value chain, total pool of key players, market classification and segmentation according to industry trends, geographic markets, and key developments from both market- and technology-oriented perspectives.

In the primary research process, various primary sources from both supply and demand sides have been interviewed to obtain the qualitative and quantitative information relevant to this report. Primary sources from the supply side include experts such as CEOs, vice presidents, marketing directors, technology and innovation directors, application developers, application users, and related executives from various key companies and organizations operating in the LED lighting market.

After the complete market engineering (including calculations for market statistics, market breakdown, market size estimations, market forecasting, and data triangulation), extensive primary research has been conducted to verify and validate the critical market numbers.

Primary research has also been conducted to identify segmentation types, industry trends, and key players, and analyze the competitive landscape and key factors affecting the market dynamics such as drivers, restraints, opportunities, and challenges. In the complete market engineering process, both top-down and bottom-up approaches have been used along with several data triangulation methods to estimate and forecast the market, including the overall market segments and subsegments listed in this report. Extensive qualitative and quantitative analyses have been performed on the complete market engineering process to list the key information/insights throughout the report.

2.1.1 SECONDARY DATA

Secondary sources referred to for this research study include government sources, corporate filings (annual reports, investor presentations, and financial statements), and trade, business, and professional associations. The secondary data has been collected and analyzed to arrive at the overall market size, which has been further validated through primary research.

2.1.1.1 Major secondary sources

Source	Web Link
Global Lighting Association	http://www.globallightingassociation.org/
Lighting Controls Association	http://lightingcontrolsassociation.org/
LEDinside	http://www.ledinside.com/

2.1.1.2 Key data from secondary sources

PARAMETER	SOURCE
MARKET SIZE	<ul style="list-style-type: none"> • Company Financials • Magazines • Journals • Press Releases • Paid Databases • MarketsandMarkets Data Repository
REVENUE OF COMPANIES	<ul style="list-style-type: none"> • Annual Reports • Company Websites • Public Databases • MarketsandMarkets Data Repository
QUALITATIVE INFORMATION (Market Dynamics, Market Trends)	<ul style="list-style-type: none"> • Company Websites • Annual Reports • Press Releases • MarketsandMarkets Data Repository

2.1.2 PRIMARY DATA

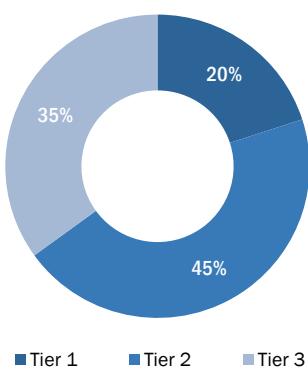
Extensive primary research has been conducted after understanding and analyzing the LED lighting market scenario through secondary research. Several primary interviews have been conducted with key opinion leaders from both demand- and supply-side vendors across four major regions, namely, North America, Europe, Asia-Pacific, and Rest of the World (South America, Middle East, and Africa). Approximately 25% of the primary interviews have been conducted with the demand side and 75% with the supply side. This primary data has been collected mainly through telephonic interviews, which consist 80% of total primary interviews; however, questionnaires and e-mails were also used to collect the data.

2.1.2.1 Primary interviews with experts

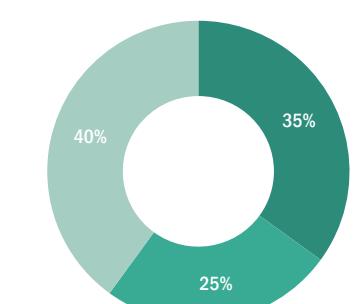
Value Chain	Intended Participants and Key Opinion Leaders	Interviews
Supply and Demand Sides (Time Spent on Interview)	Providers of LED lighting components and services	10-12
	LED lighting applications and end users in different geographies	3-5
	Industry consultants and LED lighting experts	2-4
	Government and regulatory bodies	1-3
	Total number of primary interviews conducted	16-25

2.1.2.2 Breakdown of primaries

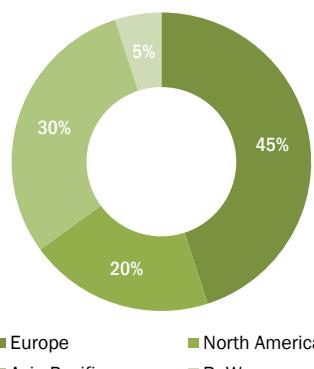
BY COMPANY TYPE



BY DESIGNATION



BY REGION



Note: The three tiers of the companies have been defined on the basis of their total revenue as of 2014; Tier 1 = >USD 10 billion, Tier 2 = USD 1 billion–USD 10 billion, and Tier 3 = <USD 1 billion.

2.1.2.3 Key data from primary sources

TYPE	PARAMETER	KEY DATA
GEOGRAPHIC SPLIT	<ul style="list-style-type: none"> Overall Market and Subsegments in 2015 CAGR of Each Region During the Forecast Period (2016–2022) 	<ul style="list-style-type: none"> Global LED Lighting Market, by Geography—North America, Europe, Asia-Pacific, and RoW
GLOBAL MARKET SIZE	<ul style="list-style-type: none"> Global Market Size for 2015 CAGR for the Forecast Period (2016–2022) 	<ul style="list-style-type: none"> Global LED Lighting Market LED Lighting Market, by Subsegment
MARKET SPLIT	<ul style="list-style-type: none"> LED Lighting Market, by Installation Type LED Lighting Market, by Product Type LED Lighting Market, by End-Use Application 	<ul style="list-style-type: none"> New Installation and Retrofit Installation Lamps and Luminaires Indoor Lighting and Outdoor Lighting

2.1.3 SECONDARY AND PRIMARY RESEARCH

The below figure illustrates the secondary and primary research process.



2.1.3.1 Key industry insights



Source: Industry Experts and Primary Interviews

2.2 MARKET SIZE ESTIMATION

In this report, both top-down and bottom-up approaches have been used to estimate and validate the market size of the LED lighting market and various other dependent submarkets. The key players in the LED lighting market have been identified through secondary research and their market share in the respective regions has been determined through primary and secondary research. This entire research methodology includes the study of annual and financial reports of top players as well as interviews with experts such as CEOs, VPs, directors, and marketing executives for key insights (both quantitative and qualitative). All percentage shares, splits, and breakdowns have been determined using secondary sources and verified through primary sources. All the possible parameters that affect the markets covered in this research study have been accounted for, viewed in detail, verified through primary research, and analyzed to obtain the final quantitative and qualitative data. This data has been consolidated and supplemented with detailed inputs and analysis from MarketsandMarkets and presented in this report. The figures given below show the overall market size estimation process employed for the purpose of this study.

2.2.1 BOTTOM-UP APPROACH

The bottom-up approach has been employed to arrive at the overall size of the LED lighting market from the revenues of the key players and their share in the market. Calculations based on the revenue of the key players identified in the market led to the overall market size.

2.2.1.1 Approach for capturing market share of application by bottom-up analysis (demand side)

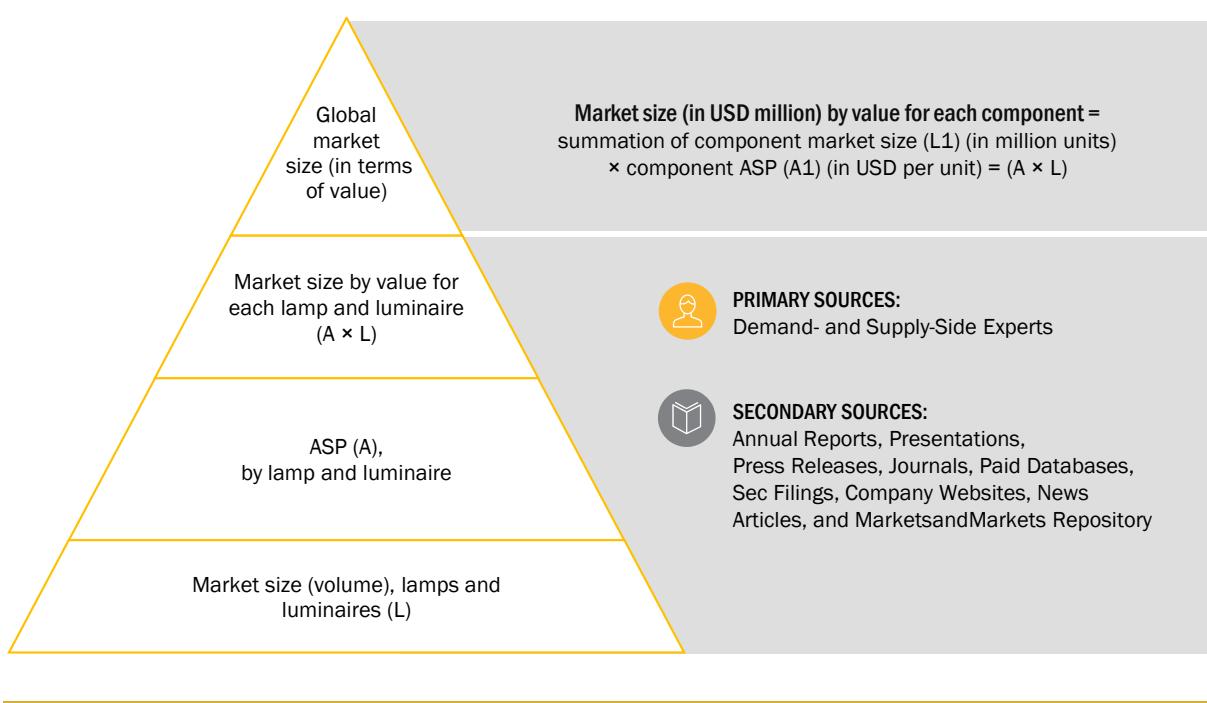
Various industries that have adopted or are expected to adopt LED lighting along with the related services were identified.

Each of these industries, along with related major companies and their system integrators, was analyzed to identify providers of LED lighting components and systems.

Demand generated by the industries for LED lighting in different applications was analyzed.

Size of the LED lighting market in each application was estimated based on the demand.

Ongoing and upcoming implementation of LED lighting by various companies across industries was tracked to forecast the market based on these developments and other critical parameters.

FIGURE 3 MARKET SIZE ESTIMATION METHODOLOGY: BOTTOM-UP APPROACH

Approach for capturing market share of each application with the help of various players in the value chain of the LED lighting market

Multiple discussions with key opinion leaders have been carried out to understand the type of contracts, services, lighting products and services, components, and subcomponents deployed by LED lighting providers for each industry. This helped in analyzing the breakup of scope of work carried out by each major LED lighting provider.

Market estimates were arrived by analyzing the market for LED lighting providers from different regions and countries, and then it was combined to get the market estimate by region.

At every level, the estimate would be verified and cross-checked by discussion with key opinion leaders such as CEOs, directors, and operations managers and finally with domain experts based within MarketsandMarkets.

This process entailed studying various paid and unpaid sources of information such as annual reports, press releases, white papers, and databases.

2.2.2 TOP-DOWN APPROACH

In the top-down approach, the overall market size has been used to estimate the size of the individual markets (mentioned in the market segmentation) through percentage splits from secondary and primary research.

For the calculation of specific market segments, the most appropriate immediate parent market size has been used to implement the top-down approach. The bottom-up approach has also been implemented for the data obtained from the secondary research to validate the market size of various segments.

2.2.2.1 Approach for capturing market share of application by top-down analysis (supply side)

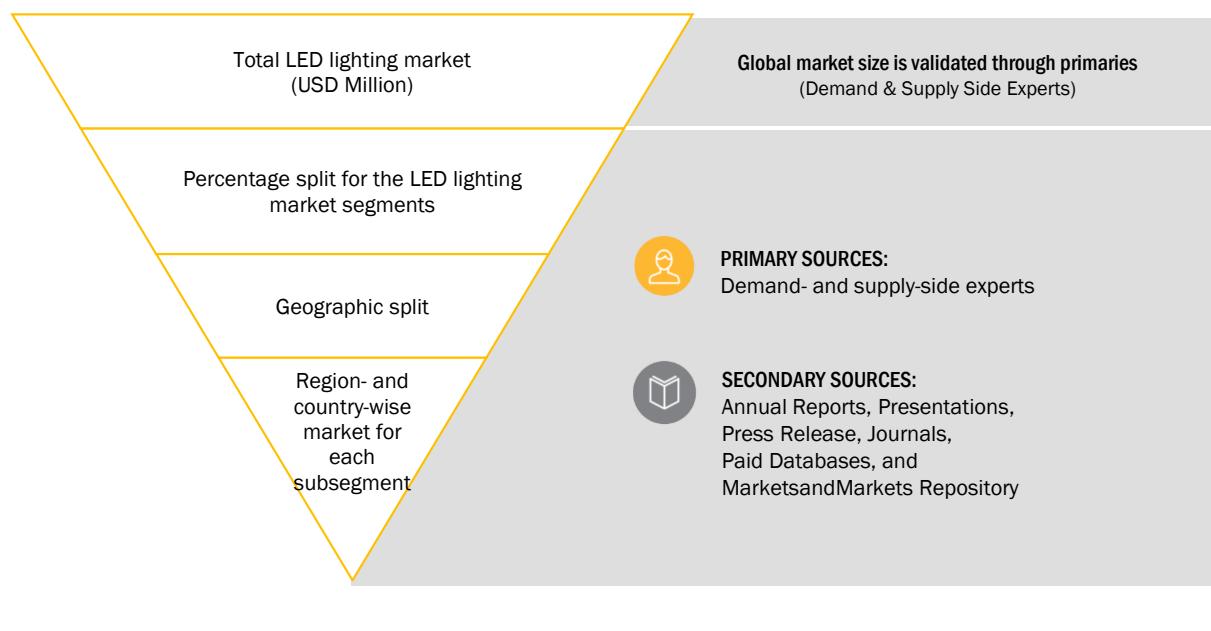
MarketsandMarkets focused on the top-line investment and expenditure by key players in the ecosystems of various industries for new installations and upgradation of LED lighting components and subcomponents and development in key market areas.

Information related to market revenue offered by the key LED lighting component and system providers was then built and developed.

Multiple on-field discussions with key opinion leaders were carried out across major companies involved in the development of LED lighting components and service providers.

Geographic splits were estimated using secondary sources, based on various factors such as number of players in a specific country and region, type of components, level of services offered, and type of standards implemented at the production floor.

FIGURE 4 MARKET SIZE ESTIMATION METHODOLOGY: TOP-DOWN APPROACH

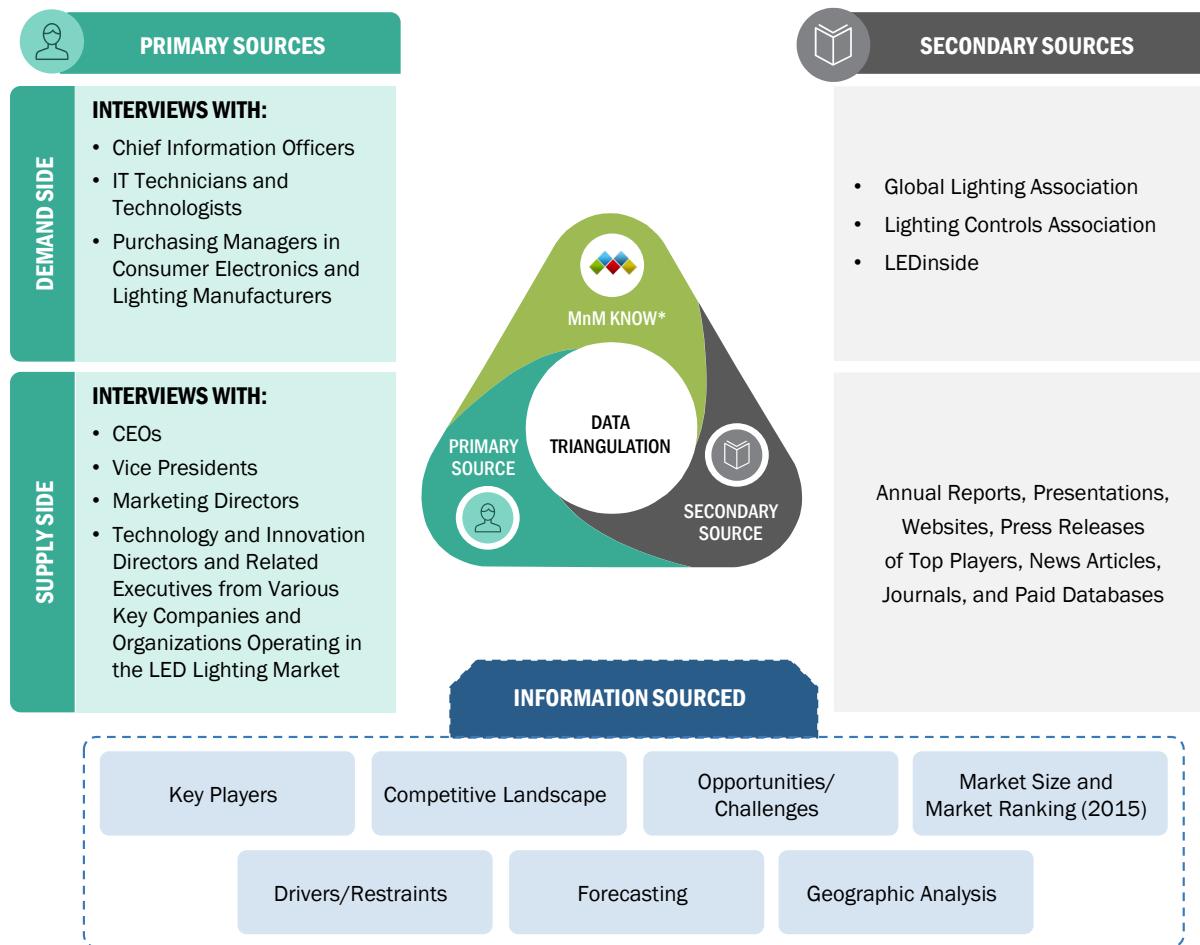


The market share of each company has been estimated to verify the revenue shares used earlier in the bottom-up approach. With the data triangulation procedure and validation of data through primaries, the overall parent market size and each individual market size have been determined and confirmed in this study.

2.3 MARKET BREAKDOWN AND DATA TRIANGULATION

After arriving at the overall market size from the market size estimation process explained above, the total market has been split into several segments and subsegments. The data triangulation and market breakdown procedures have been employed, wherever applicable, to complete the overall market engineering process and arrive at the exact statistics for all segments and subsegments. The data has been triangulated by studying various factors and trends from both demand and supply sides. The market has been validated using both top-down and bottom-up approaches.

FIGURE 5 DATA TRIANGULATION



MnM KNOW* stands for MarketsandMarkets' 'Knowledge Asset Management' framework. In this context, it stands for existing market research knowledge repository of over 5,000 granular markets, our flagship competitive intelligence and market research platform "RT", subject matter experts, and independent consultants. MnM KNOW acts as an independent source that helps us validate information gathered from primary and secondary sources.

2.4 RESEARCH ASSUMPTIONS

The following assumptions have been taken into consideration to complete the overall market engineering of the LED lighting market:

PARAMETER	ASSUMPTION
AUTHENTICITY OF DATA	Company revenue and segment-specific information have been obtained from the annual reports of the respective companies. The information provided in the annual reports has been assumed to be authentic.
GLOBAL ECONOMIC DOWNTURN	The global economy has been assumed to remain stable during the forecast period.
NICHE MARKET SEGMENTS	For niche market segments, where accurate data of the respective timeline was not available, the data was calculated using trend line analysis. In some instances, where mathematical and statistical models could not be applied to arrive at the number, generalization of trends in that particular market was done.
AVERAGE SELLING PRICE	Average selling prices (ASPs), wherever applied, were calculated using all kinds of suitable and mathematical methods and considering external qualitative factors affecting the prices.

3 EXECUTIVE SUMMARY

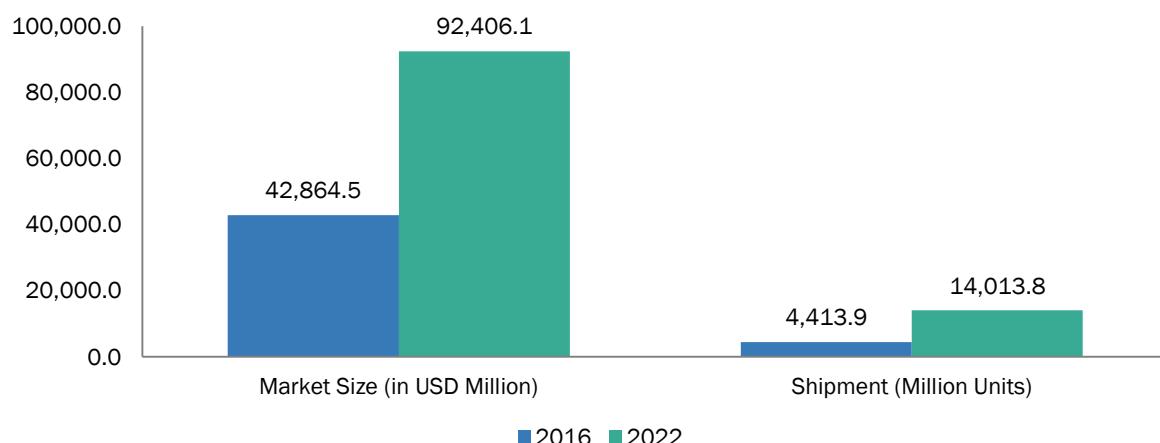
A light-emitting diode (LED) is a semiconductor light source formed from a p-n junction diode. It emits light when a suitable voltage is applied across its leads. An LED lamp is formed by assembling LED devices into a lamp to be used as a light bulb or light source in a lighting fixture. LED lighting consists of high-efficiency fixtures along with associated controls such as drivers and dimming switches which are able to adjust the lighting based on factors such as occupancy, daylight, and so on. LED lighting is being increasingly implemented to control growing energy consumption in buildings and outdoor areas such as highways, streets, and so on.

The governments of nearly all major economies have taken initiatives to implement LED lighting. The European Commission's 20-20-20 directive specifically focuses on reducing gas emissions to 20% of the 1990 level, thereby increasing the share of renewable energy consumption by 20% of the overall energy consumption and improving the energy efficiency to 20% across the European Union. According to the 20-20-20 directive, it has been estimated that energy-efficient lighting in buildings alone would avoid emission of around 12 million tons of CO₂ in Europe. According to the estimates of Energy Information Administration (EIA), in 2014, lighting constituted around 11% of the overall electricity consumption in the U.S.

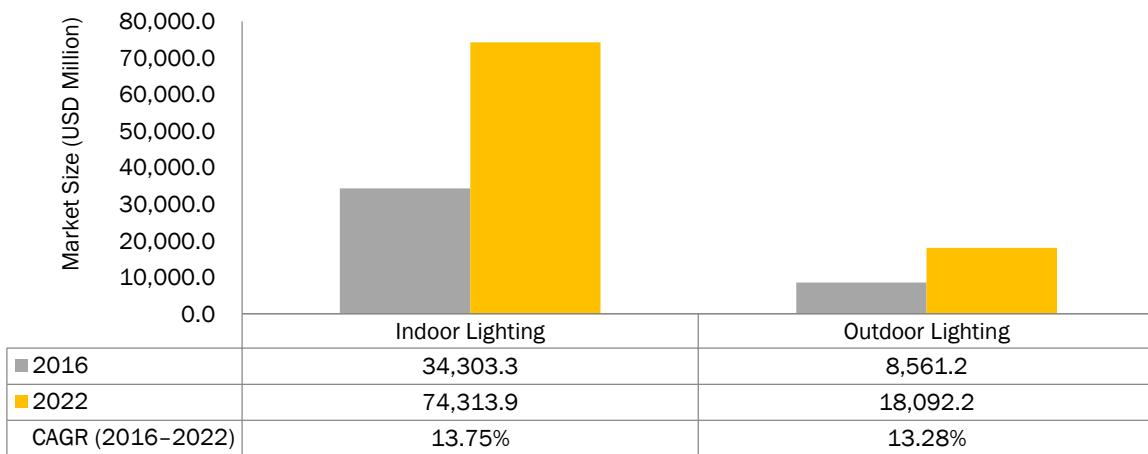
The LED lighting market was valued at USD 36.75 billion in 2015 and is expected to grow at a CAGR of 13.66% between 2016 and 2022. The major factors influencing the growth of the market are increasing demand for energy-efficient lighting systems, modernization and development of infrastructure such as smart cities, which leads to the implementation of lighting systems based on IoT, reduction in prices of LEDs, penetration of LEDs as a light source in general lighting, and the rapid rise of LED technology over conventional lighting technology.

Factors such as lack of awareness regarding installation costs and payback periods and the development of alternative technologies are inhibiting the growth of the LED lighting market. Development of wireless technology for LED lighting systems, rise of the systems/solutions market based on LED lighting, and increasing consumer awareness about the importance of energy saving are the major opportunities for the LED lighting market. However, lack of common open standards within the LED lighting industry is proving to be a challenge.

The global LED lighting market is dominated by players which manufacture LED lighting systems such as Philips Lighting Holding B.V. (Netherlands), General Electric Company (U.S.), OSRAM Licht AG (Germany), Cree, Inc. (U.S.), and Cooper Industries, Inc. (Ireland).

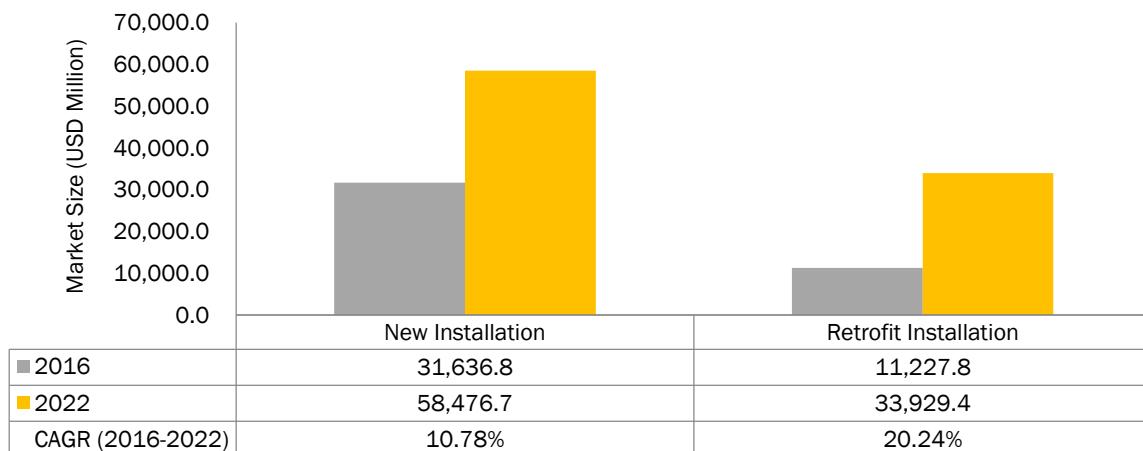
FIGURE 6 GLOBAL LED LIGHTING MARKET (VALUE AND VOLUME), 2016-2022

The LED lighting market, in terms of volume, is expected to register a shipment of 14,013.8 million units by 2022 from 4,413.9 million units in 2015, at a CAGR of 21.23% during the forecast period. This growth can be attributed to the growing adoption of LED-based lighting systems over traditional lighting systems, which is mainly driven by the increasing consumer demand for energy-efficient lighting systems such as LEDs.

FIGURE 7 INDOOR LIGHTING APPLICATION EXPECTED TO HOLD A LARGER SIZE OF THE LED LIGHTING MARKET BETWEEN 2016 AND 2022

Among the two applications, indoor lighting held a larger size of the market worth USD 34,303.3 million in 2015. The market for the highways and roadways outdoor lighting segment is expected to grow rapidly because of the growing spending on LED lighting systems by various government bodies.

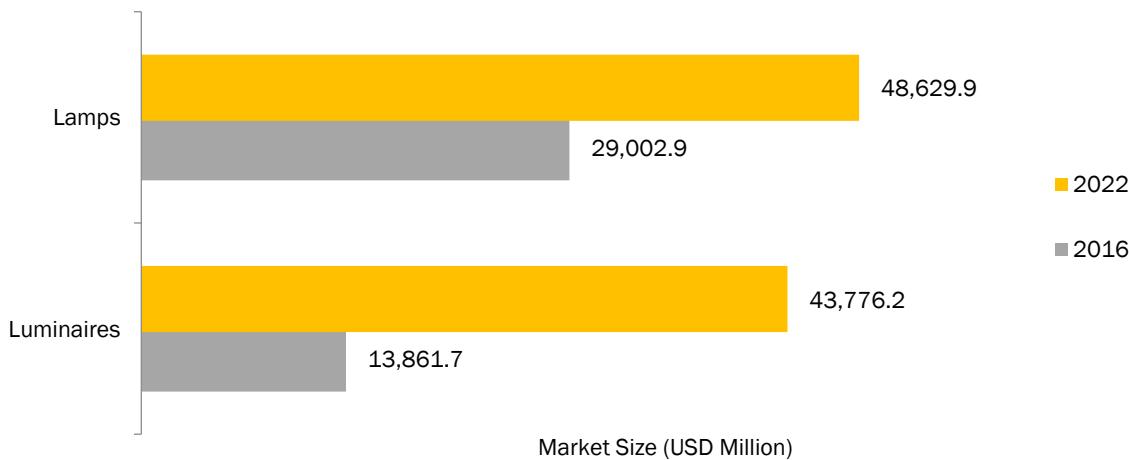
FIGURE 8 NEW INSTALLATION EXPECTED TO HOLD A LARGER SIZE OF THE LED LIGHTING MARKET DURING THE FORECAST PERIOD



Source: Press Releases, Investor Presentations, Annual Reports, Experts' Interviews, and MarketsandMarkets Analysis

New installation accounted for a share of ~74% of the LED lighting market in 2016; the market for the same was valued at USD 31,636.8 million in 2016 and is expected to grow at a CAGR of 10.78% between 2016 and 2022. The market for retrofit installation was valued at USD 11,227.8 million in 2015 and is expected to grow at a CAGR of 20.24% during the forecast period. The retrofit installations are growing at a high rate because more number of lamps of traditional lighting fixtures are being replaced with LED lamps than complete replacement of lamps and fixtures with new installations.

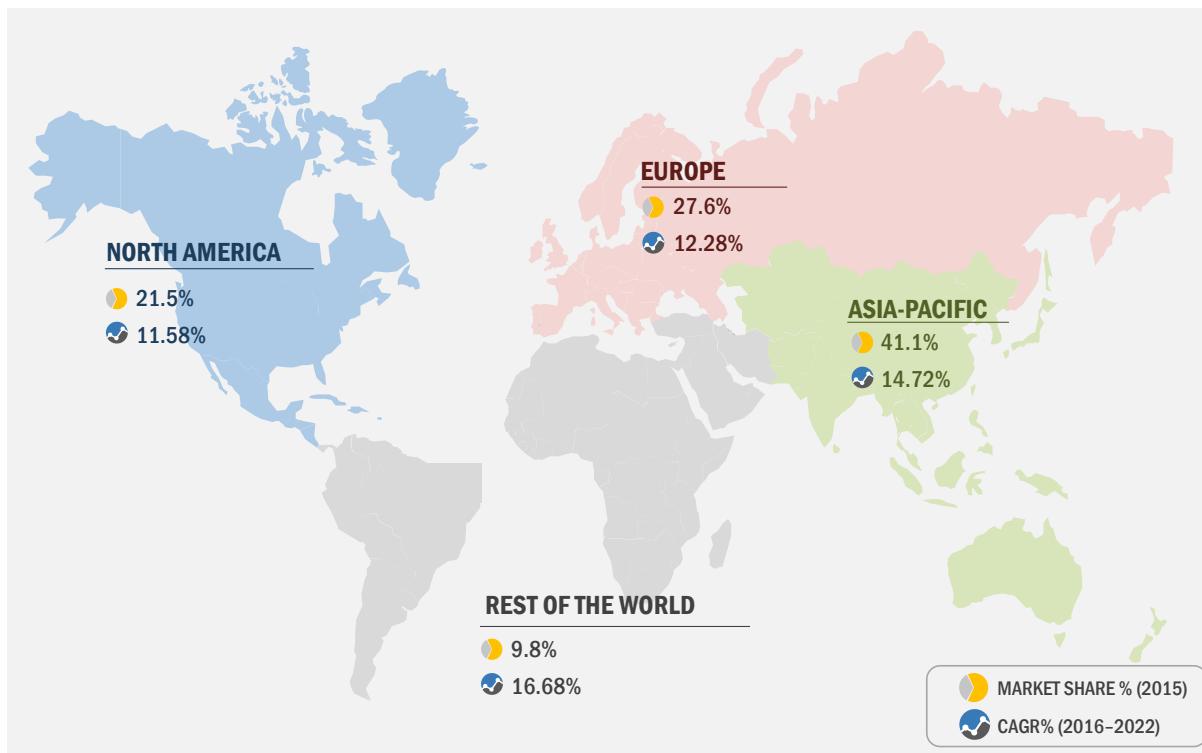
FIGURE 9 LAMPS EXPECTED TO HOLD A LARGER SIZE OF THE LED LIGHTING MARKET BY 2022



Source: Press Releases, Investor Presentations, Annual Reports, Experts' Interviews, and MarketsandMarkets Analysis

LED lamps currently hold a larger share of the LED lighting market and the same trend is expected to continue during the forecast period. The market for lamps was valued at USD 29,002.9 million in 2016 and is expected to grow at a CAGR of 9.00% during the forecast period. The LED lighting market for luminaires is expected to grow at the highest CAGR of 21.13% during the forecast period and reach USD 43,776.2 million by 2022 from USD 13,861.7 million in 2016.

FIGURE 10 ASIA-PACIFIC ACCOUNTED FOR THE LARGEST SHARE OF THE LED LIGHTING MARKET IN 2015



Source: Press Releases, Investor Presentations, Annual Reports, Experts' Interviews, and MarketsandMarkets Analysis

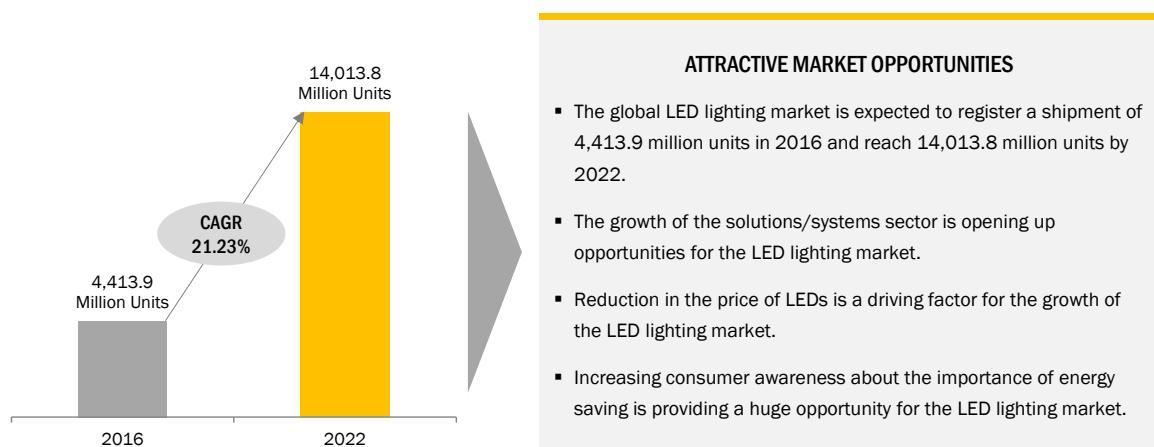
The LED lighting market has been segmented on the basis of geography into four major regions, namely, North America, Europe, APAC, and RoW. Each of these regions has been further segmented on the basis of individual countries. APAC accounted for ~41% share of the market in 2015, followed by Europe and North America with roughly 28% and 22% share, respectively. The RoW region has been segmented into Middle East and Africa and Latin America. The market in this region is expected to grow at a CAGR of 16.68% during the forecast period. The market penetration of LEDs in APAC is considerably high; APAC is expected to witness a high growth at a CAGR of 14.72% during the forecast period because of massive infrastructural projects initiated by the developing countries such as China, South Korea, and India. APAC is also home to one of the largest LED manufacturing bases in the world.

Europe has a population that has a relatively high standard of living, where the consumers are spending on smart homes of which LED lighting systems are an integral part. The European Union also has tough legislations regarding energy consumption. Owing to this, Europe is the second-largest market within the LED ecosystem.

4 PREMIUM INSIGHTS

4.1 ATTRACTIVE OPPORTUNITIES IN THE GLOBAL LED LIGHTING MARKET

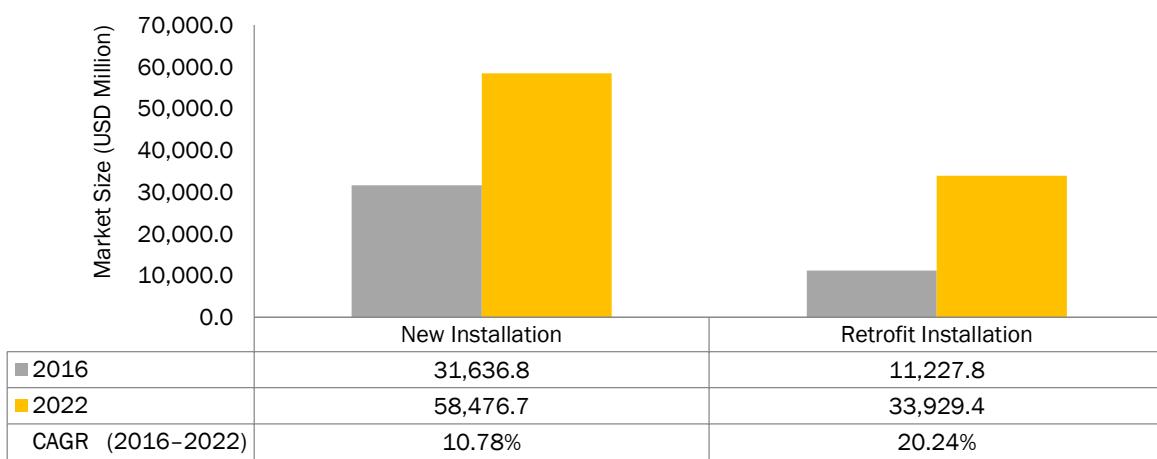
FIGURE 11 LED LIGHTING MARKET OFFERS LUCRATIVE OPPORTUNITIES Owing TO THE RAPID RISE OF THE NEW SOLUTIONS/SYSTEMS SECTOR



Source: Investor Presentations, Annual Reports, Press Releases, Experts' Interviews, and MarketsandMarkets Analysis

4.2 LED LIGHTING MARKET, BY INSTALLATION TYPE

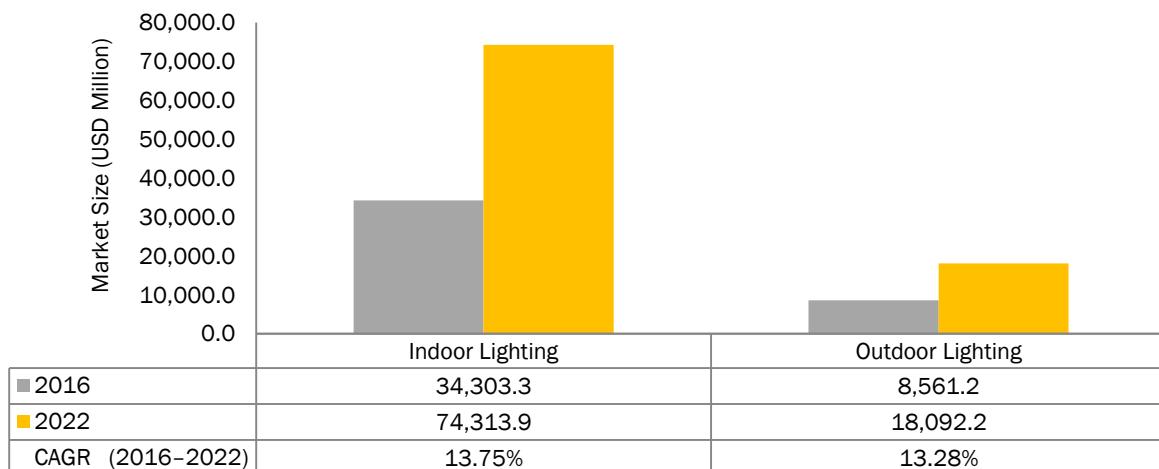
FIGURE 12 NEW INSTALLATION EXPECTED TO HOLD A LARGE MARKET SHARE DURING THE FORECAST PERIOD



Source: Investor Presentations, Annual Reports, Press Releases, Experts' Interviews, and MarketsandMarkets Analysis

4.3 LED LIGHTING MARKET, BY END-USE APPLICATION

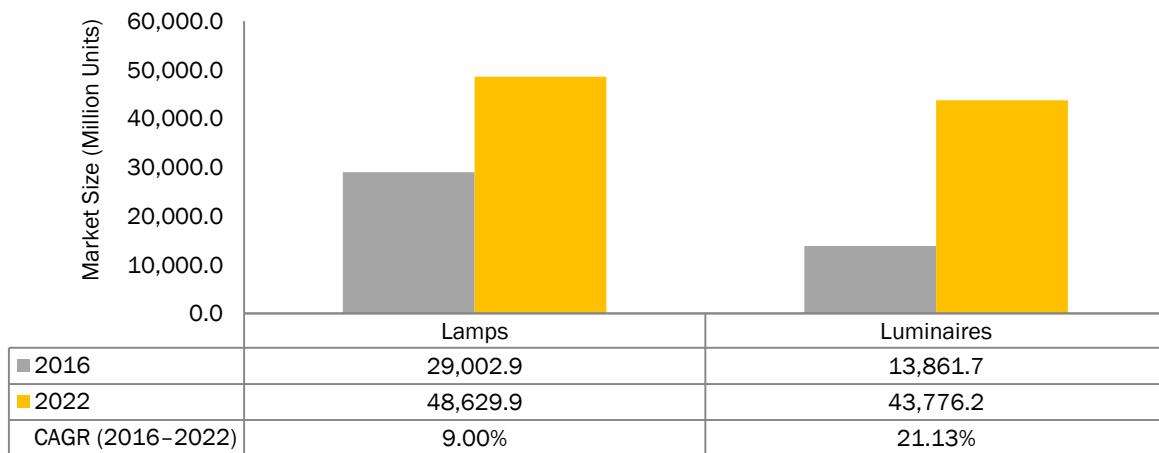
FIGURE 13 MARKET FOR INDOOR LIGHTING EXPECTED TO EXHIBIT HIGH GROWTH DURING THE FORECAST PERIOD



Source: Investor Presentations, Annual Reports, Press Releases, Experts' Interviews, and MarketsandMarkets Analysis

4.4 LED LIGHTING MARKET, BY PRODUCT TYPE

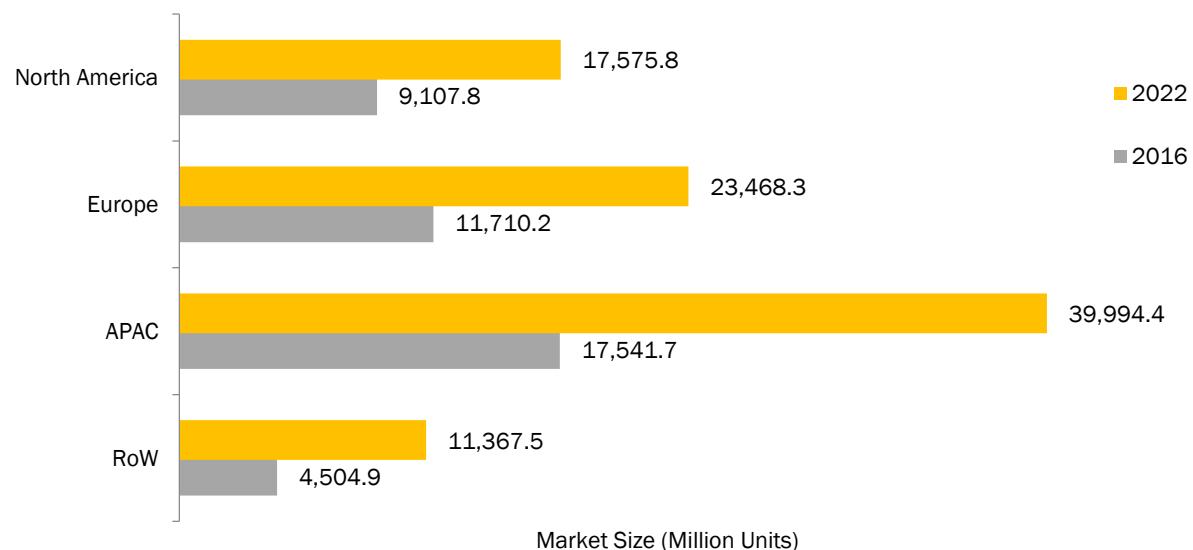
FIGURE 14 MARKET FOR LUMINAIRES EXPECTED TO GROW AT A HIGHER RATE DURING THE FORECAST PERIOD



Source: Investor Presentations, Annual Reports, Press Releases, Experts' Interviews, and MarketsandMarkets Analysis

4.5 LED LIGHTING MARKET, BY GEOGRAPHY

FIGURE 15 ASIA-PACIFIC EXPECTED TO DOMINATE THE LED LIGHTING MARKET DURING THE FORECAST PERIOD



Source: Investor Presentations, Annual Reports, Press Releases, Experts' Interviews, and MarketsandMarkets Analysis

5 MARKET OVERVIEW

KEY FINDINGS

- Increasing demand for energy-efficient lighting system is a major driver for the LED lighting market.
- Demand for LED lighting is being driven by the modernization and development of infrastructure such as smart cities.
- Government mandates on optimum energy consumption in most of the countries are supporting the growth of the LED lighting market.
- Lack of awareness regarding the payback period and installation expenses of LED lighting system is acting as a key restraint for the LED lighting market.
- The systems/solutions market in future can provide endless opportunities for the LED lighting market.
- Availability of common communication platform is a key challenge for the LED lighting market.

5.1 INTRODUCTION

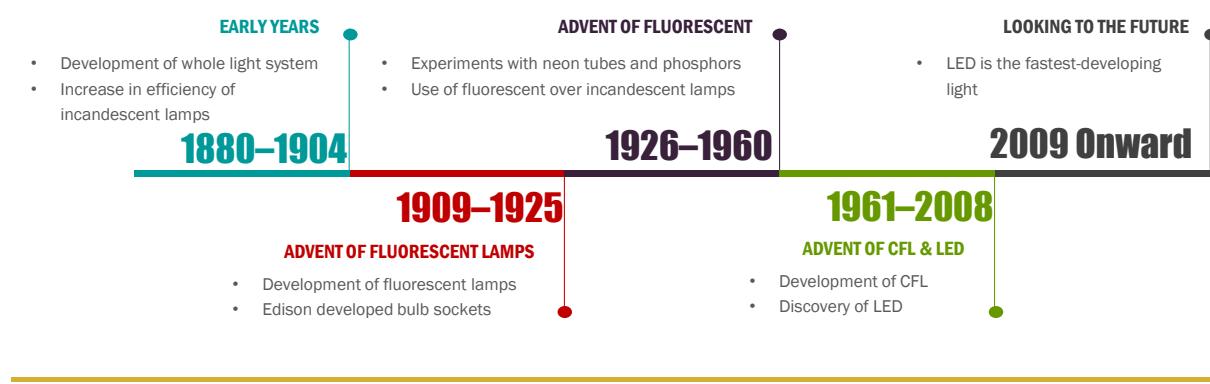
The market evolution section describes the way the LED lighting market has grown over the years. It includes the factors affecting the market dynamics such as drivers, restraints, opportunities, and challenges with respect to the LED lighting ecosystem.

5.2 MARKET EVOLUTION

The concept of LED lighting came up with the use of automatic light dimming that serves to reduce energy consumption and the invention of LED bulbs.

Compared with incandescent lamps, LED lamps are several times electrically efficient and have a longer lifespan. They are also significantly more efficient than fluorescent lamps, and unlike fluorescent lamps, LEDs do not require warm-up time to come to full brightness.

FIGURE 16 EVOLUTION OF LIGHT AND LED LIGHTING



Source: White Papers, Experts' Interviews, Industry Journals, and MarketsandMarkets Analysis

Prominent developments were observed in incandescent lighting between 1882 and 1920. The first lamp to use halogen gas (chlorine) was patented in 1882; however, the first commercial halogen lamp that used iodine as a halogen gas was patented in 1959 by General Electric. Thomas Edison focused on the entire lighting system showing that it was possible to distribute electricity from a centrally located generator in London and developing the first commercial power utility in Manhattan. In 1904, incandescent lamps with tungsten filaments were introduced in the European market. These bulbs lasted longer and were brighter and more efficient than lamps with carbon filaments. In 1909, Edison developed bulb sockets, and it is now used for almost all residential lighting applications.

Prominent developments were observed in fluorescent lighting between 1926 and 1960. In the late 1920s and early 1930s, European researchers experimented with neon tubes coated with phosphors. These experiments helped spark fluorescent lamp research in the U.S. In 1939, GE and Westinghouse introduced fluorescent lamps in San Francisco. By 1951, more light in the U.S. was being produced by linear fluorescent lamps than incandescent lamps. This change was led by the need for efficient lighting during the World War II.

Prominent developments were observed in fluorescent and LED lighting technology between 1961 and 2000. In 1962, the first light-emitting diode that emitted light in the visible part of the frequency range was developed by Nick Holonyak Jr. of the General Electric Company. The 1973 oil crisis marked a turning point in the U.S. energy consumption. Consequently, researchers began developing fluorescent bulbs for residential use. In 1974, researchers at Sylvania started investigating how they could miniaturize the ballast and tuck it into the lamp. In 1976, Edward Hammer at General Electric created the first spiral-shaped compact fluorescent lamp (CFL). Early CFLs hit the market in the mid-1980s and their prices ranged between USD 25 and USD 35 a bulb. The invention of the blue diode in the 1990s quickly led to

the discovery of white LEDs. Shortly thereafter, researchers demonstrated white light using red, green, and blue LEDs. Initially, many CFLs were big and bulky and did not fit well into fixtures. They had low light output and inconsistent performance. Since then, improvements in CFL performance, price, efficiency, and lifetime have made them a viable option for residential use.

In 2000, the U.S. Department of Energy partnered with private industries to push white LED technology forward by creating a high-efficiency packaged LED device. By 2008, there were few LED replacement bulbs in the market and most were in the range between 25 and 40 watt. In late 2009, Philips Lighting North America introduced its LED bulb in the lighting market and named it L Prize 60-watt.

Since 2008, the cost of LED bulbs has fallen by more than 85%, and in 2015, a number of retailers announced that they would sell LEDs at USD 10.

LED is one of the fastest-developing lighting technologies. It is a type of solid-state lighting. LEDs use a semiconductor to convert electricity into light and emit light in a specific direction, reducing the need for reflectors and diffusers that can trap light. Lighting manufacturers continue to make improvements in the quality of light and the energy efficiency of LEDs while cutting their cost. Today's LED bulbs are six to seven times more energy efficient than conventional incandescent lights. LED bulbs can last more than 25 times longer than conventional incandescent lights and increase efficiency by more than 80%. These advancements have led to rapid deployment of these bulbs in commercial and residential applications in the past couple of years. In 2012, more than 49 million LEDs were installed in the U.S., which is saving about USD 675 million of annual energy costs. As prices continue to drop, LEDs are expected to become a common feature in homes across the country.

5.3 MARKET SEGMENTATION

The LED lighting market has gained an important place in the global market in the past few years owing to increasing customer demands for energy-efficient and cost-effective LEDs. The overall LED lighting market has been classified into four major segments, namely, installation type, product type, end-use application, and geography. Each segment has been further classified into various subsegments.

5.3.1 BY INSTALLATION TYPE

On the basis of installation type, the LED lighting market has been categorized into new installation and retrofit lamps.

TABLE 1 LED LIGHTING MARKET, BY INSTALLATION TYPE

Installation Type	Description
New Installation	New installation refers to installation of completely new fixtures and LED lamps in place of old generation lamps and fixtures.
Retrofit Installation	It refers to the replacing of old incandescent lamps with LED lamps on the existing fixtures with slight alterations.

Source: Experts' Interviews and MarketsandMarkets Analysis

5.3.2 BY PRODUCT TYPE

The LED lighting market on the basis of product type has been segmented into lamps and luminaires.

TABLE 2 LED LIGHTING MARKET, BY PRODUCT TYPE

Product Type	Description
Lamps	Lamps refer to LED light sources or an LED lamp that gives off light in the visible spectrum.
Luminaires	A luminaire or light fixture is an electrical device used to create artificial light by using an electric lamp. All light fixtures have a fixture body and a light socket to hold the lamp and allow for its replacement. Fixtures may also have a switch to control the light.

Source: Experts' Interviews and MarketsandMarkets Analysis

5.3.3 BY END-USE APPLICATION

The LED lighting market on the basis of end-use application has been segmented into indoor lighting and outdoor lighting.

TABLE 3 LED LIGHTING MARKET, BY END-USE APPLICATION

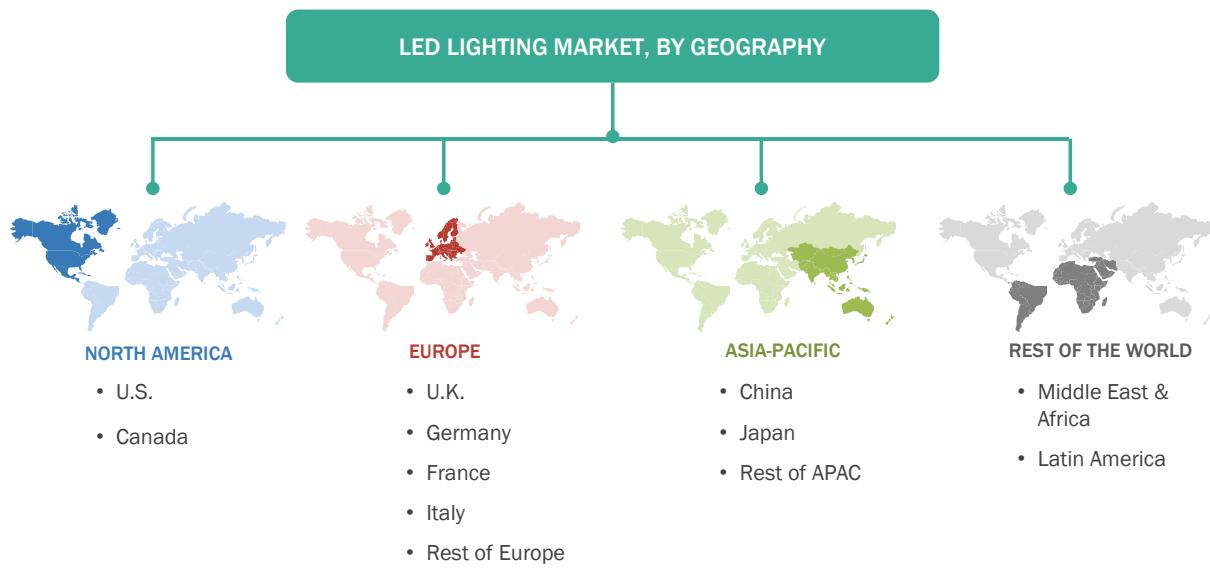
End-Use Application	Description
Indoor Lighting	Indoor lighting includes lighting for residential, commercial, industrial, and other applications.
Outdoor Lighting	Outdoor lighting includes various street lighting, architectural lighting, and public place lighting.

Source: Experts' Interviews and MarketsandMarkets Analysis

5.3.4 BY GEOGRAPHY

The LED lighting market has been broadly segmented into four major geographic regions, namely, North America, Europe, Asia-Pacific (APAC), and Rest of the World (RoW).

FIGURE 17 LED LIGHTING MARKET, BY GEOGRAPHY



Note 1: Rest of Europe includes other European countries such as Spain, Netherlands, Belgium, Russia, East European countries, and Nordic countries.

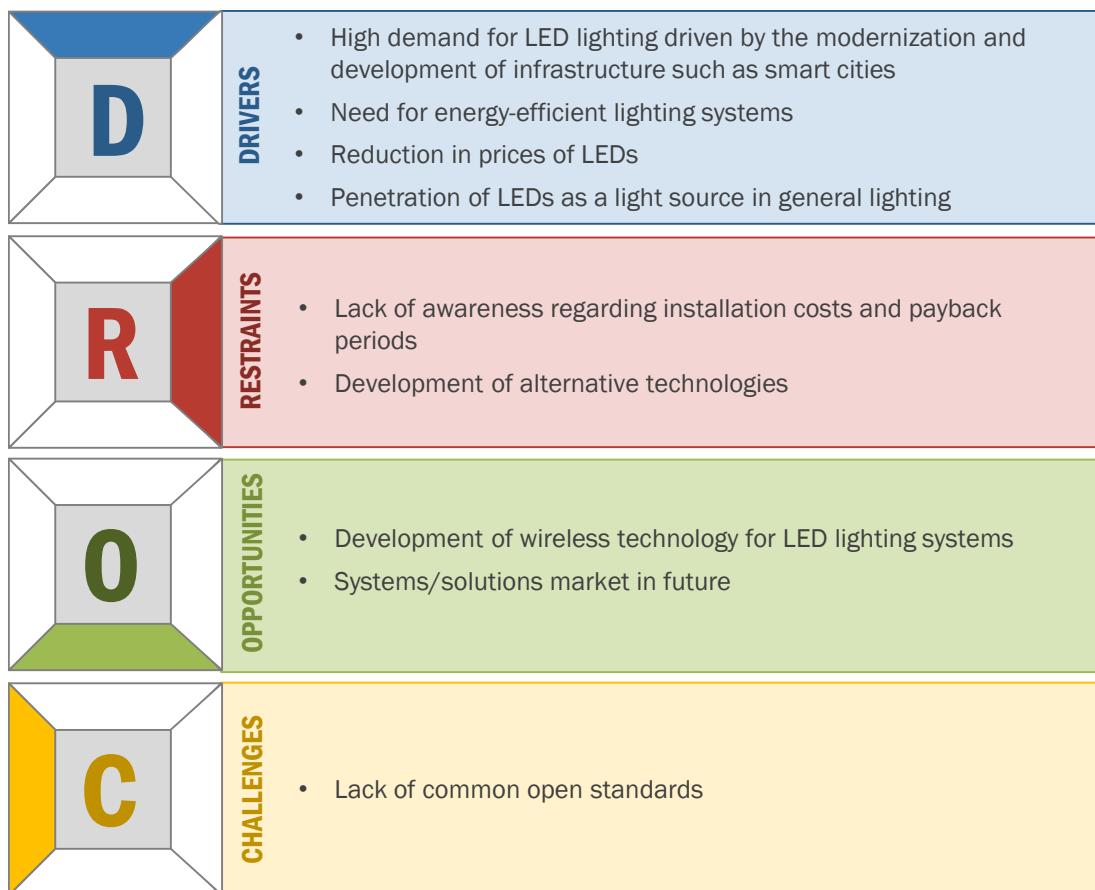
Note 2: Rest of APAC includes India, South Korea, Australia, Taiwan, and Philippines.

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

5.4 MARKET DYNAMICS

This section elaborates on the factors affecting the market dynamics, namely, drivers, restraints, opportunities, and challenges, analyzing and listing several factors that positively influence and negatively affect the individual submarkets considered in this study.

FIGURE 18 MARKET DYNAMICS: OVERVIEW



Source: Business Journal, White Papers, Experts' Interviews, and MarketsandMarkets Analysis

5.4.1 DRIVERS

5.4.1.1 High demand for LED lighting driven by the modernization and development of infrastructure such as smart cities

The application area of LED lighting is extending to warehouses, residential and commercial facilities, government buildings, and other areas. Electricity is majorly used in lighting streets and public spaces, cities, towns, and villages across the world. Today, a paradigm shift from traditional lighting systems to connected LED technology is the key to energy and cost saving in all lighting applications. LED bulbs are well known for their energy efficiency. These bulbs reduce the electric power required to generate a fixed amount of light and have the additional benefit of long life span which reduces maintenance and replacement costs. For instance, government officials in cities across the U.S. are focused on the latest innovations in lighting as they see an opportunity to do a lot more than simply illuminate an area. The smart lights are capable of communicating wirelessly to various networks, collecting various types of data such as nearby foot traffic and even helping to reduce crime rates, which traditional lightbulbs cannot do. The LED lighting system is gaining huge support and promotion from emerging countries as it forms part of their economy modernization plan.

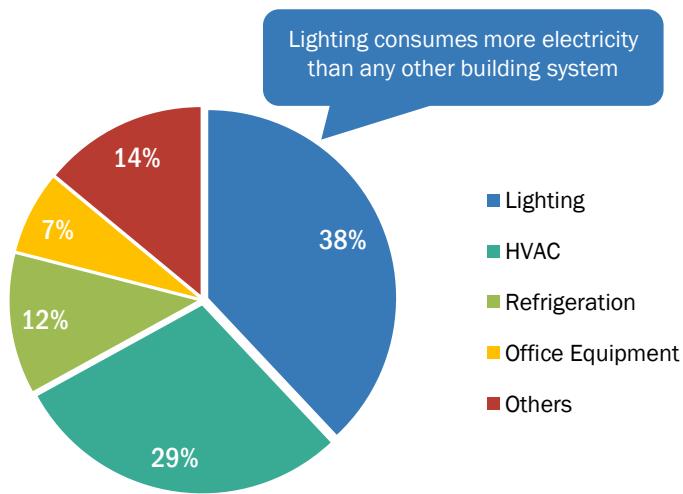
5.4.1.2 Need for energy-efficient lighting systems

The increasing price of energy is one of the major reasons behind the growing usage of LED lighting. Governments in countries such as Thailand, China, Brazil, and U.S. have implemented stringent regulations mandating the use of LED lighting and forcing fixture manufacturers to comply with minimum standards of lighting efficiency. Moreover, the use of incandescent lighting products is banned in many countries such as U.S., Russia, Brazil, Argentina, Canada, and Australia to ensure energy efficiency and to reduce the carbon footprint. This has encouraged construction enterprises to deploy LED lighting systems complying with regulations laid down by governments across nations, thereby fueling the demand from the global market for LED lighting products and solutions. The requirement of energy is also increasing because of rapidly increasing industrialization in Asia-Pacific. LED lighting provides high-efficiency fixtures and automated controls that make modifications based on conditions such as occupancy or daylight availability.

In Anchorage, new LED streetlights draw 50% less energy than existing luminaires, saving USD 360,000 a year. The city's 15,700 replacement lamps are expected to save USD 1.7 million annually.

LED lighting has a good hold in certain applications such as street lighting where it can absorb the initial cost in the short term and achieve benefits in the long term. Companies such as OSRAM AG (Germany) manufacture systems that allow keeping the entire street lighting under control via software.

FIGURE 19 U.S. ANNUAL ENERGY CONSUMPTION IN COMMERCIAL BUILDINGS, 2011



Note: Others include elevators, fire and smoke alarms, and biometric security systems, among others.

Source: U.S. Environmental Protection Agency

The above figure indicates that average lighting consumes maximum electricity in commercial buildings annually. According to the Executive Order 13423 of the U.S. Environmental Protection Agency, all government facilities must achieve a 30% total energy reduction from their 2003 baseline by 2020. Therefore, the LED lighting system has a wider scope in implementing the energy reduction strategy of the government. LED lighting systems allow to save energy. Commercial buildings and industrial plants together account for roughly 50% of the total energy consumption in the U.S., translating to approximately USD 400 billion of energy cost. Devices such as smart meters can reduce the power consumption and CO₂ emissions by up to 5%.

In countries such as the U.S. where 65% of the energy is being consumed by commercial and industrial sectors and 22% by lighting alone, there is a tremendous opportunity for saving energy. The connected lighting controls have the edge over conventional lighting switching systems as in the absence of any person they can automatically switch off the light to save power. Thus, the major advantage of lighting

controls is that they reduce the energy consumption and therefore the electricity bills. Hence, the demand for energy-efficient systems is expected to have a high impact on the demand for LED lighting globally.

5.4.1.3 Reduction in prices of LEDs

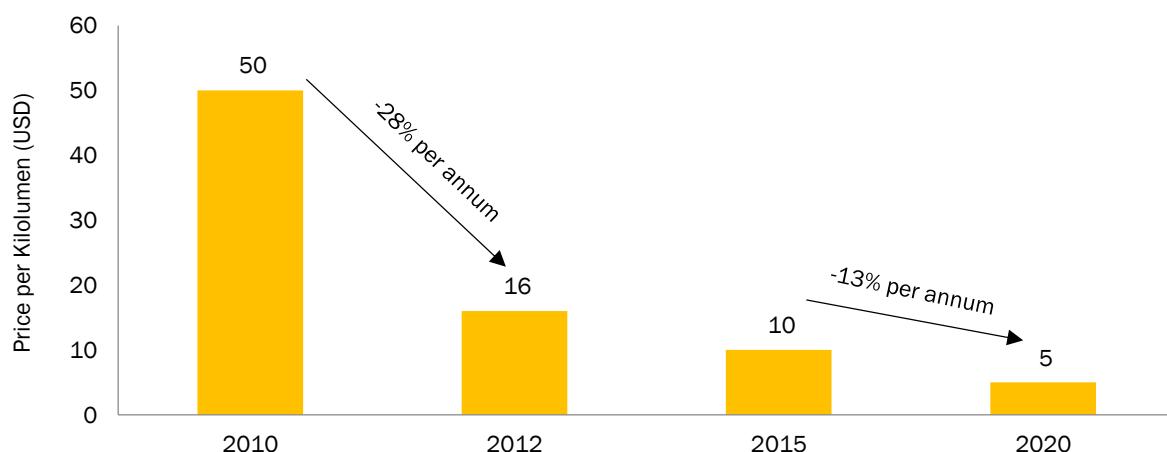
According to the findings of the U.S. Department of Energy's (DOE) 2011 Solid-State Lighting Manufacturing Roadmap, the prices of LED lamps by OEMs and LED packages are expected to drop by around 30% per annum from 2010 to 2015, and by 10–15% per annum from 2015 to 2020. This cost reduction is becoming increasingly visible every year owing to the strong focus of manufacturing companies in the LED lighting sector. The price of a warm-color LED package was USD 4 per kilolumen in 2009 and USD 3 per kilolumen in 2010, falling to USD 2 per kilolumen in the 2011 version of the DOE roadmap.

There are two main factors responsible for the reduction in prices of LED lights.

The first factor is improved luminous efficacy. Luminous efficacy is improving the brightness of light generated (measured in lumen) in terms of power consumed (measured in watt).

The second factor is low production costs of LEDs. Raw material costs for LED manufacturing are falling as the LED market is expanding due to economies of scale. The choice of material for LED production is also equally important. The most expensive component of LED raw material is the sapphire substrate. This substrate can be substituted by silicon (as in most other semiconductor applications) which can significantly reduce the cost. Downsizing the LED package and thus the entire light source (and potentially the fixture) also leads to reduction in material costs.

FIGURE 20 REDUCTION IN LED PRICES



Source: U.S. Department of Energy

5.4.1.4 Penetration of LEDs as a light source in general lighting

Penetration of LEDs in the general lighting industry is very low because LED is still expensive for high-brightness applications. Red, green, and blue LEDs are already well accepted in architectural lighting as they have clear benefits over traditional lighting, and this makes architectural lighting one of the earliest adopters of LED lights. Other LED lamps such as white LED lighting are also starting to grow. Also, as a result of substantial reductions in costs and the global awareness on energy conservation, the share of LEDs in the general lighting market is expected to rise between 2016 and 2020.

5.4.2 RESTRAINTS

5.4.2.1 Lack of awareness regarding installation costs and payback periods

Majority of the end users perceive that the cost of installing an LED lighting system is high due to the cost of the equipment as well as the cost of the integration and installation services. However, against this popular perception, the cost is primarily dependent on the complexity of integration pertaining to a specific application. The homeowners and corporate managers demand for cost-effective systems that also ensure energy savings but fail to realize the extent of the energy savings and the associated long-term cost savings. With lighting control systems, the lighting costs can be reduced by 30–60% while enhancing lighting quality and reducing environmental impact. This perception of high cost can hinder the deployment and growth of LED lighting at the global level. Efforts need to be taken by the manufacturers, facility managers, and governments to make customers aware about the long-term benefits of installing an LED lighting system.

5.4.2.2 Development of alternative technologies

The development of alternative lighting technologies such as laser lights can be viewed as a restraint for the LED lighting market. Laser lights have been proved to be more efficient than LEDs and almost as cost-effective in terms of manufacturing.

Applications of laser lights in entertainment displays and architectural lighting are already becoming popular, and it is one of the main reasons for LED application in architectural lighting to be stagnating.

5.4.3 OPPORTUNITIES

5.4.3.1 Development of wireless technology for LED lighting systems

The LED lighting market which initially started with wired technologies has entered the era of wireless technologies. The introduction of wireless technologies has boosted the market for retrofit lighting systems, leading to the growth of the LED lighting market. The wireless technologies have not only reduced the usage of wires but also helped to avoid the reconstruction of the existing buildings, thereby creating flexibility for end users.

Recently, developments have been taking place toward integrating wired and wireless technologies. BACnet has added wireless networking options by adding the ZigBee profile to the LED lighting system. ZigBee is a wireless technology designed to address the requirements of the low-cost, low-power wireless sensors and control networks in the LED lighting market. This integration between BACnet and ZigBee would allow to create an efficient and connected LED lighting system. Besides ZigBee, the other wireless communication technologies used in LED lighting systems are EnOcean, Z-Wave, and Wi-Fi. These wireless networks offer one of the biggest opportunities in the connected lighting market, especially in the areas of the retrofit market.

5.4.3.2 Systems/solutions market in future

The systems/solutions sector is expected to be a large market in the future as new solutions would be created for every application owing to the advent of LED lights. Some of the possible key players could be the companies involved in building solutions. Many lighting companies, especially those involved in making fixtures, are now targeting this sector as it has the potential to be one of the largest untapped opportunities in the lighting industry. Many building solutions companies are also targeting the lighting systems business as part of their overall building solutions business.

5.4.4 CHALLENGES

5.4.4.1 Lack of common open standards

The setting up of a general lighting standardization for LEDs has been initiated by several organizations such as the Zhaga Consortium. The lack of common open standards is creating inefficiency in the industry. For example, manufacturers of an LED module/light engine cannot benefit from the economies of scale, and designers and manufacturers of fixtures and module/light engines cannot design their products smoothly due to the lack of extensive coordination among various parts suppliers.

LED lighting system manufacturers are focusing on the development of open protocol devices with BACnet or LonMark interoperability, as these two are among the only open standard protocols for communication in LED lighting system. However, in the new world of convergence, systems that assert to offer interoperability and match the industry standards must also provide connectivity to various other equipment that integrate seamlessly into the network. BACnet or LonMark alone cannot ensure a total enterprise information compatibility and interoperability.

6 INDUSTRY TRENDS

6.1 INTRODUCTION

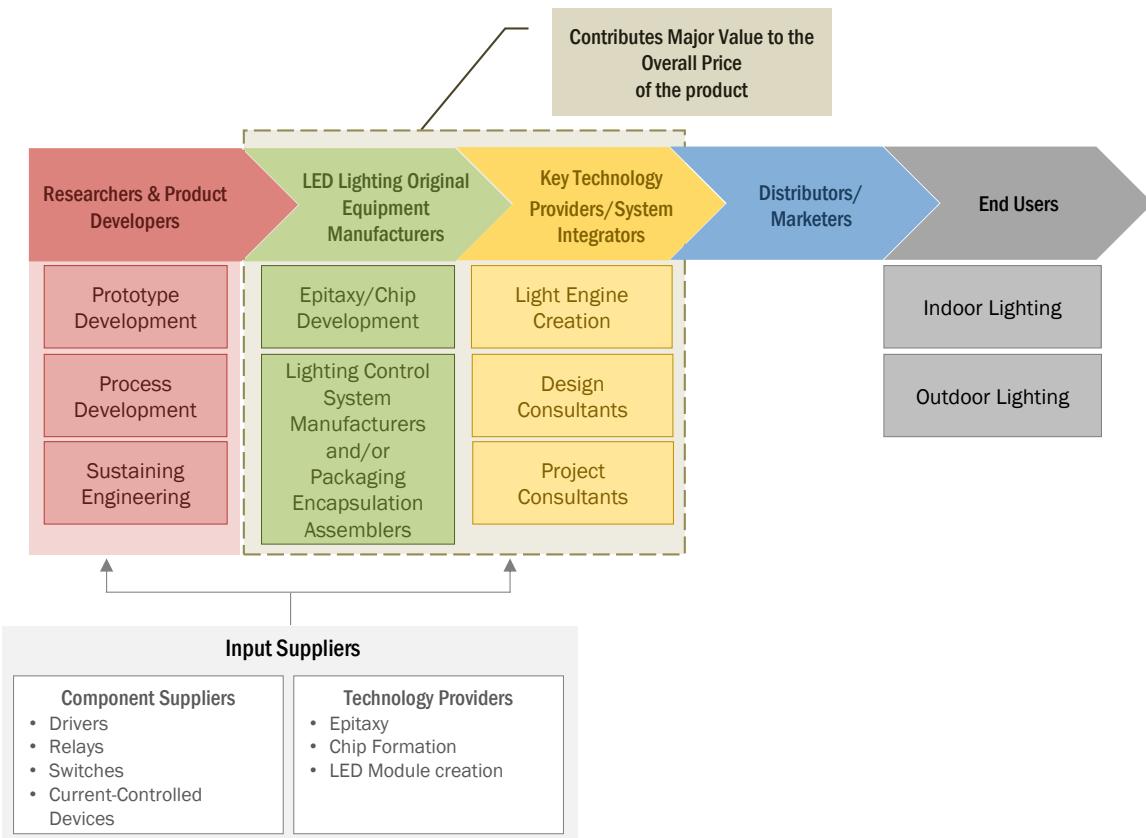
The chapter covers the value chain analysis of the LED lighting market. It also includes an analysis of the market with respect to Porter's five forces model.

The concept of LED lighting technology has evolved significantly over the last decade. This concept of having energy efficiency in lighting systems is highly technology oriented and ensures long life for lighting systems. Conventional lighting systems have not been restricted by cost and complexity, but they are not as energy efficient, nor do they have a long life. A shift from traditional incandescent lighting systems to LED lighting provides greater benefits, at a lower maintenance cost, to a much wider set of potential customers.

6.2 VALUE CHAIN ANALYSIS

The LED lighting market value chain comprises many entities from LED lighting component manufacturers to technology providers. Products and devices are distributed by specialized distributors that are into lighting and related fields. Some of the manufacturers that have a strong presence across the concerned geographic regions have a built-in distribution network. Distributors and manufacturers often establish partnerships with distributors across various regions having an expertise in products and services concerned with LED lighting because of the lack of knowledge of networking. These distributors are key points of contact for professional and custom installers. They consist of a strong network of system integrators which include custom system integrators, dealers, business models, and contractors.

FIGURE 21 LED LIGHTING MARKET: VALUE CHAIN ANALYSIS



Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

6.2.1 RESEARCH AND DEVELOPMENT

The research and product development is the first stage in the LED lighting market value chain and it takes place in the individual research institutes, universities, or at manufacturers' private research and development (R&D) facilities. The process starts with developing the prototype depending on the end-user requirements, testing the prototypes, getting regulatory approvals from the concerned governing bodies, and finally sustaining the engineering process for LED lighting systems. Some of the major stakeholders in R&D include Smart Lighting Engineering Research Center (Rensselaer Polytechnic Institute, U.S.), Boston University (U.S.), and University of New Mexico (New Mexico).

6.2.2 LED LIGHTING ORIGINAL EQUIPMENT MANUFACTURERS

In the second stage of the LED lighting market value chain, the prototype system developed and approved in the R&D stage is finally taken for further development. The lighting manufacturing companies use the approved prototypes to develop commercial lighting systems. This stage majorly involves creation of epitaxy wafers, chip packaging, and light engine modules. Notable players include Philips Lighting (Netherlands) and Acuity Brands Lighting, Inc. (U.S.). These players integrate their control systems with traditional lights to incorporate intelligent content in their products. The major manufacturers include Philips Lighting (Netherlands) and OSRAM Licht GmbH (Germany).

6.2.3 KEY TECHNOLOGY PROVIDERS/SYSTEM INTEGRATORS

The third stage includes technology providers that comprise design and project consultants and other service vendors. This stage also contributes maximum value to the overall value chain. These system integrators guide the LED lighting companies in commercial installations. These vendors provide light engines to OEMs for their LED lighting projects. The major companies in this stage are DimOnOff, Inc. (Canada), Samsung (South Korea), and Sharp Corporation (Japan).

6.2.4 DISTRIBUTORS/MARKETERS

The next step in the LED lighting market value chain is sales and marketing of the developed products. In this stage, the companies target various end users such as government organizations, commercial end users, residential building owners, educational institutions through direct sales, local distributors, and lighting vendors.

6.3 KEY INDUSTRY TRENDS

FIGURE 22 GREATER VERTICAL INTEGRATION—LEADING TREND AMONG KEY MARKET PLAYERS

KEY TREND	DESCRIPTION
Growing Connectivity and Closed Communication Protocols	<ul style="list-style-type: none"> There has been considerable growth in the number of new installations in the LED lighting market in the past five years. Players in this market are focused on establishing standards to gain a competitive advantage in the marketplace.
Greater Vertical Integration Among Lighting Players	<ul style="list-style-type: none"> In the past few years, manufacturers have put an increasing emphasis on greater vertical integration, focusing particularly on packaging, modules, and other lighting technologies. The growing vertical integration has offered many opportunities to lighting manufacturers to diversify and move downstream to ensure their competitive advantage.

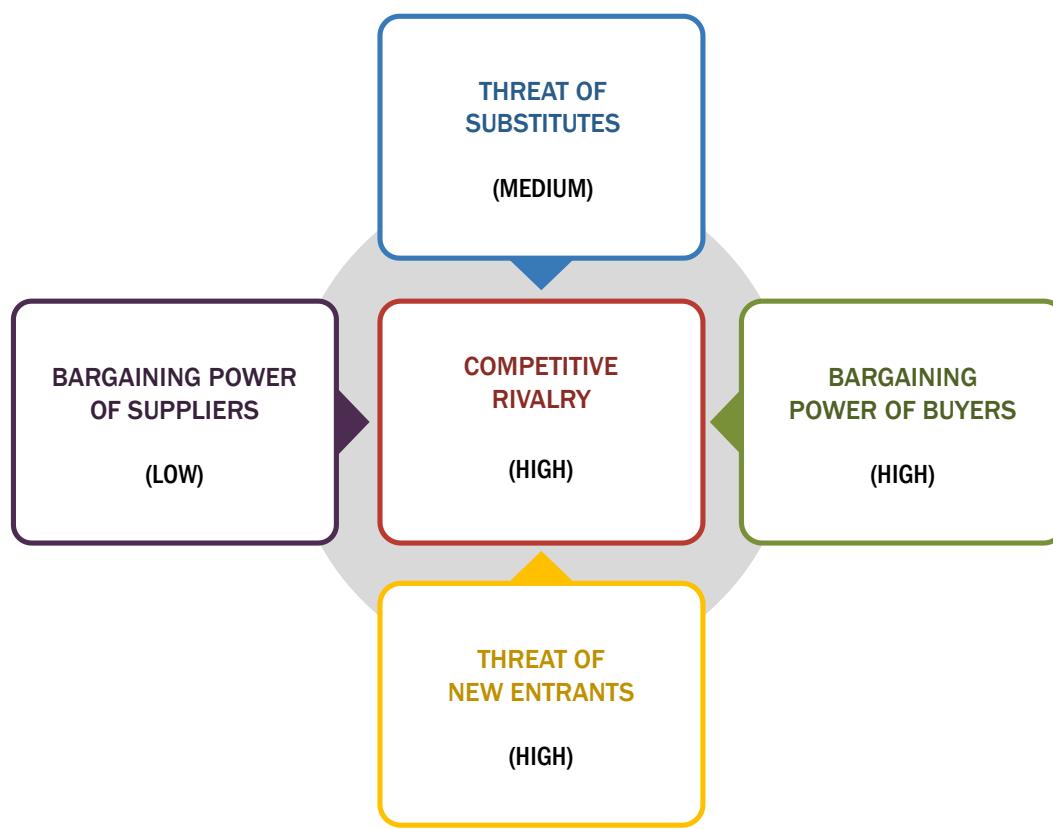
Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

6.4 PORTER'S FIVE FORCES ANALYSIS

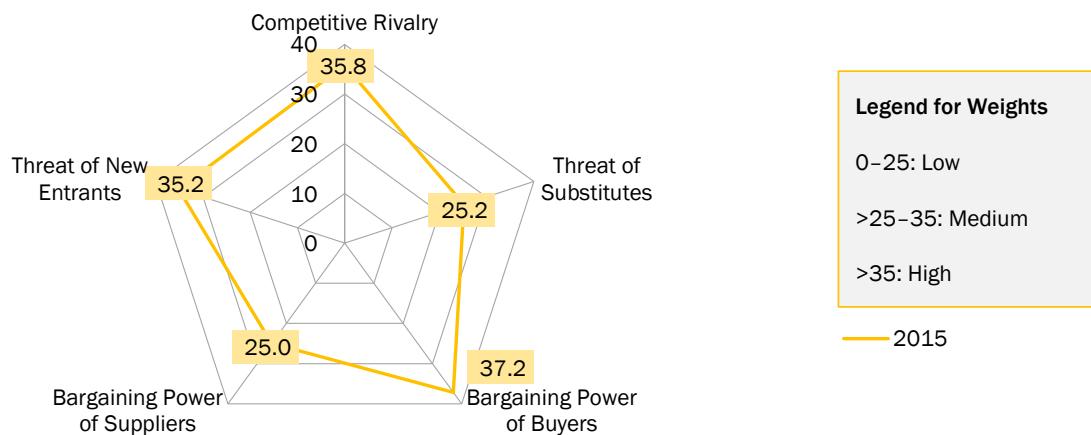
Porter's five forces model determines the current scenario of the LED lighting market. It guides companies in making decisions regarding entering or exiting a particular segment or the entire industry. Changes in these forces can have a major impact on the market. Porter's five forces analyze the LED lighting market from five different perspectives, namely, the intensity of rivalry or degree of competition within the industry, threat of new entrants, bargaining power of suppliers, bargaining power of buyers, and threat of substitutes.

The competitive environment in the industry can be analyzed through Porter's five forces analytical framework, which is based on the concept that there are five forces that determine the competitive intensity and growth potential of a market. Porter's five forces model helps to identify where the power lies in a business scenario. These five forces have been discussed in detail in the following section.

FIGURE 23 PORTER'S FIVE FORCES ANALYSIS



Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

FIGURE 24 PORTER'S FIVE FORCES: IMPACT ANALYSIS

Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

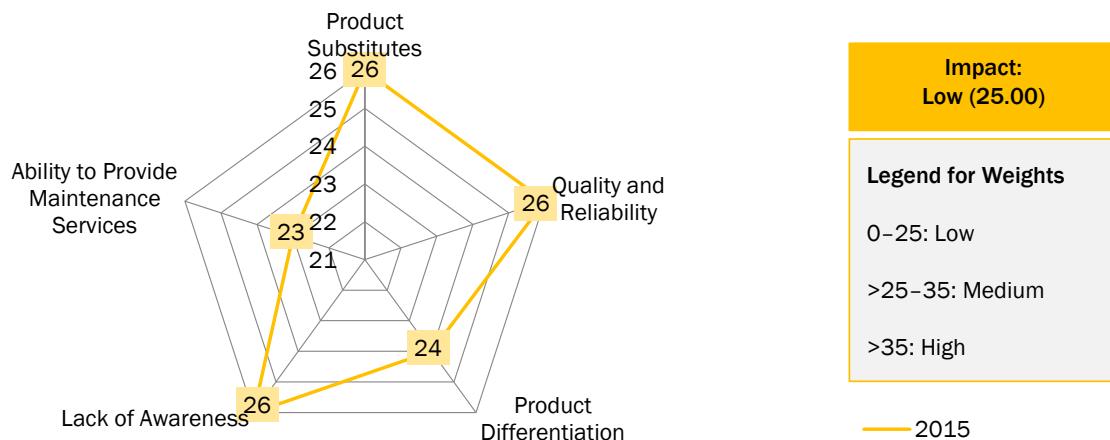
The above figure indicates that buyers' bargaining power and competitive rivalry in the market are the dominant forces that are expected to have a high impact on the current market. The low impact of suppliers' bargaining power can be attributed to the fact that the market is highly fragmented with a large number of product manufacturers, component providers, distributors, and systems integrators. The impact of the threat of new entrants has been analyzed to be high in the current market as there is a wide scope for expansion across emerging geographies.

The threat of substitutes has also been analyzed. LED lighting technology is promoted by government authorities. LEDs have fewer cost benefits than traditional lights; however, in the long-term use, LED lights are found to be beneficial. Therefore, the overall impact of this force on the market has been analyzed to be medium.

6.4.1 BARGAINING POWER OF SUPPLIERS

The bargaining power of the supplier assesses how easy it is for the suppliers to drive the prices of the equipment in the LED lighting market.

FIGURE 25 BARGAINING POWER OF SUPPLIERS IN THE LED LIGHTING MARKET, 2015



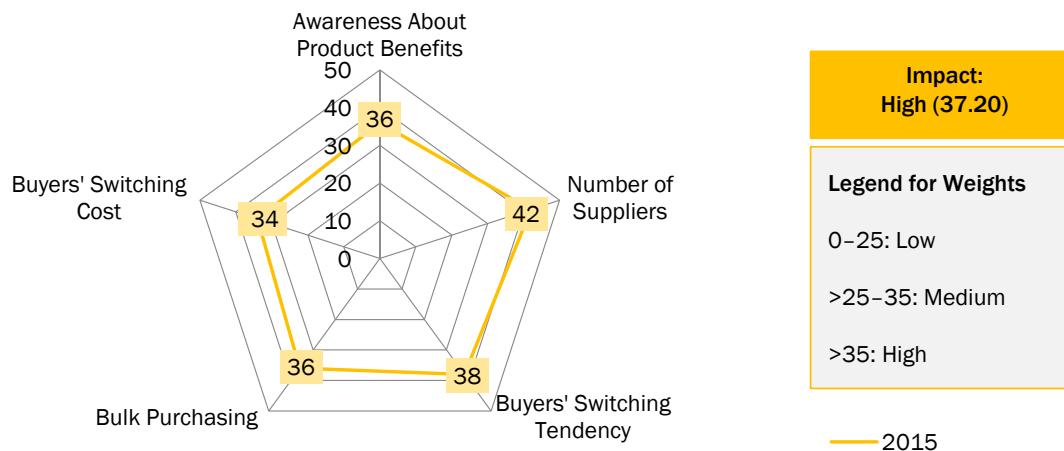
Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

The major challenge for suppliers in this market is the end users' lack of knowledge about the long-term benefits of LED lighting solutions. Taking these factors into consideration, companies need to focus more on sales and promotional activities to gain a significant share of the market as well as improve consumer awareness. In addition, the number of product substitutes in this market is medium such as normal LEDs or other similar energy-saving lighting systems without smart features. Therefore, the bargaining power of suppliers in the LED lighting market has been analyzed to have a low impact.

6.4.2 BARGAINING POWER OF BUYERS

The bargaining power of buyers assesses the ease with which buyers reduce prices in the LED lighting market.

FIGURE 26 BARGAINING POWER OF BUYERS IN THE LED LIGHTING MARKET, 2015



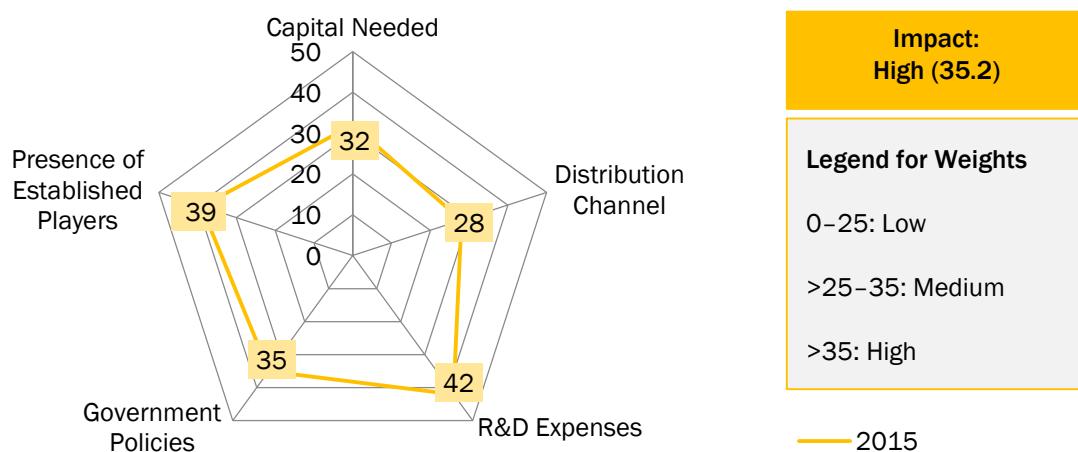
Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

Different types of LED lighting products are available in the market depending on their mode of application and end users. The customers are in a powerful position because of the presence of large number of suppliers as they can take a decision based on return on investments for deploying LED lighting solutions. Therefore, the suppliers need to reach out to customers through sales and promotional activities to sell their LED lighting products and also influence their switching tendency. It can therefore be concluded that the bargaining power of buyers has been analyzed to be high in this market.

6.4.3 THREAT OF NEW ENTRANTS

The threat of new entrants is a measure of the market situation that can affect the ability of a new entrant to enter into the LED lighting market.

FIGURE 27 THREAT OF NEW ENTRANTS IN THE LED LIGHTING MARKET, 2015



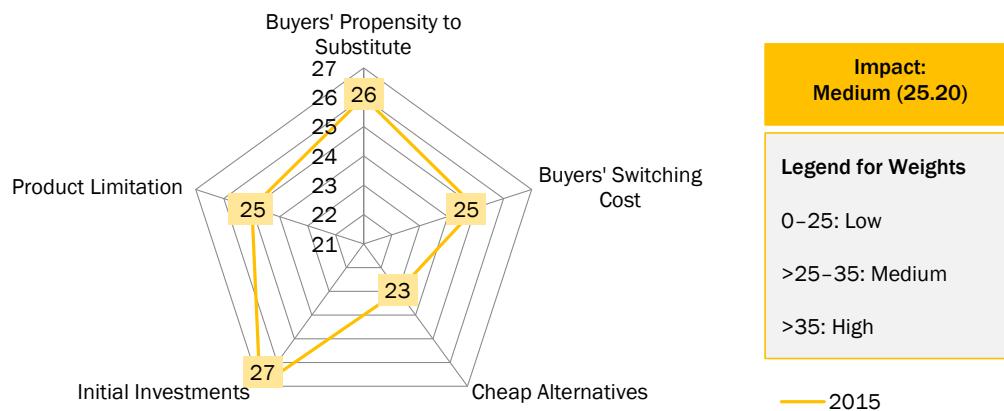
Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

The rapidly growing market and frequent technological advancements in the LED lighting market are attracting new players to enter this market. LED lighting is a fragmented market, and there is also a lack of standardization for LED lighting solutions. Different technologies based on LED lighting are easily available in the market. These factors favor the entry of new players. Moreover, the entry barriers are less as there is no stringent government law or policy that prevents new players from making an entry. However, the presence of lighting giants such as Philips (Netherlands), OSRAM GmbH (Germany), GE Lighting (U.S.), and others acts as a huge restraint for new entrants. It can be inferred that the threat of new entrants would be slightly high in this market considering all the above-stated factors.

6.4.4 THREAT OF SUBSTITUTES

The threat of substitutes arises when the customers or buyers in the market can achieve the desired end result by using other products.

FIGURE 28 THREAT OF SUBSTITUTES IN THE LED LIGHTING MARKET, 2015



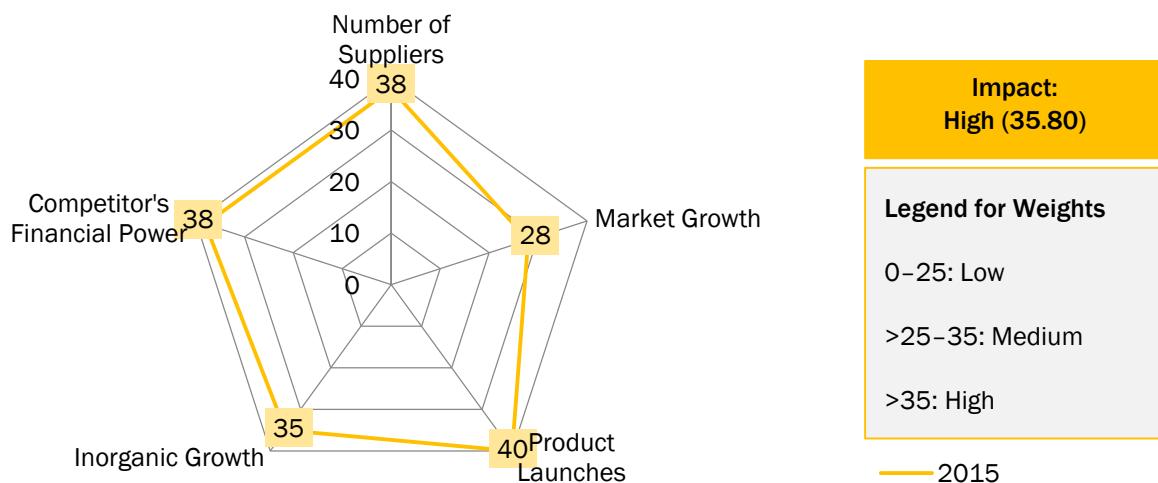
Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

The traditional lighting alternatives act as substitutes for LED lighting solutions. These products are affordable as well as simple to use. The nonconventional form of energy (solar), that is, solar lighting devices, may also be regarded as a substitute; however, they are mainly used for outdoor lighting applications. The main purpose of LED lighting is energy efficiency and longevity as none of the traditional lighting alternatives (or substitutes) offers such features; hence, they are not a threat to the LED lighting market. High initial investments are required for switching from traditional to LED lighting; hence, buyers' switching cost is critical. Individual buyers may not find it cost-effective initially. Therefore, the current impact of the threat of substitutes has been analyzed to be medium.

6.4.5 COMPETITIVE RIVALRY

The competitive rivalry assesses the market players' capability and level of rivalry among them in the LED lighting market.

FIGURE 29 COMPETITIVE RIVALRY IN THE LED LIGHTING MARKET, 2015



Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

There are established players in the market that manufacture end products such as luminaires, bulbs, control systems, and Internet-enabled devices. All these companies compete fiercely with each other. In the present scenario, many companies are launching new products in the market. It can be observed that LED products based on wireless technology are being launched on a large scale. The established players are using inorganic growth strategies by signing contracts with governments and public authorities, thereby giving tough competition to other players. Moreover, many new players are entering the LED lighting market as the entry barriers are low. For example, the LED lighting market in the U.S. is being dominated by start-up companies that are just three years old. Therefore, the degree of competition has been analyzed to be high in this market.

7 LED LIGHTING MARKET, BY INSTALLATION TYPE

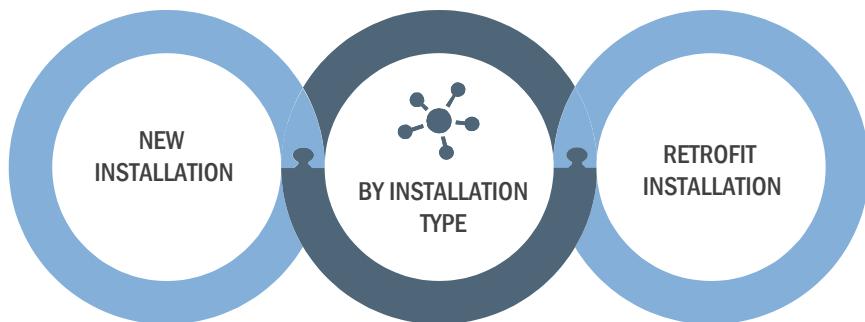
KEY FINDINGS

- The LED lighting market for new installation was valued at USD 27.59 billion in 2015 and is expected to reach USD 58.47 billion by 2022, growing at a CAGR of 10.78% during the forecast period.
- The new installation segment registered the highest shipment of 2.11 billion units in 2015 and is expected to reach 6.08 billion units by 2022, at a CAGR of 15.87% during the forecast period.
- The LED lighting market for luminaires (new installation) is expected to be valued at USD 16.90 billion by 2022, growing at the highest CAGR of 16.01% during the forecast period.
- The LED lighting market in RoW (new installation) is expected to be valued at USD 7.31 billion by 2022, growing at the highest CAGR of 12.96% during the forecast period.
- The market for the residential application (retrofit installation) was valued at USD 4.33 billion in 2015 and is expected to reach USD 14.36 billion by 2022, growing at a CAGR of 18.30% during the forecast period.

7.1 INTRODUCTION

This section provides the description of types of installations that are mainly used in LED lighting. The LED lighting market based on installation type has been segmented into new installation and retrofit installation.

FIGURE 30 LED LIGHTING MARKET, BY INSTALLATION TYPE



Note: Retrofit lamps include replacement lamps such as A-lamps, T-lamps, reflectors, and others such as low/high-bay and decorative lamps.

Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 4 LED LIGHTING MARKET, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	19,595.2	23,587.1	27,592.4	31,636.8	39,958.7	48,809.4	58,476.7	10.78%
Retrofit Installation	5,626.9	7,312.5	9,159.5	11,227.8	16,345.0	23,500.4	33,929.4	20.24%
Total	25,222.1	30,899.5	36,751.9	42,864.5	56,303.7	72,309.8	92,406.1	13.66%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market based on installation type was valued at USD 36,751.9 million in 2015 and is expected to reach USD 92,406.1 million by 2022, growing at a CAGR of 13.66% during the forecast period. The market for new installation was valued at USD 27,592.4 million in 2015 and is expected to reach USD 58,476.7 million by 2022, growing at a CAGR of 10.78% during the forecast period. The market for retrofit installation is expected to be valued at USD 33,929.4 million by 2022, growing at the highest CAGR of 20.24% during the forecast period. Increasing replacement of incandescent lamps with energy-efficient light sources such as LED lamps is the major factor contributing to the growth of the market for retrofit installation. The old generation lamps are being slowly phased out and the fixtures are being retrofitted with LED lamps as they offer a longer working life and also consume less energy.

TABLE 5 LED LIGHTING MARKET, BY INSTALLATION TYPE, 2013–2022 (MILLION UNITS)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	1,392.9	1,739.0	2,111.4	2,515.5	3,446.2	4,601.9	6,088.2	15.87%
Retrofit Installation	845.0	1,139.6	1,484.9	1,898.3	3,032.6	4,851.7	7,925.6	26.89%
Total	2,237.9	2,878.6	3,596.3	4,413.9	6,478.9	9,453.7	14,013.8	21.23%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market based on installation type registered a shipment of 3,596.3 million units in 2015 and is expected to reach 14,013.8 million units by 2022, at a CAGR of 21.23% during the forecast period. The new installation segment registered the highest shipment of 2,111.4 million units in 2015 and is expected to reach 6,088.2 million units by 2022, at a CAGR of 15.87% during the forecast period. However, shipment for the retrofit installation segment is expected to reach 7,925.6 million units by 2022, at the highest CAGR of 26.89% during the forecast period. Retrofit installations are expected to overtake new installations in terms of shipment because more number of lamps of traditional lighting fixtures are being replaced with LED lamps than complete replacement of lamps and fixtures with new installations.

7.2 NEW INSTALLATION

New installation refers to installation of completely new LED lighting systems containing the new generation LED lamps and luminaires. Unlike retrofit installation, which refers to partial replacement of lighting systems, new installation completely replaces a traditional lighting system after fully phasing out the lamp and its assorted controls and fixtures with the LED lamp and its associated controls and fixtures.

TABLE 6 LED LIGHTING MARKET FOR NEW INSTALLATION, BY PRODUCT TYPE, 2013–2022 (USD MILLION)

Product Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Lamps	16,110.2	19,009.6	21,870.7	24,702.2	30,312.1	35,912.6	41,575.5	9.06%
Luminaires	3,485.0	4,577.5	5,721.7	6,934.6	9,646.6	12,896.8	16,901.2	16.01%
Total	19,595.2	23,587.1	27,592.4	31,636.8	39,958.7	48,809.4	58,476.7	10.78%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for new installation based on product type was valued at USD 27,592.4 million in 2015 and is expected to reach USD 58,476.7 million by 2022, growing at a CAGR of 10.78% during the forecast period. The market for lamps was valued at USD 21,870.7 million in 2015 and is expected to reach USD 41,575.5 million by 2022, growing at a CAGR of 9.06% during the forecast period. The market for luminaires is expected to be valued at USD 16,901.2 million by 2022, growing at the highest CAGR of 16.01% during the forecast period. New installations of LED lighting would generate increasing demand for luminaires, and it is one of the reasons for its high growth.

TABLE 7 LED LIGHTING MARKET FOR NEW INSTALLATION, BY PRODUCT TYPE, 2013–2022 (MILLION UNITS)

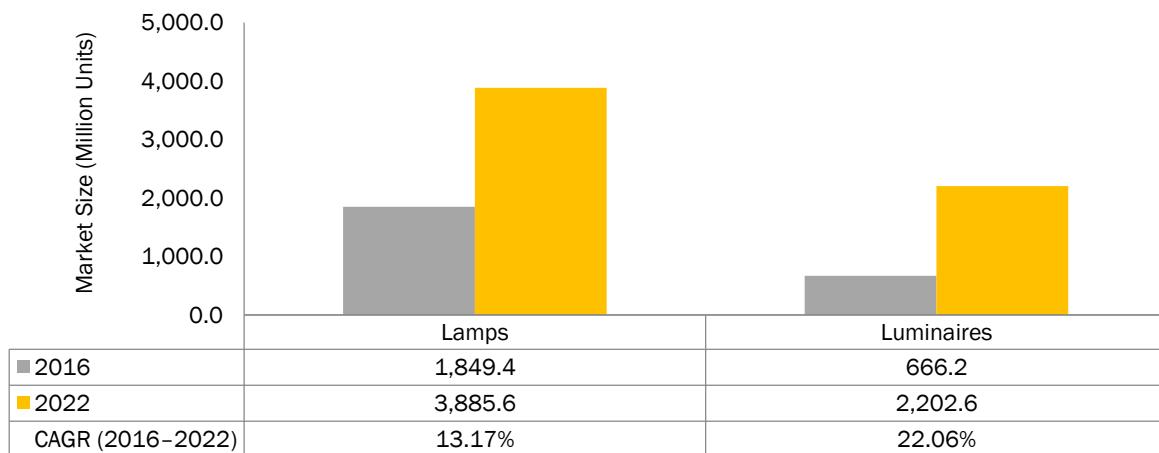
Product Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Lamps	1,097.0	1,334.7	1,584.8	1,849.4	2,430.5	3,099.7	3,885.6	13.17%
Luminaires	295.9	404.3	526.6	666.2	1,015.7	1,502.2	2,202.6	22.06%
Total	1,392.9	1,739.0	2,111.4	2,515.5	3,446.2	4,601.9	6,088.2	15.87%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for new installation based on product type registered a shipment of 2,111.4 million units in 2015 and is expected to reach 6,088.2 million units by 2022, at a CAGR of 15.87% during the forecast period. The lamps segment registered the highest shipment of 1,584.8 million units in 2015 and is expected to reach 3,885.6 million units by 2022, at a CAGR of 13.17% during the forecast period. Lamps hold a larger size of the market than luminaires because multiple lamps can be controlled with

fewer number of luminaires. However, shipment for the luminaires segment is expected to reach 2,202.6 million units by 2022, at the highest CAGR of 22.06% during the forecast period.

FIGURE 31 LED LIGHTING MARKET FOR NEW INSTALLATION, BY PRODUCT TYPE (MILLION UNITS)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 8 NEW INSTALLATION LED LIGHTING MARKET FOR INDOOR LIGHTING, BY TYPE, 2013–2022 (USD MILLION)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Residential	8,175.4	9,728.4	11,248.4	12,745.6	15,714.0	18,722.8	21,863.0	9.41%
Commercial	6,232.3	7,527.0	8,834.6	10,163.5	12,923.7	15,893.2	19,170.7	11.16%
Industrial	503.7	617.0	734.1	855.9	1,116.4	1,406.6	1,736.1	12.51%
Others	163.4	223.5	293.0	372.2	562.2	800.0	1,095.1	19.71%
Total	15,074.8	18,095.8	21,110.1	24,137.2	30,316.2	36,822.6	43,864.9	10.47%

Note: Other indoor lighting applications include government and public buildings.

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for new installation based on the indoor lighting end-use application was valued at USD 21,110.1 million in 2015 and is expected to reach USD 43,864.9 million by 2022, growing at a CAGR of 10.47% during the forecast period. The market for the residential application was valued at USD 11,248.4 million in 2015 and is expected to reach USD 21,863.0 million by 2022, growing at a CAGR of 9.41% during the forecast period. Increase in global efforts in infrastructure improvement-related works, most of the buildings of which are for residential purposes, is a driving factor for the dominance of the residential sector. The market for other indoor lighting applications is expected to be valued at USD 1,095.1 million by 2022, growing at the highest CAGR of 19.71% during the forecast period.

TABLE 9 NEW INSTALLATION LED LIGHTING MARKET FOR OUTDOOR LIGHTING, BY TYPE,
2013–2022 (USD MILLION)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Highway & Roadway	1,804.2	2,217.1	2,646.5	3,094.8	4,060.8	5,144.9	6,384.1	12.83%
Architectural	2,513.1	3,023.4	3,535.1	4,051.7	5,114.4	6,245.1	7,481.5	10.76%
Public Places	140.4	175.6	213.2	253.3	342.4	445.5	566.3	14.35%
Others	62.7	75.1	87.4	99.8	124.9	151.3	179.9	10.32%
Total	4,520.4	5,491.2	6,482.2	7,499.6	9,642.5	11,986.8	14,611.8	11.76%

Note: Other outdoor lighting applications include rail lines and harbors.

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for new installation based on the outdoor lighting end-use application was valued at USD 6,482.2 million in 2015 and is expected to reach USD 14,611.8 million by 2022, growing at a CAGR of 11.76% during the forecast period. The market for architectural segment was valued at USD 3,535.1 million in 2015 and is expected to reach USD 7,481.5 million by 2022, growing at a CAGR of 10.76% during the forecast period. Architectural lighting is one of the early adopters of LED lamps. The advantage that LED offers in architectural lighting is RGB color controllability which is absent in traditional lamps that have to use color film filters and this leads to high maintenance costs. The market for public places segment is expected to be valued at USD 566.3 million by 2022, growing at the highest CAGR of 14.35% during the forecast period.

TABLE 10 LED LIGHTING MARKET FOR NEW INSTALLATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	3,896.8	4,661.8	5,405.1	6,084.1	7,263.1	8,388.9	9,648.1	7.99%
Europe	5,030.8	6,044.2	7,028.3	7,946.2	9,764.4	11,523.0	13,575.5	9.34%
Asia-Pacific	8,717.7	10,436.7	12,323.8	14,087.5	18,318.8	23,179.6	27,942.8	12.09%
RoW	1,949.9	2,444.4	2,835.3	3,519.1	4,612.4	5,717.9	7,310.3	12.96%
Total	19,595.2	23,587.1	27,592.4	31,636.8	39,958.7	48,809.4	58,476.7	10.78%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for new installation based on region was valued at USD 27,592.4 million in 2015 and is expected to reach USD 58,476.7 million by 2022, growing at a CAGR of 10.78% during the forecast period. The market in Asia-Pacific was valued at USD 12,323.8 million in 2015 and is expected to reach USD 27,942.8 million by 2022, growing at a CAGR of 12.09% during the forecast period. High demand for new construction and increasing affordability of LEDs are strengthening the position of APAC in the global LED lighting market. Moreover, huge economic growth of developing nations such as China, India, and ASEAN countries is fueling the growth of the LED lighting market in the region. The market in RoW is expected to be valued at USD 7,310.3 million by 2022, growing at the highest CAGR of 12.96% during the forecast period.

7.3 RETROFIT

Retrofit lamps refer to those LED lamps that are used to partially replace existing lighting fixtures with LED lamps and nonintegrated luminaires and controls (such as LED drivers), to replace the traditional light sources. LED provides significant energy saving, fast illumination, and a high degree of working life which can be more than 25 times longer than incandescent lamps.

Retrofit lamps considered for the study include A-lamps, T-lamps, reflectors, and other lamps such as high/low-bay and decorative lamps.

7.3.1 A-LAMPS

A-lamps include LED replacement lamps for standard incandescent lamps. A-lamps are considered the classic replacement type of light bulbs that have been used for general-purpose lighting for over 100 years. These lamps have a medium screw base and typically have a pear-like shape.

7.3.2 T-LAMPS

Linear T-lamps are widely used in commercial and industrial lighting as they offer a cheaper, efficient, and long-lasting light source. As a result, these retrofit systems represent nearly half of all lighting services (in lumen-hour) in the U.S. Because of the significant lighting service required by these applications, the penetration of LED lighting as a replacement for linear fluorescent lamps has the potential to greatly reduce total energy consumption. Modern linear fluorescent lamps and ballast systems are tough competitors to LEDs in terms of efficacy as well as initial and life cycle costs, with efficacies as high as 108lm/W and prices as low as USD4/klm.

7.3.3 REFLECTORS

LEDs are different from conventional light sources in ways of optical behavior where they emit light in an omnidirectional manner and require a reflector to shape the radiation. LED point sources radiate in one hemisphere and often require the use of collimators in the form of total internal reflection (TIR) lenses to steer the beam. The layered structure of an LED chip and its built-in primary optics in the module always make the emission of light Lambertian in nature. This basic emission is also influenced by additional optical means that are integrated into the LED—mostly features a reduced beam angle. Optic control is usually applied with collimator lenses and reflectors—bulk optics that implement TIR.

7.3.3.1 Multifaceted reflector (MR) lamps

MR lamps are a type of reflector lamps mainly used by halogen lamps, but they are also used by LED replacement lamps and fluorescent lamps.

They were originally used for slide projectors but have also found applications in residential and commercial lighting. MR lamps usually find applications where directional lighting is required such as track lighting, recessed ceiling lights, desk lamps, pendant fixtures, landscape lighting, and retail display lighting.

7.3.4 OTHER LAMPS

Other retrofit lamps considered for the study are high/low-bay lamps and decorative lamps.

Decorative lamps cover a range of bulb shapes which include bullet, globe, flame, and candle. These are mostly used in residential lighting and are typically used in fixtures such as chandeliers, pendants, wall sconces, lanterns, and night-lights. They have low lumen outputs and high color quality. The bulbs also provide an esthetic contribution to a space and are installed in open fixtures where an omnidirectional intensity distribution is generally preferred.

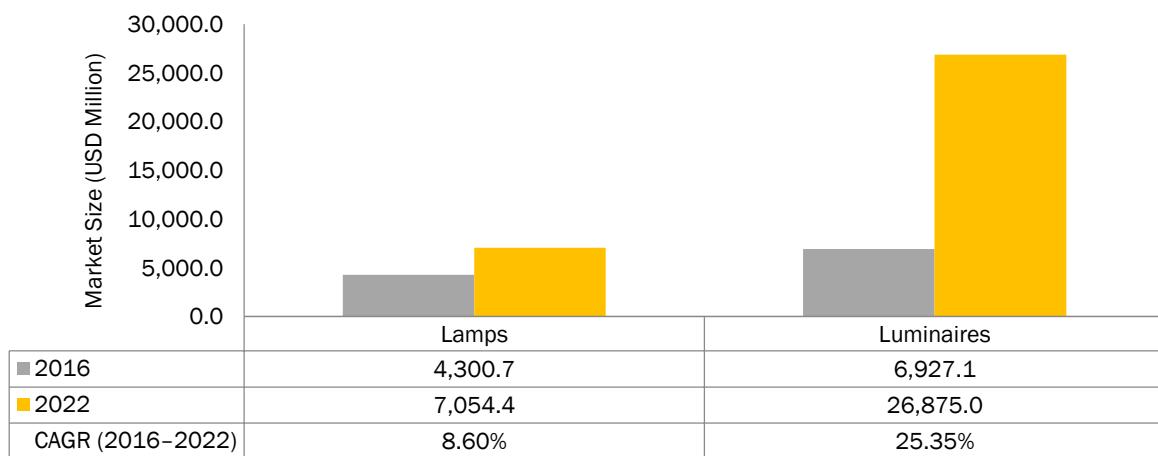
TABLE 11 LED LIGHTING MARKET FOR RETROFIT INSTALLATION, BY PRODUCT TYPE, 2013–2022 (USD MILLION)

Product Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Lamps	2,953.7	3,404.1	3,852.7	4,300.7	5,200.1	6,114.0	7,054.4	8.60%
Luminaires	2,673.2	3,908.4	5,306.8	6,927.1	11,144.9	17,386.4	26,875.0	25.35%
Total	5,626.9	7,312.5	9,159.5	11,227.8	16,345.0	23,500.4	33,929.4	20.24%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for retrofit installation based on product type was valued at USD 9,159.5 million in 2015 and is expected to reach USD 33,929.4 million by 2022, growing at a CAGR of 20.24% during the forecast period. The market for luminaires was valued at USD 5,306.8 million in 2015 and is expected to reach USD 26,875.0 million by 2022, growing at the highest CAGR of 25.35% during the forecast period.

FIGURE 32 LED LIGHTING MARKET FOR RETROFIT INSTALLATION, BY PRODUCT TYPE (USD MILLION)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis.

TABLE 12 LED LIGHTING MARKET FOR RETROFIT INSTALLATION, BY PRODUCT TYPE, 2013–2022 (MILLION UNITS)

Product Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Lamps	435.0	514.1	597.1	684.5	874.6	1,090.3	1,338.6	11.83%
Luminaires	410.0	625.4	887.8	1,213.9	2,158.0	3,761.5	6,587.0	32.56%
Total	845.0	1,139.6	1,484.9	1,898.3	3,032.6	4,851.7	7,925.6	26.89%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for retrofit installation based on product type registered a shipment of 1,484.9 million units in 2015 and is expected to reach 7,925.6 million units by 2022, at a CAGR of 26.89% during the forecast period. The luminaires segment registered the highest shipment of 887.8 million units in

2015 and is expected to reach 6,587.0 million units by 2022, at the highest CAGR of 32.56% during the forecast period.

TABLE 13 RETROFIT INSTALLATION LED LIGHTING MARKET FOR INDOOR LIGHTING, BY TYPE, 2013–2022 (USD MILLION)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Residential	2,735.2	3,508.4	4,335.6	5,241.0	7,407.9	10,314.0	14,368.0	18.30%
Commercial	2,135.5	2,784.9	3,500.2	4,304.9	6,306.5	9,119.4	13,230.7	20.58%
Industrial	194.6	267.2	354.3	460.5	758.6	1,248.2	2,093.6	28.71%
Others	57.0	84.0	117.8	159.8	277.1	461.8	756.7	29.59%
Total	5,122.2	6,644.5	8,308.0	10,166.1	14,750.2	21,143.4	30,448.9	20.06%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for retrofit installation based on the indoor lighting end-use application was valued at USD 8,308.0 million in 2015 and is expected to reach USD 30,448.9 million by 2022, growing at a CAGR of 20.06% during the forecast period. The market for the residential application was valued at USD 4,335.6 million in 2015 and is expected to reach USD 14,368.0 million by 2022, growing at a CAGR of 18.30% during the forecast period. The market for other indoor lighting applications is expected to be valued at USD 756.7 million by 2022, growing at the highest CAGR of 29.59% during the forecast period. The market for the industrial application is expected to witness a high growth of 28.71% during the forecast period as LED penetration in this segment is total cost of ownership (TCO). LEDs can reduce lighting maintenance costs significantly, especially in high, hard-to-reach places (high-bay lighting).

TABLE 14 RETROFIT INSTALLATION LED LIGHTING MARKET FOR OUTDOOR LIGHTING, BY TYPE, 2013–2022 (USD MILLION)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Highway & Roadway	320.1	426.9	548.5	689.2	1,052.5	1,583.8	2,387.7	23.01%
Architectural	148.8	193.3	241.8	295.6	426.1	601.7	842.2	19.06%
Public Places	26.9	36.0	46.3	58.1	87.5	127.9	183.1	21.08%
Others	8.8	11.7	14.9	18.7	28.6	43.6	67.4	23.83%
Total	504.7	668.0	851.6	1,061.7	1,594.8	2,357.0	3,480.4	21.88%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for retrofit installation based on the outdoor lighting end-use application was valued at USD 851.6 million in 2015 and is expected to reach USD 3,480.4 million by 2022, growing at a CAGR of 21.88% during the forecast period. The market for the highway and roadway segment was valued at USD 548.5 million in 2015 and is expected to reach USD 2,387.7 million by 2022, growing at a CAGR of 23.01% during the forecast period. Increasing government spending on improving public infrastructure such as streetlights is a major factor contributing to the high growth and dominance of the highway and roadway segment. The market for other outdoor lighting applications is expected to be valued at USD 67.4 million by 2022, growing at the highest CAGR of 23.83% during the forecast period.

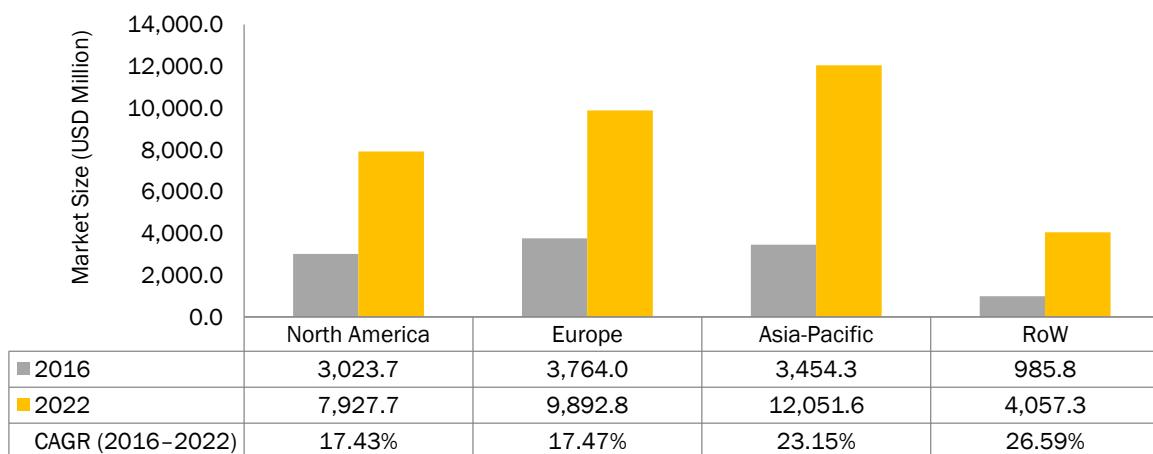
TABLE 15 LED LIGHTING MARKET FOR RETROFIT INSTALLATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	1,553.9	2,006.0	2,507.8	3,023.7	4,136.9	5,702.6	7,927.7	17.43%
Europe	1,973.7	2,521.4	3,128.8	3,764.0	5,196.3	7,098.1	9,892.8	17.47%
Asia-Pacific	1,644.6	2,170.1	2,766.1	3,454.3	5,318.5	8,113.5	12,051.6	23.15%
RoW	454.6	614.9	756.8	985.8	1,693.3	2,586.2	4,057.3	26.59%
Total	5,626.9	7,312.5	9,159.5	11,227.8	16,345.0	23,500.4	33,929.4	20.24%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for retrofit installation based on region was valued at USD 9,159.5 million in 2015 and is expected to reach USD 33,929.4 million by 2022, growing at a CAGR of 20.24% during the forecast period. The European market was valued at USD 3,128.8 million in 2015 and is expected to reach USD 9,892.8 million by 2022, growing at a CAGR of 17.47% during the forecast period. The market in RoW is expected to be valued at USD 4,057.3 million by 2022, growing at the highest CAGR of 26.59% during the forecast period.

FIGURE 33 LED LIGHTING MARKET FOR RETROFIT INSTALLATION, BY REGION (USD MILLION)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis.

8 LED LIGHTING MARKET, BY END-USE APPLICATION

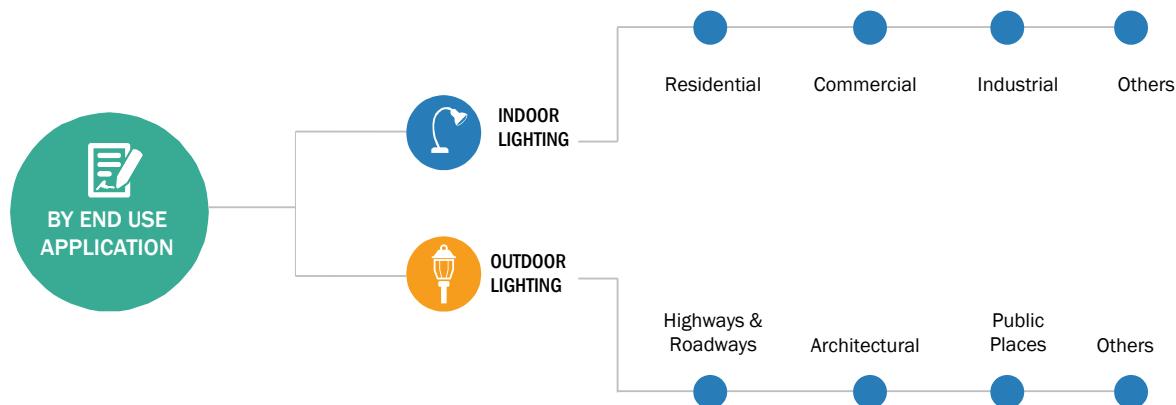
KEY FINDINGS

- The LED lighting market for indoor lighting application was valued at USD 29.41 billion in 2015 and is expected to reach USD 74.31 billion by 2022, growing at the highest CAGR of 13.75% during the forecast period.
- The shipment for outdoor lighting application is expected to reach 996.4 million units by 2022, at the highest CAGR of 23.52% during the forecast period.
- Increasing focus on enhancing connectivity by building roads and road lights, especially in the developing countries of the APAC region, would spur the growth of the outdoor LED lighting market.
- Increase in infrastructure-building activities, a large chunk of which is the residential sector, is the major factor contributing to the high growth of the residential indoor lighting end-use application.
- The market for architectural outdoor lighting application based on region was valued at USD 3.77 billion in 2015 and is expected to reach USD 8.32 billion by 2022, growing at a CAGR of 11.43% during the forecast period.

8.1 INTRODUCTION

LED lighting systems offer a significant opportunity to eliminate waste, reduce energy consumption, and save cost. Lighting is an important factor in energy consumption which is gaining recognition as the most efficient strategy for energy savings among various end users. This section describes the various end-use applications of LED lighting. The LED lighting market has been segmented on the basis of end-use application into indoor lighting and outdoor lighting.

FIGURE 34 LED LIGHTING MARKET, BY END-USE APPLICATION



Note: Other indoor lighting applications include government and public buildings; other outdoor lighting applications include rail lines and harbors.

Source: Lighting Controls Association (U.S.), National Electrical Manufacturers Association (NEMA, U.S.), Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 16 LED LIGHTING MARKET, BY END-USE APPLICATION, 2013–2022 (USD MILLION)

End-Use Application	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Indoor Lighting	20,197.0	24,740.4	29,418.1	34,303.3	45,066.5	57,966.0	74,313.9	13.75%
Outdoor Lighting	5,025.0	6,159.2	7,333.8	8,561.2	11,237.3	14,343.8	18,092.2	13.28%
Total	25,222.1	30,899.5	36,751.9	42,864.5	56,303.7	72,309.8	92,406.1	13.66%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market based on end-use application was valued at USD 36,751.9 million in 2015 and is expected to reach USD 92,406.1 million by 2022, growing at a CAGR of 13.66% during the forecast period. The market for indoor lighting application was valued at USD 29,418.1 million in 2015 and is expected to reach USD 74,313.9 million by 2022, growing at the highest CAGR of 13.75% during the forecast period. The large market size and high growth rate of indoor lighting application is attributed to the increasing infrastructural activities across the world, mainly focused on residential lighting.

TABLE 17 LED LIGHTING MARKET, BY END-USE APPLICATION, 2013–2022 (MILLION UNITS)

End-Use Application	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Indoor Lighting	2,104.1	2,702.8	3,372.2	4,133.3	6,050.8	8,805.2	13,017.4	21.07%
Outdoor Lighting	133.8	175.8	224.1	280.6	428.1	648.4	996.4	23.52%
Total	2,237.9	2,878.6	3,596.3	4,413.9	6,478.9	9,453.7	14,013.8	21.23%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market based on end-use application registered a shipment of 3,596.3 million units in 2015 and is expected to reach 14,013.8 million units by 2022, at a CAGR of 21.23% during the forecast period. The indoor lighting segment registered the highest shipment of 3,372.2 million units in 2015 and is expected to reach 13,017.4 million units by 2022, at a CAGR of 21.07% during the forecast period. However, shipment for the outdoor lighting segment is expected to reach 996.4 million units by 2022, at the highest CAGR of 23.52% during the forecast period. Increasing focus on enhancing connectivity by building roads and road lights, especially in the developing countries of the APAC region, would spur the growth of the outdoor LED lighting market.

8.1.1 INDOOR LIGHTING

The LED lighting market for the indoor lighting application has been segmented into residential, commercial, industrial, and others such as government and public buildings.

8.1.1.1 Residential

LED lighting for residential buildings is expected to have a huge potential in the future. It is expected to witness a high growth rate. However, the high installation cost is the major restraint for this application of LED lighting. Additionally, LED lighting products are more expensive than conventional lighting products, which would make it difficult for individual buyers to purchase these products. However, countries with a high per capita income would implement LED lighting solutions for residential applications. For instance, U.S., Canada, and European countries such as U.K. and Germany would have huge market for LED lighting systems in the near future.

8.1.1.1.1 Increasing standard of living

Economies with a high per capita income of population are expected to implement energy-efficient lighting solutions. U.S., Canada, and European countries such as U.K. and Germany are expected to hold a large market size for light switches and dimmers during the forecast period.

8.1.1.2 Commercial

The commercial end-use applications include offices, retail shops and malls, and hospitals. Reducing energy consumption has become a major objective for building owners, governments, utilities, and many other stakeholders. Replacing existing lights with more energy-efficient lighting sources (such as LEDs) is one of the ways to reduce this massive pool of energy use, but it is a small-scale solution. Energy reduction on a large scale can be achieved by turning off the lights when not required, optimizing light levels to suit worker needs, and reducing the overall demand for lighting energy. Adding LED lighting controls in lighting is the best way to ensure that lighting energy is automatically reduced as much as possible. According to the findings of the U.S. Energy Information Administration (EIA), the lighting control solutions based on different technologies have been proven to reduce the lighting energy consumption in commercial buildings by up to 70%. These solutions have been restricted in the past by cost, complexity, and applicability. However, new wireless technologies are providing ways to expand the capabilities of lighting control and offer them to a wider set of customers.

8.1.1.2.1 Office lighting

LED lighting provides appropriate lighting conditions at offices, instrumental in increasing workforce productivity and improving working conditions. On the other hand, improper lighting may cause personal injury including retinal fatigue caused by poor lighting and mental fatigue caused by intense light, display reflection, and other poor lighting designs. This factor is vital for modern office workers as at least 70% of them have to work in front of computer screens for more than 6 hours a day. Good lighting design based on the LED lighting concept not only enhances the efficiency of workers but also improves their overall productivity. Office lighting based on LED lighting technology ensures proper light sources and brightness, which in turn takes care of workers' physiological and psychological well-being.

8.1.1.2.2 Retail malls

Interactions between customers in the shopping mall and the merchandise are supported by mall equipment, sound system, and lighting. The design of mall lighting systems is done in a way to attract consumers as well as promote the attributes, values, and information related to the merchandise. These play a vital role in the overall spatial presentation of the mall. Different lighting arrangements and patterns are designed to showcase certain merchandise for certain sets of customers of different genders, ages, and incomes. All these lighting arrangements are designed to adapt to a variety of merchandise.

8.1.1.2.3 Hospitality

LED lighting systems in hotels are instrumental in attracting guests and making the customers feel comfortable in a bright environment. The focus of hotel management is currently on attracting an additional market share by appealing to diverse clientele which includes young travelers and tourists. Operational lighting requirements in hotels include front offices, restaurants, guest accommodations, entertainment venues, function/conference/seminar facilities, and architectural lighting.

8.1.1.3 Industrial

The industrial end users include factories, manufacturing units, warehouses, and many more. In industrial settings, safety is a primary concern and proper lighting and adequate illumination is a key factor in maintaining high worker productivity. The improper application of lighting can result in excessive lighting, leading to energy wastage. The industrial end users can save on lighting expenses and conserve energy by implementing controlled lighting using LED lighting systems.

8.1.1.3.1 Safety of workers in industrial areas

In industrial settings, safety is a primary concern and proper lighting and adequate illumination is essential to ensure proper functioning of production floors, storage units in warehouses, and overall workforce productivity. In many factories and warehouses, there is often round-the-clock illumination. Therefore, lighting is often a large consumer of energy besides process equipment. Improper lighting can result in huge amounts of energy wastage. Industrial lighting can help save lighting expenses and conserve energy by implementing controlled lighting using light switches and dimmers.

8.1.1.4 Others

8.1.1.4.1 Government and public buildings

Public and government buildings are an important application area among the other applications in the LED lighting market. As LED lighting projects for public and government buildings are funded by the government, the growth of this application is expected to be consistent as it would be given priority in every country.

Every lighting control project in public and government buildings requires specific solutions that are appropriate for the buildings. As different types of spaces in public and government buildings need different control strategies, many projects need multiple solutions to take full advantage of energy savings. Scheduling, occupancy, and daylight harvesting are the most prominent light control strategies used in these application areas. As the LED lighting projects for public and government buildings are funded by the government, these projects require adherence to a number of regulations including energy codes, sustainable building rating systems, and specific legislations according to different countries.

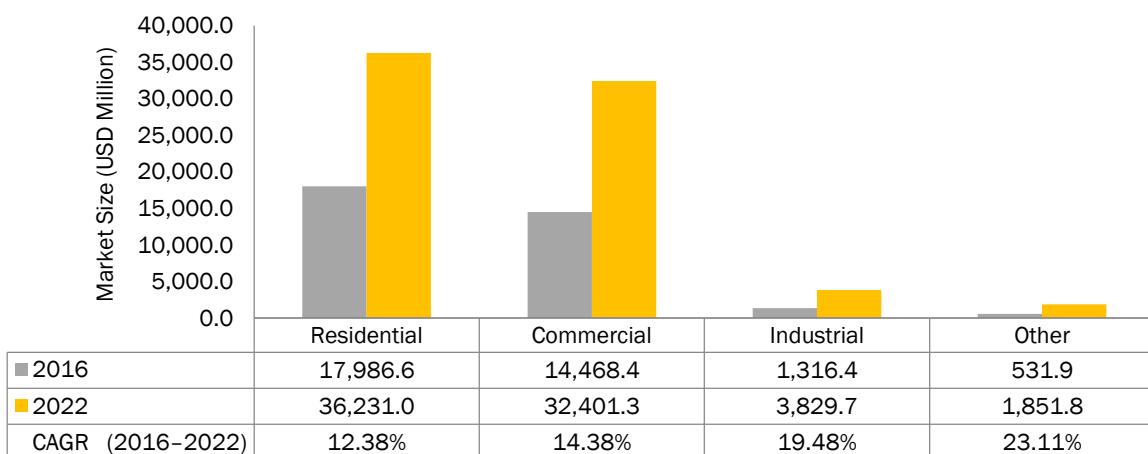
TABLE 18 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY TYPE, 2013–2022 (USD MILLION)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Residential	10,910.6	13,236.7	15,584.1	17,986.6	23,121.9	29,036.8	36,231.0	12.38%
Commercial	8,367.8	10,311.9	12,334.8	14,468.4	19,230.2	25,012.6	32,401.3	14.38%
Industrial	698.3	884.2	1,088.4	1,316.4	1,875.0	2,654.7	3,829.7	19.48%
Others	220.4	307.6	410.8	531.9	839.3	1,261.8	1,851.8	23.11%
Total	20,197.0	24,740.4	29,418.1	34,303.3	45,066.5	57,966.0	74,313.9	13.75%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market based on the indoor lighting end-use application was valued at USD 29,418.1 million in 2015 and is expected to reach USD 74,313.9 million by 2022, growing at a CAGR of 13.75% during the forecast period. The market for the residential application was valued at USD 15,584.1 million in 2015 and is expected to reach USD 36,231.0 million by 2022, growing at a CAGR of 12.38% during the forecast period. The market for other indoor lighting applications is expected to be valued at USD 1,851.8 million by 2022, growing at the highest CAGR of 23.11% during the forecast period. Increase in infrastructure-building activities, a large chunk of which is the residential sector, is the major factor contributing to the high growth of the residential indoor lighting end-use application.

FIGURE 35 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY TYPE (USD MILLION)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 19 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY TYPE, 2013–2022 (MILLION UNITS)

Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
Residential	1,647.8	2,103.1	2,607.0	3,174.4	4,585.7	6,583.5	9,599.4	20.25%
Commercial	389.2	504.4	634.8	784.9	1,169.1	1,730.8	2,602.4	22.11%
Industrial	50.8	69.9	93.0	121.1	198.2	319.0	517.1	27.37%
Others	16.3	25.5	37.4	52.8	97.7	172.0	298.5	33.46%
Total	2,104.1	2,702.8	3,372.2	4,133.3	6,050.8	8,805.2	13,017.4	21.07%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The indoor lighting end-use application of the LED lighting market based on type registered a shipment of 3,372.2 million units in 2015 and is expected to reach 13,017.4 million units by 2022, at a CAGR of 21.07% during the forecast period. The residential application registered the highest shipment of 2,607.0 million units in 2015 and is expected to reach 9,599.4 million units by 2022, at a CAGR of 20.25% during the forecast period. However, shipment for other indoor lighting applications is expected to reach 298.5 million units by 2022, at the highest CAGR of 33.46% during the forecast period. Industrial lighting is expected to experience high growth during the forecast period as LEDs can reduce lighting maintenance costs significantly, especially in high, hard-to-reach places (high-bay lighting), in an industrial workplace.

TABLE 20 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	4,364.8	5,338.7	6,333.9	7,288.7	9,124.8	11,296.2	14,134.7	11.67%
Europe	5,609.0	6,858.3	8,130.2	9,371.3	11,974.8	14,927.3	18,873.4	12.38%
APAC	8,297.8	10,093.9	12,078.7	14,038.2	18,919.7	25,085.7	32,163.9	14.82%
RoW	1,925.4	2,449.5	2,875.3	3,605.1	5,047.2	6,656.8	9,141.9	16.78%
Total	20,197.0	24,740.4	29,418.1	34,303.3	45,066.5	57,966.0	74,313.9	13.75%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the indoor lighting end-use application based on region was valued at USD 29,418.1 million in 2015 and is expected to reach USD 74,313.9 million by 2022, growing at a CAGR of 13.75% during the forecast period. The market in APAC was valued at USD 12,078.7 million in 2015 and is expected to reach USD 32,163.9 million by 2022, growing at a CAGR of 14.82% during the forecast period. The market in RoW is expected to be valued at USD 9,141.9 million by 2022, growing at the highest CAGR of 16.78% during the forecast period. The APAC region accounts for a large share of global construction investment, a significant portion of which would be invested in the lighting industry, especially in the indoor lighting sector.

TABLE 21 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY REGION, 2013–2022 (MILLION UNITS)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	454.7	583.2	726.1	878.2	1,225.1	1,715.9	2,475.9	18.86%
Europe	584.3	749.2	932.0	1,129.2	1,607.8	2,267.5	3,306.0	19.61%
APAC	864.4	1,102.7	1,384.6	1,691.5	2,540.2	3,810.6	5,634.1	22.21%
RoW	200.6	267.6	329.6	434.4	677.6	1,011.2	1,601.4	24.29%
Total	2,104.1	2,702.8	3,372.2	4,133.3	6,050.8	8,805.2	13,017.4	21.07%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The indoor lighting end-use application of the LED lighting market based on region registered a shipment of 3,372.2 million units in 2015 and is expected to reach 13,017.4 million units by 2022, at a CAGR of 21.07% during the forecast period. The APAC region registered the highest shipment of 1,384.6 million units in 2015 and is expected to reach 5,634.1 million units by 2022, at a CAGR of 22.21% during the forecast period. However, shipment for the RoW region is expected to reach 1,601.4 million units by 2022, at the highest CAGR of 24.29% during the forecast period.

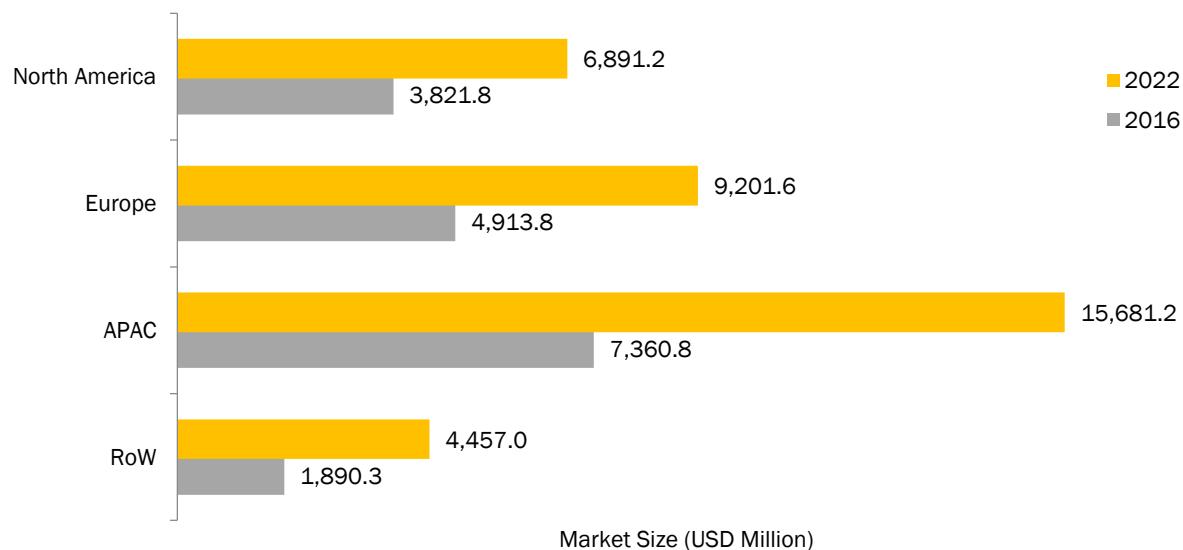
TABLE 22 LED LIGHTING MARKET FOR RESIDENTIAL INDOOR LIGHTING APPLICATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	2,357.9	2,856.3	3,355.3	3,821.8	4,681.6	5,658.6	6,891.2	10.32%
Europe	3,030.0	3,669.4	4,306.9	4,913.8	6,143.8	7,477.5	9,201.6	11.02%
APAC	4,482.6	5,400.5	6,398.6	7,360.8	9,707.0	12,566.1	15,681.2	13.43%
RoW	1,040.1	1,310.5	1,523.2	1,890.3	2,589.5	3,334.6	4,457.0	15.37%
Total	10,910.6	13,236.7	15,584.1	17,986.6	23,121.9	29,036.8	36,231.0	12.38%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the residential indoor lighting end-use application based on region was valued at USD 15,584.1 million in 2015 and is expected to reach USD 36,231.0 million by 2022, growing at a CAGR of 12.38% during the forecast period. The market in APAC was valued at USD 6,398.6 million in 2015 and is expected to reach USD 15,681.2 million by 2022, growing at a CAGR of 13.43% during the forecast period. The market in RoW is expected to be valued at USD 4,457.0 million by 2022, growing at the highest CAGR of 15.37% during the forecast period. Implementation of smart city projects in many countries of the APAC region such as India and China is the reason behind the dominance of this region in the LED lighting market for residential end-use application.

FIGURE 36 LED LIGHTING MARKET FOR RESIDENTIAL INDOOR LIGHTING APPLICATION, BY REGION (USD MILLION)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 23 LED LIGHTING MARKET FOR COMMERCIAL INDOOR LIGHTING APPLICATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	1,808.4	2,225.2	2,655.8	3,074.2	3,893.6	4,874.4	6,162.8	12.29%
Europe	2,323.8	2,858.6	3,409.0	3,952.6	5,109.7	6,441.2	8,228.9	13.00%
APAC	3,437.9	4,207.2	5,064.5	5,921.0	8,073.2	10,824.6	14,023.7	15.45%
RoW	797.7	1,021.0	1,205.6	1,520.6	2,153.7	2,872.5	3,985.9	17.42%
Total	8,367.8	10,311.9	12,334.8	14,468.4	19,230.2	25,012.6	32,401.3	14.38%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the commercial indoor lighting end-use application based on region was valued at USD 12,334.8 million in 2015 and is expected to reach USD 32,401.3 million by 2022, growing at a CAGR of 14.38% during the forecast period. The market in APAC was valued at USD 5,064.5 million in 2015 and is expected to reach USD 14,023.7 million by 2022, growing at a CAGR of 15.45% during the forecast period. The market in RoW is expected to be valued at USD 3,985.9 million by 2022, growing at the highest CAGR of 17.42% during the forecast period. The commercial sector comprising retail, offices, and hospitals is fast growing in the APAC region owing to the growing economic prosperity of the countries in this region. This is likely to fuel the demand for LED lighting in these industries, and it is the main reason why APAC is expected to experience high growth.

TABLE 24 LED LIGHTING MARKET FOR INDUSTRIAL INDOOR LIGHTING APPLICATION, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	150.9	190.8	234.3	279.7	379.6	517.3	728.4	17.30%
Europe	193.9	245.1	300.8	359.6	498.2	683.6	972.6	18.04%
APAC	286.9	360.7	446.9	538.7	787.2	1,148.9	1,657.5	20.60%
RoW	66.6	87.5	106.4	138.3	210.0	304.9	471.1	22.66%
Total	698.3	884.2	1,088.4	1,316.4	1,875.0	2,654.7	3,829.7	19.48%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the industrial indoor lighting end-use application based on region was valued at USD 1,088.4 million in 2015 and is expected to reach USD 3,829.7 million by 2022, growing at a CAGR of 19.48% during the forecast period. The market in APAC was valued at USD 446.9 million in 2015 and is expected to reach USD 1,657.5 million by 2022, growing at a CAGR of 20.60% during the forecast period. The market in RoW is expected to be valued at USD 471.1 million by 2022, growing at the highest CAGR of 22.66% during the forecast period. The APAC region is one of the largest manufacturing hubs in the world, mostly dominated by the developing economies such as China and India, as well as the developed economies of South Korea and Japan. The industrial places of these countries are implementing LED lighting for long-term benefits as well as to cut energy costs.

TABLE 25 LED LIGHTING MARKET FOR OTHER INDOOR LIGHTING APPLICATIONS, BY REGION, 2013–2022 (USD MILLION)

Region	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
North America	47.6	66.4	88.4	113.0	169.9	245.9	352.2	20.86%
Europe	61.2	85.3	113.5	145.3	223.0	324.9	470.3	21.62%
APAC	90.5	125.5	168.7	217.7	352.3	546.1	801.5	24.26%
RoW	21.0	30.5	40.2	55.9	94.0	144.9	227.8	26.38%
Total	220.4	307.6	410.8	531.9	839.3	1,261.8	1,851.8	23.11%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for other indoor lighting end-use applications based on region was valued at USD 410.8 million in 2015 and is expected to reach USD 1,851.8 million by 2022, growing at a CAGR of 23.11% during the forecast period. The market in APAC was valued at USD 168.7 million in 2015 and is expected to reach USD 801.5 million by 2022, growing at a CAGR of 24.26% during the forecast period. The market in RoW is expected to be valued at USD 227.8 million by 2022, growing at the highest CAGR of 26.38% during the forecast period.

TABLE 26 LED LIGHTING MARKET FOR INDOOR LIGHTING APPLICATION, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	15,074.8	18,095.8	21,110.1	24,137.2	30,316.2	36,822.6	43,864.9	10.47%
Retrofit Installation	5,122.2	6,644.5	8,308.0	10,166.1	14,750.2	21,143.4	30,448.9	20.06%
Total	20,197.0	24,740.4	29,418.1	34,303.3	45,066.5	57,966.0	74,313.9	13.75%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for indoor lighting end-use application based on installation type was valued at USD 29,418.1 million in 2015 and is expected to reach USD 74,313.9 million by 2022, growing at a CAGR of 13.75% during the forecast period. The market for new installation was valued at USD 21,110.1 million in 2015 and is expected to reach USD 43,864.9 million by 2022, growing at a CAGR of 10.47% during the forecast period. The market for retrofit installation is expected to be valued at USD 30,448.9 million by 2022, growing at the highest CAGR of 20.06% during the forecast period. Retrofit installation is expected to witness high growth as all the traditional light sources are being retrofitted with LED lamps and luminaires compared to new installation of LED lamps and luminaires.

TABLE 27 LED LIGHTING MARKET FOR RESIDENTIAL INDOOR LIGHTING APPLICATION, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	8,175.4	9,728.4	11,248.4	12,745.6	15,714.0	18,722.8	21,863.0	9.41%
Retrofit Installation	2,735.2	3,508.4	4,335.6	5,241.0	7,407.9	10,314.0	14,368.0	18.30%
Total	10,910.6	13,236.7	15,584.1	17,986.6	23,121.9	29,036.8	36,231.0	12.38%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the residential indoor lighting end-use application based on installation type was valued at USD 15,584.1 million in 2015 and is expected to reach USD 36,231.0 million by 2022, growing at a CAGR of 12.38% during the forecast period. The market for new installation was valued at USD 11,248.4 million in 2015 and is expected to reach USD 21,863.0 million by 2022, growing at a CAGR of 9.41% during the forecast period. The market for retrofit installation is expected to be valued at USD 14,368.0 million by 2022, growing at the highest CAGR of 18.30% during the forecast period. The new installation segment is expected to dominate the residential sector as it is more economically feasible for the civilian population to install completely new LED fixtures with a longer operating life instead of partially retrofitting old incandescent lamps with LED lamps.

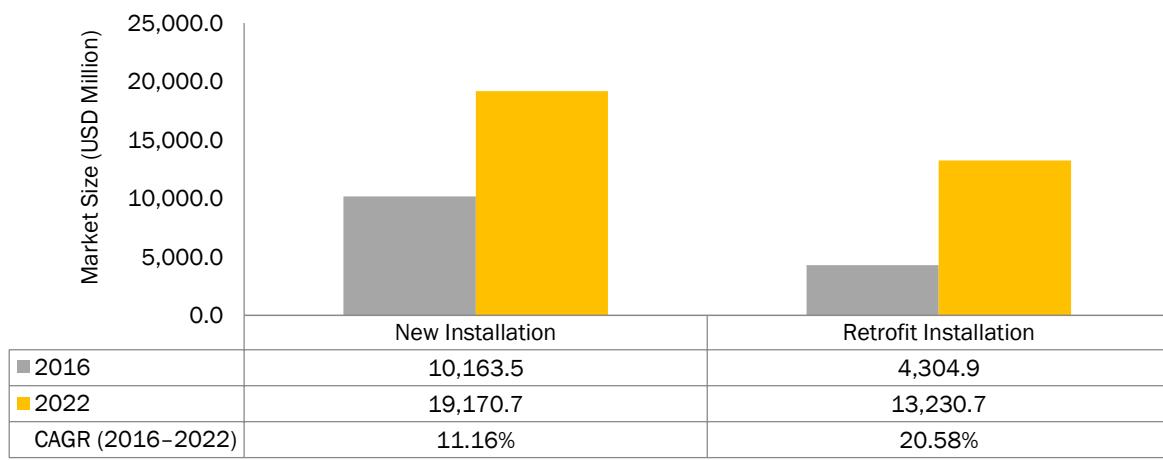
TABLE 28 LED LIGHTING MARKET FOR COMMERCIAL INDOOR LIGHTING APPLICATION, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	6,232.3	7,527.0	8,834.6	10,163.5	12,923.7	15,893.2	19,170.7	11.16%
Retrofit Installation	2,135.5	2,784.9	3,500.2	4,304.9	6,306.5	9,119.4	13,230.7	20.58%
Total	8,367.8	10,311.9	12,334.8	14,468.4	19,230.2	25,012.6	32,401.3	14.38%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the commercial indoor lighting end-use application based on installation type was valued at USD 12,334.8 million in 2015 and is expected to reach USD 32,401.3 million by 2022, growing at a CAGR of 14.38% during the forecast period. The market for new installation was valued at USD 8,834.6 million in 2015 and is expected to reach USD 19,170.7 million by 2022, growing at a CAGR of 11.16% during the forecast period. The market for retrofit installation is expected to be valued at USD 13,230.7 million by 2022, growing at the highest CAGR of 20.58% during the forecast period.

FIGURE 37 LED LIGHTING MARKET FOR COMMERCIAL INDOOR LIGHTING APPLICATION, BY INSTALLATION TYPE (USD MILLION)



Source: Industry Journals, Experts' Interviews, and MarketsandMarkets Analysis

TABLE 29 LED LIGHTING MARKET FOR INDUSTRIAL INDOOR LIGHTING APPLICATION, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	503.7	617.0	734.1	855.9	1,116.4	1,406.6	1,736.1	12.51%
Retrofit Installation	194.6	267.2	354.3	460.5	758.6	1,248.2	2,093.6	28.71%
Total	698.3	884.2	1,088.4	1,316.4	1,875.0	2,654.7	3,829.7	19.48%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for the industrial indoor lighting end-use application based on installation type was valued at USD 1,088.4 million in 2015 and is expected to reach USD 3,829.7 million by 2022, growing at a CAGR of 19.48% during the forecast period. The market for new installation was valued at USD 734.1 million in 2015 and is expected to reach USD 1,736.1 million by 2022, growing at a CAGR of 12.51% during the forecast period. The market for retrofit installation is expected to be valued at USD 2,093.6 million by 2022, growing at the highest CAGR of 28.71% during the forecast period.

TABLE 30 LED LIGHTING MARKET FOR OTHER INDOOR LIGHTING APPLICATIONS, BY INSTALLATION TYPE, 2013–2022 (USD MILLION)

Installation Type	2013	2014	2015	2016	2018	2020	2022	CAGR (2016–2022)
New Installation	163.4	223.5	293.0	372.2	562.2	800.0	1,095.1	19.71%
Retrofit Installation	57.0	84.0	117.8	159.8	277.1	461.8	756.7	29.59%
Total	220.4	307.6	410.8	531.9	839.3	1,261.8	1,851.8	23.11%

Source: Experts' Interviews, Secondary Research, and MarketsandMarkets Analysis

The LED lighting market for other indoor lighting end-use applications based on installation type was valued at USD 410.8 million in 2015 and is expected to reach USD 1,851.8 million by 2022, growing at a CAGR of 23.11% during the forecast period. The market for new installation was valued at USD 293.0 million in 2015 and is expected to reach USD 1,095.1 million by 2022, growing at a CAGR of 19.71% during the forecast period. The market for retrofit installation is expected to be valued at USD 756.7 million by 2022, growing at the highest CAGR of 29.59% during the forecast period.

8.1.2 OUTDOOR LIGHTING

The LED lighting market for the outdoor lighting application has been segmented into highway and roadway, architectural, public places such as stadiums and parks, and others such as harbors.

8.1.2.1 Highway and roadway

Street and traffic lights are the major end users of LED lights. As most lights for street and traffic lighting are funded by the government, the growth of this application is expected to be consistent as it would be given priority in most countries.

8.1.2.1.1 Different lighting controls for different types of roads, bridges, and tunnels

Every lighting control project in street lights requires specific solutions that are suitable for a particular road. As different types of roads such as streets, main roads, and highways need different control strategies, many projects need multiple solutions to take full advantage of energy savings. Scheduling,