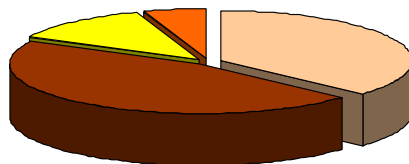


ANNOUNCEMENT

Human Centric Lighting Global Market Forecast 2018-2028

10-year global market forecast of modules/devices in LED-based
Human Centric Lighting



Market Study Release Date: January 29, 2019



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Study Release: January 29, 2019
PDF File: 319 pages
Excel File: Detailed Market Forecast Data Tables
Fee: USD 4240 (Single User License)
Delivery: PDF File sent by E-mail

Human Centric Lighting, also sometimes referred to as Biodynamic Light or Circadian Lighting, is the next development stage in the evolution of lighting and luminaire design; this report provides estimates and forecasts, based on market research study work performed by ElectroniCast Consultants.

Human Centric Lighting (HCL) is aimed to mimic (closely imitate) the natural color of daylight, which stimulates the production of melatonin and serotonin which control the physical, mental and behavioral changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in a person, or their circadian rhythm.

The module/device hardware covered in this study are used for stationary/fixed locations (non-vehicle or non-portable) solid-state general lighting applications.

The market data are segmented into the following regions; separate data-sections are provided for the following regions:

- Global
 - America
 - U.S.A.
 - Rest of America
 - Europe, Middle East, Africa (EMEA)
 - Asia Pacific (APAC)

Market Forecast by HCL Product Hardware for Solid-State Lighting

ElectroniCast provides this market forecast for product hardware that are initially and primarily used with Human Centric Lighting as the primary objective and initial consideration, as detailed in Table 1.

Light Engines A light engine is the LED equivalent of a conventional lamp. It normally consists of a LED chip mounted on a circuit board that has electrical and mechanical fixings, meaning it is ready to be fixed in the luminaire. Note that the light engine may not consist of only one chip; it may be an array of several chips, sometimes with a phosphor coating. ElectroniCast includes the following in the Light Engine category: driver, array, and power supply; however, excludes external wiring harnesses.

Light Engine Driver segmentation –

DALI Driver Control Interface - Digital Addressable Lighting Interface (DALI) is a trademark for network-based systems that control lighting in building automation. The underlying technology was established by a consortium of lighting equipment manufacturers as a successor for 0-10 V lighting control systems, and as an open standard alternative to Digital Signal Interface (DSI), on which it is based. DALI is specified by technical standards.

DMX Driver Control Interface - (Digital Multiplex) is a standard for digital communication networks. It was originally intended as a standardized method for controlling light dimmers, which, prior to DMX512, had employed various incompatible proprietary protocols.

Other or Proprietary – Other control interface units, which are not DALI or DMX-based.

Lighting Management

Sensors - Typically, lighting control sensors features include motion detection, light-level detection and IR receive (remote controlling). Each of these features can be operated at the same time, allowing automation scenarios such as turning on the lights after detecting motion and then dimming the lighting level once the available sunlight has been measured, thereby providing additional energy savings.

Color Control, Digital Dimming and Switches Control Units – These control capabilities are provided in separate stand-alone or combined units.

Table 1
Human Centric Lighting Product Categories

- Light Engine / Lamp – Module
- Lighting Management - Modules / Devices (DALI / DMX / Other)
 - Control Units / Dimming / Switches
 - Standalone / Luminaire LED Driver Modules
 - Standalone Sensors / Other

Note: Software is discussed in this report; however, software values are not counted in the market data

Market Forecast, By Function

This report provides the 2018-2028 market data review and forecast by the following functions:

- Consumption Value (US\$, million)
- Quantity (number/units)
- Average Selling Prices (ASP \$, per unit)

The consumption (use) value is determined by multiplying the number of lighting units by the average selling price (ASP) in US Dollars. The average selling prices are not retail prices; the prices are based on the price of the product at the initial factory level. These are the original manufacturer's ("factory") prices invoiced to the first (original) customer, or transfer prices for internal (captive) production.

Market Forecast by Applications:

- Offices
- Hospitality and Healthcare
- Shopping / Stores
- Education / Others

Competitive Analysis

- Company profiles and product examples of selected competitors
- Market Share Estimates of leaders in HCL (\$ Million, Year 2018)

Market Research Methodology

Market analysis and technology forecasting are complex tasks. Any predictions of the shape and trends of technology and economic movement start from the notion that the germ of what will be important tomorrow is present, although smaller or larger or in a different form, in our environment today. However, taking as a basis for a prediction the assumptions of current, conventional belief creates a set of preconceived notions that can lead to serious mistakes. ElectroniCast, instead, looks to the basic driving forces.

The future market for the use of a particular type of Human Centric Lighting solutions depends on a number of factors, including: User equipment demand, for example – applications: intelligent/smart buildings, retail store/shopping and hospitality, as well as schools/education and others to push market demand. Also, energy efficiency requirements and government regulations/laws/mandates/low carbon footprint, future-proofing (design and in technology), economy and investment community, product life cycles, competing technologies/solutions, cost/benefit ratios, requirements driven by Internet of Things (IoT), intelligent/digital building lighting controls, and others. Additionally, environment and awareness of health and alertness benefits in HCL, mood lighting, and other smart lighting solutions.

Information Base This study is based on analysis of information obtained continually since 2002 through our research regarding LED lighting solutions, but updated through the middle of January 2019 – specifically addressing the solid-state lighting (SSL) Human Centric Lighting (HCL) market attractiveness. During this period, ElectroniCast analysts performs interviews with authoritative and representative individuals in the LED manufacturing (materials, chips, packaging, devices, associated parts/pieces, fittings/ fixtures - luminaires) and building/facility management, local/state and federal government policy and management, LED driver IC and micro-controllers, product distributors, building management, import/export, and other. The interviews were conducted principally with:

- Engineers, marketing personnel and management at manufacturers of LEDs (chips, packaged LEDs, lamps, fixtures/luminaires, controls, systems) as well as other technologies.
- Design group leaders, engineers, marketing personnel and market planners at major users and potential users of Human Centric Lighting solutions.
- Other industry experts, including those focused with standards activities, trade associations, and investments.

The interviews covered issues of technology, R&D support, pricing, contract size, reliability, documentation, installation/maintenance crafts, standards, supplier competition and other topics.

Customers and distributors also were interviewed, to obtain their estimates of quantities received and average prices paid. Customer estimates of historical and expected near term future growth of their application are obtained. Their views of use of new technology products were obtained.

At ElectroniCast, analysts then considered customer expectations of near-term growth in their application, plus forecasted economic payback of investment, technology trends and changes in government regulations, to derive estimated growth rates of quantity and price of each product subset in each application. These forecasted growth rates are combined with the estimated baseline data to obtain the long-range forecasts at the lowest detailed level of each product and application.

A full review of published information was also performed to supplement information obtained through interviews. The following sources were reviewed:

- Professional technical journals and papers
- Trade press articles
- Technical conference proceedings
- Product literature
- Company profile and financial information
- Additional information based on previous ElectroniCast market studies
- Personal knowledge of the research team.

In analyzing and forecasting the complexities of the regional markets for light emitting diode products, it is essential that the market research team have a good and a deep understanding of the technology and of the industry. ElectroniCast members who participated in this report were qualified.

Cross-Correlation Increases Accuracy The quantities of packaged LEDs, LED Driver ICs, LED materials/wafer/die/chips, LED Lamps and LED fixtures (luminaire) and other LED-based components, manufacturing processes/quality control/yields, and end-use products used in a particular application are interrelated. Since ElectroniCast conducts annual analysis and forecast updates in each LED component field, accurate current quantity estimates are part of the corporate database. These quantities are cross-correlated as a "sanity check".

ElectroniCast has conducted extensive research and updated their forecasts of several LED lighting categories. As technology and applications have advanced, the number of component subsets covered by the forecasts has expanded impressively.

The calculation and analysis data spreadsheet technique is based upon input/output analysis, leveraging the quantitative consumption quantity, price and value of each item in each application at all levels to achieve reasonable quantitative conclusions; this interactive analysis concept, first applied on a major scale by Leonteff, of the US Department of Commerce, in the mid-1950s, was then adopted successfully by analyst/forecasting firms Quantum Science, Gnostic Concepts and (in 1981) by ElectroniCast.

Nature of the Data This report provides the consumption value, quantity and prices of SSL-based modules/devices, which are used in various settings (end-user locations – applications) - worldwide. The following details are important in interpreting the data presented in the study results/report:

- Significant figures - rounding: The data have been rounded to an appropriate number of decimal places. In some instances, this may result in minor apparent inconsistencies at summary levels.
- Current dollars: All values in the Market Analysis and Forecast are expressed in current US dollars. Therefore, growth rates and forecasted values include inflation, forecasted to average 5 percent per year.

The quantitative forecasts and value calculations for the SSL (currently LEDs, but eventually OLEDs may play a role) lighting modules/devices, as well as studying average selling price market data and trends.

Global Market Forecast proceeded as follows:

- 1) The values for each year were based on known raw data or calculated by formulae at the lowest data entry levels. The resulting values were summed by formulae to successively higher levels data.
- 2) With the value forecasted for each track module/device used for HCL applications, average annual growth rates for 2018-2023 and 2023-2028 were then calculated from the forecasted data.
- 3) For each module/device category, analysis was performed and breakdowns were forecasted for (geographical) regional consumption percentages for each year of the forecast.

Consumption Value: The consumption value of Human Centric Lighting (HCL) modules/devices is determined by the final application (“end-use”) and ownership of that product. For example, a standalone LED Driver is produced in Europe and is then shipped to the United States and then used in the United States, will be shown in the database as a LED Lamp consumed (used) in the U.S.A. (not Europe).

Inventory Change The change in the monetary value of the inventory between two different accounting periods. The forecasting models predict this change rather than the absolute magnitudes of the inventory levels. Normally, this is the most volatile of all of the adjustments, and has several components: parts, work-in-process, finished goods, pipeline, and imported subassembly.

R&D (Research and Development) Noncapitalized labor, which is used for research, design engineering, manufacturing development, and start-up, costs of new production lines. It does not include capital equipment and associated setup costs, marketing support, or normal production support. It does include expense incurred while prototyping and developing a new process or production line.

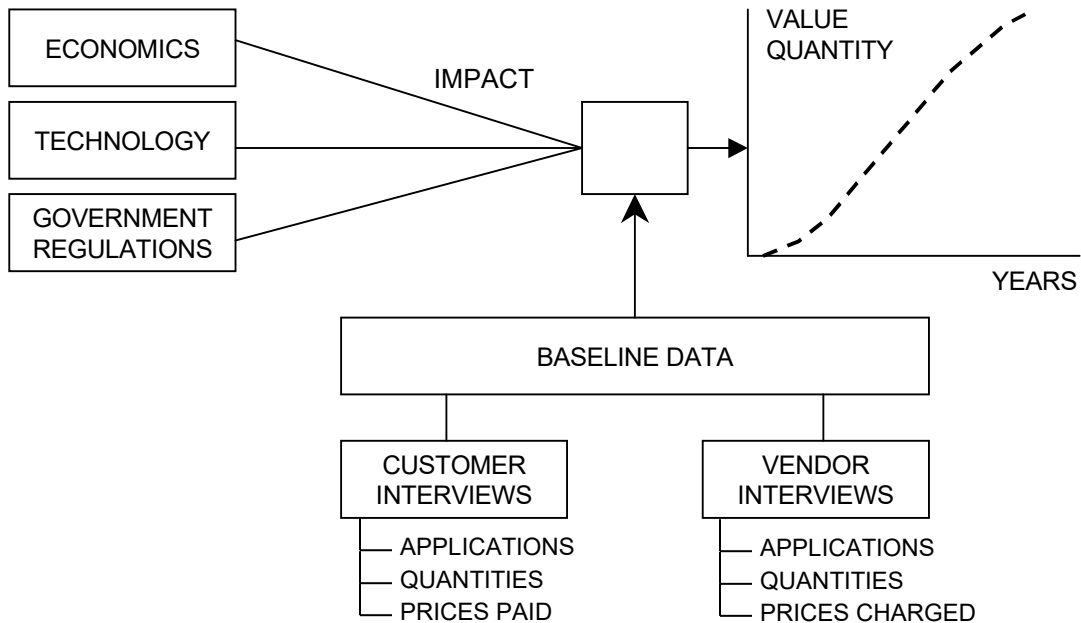
Forecast Lighting Demand Growth Based on primary research (interviews and evaluations) with engineers and product planners, ElectroniCast can see ideas and then (eventually) concepts about 3-7 years before innovation solutions (products) are announced in the public domain. Once we feel confident that these ideas and concepts will become innovative solutions (new products), we set anticipated usage into the market forecast. Therefore, as we are looking as several years, many of the future products may not even be at the idea-stage yet. It is also important to note that ElectroniCast, in effect, forecast lighting demand growth, which will drive demand for increased capability/capacity SSL-based (solid-state lighting) components, modules/devices, fixtures (luminaire), and systems; therefore, we have expertise of what to look for.

Yes, the forecast will most likely change over the 10-year forecast period, as “sure-bet” products “flop” and innovation solutions enter the arena. ElectroniCast analysts have extensive experience at searching for and finding-out about these ideas-concepts-innovations and evaluating them.

Bottom-up Methodology ElectroniCast forecasts, as illustrated in the forecast data structure, are developed initially at the lowest detail level, then summed to successively higher levels. The background market research focuses on the estimated quantity of each HCL module/device of product used in the base year (2018), and the prices paid at the first transaction from the manufacturer. This forms the base year data.

ElectroniCast analysts then forecast the growth rates in component quantity use in each application, along with price trends, based on competitive, economic and technology forecast trends, and apply these to derive long term forecasts at the lowest application levels. The usage growth rate forecasts depend heavily on analysis of overall end user trends toward equipment usage and economic payback. Figure 1 further illustrates the research methodology regarding this study.

Figure 1
ElectroniCast Market Research & Forecasting Methodology



About ElectroniCast

Founded in the San Francisco Bay-Area in 1981, ElectroniCast was the first market research firm to specialize and provide detailed study reports forecasting technology and global market trends in various optical fiber communication components and devices. In 1999, ElectroniCast added market data on light emitting diodes (LEDs) used in lighting applications to our market/technology study portfolio.

As an independent consultancy we offer multi-client and custom market research studies to the world's leading companies based on comprehensive, in- depth analysis of quantitative and qualitative factors. This includes technology forecasting, markets and applications forecasting, strategic planning, competitive analysis, customer-satisfaction surveys, due diligence analysis and marketing/sales consultation. ElectroniCast, founded as a technology-based independent consulting firm, meets the information needs of the investment community, industry planners and related suppliers.

Proprietary Statement

All data and other information contained in this data base are proprietary to ElectroniCast and may not be distributed or provided in either original or reproduced form to anyone outside the client's internal employee organization, without prior written permission of ElectroniCast.

ElectroniCast, in addition to multiple-client programs, conducts proprietary custom studies for single clients in all areas of management planning and interest. Other independent consultants, therefore, are considered directly competitive. ElectroniCast proprietary information may not be provided to such consultants without written permission from ElectroniCast Consultants.

– Human Centric Lighting (HCL) –

– Tables of Contents –

1.	Executive Summary	1-1
1.1	Overview	1-1
1.2	Human Centric Lighting Product Examples	1-15
1.3	Technology Research Summaries – Human Centric Lighting	1-35
1.4	Software Considerations for Human Centric Lighting	1-62
2.	Global Market Forecast - Human Centric Lighting	2-1
2.1	Overview	2-1
2.2	America Market Forecast (USA and Rest of America)	2-15
2.3	EMEA Market Forecast	2-23
2.4	APAC Market Forecast	2-31
3.	LED Lighting: Competitive Analysis/Market Opportunity Analysis	3-1
3.1	Overview	3-1
	Market Opportunity Analysis – Market Dynamics	
	Market Opportunity/Sales Channels	
3.2	Company Profiles – General Lighting	
	A-Bright Incorporated	3-6
	AbstractAVR	3-7
	Acuity Brands Lighting, Inc. (ABL)	3-8
	AFX, Inc.	3-10
	ALPHABET Lighting (Ledra Brands, Inc.)	3-11
	American Bright Optoelectronics Corp.	3-12
	Amerlux, LLC.	3-13
	ams AG	3-14
	Analog Devices, Inc.	3-15
	Arduino	3-17
	Asia Unique LED Lighting Co., Ltd.	3-18
	Aurora Ltd.	3-19
	Bajaj Electricals Limited (BEL)	3-20
	Bridgelux, Inc.	3-21
	Citizen Electronics Company, Limited	3-22
	Cisco Systems Inc.	3-23
	CITYLUM	3-24
	CLARUS Korea/CLARUS UK (Jungho Group)	3-26
	Cree, Inc. (Cree LED Lighting - Cree Bulb)	3-27
	Crestron Electronics, Inc.	3-31
	Derungs Licht AG (the Waldmann Group)	3-32
	Dialight	3-33
	Dialog Semiconductor	3-34
	Display Lighting Ltd.	3-35
	Dow Corning Electronics (Dow)	3-37
	Eaton Corporation plc (Cooper Lighting)	3-40
	EcoSense Lighting	3-43
	Epistar Corporation	3-45
	ESYLUX GmbH	3-46
	Everlight Electronics Company Limited	3-47
	Fagerhult (AB Fagerhult)	3-48

Feit Electric	3-49
Finetechnix Company, Ltd. (Fine Group)	3-50
Flex LTD.	3-51
Fulham Company, Inc.	3-52
General Electric Company (GE) / Current	3-54
GlacialLight Inc.	3-59
Glamox	3-60
Green Creative (Harbour Group)	3-61
GuangZhou Lovely Lighting Co., Ltd	3-62
Harvatek International	3-63
Helvar	3-64
High Power Lighting Corp. (HPLighting)	3-67
Horner Lighting Group (Horner APG, LLC.)	3-68
Hubbell Lighting Inc.	3-69
Integrated Device Technology, Inc.	3-77
Illumitex Incorporated	3-78
Independence LED Lighting, LLC	3-79
Infineon Technologies AG	3-80
Intelligent LED Solutions (ILS) – Intelligent Group Solutions Ltd (IGS)	3-86
Intematix Corporation	3-87
JESCO Lighting	3-89
Johnson Controls	3-90
Kenall Manufacturing Company	3-92
KKDC	3-93
L&S LED Company	3-94
LED-LS (Latin America)	3-95
LEDMOTIVE	3-96
LEDtronics®	3-97
LEDVANCE GmbH - MLS Co., LTD. (MLS)	3-98
Legrand S.A.	3-101
LEISO Lighting (DongGuan) Tech., Ltd.	3-105
Leviton Manufacturing Company / ConTech Lighting / Intense Lighting	3-106
Lextar Electronics (AU Optronics)	3-108
LF Illumination, LLC	3-109
LG Innotek	3-110
Light Corporation Group	3-113
Lighting Science	3-114
Liton Lighting	3-116
LSI Industries Inc.	3-117
Luming Technology Group Co., Ltd.	3-119
Luminus Devices	3-120
LUMITECH Produktion und Entwicklung GmbH (LUMITECH)	3-122
Lutron Electronics Co., Inc.	3-124
Marvell (Marvell Technology Group Ltd; Marvell Semiconductor, Inc)	3-125
MAXIC Technology Corporation	3-126
MEAN WELL Enterprises Co., Ltd.	3-127
Microchip Technology Inc.	3-128
Molex LLC	3-132
Navray Korea Company, Ltd.	3-133
NexLight (Northport Engineering Group)	3-134
Nichia Corporation	3-135
Nualight	3-137
Oktalite Lichttechnik GmbH (TRILUX GmbH & Co. KG)	3-138
ON Semiconductor	3-139
OPPLE - Latin America	3-140

	OSRAM (OSRAM Sylvania Inc.)	3-141
	Panasonic Corporation / Universal Lighting Technologies	3-148
	Philips - Signify Holding	3-151
	Power Integrations™	3-156
	Regiolux GmbH	3-157
	Renesas Electronics Corporation	3-158
	Revolution Lighting Technologies, Inc. (TNT Energy)	3-160
	Richtek Technology Corporation	3-162
	ROHM Company, Ltd.	3-163
	Samjin Company, Ltd.	3-165
	Samsung Electronics Co., Ltd	3-166
	Sanken Electric Co., Ltd. (Allegro MicroSystems)	3-169
	SemiLEDs Corporation	3-170
	Senslite Corporation	3-173
	Seoul Semiconductor	3-174
	Sharp Microelectronics, Sharp Devices	3-179
	Sheenly Lighting Co. Ltd	3-181
	Silergy Corporation	3-182
	STG Aerospace Limited	3-183
	STMicroelectronics	3-184
	Targetti Sankey S.p.A.	3-185
	Tech Lighting (Generation Brands)	3-186
	TE Connectivity	3-187
	Texas Instruments Incorporated	3-188
	Thorn Lighting (Zumtobel Group)	3-189
	Toshiba Materials Company, Ltd.	3-190
	WAC Lighting	3-192
	Zencontrol	3-193
3.3	Competitor Global Market Share (2018) HCL Modules/Devices	3-195
4.	ElectroniCast Market Research Methodology	4-1
5.	Human Centric Lighting Market Forecast Data Base (Explanation: Excel worksheets)	5-1

Addendum – Microsoft Excel File

– Human Centric Lighting (HCL) –

– List of Tables –

1.1.1	Human Centric Lighting Product Categories	1-4
1.1.2	Modules/Devices in HCL Global Forecast, by Region (\$ Million)	1-9
1.1.3	Modules/Devices in HCL Global Forecast, by Major Product Type (\$ Million)	1-10
1.1.3	Modules/Devices in HCL Global Forecast, by Application (\$ Million)	1-14
1.3.1	LED Color Variety – Selected Examples	1-59
1.3.2	LED Color Chart	1-61
2.1.1	Modules/Devices in HCL Global Forecast, by Major Product Type (\$ Million)	2-9
2.1.2	Modules/Devices in HCL Global Forecast, by Major Product Type (Quantity/Units)	2-10
2.1.3	Modules/Devices in HCL – Lighting Management Products Global Forecast (\$Million)	2-11
2.1.4	Modules/Devices in HCL – Lighting Management Products Global Forecast (Quantity)	2-12
2.1.5	Modules/Devices in HCL – Global Forecast, by Application (\$Million)	2-14
2.1.6	Modules/Devices in HCL – Global Forecast, by Application (Quantity/Units, Million)	2-14
2.2.1	SSL-Based HCL – America Region Forecast (USA and “Rest of America”) (\$Million)	2-15
2.2.2	Modules/Devices in HCL America Region Forecast, by Major Product Type (\$ Million)	2-16
2.2.3	Modules/Devices in HCL America Forecast, by Major Product Type (Quantity/Units)	2-17
2.2.4	Modules/Devices in HCL – Lighting Management Products America Forecast (\$Million)	2-18
2.2.5	Modules/Devices in HCL – Lighting Management Products America Forecast (Quantity)	2-19
2.2.6	Modules/Devices in HCL – America Forecast, by Application (\$Million)	2-20
2.2.7	Modules/Devices in HCL – America Forecast, by Application (Quantity/Units, Million)	2-21
2.3.1	Modules/Devices in HCL EMEA Forecast, by Major Product Type (\$ Million)	2-25
2.3.2	Modules/Devices in HCL EMEA Forecast, by Major Product Type (Quantity/Units)	2-26
2.3.3	Modules/Devices in HCL – Lighting Management Products EMEA Forecast (\$Million)	2-27
2.3.4	Modules/Devices in HCL – Lighting Management Products EMEA Forecast (Quantity)	2-28
2.3.5	Modules/Devices in HCL – EMEA Forecast, by Application (\$Million)	2-30
2.3.6	Modules/Devices in HCL – EMEA Forecast, by Application (Quantity/Units, Million)	2-30
2.4.1	Modules/Devices in HCL APAC Forecast, by Major Product Type (\$ Million)	2-38
2.4.2	Modules/Devices in HCL APAC Forecast, by Major Product Type (Quantity/Units)	2-39
2.4.3	Modules/Devices in HCL – Lighting Management Products APAC Forecast (\$Million)	2-40
2.4.4	Modules/Devices in HCL – Lighting Management Products APAC Forecast (Quantity)	2-41
2.4.5	Modules/Devices in HCL – APAC Forecast, by Application (\$Million)	2-43
2.4.6	Modules/Devices in HCL – APAC Forecast, by Application (Quantity/Units, Million)	2-43
5.1	Human Centric Lighting Product Categories	5-1
5.2	Human Centric Lighting Application Categories	5-2

– Human Centric Lighting (HCL) –

– List of Figures –

1.1.1	Product Life Cycle	1-4
1.1.2	Evolution of Research Emphasis during Technology Life Cycle	1-5
1.1.3	Modules/Devices in HCL Global Forecast, by Region (\$ Billion)	1-8
1.2.1	LED DALI Driver used in Human Centric Lighting	1-16
1.2.2	LED DALI Driver used in Human Centric Lighting	1-17
1.2.3	LED Light Engine and DMX Control used in Human Centric Lighting	1-18
1.2.4	2-Channel LED Light Engine and DALI Controllers used in Human Centric Lighting	1-19
1.2.5	LED Light Engine, DALI Controllers, Sensors and Touch-panels used in HCL	1-20
1.2.6	Spectrally Tunable LED Modules	1-21
1.2.7	10-Channel Spectrally Tunable LED Modules	1-22
1.2.8	Recessed LED light fixture for drop ceilings (Panel Modules)	1-23
1.2.9	Circadian PAR30 Gimbal Spot	1-25
1.2.10	External Control Module for Luminaires	1-27
1.2.11	Intelligent Lighting Control Network	1-28
1.2.12	Room Controller	1-29
1.2.13	Network Bridge Module	1-30
1.2.14	Specialty Switches	1-31
1.2.15	Color Control Preset Switch	1-32
1.2.16	Occupancy/Vacancy Sensors	1-33
1.2.17	Daylight Sensor	1-34
1.3.1	Lobby of Building	1-42
1.3.2	Controlling Dimming and Correlated Color Temperature (CCT) Levels	1-53
1.3.3	Circadian Phototransduction	1-55
1.3.4	Circadian Phototransduction	1-56
1.3.5	Risk Classification (Safety Limits)	1-57
1.3.6	LED Chromatic Chart	1-60
2.1.1	Incandescent Ban - Global Map	2-6
2.2.1	SSL-Based HCL America Region Forecast, (USA and “Rest of America”) (\$Million)	2-12
2.3.1	SSL-Based HCL EMEA Region (\$Million)	2-24
2.4.1	SSL-Based HCL APAC Region (\$Million)	2-37
3.2.1	LED Track Head	3-10
3.2.2	Downlight	3-13
3.2.3	Smart Lighting System	3-16
3.2.4	Tunable-white controller for use with LED power supply	3-25
3.2.5	High Current LED Array	3-28
3.2.6	High Efficacy LED	3-29
3.2.7	Light Engine	3-30
3.2.8	240V LED Display Case Lighting System	3-36
3.2.9	Silicone Encapsulant and Silicone Lens in LEDs	3-39
3.2.10	Wireless Area Controller	3-41
3.2.11	LED Lighting Fixture	3-42
3.2.12	Mounting Track and Light Fixture	3-44
3.2.13	Input unit DALI PCU – compact power control unit	3-48
3.2.14	LED Product Area and Capability	3-50
3.2.15	integrated driver with wireless, cloud-based IoT management and controls	3-53
3.2.16	Lighting Control Sensor	3-56
3.2.17	Human Centric Lighting – Typical Distributed Intelligence Network Topology	3-76
3.2.18	Red-Green-Blue (RGB) LED Lighting Shield Board	3-82

3.2.19	Red-Green-Blue (RGB) LED Lighting Shield Link and Bluetooth Low Energy Unit (BLE)	3-83
3.2.20	RGB) LED Lighting Shield Link and Bluetooth Low Energy Unit (BLE) /Power Supply	3-84
3.2.21	Controls for Building Management System	3-91
3.2.22	Key Technology of company products	3-94
3.2.23	Linear / Area Constant Current – Dimmable DALI	3-100
3.2.24	DLM Color Control Schedule Switch (without wall plate)	3-102
3.2.25	Light Engine for Human Centric Lighting	3-103
3.2.26	DMX-DALI Gateway Control for Human Centric Lighting	3-104
3.2.27	Occupancy Sensor (Wall Unit)	3-107
3.3.28	Driver on Board LED Module for Lighting	3-112
3.2.29	Circadian PAR30 Gimbal Spot	3-115
3.2.30	LED Lighting unit	3-116
3.2.31	LED Lighting unit	3-118
3.2.32	Average Current Mode Control LED Driver IC	3-130
3.2.33	Smart Lighting Demo Solution – Application Illustration	3-133
3.2.34	Wire Interconnect for LED Lighting-Module Applications	3-134
3.2.35	DALI Power Control Unit (PCU)	3-144
3.2.36	Standalone (6-inch) Track Lighting Linear LED Driver Module (DALI)	3-149
3.2.37	Simulation of Daylight - Supporting the Circadian Rhythm	3-157
3.2.38	Building Management - Network Central Monitoring	3-159
3.2.39	LED-MR16 Lamp Unit	3-161
3.2.40	Low-Profile / Ultra-Compact Chip LEDs	3-164
3.2.41	Smart Lighting Module	3-167
3.2.42	High Power (LED Component)	3-168
3.2.43	LED package unit	3-175
3.2.44	LED Driver semiconductor	3-176
3.2.45	LED Driver small (micro) unit	3-177
3.2.46	LED- Chip-On-Board (COB)	3-180
3.2.47	General Lighting Power Controller IC	3-188
3.2.48	Smart Driver and Smart Sensors	3-194
3.3.1	Competitor Market Share (2018) - Human Centric Lighting- Specified Modules/Devices	3-195
4.1	ElectroniCast Consultants - Market Research & Forecasting Methodology	4-5