

# STATUS OF THE SOLID-STATE LIGHTING SOURCE INDUSTRY 2019

## Market & Technology Report - July 2019

*From lighting to sensing: a new growth era for the solid-state lighting industry.*

### REPORT KEY FEATURES

- SSL global market, industry, and technology landscape
- Per source type:
  - Application trends
  - Technology trends and development axis
  - Industry trends
  - Supply chain analysis and market share
  - Revenue, unit, and wafer forecasts
- Light function evolution

### REPORT OBJECTIVES

The report will provide:

- A global examination of SSL source trends
- A detailed analysis of SSL source types (visible LED, UV LED, IR LED, EEL, and VCSEL)
- An understanding of SSL source markets, applications, industries, and technologies
- SSL source players, dynamics, and rankings
- SSL source market data in \$M, units, and wafers for 2018 - 2024

## SOLID-STATE LIGHTING SOURCE - A BUSINESS OPPORTUNITY OF \$32B IN 2024

Solid-state lighting (SSL) sources aren't new technologies. In fact, they've existed since the 1960s. However, only in the last 25 years have they started appearing in high-volume applications.

Laser diode (LD) found its sweet spot in the 1990s as a light source for optical transceivers used in datacom (i.e. vertical cavity surface-emitting laser (VCSEL)) and telecom (i.e. edge-emitting laser (EEL)) applications. Further refinement, coupled with the internet's boom, drove the LD market forward to a point where each technology has now followed its own path.

EEL, driven by the increased use of lasers in different industries, soon found growth opportunities in areas like material processing and optical storage. VCSEL took more time to find its strong growth drivers, but the smartphone boom created a window of opportunity that allowed VCSEL to find its killer application: 3D sensing.

In 2018, LD represented a market opportunity of \$3.2B. This figure is likely to reach \$8.9B in 2024, at a CAGR<sub>2018-2024</sub> of 18%.

Regarding light-emitting diode (LED), it found its first high-volume applications in the 2000s, mostly in the visible LED field: automotive lighting, signs, traffic signals, and the like. Mobile phones were the next key segment, followed by TV LCD backlights and general lighting.

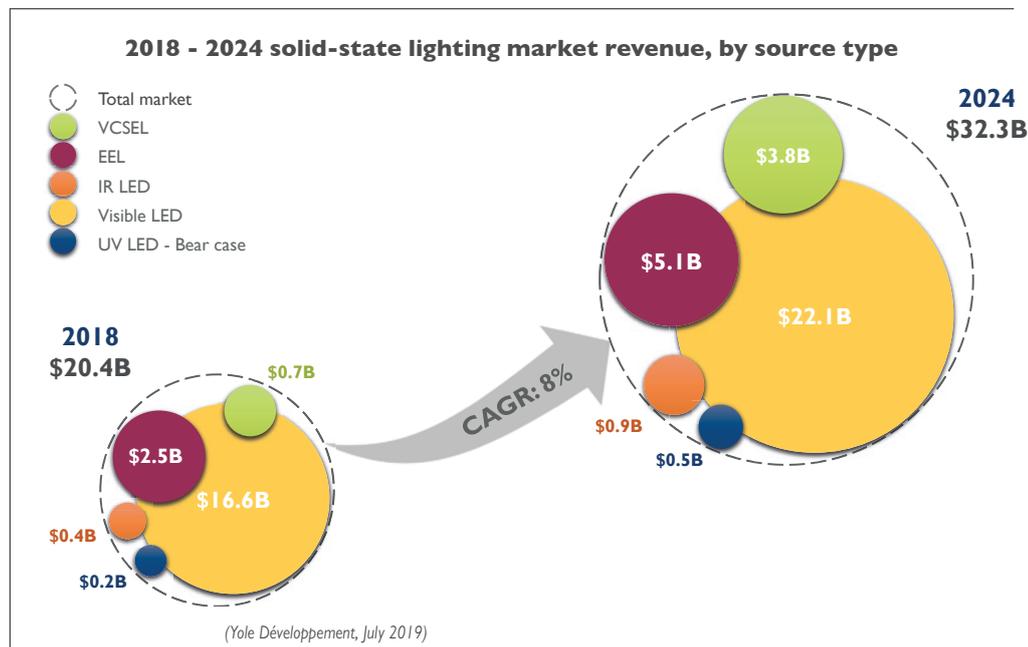
LED growth was non-linear though: periods of recession were followed by waves of new applications and growth, followed by periods of oversupply that depressed prices, etc. This uneven growth resulted in a depressed environment, leading the industry to seek niche/specialized applications in order to reap higher margins and diversify activities towards non-visible LED (i.e. ultraviolet (UV) and infrared (IR)).

In 2018, LED represented a market opportunity of \$17.2B. This figure is likely to reach \$23.4B in 2024, at a CAGR<sub>2018-2024</sub> of 5%.

In this context, the SSL source industry is at a crossroads between:

- An LED industry that has reached a critical size, but is now mature and lacks strong market dynamics (except potential upsides, i.e. microLED displays)
- An LD industry that is booming but still emerging and proliferating, in terms of application/technology landscape

Yole Développement estimates therefore that the overall SSL source market will grow from \$20.4B in 2018 to \$32.3B in 2024, at a CAGR<sub>2018-2024</sub> of 8%. Such growth will be driven mostly by LED technologies. However, related market share will decline from ~84% in 2018 to ~73% in 2024, reflecting different market/application dynamics and a transition towards LD technologies.



## GENERAL LIGHTING IS MATURING. WHAT'S NEXT?

LED revenue will continue to thrive on visible applications over the next five years, with general lighting holding the majority (~45% of the total "LED opportunity"). However, such an application has already reached a certain degree of maturity, and thus related LED devices can be considered as commodities - leading to a high-volume/low-margin market.

Automotive lighting and direct-view displays are other booming LED applications. These will become critical for the industry's survival, since most other applications can be considered as declining or "flat" (i.e. LCD backlights). The one exception is horticultural lighting, which is still emerging.

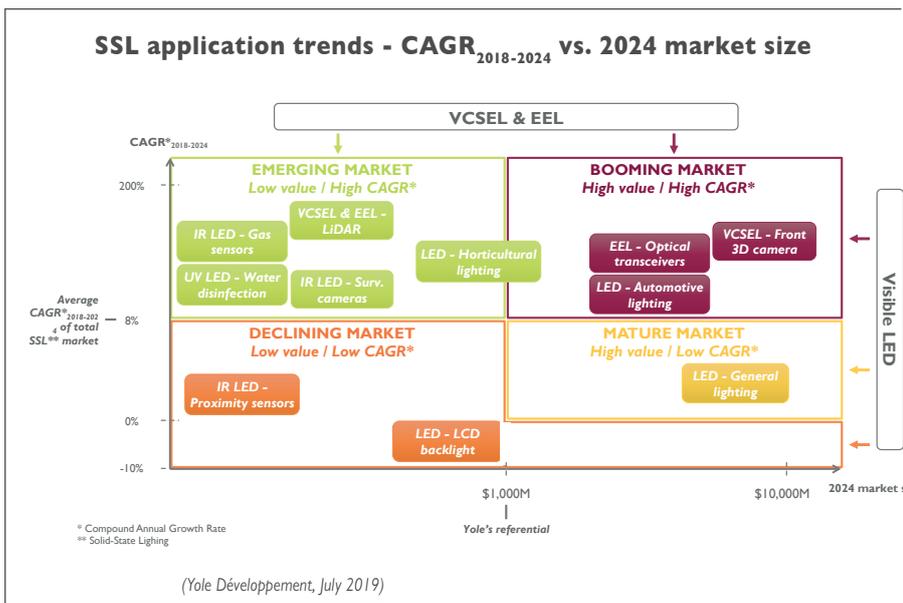
A large part of the LED industry also has a foothold in the non-visible LED market, with UV and IR LEDs highlighting several high-potential applications (i.e. gas sensing and water disinfection). But these are still emerging, and will not fully materialize in the next five years.

On the other hand, the LD industry is booming. Several applications are rising and plenty of others are emerging or in development.

VCSEL, driven by the integration of front 3D cameras in smartphones, will likely see a 5x market revenue increase from 2018 - 2024. And this is just the beginning, with smartphone rear 3D cameras and LiDAR likely next in line.

EEL will experience strong but much steadier growth during the same period (i.e. only a 2x revenue increase), driven mostly by optical transceivers and the increased development of telecom infrastructure (around 55% - 65% of EEL market opportunity). Here also there are a large number of applications that could further boom in the future - for example, LiDAR and sensors.

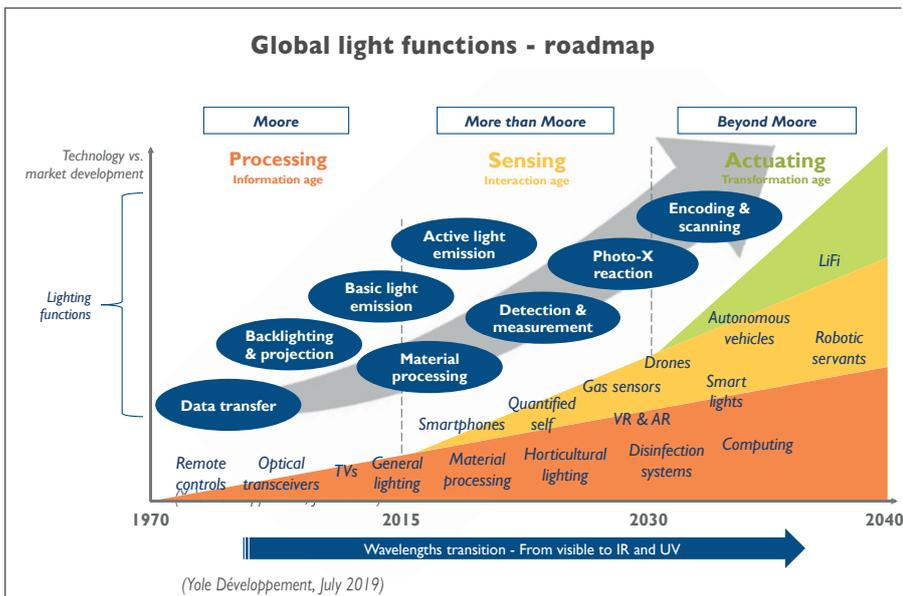
In this context, it is likely that the visible LED industry will further consolidate in the future as markets reach maturity. Such a trend will directly impact other SSL source industries, since several visible LED players might "forage new lands" in order to survive.



## WE ARE JUST SCRATCHING THE SURFACE OF LIGHT SCIENCE

The visible SSL market is driven by the best-established, most common functions of light: "basic" lighting (i.e. general lighting) and backlighting (i.e. display). Visible SSL is a replacement market (specifically, replacing old light sources with SSL ones) that will quickly

reach saturation. The only upside will be related to the development of breakthrough SSL sources (i.e. microLED) and applications/systems (LiFi, smart lighting, etc.).



Visible lighting is therefore less and less at the heart of the SSL industry, while IR/UV lighting is experiencing increased interest. Indeed, SSL development has allowed the industry to better understand the science behind light and investigate lighting functions related to UV and IR wavelengths. Typically, UV light provides functions like photopolymerization (i.e. phototherapy) and photodisruption (i.e. water disinfection). When mixed with a miniaturized lighting source, these functionalities can usher in a completely new range of applications, including portable water purifiers.

Such trends are emerging today with IR lighting, driven mostly by detection and measurement functions (i.e. sensing & imaging) for mobile/consumer and automotive/transportation. Smartphones integrating face-recognition features, and automobiles featuring driver-monitoring systems, are just two examples of what is possible with a non-visible SSL source.

**COMPANIES CITED IN THE REPORT (non exhaustive list)**

3SPTechnologies, A-Bright, Access Pacific, Adtech Optics, Advanced Laser Diode Systems (NKT Photonics), Akela Laser, Allwave Lasers, Alpes Lasers, AltaLED, American Bright, AOT, Apex Science & Engineering Corp., Applied Optoelectronics, Arima, Bolb, Bridgelux, Bright Solutions, BrightLED, Broadcom, Brolis Semiconductors, BYD, Canadian Photonics Fabrication Centre, Citizen Electronic, Clean Technology Leader, Coherent, Compound Photonics, CREE, CST Global, Daina, DenseLight Semiconductors, DILAS, Diode Laser Concepts, Dominant Opto Technologies, eagleyard Photonics GmbH, Eblana Photonics, Edison Opto, Egismos Technology, Electech, Emcore, Epileds, Epilight Technologies, Epistar, Epitex, Epitop, Everlight, Excellence Opto, Fiibercom, Finisar, FITEL - Furukawa, Flip Chip Opto, Fox Group, FullSun Optotech, FuriElectric, Genesis Photonic, Gooch & Housego, Hamamatsu, Harvatek, HC Semitek, Helio, High Power Opto, Honglitrionic (HongliZhihui), High Power Lighting, II-VI Laser Enterprise, Iijin Semiconductor, Innolume, Innovative Photonic Solutions, Inolux, InPhenix, Intense Photonics, IPG Photonics, Itswell, JENOPTIK, Jufei Optoelectronics, Kingbright, Kodenshi, Kwalify Group, Laserline, LaserMaxDefense, LasersCom, Lasertel, Lattice Power, LDX Optronics, LED Engin, Ledtech, Lextar, LG Innotek, Lighten, Ligitek, LiteOn, Lumens, Lumentum, Lumex, Lumichip, Lumics, Lumileds, LumiMicro, Lumimodule, Luminus Devices, Luxpia, Masimo Semiconductor, Mason Technologies, Mitsubishi Chemical, Mitsubishi Electric, Modulight, Mok San Electronics, Monocrom, Mulinsen (MLS), nanoplus, Nationstar, Necsul (Ushio), Neo Neon, Newport (now MKS Instruments), Nichia, nLIGHT, NOLATECH, Norcada, Norlase, Northrop Grumman Cutting Edge Optronics, Oasis, Oclaro (Lumentum), Optek Technology, Optodiode, OPTOENERGY, Optotech, Optoway Technology, OSI Laser Diode, Osram, Panasonic Semiconductor Solutions Co., Ltd. (Japan), Paralight, PD-LD, Pegasus Lasersysteme, Photodigm, Plessey Semiconductor, and more.



**AUTHORS**

**Pars Mukish** holds a master degree in Materials Science & Polymers (ITECH - France) and a master degree in Innovation & Technology Management (EM Lyon - France). Since 2015, Pars has taken on responsibility for developing SSL and Display activities as Business Unit Manager at Yole Développement (Yole). Pars is part of the Photonics, Sensing & Display division at Yole. Previously, he has worked as Marketing Analyst and Techno-Economic Analyst for several years at the CEA (French Research Center).



As part of the Photonics, Sensing & Display division at Yole Développement (Yole), **Pierrick Boulay** works as Market and Technology Analyst in the fields of Solid State Lighting and Lighting Systems to carry out technical, economic and marketing analysis. Pierrick has authored several reports and custom analysis dedicated to topics such as general lighting, automotive lighting, LiDAR, IR LEDs, UV LEDs and VCSELs. Prior to Yole, Pierrick has worked in several companies where he developed his knowledge on general lighting and on automotive lighting. In the past, he has mostly worked in R&D department for LED lighting applications. Pierrick holds a master degree in Electronics (ESEO – Angers, France).



**Martin Vallo**, PhD, serves as a Technology & Market Analyst specialized in solid-state lighting technologies, within the Photonics, Sensing & Display division at Yole Développement (Yole). With 9 years' experience within semiconductor technology, Martin is involved today in the development of technology & market reports as well as the production of custom consulting projects at Yole. Prior his mission at Yole, he worked at CEA (Grenoble, France), with a mission focused on the epitaxial growth of InGaN/GaN core-shell nanowire LEDs by MOCVD and their characterization for highly flexible photonic devices. Martin graduated from Academy of Sciences, Institute of Electrical Engineering (Slovakia) with an engineering degree in III-nitride semiconductors.

**TABLE OF CONTENTS (complete content on i-Micronews.com)**

<b>STATUS OF THE SSL</b>	
<b>SOURCE INDUSTRY</b>	<b>36</b>
> Market forecast	
- Scope of applications	
- 2017-2024 market forecast - Split by source type / wavelength / market segment	
- 2017-2024 market forecast - Focus by market segment - Split by source type	
> Market segment trends	
- Market synergies between SSL sources	
- Focus on mobile & automotive	
> Industrial trends	
- LED industry vs. laser diode industry	
- Solid state lighting industry	
<b>VISIBLE LED LANDSCAPE</b>	<b>77</b>
> Introduction	
> Market forecast	
- 2018-2024 device market forecast - By application	
- 2018-2024 growth trends - CAGR vs. Market size	
- 2018-2024 wafer start market forecast	
> Market trends	
- Application vs. function / technology / economic	
- Market drivers	
> Application landscape - Analysis of key applications	
> Industrial landscape	
- Map of players & market shares	
- Ecosystem analysis	
- Trends	
> Technology landscape	
- Segmentation	
- Manufacturing process	
- Cost aspects	
- Development axis	
<b>IR LED LANDSCAPE</b>	<b>122</b>
> Market forecast & trends	
> Application, Industrial, & technology landscapes	
<b>UV LED LANDSCAPE</b>	<b>155</b>
> Market forecast & trends	
> Application, Industrial, & technology landscapes	
<b>VCSEL LANDSCAPE</b>	<b>194</b>
> Market forecast & trends	
> Application, Industrial, & technology landscapes	
<b>EEL LANDSCAPE</b>	<b>229</b>
> Market forecast & trends	
> Application, Industrial, & technology landscapes	
<b>CONCLUSION</b>	<b>269</b>

**RELATED REPORTS**

*Benefit from our Bundle & Annual Subscription offers and access our analyses at the best available price and with great advantages*



- VCSELs – Market and Technology Trends 2019
- Edge Emitting Lasers: Market and Technology Trends 2019
- VCSEL in Smartphone – Comparison 2019
- UV LEDs – Technology, Manufacturing and Application Trends 2018
- IR LEDs and Laser Diodes – Technology, Applications, and Industry Trends

Find all our reports on [www.i-micronews.com](http://www.i-micronews.com)

# ORDER FORM

## Status of the Solid-State Lighting Source Industry 2019

### BILL TO

Name (Mr/Ms/Dr/Pr): .....

Job Title: .....

Company: .....

Address: .....

City: .....

State: .....

Postcode/Zip: .....

Country\*: .....

\*VAT ID Number for EU members: .....

Tel: .....

Email: .....

Date: .....

### PAYMENT

#### BY CREDIT CARD

Visa  Mastercard  Amex

Name of the Card Holder: .....

Credit Card Number:

□□□□ □□□□ □□□□ □□□□

Card Verification

Value (3 digits except AMEX: 4 digits):

□□□□

Expiration date:

□□ / □□

#### BY BANK TRANSFER

BANK INFO: HSBC, 1 place de la Bourse,  
F-69002 Lyon, France,  
Bank code: 30056, Branch code: 00170  
Account No: 0170 200 1565 87,  
SWIFT or BIC code: CCFRFRPP,  
IBAN: FR76 3005 6001 7001 7020 0156 587

#### RETURN ORDER BY

• MAIL: YOLO DÉVELOPPEMENT, Le Quartz,  
75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

#### SALES CONTACTS

- Western US & Canada - Steve Laferriere:  
+ 1 310 600-8267 – laferriere@yole.fr
- Eastern US & Canada - Chris Youman:  
+1 919 607 9839 – chris.youman@yole.fr
- Europe & RoW - Lizzie Levenez:  
+ 49 15 123 544 182 – levenez@yole.fr
- Japan & Rest of Asia - Takashi Onozawa:  
+81-80-4371-4887 – onozawa@yole.fr
- Greater China - Mavis Wang:  
+886 979 336 809 – wang@yole.fr
- Korea - Peter OK:  
+82 10 4089 0233 – peter.ok@yole.fr
- Specific inquiries: +33 472 830 180 – info@yole.fr

<sup>(1)</sup> Our Terms and Conditions of Sale are available at  
[www.yole.fr/Terms\\_and\\_Conditions\\_of\\_Sale.aspx](http://www.yole.fr/Terms_and_Conditions_of_Sale.aspx)  
The present document is valid 24 months after its publishing date:  
July 25, 2019

### PRODUCT ORDER - REF YDI9033

Please enter my order for above named report:

- One user license\*: Euro 5,990  
 Multi user license: Euro 6,490

- The report will be ready for delivery from August 29, 2019  
- For price in dollars, please use the day's exchange rate. All reports are delivered electronically at payment reception. For French customers, add 20% for VAT

I hereby accept Yole Développement's Terms and Conditions of Sale<sup>(1)</sup>

Signature: .....

\*One user license means only one person at the company can use the report.

### SHIPPING CONTACT

First Name: .....

Email: .....

Last Name: .....

Phone: .....

### ABOUT YOLO DEVELOPPEMENT

Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 120 collaborators worldwide covering MEMS and image sensors, Compound semiconductors, RF Electronics, Solid-state lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Power Electronics, Batteries & Energy Management and Memory.

The "More than Moore" market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO, KnowMade and Blumorpho, supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

#### CONSULTING AND ANALYSIS

- Market data & research, marketing analysis
- Technology analysis
- Strategy consulting
- Reverse engineering & costing
- Patent analysis
- Design and characterization of innovative optical systems
- Financial services (due diligence, M&A with our partner)

More information on [www.yole.fr](http://www.yole.fr)

#### MEDIA & EVENTS

- i-Micronews.com website, application & related e-newsletter
- Communication & webcast services
- Events: TechDays, forums...

More information on [www.i-Micronews.com](http://www.i-Micronews.com)

#### REPORTS

- Market & technology reports
- Patent investigation and patent infringement risk analysis
- Structure, process and cost analysis, and teardowns
- Cost simulation tool

More information on [www.i-micronews.com/reports](http://www.i-micronews.com/reports)

#### CONTACTS

For more information about :

- Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
- Reports & Monitors: David Jourdan (jourdan@yole.fr) & Fayçal Khamassi (khamassi@yole.fr)
- Marketing & Communication: Camille Veyrier (veyrier@yole.fr)
- Public Relations: Sandrine Leroy (leroy@yole.fr)