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 2018-2024 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 2018-2024 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 2018-2024 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.

![2018 - 2024 solid-state lighting market revenue, by source type](image-url)
**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.
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