Chain Lightning: Charting the Evolving Automotive LED Value Chain

Coming shifts in the automotive LED value chain promise structural industry changes that players should position themselves for now.

By Yoshie Fujii, Willem Strijbosch, Oliver Vogler, Florian Wunderlich, and Dominik Wee

Automakers worldwide have seen the light and it's shining on light-emitting diode (LED) technology. Of the total market for automotive lighting – USD 19 billion at the fixture level today – LED products already make up about USD 4 billion of the total. Furthermore, the automotive LED market continues to develop rapidly on a content-per-car basis despite the economic downturn, with vehicle interior applications leading the way. For example, LEDs are already found in about 70 percent of interior indicator lights and 25 percent of instrument display backlights (Exhibit 1). Currently, the largest exterior applications are center high-mounted stop lamps (CHMSLs) at 20 percent penetration, and brake and tail lights at about 10 percent each. The automotive LED supplier landscape remains highly fragmented at the module level and dealing with modules will likely have significant impact on the value chain.

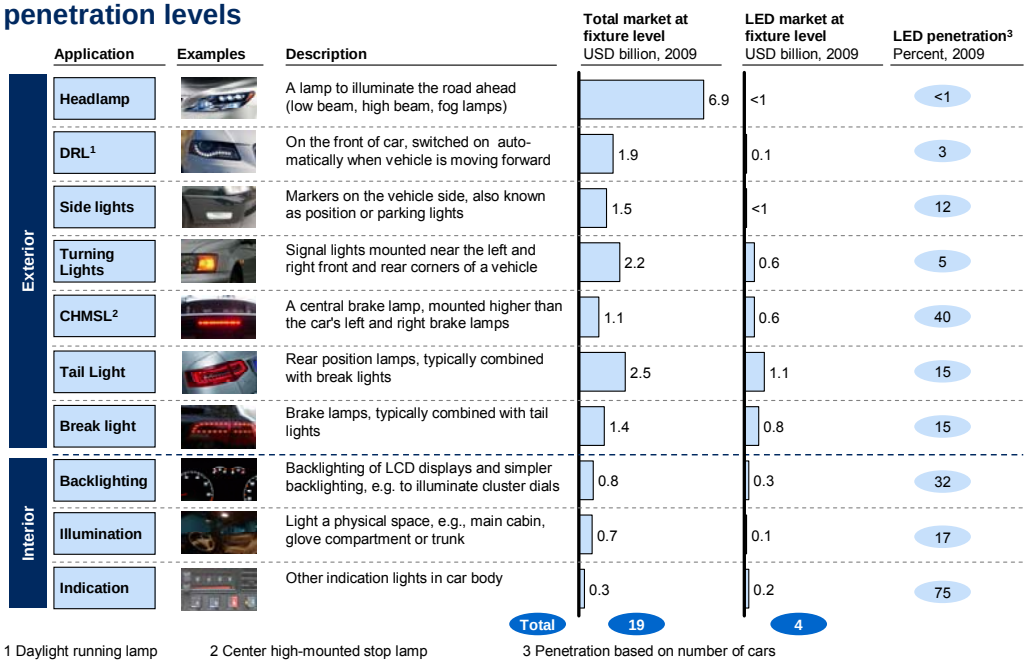
Four Key LED Trends

Four major trends are shaping the LED market, with the first three affecting overall market development and the final one focused on the lighting value chain and automotive aftermarket.

Trend #1: Per-vehicle lighting value will increase due to the continued need for vehicle design differentiation and introduction of new applications. Some LED applications provide car designers with unmatched flexibility in creating new exterior and interior lighting styling treatment, thus commanding significant price premiums. One notable comparison of innovative LED headlamps and high-intensity-discharge (HID) Xenon lighting revealed that the LED solution was more than twice as expensive as Xenon. New LED applications include enhanced night vision and head-up displays, and new features are also being introduced, such as active light bending for front lights that allow drivers to "see" around corners or "communicating" brake lights that can pulse-out messages.

Exhibit 1:

Interior automotive light segments currently see high LED penetration levels



SOURCE: Automotive Lighting, IMS 2009, SupplierBusiness, press search, McKinsey LED market model

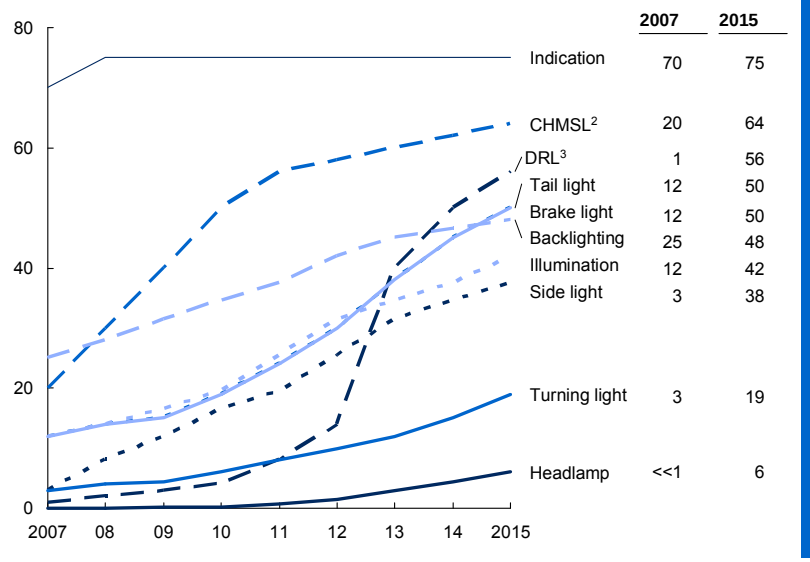
Trend #2: LED adoption rates will vary significantly depending upon application. LED market penetration will be uneven through 2015, with new applications (e.g., headlamps and daytime running lamps) growing rapidly from very small bases, while CHMSL and indicator light growth will slow as LEDs become the dominant solution in these applications (Exhibit 2).

Growth will come from increased LED lighting content in cars, which will overwhelm expected decreases in average selling prices (ASPs). For example, the global automotive lighting market in 2007 was just over USD 20 billion and is expected to grow at 3.5 percent annually to USD 27.1 billion by 2015. Most of this growth will come from the higher value of LED content in cars, which will be nearly twice the size of predicted declines in LED ASPs (Exhibit 3).

Exhibit 2:

In 2015, CHMSL and DRL will have the highest penetration, while headlamp will only achieve about 6%

LED automotive lighting penetration rates[1]
Percent



- **CHMSL[2]** and **DRL** with highest exterior penetration increase (regulation driven)
- **Headlamp** only with ~6% in 2015
- **Interior lighting** with penetration rates from ~40% up to ~75%

1 Luminaire level, including after-market; global penetration rates 2 Center high-mounted stop lamp 3 Daylight running lamp

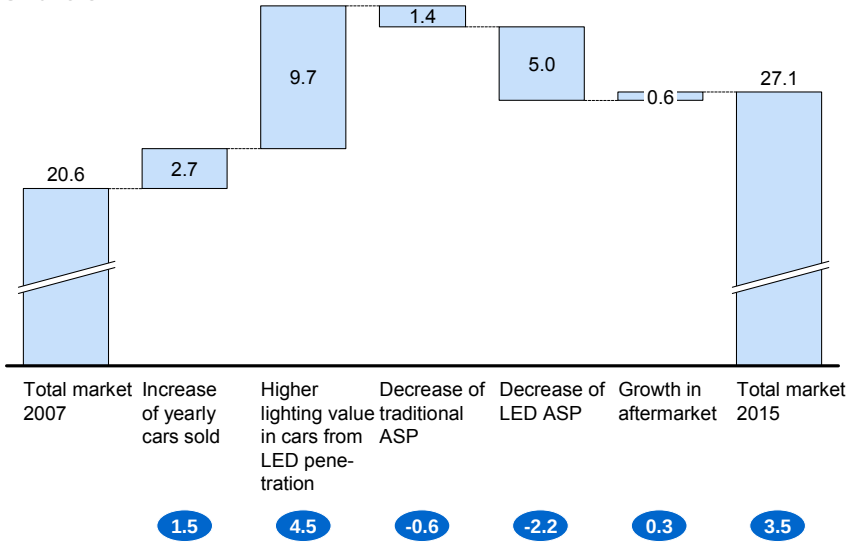
SOURCE: McKinsey LED market model

Exhibit 3:

Growth waterfall shows that biggest proportion comes from LED penetration – even net of LED ASP decrease

Automotive lighting market (incl. traditional and LED)
USD billions

x Correspond CAGR



SOURCE: McKinsey

Today, many drivers and OEMs prefer LED lighting solutions for a number of reasons:

- *Design and performance:* LEDs provide design flexibility, better packaging, and better dimming and turn-on speed performance.
- *Energy and CO_2 savings:* LEDs offer better power efficiency and significantly longer life cycles. They have also proven extremely durable in automotive use because of their innate shock resistance.
- *Cost:* Cost remains a hurdle in some areas, such as headlamp applications, but continued cost decreases and proven superior quality and durability have made LEDs the new industry standard in terms of end-customer value.
- *Regulation:* LED lighting demand has benefited from government regulations that specify requirements for headlamps and other applications. Governments are also enacting new vehicle lighting mandates, such as the European Union's requirement for daytime running lights (DRLs) beginning in 2011.

Overall penetration will increase as LEDs reach cost parity with conventional solutions, such as halogen lighting. Beyond regulatory mandates, LED lights will continue to enter the market incrementally as each new generation of cars takes increasing advantage of their performance and stylistic differentiation potential.

3) Cost-based LED substitution for halogen and HID Xenon headlamps will not occur until the end of the decade. Currently, comparable LEDs cost about 100 percent more than halogen headlamps and 150 percent more than HID Xenon solutions (i.e., achieving comparable performance to HID Xenon headlamps requires a much more expensive LED solution than for lower-performance halogen technology). Based upon a model developed by McKinsey & Company, LEDs of comparable performance will ultimately achieve cost parity with both halogen and HID Xenon technologies, but not until the 2020 timeframe. Until then, the vehicles that feature LED headlamps are trading off the often significantly higher costs against the ability to offer the innovative styling and design solutions that customers demand.

4) The aftermarket for LEDs will lag behind the overall automotive lighting market. Aftermarket demand for automotive LED lighting will grow more slowly than the overall vehicle lighting market. This is due to the technology's greater durability compared to that of traditional lamps, which will offset higher average selling prices. Burned out bulbs and damage from accidents are the two main

sources of traditional aftermarket lighting demand. The significantly greater durability of LEDs will effectively stunt replacement demand going forward, leaving collision repair as the main demand driver.

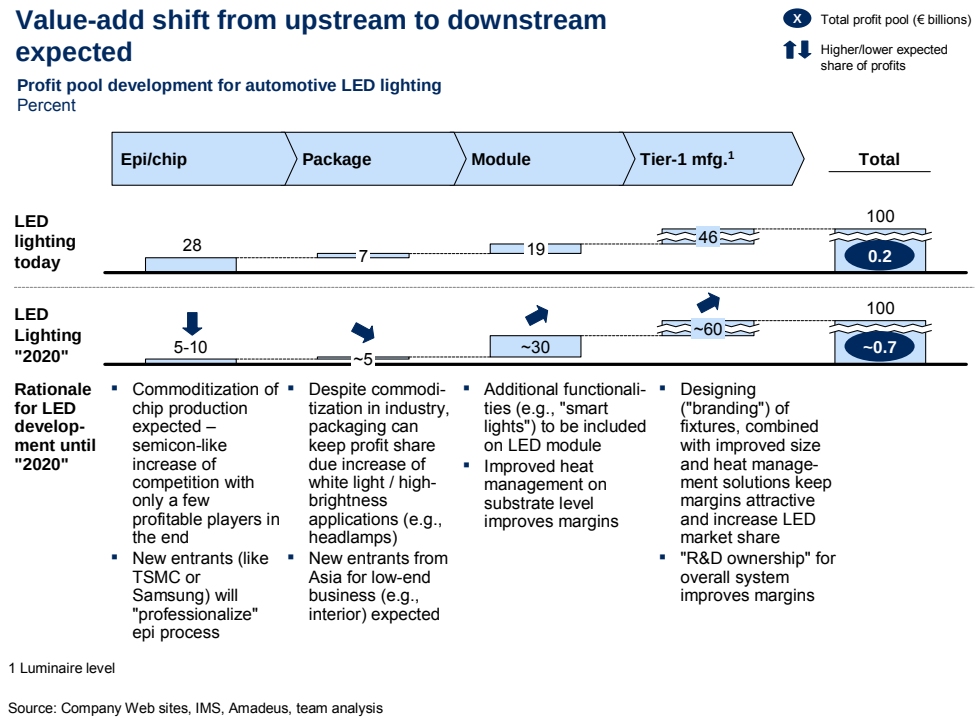
The Impact on LED Industry Structure

Given the four LED trends mentioned, managers can anticipate changes in industry dynamics that will likely lead to a number of structural changes in the supply industry. First, the upstream portion of the automotive LED value chain will become commoditized due to scale and learning curve effects as volume rise, but the degree to which this occurs will depend upon the strategies of the "Big 5" LED producers. While scale will drive down costs, it won't become a "biggest-takes-all" business, since the advantages of scale in the LED industry are not as pronounced as those in the semiconductor sector due to lower fixed costs. If the Big 5 continue to own intellectual property (IP) rights despite high IP litigation costs, they will prevent competition and the current oligopoly market structure will remain. If, on the other hand, they expand cross-licensing, the market will become fragmented in the short term, but scale effects will drive consolidation in the long term.

Second, room still exists for chipmakers and packagers interested in supplying premium LED chips for automotive lighting applications. As observed in the semiconductor industry, these automotive-focused fabricators typically offer the higher quality demanded in safety-related and recall-prone automotive lighting systems by adding extra process steps and more inspections, and by scheduling additional maintenance compared to non-automotive "fab" plants. The trade-off is higher cost, which automakers are compelled to pay.

Third, the lighting industry profit pool will migrate from chip making/packaging to modules and fixtures (Exhibit 4). By 2020, chip production will become increasingly commoditized and thus, less profitable. Also, new entrants from Asia will speed the commoditization shift. The inclusion of "smart lighting" functionality on the LED module will boost its value, as will improved heat management substrates. Also, tier-one supplier branding efforts and improved thermal management solutions should keep margins attractive and thus, increase their LED market share.

Exhibit 4:



And, because tier-one suppliers will likely take on a leading role, LED module specialists will probably disappear. Lighting-focused tier-one companies have specific product design and quality-related strengths that pure module players and integrated LED manufacturers lack. LED technology allows for more design differentiation, upon which tier-one suppliers can capitalize by having in-house module capability. Furthermore, tier-one suppliers can source quality LED chips at lower cost by leveraging their inherently larger volumes compared to the typically more fragmented module players. The alternative – direct cooperation between LED manufacturers and automakers – seems unlikely without also tying-in tier-one suppliers, which typically supply large portions of interior or exterior systems.

Finally, the tier-one supplier market will become more consolidated, especially when it comes to mature geographies and established technologies. Scale will become an increasingly important avenue for driving down cost and only a few tier-one players will be able to secure heavy demand. Furthermore, the growing consolidation among OEMs will increase price pressure on tier-one suppliers. This same type of consolidation occurred when the automotive airbag industry reached the commoditization phase, resulting in three global players now controlling the airbag industry.

These shifts mean that the automotive LED industry will change from its current value chain – from chipmaker to module specialist to tier-one supplier – to a situation in which integrated tier-one suppliers with in-house module-making abilities take over the module role, while auto-focused chipmakers provide LED chips of the required quality. Alternatively, for largely commoditized products (e.g., interior lamps), a large-scale lighting specialist with chip-making capabilities could produce standardized, cost-competitive modules while the tier-one supplier focuses on cost reduction.

Strategies for Integrated LED Manufacturers and Tier-One Players

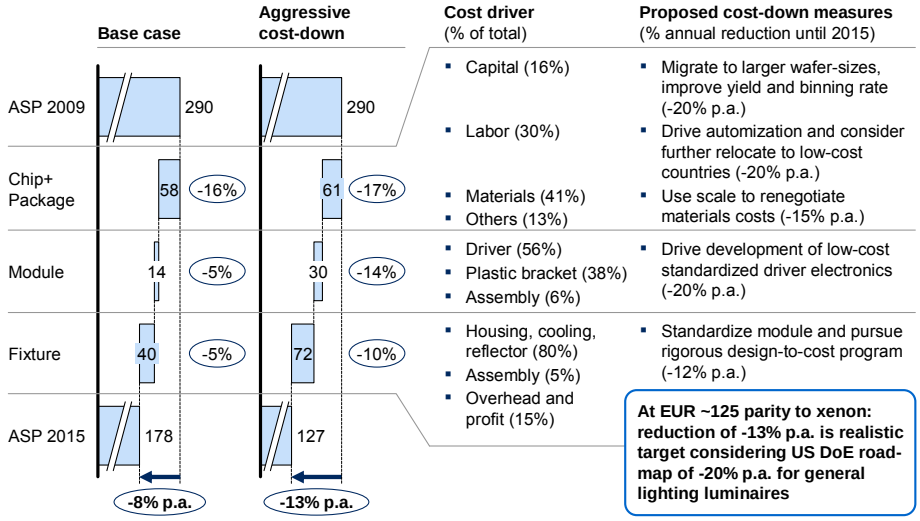
To position themselves to take advantage of impending LED value chain shifts, integrated LED manufacturers, tier-one suppliers, and OEMs have a number of choices to make.

LED manufacturers should develop new applications by integrating their products with electronic components such as sensors, while maintaining close communication with OEMs and end customers. They can also pursue a stretch goal to reduce chip and module costs twice as quickly as currently predicted, striving to, for example, reach cost parity with halogen technology by 2014 rather than 2020 (Exhibit 5). Or, they can aggressively lobby for regulations mandating LED use in specific applications (e.g., DRLs, CHMSLs, or brake lights) based upon their increased safety (i.e., reliability) or superior CO_2 abatement properties. LED makers could also pursue a value chain play, working directly with OEMs instead of through tier-one suppliers. This strategy can be risky, however, since LED suppliers must guard against earning tier-one margin levels, which can be half the size of their current ones.

Exhibit 5:

Significantly accelerating future cost reductions implies decisive action along main cost drivers

Cost structure LED headlamp
ASP to OEM USD/car



1 Base case: ASP reductions of -16% p.a. for chip/package at constant margins and -5% p.a. for downstream production steps (source iSupply, IMS)

SOURCE: McKinsey

LED makers must also guard against the threat of backward integration by tier-one suppliers and watch out for "attacks" from backlighting players with natural cost advantages, which could precipitate price wars. In either case, it will be critical to establish long-standing relationships with tier-one players and be involved in product development early on.

Tier-one suppliers also have a number of options open to them; many similar to those available to LED makers. Like LED players, tier-one suppliers can aggressively go after LED chip and module costs, or attempt to shape regulation to their advantage. They can develop new applications that integrate with other electronics systems or enter adjacent segments, such as car customization, public transportation, or street lighting. They can also expand their business to provide standardized LED modules to pure tier-one suppliers or actually backward integrate into modules.

At the same time, tier-ones must guard against being squeezed-out by the forward-integration moves of LED manufacturers or becoming too dependent upon a few chip suppliers with large market shares and significant amounts of market power.

Finally, *OEMs* should pursue a targeted LED option strategy, designing attractive LED solutions for DRL, CHMSL, or interior applications, and driving the customer adoption rates of existing high-margin options by offering them in attractive bundles. They can also strive to offer break-through functionality in new vehicle options by brainstorming with chipmakers or systems integrators on true innovations. OEMs can further attempt to attract new chipmakers into the automotive industry to increase price pressure.

Automakers can also mitigate a number of risks (e.g., new regulations that make current vehicle options mandatory) and thus, squeeze margins or have dominant upstream players take on attacker roles and forward-integrate, thus gaining market power. Other risks involve dealing with price hikes caused by the industry's cyclical nature and facing profit and/or market share losses caused by OEMs' slow reaction and long development lead times.

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Expected changes will present challenges and opportunities for players in the automotive LED value chain. Some participants, such as module specialists, may soon find themselves crowded out by tier-one players seeking to capture greater value. At the same time, others will have to invest and forge cooperative relationships in order to position themselves to claim a larger portion of this migrating industry profit pool.