

# clearthought

## Automotive Lighting

New technologies and increasing safety concerns are driving the industry

### Bright future

Driven by increasing vehicle production, cutting-edge technological advances, and increasing safety concerns, the global automotive lighting market is undergoing huge change.

Electronic and digital technologies are transforming the automotive lighting industry, offering more design flexibility, increased efficiencies and new functionalities for manufacturers and consumers alike.

These trends are translating into significant market growth which is only set to intensify further over coming years. In particular, manufacturers of mass market vehicles are set to take full advantage of the improved performance, safety and environmental benefits that new technologies can bring - features which until now have largely only been used in luxury, premium vehicles.

For instance, the market is starting to see huge growth in China and India, while Asia as a whole remains the largest region for automotive lighting with forecasts that the market will be worth \$15.9bn by 2020<sup>1</sup>.

However, European and Japanese companies together still supply more than 80% of the market. Hella, Osram, Magneti Marelli, ZKW Lighting Systems and Valeo are among the leading names in Europe, while Koito Manufacturing, Ichikoh Industries and Stanley Electric are major players in Japan.

#### Supply chain

These trends are having a huge impact on the supply chain. Advances in LED (Light-Emitting Diode) technology are reducing the cost of lighting, while an increasing emphasis on design and performance of exterior lighting brings new players into the sector. These changes also impact the mould and injection moulding industry and as manufacturers adapt designs to cater for the next generation of lighting solutions.

#### Market overview

The global lighting market is forecast<sup>1</sup> to be worth \$27.7bn in 2017 and is expected to reach \$34.8bn in 2020, growing at a CAGR of 7.3% between 2014 and 2020.

The market is being driven by the following key trends:

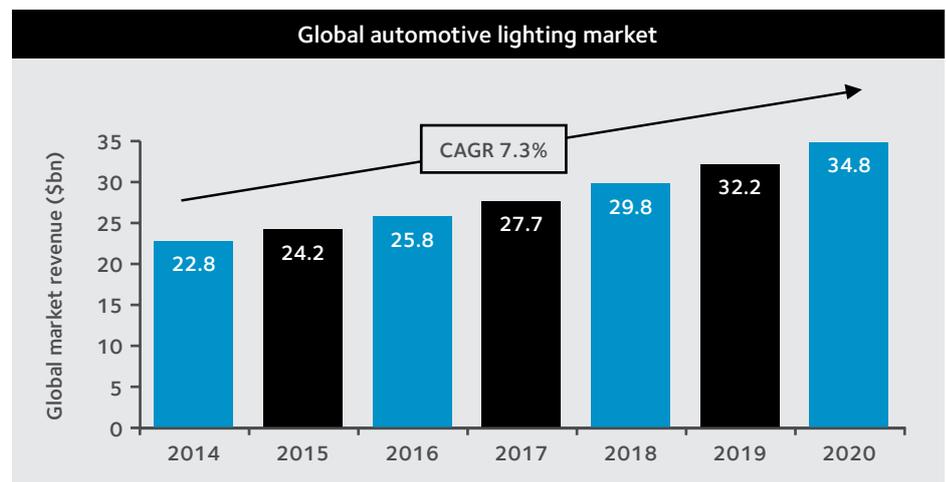
- More energy-efficient LED technology penetrating into different automotive lighting applications and systems
- the integration of OLED (Organic Light-Emitting Diode) and laser systems, and development of AFLS (Adaptive Front Lighting Systems)
- demand for increased safety features
- demand for vehicle design differentiation

- customised interior lighting driven by changing consumer tastes
- wireless remote control of interior ambient lighting

The exterior lighting market remains by far the biggest segment within the industry. In 2016 it was worth \$24.7bn, compared to interior lighting being worth just \$1.1bn. It is forecast that by 2020 the exterior market will be worth \$33.5bn<sup>1</sup>.

Meanwhile new technologies are taking increasing market share. For instance, by 2020 it is estimated that the LED market will be worth \$7.3bn<sup>1</sup>, although this will still only be half the size of the halogen market.

<sup>1</sup> Technavio, Global Automotive Lighting Market 2016-2020



SOURCE: Technavio, Global Automotive Lighting Market 2016-2020

## Exterior lighting

A defining characteristic of the automotive lighting industry is how technology has continually evolved over the past century, providing new solutions and innovations for manufacturers.

Today it is LED technology that is transforming the exterior lighting market, replacing more traditional halogen solutions for vehicles and rapidly being commercialised in fast growing markets such as Asia. Nearly all relevant tier one manufacturers have now developed full LED-based headlamp systems.

LED technology is particularly attractive for exterior lighting for a number of reasons<sup>1</sup>:

- it offers better optical precision and is more efficient. While halogen offers 15-30 lumens per watt, LEDs offer 60-120 lumens per watt (a lumen is a measure of how much visible light is emitted by a source)
- low power consumption and lower weight make LEDs ideal for electric vehicles. LED bulbs typically use up to 25% less energy than traditional lights, meaning that electric vehicles can travel much further on a single charge
- LEDs last the lifetime of a vehicle and contribute to lower CO<sub>2</sub> emissions. It has been estimated that if the world used LED lamps in all sectors then global electricity consumption for lighting would be reduced by more than half, with 735 million tons of CO<sub>2</sub> avoided each year<sup>2</sup>
- faster illumination and focused brightness are a strong safety benefit, in particular for brake lights

A good example of a vehicle employing LED technology is the Audi A7 which is regarded as having one of the most extensive automotive lighting systems.

Rather than having traditional low and high beams, the car has 25 separate LEDs per headlamp. Thanks to on-board cameras, the car's headlamps can be dipped to avoid blinding oncoming drivers, while if the driver gets too close to a vehicle in front the car adjusts its light pattern to prevent the driver from being dazzled by reflected light from their own headlamps. The car's lights can also better detect writing on street signs, adding to its safety features.

A major German research project into a new smart, high resolution headlight was completed in late 2016.

The project – headed by Osram in collaboration with Daimler, the Fraunhofer Institute for Reliability and Microintegration, Hella, semiconductor manufacturer Infineon, and the German government – saw the launch of a headlight which contains three LED light sources, each with 1,024 individually controllable light points integrated into a thumbnail sized chip.

This means that the headlight can be adapted very precisely to suit the

respective traffic situation to ensure optimum light conditions at all times. For instance, the light can be adapted to take account of every conceivable bend in the road so that there are no dark peripheral areas.

In addition, with the aid of sensors in the vehicle, the surroundings can be analysed in order to illuminate oncoming traffic. This allows the driver to see these vehicles more clearly. At the same time the beam of light does not dazzle oncoming drivers. As a result, such shifting headlights no longer have to be dimmed on country roads.

## Interior lighting

The interior lighting market is forecast to grow at a CAGR of 3.8% from 2014 to 2020 reaching \$1.3bn<sup>3</sup>, driven by the flexibility of LED technology and the increasing appetite of manufacturers to create ambient lighting which gives drivers and passengers a sense of space and comfort.

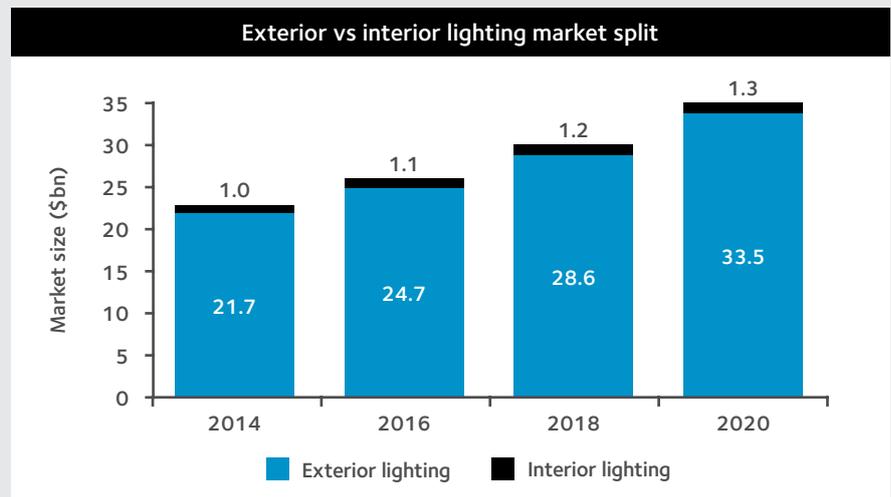
LEDs can automatically adapt to surrounding ambient light, and they are so small and light that they can be easily mounted to many interior parts. As a result, such

lighting is now commonly incorporated into virtually every aspect of a vehicle. As well as traditional turn and brake-lighting applications, you increasingly find ambient lighting in ceiling domes, map lights, instrument panels, gear sticks and door panels.

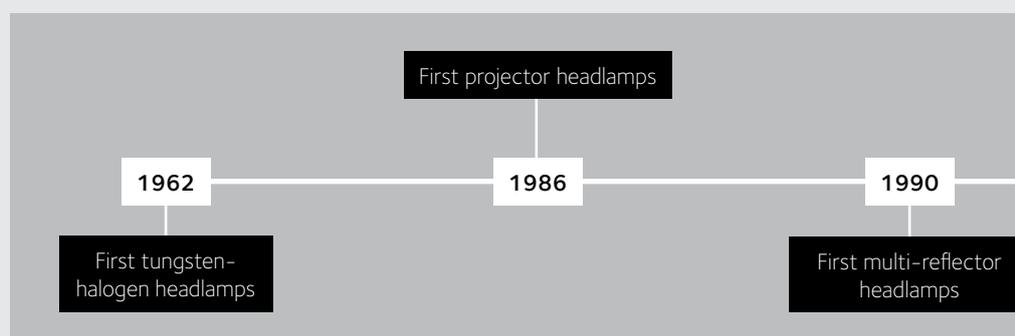
<sup>1</sup> IHS Automotive

<sup>2</sup> The Climate Group: Support The Big Switch

<sup>3</sup> Technavio, Global Automotive Lighting Market 2016-2020



SOURCE: Technavio, Global Automotive Lighting Market 2016-2020





# Emerging technologies

## OLED systems

OLED lighting is among the most advanced lighting technology now available. As well as being thinner, lighter and more flexible than LEDs (they can be about one-tenth of the thickness of LEDs), they also offer major energy efficiencies (as they produce less heat) and design opportunities.

The technology, which is already widely used in smartphones and televisions, uses stacked layers of organic compounds that emit light when submitted to an electric current. It boosts luminance efficiency and

enables bendable displays as it reduces the light's thickness and weight. This makes OLEDs ideal for lighting curved surfaces both in and outside vehicles.

Due to its high cost OLED is still largely restricted to the luxury market. However, the prospects are strong with estimates<sup>1</sup> that the global automotive OLED market will reach 7.74 million units by 2019.

Among the most active players are Far East companies such as LG Chem, South Korea's biggest chemicals company and the world's largest manufacturer of OLED

lights. Japanese companies such as Konica Minolta, Pioneer and Mitsubishi Chemical are also big players in this market.

## Laser lighting

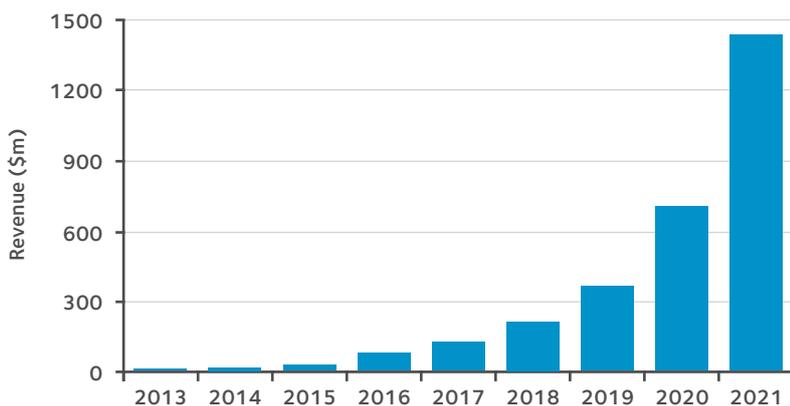
Lasers open up new horizons in the design and performance of headlights, enabling lights to be designed to much smaller specifications and be more efficient.

One of the great advantages of laser diodes is their small size with one laser diode generating an almost punctiform luminous flux on a few thousandths of a millimetre, and giving off a brightness almost four times that of an LED<sup>2</sup>.

This means that headlights can be made even smaller in the future without having to compromise on light intensity. The primary benefit for drivers is that these headlights have the longest range provided by any current headlight technology, offering the driver improved visibility and safety.

The BMW i8 and the Audi R8 LMX were launched almost at the same time as the first series production vehicles with laser headlights. In 2015, the new BMW 7 Series also followed with a laser full beam based on developments by Osram Specialty Lighting. As a result of this laser technology the full beam of these vehicles has a range of up to 600 metres, double the distance of current standard LED headlights.

OLED lighting panel revenue (2013-2021)



SOURCE: Yole Développement, OLED for Lighting - Technology, Industry and Market Trends

First High-Intensity Discharge (HID) xenon headlamps

1992

First Adaptive Front Lighting Systems (AFLS)

2003

First all-LED rear lamps

2000

First full-LED headlamps

2007

### Adaptive front lighting systems

One of the most important factors in mitigating driver fatigue and increasing safety during night driving is providing a well-illuminated field of view.

The use of matrix LED systems<sup>3</sup> combined with camera and image processing functions has allowed for the creation of new lighting functions like adaptive front lighting systems (AFLS) and glare-free lighting.

AFLS optimises the distribution of light from the headlights according to driving circumstances, and is being increasingly adopted by all major automotive manufacturers.

Depending on vehicle speed and steering input, the system points the low beam headlights in the direction the driver intends to travel. The system illuminates a greater distance and more brightly compared to halogen headlights, improving the driver's field of vision and visibility around curves and at junctions.

In particular the system helps to prevent drivers of oncoming vehicles from getting blinded when many people or a lot of luggage weighs down the back of the car, or when the vehicle position changes going over a bump or up a slope.

### Glare-free lighting

The technology is increasingly used by OEMs. For instance Ford has developed a new glare-free high beam that avoids drivers having to dip their headlights by simply blocking those rays that would otherwise shine in the eyes of other road users.

The system works alongside the company's AFLS which can adjust the headlight beam angle and intensity according to speed, light and steering direction.

It uses a windscreen-mounted camera which detects the headlights or taillights of vehicles

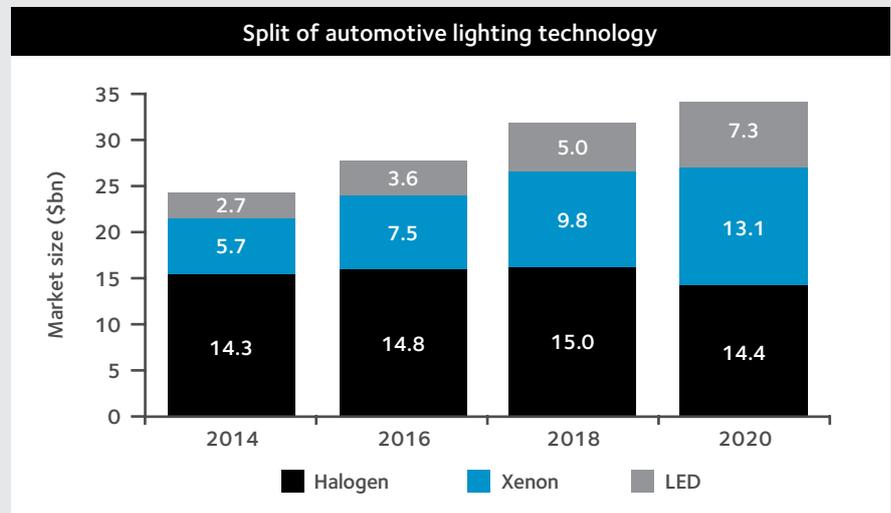
and bicycles up to 800 metres away at night, and uses specially developed headlights to block light that could otherwise temporarily blind other drivers and cyclists.

Driving with high beam headlights enables drivers to see hazards in the road much earlier. Studies have shown that automated high beam headlights are activated up to 10 times more than when drivers have to switch to such a beam themselves.

<sup>1</sup> Technavio, Global Automotive Lighting Market 2016-2020

<sup>2</sup> Osram: Trends in automotive lighting

<sup>3</sup> Yole Développement Automotive Lighting: Technology, Industry and Market trends – May 2016



SOURCE: Technavio, Global Automotive Lighting Market 2016-2020



Timeline of automotive lighting milestones:

- 2013**: First digitally controlled, full LED glare-free adaptive high beam
- 2014**: BMW and Audi launch first series production vehicles with laser headlights
- 2019**: Global automotive OLED market forecast to reach 7.74 million units
- 2020**: LED market expected to be worth \$7.3bn



## M&A activity

In 2017 electrification, autonomous driving, connectivity and the drive to lightweight vehicles will continue to be main drivers of M&A among automotive suppliers. Many suppliers will be forced to take a new strategic direction, which will fuel global M&A activity in the automotive industry, both in terms of growth and consolidation.

In particular we expect Chinese companies to continue to play a major role in technology-based M&A, especially in the European automotive landscape. Lighting is one area that Chinese investors have already been focusing on, as highlighted by a failed bid by GO Scale Capital for Philips' Lumileds business.

Philips had agreed to sell its stake to the Chinese group but this was blocked by the US Committee on Foreign Investment which argued that the deal created security concerns. Philips subsequently announced plans in late 2016 to sell a controlling stake in the business to a consortium led by US private equity group Apollo Global Management in a deal that values the division at \$2bn.

GO Scale Capital has since said it will seek other large LED industry acquisitions to combine with China's manufacturing base. "China will inevitably become the leader of the global LED industry because of its industrial ecosystem and competitive advantages in scale and cost," said its chairman Sonny Wu.

Meanwhile it was reported in late 2016 that South Korean tech giant Samsung had dropped its interest in acquiring Magneti Marelli, Fiat Chrysler's car components business. The telematics, in-car entertainment and lighting operations of Magneti were regarded as particularly attractive to Samsung, but reports say Samsung's subsequent purchase of Harman International Industries put paid to the deal.

### Recent deal activity:

- OLEDWorks, the US OLED light engine and panel manufacturing company, acquired the key OLED assets and relevant intellectual property from Royal Philips. Philips disposed of the business, which is based in Germany, to focus on lighting products, systems and services. OLEDWorks has been granted a license by Philips to market its OLED light source
- Kateeva expanded its Korean operation with the acquisition of OLED Plus, an OLED equipment design, sales, service and support company. Kateeva has developed an inkjet printing manufacturing equipment solution for flexible and large-size OLEDs. With the market for rigid OLED devices now maturing, demand for flexible OLED products is on the rise.

"China will inevitably become the leader of the global LED industry..."

Sonny Wu, GO Scale Capital

- components under the Philips brand, and Philips will remain a distributor of the panels through its OEM sales channels.
- Aixtron acquired Californian company PlasmaSi Inc., a designer of OLED applications, and integrated PlasmaSi's thin-film encapsulation process into its existing OLED product portfolio. Encapsulation is an essential process step for OLED high volume manufacturing, specifically for flexible devices. Aixtron has a track record in the successful commercialisation of deposition technologies in the semiconductor equipment industry.
- Solvay acquired US-based Plextronics Inc. to bolster its OLED electronic display technology and launch a new development platform with a strong Asian foothold. Following the deal Solvay was able to expand its emerging applications such as OLED TV screens, OLED lighting and lithium-ion batteries.
- Veeco Instruments Inc. acquired Synos Technology Inc., a designer and manufacturer of Fast Array Scanning™ Atomic Layer Deposition (FAST-ALD™) systems that enable the production of flexible OLED displays for mobile devices.
- Hella acquired Danish company FTZ Autodele & Værktøj, and the remaining 50% of its Polish JV Inter-Team.
- Valeo has made a number of acquisitions over the last year. It acquired German company Peiker, a major supplier of on-board telematics and mobile connectivity solutions, and Spheros, the worldwide leader in air conditioning for buses, from Deutsche Beteiligungs AG (DBAG).
- Magneti Marelli and Changchun Fudi Equipment Technology Development Co., a Chinese investment company active in the automotive components industry, established a JV company for the production and sale of automotive lighting systems. The two companies are already partners in a JV manufacturing powertrain components.

## Deal highlights

### Some of our recent deals

#### Finoba Automotive

##### Lightweight component processing and machining firm

Clearwater International advised the shareholder of Finoba Automotive on the disposal of its shares to China National Machinery Industry Corporation

#### Starco

##### One of Europe's leading wholesalers and distributors of industrial tyres and wheels

Clearwater International advised the owners of STARCO on the divestment of major parts of its aftermarket business to German Bohnenkamp

#### King Vehicle Engineering

##### Trailers & transport equipment solutions for specialist applications

Clearwater International advised the shareholders of King Vehicle Engineering Ltd on its sale to HW Martin Holdings Ltd

#### Mobile City

##### Leading provider of automated payment processes for several mobility related services

Clearwater International advised the shareholders of Mobile City on the sale of the company to EasyPark

#### Reverse Logistics

##### Reverse logistics services

Clearwater International advised Reverse Logistics on the structuring of two loan notes facilities with Proventus Capital Partners

#### Joyson

##### Leading global automotive supplier

Clearwater International advised Ningbo Joyson Electronic Corporation on its acquisition of Key Safety Systems, a leading global supplier of advanced engineered safety products

## Meet the team



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