

OLED LIGHTING

THE OLED LIGHTING

market is currently moving from a pilot phase to a full production model, albeit in small quantities, as manufacturers find their feet.

Projections of the market are therefore difficult to read at this stage. With so many different ideas about where OLED lighting can fit in, projecting the right figures is tricky.

Some companies, such as Novaled, are producing luminaires under a new manufacturer brand, aiming them at the

niche product market. Others, such as Philips, believe that their business lies in building design. There are also companies that see them as a replacement for the traditional compact fluorescent tubes (CFTs) found in many offices.

While the OLED display panel is continuing its ascent to the top of its market, lighting panels are at an earlier stage in their adoption curve. Displays do not have many competing technologies, and the one that is currently top of the sector, LCD, has reached a plateau, offering the consumer no more unique selling points.

In the lighting industry, LED technology is making

significant inroads. The technology has become a viable replacement for incandescent bulbs. With various governments beginning to ban incandescents, LEDs are finding a more open market. Their adoption now, with OLED still developing, could further trouble the potential of the newer technology.

PILOT-SCALE

The current state of OLED lighting is far from realising its promise with high cost, modest efficiency, and poor lifetimes inhibiting its growth. Because all manufacturing is presently on pilot-scale production lines with little automation and low throughput, labour and expenditure represent a high portion of the cost.

Much investment and development is required for OLED to realise its potential. The two biggest material needs are for more efficient, longer-life blue emitters and improved barrier films for flexible substrates.

The difference in predictions for the future of the OLED lighting market is highlighted further in various market

reports. Although all seem to agree on the size of the lighting market in general, at around \$75 billion (€54 billion) annually, the growth forecasts of OLED lighting to various points suggest little is actually known about the paths the technology could take.

LUMINAIRES

An important segment of the lighting market, luminaire lighting is perhaps not the specific target for OLED lighting. However it is a market that contributes a lot to the overall annual lighting figures, and is one where the technology could sit.

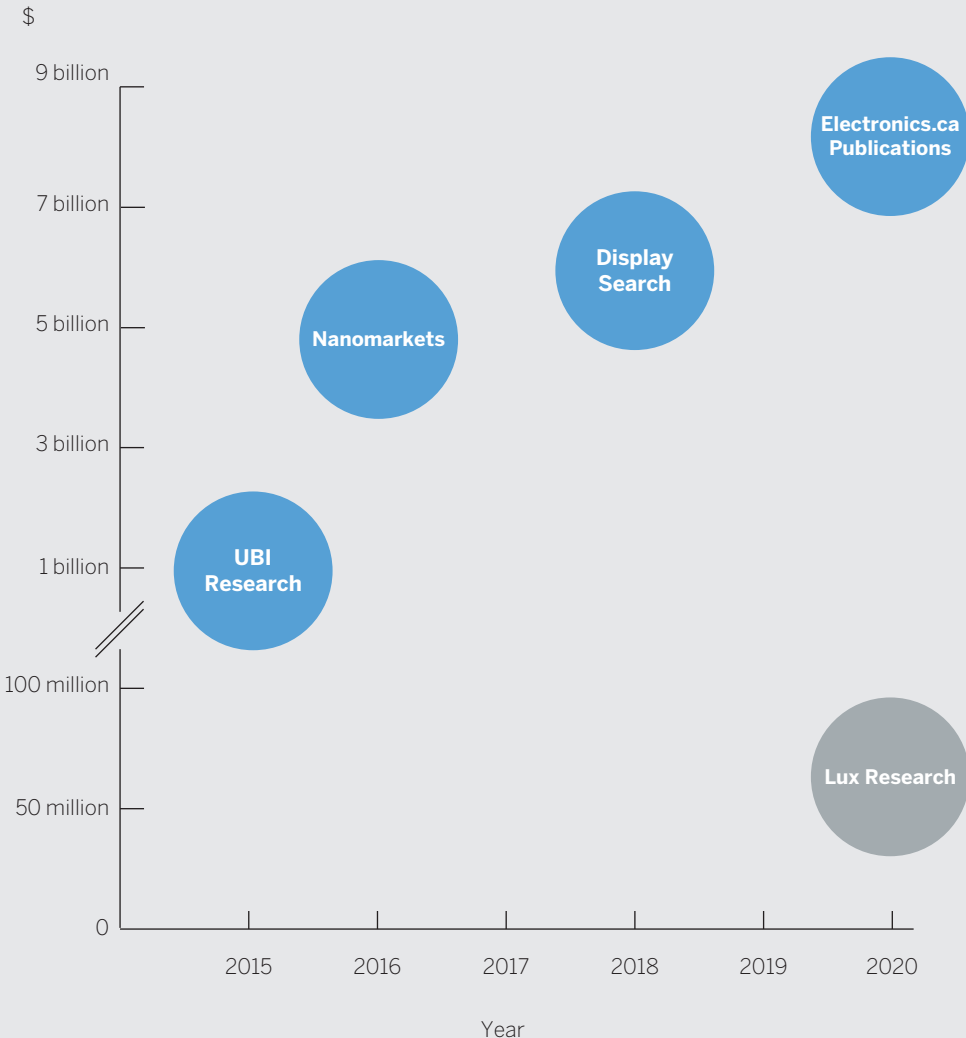
NanoMarkets predicts this segment will generate \$149.1 million for OLED lighting in 2012, based on global sales. This figure will increase to \$470.1 million by 2014, before a rapid increase to \$2.1 billion in 2016. The company states that the technology will have matured enough for mass market penetration by 2015–16, which is represented in these figures.

Lux Research, by contrast, is much more conservative. The

MARKET WATCH

Variation in forecasts for the OLED lighting market

There is a lack of consensus among forecasters of the OLED lighting market to 2012, with a wide spectrum across various publications, and one very significant outlier



Source: respective publications, collated by Smithers Apex

consultancy points out that while OLED panel manufacturers are

targeting this market through strategic partnerships with

luminaire designers, in their overall figures it will be much smaller than

NanoMarkets' predictions, with a 2020 market size of \$22 million, 38% of

TABLE 1 Potential advantages of OLED lighting

Large area diffuse light source
Thin, flat, lightweight
Form freedom in design
Fast switch-on; fully dimmable
Many colours, including whites
Robust source (no wires inside)
Transparent, mirror-like, black or white appearance
Low-voltage technology
Potentially high efficiency
Environmental product (energy efficient, recyclable)
Potentially cheap fabrication

Source: OLLA

its 2020 total forecast. This is also lower than NanoMarkets' prediction of market share, as it believes the luminaire sector will account for 44% of the total OLED lighting market by 2016.

PANEL COST

Prices are one of the main problem areas for OLED lighting at the moment. A high cost for a technology that is not proven puts many off, especially when there is no evidence of its superiority over other lighting forms.

Some manufacturers, such as Novalled, are

seizing on this by creating lamps targeting a niche clientele. Yet for the mass expansion, there needs to be a drop to around the levels of LED bulbs, which can cost \$25–\$45.

Panel prices are something that will continue to fall, as predicted by NanoMarkets. The company says that over the next 2–3 years, there will be a dramatic drop, with continual, slower falls occurring after that.

While the cost of OLED lighting will inevitably come down, as suppliers

move from today's pilot plants to full-scale manufacturing, it should be considered that this transition could happen too late.

Perhaps affordable OLED lighting, when it finally arrives, will find a customer base that has only recently adapted to LED lighting and is highly resistant to making another change.

While NanoMarkets sees the overall prospects for the OLED lighting market as remaining strong, it also expects to see a major decline in OLED retail prices in the next two years, as mass production technologies start to be applied to this kind of lighting. This pricing trend is expected to dampen OLED lighting revenues for the next three years, until OLED lighting efficiency, panel size and light output have improved to the point, where it is acceptable in mainstream and mass-market residential and business lighting markets.

Lux Research agrees, forecasting an overall cost reduction of 94% in 2011–20, from \$18.06 per lumen to \$0.71/lm. Despite the

decline in absolute cost, Lux predicts the expenditure will increase as a percentage of the overall cost, from 38% now to 51% in 2020, as processing scales and becomes more automated.

In terms of flexible OLEDs, these are cheaper overall, and it is projected that they will decrease to \$0.18/lm in 2020 – a dramatic drop from \$6.92/lm today, but still twice the current cost of LEDs.

DESIGN

Because OLED will not be able to compete with incandescent, fluorescent, or even LED on a cost basis, according to Lux, its best opportunity is in designer lighting. It will be used particularly in places that can absorb high-priced fixtures, such as casinos, cruise ships, high-end hotels, and upscale bars and restaurants.

Since design is the main driving force in this market, the introduction of commercial flexible panels, which the company expects in 2015, will provide a big bump for OLEDs. Nonetheless, these markets are

TABLE 2 Roadmap issues and elements for OLED lighting manufacturing

Manufacturing strategies
Cost reduction
Luminaire assembly
Sizing issues and brightness Variability/binning Electrical circuits Reliability issues Physical protection Product differentiation and market expansion
Substrates and encapsulation
Substrate and encapsulation material selection Substrate coatings Transparent anodes Out-coupling enhancement structures Encapsulation
Batch processing on rigid substrates
Deposition of organic layers Cathode deposition Patterning techniques Inspection and quality control
Web processing on flexible substrates
Web handling Deposition of organic layers Cathode deposition Patterning techniques Inspection and quality control
Source: OLLA

relatively limited. Of course options other than OLED abound for creative craftsmen; all told, this market for OLED lighting reaches to just \$32 million in 2020.

According to the Electronics.ca report *OLED Displays and Lighting Market to*

2020 - Technological Innovations Lead to Cost Efficient Products and New Aesthetics, the primary revenue driver for OLED lighting is expected to be speciality lighting.

Some of the applications that OLED lighting is targeting are also served by compact fluorescent

lamps, which turns OLED into a replacement technology. This makes it a difficult item to sell, as companies will have to weigh up the cost of taking all existing systems out, to put in as yet unproven and costly technology, which may struggle to match the existing lifetimes.

In terms of architecture – another important area where OLED lighting is expected to make a breakthrough – NanoMarkets believes that the unique features of OLEDs, such as flexibility and colour tunability, make OLED lighting technology highly suitable. NanoMarkets sees architectural applications of OLED lighting generating more than \$950 million by 2016.

TOTAL FIGURES

UBI Research expects that leading OLED lighting companies will expand their product lines, and Chinese companies will also make massive investments in the OLED lighting industry, which will increase the industry by 500% annually all the way to 2015. This year would see a shipment volume of 25 million

units OLED lightings in an expected \$1 billion OLED lighting market.

UBI's prediction is modest, with only Lux Research's coming in lower with its projected a total OLED lighting market of \$58 million in 2020, dominated by designer lighting and luminaires.

According to Lux, the potential for OLED lighting has led to some lofty, over-hyped expectations; as in many emerging technologies, these unrealistic projections of growth may produce disappointment when results do not match the hype. However, as long as companies continue to invest in OLED lighting, which seems likely given the interest in the field, and the strategic play it constitutes for companies from LG Chemical to Philips, it will continue to improve, and become more competitive with other lighting sources.

The large divide on cost, efficiency and lifetime between OLED and LED (not to mention incandescent and fluorescent) lighting, will take a long time to close,

or even to become close enough for designers to employ OLEDs. While the technology could always sputter out entirely, Lux still foresees potential for OLED to begin to take significant lighting market share after 2020.

But this is a view that is not shared by NanoMarkets. It believes the time for growth in the lighting market is 2015–16. The company predicts that the global market will achieve \$4.8 billion by 2016. In comparison, Lux Research believes at this point the market will be achieving \$15 million.

Electronics.ca's projections to 2020 are certainly not as conservative as those presented by Lux. The firm's projections show the market achieving growth to \$8.3 billion by this time. DisplaySearch, meanwhile, predicts a 2015 total of \$1.5 billion in its 2009 report *OLED Lighting in 2009 and Beyond: The Bright Future*. That figure rises to a high of \$6 billion in 2018, a figure in between NanoMarkets and Electronics.ca, and perhaps pointing to growth for the market.

TABLE 3 Comparison of encapsulation method and cost for OLED lighting

Barrier material	Barrier material cost (\$/m ²)	Total encapsulation cost (\$/m ²)
Metal foil	1–2	5–10
Soda lime glass	4	10–70
Soda lime glass with desiccant pocket	30	35–40
Low WVTR barrier film on plastic	50–200	55–210
Thin-film encapsulation	80–160	8–160

Source: Kodak

DisplaySearch believes this figure will be helped by manufacturers turning their display fabrication facilities to OLED lighting. The report also predicted that 2011 would be a turning point for the technology when it was first published in 2009. To a degree this has proven to be true, with companies launching new luminaires to take advantage of an almost empty marketplace.

CONCLUSIONS

The general consensus of all these reports is that OLED lighting will be successful up to 2020, with continued growth as prices fall. However Lux Research is much more conservative in its estimates, blaming the hype of the technology for allowing figures to get carried away. The

consultancy also believes other technologies will continue to dominate, particularly while retail prices are so prohibitive. Further work on reducing costs across all aspects of an OLED light, from materials and components to processing, may be needed (see Table 3).

The market is difficult to predict, as the technology is still developing, and there is still no mass-market product feedback. A confusing picture is painted by the varying figures.

The OLED display market is forging ahead. Developments like larger screen panels suggest the technology can grow. However it is competition that will ultimately limit sales of one technology,

and in the lighting market, end users do not often change their entire luminaire or lighting setup too often +

THIS ARTICLE IS BASED ON DATA FROM THE FOLLOWING REPORTS:
 - *FINDING THE END OF THE TUNNEL FOR OLED LIGHTING*, LUX RESEARCH, 2011
 - *OLED LIGHTING MARKET FORECAST Q2 2012*, NANOMARKETS, 2012
 - *OLED LIGHTING IN 2009 AND BEYOND: THE BRIGHT FUTURE*, DISPLAYSEARCH, 2009
 - *OLED DISPLAYS AND LIGHTING MARKET TO 2020 – TECHNOLOGICAL INNOVATIONS LEAD TO COST EFFICIENT PRODUCTS AND NEW AESTHETICS*, ELECTRONICS.CA, 2011
 - *OLED LIGHTING INDUSTRY ANNUAL REPORT*, UBI RESEARCH, 2012