



International SSL Alliance



Market volume is about 1,2 billion US dollars

# ISA Global SSL Industry Quarterly Report

## (2023-2)

INDOOR – MARKET-LEADING EFFICACY (ENERGY EFFICIENCY = Lumens/Watt)



ISON™ PUREMOTION™ UV-C Gen1 | IPAU1

ISON™ LINEAR LED High Bay Fixture, Gen1 | HBAF1

HARRIS Star Line Freezer High Bay | HSLF1

HARRIS LED High Bay UFO, Gen3 | HBUF3

HARRIS LED LDR Troffer Retrofits, Gen2 | LDRE2

# International Solid-State Lighting Alliance

## SSL Industry Quarterly Report 2023-2

Editor: J. Norman Bardsley

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#### 1. Introduction:

One of the themes of our first quarter report was affirmed by Siegfried Luger in the July/August issue of LED Professional Review<sup>1</sup>. In his editorial, Siegfried writes

“Nowadays, energy efficiency is resuming a more dominant role. It involves optimizing the efficiency of lighting systems to reduce energy consumption, lower electricity costs, and minimize environmental impact. Some critical aspects of energy efficiency in lighting are LED

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<sup>1</sup> LED Professional Review Issue 98, July/August 2023: available from <https://www.led-professional.com/lpr-magazine>

Lighting, Lighting Controls, Efficient Lighting Design, Labeling Programs, Maintenance and Inspection, Natural Light, Awareness & Education.”

Energy efficiency will be particularly important in providing the healthy indoor lighting that has been promulgated by the “Good Lighting Group”. In a commentary in this same issue of LPR, Jan Denneman states “During the day, people need at least 250 Melanopic Equivalent Daylight Illuminance (m-EDI lux) for an effective impact on their biological clock. In many indoor spaces that are adequately lit for vision, people receive two to five times less light in their eyes than this recommendation.”

The scientific arguments for substantial increases in the level of indoor lighting during daytime and reduced illumination in the evening and night-time were summarized last year in an article by a large group of experts in PLOS Biology<sup>2</sup>. Their recommendations are included in the draft standard ISO 8995 for indoor lighting.

The negative impact of traditional indoor lighting in classrooms has been well documented in China and elsewhere and the industry needs to pay attention to these recommendations. However, greater efficiency will be needed to avoid increases in the global use of electricity for lighting. The typical system efficacy of 100-150 lm/W is not enough.

In his editorial for LPR98, Siegfried Luger also reminds that from August 25th, 2023, fluorescent T5 and T8 lamps will be banned from being placed on the European Union market. “This significant transformation requires safe and efficient changeover concepts for new installations and retrofitting that comply with technical and legal regulations.” This challenge is discussed in section 4. The US Department of Energy has finally approved regulations on efficacy that will make most incandescent lamps illegal, starting on August 1, 2023.

Data from LEDInside confirmed that 2022 was a difficult year for the global LED industry. They estimate that revenues for LED chips and packages were down by 19% to US\$14.2B, despite a 40% increase in the demand for mini-LEDs in displays. The chart below shows that they expect the recovery to be steady but slow, and that revenues may not exceed the 2021 level until 2026.

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<sup>2</sup><https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3001571>



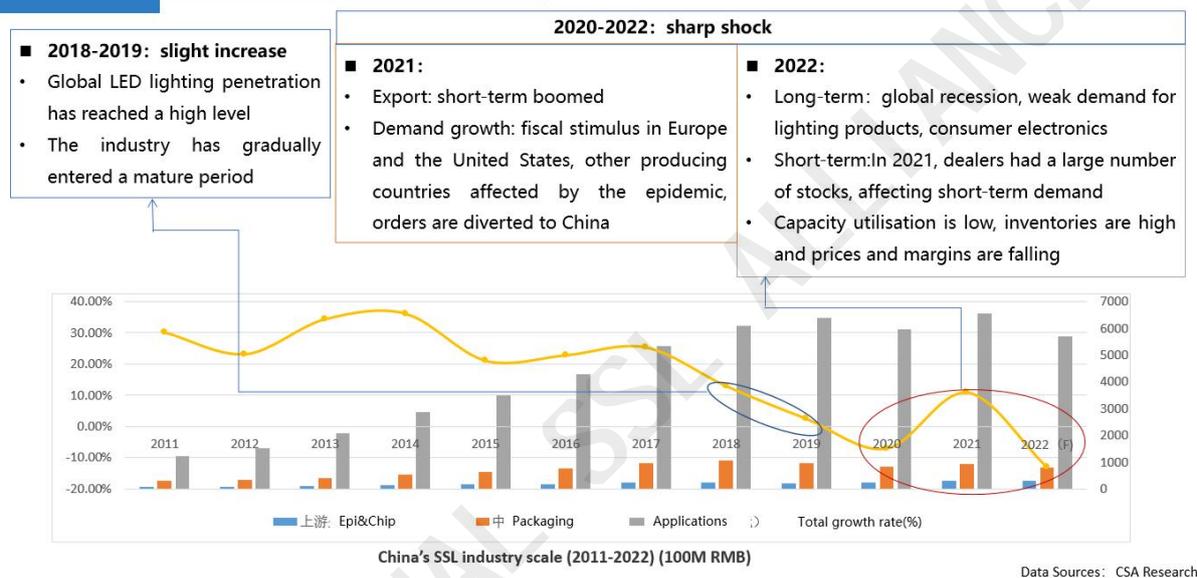
Outdoor lighting remains an attractive market for LED lighting, since there are many benefits beyond energy savings. The status of the streetlight market in Australia and New Zealand is discussed in section 5.

## 2. The View from China

At the 2023 meeting of the ISA BRICS Working Group, an overview of the status of solid-state lighting was given by Jun Ruan, Secretary General of the China Solid State Alliance (CSA). His presentation included production and market data for the full year of 2022 and valuable insights into recent developments. This section is based mostly on his report and on news articles published on the Aladdin Lighting Network web site at [alighting.cn/news](http://alighting.cn/news).

The impact of COVID-19 on the SSL industry in China are shown clearly in the slide below.

### Shock caused by COVID-19: Disordered industry cycles



Domestic demand for LEDs and lighting products has been constrained by the lockdown measures in China. Exports were impacted by higher transportation costs as well as strained global economies. Given the fierce competition in the post-epidemic era, the pace and intensity of recovery in different markets, regions, and fields of the lighting industry are not the same, resulting in large differences in expectations among the thousands of enterprises. This situation will also exist for a long time.

### 2.1 Chip Manufacturing

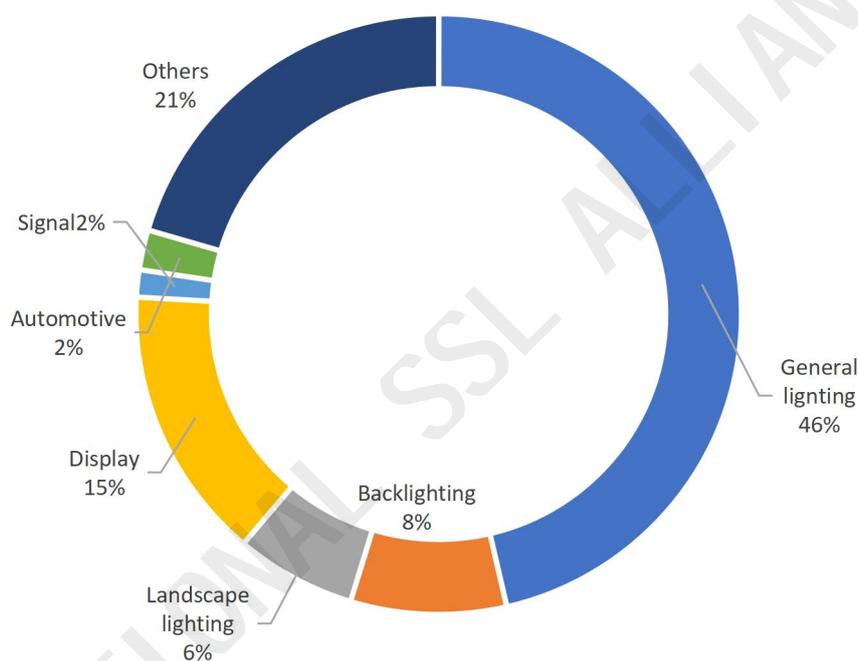
In 2022, the output value of epitaxial products was RMB 28.1B yuan, down 8% year-on-year. The leading companies are looking beyond general lighting applications in order to maintain their growth. This includes a greater emphasis on automotive lighting and mini-LEDs for displays. In the future this may extend to micro-LEDs to enable the production of direct-view LED displays at all screen sizes. In 2022, LED chip companies invested more than RMB10B yuan in the Mini/Micro-LED field. Further afield, manufacturers such as Sanan and HCSemitek are developing GaN and SiC technologies for the whole range of power devices. Changelight is developing VCSELs at multiple wavelengths.

## 2.2 Packaging

The output value of packaging in 2022 was RMB 77.8B yuan, declining 15% year-on-year. Since profitability can be higher in specialty lighting applications, most package producers are collaborating with other companies with better understanding of the needs of each application.

## 2.3 Applications

In 2022, the output value of applications was RMB 569.1B yuan, down 13.1% year-on-year. As seen below in data from CSA Research, general lighting now contributes less than half of the total market.



*Data sources : CSA Research*

**Classroom lighting:** Within general indoor lighting there has been special interest in classrooms. China has >550,000 primary and secondary schools, > 4 million classrooms, and > 200 million students. It has been clearly demonstrated that improved lighting leads to better student health as well as more effective education. Technical specifications and guidelines have been formulated for classroom lighting, recommending  $R9 > 50$  and encouraging the use of full-spectrum sunlight lamps ( $R1-R15 > 90$ ). Average illuminance should be at least 300lux.

From January to June in 2023, at least 26 regions across the country announced classroom lighting projects. About 172 projects were implemented at a total cost of 538M yuan. The goal is to upgrade all classrooms in China by 2025.

Outdoor lighting: Major lighting projects by regional and local governments are also an important part of the outdoor lighting market in China. As part of the recovery from COVID, many regions in China are keen to promote tourism and encourage outdoor activities. The editor of the Aladdin Lighting Network has compiled a list of 71 projects, each costing over RMB 50M yuan, in the first half of 2023. The total value of these contracts was RMB 9B.

Several issues have been raised about the proliferation of night scene lighting. The increased need for lighting and air-conditioning in urban homes means that the peak demand for electricity extends into the evening hours. City residents may not appreciate the incursion of light into their bedrooms and the impact on skyglow and wildlife is of concern to others. Regulations of night scene lighting, such as that shown below, are being formulated in Quanzhou.



*Source: Aladdin Lighting Network*

These problems have been compounded by the high temperatures experienced in many regions this year. The Shantou City Development and Reform Bureau and the Shantou Power Supply Bureau of Guangdong Power Grid Co., Ltd. jointly issued the '2023 Shantou Electricity Conservation Proposal'. "The proposal proposes to strictly control lighting facilities such as landscape lights, and try to reduce the time and number of lights turned on for parks, scenic spots, scenic spots, and building beautification lighting. During the peak period of electricity consumption, landscape lights, advertising lights, neon lights, and outdoor electronic screens should all be turned off".

Automotive lighting: Despite the emphasis on automotive lighting, the sector contributes only about 2% to total revenues (about RMB 11B yuan). The penetration rate of LED headlights in new vehicles sold in China is now over 72%. The penetration rate for electric vehicles is even higher, at 92% in 2022. CSA estimates that the global automotive LED market was US \$3.27B (RMB 23.4B yuan) and is growing at 4% per year. This suggests that about half of the global market is being met by Chinese suppliers.

LEDInside reports that “due to fierce competition in the vehicle market, prices of automotive LEDs have dropped noticeably, consequently delaying several projects for LED product development. That being said, advanced technologies related to ADB headlights, Mini LED taillights, full-width taillights, logo lamps, and (intelligent) ambient lights will jointly push the automotive LED market value to USD 3.31B in 2023”.

UV lights: LEDInside has provided a status report on applications of UV light. “In the UV-C LED sector, most home appliance manufacturers delayed product development plans due to weak consumer spending, indicating their lower willingness to introduce UV-C LED products. Further, UV LED manufacturers adopted low pricing strategies with hopes of increasing orders and revenue, throwing UV-A/UV-C LED prices into chaos. Overall, the UV LED market value for 2022 plunged to USD 207 million. Moving in to 2023, major UV LED manufacturers will maintain the target on double-digit growth. Moreover, projects involving UV-C LED applications are likely to be relaunched thanks to less strict COVID-19 restrictions in China. UV-C LED manufacturers are also racing to develop air disinfection, household water purification and industrial / commerce. To meet the requirements of high-power disinfection, these companies will roll out single-chip high power products and novel integrated packages. The UV LED market value is expected to rise to USD 411M in 2027 with a 2022-2027 CAGR of 15%ial water markets.”

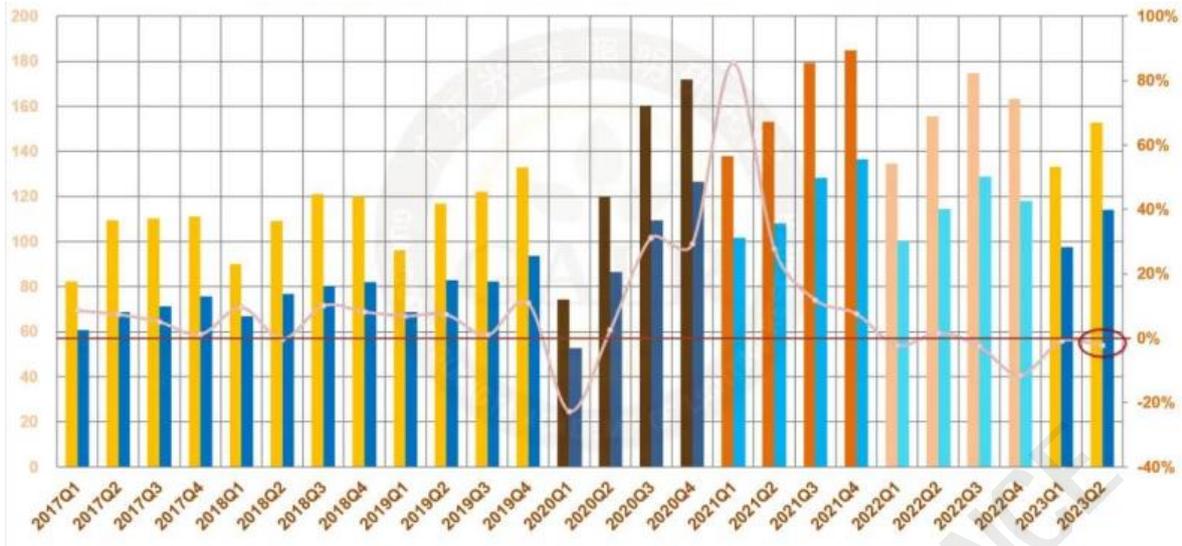
“Seoul Viosys continued to generate the highest UV LED revenues between 2019 and 2022. Benefiting from growth in UV-C LED revenue, Nichia came in second, followed by Asahi Kasei (Crystal IS) in third place thanks to orders from Japanese home appliance brand DAIKIN. By developing UV Micro LED business, Nitride Semiconductors saw only a 10% dip in UV LED revenue in 2022.

Currently, UV-C LED’s optical power reaches 40-120mW (350mA). Nichia, ams OSRAM, LITEON, UVT, and Stanley have announced  $\geq 100\text{mW}$  UV-C LED single-chip products. In particular, LITEON’s mass produced UV-C LED (single chip) boasts an optical power level of 175mW (600mA) thanks to the company’s exceptional light extraction patents. Asahi Kasei (Crystal IS), Violumas, and NKFG plan to roll out their  $\geq 100\text{mW}$  UV-C LEDs in 2H23 with better product reliability, namely a lifetime of  $\geq 10,000$  hours (R70).”

## 2.4 Exports

The decline in exports of lighting products from China accelerated in 2022Q4, with a year-on-year fall of 12%. The year-on-year decline continued in the first half of 2023, but at a lower rate of 1% in Q1 and 2% in Q2. The value of exports in 2023H1 was US\$28.6B, down by 1.4%. Price increases helped to moderate the decline, but unit volume was down by 13.4%. The export value of LED lighting products was US\$21.2B, accounting for 74% of the overall export value, down 0.8% year-on-year. There is clearly market resistance to the higher costs of LED.

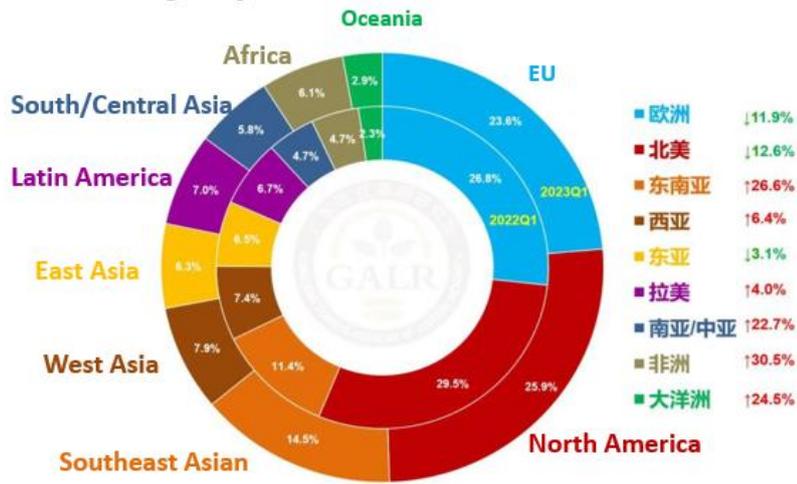
The following chart shows the value of lighting product exports from China since 2017. The higher bar in each quarter is for all technologies, while the shorter one is for LED products. The unit used on the left-hand side is hundred million US dollars. The continuous line shows the year-over-year change, with the scale on the right-hand side.



The next chart shows the change in exports of the different types of lamp between 2022H1 and 2023H1. This shows that global demand for LED tubes has risen substantially due to the impending bans of fluorescent lamps.



The geographic distribution of exports, shown in the chart below, confirms that although demand is growing in developing economies, Europe and North America still account for around half of the exports.



Data Sources : alighting.cn

The next chart show that lighting exports to Russia have continued since the invasion of the Ukraine, but that exports to Ukraine have dropped sharply.



### 3. Company Reports

#### 3.1 China and East Asia:

Chinese manufacturers of LED chips and packages reported mixed results for the full year of 2022 and the first quarter of 2023.

- For 2022 **Sanan Optoelectronics** reported a 5.2% increase in revenues to CNY13.2B. However, net income fell to CNY 685M compared to CNY 1,313M in the previous year. Revenues were down slightly in 2023Q1 to CNY2.9B. Net income was CNY213M, reversing a loss of 302M in 2022Q4 but still well below the CNY429M in 2022Q1. Sanan has reaffirmed that its joint venture with ST Microelectronics will spend US\$5B to build an 8-inch SiC substrate factory in Chongqing, which is expected to be put into operation in the fourth quarter of 2025 and fully completed in 2028. In 2030, silicon carbide revenue will exceed US\$5 billion (approximately RMB35.6B). Sanan continues to receive substantial government subsidies, totalling \$1.03B in 2022. This support accelerated in 2023H1 with a further 1.01B yuan. Hunan Sanan received the highest proportion of subsidies in 2023, including 525B yuan for equipment purchases.

- 2022 was a difficult year for **Huacan Optoelectronics** (HC Semitek) with revenues falling by 25% to CNY2.35B. Net income showed a loss of CNY147M compared to a profit of CNY94M in 2021. A further loss of CNY124M was reported in 2023Q1 as revenues fell to CNY399M from CNY 677M a year ago. To help boost its finances, HC Semitek has issued new shares to BOE for CNY2.08B, perhaps indicating a greater focus on display applications.

In 2022 HC Semitek received CNY 326M in government subsidies, down from CNY 424M in 2021.

- Chipmaking in Taiwan has also suffered, despite the merger of Epistar Corporation and Lextar Electronics Corp to form **Ennostar**. Its revenues in 2022 were TW\$28.9B, down 21% from 2021. Net profit was a mere TWD38K, compared to TW\$2180K in 2021. The decline in revenues continued into 2023, with a decrease of 39% in the first 5 months. Ennostar has seen substantial growth in sales of mini-LEDs for displays and is looking forward to the production of microLEDs. It also hopes to supply mini-LEDs for automotive applications in 2023.
- **Mulinsen**, a manufacturer of LED packages and major global supplier of lamps, reported 2022 revenues of CNY16.6B, down 11% from 2021, and net income of CNY194M, well below that of the previous few years. A substantial fraction of Mulinsen's income reduction came from its factory in Russia, which lost an estimated CNY200M. For the first quarter of 2023, the company reported revenue of CNY 4.08B compared to CNY 3.99B a year ago. Net income was CNY 141M compared to CNY 182M million a year ago.

- **Shenzhen Refond Optoelectronics** has focused its packaging business on Mini-LED backlight, direct display, touch display, automotive and laser applications. For 2022 the operating income was reported as CNY1.34B, a year-on-year decrease of 9.27%; net profit was about CNY12M, a year-on-year decrease of 88%. In May 2023 the company provided a detailed analysis of its performance in each market segment in 2022<sup>3</sup>.
- **Everlight Electronics** reported 2022 revenues of TW\$19.9B, down by 20.5% since 2021. Net income fell by 37% to TW\$1.2B. In 2023Q1 revenues were down year-on-year to TW\$4.5B but net income was flat near TW\$460M.
- Moving downstream to a major lighting company, **Oppl's** revenues in 2022 fell by 18% to CNY7.3B, the lowest level since 2017. Net income also fell by 14% to CNY 786, also a five-year low. 2023Q1 brought better results, with revenues of CNY1.5B, up slightly from CNY1.45B year-on-year. Net income also rose to CNY 97M from CNY64M in 2022Q1.

Rising costs in China mean that the prices for LED chips and packages have fallen below the cost of production. Several leading manufacturers announced price increases of 5-10% in the first half of 2023.

**Seoul Semiconductor** (SSC) claims to be the third largest global manufacturer of chips and packages, after Nichia and AMS Osram. 2022 was a difficult year, with revenues falling by 15% to KRW1109B. Despite the reduction in sales, they increased R&D spending by 20% to KRW101B. SSC's problems continued into 2023Q1, with revenues of KRW225B, down 22% from a year earlier. They reported an operating loss for the third quarter in a row.

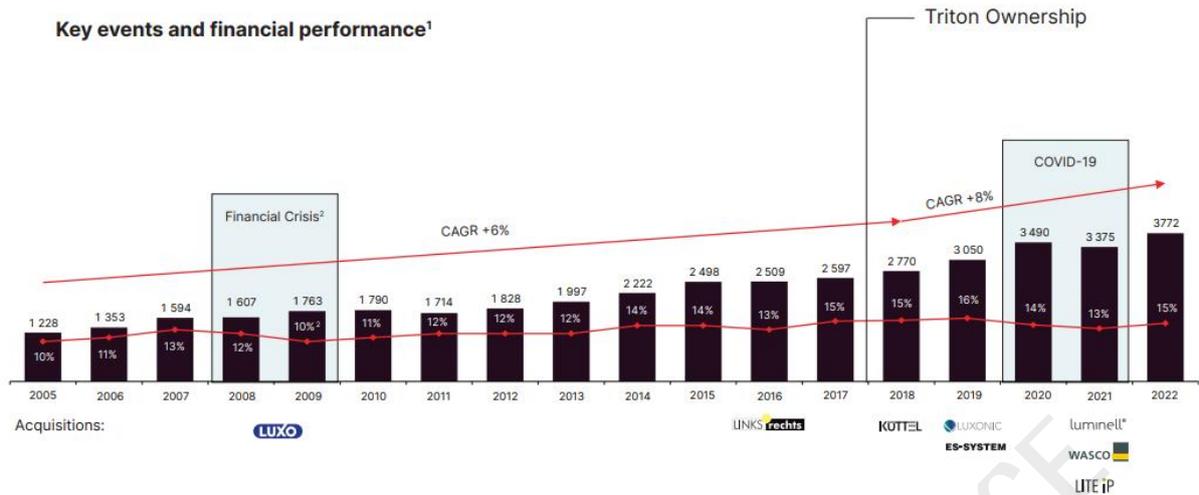
**Seoul Viosys** (SVC) is a smaller Korean company emphasizing emerging markets, such as UV and microLEDs. Their revenues also fell in 2022 to KRW439B, down 10% from 2021. 2023 began well, with 1<sup>st</sup> quarter revenues up by 15% y-o-y to KRW111B. UV applications contributed only 8% to their sales in the quarter. SVC has reported operating losses for five consecutive quarters, with operating margin deteriorating to -17.8% in 2023Q1.

### 3.2 Europe:

Many of the small and medium sized European lighting companies are privately owned and do not publish financial reports. One exception is **Fagerhult**, which is based in Sweden but now has subsidiaries in 27 countries. Sales in 2022 exceeded pre-COVID levels, rising by 17% to 726M euros. Operating profits remained steady at 10% of sales and orders reached record levels. The progress continued in 2023H1, with sales increasing by 11.6% year-on-year and operating profit rising by 23.9%. Growth was particularly strong in Finland, Turkey and the UK.

**Glamox** is another mid-sized company in Scandinavia, with headquarters in Norway. Founded 75 years ago, Glamox has a remarkable record of steady sales growth over the past 17 years, including two stressful economic periods.

<sup>3</sup> <http://www.china-led.net/news/202305/16/51937.html>



Glamox has two major business units, ‘Professional Business Solutions’ (PBS) and ‘Marine, Offshore and Wind’. PBS helps schools, hospitals, offices, warehouses, industry, and stores to reduce their energy costs and carbon footprint. In recent years it has emphasized “Human Centric Lighting that syncs with people’s circadian rhythms to help them sleep, feel, and perform better.” MOW provides LED luminaires and connected lighting systems to the commercial marine, cruise & ferry, navy & coastguard, and offshore energy sectors.

In 2022 the total revenues at Glamox rose by 12% to 334M euros with operating profits of around 9%. Sales gains were higher in the MOW business segment, but profitability lower.

One highlight of 2022 was the installation of about 640 Glamox marine LED luminaires on an electrical substation that was launched from Haugesund, Norway and is now installed at the Dogger Bank A windfarm about 80 miles off the northeast coast of England. This is a fine example of collaboration between the lighting and renewable energy industries.



Let us now look at the results of the larger European lighting companies. In the fiscal year ending March 31, 2023, **Zumtobel** reported that its sales had finally exceeded pre-COVID levels, with group revenues increasing by 5.3% to EUR1,209M. Growth was stronger in the lighting segment at 6.9%, compared with 1.2% in the components segment (Trident). Sales were particularly strong in Switzerland and Germany. Net profits rose by 32% to EUR60M as

growth in revenues offset higher costs for material, energy and personnel as well as the USD appreciation.

In its annual report, Zumtobel provides a table demonstrating the potential energy savings achievable by the installation of LED lighting systems.

## ENERGY SAVINGS THROUGH LIGHTING REFURBISHMENT

Application	Luminaire old	Energy consumption old [kWh/m <sup>2</sup> ·a]	Luminaire new	Energy consumption new [kWh/m <sup>2</sup> ·a]	Amortisation in years <sup>1</sup>	Reduction of energy consumption	Savings in €/a <sup>4</sup>	Reduction of CO <sub>2</sub> equivalent [kg/m <sup>2</sup> ·a]
Industry <sup>1</sup>	 COPA I	37.54	 CRAFT II plus	11.58	1.1	-69 %	8,963	5.69
	 TECTON-I	40.38	 TECTON C	9.54	0.89	-76 %	10,647	6.75
Office <sup>2</sup>	 ONDARIA O	30.76	 ONDARIA	13.04	2.93	-58 %	497	3.88
	 RTX II	34.32	 ECOOS II	13.46	4.73	-61 %	585	4.57
Boutique <sup>3</sup>	 SPIRIT	88.98	 VIVO II	48.43	1.89	-46 %	875	8.88

FY 2022/23 results

<sup>1</sup> Industrial warehouse; 40m/20m/8m  
<sup>2</sup> Office space; 10m/6m/2.8m

ZUMTOBEL Group

<sup>3</sup> Boutique; 5m/10m/5m  
<sup>4</sup> The calculations are based on a price of 30 cents/kWh

6

AMS-Osram is still reorganizing towards its goal of providing complete optical solutions for key applications.

### Sensing



### Illumination



### Visualization



#### Emitters



- LED incl. NIR, IR, UV-C
- MicroLED
- EEL / VCSEL
- Lamps

Key solution components

#### Optical components & micro-modules



- Optical elements
- Micro-optical packaging
- Optical modules

#### Detectors



- Light sensors
- Image sensors
- Other optical

#### Integrated circuits & algorithms



- Emitter driver ICs
- Sensor interfaces
- Sensor processors (incl. algorithms)

In fiscal year 2022, consolidated revenue decreased by 4% to EUR 4.82B, compared to EUR 5.04B in 2021. The decrease was primarily due to sales from disposed businesses amounting to EUR 307M. The discontinued units include Automotive Lighting Systems (AMLS), Fluence Bioengineering, Inc., Digital Systems (DS) North America, Connected Building Applications (CBA), and Traxon Technologies. The Semiconductors segment contributed EUR 3.16B (2021:

EUR 3,28B), which equates to a share in sales of 66% (2021: 65%). The Lamps & Systems (L&S) segment contributed EUR 1.65B (2021: EUR 1.76B) to consolidated revenue, which equates to a share in sales of 34% (2021: 35%).

In the first half of 2023 the company reported continued lower demand in LED industrial, outdoor, and horticulture lighting, but certain signs of stabilization in other industrial markets. With the disposals of the Entertainment Lighting and Digital Systems (Europe/Asia), all businesses outside of their strategic focus areas now are closed. Total revenues decreased by 27% from 2022H1 to EUR1778M. The reduction was partly, but not completely, due to the business disposals. The Semiconductor segment contributed 65% of sales, with 35% coming from Lamps & Systems.

Despite the challenges of the restructuring, AMS-Osram has reaffirmed its commitment to LED manufacturing with the construction of the first 8" wafer fab in Malaysia. Capital expenditures in 2023Q1 were EUR302M and will be close to EUR1B in the whole of this year, almost double the spending in 2022.

In its annual report for 2022 **Signify** noted significant challenges in its global business. Following the start of the war in Ukraine, Signify stopped investments and paused new business in Russia. Sales in China were held back by continued COVID-19 disruptions. Nevertheless, Signify increased its sales by 9.5% to EUR7.5B million. Net income increased from EUR 407 million in 2021 to EUR 532 million in 2022. The table below shows that the growth was spread across the globe. Despite this positive overall performance, it is disappointing that non-LED products still account for 18% of Signify's sales.

Sales by geography in millions of EUR unless otherwise stated

	2021	2022	Change	CSG
Europe	2,130	2,230	4.7%	3.9%
Americas	2,581	2,978	15.4%	3.2%
Rest of the world <sup>1</sup>	1,606	1,709	6.5%	(1.5)%
Global businesses <sup>2</sup>	543	597	9.9%	(9.2)%
<b>Total</b>	<b>6,860</b>	<b>7,514</b>	<b>9.5%</b>	<b>1.2%</b>

<sup>1</sup> Rest of the World includes Pierlite since April 29, 2022.

<sup>2</sup> Global businesses includes Fluence since May 2, 2022.

Along with most industry leaders, Signify is committed to reducing the environmental impact of its products. It has launched new 'Philips StoreFlow' retail lighting, 'Interact Retail' hybrid lighting controls, and a range of luminaires made from waste materials. Philips StoreFlow is made of at least 68% biobased plastic, reducing the CO<sub>2</sub> footprint of the plastics by ~80%. The efficacy ranges from 120lm/W up to 142lm/W.

In the first half of 2023 Signify experienced "persistent weakness in the consumer segment and the indoor professional business, softness in horticulture lighting and a slowdown in OEM sales". Recovery of Chinese market was slower than anticipated. Good signs included positive traction in the outdoor professional and professional connected lighting businesses, and resilience in Digital Solutions. Revenues were EUR 3.32B, down by 8.3% from EUR3.62B in 2022Q1. Some of the revenues came from acquired businesses and comparable sales

declined by 8.9%

### 3.3 India:

Financial results for FY2022-23, which ended on March 31, 2023, show mixed performance for the leading lighting companies. Bajaj Electricals, Havells and Surya Roshni report increased sales for their lighting divisions, while Crompton Greaves and Dixon saw reduced sales.

At **Surya Roshni** LED lighting witnessed strong revenue growth of 27% during FY23, with growth in both B2C and B2B. Consumer Lighting grew by 12%, along with higher growth for value added products. Professional Lighting saw 38% growth YoY in revenue, with a robust order inflow. The downtrend in LED lighting bulb replacement cost continued (~457 bps from 678 bps). Remarkable growth was reported in new age smart LED products. Before-tax profits in the Lighting and Consumer Durable business unit grew by 24% to 900M rupees (INR 90crore).

IllumiNation is a quarterly on-line magazine published by ELCOMA. In its April edition, Jitendra Agrawal, CEO of Lighting and Consumer Durables at Surya Roshni, recommended that “the Indian industry should work with lighting authorities, opinion makers, customers and regulatory authorities to raise the lighting specification and standards for all applications”. He also urged the Indian government to “ensure compliance of standards by all manufactures. They may start with at least one application such as Street Lighting, make world class standards and enforce them across the industry. This can not only help in improving public lighting and its maintenance to global standards but also prep up the local industry to vie for global markets”.

The Lighting and Fixtures segment of **Havells** reported sales of INR 1602crore (16B Rs), up by 15% from the previous year. However, profits fell slightly from INR 258crore to INR 247crore.

The revenues of the Lighting Solutions segment of **Bajaj Electricals** in FY2022-3 rose by 4% to INR1125crore. Profits increased more rapidly by 48% to INR87crore.

The April 2023 edition of IllumiNation includes an advertisement from Bajaj Electricals for its ‘Supremo’ Solar streetlight with an impressive head efficacy of up to 195 lm/W. In ‘super-bright mode’ operation, the 12W lamps produce 2100lm while the 48W version gives 7200lm, showing a system efficacy of 1980 lm/W. A motion sensor is available and the company recommends running a dim-mode at 20% of full power and a normal bright mode at 40-50% power. The power is generated by 40-80Wp solar cells and stored in batteries with capacity of 115 Wh to 345Wh.

**Crompton Greaves** reports that lighting segment revenues declined by 8% in Q4, but margins have improved consistently despite cost headwinds. For the full year ending March 31,2023, lighting revenues fell by less than 1% to INR 1054crore. Profits were down on the year by 14% to INR100crore as both B2C and B2B trade in LED products faced pricing pressures.

**Dixon** reported that its lighting revenues for FY2022-3 fell by 18% to INR 1055crore, but profits rose by 3% to INR 90crore.

The January 2013 issue of IllumiNation contains an interview with Atul B Lall, Vice Chairman and Managing Director of Dixon Technologies. He reports that Dixon has “already committed a capex of INR 100 Crores for lighting components under the government’s Product Linked Investment scheme. The first phase of investment has already been done and production of components is going to start in the current quarter. Components to be produced are LED drivers, LED Engines, LED modules, mechanicals- housing, wire wound inductors and LED Light management system (LMS)”.

Also in the January 2023 issue of IllumiNation, Krishan Sujana, Managing Director, LEDVANCE India, reported that “more than 90% of our portfolio is sourced and manufactured locally and complies to all Indian standards. In fact, a lot of our products are especially hardened to meet the demands of India's tough power conditions and consumer behaviour. The Indian government's initiatives for promoting local manufacturing are a very welcome step especially given the challenges with supply of raw materials and goods from China in the last couple of years. However, the government needs to invest a lot more in Infrastructure for manufacturing. Roads, electricity, water, access to ports, etc are some of the areas where a lot more is to be done to make India a manufacturing hub that exports to the world”.

Growth in lighting exports from India is the major theme of Vision 2030, which is being prepared by ELCOMA and was outlined in the presentation by Shyam Sujana at the ISA-BRICS meeting for 2023. The specific goal is to make India an export hub for lighting products and capture at least 10% of Global lighting market by 2030. Another goal is to drive domestic growth through a government initiative to increase per capita public light points. The combined effect should result in industry growth at CAGR 10% through 2030.

To accomplish these goals, ELCOMA suggests several support programs and focus areas for applications.

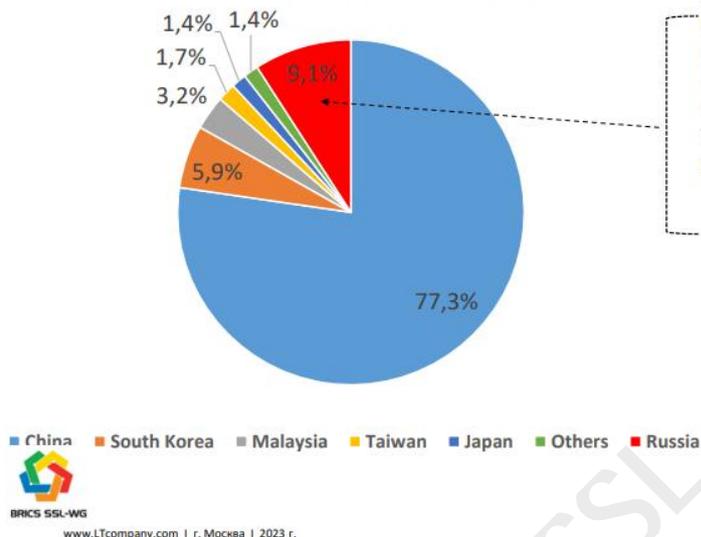
- A semiconductor initiative from the government
- Creation of a Lighting and Illumination University
- More post-graduate engineering courses and research on new technologies
- Greater focus on campuses on industry needs and global interactions
- Initiate use of artificial intelligence in lighting applications
- Make India a hub for global studies of IOT in lighting
- Further development of India-centric standards
- Lighting for horticulture, poultry farming and fisheries
- Lighting for automotive and aerospace applications
- Development of fog-enabled lighting
- Integration with renewable energy sources such as solar
- Connected and digitized lighting
- Cost-effective and eco-friendly lighting solutions with LED and laser sources
- Customized and competitive products for export markets

### 3.4 Russia

At the 2023 meeting of the BRICS Working Group of ISA Alexander Karev, Director for Science at LT Company, gave an excellent overview of the lighting industry in Russia. The country has responded rapidly in expanding domestic manufacturing to replace imports that are not available due to international sanctions. As shown below, in 2022 almost 10% of LED market was produced in Russia, with most still coming from China.

#### The LED market for SSL in the Russian Federation

The Russian Federation LED market structure in 2022



The production of modern LEDs in Russia began in 2020.

Manufacturing companies:

**GS Group**, Kalinigrad

**Company "RuSID"**, Armavir

**Company "Klever"**, S. Petersburg

The product range consists of LEDs in three main package types: 2835 PLCC, 3030 EMC and 5050 EMC.

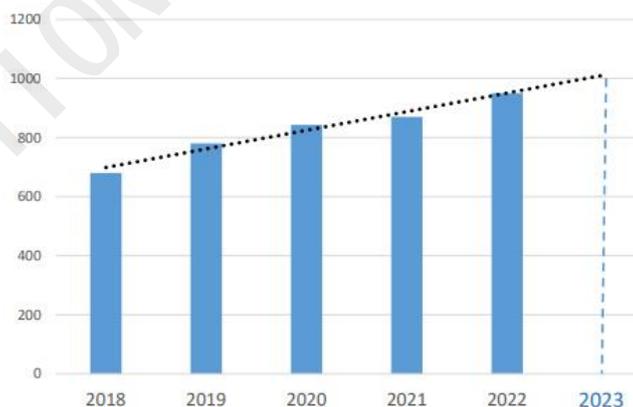
Total output of the three companies is about **100 million units in 2022.**



Световые Технологии

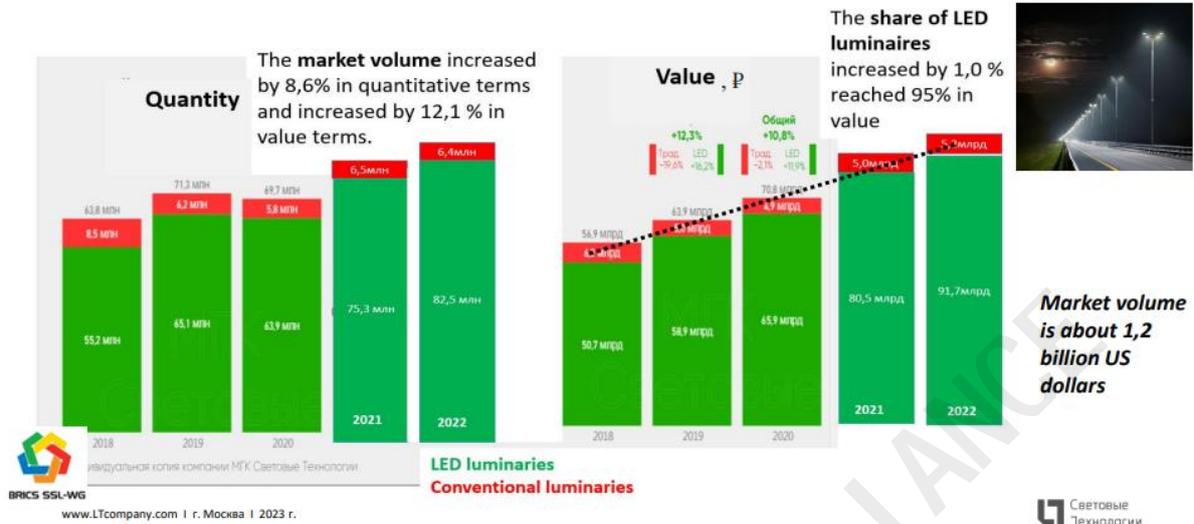
The number of LEDs needed by the Russian lighting industry has grown steadily and is now around 1 billion pieces with a value of 10B roubles (~US\$90M).

LEDs number for luminaries, mln. ps.



The growth of the market for professional LED luminaires is shown in the next figure.

## The Professional Luminaries market of the Russian federation in 2022



To finance new manufacturing facilities, an Industrial Development Fund was established in 2021, supplying loans with interest rates as low as 1%.

Several steps are being taken to control the market for lamps and luminaires. A mandatory label was introduced to combat the sale of counterfeit goods. The label is applied to the product to obtain full control, communication of information about the product, checking it for compliance with all accepted norms and standards. The Ministry of Industry and Trade is preparing proposals to increase customs duties on imported lighting equipment and components for it by an average of 10-15%. The authorities intend to introduce a recycling fee for foreign electronics, the proceeds from which are planned to be used not only for recycling but also to support Russian manufacturers of equipment and components.

In 2021 GS Group launched large-scale LED packaging operations in the town of Gusev, Kaliningrad Oblast. Initial production capacity was set at 145 million LEDs per year, with a future increase to 400 million per year. The product range includes LEDs with three main packaging types: 2835 PLCC, 3030 EMC, and 5050 EMC. These three types combined currently make up over 90% of the Russian lighting market.

The production infrastructure includes 700 m<sup>2</sup> of class 7 cleanrooms, with the prospect of expansion up to 1,500 m<sup>2</sup>. The production operations have received more than RUB 300M in investments. The main technology used for packaging the LEDs is a method of fixing the chip to the frame, followed by micro-welding, sealing with luminiferous gel, and testing its commercial characteristics.

In October 2020 Lighting Technologies and NPO RoSAT established a joint venture **LLC RUSID** that will develop the production of Russian LEDs at the RoSAT site in Armavir. **Planeta-SID** is another small enterprise specializing in the manufacture of light emitting diodes (LEDs), infrared diodes, photodiodes in both traditional packages and for surface mounting.

### 3.5 North America

In the quarter ending June 30, 2023, market leader **Acuity Brands** focused on increasing margins despite decreasing sales volume. Revenues were US\$1.0B, down by 6% from the previous year, but the operating margin rose from 13.5% to 14.3%. Sales by the Intelligent Spaces Group grew by 13%, partially offsetting losses in the traditional Lighting and Lighting Controls business. Total cash flow was large enough to enable the company to repurchase shares. For the three quarters from October 2022 through June 2023, revenues rose slightly to US\$2.94 from US\$2.90.

Cree Lighting is now a part of Ideal Industries and no longer publishes financial information. However, **Cree LED** is a subsidiary of Smart Global Holdings (SGH) which does publish sales figures for its three major businesses. They have outsourced much of their component fabrication and have become more dependent on manufacturing in China. Revenues for SGH LED Solutions in FY2022 (ending August 26, 2022) were US\$403M. Operating income was US\$54M. In the first nine months of FY2023, sales fell to US\$182M to \$320. They attribute the sharp reduction to supply chain issues and the decrease in global demand, but have seen improvements in the second half of their fiscal year.

As an example of a small US company, **LSI Industries Inc.** produces and sells non-residential lighting and retail display solutions in the United States, Canada, Mexico, Australia, and Latin America. It operates in two segments, Lighting and Display Solutions. The Lighting segment manufactures, markets, and sells non-residential outdoor and indoor lighting fixture and control solutions in the commercial and industrial markets. This segment also offers lighting control products, including sensors, photocontrols, dimmers, motion detection, and Bluetooth systems to support lighting fixtures; and designs, engineers, and manufactures electronic circuit boards, assemblies, and sub-assemblies. The Display Solutions segment manufactures, sells, and installs exterior and interior visual image and display elements, including printed and structural graphics, digital signage, menu board systems, display fixtures, refrigerated displays, and custom display elements.



Although the company struggled to maintain sales and profits during the COVID crisis, performance in FY2022 was excellent, as shown below.

### Total Net Sales (\$M)



### Total Adjusted Operating Income



This progress has continued in the first three quarters of FY 2023. Sales increased by 14% to US\$373M while operating profits almost doubled, from US\$14M to US\$27M.

**Orion Energy** is a provider of energy-efficient LED lighting, maintenance services and electric vehicle (EV) charging station solutions. As noted in our last report, their revenues fell substantially early in FY2023 due to the loss of business with their largest customer. The situation stabilized in the fourth quarter, ending March 31, 2023. Revenues were down by only 2% to US\$21.6M. For FY 2024, the company expects revenues to increase by about 34%.

Orion continues to provide very efficient luminaires for commercial and industrial applications.

### INDOOR – MARKET-LEADING EFFICACY (ENERGY EFFICIENCY = Lumens/Watt)



### 3.6 Equipment companies

The demand continues to grow for MOCVD tools and other equipment for the manufacturing of compound semiconductors. In its report for 2023H1 Aixtron states “Thanks to the continuous growth in demand for SiC/GaN-based high-efficiency power electronics products, in the second quarter and the first half of 2023, Aixtron's order volume, revenue, total profit, gross profit, EBIT (earnings before interest and taxes/operating profit) and other performance indicators have achieved double-digit growth, with a gross profit margin of 42%”.

Veeco has also experienced market growth since 2019 with increasing revenues and profits.



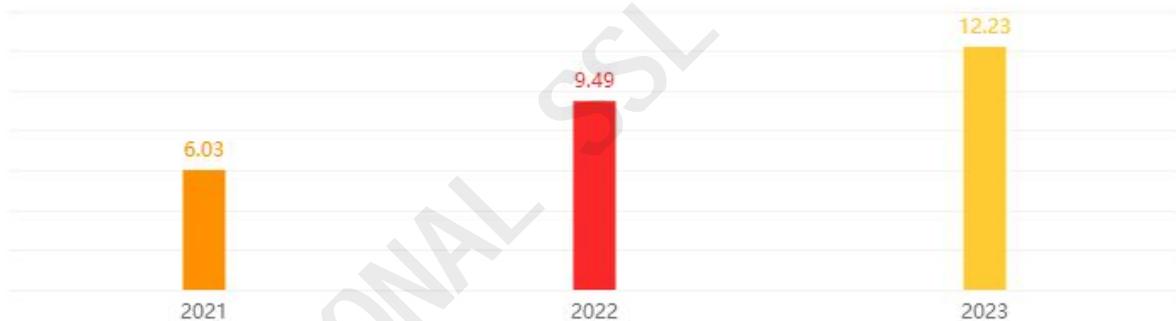
# Compound Semiconductor Market (SAM)



Equipment suppliers in China are also doing well, as shown in the 2023Q1 report from AMEC.

The data is taken from the first quarter financial report

Unit: 100 million yuan



Naura Technology Group (North Huachuang) credited high local demand for its 14.7B yuan revenue in 2022, up 52% from the previous year. Revenue in 2023Q1 was CNY 2.87B compared to CNY 2.14B a year ago. In 2022 Naura received CNY 318M in government subsidies, up from \$303M in 2021.

## 4 Replacing Fluorescent Tubes

In an article in LPR98, Peter Haumer of Lumitech/Kiteo describes the challenges that are faced in Europe in choosing a replacement strategy. One option for ceiling luminaires is just to replace the fluorescent tubes by LED tubes. The advantages he cites are: “simple to exchange, housing preservation, and average energy saving, respectively, beam angle and lifespan improvement.” However, this approach brings several potential problems.

- A simple source substitution may violate local regulations, such as conformity to CE-standards in Europe.
- Further use or bridging old ballasts leads to potential sources of danger! Plastic covers and lamp sockets may turn yellow and become brittle and tend to break.
- The mere exchange of the light source is typically outside the scope of environmental subsidies.

Peter describes how his company’s retrofit approach can provide operational lifetimes of over 70,000 hours and energy savings of over 70% compared to the original fluorescent fixtures, well exceeding what can be achieved by simple source substitution.

Some leading suppliers claim that their retrofit LED tubes can meet the European standards. For example, Signify states<sup>4</sup> “Our assessment indicates that modified products fitted with Retrofit LED tubes do not significantly impact compliance with the safety standards and therefore no new conformity assessment is required, but with the condition that installation and rewiring must be done in accordance with the instructions supplied by Signify.”

Zumtobel offers further advice<sup>5</sup>.

- “There are some quick wins retrofitting LED lamps, but there is a lot to consider before pressing the order button. Many choose LED tubes for cost or speed of replacement. However, is the existing fitting suitable? If it has been in place for some time, there is the risk of plastic degradation – which could easily result in breakages whilst removing the existing tube or swapping in the replacement. The result? A bodged job or extra costs for replacement parts: making a ‘quick fix’ slower and more expensive than planned.
- A product will have been designed for a specific technology’s weight and thermal characteristics: aspects that significantly differ between LED and fluorescent technologies. LEDs require a method of heatsinking to remove heat. Which adds weight. The lamp holders are specified based on a specific lamp weight and increasing this weight can result in them being insufficiently robust to hold the LED tube.
- Generally LED tubes that are non-dimmable and non-compatible with the existing control system do not offer emergency lighting compatibility – which necessitates a new emergency lighting system – fitting and labour costs.

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<sup>4</sup> <https://www.assets.signify.com/is/content/Signify/Assets/philips-lighting/global/20210707-ledtubes-product-compliance.pdf>

<sup>5</sup> <https://professional-electrician.com/features/think-refurbishment-but-re-think-using-led-tubes-zumtobel-group/>

## 5 Streetlights in Australia and New Zealand

Australia and New Zealand provide a good opportunity to study the progress in the installation of LED and smart streetlighting. There are many useful reports and a great deal of collaboration and information sharing between those involved. For example, Ironbark Sustainability has worked with councils across the country on over 100 projects and shared lessons learned.

Australia and New Zealand share a common public lighting standard, AS/NZS 1158. This standard has close parallels to other international lighting standards, particularly with regards to the lighting of main roads. However, the standard is unique in permitting extremely low lighting levels and long spacings between lights on residential roads.

### 5.1 LED Installation in Australia

Australia's street lighting market is heavily dominated by a dozen electricity distributors who own and manage some 90% of the street lighting in the country. Australian local governments tend to directly own street lighting (and other types of public lighting) in prominent commercial and entertainment precincts but the vast bulk of ordinary street lighting on residential and main roads across the country is owned by the electricity distributors.

According to Graham Mawer, a director of Next Energy Lighting, "the emergence of new lighting technologies has led to some tensions between Australian local governments and the utilities owning the lights. Local governments have been understandably keen to see LEDs and smart controls widely adopted to secure energy and cost savings, greenhouse gas reductions and improvements in the quality of public lighting outcomes. However, disputes with the utilities over the residual values of the old lights, the costs to install the new lighting and the speed of adoption have dominated public lighting policy discussions and regulatory pricing reviews in recent years. Such tensions will be familiar to those in other parts of the world with utility-owned street lighting".

The Institute of Public Works Engineering Australasia (IPWEA) has recently provided a status report on the installation of LED streetlights in Australia<sup>6</sup> The progress is summarized in the next table.

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<sup>6</sup> <https://insite.ipwea.org/a-stocktake-of-australias-progress-towards-smart-street-lighting/>

	2016 IPWEA SLSC Roadmap Figures <sup>1</sup>	2023 Estimated Figures <sup>2</sup>	Estimated Figures with Full LED Conversion	Estimated Figures with Full LED & Smart Controls Conversion
# Lights	2,317,000 (150,000 LEDs)	2,500,000 (1,430,000 LEDs)	2,500,000 (1,070,000 additional LEDs)	
Total Estimated Street Lighting Energy Use	1,181,000 MWh/yr	825,000 MWh/yr	475,000 MWh/yr	380,000 MWh/yr (e.g. 95,000 MWh/yr of additional savings with full smart controls deployment)
Total Estimated Emissions	1,251,000 tCO2-e/yr	875,000 tCO2-e/yr	505,000 tCO2-e/yr	405,000 tCO2-e/yr (e.g. 100,000 tCO2-e/yr of additional savings with full smart controls deployment)

“There remains work to do with an estimated 1.1 million streetlights left to convert to LEDs. However, the drivers for changing to LEDs are only strengthening and include:

- an ever more compelling business case
- the increasing push to save energy and reduce GHG emissions
- Australia’s recent ratification of the Minamata Convention on mercury
- the global winding down of legacy lamp production of all types.

Based on recent industry sales figures, the bulk of the remaining non-LED streetlights will be converted in the next 3-4 years. Completing the conversion with ever more efficient LEDs should result in 60% energy savings compared to 2016.

The upgrading of streetlights has been supported through the ‘Local Roads and Community Infrastructure Program’ that was initiated in July 2020. The Government has committed AUS \$3.25B to the LRCI Program over four phases. Phase 4 was announced in July 2023, with AUS \$750M made available to local councils for projects that should be completed by June 2025.

**New South Wales:** Ausgrid is distributor of electricity on Australia’s east coast, providing power to 1.8 million customers. Their network is made up of substations, powerlines, underground cables and power poles, spanning 22,275 square kilometres throughout Sydney, the Central Coast and the Hunter Valley. Ausgrid installed 36,797 LEDs in FY23 taking the total to more than 190,000 LEDs installed since the beginning of the program (81% of the 260,000 streetlights in our network) across 33 Council areas. The goal is to finish the LED rollout by 2026.

**South Australia:** SA Power Networks is the sole supplier of power to South Australia serving 900,000 residential and commercial customers. In 2022 they converted 17,400 streetlights

to LEDs, bring the total number of conversions to 60% of their stock of over 200,000. They forecast that 74% of lighting installations will be LED by 1 July 2025.

**Queensland:** In December 2022<sup>7</sup>, journalist Brittney Manning expressed concern that Queensland still relied heavily on mercury-vapour lamps, known as HPMVs. In 2021 it had an estimated 176,000 HPMV streetlights – more than the total in Victoria, NSW, Tasmania, Northern Territory and the Australian Capital Territory combined. In addition, the city of Brisbane installed a large number of fluorescent streetlights, some of which are less than 10 years old. Concern about the health effects of mercury should lead to an acceleration of the installation of LED replacements.

## 5.2 Lighting Controls

While there has been welcome progress in LED uptake, as few as 4-5% of Australian streetlights have been deployed with smart street lighting controls and much of this has been on customer-owned lighting portfolios.

One pioneer in the adoption of smart lighting is the Queensland Department of Transport & Main Roads (TMR), which is responsible for 65,000 streetlights on arterial roads. In 2021 they launched a six-year project to install LEDs lights with smart controls. The controls system for the project is being provided by a consortium of Schréder-Sylvania, CIMCON and Telstra.

In May 2023 Ausgrid announced that it is upgrading street lighting across its network with LEDs and smart controls to improve reliability and community safety on the roads, while significantly reducing energy usage and carbon emissions. The roll out commenced in Maitland and Lake Macquarie, with over 62,000 lights to be installed by 2026. The upgrade is using latest smart cities technology that will help to detect faults, optimise maintenance, measure energy use and facilitate off-peak dimming as part of future capabilities. By updating community centred assets such as streetlighting and allowing installation of sensors for parking, traffic management and air quality, communities can experience safer, more liveable cities with smart city solutions.

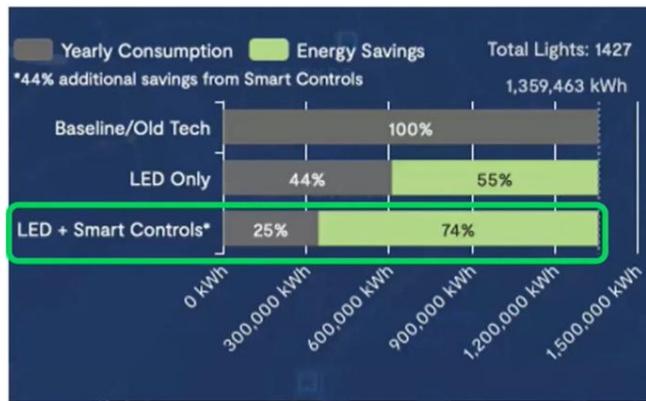
A recent collaboration between Endeavour Energy and the City of Parramatta led to the installation of over 4600 LED lights with smart controls. The project cost study and energy savings are shown below. These charts were taken from a webinar organised by Ironbark Sustainability to discuss the lessons learned<sup>8</sup>.

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<sup>7</sup> <https://www.theguardian.com/australia-news/2022/dec/11/blinded-by-the-light-how-skyglow-pollution-is-separating-us-from-the-stars>

<sup>8</sup> <https://www.ironbarksustainability.com.au/resources/articles/parramatta-smart-lighting-special-webinar-monday-3rd-april-2023>

Project Summary	Average Scenario Outcomes
Total project cost	\$5,550,000
Net savings over 20 years	\$7,261,292
First year savings	\$450,996
Net Present Value	\$4,612,124
Energy Savings Certificate (ESC) value	~\$774,000
Payback period (years) including ESC income	7.5
Greenhouse gas savings over 20 years (tCO <sub>2</sub> -e)	54,751
Average greenhouse gas savings per year (tCO <sub>2</sub> -e)	2,738*
Number of major road lights changed (local 2,382, regional 990, state 1,259)	4,631



Omexom has deployed approximately 24,000 Smart Efficient Lighting Control (SELC) lighting control modules across the Australian Capital Territory. These were especially valuable during the extreme storms experienced in Canberra in 2022. The control modules proved to be very robust, with almost 100% reliability.

In March 2021, the City of Greater Geelong in **Victoria** began a project to replace over 25,000 mercury vapour streetlights with smart LEDs. The lights on residential streets were upgraded by October 2022 and those on main roads should be replaced by December 2023. The lights are owned and maintained by Powercor. They are made by Sylvania Schreder and are assembled in Australia. The upgraded LED lighting is expected to deliver a reduction in energy consumption of around 64%. The project will reduce CO<sub>2</sub> emissions for the City of Greater Geelong by about 8,000 tonnes per year.

The tender for installation of the lights specified waste disposal requirements, which include the recycling of around 98% of the material in the old lights.

- The glass collected is recycled into products such as glass wool insulation for homes.
- The mercury is distilled and reused in the dental industry to manufacture amalgam.
- The aluminium body is collected and end up as ingots used in industry.

Several proponents of LED streetlights claim that their disposal will lead to smaller loads on landfills.

TasNetworks, a state-owned company, is responsible for electricity transmission and distribution in **Tasmania**, along with the operation of over 50,000 streetlights throughout the state. Traffic Technologies Ltd has supplied over 26,000 Smart City LED streetlights to TasNetworks under contracts extending through 2023.

A key reason for the slow uptake of smart lighting is that it is challenging in Australia's National Electricity Market for public lighting customers to get any financial benefit from dimming and trimming their streetlights. Most street lighting in Australia is currently billed as a deemed load based on the wattage of the light, not the energy it is actually using. This avoids the need to install meters on each light.

According to IPWEA, the average residential road LED streetlight now uses 13-20W (and residential roads make up 70% of the national portfolio) and the average main road LED street light uses 80-150W (with a very small percentage using higher Wattages). It is

therefore vital that the cost of adopting and complying with the regime is very low on a per lighting point basis if adoption is to be encouraged. Put simply, if it costs even a few dollars a year to meter a streetlight using \$15-\$150 of electricity a year, there will be little take-up and a significant lost opportunity to materially improve metering of these currently unmetered devices and help deliver a wide array of other broader public benefits that smart street lighting controls offer.

After sustained calls for reform, Australia's electricity market operator has recently proposed changes that would recognise the data coming out of smart street lighting controls systems as valid metering data<sup>9</sup>.

### 5.3 New Zealand:

According to IPWEA, progress with smart street lighting controls in New Zealand is dramatically ahead of Australia, with some 75% of the national street lighting network either deployed or committed to deployment of smart controls as LEDs are rolled out nationwide. Auckland's deployment of 130,000 Telematics Wireless smart controls is the largest in the region by some margin.

**Auckland** Transport owns and maintains more than 110,000 streetlights, approximately one third of New Zealand's total lighting stock. Lighting is the largest user of direct electricity among all its assets.

Stage 1 in the streetlight upgrade began in October 2014, with 44,000 high-pressure sodium streetlights replaced by LED lights. This provided 11.2 GWh of energy savings and an estimated \$1.7 million reduction in our electricity bills each year. The LED technology also saved Auckland Transport an additional \$1.2 million per year in maintenance costs.

Stage 2 of the streetlight retrofit was approved in April 2018 to replace an additional 49,000 high-pressure sodium lights over the following five years. This stage of upgrades is expected to deliver an additional 16.3 GWh of savings, resulting in a cost reduction of \$2.6 million per year. Maintenance costs will be further reduced by \$1.3 million per year.

All of the LED streetlights are connected to a central management system (CMS). This system can provide a daily report to contractors advising of any problems on the network, reducing the numbers of calls to our call centre. Additionally, the CMS can decrease light levels with dimming functions. This allows for reduced nightglow and further energy savings during off-peak hours.

In August 2021, the **Christchurch** City Council reported that over 90% of its 44,000 streetlights had been replaced by LEDs. Most are connected to a Central Management System. Plans were underway to upgrade the remaining 2500 lights by 2024.

In 2012 the Council began installing LED streetlights in new subdivisions and in areas where it was undertaking roading improvements. In late 2017 it set up an accelerated delivery programme in order to maximise an 85 per cent funding subsidy being offered by Waka

<sup>9</sup> <https://www.aemc.gov.au/sites/default/files/2023-03/IPWEA%20Submission%20for%20AEMC%20on%20Minor%20Energy%20Flow%20Metering%2016%20Feb%202023.pdf>

Kotahi NZ Transport Agency.

The upgrades have reduced the annual street lighting power consumption by more than 70% and cut our carbon emissions by more than 1150 tonnes a year, which is significant as the Council has committed itself to becoming net carbon neutral by 2030. The new LED streetlights direct all their light in a downward direction, meaning there is less light spill into the surrounding environment and the night sky compared with the older forms of street lighting.

#### 5.4 Environmental Impact:

The environmental impact of outdoor lighting is of concern to most councils, especially those that are along the coasts.

To reduce the impact on the night sky, some astronomers and ecologists have been calling for the use of 2200K amber lights. But as pointed out by Bryan King<sup>10</sup>, “These are more expensive than the more common 3000K or 4000K versions and are not as energy efficient, AS/NZS 1158 lighting design standards require designers to de-rate the light output of low CCT light sources as their performance in delivering visual acuity for humans is not as good as that of 3000K or 4000K luminaires. In short, you need much more 2000K light to achieve the same visual and safety outcomes as 3000K or 4000K luminaires. Raising lighting inputs in this way to meet safety objectives may actually increase overall light pollution, and hence defeat the original objective.”

NZ has well-developed lighting technical standards<sup>11</sup> that define good design for outdoor lighting, with recommended CCT values, and most local councils already have planning codes and bylaws for outdoor light, spill light and obtrusive light. In addition, Lighting Council New Zealand (LCNZ) has developed a night sky Position Statement in conjunction with the professional body for lighting designers and engineers, the Illuminating Engineering Society of ANZ.

Concern about the impact on wildlife extends even into urban communities. For example, the National Institute of Water and Atmospheric Research has conducted a study of the effect on freshwater insects in Christchurch<sup>12</sup>. By mapping city "lightscares" and investigating changes in the behaviour of adult insects under different lighting scenarios, this research aimed to provide information that could assist in the design of ecologically sensitive streetlighting plans and help identify critical areas where alternative lighting solutions might be required.

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<sup>10</sup> <https://insite.ipwea.org/the-new-zealand-colour-temperature-debate-heats-up/>

<sup>11</sup> AS/NZS 4282 Control of the obtrusive effects of outdoor lighting, and the series AS/NZS 1158 Road and public lighting

<sup>12</sup> <https://niwa.co.nz/freshwater/freshwater-update-90-april-2023/investigating-ecological-impacts-led-streetlight-conversions-on-freshwater-insects%C2%A0>

The conversion from HPS streetlights to 4000 K LED generally reduced insect attraction, contrary to initial expectations, given that the LEDs emit a higher proportion of blue light than the HPS. However, the LED streetlights were commonly dimmer than the HPS lights.

The report concluded that “Using lights that emit less blue light is likely to benefit certain groups of insects (particularly moths and caddisflies), with the magnitude of effect dependent on the insect taxa, relative light intensity, and colour spectrum of the lamps being replaced. Placing lights further from waterways or behind screens such as riparian plants will also likely reduce the attraction of freshwater insects to streetlights.”

#### 5.4 Conclusion

The installation of LED streetlights has been received well in Australia and New Zealand by residents as well as managers of lighting systems. The reticence of local councils to add smart controls to the new LED lights is being overcome, but the cost of their use with low-power lamps in residential areas is still of concern. Almost all decisions are based on the value of controls in lighting management, rather than the potential for additional functionality.

However, there have been some unexpected effects. For example, residents of Sydney's Bondi Beach were baffled after their streetlights suddenly started glowing a majestic purply-blue. The investigation discovered that areas in North America such as Vancouver, California, New Mexico and Wisconsin had also observed purple LED streetlights, as well as places in the UK like Ireland. The problem was attributed to heat damage - a mistake in either assembling or creating the bulb can make it more susceptible to warmer weather (perhaps another consequence of global warming).

In **Wellington**, New Zealand, 17 of 17,000 LED streetlights that were installed in 2018 have fallen during storms. The damage was attributed to the aluminium-alloy adaptor that's part of the structure attaching LED lamps to poles around the city. The adaptors were not suited to Wellington's strong winds, causing the lamps, which weigh up to 11.2kg, to either droop or, in worst cases, detach and fall to the ground. The City Council has started a programme to fix faulty streetlights, prioritising fixing around 3200 heavier lights in high wind areas within the next few months.