DALI Alliance

WHITE PAPER
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Sustainable, Smart and Standardized:

How DALI Enables Efficient, Future-Proof Lighting Control Systems

Credit: Signify

Contents

Introduction

With the world facing an unprecedented climate crisis and rising energy costs, all businesses need to become more sustainable and reduce their energy consumption and carbon footprint – not least when it comes to lighting, which accounts for around 15% of global electricity consumption and 5% of worldwide greenhouse gas emissions[1].

This White Paper discusses sustainability, future-proofing and the opportunities offered by smart, data-rich lighting systems. It also looks at the role of established global standards such as the Digital Addressable Lighting Interface (DALI®).

1. *Data from the US Department of Energy*

Sustainability in lighting

Sustainability in lighting starts with reduced energy consumption. Use of sophisticated lighting control systems, enabled for example by DALI (see figure 1), builds on the gains achieved through the use of LED light sources as well as simple control techniques like switching and dimming. We will return to energy efficiency later in this White Paper.

Sustainability also includes factors such as reduced materials usage and recycling in line with the UN's Sustainable Development Goal 12: Responsible Consumption and Production. The main driving forces for sustainability are legislation, environmental issues, and social responsibility. Another factor is the trend toward a 'circular economy', which has found broad support, including a policy and regulatory framework in the European Union (EU)[2]. Products that can be reused, refurbished, upgraded and recycled offer the potential for less waste, lower energy consumption and financial savings.

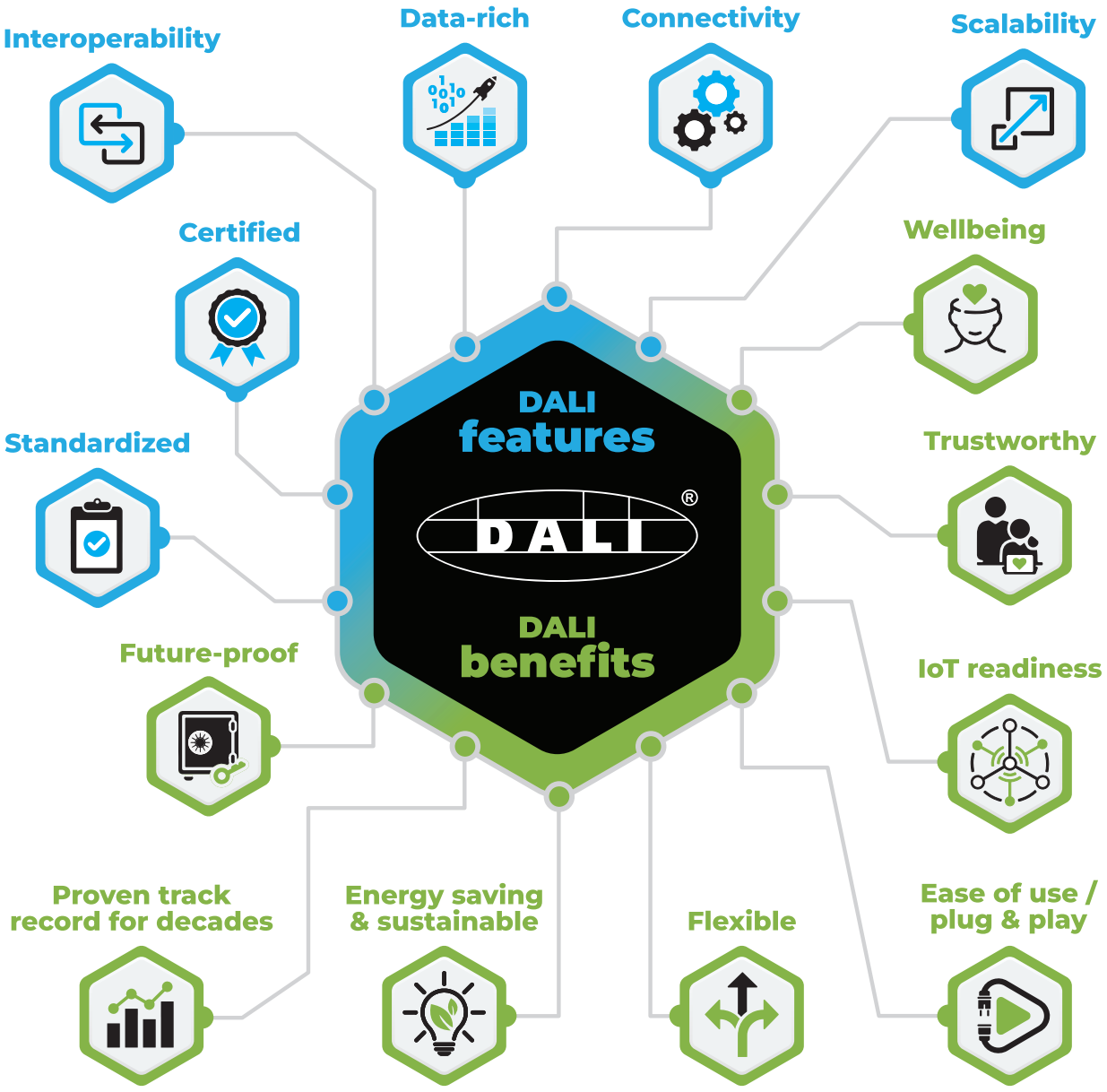


Figure 1

DALI features and benefits.

2. *www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits*

DALI's role in future-proofing

In the lighting industry, there is an increasing drive for replaceable components that extend the service life of luminaires. If suitable components are available – and if replacement is possible – then luminaires can be repaired, or upgraded with new and improved features and functions.

Here, the strength of DALI as a globally standardized protocol comes to the fore. The DALI-2 certification program, developed and maintained by the DALI Alliance, has created an ecosystem of interoperable products from multiple vendors. This ensures the long-term availability of compatible components, and avoids issues associated with vendor lock-in and reliance on proprietary solutions that may not be supported in the future.

DALI-2 also provides backwards compatibility with earlier product generations. Rather than being a temporary solution or a fast-changing trend, the DALI protocol has been around for decades, supported by all major players in the lighting industry. New extensions and certification programs (such as DALI-2, D4i and DALI+) are forward-looking and – crucially – standardized.

DALI is inherently flexible and lends itself to future-proof designs that extend the useful life of a lighting control system. Changes to the design of a DALI system and how it is operated can often be dealt with by software reprogramming, rather than having to rewire or replace luminaires and other equipment. This could, for example, allow a building operator to easily change the utilization of space to accommodate new tenants.

Future-proofing is enabled at the luminaire level by the Zhaga-D4i connector system, which facilitates plug-and-play replacement of luminaire-mounted sensors and communication nodes. Zhaga-D4i combines the standardized mechanical interface from the Zhaga Consortium with the communication and power requirements specified by the DALI Alliance as part of the D4i certification program[3].

Zhaga-D4i certification has enabled an ecosystem of interoperable luminaires and control devices. This allows luminaire owners to easily update their fixtures, protect their investment, sustainably extend the life of the luminaire, and keep pace with fast-moving developments in digital networking and sensing technologies.

A wireless future?

While wired systems provide network stability and reliable connectivity, there is a growing interest in wireless capabilities, which must be considered in future-proofing any system design. Two approaches have been developed that combine the DALI protocol with wireless technology.

The standardized gateways[4] approach enables wired DALI networks or D4i/DALI-2 luminaires to be incorporated into certain wireless ecosystems, such as Zigbee and Bluetooth Mesh.

The DALI+ approach enables DALI to be used over wireless and IP-based networks, thus increasing choice and flexibility. The DALI Alliance is currently developing certification programs for both the standardized gateways and DALI+ with Thread as the carrier[5].

With a wireless lighting control system, it's possible to position wireless control devices without the restrictions of having to run network cables (although power is still required). This has the potential to increase flexibility while also making it easier to scale up systems and add new devices. With no new cabling, labour and material costs are reduced, and there's less damage to the building.

However, there are other scenarios where a wired solution is preferred or mandated. In different circumstances, hybrid solutions may be desirable. DALI provides choice and keeps future options open by enabling wired and wireless networks to operate together. For example, wireless DALI+ networks can incorporate bridges that provide a link to a wired DALI network, with DALI used throughout as the communication language.

DALI+ over an IP-based carrier such as Thread also opens the possibility to integrate the lighting system with other functions via a building's IT infrastructure.

3. *www.dali-alliance.org/d4i*
4. *www.dali-alliance.org/wireless/gateways.html*
5. *www.dali-alliance.org/daliplus*

Minimising energy consumption with lighting control

Let's go back to one of the most important aspects of sustainability—how to reduce the energy consumption of lighting systems, and therefore help to cut carbon emissions, while also reducing running costs. Figure 2 summarizes some of the important ways in which DALI contributes to sustainable lighting systems.

Even when using efficient light sources, most commercial buildings have poor lighting efficiency because the lights are on even when the illuminated spaces are not in use. Lighting often accounts for around 20 to 30% of total energy costs, depending upon the building type, so the potential savings are very significant.

Even simple timers are better than relying on building occupants to switch off the lighting. A much more effective approach is to adopt an automated DALI lighting control system, with sensors to detect occupancy, movement and daylight levels. PIR (passive infrared) sensors can detect occupancy in different parts of the building, and the system can then turn lights on and off in response – a large system may have thousands of such occupancy sensors. DALI sensors coupled with occupancy-based data analytics provide an extremely useful tool for facility managers tasked with reducing electricity consumption.

Light-level sensors also help save energy. With sensor data telling the system how much natural light is available in a particular location, the artificial lighting can be controlled in response. This 'daylight harvesting' method takes into consideration factors such as the time of day, the sun's position in the sky and even the time of year, thus minimising energy consumption.

Sensor-based lighting control can also optimize both the brightness and colour temperature of the artificial lighting and monitor environmental conditions to create a comfortable environment for building occupants. As well as promoting health and well-being, this can also help drive higher productivity in workplaces.

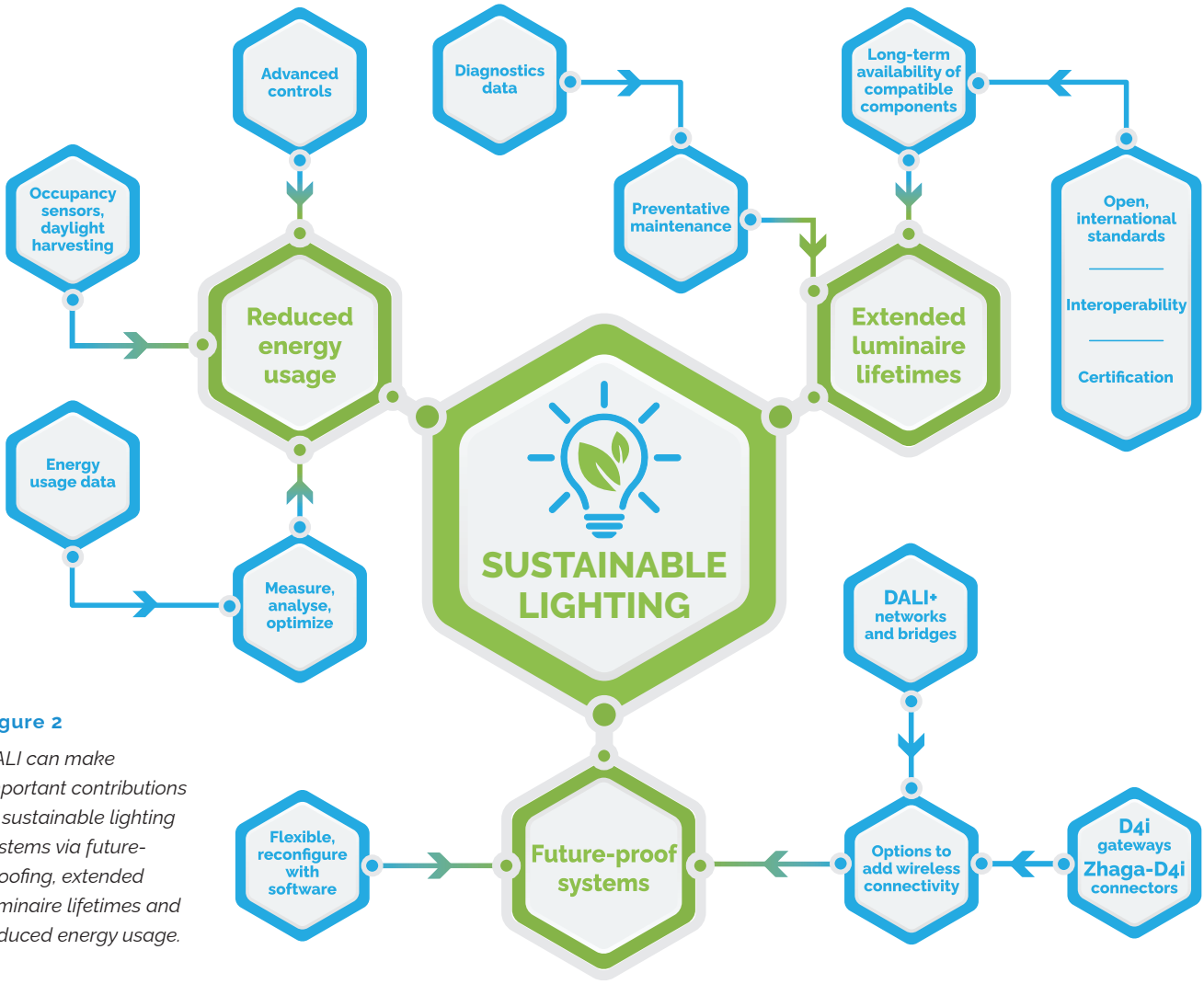


Figure 2

DALI can make important contributions to sustainable lighting systems via future-proofing, extended luminaire lifetimes and reduced energy usage.

Overall, the more sophistication, more functions, and more intelligence we can add to a lighting control system, the greater the energy savings that are possible. Of course, this requires suitable software that is intuitive and user-friendly, and straightforward controls and user interfaces that building occupants will be able to understand and use. DALI's role here is to standardize the functionality of input devices such as switches, sliders and push-button devices.

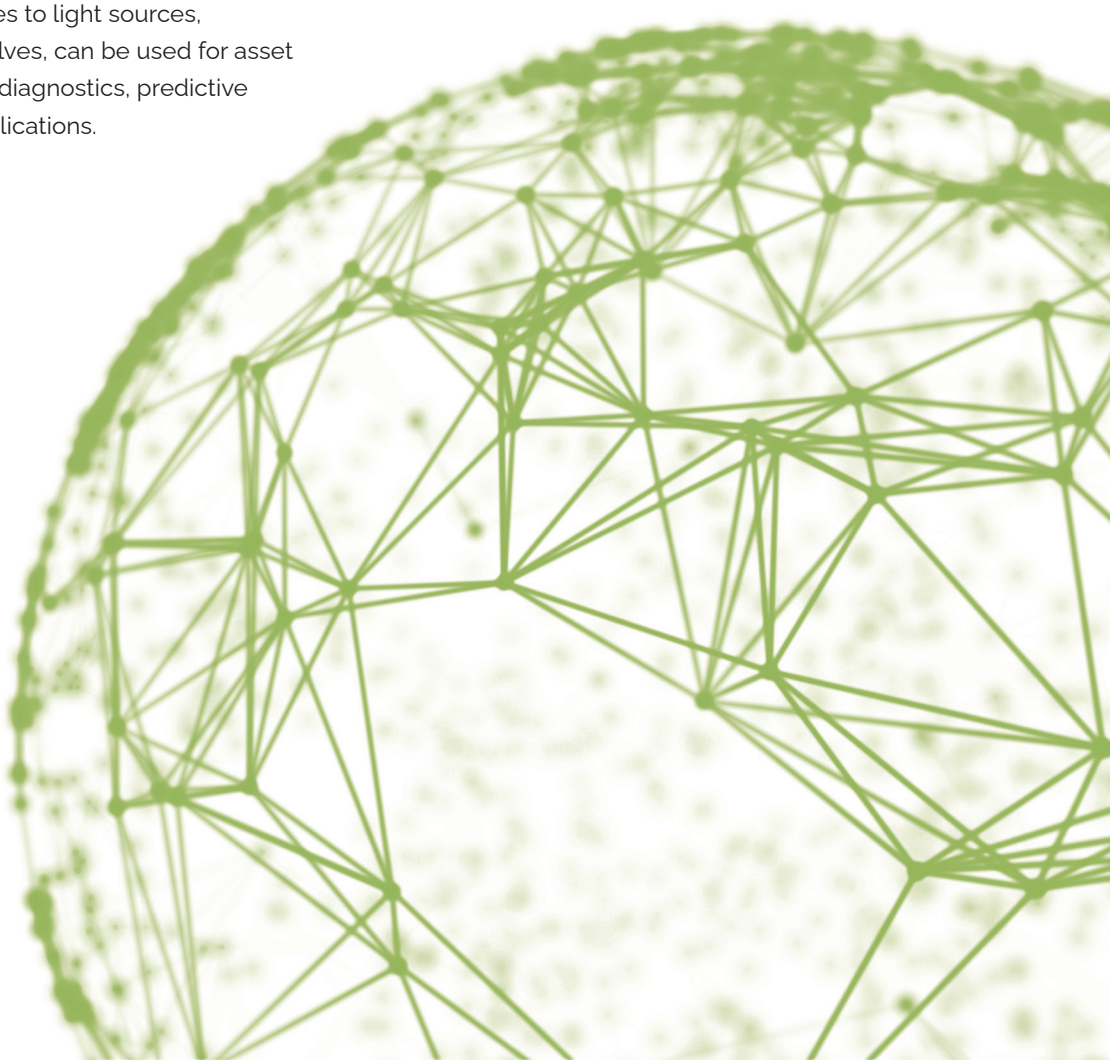
The power of data

It's hard to overstate the importance of data in lighting control systems. The standardized DALI protocol is built to enable smart, data-rich networks in which the feedback and exchange of data is enabled by two-way digital communication. DALI control gear routinely report their output levels, lamp failure information, emergency test data and other information to application controllers, the decision-making devices in a DALI system. As discussed earlier, DALI sensors and other input devices all provide valuable data that feeds into the lighting-control system and can trigger automated, real-time changes.

Recently, several DALI data specifications have been developed to standardize the location and format of new types of data that can be stored in control gear such as LED drivers. This data, which relates to light sources, luminaires and the drivers themselves, can be used for asset management, energy monitoring, diagnostics, predictive maintenance, and many other applications.

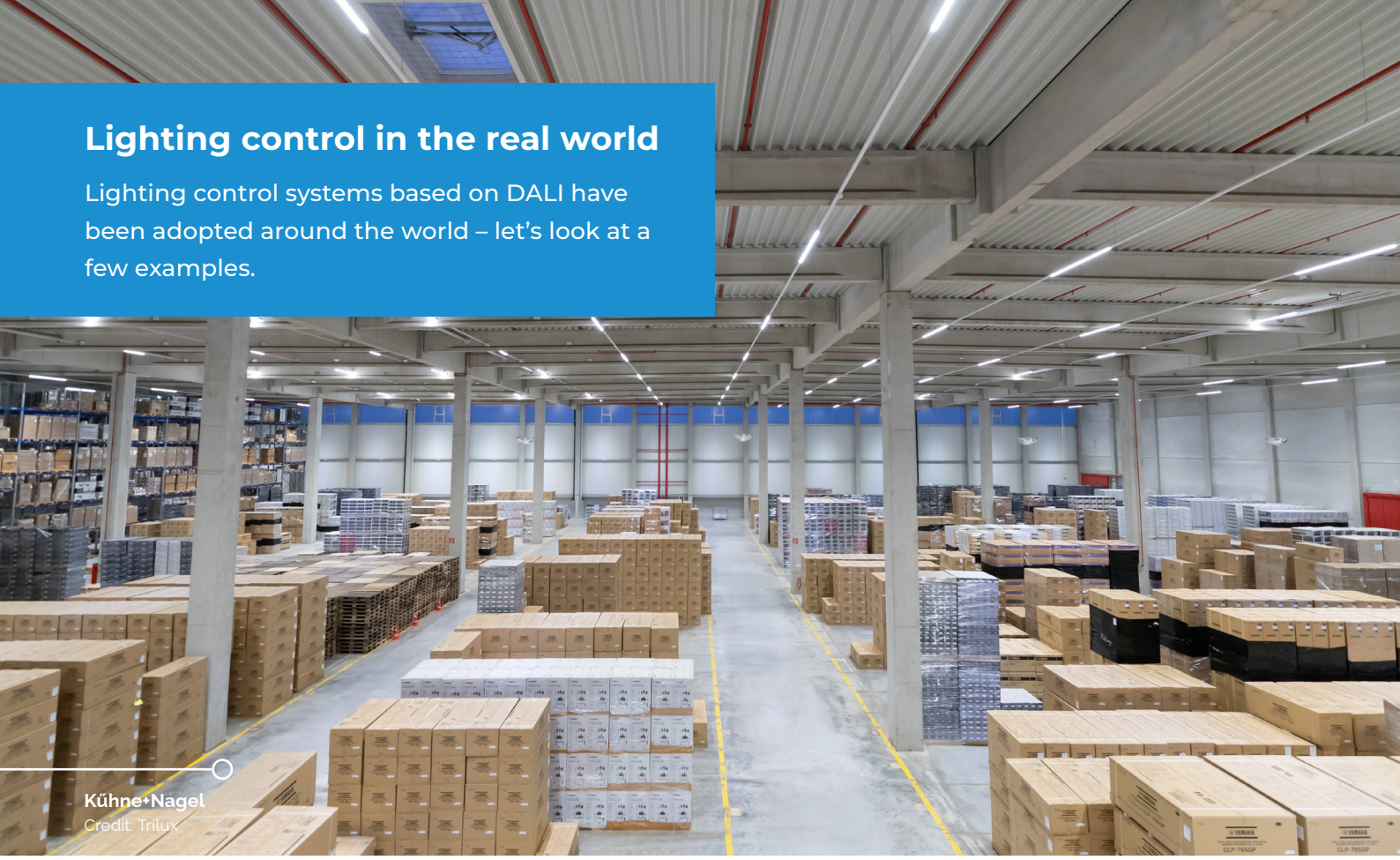
Perhaps most importantly, some drivers have the capability to report real-time energy usage and power consumption. To quantify the savings achieved through the effective use of a lighting-control system, we also must have effective monitoring of energy consumption—savings must be measured, not guessed. As well as measuring the overall energy usage, we need to get granular information of what's actually happening in specific areas of a building, or even inside individual luminaires. Data of this nature can prove crucial in applying for energy rebates.

Also, LED drivers can report a wide range of operational and diagnostics data, which enables the system to proactively alert the manager to any faults. Data analysis can predict when individual components or fixtures should be replaced, rather than employing a comprehensive replacement schedule after a fixed period of time. Significant savings can be achieved by employing a data-driven 'predictive maintenance' strategy, contributing to the overall sustainability of the lighting-control system.



Lighting control in the real world

Lighting control systems based on DALI have been adopted around the world – let's look at a few examples.



Kühne+Nagel
Credit: Trilux

Manchester Airport
Credit: Laing O'Rourke

University of Warwick
Credit: Zencontrol

At **Manchester Airport**, the main objective of the DALI-based lighting control system is to reduce energy usage. The specification for the project required open protocol technologies in order to future-proof the building. DALI offers a standardised approach across all the airport areas. One interesting feature was the ability to adjust light levels according to the airport's flight data system – light setpoints are increased if a flight is due at a gate, either for arrival or departure, and reduced when no flights are happening.

The combination of DALI luminaires and controls has reduced the operating costs and CO_2 emissions at two **Kühne+Nagel** logistics hubs in Hamburg, Germany. The project features sophisticated use of data as the basis of predictive maintenance and heat mapping strategies. For predictive maintenance, operational data is collected from each light point in real time, allowing early-stage detection of the need for maintenance, and reducing associated costs.

With sustainability in mind, it was essential that the lighting controls installed at the **University of Warwick** Faculty of Arts, UK, were based on an open protocol to ensure longevity and interoperability. The DALI-2 system, which includes emergency lighting testing and monitoring, provides a level of granularity and flexibility not available from other protocols. DALI data was an essential requirement for energy-use monitoring and logging, as well as maintenance. The data obtained from the DALI-2 system was seen as a key factor in minimizing the university's carbon footprint.

The **Doha Metro** system uses 133,000 DALI lamps, 500 DALI sensors and 200 DALI switches across 37 stations. The DALI systems monitor the health and status of the DALI drivers and devices in real time to enhance the efficiency of the entire lighting installation, and enable rapid maintenance and proactive relamping schedules.

In the **Londoner** hotel, DALI provides flexibility to re-zone and adjust the layout via software revisions, without changing the infrastructure. The system provides fault finding and reporting to reduce disruption, as well as energy-usage reporting. If a luminaire must be replaced after a few years, DALI provides the ability to adjust the lumen output of a single luminaire to compensate for lumen depreciation, therefore maintaining a consistent aesthetic.

Doha Metro
Credit: Delmatic

The Londoner Hotel
Credit: Inverse Lighting Design

Conclusions

Designers, architects and building owners must consider a wide range of lighting-related aspects including sustainability, the circular economy, energy consumption, data and analytics.

An effective DALI lighting control system will handle all of these, bringing peace of mind to all concerned. It will help meet external requirements, such as legislation for emergency and roadway lighting, while also ensuring the lighting achieves the appropriate performance requirements.

An advanced lighting-control system, based on a global standard such as DALI, will reduce energy usage and carbon footprint, as well as decreasing total cost of ownership.

As a global industry organization focused on standardization and market acceptance, the DALI Alliance enables the broad adoption, scale and technology leadership needed by the industry.

Whatever the lighting system's requirements, standardization with DALI can deliver an efficient, flexible, sustainable and cost-effective solution.