

An aerial night view of a city, likely Dubai, with a heavy purple overlay. The city lights are visible, and a large body of water is on the right. The text is overlaid on the left side of the image.

Artificial Light at Night: Zhaga's contributions to balancing benefits and challenges

White Paper

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Artificial Light at Night (ALAN) has become an integral part of modern life, providing significant benefits to communities over centuries. Public outdoor lighting, which dates back to the 16th century, has played a crucial role in enhancing safety, transportation, and social interactions. It highlights architectural beauty, improves neighborhood ambiance, and drives economic development by extending productive hours, enabling outdoor leisure activities, and fostering social connections during evening and nighttime hours. Well-designed road lighting, in particular, enhances motorists' visual performance and comfort, helping drivers remain alert and contributing to overall traffic safety. The issue of Artificial Light at Night (ALAN) is gaining increasing attention, with several white papers and regional legislation already addressing the subject (e.g., those by DALI Alliance, LightingEurope, and DarkSky).

This paper will focus on the valuable opportunities offered by Zhaga and demonstrate how Zhaga standards can play a key role in reducing the negative impacts associated with the misuse and excessive use of artificial lighting at night.

Adverse Effects of ALAN

The prevalence of ALAN has increased significantly in recent decades and is projected to grow further. Therefore, despite the earlier mentioned benefits, ALAN also presents challenges that demand growing attention.

Poorly designed lighting systems can lead to adverse effects, including:

- **Energy Waste:** Excessive light at night consumes unnecessary energy.
- **Glare and Obtrusive Light:** Poorly designed lighting installations can disrupt visibility and invade private spaces.
- **Impact on Biodiversity:** Especially in sensitive areas like nature reserves, ALAN can disturb ecosystems and natural habitats.
- **Skyglow:** Scattered light particles reduce the visibility of stars and celestial bodies, affecting astronomy and the natural nighttime environment.

Striking a Balance

While mitigating these effects is essential, simply switching off lights is not a viable solution for urban populations who rely on ALAN to meet their needs. Instead, careful design and application of lighting systems can ensure the positive effects of ALAN outweigh its drawbacks. The impact of ALAN varies based on location and time; for instance, lighting in city centers has less environmental impact than in nature reserves, and light used early in the evening differs in necessity compared to late-night hours. A balanced approach is crucial to harmonize human and environmental needs.

LED Technology offers an increasing lighting design toolbox

The transition to LED technology has revolutionized lighting design, offering tools to optimize systems and minimize adverse effects. LEDs provide:

- **Enhanced Light Control:** Compact LED sources enable precise optical designs to control light distribution effectively.
- **Dimming Capabilities:** LEDs can easily be dimmed smoothly and more deeply, reducing light intensity when not needed.
- **Spectral Tuning:** LED technology allows for fully adaptable spectral outputs, addressing the specific needs of various environments, applications and species. While no single spectrum suits all, LED systems can be customized to a wide range of applications and different environments.

Lighting Industry Innovations

The lighting industry is equipped to mitigate ALAN's adverse effects through advanced tools and techniques:



Right Place: State-of-the-art optics direct light precisely where it's needed.



Right Time: Local and remote-control systems optimize lighting schedules, ensuring appropriate light levels at the right time.



Right Light: Spectrally optimized lighting minimizes ecological disruption while serving human needs.

Zhaga Consortium's Contributions

As a global organization in the lighting industry, the Zhaga Consortium is dedicated to standardizing the interfaces of components used in LED luminaires, including key elements such as LED modules, LED drivers and optics. By fostering interoperability and circularity, Zhaga plays a crucial role in promoting sustainable indoor and outdoor lighting practices that balance environmental considerations with human needs.

Right Place

Zhaga defines interface specifications between LED modules and optical components, such as lens plates (e.g., Books 15 and 19 for outdoor applications). These specifications ensure stable luminaire design platforms and ecosystems where LED modules and optical elements from different vendors can seamlessly integrate. By using Zhaga-certified modules and optics, manufacturers can select the ideal combination of LED light sources and optical components for a broad range of applications. This enables optimized light distribution, ensuring illumination is directed precisely where needed, without unnecessary trespass, spill or energy waste.

Right Time

Zhaga-D4i certified systems enable intelligent lighting control, allowing luminaires to dim or turn off when not required. The main ALAN focus is on outdoor lighting. This is addressed by Zhaga Book 18 certified luminaires, and sensor and communication modules. However interior lighting that shines outward can also be a nuisance and should be minimized, especially when buildings are unoccupied. This is enabled by Zhaga Book 20 certified solutions. Additionally, standardized and secure programming tools, as defined in Zhaga Books 24 and 25, allow installers to easily configure drivers with customized dimming profiles and timing settings. This ensures that lighting is only active when needed, reducing energy consumption and operational costs.

Right Light

By defining the key interface specifications between luminaires and LED modules, Zhaga provides stable design platforms for luminaire OEMs and LED module manufacturers. Future upgrades are also facilitated by defined keep-out zones in luminaires and clear mounting specifications.

These standardized platforms enable the implementation of a specific light spectrum being optimized for a particular application or lighting environment.

Moreover, light spectra can be set dependent on location, daytime and season, using remote control provided by Zhaga Book 18 or Book 20 certified sensor and communication modules, and LED drivers programmable according to Zhaga Books 24 and 25.

In this way, Zhaga plays a key role in creating lighting solutions that prioritize human-centric design, environmental sustainability, and adaptability to meet the changing demands of modern applications.

By leveraging its standardization efforts, the Zhaga Consortium empowers the lighting industry to develop sustainable, efficient, and versatile lighting solutions that balance functionality with ecological stewardship.