SLSC STREET LIGHTING SMART CONTROLS

IPWEA

SLSC BRIEFING

Using new energy performance metrics to effectively measure public lighting energy efficiency

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KEY POINTS:

Public lighting is rapidly becoming adaptive. However, as light output varies with time and need, so too does energy consumption.

- How does one estimate or measure the energy performance of a planned or existing lighting scheme when there is dimming, brightening, trimming, constant light output controls or sensor controlled lighting installed?
- Is a new lighting scheme efficient compared to an existing one?
- Does it save enough energy or reduce light pollution or improve visual conditions to justify smart controls?

A new energy performance calculation methodology, backed by international precedent, is being introduced within the AS/NZS 1158 standards framework to answer these questions.

ENERGY PERFORMANCE ASSESSMENT AND REPORTING

Where road lighting energy performance assessment and reporting is required by road authorities or other related parties there the will soon be AS/NZS standardised techniques available, as a voluntary feature. Systemic approaches to energy assessment including terminology, metrics, methods and formulae will be described in forthcoming updates to AS/NZS 1158 Part 3.1 (Category P lighting) and Part 1.1 (Category V lighting). These methods align with the principles of European Standard *EN 13201-5 Energy Performance Indicators* which defines international best practice.

The energy performance of a road or public lighting scheme is systems based and outcomes are determined by the interaction and combined effects of the:

- Luminous efficacy and photometric distribution of the luminaires
- Appropriateness of the lighting design for the site layout and geometry
- Operation of the lighting scheme in practice

Such an approach gives the ability to objectively quantify and compare the systemic energy impacts of road lighting schemes at the planning stages to provide the facility for the lighting designer to tune and optimise various alternative options and to evaluate the energy use outcomes of a proposed lighting scheme.

This approach treats lighting levels and operation timing as dynamic and changing parameters rather than only as fixed values, as in the past. Accommodating variable light levels and timing allows for quantification of the resultant effects of adaptive lighting techniques such as constant light output (CLO), scheduled control, and real-time sensor control with smart control devices with internet connected Central Management Systems (CMS). This methodology supports the growing application of traffic adaptive lighting (ie off-peak dimming or on-peak brightening) and the consequent re-classifying of lighting design hierarchy subcategories at multiple stages over the nightly or weekly time cycle.

These methods provide rules for the structured description, calculation and reporting of annualised energy performance for road and public space lighting schemes, including any temporal or seasonal usage variances. The holistic approach is inclusive of system losses in the form of control device non-active power modes, such as standby mode and network standby mode.

Standardised comparison of options at the planning stage will allow for credible and impartial like-for-like reviews of the energy use implications of various items of equipment, design approaches, and any dimming or brightening adaptive control operations employed. This standardised framework will provide road authorities, designers, energy analysts and investors the tools to assess, benchmark or audit the energy performance of both planned and existing lighting schemes in a systemic and objective manner. Such tools are also useful to enable business case calculations on the financial implications and return on investment of energy saving technologies.

The two metrics are, Power Density Indicator (PDI) and Annual Energy Consumption Indicator (AECI).

Power Density Indicator (PDI) is, watts per lux per square metre ($W/lx/m^2$). The wattage is the sum of the luminaire wattage over the road length, plus the sum of any devices used to directly control the luminaires (e.g. NEMA/ANSI light point controllers). The road area is determined by the same dimensions (design width and length) as those used in the lighting design calculations, and lux (average maintained horizontal illuminance) is the lighting design calculated value to meet the requirements of the selected AS/NZS 1158 lighting subcategory.

Annual Energy Consumption Indicator (AECI) is, kilowatt hours per square metre per year ($kWh/m^2/yr$). The energy use is the product of variable light levels applied at variable times over an annual cycle, and the road area is the same as that used in the PDI calculation. The annual energy consumption of a road lighting scheme depends on the:

- Period of time for which lighting is provided
- Lighting subcategory specified by the relevant lighting standard for each lighting period
- Efficiency of the lighting scheme, when providing lighting for each period
- Way the lighting control system follows the change in visual needs of road users
- Non-active energy consumption of control devices at times when lighting is not needed.

The AECI incorporates the annual accumulated energy use of road lighting, and actual lighting needs may vary during the year for the following reasons:

- Seasonal variations of daylight/night time hours
- Changing weather conditions
- Changing traffic activity on roads and public areas during the night
- Changing functions of the road or public area

The PDI is first required in order to calculate the AECI. The two values are complementary and should always be presented together. The AS/NZS 118 standards will provide calculation worked examples, including those using constant light output technology. In European regions lighting design software vendors have adapted their packages to rapidly and automatically calculate and report PDI and AECI values for lighting designs, and indications are that local vendors will follow suit.

MORE READING:

1. EN 13015-5:2015 Road Lighting – Part 5: Energy Performance indicators