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MODERNIZATION OF STREET LIGHTING USING LEDs

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Abstract: LED technology is revolutionizing street and area lighting, offering 70-90% energy saving, extremely long lifetime, low maintenance costs and most importantly: improving lighting. Municipalities, state transport departments, ports, prisons and many others use LED technology for street lighting, highways, parking lots, high buildings, bridges, tunnels and general lighting.

Keywords: LED technology, highways, energy consumption.

1. INTRODUCTION

The switch to modern street lighting systems, based on LED technology, offers low energy consumption and brings a number of socio-economic benefits, such as safety and comfort for citizens [1], [6], [20].

Fig.1. Street lighting using LEDs vs. old generation street lighting

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A public street lighting system is a set of technical elements that includes lighting fixtures, light source, fixing poles, electrical wires, control and protection elements. They are intended to provide lighting at night on roads and pedestrian areas, providing comfort and safety to pedestrians and drivers [2], [19], [24].

2. LED RELIABILITY

If we talk about the reliability of the lighting system, we are talking about quality and energy efficiency.

Power quality is a permanent concern for both the energy supplier and the consumer, especially in terms of the benefits of maintaining the parameters within the limits specified by the standards in force, especially in terms of the benefits of maintaining parameters within specified standards. Speaking of street lighting systems, "clean" power means significant savings on energy supplier bills and lower maintenance costs of lighting equipment. Implementing a modular system performance and modernization light sources informed is paramount to decrease consumption and reduce electricity losses in a lighting network [3], [4], [7], [12].

In Romania, the electricity consumption of a city's public lighting system is on average 20% of total energy consumption. At European level, the problem of reducing pollution is becoming more and more important. Currently, public lighting in Romania is a source of pollution with CO2 emissions, but also light pollution which is less considered, yet is of major importance in certain sectors such as astronomical observatories. Therefore, it is necessary to integrate lighting efficiency solutions with long-term investments. A project of this scale can be started but only after measurements adapted to the specific situation. In addition, further verification of the results of the upgrades is required [5], [8], [21] [23].

In this context, the Ministry of Environment, Waters and Forests launched this year, through the Administration of the Environment Fund (AFM), a program for ecological lighting of the cities and communes of our country. The program is multi-annual, the budget established for 2020 being 384 million lei. Through the program, Romanian localities can replace their high-energy cost lighting fixtures using brand new LED lighting fixtures. At the same time, the administrations could also purchase dimming / remote management systems [9], [22], [17].

What is the process of estimating a lighting system?

The demands imposed by the LEDs used in street lighting would be:

1. After 100.000 activity hours (about 22 years at 6 hours of operation per day), degradation of more than 30% is not permissible for any equipment. At the same time, the 5-year warranty condition does not allow the degradation process to take place during this period. So, the light degradation of maximum 30% to occur only after 5 years warranty, up to 22 years from commissioning. Of course, when the warranty means only the failure and not the maintenance of the parameters (light degradation less than 30%). However, verifying the maintenance of the flow during the warranty period would be

difficult to stipulate in a contract but especially after the 5 years period, up to 100,000 hours according to the specified service life [11].

2. The correlation of the assurance period with the lifetime but also with the degradation of the light flux is kept ambiguous in the specifications, but also in the contracts. This allows both sides involved to interpret them conveniently. The correlation of the maintenance of the parameters in the context of the harmonization with the guarantee period supposes the recording of the values and of the statistical data to be verifiable in this period.Such a correlation should, for example, be recorded as follows:

"Lighting fixtures should have light degradation of L90 B5 F5 for 16 000 hours up to 5 years of assurance, or light degradation allowed during assurance (16 000 hours continuous operation) should not be higher than 10% for a maximum of 5% of the installed devices and failure rate should not be higher then 5%." according to Stelian Matei, Prof. Dr. Eng., Photometry and Electromagnetic Compatibility Laboratory S.C. Electromagnetica S.A. [13], [15].

To help designers and consumers compare high-power white LEDs from different manufacturers, two US labs, the Pacific Northwest National Laboratory (PNNL) and the National Institute of Standards and Technology (NIST), together with a group of six manufacturers of LEDs (including OSRAM and Cree), wrote a technical memorandum (TM-21, "Designing Long-Term Light Maintenance of LED Light Sources") to define a generalization algorithm for lumen maintenance testing [14], [18].

The new algorithm ignores data from the first 1000 hours and uses data from the last 5000 hours of the test (or 50% of the final data in case of 10,000+ hours tests). then, the data fit an exponential extrapolation model using a least squares curve method (Fig. 2).

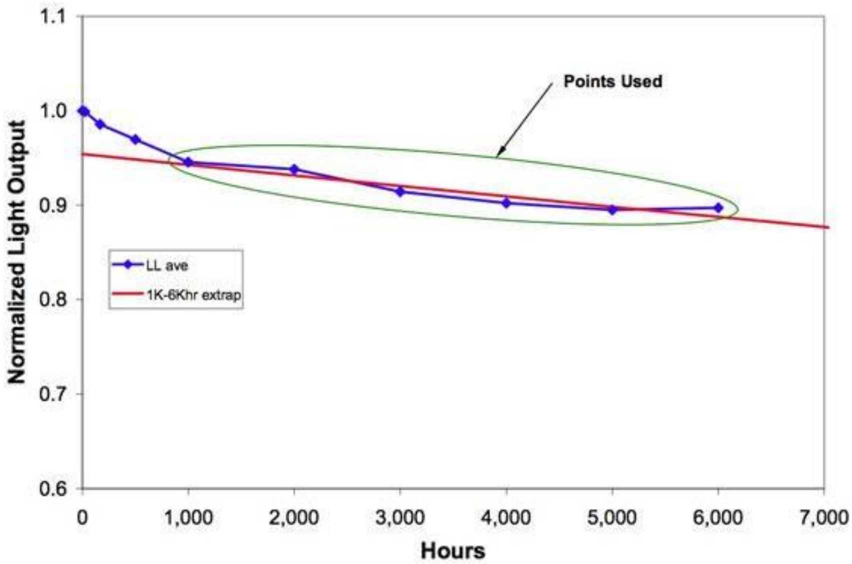

Fig.2. Sample TM-21 test showing data points used to calculate L70. (Courtesy of the Street Lighting Consortium.)

The extrapolation function defined by TM-21:

$$\Phi(t) = B \exp[-\alpha t] \quad (1)$$

Where α and B are determined by the least squares fit function.
Then,

$$L70 = \ln(B/0.7) / \alpha \quad (2)$$

TM-21 allows the manufacturer to state, with reasonable accuracy, that the average value of L70 for a product sample lot is a certain number of hours, for example 50.000. Engineers and consumers can then compare this to another supplier's figure, for example, 36.000 hours. In fact, the US Energy Star program requires an LED to obtain a L70 figure of 35.000 hours to qualify under the program [16].

Although, TM-21 defines a standard algorithm for extending LM-80 data beyond the 6.000 or 10.000 hour test point to accurately determine L70, the test will not tell the manufacturer how many of the devices it manufactures might expect to reach point L70 without failing.

It takes a combination of data from a long-term test to determine failure rates in all failure modes (called Bp - where p is a percentage of failures at a given time), including L70.

We have no doubt that properly installed high brightness LEDs last longer than conventional light sources. Consumers are a little more skeptical, and the lack of certified information does not help to overcome their doubts.

While testing the nominal life of LEDs is not a common practice, testing for light flux degradation is more common. Establishing a standardized test and extrapolation algorithm will improve the credibility of figures from different manufacturers, so that similar comparisons are practical [10], [25].

However, current tests do not take into account other forms of failure. The excuse is that the comprehensive tests take too long, and these other modes of failure are insignificant. However, LED manufacturers should be encouraged to engage in long-term repeated testing with large batches of products.

In this way, statistically significant samples would be available for further analysis, allowing fine-tuning of extrapolation algorithms to include all failure modes to estimate a nominal lifetime for a given product.

The lighting system must primarily contain the needs of modern life of the population. Compared to an old type lighting system, the modern one also combines intelligent software elements that helps for a better management of the lighting system, with a minimum energy consumption and maximum reliability. It offers the possibility to apply the latest solutions and technologies for energy efficiency, and its management is possible remotely.

3. CONCLUSIONS

The current trend clearly suggests that LED-based technologies will dominate public lighting systems. The current situation requires the need of national programs to modernize public lighting systems, so during 10 years thus, during 10 years, the image of the localities during night time can be completely changed.

During this period, I hope that differentiated pricing will be implemented for public lighting system managers, which would allow the reduction by at least 30% of the expenses for electricity consumption only by applying the coefficient 0.6 from the tariff established in the time interval 22-7.

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