

Energy Saving Lighting Solutions for Industry

**Ružena Králiková
Miroslav Badida
Tibor Dzuro**

TECHNICAL UNIVERSITY OF KOŠICE, FACULTY OF MECHANICAL
ENGINEERING, INSTITUTE OF DESIGN MACHINE AND PROCESS ENGINEERING,
DEPARTMENT OF PROCESS AND ENVIRONMENTAL ENGINEERING,

Energy Saving Lighting Solutions for Industry

doc. Ing. Ružena Králiková, PhD.

Dr.h.c. mult. prof. Ing. Miroslav Badida, PhD.

Ing. Tibor Dzuro, PhD.

Abstract

This monograph deals with actual issues, the search for rationalization measures in the energy consumption for lighting. Lighting systems is no small part of the share of total energy consumption, so it is necessary to look for energy savings opportunities in this area. In Slovakia, especially in industrial plants, a large amount of lighting systems that do not meet the requirements of energy efficiency, but what is worse, employees do not ensure an nor the minimum lighting requirements at work, which is the primary function of lighting workplaces.

The development of light sources and lighting equipment provides both opportunities and challenges for the lighting designers in providing lighting that is not only adequate in terms of quantity, but also meets the lighting quality demands. Recent developments in lighting technology combined with planned lighting control strategies can result in very significant cost savings, typically in the range of a third to a half of the electricity traditionally used for lighting.

Energy-efficient lighting solutions for industry can help to reduce environmental impact and save on costs which will ultimately brings also financial savings for consumers, but mainly with a view to ensuring a safe working environment for employees. Based on a synthesis of theoretical assumptions and practical verification options to streamline lighting systems engineering operations is presented in the monograph designing methodical process economic and energy-efficient lighting systems. Processed methodology served as the basis for designers. Within this methodology were conducted measurements of parameters of lighting in production rooms of engineering establishments, which were unsatisfactory with main goal - to arrive at a solution that provided a reduction of energy consumption and increase of illuminance values in operation, which is how we assume the sufficient reason in search of rationalization measures.

Key words: *color temperature, computer simulation, industry, luminaires, reducing energy,*

This monograph was written on the base of the project VEGA 1/0537/15 Research of influence of chosen parameters of working environment on working power and productivity and project Park Technic - ITMS 26220220182 University science park TECHNICOM the innovative applications to support knowledge technologies.

Reviewer: prof. Ing. Irida Kolcunová, PhD. (SK)
prof. Ing. Vojtech Dirner, CSc. (CZ)
Dr. Dezső Gergely, PhD. (HU)

Edition of Scientific and Technical Literature

© doc. Ing. Ružena Králiková, PhD., Dr.h.c. mult. prof. Ing. Miroslav Badida, PhD.,
Ing. Tibor Dzuro, PhD.

ISBN 978-3-942303-43-9
EAN 9783942303439

Contents

Abbreviations.....	6
Dictionary	8
Introduction.....	12
1. Sustainable lighting for industry.....	14
1.1. Development of light sources	16
1.2. Lighting quality	17
2. Rationalization measures	24
2.1. Replacement of Lamps	28
2.1.1. Luminous Flux.....	29
2.1.2. Luminous efficacy	30
2.1.3. Color Temperature.....	31
2.1.4. Color Rendering Index.....	33
2.1.5. Lamp Lifetime	34
2.2. Replacement of Luminaires.....	35
2.3. Application of Electronic Ballasts.....	38
2.4. Renewal of Lighting System	43
2.5. Lighting Control	44
2.6. Change in Lighting System Maintenance.....	48
2.6.1. Maintenance Plan.....	49
2.7. Daylight Utilization	51
3. Computer Simulation	54
3.1. Creation of Lighting Environment	55
3.2. Reference Object Selection	60
3.3. Comparison and Selection of Luminaires and Lamps.....	61
3.3.1. PHILIPS Leuchten Cabana HPK150.....	65
3.3.2. PHILIPS Leuchten PerformaLux.....	65
3.3.3. PHILIPS Leuchten GentleSpace.....	67
3.3.4. PHILIPS Leuchten Pacific LED a Maxos LED.....	69
3.4. Comparison of Lighting Systems from the Point of View of Economy.....	70
3.5. Energy savings calculator for LUMILUX T8, XT T8 und XXT T8 lamps.....	77
4. Influence of Maintenance Factor on Energy Consumption	79
4.1. Lumen Loss Maintenance Factor (LLMF)	79
4.2. Premature lamp mortality (LSF).....	80
4.3. Lumen Loss Maintenance Factor Caused By Dirty Luminaires (LLMF)	81
4.4. Room Surface Maintenance Factor (RSMF)	82

Introduction

Lighting is the way to a greener future. Sustainability meeting our needs today without compromising the resources future generations will need touches everything we do as a company. It's all about reducing environmental impact, a commitment that goes beyond our products to include how the products are used, how they are manufactured and how they are distributed. It even extends to the design of "greener" buildings. "Green building" incorporates environmentally responsible practices into the design of new construction and the renovation of existing buildings. Green facilities aren't just healthier for people and the planet. Using only as much light as is needed when it is needed is key to reducing energy consumption. One popular control device is the occupancy sensor, which simply turns the lights off when no one is in the room. Another type of control uses multiple lighting circuits that allow the occupants to use some or all of the light sources, depending on the availability of natural light, task requirements or occupant needs. More sophisticated dimming ballasts and control devices let occupancy of building management systems control overall energy use by smoothly dimming or increasing light levels as required. These systems can also utilize bi-level switching and occupancy sensors, so employees only use the amount of electric light needed and lights are turned off when spaces are unoccupied. Lighting can do so much more than illuminate of space. It can enhance form and function, improve safety and security and create flexible spaces that adapt to the task at hand. And in these worrying times of soaring energy prices and legislation targets it can also help companies to achieve the sustainability goals that communicate corporate responsibility. Alternative energy systems are already reducing the impact that industry has on the planet. To make real steps forward in sustainability, innovative lighting solutions are required that complement those natural sources of energy. Energy-efficient lighting solutions for industry can help to reduce environmental impact and save on costs, at the same time as increasing quality and productivity.

The famous energy efficiency analyst for the International Energy Agency (IEA) said that, „Heavy industry could reduce energy used by 18 % to 36 % just by applying best practices and available technologies and light industries like retailing and the food sector could cut energy use by an even greater percentage up to 50 % because they haven't always made efficiency a priority.” In the same time (article), Charles Zimmerman, Walmart Vice President of Prototype and New Format Development stated, “Energy efficiency is one of the best investments we can make and indicated that many of the savings will come through lighting innovations.”

There are many good reasons to use energy-efficient lighting systems. Here are a few of them:

- **Lower operating costs:** Reduced energy usage directly translates to your bottom line. The longterm savings can quickly repay the minimal capital investment. Additionally, incentives may be available to building owners to help offset the financial investment in new energy-efficient systems. These include allowing owners to use the money saved on energy bills to pay for the new system, utility incentive programs and government tax incentive programs.
- **Attract energy conscious tenants.** Energy efficient systems help buildings achieve the green energy rating in addition to lowering operating costs.
- **Improved workplace conditions.** Many of today's lighting systems deliver more comfortable illumination and provide employees with the ability to select light levels that are suitable and comfortable for specific tasks. In many cases, employees chose lower light levels, which translate into greater energy savings.
- **Be seen as a better neighbor.** Installing energy-efficient systems provides an opportunity to identify your company as an environmentally conscious member of the community.

Any attempt to develop energy efficient lighting strategy should, as the first priority, guarantee that the quality of the luminous environment is as high as possible. The results presented in this book demonstrate that this is achievable, even with high savings in electricity consumption. Lighting quality is also a financial issue which can be best illustrated in the case of the luminous environment of work spaces.

In the search for highly efficient lighting schemes, it is essential to fully understand the detailed lighting specification of given environments. The integration of this knowledge in lighting design leads to opportunities to develop win-win scenarios, offering combination of energy performance and lighting quality.