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Part 1 – Electronic and Electrical Engineering

Techno-economic Analysis of LED Lighting: A Case Study in UTeM's Faculty Building

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Abstract

This paper examines the feasibility of adopting LED lamp in replacing the conventional fluorescent lamp. Analysis and comparison have been carried out on the two lighting systems in terms of electrical and photometrical performance. A case study on UTeM's building has also been presented, which focuses on the economic evaluation. In addition, various lighting energy saving strategies have been proposed. The economic benefits of the respective energy saving measures have been successfully quantified. The study suggests that LED tubes has great potential to replace fluorescent lamps, mainly driven by the cost savings.

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Keywords: component; Lighting system; LED tubes; Fluorescent lamps

1. Introduction

The recent years are witnessing an increasingly important role assumed by climate change issues in the electrical that energy sector [1-4]. Much of the attentions have been focused on energy efficiency with the common target to reduce greenhouse gases emissions. This has led to the development of various emerging technologies, which are energy efficient and able to reduce energy consumption, such as solar photovoltaic (PV) and light-emitting diode (LED) [5-9]. It is expected utilising such emerging green technology in an early stage will incur much higher upfront investment cost, which may become the barrier for its large-scale implementation. However, the associated costs saving and environmental benefits of

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implementing energy efficient technology over the longer-term period may be significant [10]. Therefore, the life-cycle cost methodology [11], which considers both operational and investment cost over the technical lifetime of equipment should be applied in justifying the expenditure into the implementation of various energy efficient technologies.

In light of this, it becomes imperative that the manufacturers should have the relevant tools and analysis framework that are capable of evaluating the costs and benefits of up-taking energy efficient technologies. This is important to ensure that the most cost effective and efficient integration of system design is adopted [12].

In view of the Malaysian context, lighting is one of the major uses of electricity and accounts for approximately 17% of national electricity usage [13]. Thus, the use of higher efficiency lighting systems such as LED offers significant potential for electricity saving, and reduces CO_2 emissions. Therefore, this project aims to investigate the efficient integration of emerging green technologies on buildings at UTeM's main campus. More specifically, the techno-economic of integrating light-emitting diode (LED) for lighting purposes are evaluated on the existing system. The findings are expected to be beneficial to assist management in the decision-making process on the choice of several feasible options, hence provides significant opportunities for industry consultation in relation to establishing a business case for efficient integration of green technologies.

This paper examines the feasibility of LED lamp in replacing the conventional fluorescent lamp. Analysis and comparison have been carried out on the two lighting systems in terms of electrical and photometrical performance. A case study on UTeM's building has also been presented, which focuses on the economic evaluation. In addition, various lighting energy saving strategies have been proposed. Subsequently, the economic benefits of the respective energy saving strategy have been quantified.

2. Lighting Systems Characteristics

2.1 Lumen

Lumen is the SI units for luminous flux, which is the quantity of light emitted by a source or the quantity of light received by a surface. Typical values of luminous flux emitted by some common sources of light are given in Table 1

Table 1: Number luminous flux emitted by common light sources

Lamp	Lamp Wattage	Lumens
Incandescent lamp	75W	950
Compact Fluorescent lamp	15W	810
Fluorescent lamp	36W	2,400
LED	18W	1,600

2.2 Lux

Lux is the SI unit for illuminance, which is a measure of the direct illumination on a surface area of one square meter. One lux is one lumen/m^2. Some typical lux values are given in Table 2.

Table 2: Recommendation average illuminance levels based on malaysian standard (ms1525:2007) [14]

Task	Illuminance (Lux)	Examples of Applications
Lightingfor infrequently used area	100	Interior walkway and car-park, hotel bedroom, lift interior, corridor, passageways, stairs, entrance and exits and etc
Lighting for working interiors	300-400	General offices, shops and stores, reading and writing, drawing office, class room