Analysis on Energy Efficiency and Optimality of LED and Photovoltaic Based Street Lighting System

Master of Science Dissertation

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Analysis on Energy Efficiency and Optimality of LED and Photovoltaic Based Street Lighting System

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by

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Declaration

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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18. 04. 2013

I/We endorse the declaration by the candidate.

Dr. Satish S. Namasivayam

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EXECUTIVE SUMMERY

This research evaluates what is the most suitable energy efficient street lighting system for Sri Lanka as a part of energy conservation which can be taken as a highly relevant topic nowadays. This research is based on the detailed review of street lamps operated in the country. The said review was mainly carried out through a comprehensive street lamp census conducted in all over the country in between late February 2010 and mid May 2010.

Several lamp technologies are presently used for street lighting; however, Light Emitting Diodes (LEDs) are becoming increasingly competitive with established technologies due to their rapidly increasing efficiencies and decreasing cost. The research assessed the LED fixtures which have a capability of significant energy savings potential achieving from 50% to 70% energy savings compared to the existing street lamps that are the best option for replacement of existing lamps. Stand-alone solar powered LED system and the street lighting control methods were also discussed and evaluated to verify the optimum outcome. Mainly, lighting design and comparison have been taken into account along Bambalapitiya – Kollupitiya Galle road section with Sodium Vapour Lamps and LED by actual field measurements and Lighting Reality, simulation software to evaluate better street lighting options. This study found that the LEDs with photocell or timer controlling methods delivered both significant energy savings and equivalent or improved lighting performance relative to the existing lamps.

The potential for energy savings from LED street lights is very large. It was estimated by economic evaluation that 155 GWh of energy was used by existing street lighting in Sri Lanka in year 2010. This study reveals that the current energy consumption would be reduced by over 1/3 using LED replacement to the existing lamps. As LED technology advances and efficacies improve as demonstrated by "Haitz's Law", these savings will likely more improve as well.

The overall savings potential which will be made by conversion of existing lamps by LED, is likely to further increase in the future as the energy and lighting performance. Even though solar power systems need high capital expenditure, it will be one of the most appropriate energy solutions for the country like Sri Lanka. However, LED technology is unfamiliar to our country and not readily available for mass deployment; limitations continue to exist in the lighting performance of some. Additionally, economic viability, though subject to location details, will remain a key factor that must be weighed in concert with lighting performance. Incentive program development by the government may further encourage LED street lamp and solar powered system development adoptions. This research recommends that any such incentive programs include performance standards that consider warranty, efficacy, light distribution, and other important criteria.