ELECTRICAL ENERGY SAVING POTENTIAL IN SRI LANKA OFFICE BUILDINGS - APPLICATION TO OFFICE BUILDINGS IN COLOMBO

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Degree of Master of Science in Building Services Engineering

Department of Mechanical Engineering

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DECLARATION

I declare that the research work submitted in this dissertation is of my own investigation except where otherwise stated.

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Signature of the Supervisor Date

(Prof. R. Attalage)

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ABSTRACT

This research study is focused on the applications to find out the potential cost effective energy saving measures (ESMs) to make projection of EUI (Energy Unit Intensity) values in kWh/m^2.year for high rise office buildings in Colombo, Sri Lanka, as it is a widely accepted fact that energy efficient building design measures and techniques are application specific.

Therefore, the objectives of this thesis include detailed study in relation to office building energy efficient measures (EEMs) and also study for office building energy saving potential using established Baseline Building parameters. This helps to quantify 'office buildings energy saving potential' and make projection of building energy consumption savings for new office buildings. This also helps to find out the potential energy saving measures to make projection of EUI values for office buildings in Colombo, Sri Lanka.

The results of this research are based on two selected office building applications in Colombo. The building categories subject to this research are one high-rise office building (height around 100m) and one medium-rise office building (height around 30m) in Colombo. Life cycle analysis is done using the present tariff structure of the Ceylon Electricity Board.

In most of the projects, the building sites are selected before the involvement of the design team. Also, within the limited site area, the building is orientated and the outer appearance of the building also finalized in order to maximize the useable capacity and aesthetics. Therefore, due to the above project constraints, some ESMs for building form such as aspect ratio of the building, orientation (reduced East-West faced windows) and WWR (window to wall ratios) are not considered in investigation.

The analyzing of the potential ESMs for the selected office buildings are limited to the following energy saving measures due to the project specific limitation mentioned above, current industry practices, modeling software analysis limitations, owners of the buildings planning to rent out the spaces to outside tenants, time frame limitation of this study, viz., Selective glazing for windows, Perimeter circulation space, Open office space at perimeter, Daylighting through windows, Energy efficient lamps and ballasts, Lighting controls and High Efficiency cooling equipment (i.e. efficient chillers).

TRACE 700 computer simulation software is used for modeling the buildings as it is a detailed simulation tool that computes building energy use based on the interactions between climate, building form and fabric, internal gains, HVAC systems and day lighting integration.

It has been found that incorporation of cost effective energy saving measures (ESMs) for high-rise office buildings in Colombo, Sri Lanka have greater potential to reduce annual electrical energy consumption by minimum 20 percent in comparison with a Baseline Building and it can also establish better EUI values for high-rise office buildings in Colombo, Sri Lanka.

Based on this study, it has been established that the EUI value for the high-rise office building in Colombo is 124 kWh/m^2.year and EUI value for the medium-rise office building in Colombo is 83 kWh/m^2.year.

Further it has been found that the payback periods for selected cost effective ESMs are between 2.3 and 3.8 years under Ceylon Electricity Board (CEB) present tariff structure (General Purpose tariff).

It is recommended that further research be carried out in this area for both computer modeling and data collection from existing office buildings in Sri Lanka to establish a better and more precise EUI values and higher annual energy saving percentage for office buildings in Sri Lanka, as this study is limited to few ESMs and computer simulation has been done for only two office building applications.

Key Words: Energy Saving Measures (ESMs), Energy Efficient Measures (EEMs), Baseline Building, Benchmark, General Purpose Tariff, Energy Unit Intensity (EUI).

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AC	- Air Conditioning
ASHRAE	- American Society of Heating, Refrigerating and Air-Conditioning Engineers
AHU	- Air Handling Unit
BIPV	- Building Integrated Photovoltaic panels
BMS	- Building Management System
CAV	- Constant Air Volume
CEB	- Ceylon Electricity Board
cfm	- Cubic feet per minutes
COP	- Coefficient of Performance
EEMs	- Energy Efficient Measures
ESMs	- Energy Saving Measures
EUI	- Energy Unit Intensity
FCU	- Fan Coil Unit
GBCSL	- Green Building Council of Sri Lanka
HVAC	- Heating Ventilation and Air Conditioning
IEA	- International Energy Agency
LED	- Light Emitting Diode
LPD	- Lighting Power Density
POE	- Post Occupancy Evaluation
PV	- Photovoltaic panels
QA	- Quality Assurance
QC	- Quality Control
ROI	- Return of Investment
SC	- Shading Coefficient
SHGF	- Solar Heat Gain Factor
TR	- Ton of Refrigerants
WWR	- Window to Wall Ratios
VAV	- Variable Air Volume
VE	- Value Engineering
VLT	- Visual Lights Transmittance
VSD	- Variable Speed Drives