# ANALYSIS OF IMPACT ON GREENHOUSE GAS EMISSIONS OF COMMERCIAL BUILDINGS BY IMPLEMENTING ENERGY-EFFICIENT BUILDING CODES IN SRI LANKA

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Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

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Thesis submitted in partial fulfilment of the requirements for the degree Master of Engineering in Energy Technology

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**Declaration**

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Master's thesis under my supervision.

Name of the supervisor: Dr MMID Manthilake

Signature of the supervisor: Date: 26.05.2023

## Abstract

Global warming and climate change, a result of abundant anthropogenic GHG emissions, is the fundamental human development obstacle in the 21st century. In Sri Lanka, buildings and services account for roughly 29.72% of total $CO_2$ emissions. Energy Efficient Building Codes are one of the key initiatives proposed to reduce emissions in buildings. Sri Lanka is in the process of preparing a mandatory EEBC, and a draft 'Building Code of Sri Lanka 2020' has been released. But its potential impact on energy and GHG emissions reduction has not been properly investigated. The study presents an analysis of a prototype commercial building in Colombo, comparing the energy and GHG emissions impact of EEBC requirements from different codes, namely, Code of Practice for Energy Efficient Buildings in Sri Lanka – 2008 (SLBC 2008), Draft Energy Efficiency Building Code of Sri Lanka – 2020 (SLBC 2020), ASHRAE 90.1 – 2022 and NCC Section J - 2022. The analysis was conducted using a calibrated whole-building energy model of the prototype building created using the DesignBuilder and EnergyPlus software. The results indicate that the draft SLBC 2020 can reduce overall energy use and GHG emissions by 8% compared to a BAU scenario with SLBC 2008, with the biggest improvement in lighting energy. The draft SLBC 2020 can also reduce the HVAC design load by 14.1% compared to a standard design thermal envelope. However, compared to leading EEBCs such as ASHRAE 2022 and NCC 2022, the draft SLBC 2020 lags by 2.5% and 15.6%, respectively. The energy and GHG emissions reduction potential of the draft SLBC 2020 could provide massive energy, foreign currency and GHG emissions savings to Sri Lanka over the coming years. Therefore, implementing the draft SLBC 2020 is seen as a timely solution to achieving the GHG emissions reduction targets of Sri Lanka and addressing the deep economic and energy crisis. Further, the draft SLBC 2020 has the potential for further improvements compared to some of the leading EEBCs, and the implementation of the first mandatory EEBC in Sri Lanka can be challenging.

Keywords: Building Energy Efficiency, Energy Efficient Building Codes, Energy Modelling, GHG emissions

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**TABLE OF CONTENTS**

## LIST OF FIGURES

## LIST OF TABLES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| GHG | Greenhouse Gas |
| EEBC | Energy Efficient Building Code |
| HVAC | Heating, Ventilation and Air Conditioning |
| SLBC | Sri Lanka Building Code |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| NCC | National Construction Code (Australia) |
| NABERS | National Australian Built Environment Rating System |
| OTTV | Overall Thermal Transfer Value |
| UN | United Nations |
| IPCC | Intergovernmental Panel on Climate Change |
| COP | Conference of the Parties |
| GDP | Gross Domestic Product |
| PPP | Purchasing Power Parity |
| ODS | Ozone-Depleting Substances |
| CDM | Clean Development Mechanism |
| BAU | Business-As-Usual |
| DSM | Demand Side Management |
| NDCs | Nationally Determined Contributions |
| SHGC | Solar Heat Hain Coefficient |
| VLT | Visual Light Transmission |
| COP | Coefficient of Performance |
| LPD | Lighting Power Density |
| VRF | Variable Refrigerant Flow |

| | |
|---|---|
| FCU | Fan Coil Unit |
| WWR | Window-to-Wall Ration |

## LIST OF APPENDICES