TECHNO ECONOMIC SITE SELECTION AND PRIORITIZATION OF MEDIUM SCALE SOLAR PROJECTS IN SRI LANKA USING MULTI CRITERIA APPROACH

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Degree of Master of Science in Electrical Installations

Department of Electrical Engineering

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Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science in Electrical Installations

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DECLARATION

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

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(Candidate)

The above candidate has carried out research for the Masters thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

…….. ……..

Prof W.D.A.S. Rodrigo Date

(Supervisor)

DEDICATION

To my beloved wife, parents, other family members and friends

ACKNOWLEDGEMENT

First, I offer my sincere gratitude to my supervisor, Prof W.D.A.S Rodrigo of Department of Electrical Engineering, University of Moratuwa for his unwavering and continuous support in many ways throughout the course of this whole research. From the research idea to formulation of the methodology, he provided immense support and guidance which enabled me to conduct this research.

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ABSTRACT

Renewable energy sources are highly preferable over fossil fuels due to their availability, low environmental impact, and often being free. Sri Lanka, like many other countries, aims to shift towards green economies and achieve sustainable development by pursuing clean energy options such as solar power, wind, biomass etc. However, not all locations are equally suitable for solar energy generation so that selecting optimal sites for solar power plant installation has become a crucial factor in project planning. Many studies have used multicriteria decision analysis (MCDA) to identify suitable sites for solar power plants, but no comprehensive study has been conducted for the entire land of Sri Lanka, despite renewable energy resource development throughout the country being a priority for the Sri Lanka Sustainable Energy Authority (SLSEA).

This study comprises of two objectives where the first objective is to develop a method to identify the best suited Land plots for Medium-Scale Solar Power Development projects in Sri Lanka using Multi Criteria Decision Approach. The second objective of this study is to prioritize the identified renewable energy development projects/sites in the country in order to come up with a future RE Development plan, through the proposed method. The study will utilize Arc GIS Software for land plot selection of solar PV infrastructure development, and implement the TOPSIS Method (Technique for Order of Preference by Similarity to Ideal Solution) as the MCDA method for renewable energy project prioritization in Sri Lanka. The study will develop a spatial MCDA framework incorporating various GIS tools (Overlay Analysis) for land plot selection and TOPSIS criteria for project prioritization. The framework aims to identify optimal sites for solar power plants across the country, considering the potential photovoltaic electricity production (PVOUT) that could be generated from solar energy, and may also be limited to specific regions of the country.

Accordingly, Land plot selection has been carried out first considering land use type, distance to Grid Substation (GSS), distance to main roads, distance from protected areas, distance from water resources, building density, solar radiation and slope as the identified criteria. After land plot selection, project prioritization has been carried out based on irradiance level, Distance to Grid Substation (GSS), Distance to the site (from the closest available port), Potential Opportunity Cost and average air temperature.

The ultimate site selection for harvesting renewable energy must be done in a way that best utilizes both the potential of the resource and also the availability of transmission capacity. CEB and SLSEA have specifically used this in the finalization of sites, and the future requirement is further discussed in the CEB's transmission development plan.

Keywords: Renewable Energy, Clean Energy, Sustainable Development, Geographical Information System, Multi Criteria Decision Approach, Technique for Order Preference by Similarity to Ideal Solution

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LIST OF ABBREVIATIONS

Abbreviation	Description
SL	Sri Lanka
SLSEA	Sri Lanka Sustainable Energy Authority
MCDA	Multi Criteria Decision Approach
NCRE	Non-Conventional Renewable Energy
GIS	Geographical Information System
PV	Photovoltaic
CEB	Ceylon Electricity Board
LECO	Lanka Electricity Company
PUCSL	Public Utilities Commission of Sri Lanka
USA	United States of America
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
MW	Mega Watts
kV	Kilo Volts
GW	Giga Watts
RE	Renewable Energy
IEEE	Institute of Electrical and Electronics Engineers
NRE	National Renewable Energy Laboratory
LTGEP	Long Term Generation Expansion Plan
USD	United States Dollars
WLC	Weighted Linear Combination
SAW	Simple Additive Weighting
AHP	Analytic Hierarchy Process
ELECTRE	Elimination and Choice Expressing Reality
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluations
MAUT	Multi-attribute Utility Theory
LGA	Local Government Area
GHI	Global Horizontal Irradiance
LCOE	Levelized Cost of Energy

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