TECHNO-ECONOMIC FEASIBILITY ASSEMEMNT OF INTEGRATING FLOATING SOLAR WITH HYDRO: A CASE STUDY FOR VICTORIA POWER STATION SRI LANKA

Noopehewa E.L

198727G

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

June 2025

TECHNO-ECONOMIC FEASIBILITY ASSEMEMNT OF INTEGRATING FLOATING SOLAR WITH HYDRO: A CASE STUDY FOR VICTORIA POWER STATION SRI LANKA

Noopehewa E.L

198727G

Thesis/ Dissertation was submitted to the Department of Electrical Engineering of the University of Moratuwa in partial fulfillment of the requirements for the Degree of Master of Science in Electrical Installation

June 2025

Supervisors : Prof. L N W Arachchige
: Dr. Upuli Jayatunga

DECLARATION

I declare that this is my own work, and this thesis/dissertation 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.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (Such as articles or books).

Signature:

……………………. Date: 13-06-2025

Noopehewa E.L

The above candidate has carried out research for the Masters Dissertation under my supervision.

Signature of the supervisors:

……………………. Date: 13-06-2025

Prof. L. N. Widanagama Arachchige

……………………. Date: 13-06-2025

Dr. Upuli Jayatunga

ABSTRACT

The addition of floating solar photovoltaic (FSPV) to existing hydropower facilities is a potential game-changer in the incorporation of renewable power sources while maximizing resource allocation. This study explores the potential deployment of an FSPV system configuration at the Victoria hydropower station in Sri Lanka from a technical, as well as a financial perspective. It explores the possibility of approximately 93 MWp of solar capacity being placed on the surface of the reservoir, which would result in the generation of 133.5 GWh of energy per year. By utilizing the existing grid structure at Victoria, this method serves as a cheaper solution than ground-mounted and independent floating solar plants. The analyzed comparative levelized cost of electricity (LCOE) data is suggestive of a hybrid model in comparison to the standard solar PV design in the country.

Dynamic simulations were carried out on the proposed system with the aid of Power System Simulator for Engineering (PSS/E) and a dynamic model received from the Ceylon Electricity Board (CEB) Transmission Division. The outcome suggests that the complementary operation of FSPV and hydropower does not put system stability at risks, since the frequency response and bus voltage profiles of the system are within allowed limits under all system disturbances. Furthermore, the existing arrangement for power sharing between solar and hydro resources offers additional energy security in that it permits dominance of solar over daylight hours while allowing hydro resources to be stored for generation during the night.

The results of this study elaborate that the complimentary use of floating solar PV (FSPV) and hydropower has the potential in making the country's energy transition economically sustainable. Even though there may be some boundaries, the analysis does set up a strong case for the future large-scale implementation of hybrid FSPV-hydro systems.

Keywords: Complementary Operation, Financial feasibility, Floating Solar Photovoltaic (FSPV), Frequency stability, Hybrid Energy Systems (HESs), Power system stability, Solar energy penetration.

ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude to my supervisors, Prof. L. N. Widanagama Arachchige and Dr. Upuli Jayatunga, who greatly assisted me throughout my research. My work has greatly benefited from their expert advises, for their commitment and guidance.

Let me also thank the entire review panel for the progress review sessions. I appreciate their effort and their comments, their thorough evaluations and recommendations have significantly contributed to refining my research, helping me improve my work at every stage. Their insights helped me refine my work at each stage while helping me structure a clear and meaningful study.

I would also like to thank Dr. H.M.Wijekoon Banda, Deputy General Manager (DGM) from the Ceylon Electricity Board transmission and generation planning branch and as well as Mr. Asiri Mihindukulasuriya, Electrical Engineer from Ceylon Electricity Board transmission planning branch, for helping me obtain important information pertaining to my PSS/E simulation. Their assistance is greatly appreciated and played a big role in me enabling me to conduct an effective simulation.

Additionally, I would like to extend my appreciation to Dr. Thushara D. Rathnayaka, the course coordinator of Electrical Installations, for her continuous support and guidance throughout the course.

Further, I would like to thank to Dr. Manuja Gunawardana from the University of Moratuwa and Dr. Iromi Ranaweera from the University of Ruhuna for their valuable feedback and comments. Their guidance played a crucial role in refining and strengthening the quality of my research.

Finally, I am deeply thankful to my family for their unwavering support, encouragement, and understanding throughout this journey. Their belief in me has been a constant source of motivation, and I could not have accomplished this without their love and support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
CEB	Ceylon Electricity Board
LTGEP	Long Term Generation Expansion Plan
RE	Renewable Energy
NCRE	Non-Conventional Renewable Energy
ORE	Other Renewable Energy
FSPV	Floating Solar Photovoltaic
HES	Hybrid Energy Sources
LCOE	Levelized Cost of Electricity
PUCSL	Public Utilities Commission of Sri Lanka

LIST OF APPENDICES