

**SEASONAL AND TIME OF DAY DEPENDENT
ELECTRICITY COSTS IN SRI LANKAN POWER
SYSTEM, CONSIDERING WATER VALUE**

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Master of Philosophy

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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree
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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. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the MPhil thesis under our supervision. We confirm that the declaration made above by the student is true and correct.

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Dedication

I dedicate this thesis to my parents and in memory of Emeritus Professor H.Y. Ranjit Perera, the initial supervisor of this research, who suddenly passed away.

Acknowledgement

It is with great pleasure that I acknowledge the assistance and contribution of all the people who helped me successfully finish this research. I am greatly indebted to my supervisors, who have been towers of strength throughout this project with their insight and guidance. I would like to acknowledge all the other academic staff members of the Department of Electrical Engineering, University of Moratuwa for their kind suggestions, feedback, and helping hand.

My appreciation goes to the members of the Progress Review Panel and the members of the Final Examination Panel for delivering their guidance and valuable comments, which have been instrumental in successfully continuing my research work. My heartfelt thanks go to the University of Moratuwa and the System Control Centre of the Ceylon Electricity Board for their guidance.

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Abstract

Electricity generation costs fluctuate significantly due to seasonal, daily and hourly variations in electricity demand and powerplant availability. Utility providers prioritise optimising overall generation costs while ensuring continuous and high-quality electricity supply. The scheduling of power plant dispatches follows Stochastic Dual Dynamic Programming (SDDP) principles to maximise operational efficiency. Unlike thermal power plants, the evaluation of water value for hydropower plants introduces complexity in generation cost calculations. This research introduces novel approaches for estimating water value. These approaches include assigning a zero value to water, as well as proposing the generation cost of the most expensive thermal power plant in the daily load curve and the weighted average value of variable thermal power plants as optimal methods for water value estimation. The study accurately estimates seasonal and time-of-day-dependent electricity costs using advanced economic dispatch techniques and refined water value estimation methodologies. Furthermore, it explores the comparative water values between power generation and agriculture, enhancing decision-making processes. Focused on the Sri Lankan power system, this research contributes valuable insights into optimising electricity generation strategies amidst dynamic operational conditions.

Keywords: Generation Cost, Water Value, Economic Dispatch, SDDP, Optimise

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List of Abbreviations

Abbreviation	Description
CEB	Ceylon Electricity Board
DDDP	Discrete Differential Dynamic Programming
DDP	Differential Dynamic Programming
DP	Dynamic Programming
DPSA	Dynamic Programming with Successive Approximations
FCF	Future Cost Function
FSL	Full Supply Level
GT	Gas Turbine
ICF	Immediate Cost Function
IPP	Independent Power Producers
KCCP	Kelanitissa Combined Cycle Power Station
KPS	Kelanitissa Power Station
LKR	Sri Lankan Rupees
MCM	million cubic metre
METRO	Medium Term Reservoir Optimisation
MOL	Merit Order List
Mt	Metric ton
PUCSL	Public Utilities Commission of Sri Lanka
SDDP	Stochastic Dual Dynamic Programming
SLMA	Sri Lanka Mahaweli Authority
ST	Steam Turbine
WPS	Wimalasurendra Power Station

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