UTILIZATION OF WAVE POWER AS A RENEWABLE ENERGY STORAGE FOR ELECTRICITY GENERATION

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Master of Science in Electrical Installations

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Thesis/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/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. I retain the right to use this content in whole or part in future works (such as articles or books).

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R.P.T.S.Gunawardana

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

Name of Supervisor:

Prof. W.D.A.S.Wijayapala

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Signature of the Supervisor: Date:28.07.2025

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ABSTRACT

The growing demand for sustainable energy solutions necessitates innovative approaches to renewable energy extraction and storage. This research introduces a novel concept for wave energy extraction and storage systems as a renewable energy source, utilizing an oscillating floater to produce compressed air for electricity generation.

The study titled “Utilization of wave power as a renewable energy storage for electricity generation” was conducted through two main approaches: (1) designing and simulating a 1 kW pilot wave energy extractor model and (2) constructing the optimum design of the pilot model. The system is designed to extract 1 kW of power from 1 m^2 of the sea wave surface. The parameters 1 m^2 and 1 kW were selected on the basis of maintaining a per-unit value for scaling calculations.

The conceptual design consists of a floating mechanism that captures wave energy through buoyancy. This energy is amplified through a lever system and converted to compressed air via pistons. The compressed air is then stored in accumulators, such that it can be discharged on demand. For a continuous operation, multiple interconnected accumulators can operate in alternating charge-discharge cycles. The released air energy is then captured by an air turbine coupled to an electricity generator.

Given the absence of an exactly similar comparable system, this research was conducted on theoretical calculations, evidence-based assumptions, and iterative trial-and-error methods to achieve the outcome. For the ease of the study, the complete system was executed mainly in two phases, from energy extraction to energy storage and from energy storage to electricity generation.

This innovative approach offers significant potential for harnessing wave energy, one of the most abundant and underutilized renewable resources. By addressing both energy extraction and storage simultaneously, the system provides a comprehensive solution to the untapped potential of wave energy to meet global energy demand.

Keywords: Wave energy, Oscillating floater, Compressed air energy storage, Renewable energy, Energy extraction, Energy conversion, Electricity generation

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LIST OF ABBREVIATIONS

Abbreviation	Description
WEC	Wave Energy Converters
CAES	Compressed Air Energy Storage
PTO	Power Take Off
CFD	Computational Fluid Dynamics
PMAC	Permanent Magnet Alternating Current
PSI	Pounds per Square Inch
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
R&D	Research & Development

LIST OF APPENDICES