STUDY OF SUITABILITY OF SMALL HYDROPOWER GENERATION IN CANAL SYSTEMS: A CASE STUDY IN MAHAWELI SPECIAL AREAS

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DECLARATION

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The above candidate has carried out research for the Masters/MPhil/PhD thesis/Dissertation under my supervision.

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Abstract

Sri Lanka is currently facing an energy crisis, with a considerable amount of the country's foreign reserves being used to import fossil fuels for power generation. Power generation using fossil fuels in thermal power plants has a significant impact on the environment. Additionally, the maintenance of thermal power plants is costly. As a result, Sri Lanka has focused on generating electricity using renewable energy sources, which have lower operational costs and less environmental impact. Currently, solar PV, small hydro, wind, and biomass are the renewable energy sources used to generate electricity in Sri Lanka. Sea wave power is also considered a feasible renewable energy resource.

Small hydropower generation is one of the best methods for renewable energy production. Social and environmental impacts are low for small hydropower generation, and the plant capacity factor is higher compared to other renewable energy sources. Small hydropower projects can be implemented using natural flows or canal falls in irrigation systems. Hydropower generation using river runoff has already been extensively explored and is nearly saturated in Sri Lanka. Canal fall-based small hydropower projects (SHPPs) have lower environmental impacts than natural flow-based SHPPs because the canal infrastructure already exists. Sri Lanka has irrigation canal systems in the dry zone that can be considered for small hydropower generation.

In this research, the suitability of small hydropower generation in irrigation canal systems in Sri Lanka is investigated through a case study of the irrigation canal systems in the System B and System C Mahaweli Special Areas. Suitable locations for SHPPs development in these irrigation canal systems were identified, and the feasibility of technological, economic, environmental, and social factors in these proposed SHPPs was analyzed. A sensitivity analysis was conducted to determine the optimal design flow for achieving the best financial metrics. Of the nine initially identified projects, six were deemed feasible for implementation following the feasibility analysis.

Key findings include:

1. The plant capacity factors for proposed canal fall-based SHPPs are higher than those for SHPPs in unregulated natural waterways in Sri Lanka.
2. The Q_{40} design flow consistently provides optimal financial metrics for proposed SHPPs.
3. Higher-capacity SHPPs result in better financial metrics than lower-capacity SHPPs.

Keywords: Renewable energy, Canal fall, Small hydropower, Grid-connected, EIA.

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LIST OF ABBREVIATIONS

Abbreviation	Description
AVR	Automatic Voltage Regulator
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
EIA	Environment Impact assessment
ELC	Electronic Load Controller
FDC	Flow Duration Curve
GSMB	Geological Survey and Mines Bureau
IEE	Initial Environmental Examination
IRR	Internal Rate of Return
LOI	Letter of Intent
LV	Low Voltage
MASL	Mahaweli Authority of Sri Lanka

MCM	Million Cubic Meters
MV	Medium Voltage
NBRO	National Building Research Organization
NPV	Net Present Value
NWS&DB	National Water Supply and Drainage Board
PA	Provisional Approval
PAA	Project Approving Agency
PAT / MAG	Pump as Turbine / Motor as Generator
PDC	Power Duration Curve
PMG	Permanent Magnet Generator
PUCSL	Public Utilities Commission of Sri Lanka
PV	Photo Voltaic
PVC	Polyvinyl Chloride
ROCOF	Rate of Change of Frequency
SHPP	Small Hydro Power Project
SLSEA	Sri Lanka Sustainable Energy Authority
SPPA	Standard Power Purchasing Agreement

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