A METHODOLOGY FOR TECHNO-ECONOMIC COMPARISON OF PV INVERTER STRUCTURE TOPOLOGIES: A CASE STUDY ON PROPOSED 1 MWP SOLAR POWER DEVELOPMENT SCHEME IN SRI LANKA

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Degree of Master of Science

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University of Moratuwa
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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.

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Above candidate has carried out research for the Master's Thesis under my supervision.

Signature of the supervisor:

Dr. Asanka Rodrigo Date:

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ABSTRACT

Sri Lanka's recent energy policies are focused on promoting economically viable solar power generating schemes introducing novel market segments. It's envisioned to ensure nation's energy security while promoting utilization of indigenous energy generating resources. Recent 1 MWp solar power development scheme is one such novel market segment. PV inverters play a significant role in any PV plant performance. Lack of research on identifying the technically and economically most suited PV inverter architecture has caused high risk of failed project objectives. Following research presents a comprehensive framework for a techno-economic comparison of different PV inverter architectures which are central inverters, string inverters, micro inverters and power optimizer systems. 1 MWp capacity PV plant models are designed for analytical purposes of the research. Technical aspects such as energy yield, safety aspects, power output quality, reliability and performance monitoring are assessed using simulation tools (PVSyst, PSCAD and MATLAB), field data analysis, Cost Priority Number method and Markov reliability models. Economic impact is evaluated using Levelized Cost of Electricity calculations and project financial assessments followed by a sensitivity analysis. It's found that distributed power electronics in PV systems provide higher energy yield, reduced safety risk, higher reliability and lower system down-time due to failures compared to central and string inverters. String inverters and power optimizer systems are more economically feasible in 1 MWp scale. Finally, it's concluded that the presented methodology furnishes a proper techno-economic comparison for different PV inverter architectures.

Keywords: Inverter architectures, Solar power development in Sri Lanka, Photovoltaic, Central inverters, Micro inverters, String inverters, Power optimizers

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List of Abbreviations

Abbreviation	Description
AC	Alternating Current
BOS	Balance of System
CEB	Ceylon Electricity Board
DC	Direct Current
GOSL	Government of Sri Lanka
GW	Giga Watt
HV	High Voltage
LCOE	Levelized Cost of Electricity
LECO	Lanka Electricity Company
LV	Low Voltage
MPPT	Maximum Power Point Tracking
MV	Medium Voltage
MW	Mega Watt
OEM	Original Equipment Manufacturer
PV	Photovoltaic
RE	Renewable Energy
SLSEA	Sri Lanka Sustainable Energy Authority
STC	Standard Testing Conditions