USE OF ON-LOAD TAP CHANGERS IN DISTRIBUTION TRANSFORMERS FOR ENHANCED RENEWABLE ENERGY INTEGRATION AND ACQUISITION : CASE STUDY

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Degree of Master of Science in Electrical Installations

Department of Electrical Engineering

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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(Prof. W.D.A.S. Wijayapala)

ABSTRACT

The increasing integration of rooftop solar PV systems into low-voltage (LV) distribution networks has introduced significant voltage regulation challenges. This study focuses on a real-world distribution transformer within the Sri Lankan electricity distribution network, where high solar penetration has led to persistent overvoltage issues across multiple feeders. Using OpenDSS modeling and field data, a range of mitigation strategies was analyzed, including power factor correction, parallel feeder installation, and fixed tap setting adjustments.

Simulation results revealed that traditional approaches such as manual tap changes were either insufficient or impractical for sustained voltage control. While power factor correction helped reduce peak voltages, it also increased system losses and required deviations from grid standards. Parallel feeder installations, although technically viable, were cost-prohibitive and lacked demand justification.

The study identifies the adoption of On-Load Tap Changers (OLTC) as the most effective solution. OLTCs offer real-time voltage regulation without the need for major infrastructure changes or policy modifications. The selected OLTC solution, which uses vacuum-based switching, was found to be cost-efficient, operationally reliable, and thermally robust, making it highly suitable for addressing the identified voltage issues.

This thesis concludes that OLTC technology provides a scalable and sustainable pathway to enhance hosting capacity and ensure voltage stability in LV networks with high solar PV penetration.

Keywords: On-Load Tap Changer (OLTC), voltage regulation, solar PV integration, distribution transformer, hosting capacity, renewable energy integration, overvoltage mitigation.

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LIST OF ABBREVIATIONS

Abbreviation	Description
LECO	Lanka Electricity Company Private Limited
CEB	Ceylon Electricity Board
LV	Low Voltage
MV	Medium Voltage
GIS	Geographic Information System
DPV	Distributed Photovoltaic
DC	Direct Current
AC	Alternating Current
OLTC	On-Load Tap Changer
DG	Distributed Generation
THD	Total Harmonic Distortion
NMD	Network Monitoring Device
kW	Kilowatt
kVA	Kilovolt-ampere
TF	Transformer
PS	Pre-Stressed
RC	Reinforced Concrete
PFC	Power Factor Correction