# SOLID STATE TRANSFORMER BASED HYBRID MICROGRID ARCHITECTURE FOR INCREASED SOLAR PV PENETRATION

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Degree of Master of Science by Research

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

September 2020

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# DECLARATION

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Signature: H.H.H. De Silva Date

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

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Signature of the supervisor: Dr. L.N.W. Arachchige Date

## ABSTRACT

Increased penetration of rooftop solar PV is causing undesirable technical impacts on the distribution networks. It has been identified that several urban distribution transformers in Sri Lanka are exceeding fifty percent of the solar PV over the transformer capacity. Improving the hosting capacity of the existing distribution network has thus become a trending research topic in both local and international power systems industry. Among the identified technical impacts of high solar penetration are; voltage rise, harmonics and DC injection. The contribution of this study is focused on designing a new microgrid architecture that integrates the solid state transformer with zonal hybrid microgrids to mitigate the aforementioned issues. By utilizing the dc and ac ports of the solid-state transformer, the hybrid network can access the distribution system, which renders the coordinate management of the power and improves the power supply reliability. The designed solid state transformer controllers maintains the AC and DC feeder voltages. MATLAB/ Simulink platform was used to model and simulate the proposed network and to demonstrate how the proposed system has mitigated the power quality issues.

**Key words:** distributed generation, dual active bridge, grid tie inverters, high frequency transformer, hybrid microgrids, power quality, rooftop solar PV, solid state transformer, zonal microgrids

# ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude towards my supervisor, Dr L.N.W Arachchige (Senior Lecturer- Department of Electrical Engineering, University of Moratuwa) for the consistent motivation and guidance she has offered me throughout the research. I am honoured to work under her, and I will be forever thankful for the opportunity she offered to me.

Next, I extend my sincere gratitude to the progress review panel chaired by Prof. J. P. Karunadasa and Dr. W. D. Prasad for their valuable feedback and useful suggestions to improve the quality of my research. The assistance given by Mr. Piyaka Amarasingha (Electrical Engineer, LECO Head Quarters Branch) in utilizing the field data for the research is also appreciated. Further, I am grateful to the University of Moratuwa for the financial grants under Senate Research Committee (SRC) Grant scheme.

I thank my research colleagues Shan Jayamaha, Shehani Attanayaka, Jayaminda Anuradha, Sheron Bolonne and Gihan Amarasingha for their time and support for the approaches in various research questions I was dealing with. The constructive discussions and the suggestions offered by them were a mere support towards the success of this research.

Finally, and most importantly I am thankful to my family, the most amazing support system for tolerating me throughout my academic endeavours.

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| Abbreviation | Description |
|---|---|
| DRER | Distributed renewable energy resource |
| CEB | Ceylon Electricity Board |
| HFT | High frequency transformer |
| MVDC | Medium voltage DC |
| LVDC | Low voltage DC |
| DESD | Distributed energy storage device |
| DCMG | DC microgrid |
| ACMG | AC microgrid |
| DSO | Distribution system operator |
| THD | Total harmonic distortion |
| MMC | Modular multi-level converter |
| MMP | Maximum power point |
| MPPT | Maximum power point tracking |
| PSM | Phase shift modulation |
| ESD | Energy storage devices |