Improving Transient Stability of an Islanded Microgrid Using PV Based Virtual Synchronous Machines

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Declaration of The Candidate and Supervisor

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 person except where the acknowledgement is made in the text.

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Signature of the supervisor Date

(Dr. Lidula N. Widanagama Arachchige)

Abstract

Renewable energy integrations are increasing rapidly in this decade. Lot of countries like Denmark, German and United Kingdom have already set their own targets for renewable energy instigation in their future grids. When considering renewable energy power generation (Solar and wind), most of the time, inverters are used for grid integration. Conventional power generation is based on synchronous generators (Coal, Nuclear, Hydro). Due to the large integration of renewable power plants, power system is moving to a synchronous generator dominant power system to inverter dominant power system. This makes a significant impact on the system inertia response. Inertia is given from the rotating mass of the conventional generators but in inverters, as there are no any rotating masses, inverters cannot contribute to system inertia. Lack of inertia makes poor inertia response. When there is lack of inertia, system's ability to maintain stability under disturbances will be weakened, which would limit the integration of renewable sources. Microgrids, particularly PV-Hydro based Microgrids would be seriously affected from this issue.

This research is carried out to provide a solution for the aforementioned issue by emulating inertia through inverters. Since there are no any actual rotating parts, when emulating inertia through inverters, dynamic inertia response can be implemented compared to the static inertia in synchronous generators.

Due to disturbances in the system, the operation of solar PVs will also be affected. Because of that an energy management system is introduced to support virtual synchronous generator and to keep the PV plant operation at its maximum power point without interruption. The proposed controllers are verified through simulated PV-Hydro microgrid. Simulations are carried out using PSCAD.

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Abbreviations

ROCOF	Rate of change of frequency
VSM	Virtual synchronous machines
PV	Photovoltaic
MPPT	Maximum power point tracking
IGBT	Insulated gate bipolar transistor
SOC	State of charge
PLL	Phase lock loop
EMS	Energy management system
VSC	Voltage source converter
PWM	Pulse width modulation