STABILITY ANALYSIS OF AN ISLANDED MICROGRID WITH RING AND RADIAL DISTRIBUTION

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(188507A)

Degree of Master of Science

Department of Electrical Engineering

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DECLARATION PAGE OF THE CANDIDATE & SUPERVISOR

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Dr.Lidula N.Widanagama Arachchige Date

Dr.P.S. Narendra de Silva Date

ABSTRACT

Colombo being the commercial hub of Sri Lanka, maintaining high reliability of electricity supply is critical. Thus, the electricity distribution network of Colombo city comprises of six, 11 kV ring networks formed around five grid substations and five primary substations. However, the network is currently operated in open-ring topology.

In the present operation, under maintenance periods, at times of load shedding and "self-generation" schemes, diesel generators are connected to the network. The generators, which are connected under the self-generation schemes are synchronized with the network. The generators, which are connected during maintenance and times of load shedding, are not synchronized. Hence, it is required to split the satellite belts into several sub sections to match the capacity of the generator to the load, so that the generator would not be tripped due to over loading. With the government policies to encourage renewable generation, solar PV generation has also been increasingly connected to the distribution network, which are not dispatched. With increasing penetration of solar PV, proper planning is required to maintain system stability and reliability under grid failures.

The substations in Colombo city do not follow the conventional diurnal load pattern of Sri Lanka; instead, during day time, the load reaches a peak and during night time it drops. This load pattern follows a curve similar to the diurnal generation curve of solar PV. Thus, by introducing solar PV to such substations, the installed diesel generation capacity can be reduced and the rings can be operated as microgrids when the grid fails.

In this research a case study is carried for the ring network based on primary substation-B of the Colombo city network with the distributed generation of solar PV and diesel generators to evaluate the ability of forming ring-connected microgrids for a commercial city with peak, day-time loading. The ring is split into smaller rings to form microgrids with capacity below 10 MVA. The satellites are considered as open looped. Loads of the satellite loop and the generation (solar PV/ diesel generators) are lumped to the respective radial/ ring substation.

The results indicate that when the network has three, 2 MVA generators fixed to the highest loaded substations, the system is stable and when the network has 1 MVA generators fixed to all the substations, the system becomes unstable at N-1 emergency operation. Instability occurs due to small perturbations to diesel generators at some substations.

Research reveals that with increasing penetration of solar PV, the system can be planned to be operated in ring-connected microgrids in stable operation to maintain the system reliability under grid failures.

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