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Batteries to Manage Voltage Rise Caused by Solar PV in LV Distribution Networks

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Solar power from solar photovoltaics (PV) is one of the fastest growing renewable energy sources in the world. Recent government policy initiatives in Sri Lanka have significantly increased the number of rooftop solar PV systems connected to the low voltage (LV) distribution network. As a result, increased solar PV penetration to LV distribution network can nominally disrupt network operating conditions and leading to power quality issues. Voltage rise has been reported as the most prominent power quality issue with high solar PV penetration levels. This will significantly exceed the load requirement. In order to reduce the voltage rise, excess power from the solar PV units must be reduced. Therefore, battery energy storage systems (BESS) are recommended to store the excess energy. This project presents real feeder and real data of the Rajagiriya area in Sri Lanka to prove voltage violation issues and find optimal solution through research. All simulations are made using the DIgSILENT powerfactory platform, mainly to detect the location of the voltage violation at the selected feeder. Based on that, it has been identified which customers' solar PV system is causing the voltage violation for the particular time in the feeder. Subsequently time required to store energy which is supplied from the particular solar PV system has been calculated for a day. Based on that, the battery capacity was calculated and it is recommended to the particular solar PV customer. For this study lithium-ion batteries were selected according to the Depth of discharge (DOD), efficiency, and calendar life cycle. The amount of power that can be delivered to the grid for night peak demand is calculated by the DOD rating of the lithium-ion battery. And it is decided that the hybrid inverter was optimal for this system. Total cost is calculated considering the capital cost of solar PV, batteries, and inverter. The income and the capital cost were compared and the payback period was observed. Finally, it is verified that the cost of capital can be recovered by the customer within the specified year.

***Keywords*:** Solar Photovoltaic; Voltage Violation; Low Voltage Distribution Network; Battery Energy Storage System