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Design of a DC MicroGrid for utilization of solar photovoltaic sources

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To satisfy the demand for electricity, renewable energy sources (RES) are being used at an increasing rate y. Though these sources are environmentally friendly, the addition of RES to the low voltage distribution network directly may create voltage and stability issues. MicroGrids are considered a promising solution that will help overcome these problems.

MicroGrid is a small power system which consists of a local energy source, storages and loads. Since MicroGrid has a utility connection, it can be in grid connected mode or islanded mode. If the plug and play capability within a MicroGrid can be realized, any source or storage can be connected or disconnected from the MicroGrid without making significant changes to the system. Therefore, MicroGrids unveil a platform to connect RES such as wind, solar photovoltaic (PV) etc., which has an energy output highly dependent on environmental conditions. In recent years researches were carried out on alternative current (ac) and direct current (dc) MicroGrids worldwide. As a result, the use of dc MicroGrids has increased rapidly; in solar PV systems dc is the natural power output and in wind power systems there is an intermediate dc power stage. In addition, the ac-dc converter in most existing loads can be eliminated in a dc system resulting in further reduction in losses.

In this study, a dc MicroGrid was designed with a utility connection, a solar PV and resistive loads. The proposed system was simulated in PSCAD/EMTDC software. A bi-directional ac-dc converter was designed to interface the utility with a dc-link of the dc MicroGrid. A uni-directional dc-dc converter was designed to interface the photovoltaic system to the dc-link. The controller of the ac-dc converter maintains the dc-link voltage of the MicroGrid constant while the photovoltaic system delivers available maximum power. The performance of the MicroGrid was studied by applying variations to the load and to the irradiance of the solar PV panel. The system dynamics of the MicroGrid were studied and presented. Further studies will be carried out to incorporate energy storages, to optimize the overall control process and to improve the protection of the dc MicroGrid.

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