INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Rampelli Manojkumar

Roll Number : 176102004

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Thesis Title: Optimal Rule-based Energy Management and Voltage Control Using Battery Energy Storage and Smart Power Converters

Name of Thesis Supervisor(s) : Dr. Chandan Kumar
Dr. Sanjib Ganguly

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SHORT ABSTRACT

Energy management and voltage control are essentially required for the optimal management of energy flow when there is more than one energy source available for power supply (e.g. renewable energy sources (RESs), diesel generator (DG), etc.) and for improving the voltage profile, respectively}. The battery energy storage and smart power converters are extensively used to implement the energy management and voltage control applications in low voltage (LV) distribution systems. Moreover, the optimal rule-based energy management approaches are considered as simple yet effective strategies used to implement energy management and voltage control applications.

Out of the various energy management applications, the peak shaving is an important application which benefits both grid operators and end-users. Therefore, in this thesis firstly an optimal rule-based peak shaving method is proposed using battery energy storage system (BESS) which minimizes the peak grid demand in LV distribution system considering load and RES power profiles as inputs. However, the energy price is not considered as input while formulating the peak shaving control strategy. The demand response (DR) application becomes important when the energy price profile along with load and renewable energy sources (RESs) power profiles is considered as input. Therefore, further an optimal rule-based DR method is developed using BESS which minimizes the energy consumption cost of the system over a day.

These proposed rule-based peak shaving and DR methods are developed considering the aggregated load and RES at LV ac bus. However, in case if the loads and RESs are considered to be connected at various buses in the distribution system, the voltage control application becomes important for satisfactory operation of consumer equipment while maintaining the load bus voltages within the limits of grid codes. Therefore, an optimal rule-based voltage control method is proposed to know the optimal set points of LV ac bus voltage which minimizes the voltage deviation in LV distribution system over a day.

Further, in order to show the impact of optimal control of BESS along with the LV ac bus voltage control and RESs converters reactive power control, an isolated DG supplied LV distribution system is considered. The proposed optimal rule-based peak shaving control is modified for the application in DG supplied distribution system while minimizing the LV ac bus demand using LV ac bus voltage and reactive power control of RES converters.