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Review

Electric Vehicles Charging Stations' Architectures, Criteria, Power Converters, and Control Strategies in Microgrids

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Abstract: The usage of electric vehicles (EV) has been increasing over the last few years due to a rise in fossil fuel prices and the rate of increasing carbon dioxide (CO_2) emissions. EV-charging stations are powered by existing utility power grid systems, increasing the stress on the utility grid and the load demand at the distribution side. DC grid-based EV charging is more efficient than AC distribution because of its higher reliability, power conversion efficiency, simple interfacing with renewable energy sources (RESs), and integration of energy storage units (ESU). RES-generated power storage in local ESU is an alternative solution for managing the utility grid demand. In addition, to maintain the EV charging demand at the microgrid levels, energy management and control strategies must carefully power the EV battery charging unit. In addition, charging stations require dedicated converter topologies, control strategies, and need to follow set levels and standards. Based on EV, ESU, and RES accessibility, different types of microgrid architecture and control strategies are used to ensure optimum operation at the EV-charging point. Based on the above said merits, this review paper presents different RES-connected architecture and control strategies used in EV-charging stations. It highlights the importance of different charging station architectures with current power converter topologies proposed in the literature. In addition, a comparison of microgrid-based charging station architecture with its energy management, control strategies, and charging converter controls are also presented. The different levels and types of charging stations used for EV charging, in addition to controls and connectors used, are also discussed. An experiment-based energy management strategy was developed to control power flow among the available sources and charging terminals for the effective utilization of generated renewable power. The main motive of the EMS and its control is to maximize the usage of RES consumption. This review also provides the challenges and opportunities in EV-charging, and parameters in selecting appropriate charging stations.

Keywords: microgrid; electric vehicle; energy management controls; renewable energy sources; energy storage unit

1. Introduction

Electric vehicles are becoming popular due to their less emissions and lower fossil-fuel dependency [1]. The renewable energy sources used in distribution networks, in