

Chapter-19

Vehicle-to-Grid Technology in a Micro-Grid Using DC Fast Charging Architecture

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Energy storage systems are important components of a micro-grid as they enable the integration of intermittent renewable energy sources. Electric vehicle (EV) batteries can be utilized as effective storage devices in micro-grids when they are plugged-in for charging. Most personal transportation vehicles sit parked for about 22 hours each day, during which time they represent an idle asset. EVs could potentially help in micro-grid energy management by storing energy when there is surplus (Grid-To-Vehicle, G2V) and feeding this energy back to the grid when there is demand for it (Vehicle-To-Grid). V2G applied to the general power grid faces some challenges such as; it is complicated to control, needs large amount of EVs and is hard to realize in short term

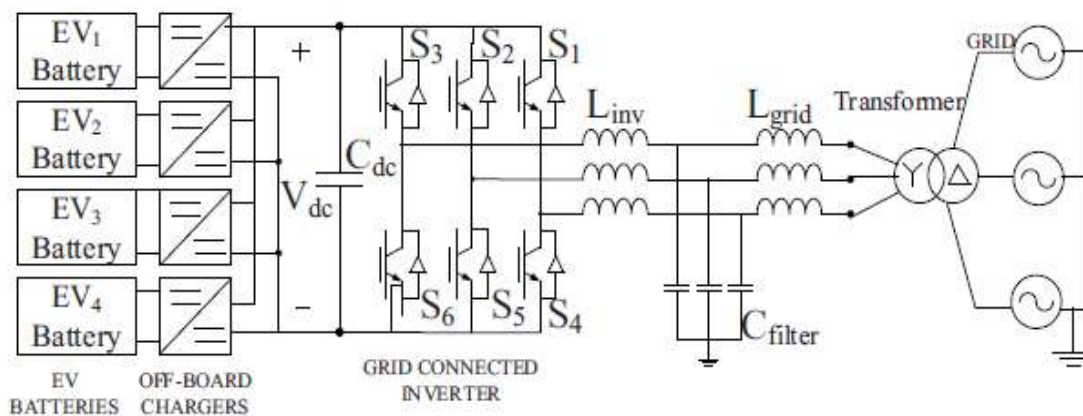


Fig.1: Block Diagram

In this scenario, it is easy to implement V2G system in a micro-grid. The Society of Automotive Engineers defines three levels of charging for EVs. Level 1 charging uses a plug to connect to the vehicle's on-board charger and a standard household (120 V) outlet. This is the slowest form of charging and works for those who travel less than 60 kilometres a day and have all night to charge. Level 2 charging uses a dedicated Electric Vehicle Supply Equipment (EVSE) at home or at a public station to provide power at 220 V or 240 V and up to 30 A. The level 3 charging is also referred to as dc fast charging. DC fast charging stations provide charging power up to 90 kW at 200/450 V, reducing the charging time to 20-30 mins. DC fast charging is preferred for implementing a V2G architecture in micro-grid due to the quick power transfer that is required when EVs are utilized for energy storage. Also, the dc bus can be used for integrating renewable generation sources into the system

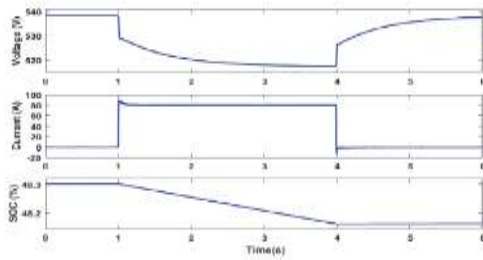


Fig 2. Results During V2G operation

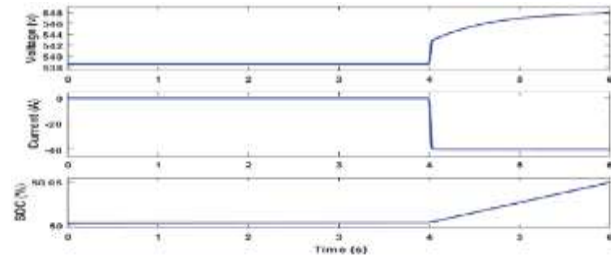


Fig 3. Results During G2V operation

In majority of the previous studies, V2G concept has been applied in the general power grid for services like peak shaving, valley filling, regulation and spinning reserves. The V2G development in a micro-grid facility to support power generation from intermittent renewable sources of energy is still at its infancy. Also, level 1 and level 2 ac charging is utilized for V2G technology in most of the works reported. These ac charging systems are limited by the power rating of the on-board charger. An additional issue is that the distribution grid has not been designed for bi-directional energy flow. In this scenario, there is a research need for developing technically viable charging station architectures to facilitate V2G technology in micro-grids. This work proposes a dc quick charging station infrastructure with V2G capability in a micro-grid facility. The dc bus used to interface EVs is also used for integrating a solar photo-voltaic (PV) array into the micro-grid. The proposed architecture allows high power bi-directional charging for EVs through off-board chargers. Effectiveness of the proposed model is evaluated based on MATLAB/Simulink simulations for both V2G and G2V modes of operation.