Energy management of multiple resource charging

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Abstract

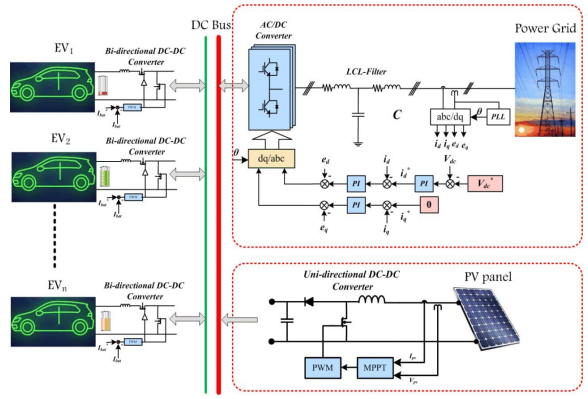
Managing plug-in electric vehicles (PEVs) recharging with different capacities can achieve the optimum operation schedule. Otherwise, stability issues for the microgrid may occur. Therefore, Energy management becomes essential for charging stations to meet the complexity of bidirectional power flow and multiple resource availability. This paper presents an energy management system of PEVs based on multiple resources managed by a DC microgrid. Three main resources are used: the national grid, Photovoltaic cells (PV), and Battery. The grid and PV cells are centralized distributed, whereas Batteries are decentralized distributed. Balance options are defined to match the vehicle requirements based on power availability, even the surplus power between the connected vehicles. The aims are to optimize grid energy usage, long life of the storage devices, and improve resilient power to the load demand. Metaheuristic methods (PSO) are used to enhance the response to the charging station operator. The results show that electric vehicles are a promising solution to keep the voltage stability of the grid in a high-demand approach. The PV is a flexible and cheap resource to recharge electric vehicles and synergize the national grid. Sometimes, trading power from a high state of the charging PEV to a lower one is beneficial to maintain the stability of the charging station.

The research aims to:

1- design the electrical architecture of the charging station based on size and capacity, including photovoltaic panel and national grid
2- proposed management strategy for station and policy with owners for charging and discharging PEVs.
3- study the effect of PEVs in charging mode, discharging mode, and interflow power between them

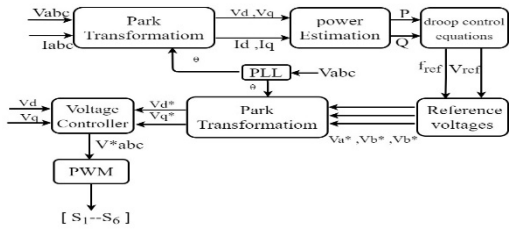
System components

the system consists of a PV system and a national grid as part of the charging station topology and a battery for the electric vehicle. All of them are connected to the DC bus via converters and filters

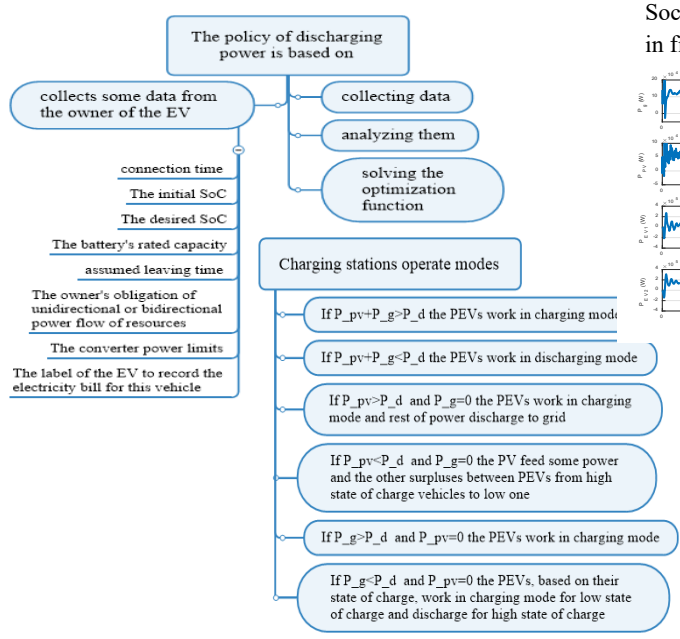


synchronization between the resources

The droop control is used for synchronization between the resources and ignite the inverter switches as shown in Fig. 2. Two inner loops are used to control the actual voltage at the PCC sides



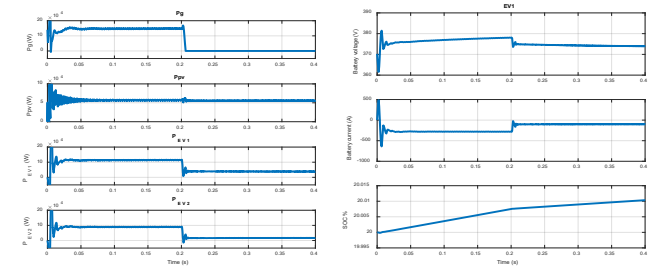
policy and operation modes

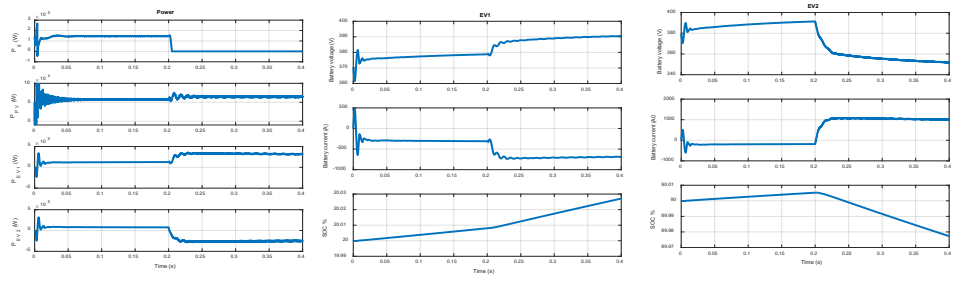


Case studies

Case one

1Case one: Integrating PV System for EVs Charging
Both PV and grid share power to charge EVs. At 0.2 s, the grid outages, whereas the PV keep the same power level. All plugged-in electric vehicles are charging at a high level from both sources of charging station until the second 0.2, the level of charging EVs is stepped down, as shown in figures besides.



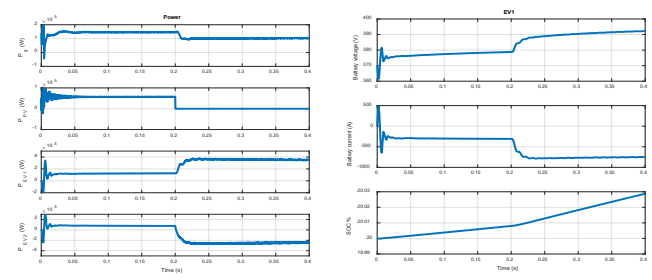


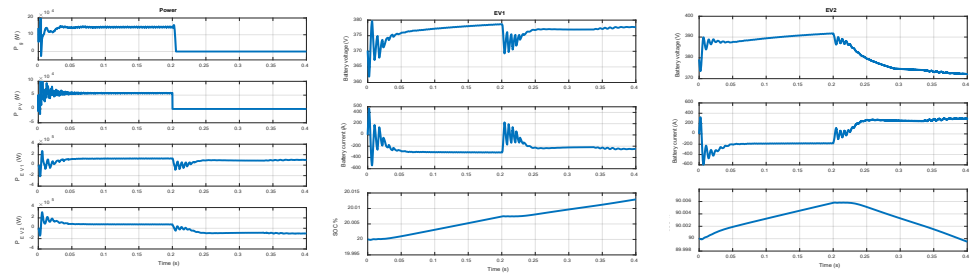
Case two

Both PV and grid are charging EVs. However, at 0.2 s grid outage of service therefore EVs with high SoC (EV2) start synergize PV for charging lower Soc's EVs (EV1) as shown in figures besides

Case Three

Both PV and grid are charging EVs. However, at 0.2 s PV outage of service therefore, EVs with high SoC (EV2) start synergize grid for charging lower Soc's EVs (EV1) as shown in figures besides





Case Four

oth PV and grid are outage at .2 s whereas EV2 charges V1 as shown in Fig. 11, Fig. 2, and Fig. 13

Conclusion

Results are demonstrated when operating the system in different modes: battery charge or discharge. In charging mode, it acts as a load; in discharging mode, it acts as a source. Furthermore, the energy flows from the charging station's resources to the EVs until the desire to leave a state of charge is reached. Vehicles' batteries are synergized in discharging mode to provide the required power. PV is an effective and cheap source for charging EVs.