International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Optimizing Micro-Grid Performance with Vehicle-To-Grid Technology and Dc Fast Charging Solutions

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ABSTRACT

Electric Vehicle (EV) batteries can be utilized as potential vitality capacity gadgets in micro-grids. They can offer assistance in micro-grid vitality administration by putting away vitality when there's surplus(Grid-To-Vehicle,G2V) and supplying energy back to the grid(Vehicle-To-Grid, V2G) when there is demand for it. Legitimate foundation and control frameworks ought to be created in arrange to realize this concept. Architecture for implementing a V2G-G2V system in a micro-grid utilizing level-3 quick charging of EVs is presented in this paper. A micro- grid test system is modeled which encompasses a dc quick charging station for meddle the EVs. Recreation ponders are carried out to illustrate V2G-G2V control exchange. Test results show active power regulation in the micro-grid by EV batteries through G2V- V2G modes of operation. The charging station plan guarantees negligible consonant mutilation of lattice infused current and the controller gives great energetic execution in terms of dc transport voltage solidness

Keywords: DC fast charging, Electric vehicle, Grid connected inverter, Micro-grid, Off-board charger, Vehicle-to-grid

INTRODUCTION

Vitality capacity frameworks are vital components of a micro-grid as they empower the integration of discontinuous renewable vitality sources. Electric vehicle (EV) batteries can be utilized as compelling capacity gadgets in micro-grids when theyare plugged-in for charging. Most individual transportation vehicles sit stopped for almost 22 hours each day, amid which time they represent an idle asset. EVs could potentially help in micro-grid energy management by storing energy when there is excess (Grid-To-Vehicle, G2V) and bolstering this vitality back to the grid when there is demand for it(Vehicle-To-Grid).V2G connected to the common control lattice faces a few challenges such as; it is complicated to control, needs large amount of EVs and is hard to realize in short term[1].In this scenario, it is easy to execute V2G framework in a micro-grid.

The Society of Automotive Engineers defines three levels of LadingForevs.Level1 loads loaded with vehicles from vehicle vehicles and standard households (120 V). This is the slowest shape of the shop, working for 60km of Adayan Davealal night people at a rate of 60km. Level 2 Reading uses dedicated electric vehicle supply equipment (EVSE) at home or at public stations to power at 220 V or 240 V and up to 30 A. Level 3 charge is also known as DC velocity. The DC Fast Charging Station is also offers loading forces of up to 90 kW at 200/450 V, which reduces load times to 20-30 minutes. DC high-speed loading is recommended for implementing the V2G architectures with micro grids for quick power transmission required when EVs are very much needed. . Utilized for energy storage. Also the dc bus can be used for integrating renewable generation sources into the system.

In most extreme of the going before thinks about, the thought of V2G changed into utilized with inside the broad power framework for offerings comprehensive of crests, valley filling, control, and turning saves [2]. V2G enhancement of microgrid structures that back period from irregular renewable power sources proceeds to be conceivable. These AC charging structures are restricted through way of implies of in general execution rankings of onboard charging gadgets. An additional bother is that dissemination systems are not outlined for bidirectional power stream. This circumstance calls for ponders to broaden a actually maintainable structure for charging stations to offer micro g mile V2G innovation. This canvases shows a DC Fast Charging Station foundation with V2G competencies with inside the micro grid framework. The DC transport to the EVS interface is moreover utilized to combine the sun cluster (PV) into the Micron net. The proposed structure grants for bi-directional charging of EVs with over the top power loaders thru off-board chargers. The adequacy of the proposed adaptation is assessed the utilize of MATLAB/SIMULINK reenactments in each V2G and G2V running modes .

DCFASTCHARGINGSTATIONCONFIGURATIONFORV2G

Configuration of DC Quick Charging Station for the implementation of V2G-G2V infrastructure in a micro-grid is shown in fig.1 [4]. The EV battery is connected to the DC bus via an off-board charger. The network inverter connects the DC bus with the utility grid CL filter and step-up transformer. The key components of the charging station are explained below.

Battery Charger Configuration

DC Fast Lading is the charger on the outside of the board and has an EVSE LEAN. The DC converter forms the basic components of an off-board charging device with V2G functionality. It forms an interface between the EV battery system and the DC distribution cooler. The converter configuration is shown in Figure 2. It consists of two IGBT/MOSFET switches, which are constantly operated by free control signals.

Buck mode of operation (charging mode):

When the upper switch (S_{buck}) is operating, the converter acts as a buck converter stepping down the input voltage (V_{dc}) to battery charging voltage(V_{batt}). During the on state, current flows through the switch and inductor to the battery. This is the charging operation, here the power flow is from the grid to

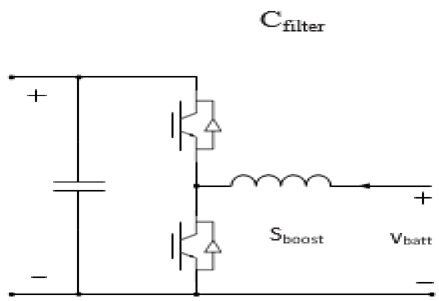

Fig.2.Batterychargerconfiguration

vehicle (G2V). When the switch is off, the current takes its return path through the inductor and diode flower switch and completes the circuit. If D is the duty ratio of the upper switch, the battery voltages given by:

$$V_{batt}=V_{dc}*D \quad (1)$$

4) Boost mode of operation (dischargingmode): When the lower switch(S_{booct}) is operating, the converter acts as a boost converter stepping up the battery voltage (V_{batt}) to the dc bus voltage(V_{dc}).When the switch is in on state, current continues

to flow through the inductor and completes its circuit through the anti-parallel diode of the upper switch, and the capacitor. The net power flow in this case is from the vehicle to the grid (V2G) and the battery operates in the discharge mode. If the capacitor is large enough to provide a constant dc voltage, the output voltage during boost mode of operation is given by:

$$V_{dc} \text{ is equal to } \frac{V_{batt}}{1-D'} \quad (2)$$

where D' is the duty cycle of the lower switch.

B.Grid Connected Inverter and LCL Filter

The grid connected inverter (GCI) converts the dc bus voltage into a three phase ac voltage and also allows the reverse flow of current through the anti-parallel diodes of the switches in each leg (Fig. 1). An LCL filter is connected at the output terminals of the inverter for harmonic reduction and obtaining a pure sinusoidal voltage and current. The design procedure for determining he LCL filter parameters for this work is adapted from [4].

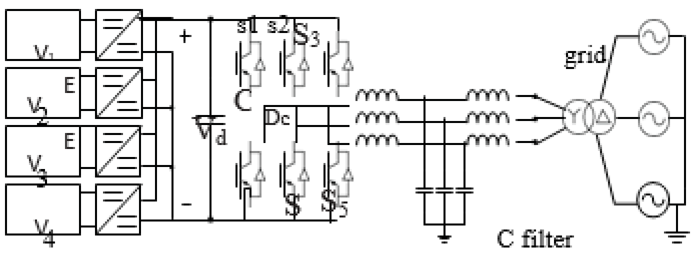

Fig.1.EVchargingstation for fast dc charging

CONTROLSYSTEM

Off-Board Charger Control

A constant current control strategy[5]using PI controllers is implemented for charge/discharge control of the battery charger circuit and is shown inFig.3.Thecontrollerfirst compares the reference battery current with zero, in-order to determine the polarity of the current signal, to decide between charging and discharging modes of operations. Once the mode is selected, the reference current is compared with the measured current and the error is passed through a PI controller to generate the switching pulses forS_{buck}/S_{booct}.S_{booct}will be turned off throughout the charging process and S_{buck}will be turned off throughout the discharging process.

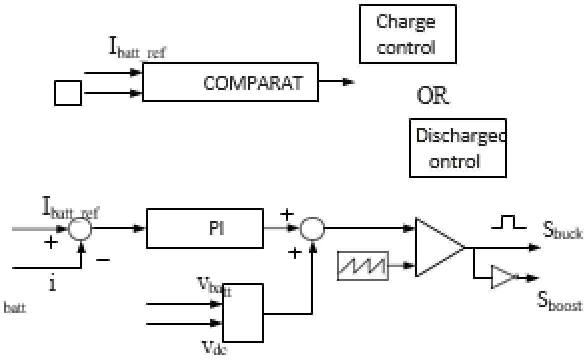

Fig.3.Constantcurrentcontrolstrategyforbatterycharger

Inverter Control

A cascade control in synchronous reference frame is proposed for the inverter controller. The conventional standard vector control using 4PI controllers in a nested loop is shown in
Fig. 4 [4]. The control structure consists of two outer voltage control loops and two inner current control loops. The d-axis outer loop controls the dc bus voltage and inner loop controls the active ac current. Similarly, the q-axis outer loop regulates the ac voltage magnitude by adjusting the reactive current, which is controlled by the q-axis inner current loop. Also, dq decoupling terms ωL and feed-forward voltage signals are added to improve the performance during transients.

MICRO-GRID TEST SYSTEM CONFIGURATION

The micro-grid test system configuration with the dc fast charging station is shown in Fig. 5.A 100 kW wind turbine (WT) and a 50kW solar PV array serve as the generation sources in the system

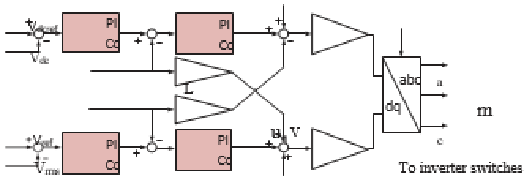

Fig.4.Inverter control system

An EV battery storage system for EV batteries connected to an

offboard charging device with a 1.5 kV equal power bus from the charging station. The solar PV is also connected to this DC bus via a boost converter with a maximum power tracking con troller (max powerpoint tracking). The supply network consists of a 25 kV distributor and a 120 kV transmission system. The double feed induction generator, suitable for the wind turbine, is connected to the micro net at the point of the joint coupling. The transformer is used to enhance tension and connect each alternating current system with the power grid.

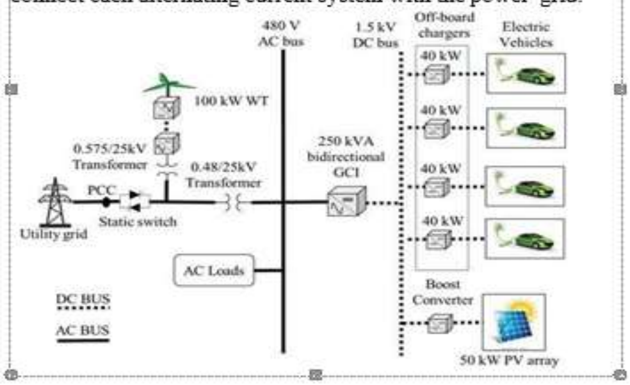

Fig.5.Proposed micro grid test system configuration

V. SIMULATIONRESULTS

Charging station design method has been adapted [4] and the obtained parameter values are shown in the Appendi x. The wind turbine operates at nominal speed and operates up to 100 kW of power and output power. The solar PV operates unde r standard test conditions (1000 w/m2 arradiance and 25°C) with a maximum output of 50 kW. The 150 kW resistance load is con nected to a change in 480 V change. Reactive power reference to GCI is set to zero for unified obligation. The initial state (SOC) o f the EV battery is set to 50%. As soon as static conditions are re ached, the EV1 and EV2 batteries (Figure 1) are operated to run t he V2GG2V service transmission. Current setpoints given to batt ery load circuits for EV1 and EV2 batteries.

The battery parameters when EV_1isoperatinginV2Gmode and EV_2operating in G2V mode are shown in Figs. 6 and 7, respectively.

TABLEI. CURRENT SET-POINTS TO EV BATTERIES

Time range(s)	0t o1	1t o4	4to 6
Current set-point to EV_1battery(A)	0	+8 0	0
Current set-point to EV_2battery(A)	0	0	-40

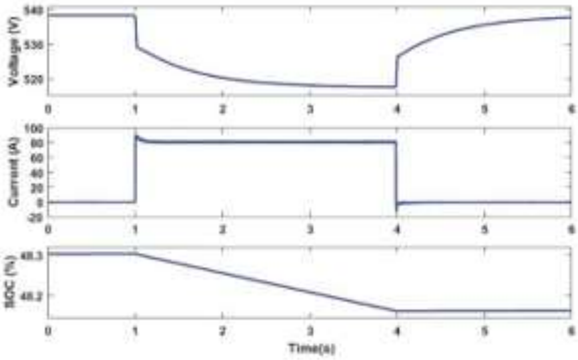

Fig.6.Voltage,current,andSOCofEV_1batteryduringV2Goperation

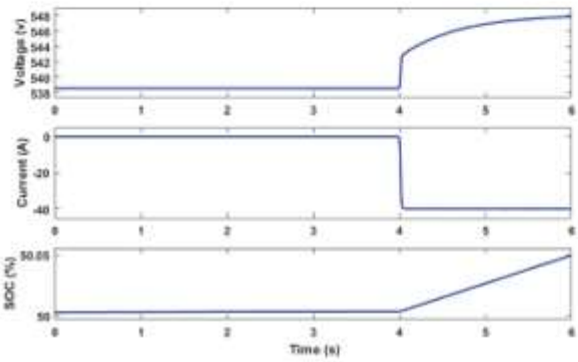

Fig.7.Voltage,current,andSOCofEV_2batteryduringG2V operation

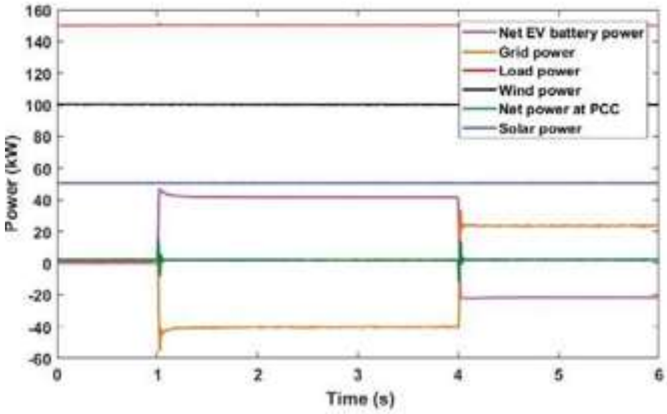

Fig.8.Activepowerprofileofvariouscomponentsinthe system

The active contributions from the various components of the system are shown in Figure 8. Electrical network power changes taking into account the services transferred by the E
V. The negative polarity of 1STO4S grating performance indi cates that the Vehicle's performance is fed into the grid. The change in the polarity of the network current at 4S indicates t hat power is provided from the network to load the vehicle ba ttery.This shows V2GG2V operation. Furthermore, the net pe rformance of the PCC is zero, indicating the optimal current a ccount in the system.
The dc bus voltage is regulated at 1500 V by the outer voltage control loop of the inverter controller and is shown in Fig.9.Thisinturnisachievedbytheinnercurrentcontrolloop tracking the changed d-axisreference current as shown in Fig. 10.

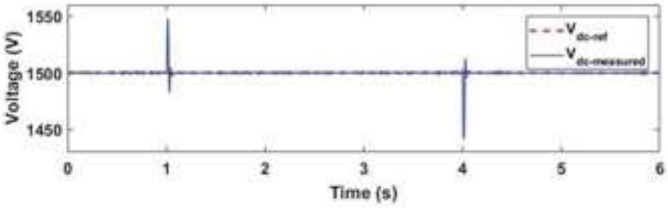

Fig.9.Variationindcbusvoltage

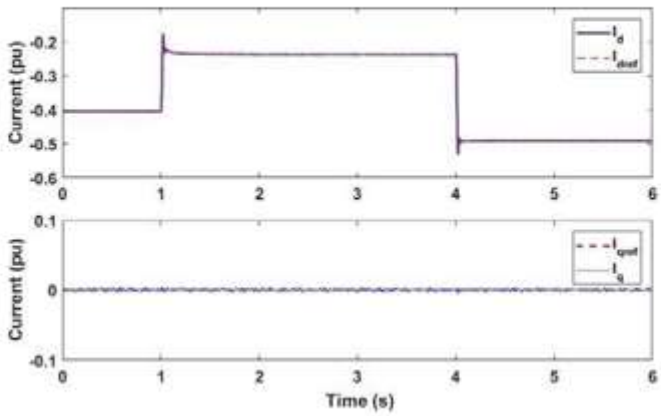

Fig.10.Referencecurrenttrackingbyinvertercontroller

ThegridvoltageandcurrentatPCCareshowninFig.11.
Voltage and current are in phase during G2V operation and 180*o*out of phase during V2G operation showing the reverse power flow.

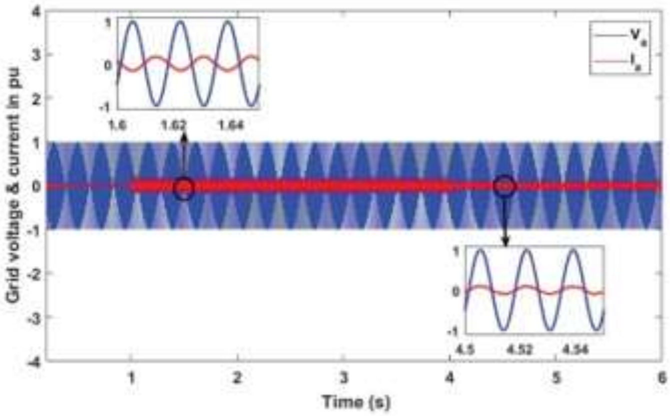

Fig.11.Grid voltage and grid injected currentduringV2G-G2Voperation

Total harmonic distortion(THD)analysis is done on the grid injectedcurrentandtheresultisshowninFig.12.Accordingto IEEEStd.1547,harmoniccurrentdistortiononpowersystems 69 kV and below are limited to 5% THD. The THD of grid- injected current is obtained as 2.31 % and is achieved by the judicious design of LCL filter.

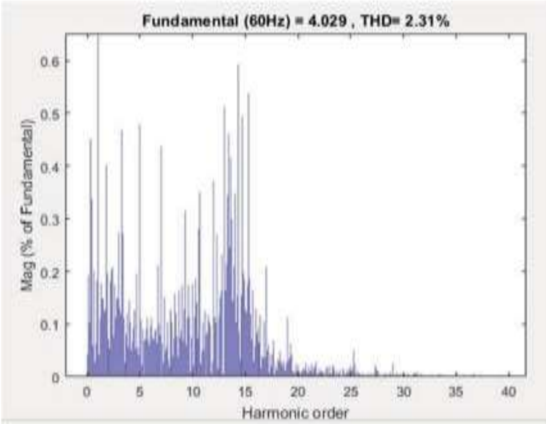

Fig.12.HarmonicspectrumandTHDofgrid-injected current

CONCLUSIONS

This article shows the modeling and design of a V2G system on a micr on net using a DC fast charging architecture. The DC Fast Charging Station with an off- board charging device and an inverter connected to the network is designed so that the EVS is connected to the micro gitter. The control system developed for this electronic interface allows for bidirectional power transfer between the EV and the raster. Simulation results show smooth power transfer between the EV and the raster and the quality of the network injected from the EVS. Related criteria follow the relevant criteria. The designed controller offers excellent dynamic performance in terms of DC bus voltage stability and persecution of changes in active performance references. This work takes into account aspects of the active performance regulation of microgitters, and the proposed V2G system can be used for several other services, such as reactive performance control and frequency adjustment. The design of supervisory controllers providing individual EV charging device command signals has been proposed for future research

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