VEHICLE TO GRID / GRID TO VEHICLE TECHNOLOGY IN A MICRO GRID BY USING DC FAST CHARGING ARCHITECTURE

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ABSTRACT:

The concept of this paper electric vehicle (EV) batteries is used for storing the potential energy in the micro grid. By storing this energy can help in the energy management of the micro grid when the excess of energy [GRID TO VEHICLE, G2V]& giving energy to the grid when it is needed [VEHICLE TO GRID, V2G]. Appropriate structure design and control system has to be implemented for this concept. In this paper A DC FAST LEVEL ARCHITECTURE of electric vehicle 's is to be presented. So that the charging time will be reduced. Simulation in this paper shows power transfer from "VEHICLE TO GRID "&"GRID TO VEHICLE" operation.The current injected and the controller used in it gives better dynamic response in stability of dc bus voltage. In this reliability and efficiency of the power system will increase.

KEYWORDS: Electric vehicle, DC Fast Charging, OFF Board charger, Grid connected inverter, micro grid

I.INTRODUCTION

At present days we are using the vehicles which are run with petrol and diesel. So, it releases more greenhouse gases to the environment, which pollutes the earth and cause ozone layer depletion. So, to avoid these problems" ELECTRIC VEICLES "are to be used. We use large batteries for the electric vehicles. Thus, the batteries are used for storing the potentialenergy in a micro grid while they areplugged in for charging. And it also helps in energy management when there is more and feeding back to the grid when it is needed. When the general power grid is used for this V2G concept, it is hard to operate and need large number of electric vehicles batteries& duration time will be more. So that we are using VEHICLE TO GRID concept in amicro grid to overcome such problems.

There are 3 EV charging levels.

Level 1 charging: it is the slowest form of charging uses a plug to connect the on – board of charge [house hold up to 120v]. This setup provides between 2 and 5 miles per hour. It can work for who has travel less than 40 miles a day and it takes all night to charge.

Level 2 charging: uses an EVSE to provide voltage up to 220v or 240 volts and current is 30 Amps. it can charge at home or the public station.

Level 3 charging:it is commonly known as dc fast charging charges through a 480v dc plug. it charges 80% of charge in 30 minutes. If the weather is cool, it will take more time to charge. DC fast charging architecture for V2G in a micro grid has been implemented due to this quick power has to be transferred and used as energy storage.

Level 1 and level 2 used for ac charging vehicle to grid technology and these are limited in power rating of on-boardcharges and it is designed for unidirectional energy flow but not for the bidirectional, but in this concept level 3 for dc fast charging and bidirectional energy flow. In this dc bus use as interface to connect "SOLAR PHOTO VOLTAIC" into "MICRO GRID". In this the power is transferred Bidirectionally through OFF BOARD CHARGES. This proposed methodology has been implemented in simulation diagram in MATLAB for V2G AND G2V operation.

II.PROPOSED DC FAST CHARGING STATION CONFIGURATION FOR V2G

This design shows that DC FAST CHARGING station of V2G concept in micro grid EV batteries are connect to the GRID CONNECTED

INVERTER through OFF BOARD CHARGERS and to the LCL filter, then to the GRID through the transformer.

The basic concept of this is EV batteries are low voltage and grid has high voltage to convert this low voltage to high voltage buck\ boost converters are used as OFF BOARD CHARGERS and these are bidirectional and EV batteries are DC in nature and GRID s are AC in nature to convert this DC to3 phase AC voltagea GRID CONNECTED INVERTER is connected. But GRID CONNECTED INVERTER will not give pure ac. To get pure ac LCL filter is connected and given to the GRID through the transformer.

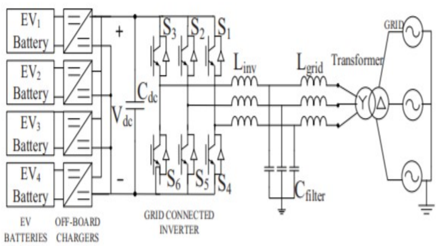

Fig. 1. Proposed EV charging station for fast dc charging

A. BATTERY CHARGER CONFIGURATION

To get DC Fast charging, fast chargers are located in OFF BOARD CHARGERS in the form of BUCK /BOOST CONVERTERS is also a Bidirectional DC-DC CONVERTERS. converter consist of 2 IGBT/MOSFET switches which are operated in complementary modes of signals.

1.CHARGING MODE (BUCK Mode of operation): During buck mode of operation, the voltage of input (Vdc) is reduced (step down) to battery chargingvoltage (Vbatt). During ON state of operation, the current (I) flows through the switch, inductor(L) and through the battery. In this operation the power flow is from GRID to VEHICLE BATTERY Because the battery needs less voltage so the voltage is to be reduced in this operation. During the OFF state of operation, the current takes return path through the inductor(L) and to the lower switch of the diode

The Battery voltage is given by

Vbatt = Vdc *D (1)

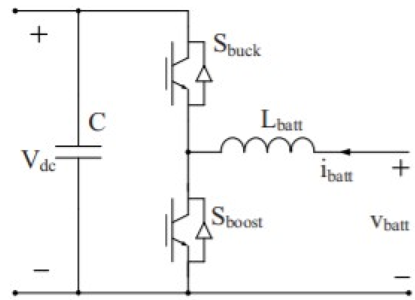

Fig.2 Battery charger configuration

2. DISCHARGING MODE (Boost mode of operation): During the boost mode of operation the voltage of the battery is increased (step up) to grid voltage. In this the converter acts as Boost converter when the switch is in ON position current(I) flows through the inductor (L) and upper switch of the anti parallel diode and capacitor(C) and completes the circuit. In this the power flow is from VEHICLE BATTERY TO GRID. In the capacitor provide constant DC voltage & it will operate in a discharging mode.

The output voltage during boost mode is

Vdc =Vbatt/1-D' (2)

D= Duty cycle of the lower switch.

B. GRID CONNECTED INVERTER & LCL FILTER

Grid connected inverter converts DC Bus voltage to 3 phase ac voltage and allows return path to the current through anti parallel diode. LCL filter is connected after the inverter because INVERTER will not give pure ac. LCL filter will reduce the harmonics and will give pure AC voltage and current.

III.CONTROL SYSTEM

A. OFF -BOARD CHARGE CONTROL

In this PI controller is used with this a constant current(I) control strategy is used for charging and discharging. The PI controller compares the battery current with 0& to determine charging and discharging modes of polarities of the signal. When the mode is selected reference and actual(measured) value of the current are compared and the difference between them is passed through the PI controller to generate switching pulses

(Sbuck or Sboost). Sbuck will be turn OFF during discharging process. And Sboost will be turn ON during charging process.

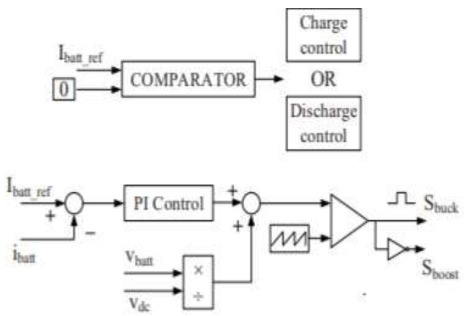

Fig 4. Constant current control strategy for battery charger

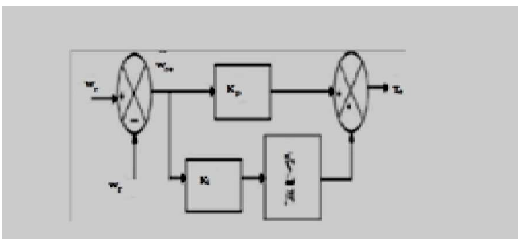

Fig.5.General block diagram of PI Controller

B. INVERTER CONTROL

The control design consists of 2 outer voltage and 2 inner current control loops which are in a nested loop. In these 3 phases is connected into 2 phase dqaxis to measure easily and d axis and q axis are separately controlled with PI Controller and then the total dq axis is converted to 3 phase and given to the inverter switching circuit.

IV. MICRO GRID TEST CONFIGURATION

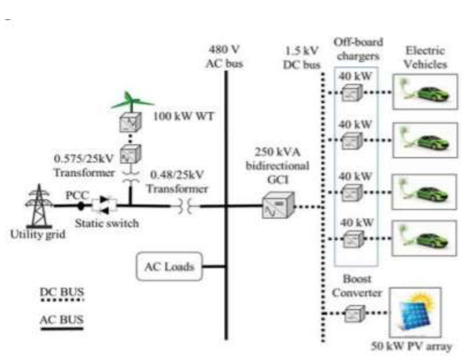

Fig 6. Proposed microgrid test system configuration

The Storage system has 4EV batteries connected to 1.5kv DC bus through OFF Board charges and 50kw PV ARRAY is connected to 1.5 kv c bus through Boost converter which has MAXIMUM POWER POINT TRACKING (MPPT). Utility grid has distribution feeder of 25kv and has 120 kv equivalent transmission system and a transformer is placed between the utility grid and the AC Bus.

V.SIMULATION RESULTS

(0-1) The vehicle is not connected to grid

(1-4) vehicle is connected to grid

(4-6) grid is connected to vehicle

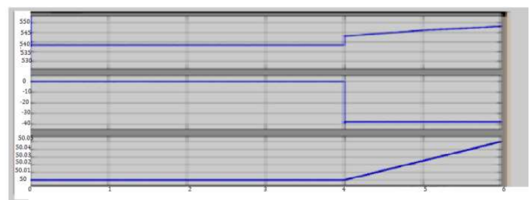

Fig .7voltage, current and soc of EV2 battery G2V configuration

During G2V Configuration (4-6) the voltage increased current will be decreased (because V=1/I) and the state of charge will be increased

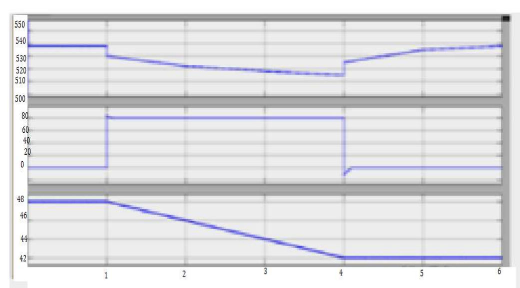

Fig 8.Voltage, current and soc of EV1 battery V2G configuration

During V2G configuration (1-4) the voltage will be decreased and current will be increased so the state of charge will be decreased same that of a voltage

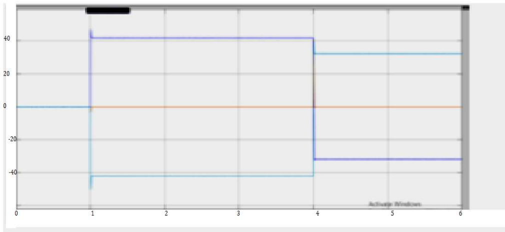

Fig.9 Active power profile of various components in the system

The vehicle power and the grid power are same but in opposite direction so the net power will be zero.

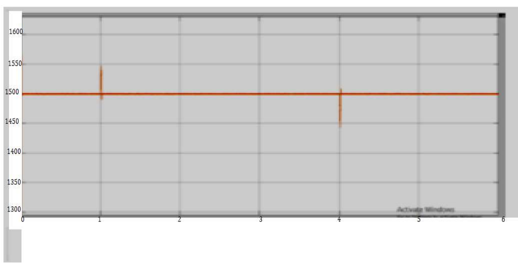

Fig .10 Variation in dc bus voltage

The fluctuations are occurred in dc bus voltage at 1 and 4 that is because of the V2G connected and G2V connected

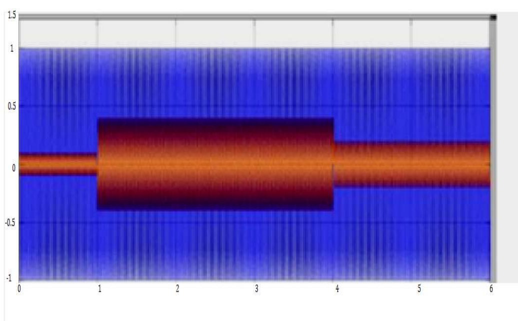

Fig.11 Grid voltage and grid injected current during V2G OR G2V Configuration

Grid voltage is in sinusoidal and the current lags behind the voltage. The voltage raises up because it is connected to V2G at 1-4

CONCLUSION

This paper presents the designing and modelling of a "V2G/G2V TECHNOLOGY IN A MICRO GRID USING DC FAST CHARGING ARCHITECTURE". The draw back of the previous paper is overcome in this paper that the controller used in this designing gives good dynamic response in DC bus voltage stability and the efficiency will be high. Allows bidirectional power flow. Effectiveness of the proposed model is evaluated based on MATLAB simulation of both V2G and G2V modes of operations. Smooth power transfer takes place between V2G AND G2V.

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