An Innovative Method on Micro Grid Systems by using Electric Vehicle as a Storage Device

Arjun Sharma
Senior Lecturer and Examination Controller, Department of Mechatronics
Advanced Technical Training Centre (ATTC), Bardang, Sikkim, India

Abstract

In this emerging world, there is a great demand in electricity and the usages have been increasing day by day due to the accomplishment of the electrical instruments. Hence the development of sustainable resources such as solar, wind, tidal, biomass etc. has been seriously concerning all over the world. The technical progression in the field of power electronics directed to the practice of using solar power for their working. The output of the solar power shows discrepancy to the climate changes and some other veiling circumstances. Due to growing impacts of the high penetration of Photo voltaic systems (PVS), the utility grid module is essential for the effects on the power quality. This paper proposes the operative session of the grid module secluded with the PVS. The atmospheric conditions such as irradiation, high temperature, moisture, mist and fog are also considered for the better performance. For the process stabilization of the power supply to the grid module from the photovoltaic source, we use Electric Vehicle, as energy storage device. The electric vehicle requires a coordination of control to achieve preferred result. The demonstration of the above proposed system is carried out in Power system CAD and the consequences are verified through simulation results by considering real field data such as atmospheric conditions.

Keywords: *Photo voltaic systems, utility grid, storage device, PSCAD.*

I. INTRODUCTION

According to the recent review around the world, energy crisis is the major social and economic issue. This is mainly due to the Industrial development, economic development and population growth in the global demand for energy. As a result the nations have been tending to what are all the other sources to tackle such serious crisis. So they used many other resources for the needs of the people. But it has been raised gradually and gives a great impact to the development of the society. Final some nations used nuclear resources to demolish the lacking of the power. It also gives a better result and rectifies the entire problems that are created by the emerging issues. Lately many developing countries have even withdrawn the nuclear power plants after many problems and disaster occurred worldwide. They realized that this is not a safe solution to the disputes. Hence they turned into another permanent and safest solution and finally micro grid technology is becoming more popular. The micro grid can be well-defined as a power system which has restricted geographic range and comprehends entrenched generation or storage resources or both which may function similar to the grid or in isolation mode.

Micro grid technology is one of the sustainable solutions for electrification where the development of the main grid is either not possible or has no economic explanation. Micro grids can separate from the centralized grid and operate independently, strengthen grid flexibility and help alleviate grid conflicts. An incorporated energy system perceptively handling interconnected loads and scattered energy resources and accomplished of operating in parallel with, or independently, from the existing utility's grid. The micro grid compromises decentralized operation and govern which supports to decrease the transmission liability on power utility systems. Micro grid has been essentially accompanied with the Distributed energy resources (DER). Distributed energy resources are a part of the micro grid which includes small wind turbines, photovoltaic (PV), heat or electricity storage, united heat and power, well-regulated loads, micro turbines or reciprocating engines to turn generators. By using the various DERs the PV resource is more pleasing as it is not having any moving parts and the losses associated with motion are unreal. Solar power systems are also used in applications which are closely related to a generator to avail enough amounts of remote loads. The most important drawback of solar power system is intermittent in nature. Energy storage is usually suggested in the situation of an intermittent source. It has been revealed before that plug-in vehicle parking lots can be used to engage the dissimilarities caused due to the intermittency in wind power.

The main concern of using an electric vehicle as external energy storage can be stretched to a solar powered system. In the future the increasing perception of Photo Voltaic system may also lead to significant effects on power distribution systems, mainly due to the intermittent nature of its output instigated by cloud cover. Consequently, a synchronized use of solar powered system with Electric Vehicles will be a probable solution which

can help to sustain a flat power profile to the grid. Electric Vehicles can be synchronized with the systems in many ways. Not only that, to standardize the energy imbalance in the system, the day time solar generated power can efficiently be converted into night time depletion using the vehicle to grid and grid to vehicle concept. The proposed system is propelled into the existing power systems which are already in use; the essential part of this session is that the energy storage system is also cost effective in nature. Nevertheless, in order to produce more assurance on this technology, the system has to be uncovered to realistic field data. The most significant objective of this paper is that a grid connected combined Photo Voltaic system and Electric Vehicle system is systematically demonstrated and considered by combining the real field data in PSCAD environment. In order to confirm the performance of the both the systems are combined micro grid, field data acquired from National Institute of Wind Energy (NIWE), Tamilnadu, India. The outcomes attained from the centre shows that this Electric Vehicle technology in coordination with the solar Photo Voltaic system producing unit gives a smooth power output to the grid.

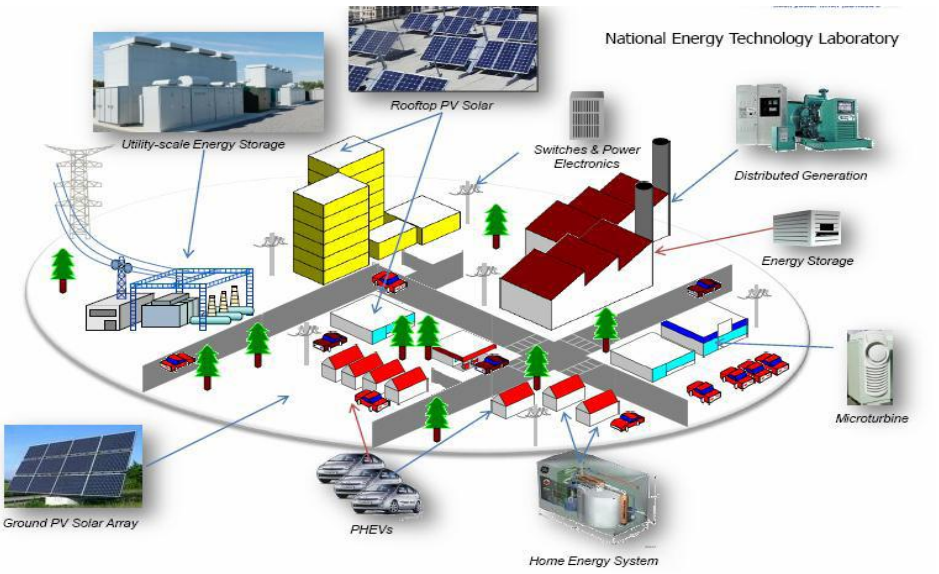

Fig.1: An Example For Micro Grid Power Distributed System

II. PROPOSED SYSTEM

The proposed system demonstrated that a grid-connected photovoltaic system is electricity generating solar PV system that is associated to the utility grid. They range from minor domestic and marketable rooftop systems to huge utility-scale solar power stations. It is different from the usual power systems; a grid-connected system hardly ever comprises an integrated battery solution, as they are still very costly. When situations are accurate, the grid-connected PV system deliveries the additional power, further than consumption by the connected load, to the utility grid.

A. Grid Connected Photo Voltaic System

The grid connected Photo Voltaic system is shown in the fig.1. Apart from all the issues, an intellectual PV module as an alternative of interconnection between segments they are interconnected with linked DC-DC converter for MPPT tracking which confirms ideal processes of PV systems. The chief usage of DC-DC converter is to boost the output of the PV module. In this paper, we suggest perturb and observe technique to excerpt maximum possible power from solar panel. The firing pulse of the DC-DC converter is produced through the MPPT control logic. A two-stage PV system is projected which involves of a DC-DC boost converter with MPPT and a DC-AC inverter to convert photovoltaic DC voltage into line 50 Hz AC voltage. The output of the converter is connected to the grid through a three phase current controlled PWM inverter.

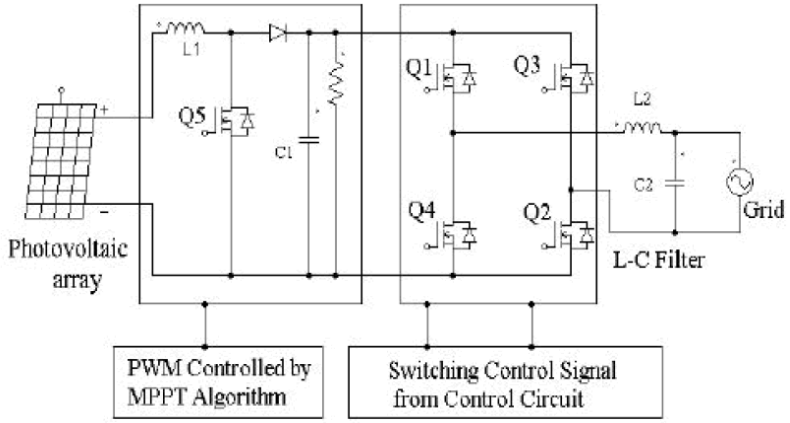

Fig.2: Schematic Diagram of the Grid Connected PV System

1) ***Solar Panel***

In this paper, a 110 kW solar farm is demonstrated in PSCAD/EMTDC platform. The parameter values of all the passive components are obtained from the Mat lab demo model of a 110 kW solar PV system. Ten numbers of modules are connected in series and eight numbers of modules are connected in parallel. There are 216 cells connected in series per module and eight cells in each string per module in series. The series resistance per cell is 0.02 ohm and the shunt resistance is 1000ohm. The output voltage of the solar panel is obtained across a capacitor.

2) ***Boost Converter***

The chief purpose of this proposal is to excerpt the extreme possible power from the panel using Maximum Power Point Tracking (MPPT) algorithm. The algorithm is entrenched inside the control of the boost converter. The implementation of MPPT based boost converter control. The algorithm decreases or increases to take the maximum power point when functioning under changing climatic conditions and temporary clouds. The voltage is then compared with the dignified PV panel output voltage and is provide for as the input to PI controller. The output of the PI controller is used to produce the switching pulses for the boost converter.

B. System Connected With Electric Vehicle

Electric vehicle (EV) describes a system in which plug-in electric vehicles, such as electric cars (BEVs) and plug-in hybrids (PHEVs), connect with the power grid to retail demand response services by either recurring electricity to the grid or by strangling their charging rate. The electric vehicle is demonstrated as a DC voltage source with an inverter through which it associates to the grid. The control of the electric vehicle inverter system is nearly the same as the PV inverter. The only difference between the two is that since it is connected to a constant DC voltage source, the DC voltage control is not necessary. Instead, it can directly control the active power commanded from the electric vehicle. Nevertheless, here the active power order originates from the synchronizing controller which controls the complete power injection into the utility grid.

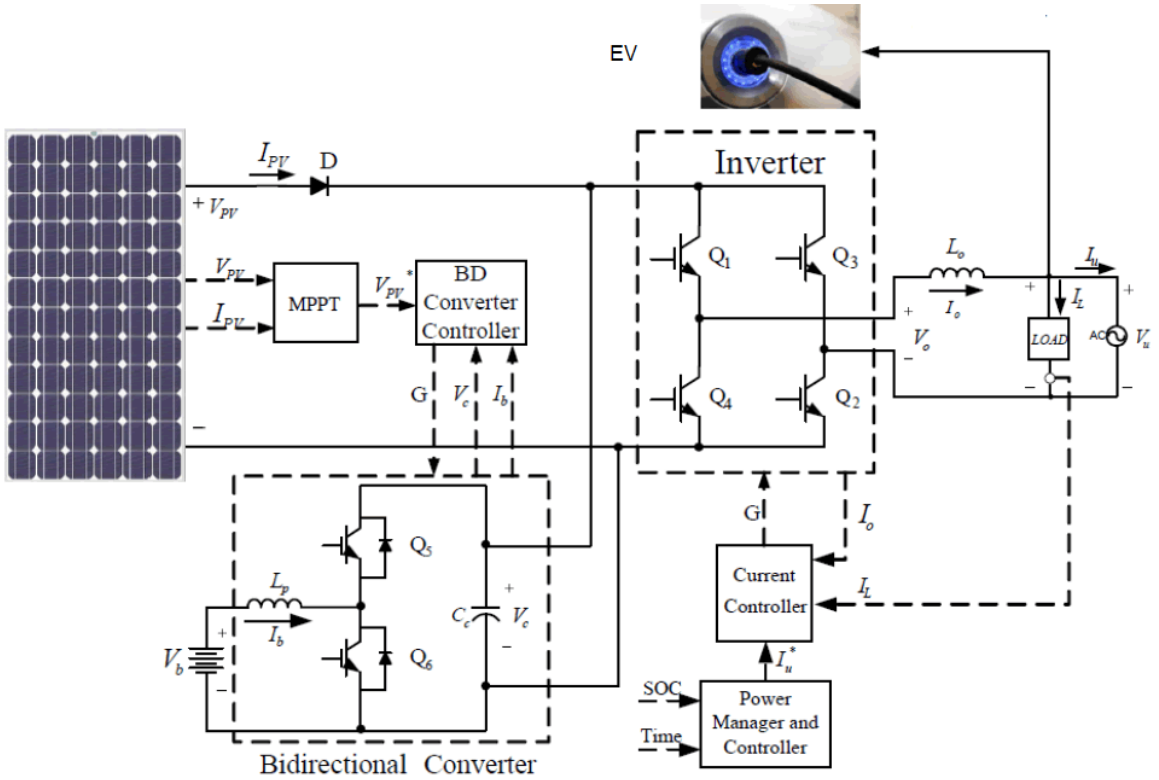

Fig.3. Overall Schematic Diagram of Grid Connected Electric Vehicle

C. Coordinated Control of the PV-EV Combined Micro Grid

With the purpose of smooth out the power variations from the PV inverter and to ensure the power injection to the utility grid is completely constant, a bidirectional controller is essential. The preferred power to the utility grid is given as an input to the bidirectional controller. It also watches the output power from the PV system. Then the alteration between these two powers, which is the output of the bidirectional controller, can be used as the demanded power for the EV system. The PV Inverter is fundamentally controlled by current controller which will be determined to decrease reactive power loss. The current controller will yield it reference from the power management system. In day time if the battery is full, power manager services the system to push the power produced from the PV panels to grid or load but if the battery is not full, system deliveries the power only for load and charges the battery pack with the extra energy from panels. If the solar energy is not enough to supply the load, required power is taken from the battery. In night time, load is supplied from battery if the SOC is over a minimum value. The battery is empty, the load is supplied from the grid and battery pack can be charged when the electrical energy price is low. Inverter also recompenses the system by producing essential to reactive power.

It can be explained in mathematical expressions by,

$$P^*grid - PPV = P^*EV$$

Where

P^*grid represents the anticipated power output of the utility grid,

PPV represents the output power from the solar generating plant and

P^*EV represents the demanded power from the electric vehicle.

III. SIMULATION RESULTS AND DISCUSSIONS

The performance of the proposed scheme was verified based on the simulation studies carried out in PSCAD/EMTDC software environment. The required field data obtained from National Institute of Wind Energy (NIWE), Tamilnadu, India has been used. The organization provides site data for both solar PV and wind systems. The fig.4 shows that the input for the system i.e. solar irradiance and temperature variations can be determined as per the field data.

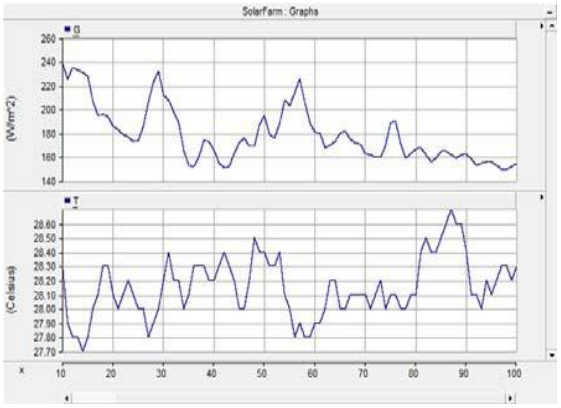

Fig.4: Solar Irradiance and Temperature Variation

At this instant, an electric vehicle is used in order to fascinate the power discrepancies caused due to the variation in irradiation and temperature. These variations are simulated using the real time field data obtained are shown in fig.5. The Control circuit of the electric vehicle records the vehicle power monitors the same reasonably.

In this model a constant dc source of 5kV is used as reference. The control of the electric vehicle inverter system is related to that of the PV inverter. Since a constant DC source is used, DC voltage control is not essential. As an alternative, it can directly control the active power demanded from the electric vehicle. On the other hand, the active power order comes from the bidirectional controller which controls the overall power injection into the utility grid.

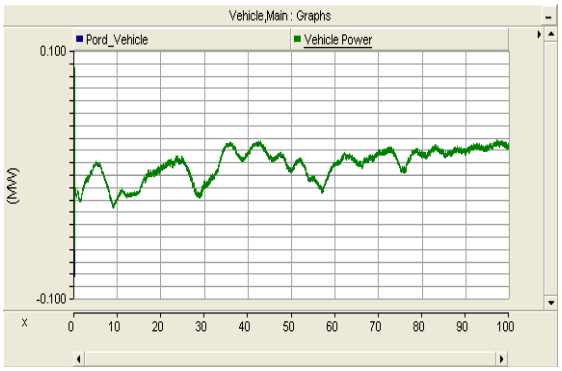

Fig.5: Reference and Real Vehicle Power

The solar power fluctuations are absolutely fascinated by the EV system, which helps the combined system to conserve a flat power profile is shown in fig.6. It is obvious from the field data acquired from the renewable energy sources like solar, wind, etc., upturns the demand for assets and regulations in view of their recurrent nature. These sources are inoculated into the grid. The electric grid requests something to bond the gap between varying demand or supply and the reaction of the large generation units. In the role of Electric Vehicles is specified and the number is to be positioned in accordance to the load request is described. In the modelling of the solar PV system is supported but the intermittency has not been lectured. In the present work the real field data of the solar irradiance and temperature has been used to authenticate the EV technology and the consequences attained obviously demonstrates that the power output to the grid is stable.

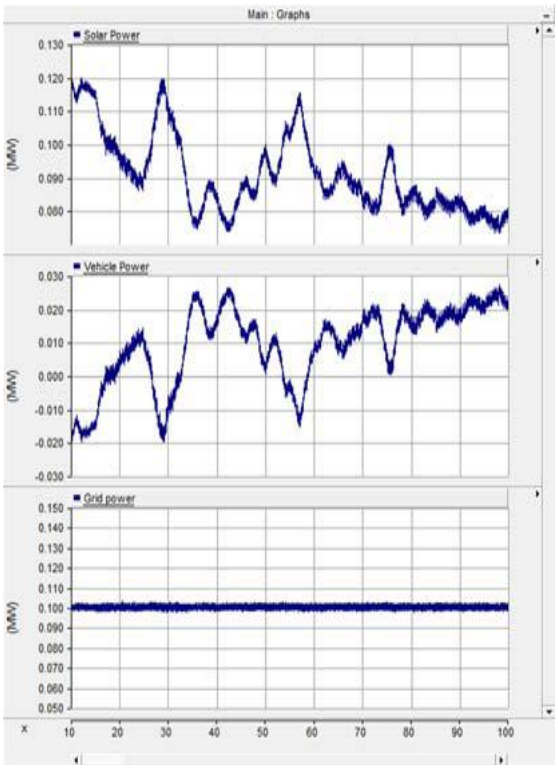

Fig.6: Performance of the PV-EV Combined Micro Grid

The simulation results are in good agreement with the experimental results. It shows clearly about the performance of the combined photo voltaic- electric vehicle in the utility grid

IV. CONCLUSIONS

In this paper, the use of electric vehicle for the purpose of energy storage in the micro grid can be clearly explained. It also elevated that a capability of maintain a power profile from the coordinated control which is mounted in the utility grid. This can be achieved by qualifying the electric vehicle in the combined PV-EV systems. The simulation result from PSCAD simulation shows the accurate determination of the field data and the output are verified. The consequences of this proposed system are auspicious to establish the assertion that electric vehicles can be used as external energy storage to a solar PV unit in micro grid.

REFERENCES

[1] Aguero, J.R. Chongfuangprinya, P. Shengnan Shao, Le Xu , Jahanbakhsh, F.Willis, H.L., "Integration of Plug-in Electric Vehicles and distributed energy resources on

power distribution systems", Electric Vehicle Conference (IEVC), March 2012, 1– 7.

[2] Brissette, A. Hoke, A. Traube, J. Fenglong Lu Maksimovizc, D. "Study on the effect of solar irradiance intermittency mitigation on electric vehicle battery lifetime", Technologies for Sustainability (SusTech) IEEE Conference, Aug 2013; 262 – 267.

[3] Changsong Chen, Huazhong, Wuhan, Shanxu Duan, "Optimal Integration of Plug-in-Hybrid Electric Vehicles in Micro grid" , IEEE Transaction on Industrial Informatics. 2014; Vol 10 (Issue 3); 1917-1926.

[4] Foster, J. M., Trivino, G., Kuss, M., Karamanis, M.C., "Plug-in-Electric Vehicle and voltage support for distributed Solar", Systems Journal IEEE, 2013; Vol 7 (Issue 4); 881-888.

[5] Joydeep Mitra, Niannian Cai, Mo-Yuen Chow, Sukumar Kamalasadan, Wenxin Liu, Wei Qiao, Sriniwas Singh, Anurag K. Srivastava, Sanjeev K. Srivastava, Ganesh K. Venayagamoorthy, Ziang Zhang, "Intelligent Methods for Smart Micro grids" ,Power & Energy society General Meeting. IEEE Conference. July 2011; 24-29.

[6] Kumaravel, S., Ashok, S., "Adapted Multilayer feed forward ANN based Power Management Control of Solar Photovoltaic and wind Integrated Power Systems", Innovative Smart Grid Technologies - India (ISGT India) IEEE PES, 2011; 223-228.

[7] Kodanda Ram, Venu Gopala Rao Mannam, "Operation and Control of Grid Connected Hybrid AC/DC Microg rids using RES" , IJPEDS. October 2014; Vol 5 (No 2); 195-202.

[8] Mohamed Louzazni, El Hassan Aroudam, Hanane Yatimi, "Modelling and Simulation of a Solar Power Source for a Clean Energy without Pollution", August 2013; Vol 3 (No. 4); 568-576.

[9] Pinaki Mitra, Ganesh K. Venayagamoorthy, "Intelligent Coordinated control of a Wind farm and Distributed Smart Parks" , Industry Applications Society Annual Meeting (IAS) IEEE. 2010.

[10] G. K. Venayagamoorthy and P. Mitra,"Smart Park Shock Absorbers for Wind Farms", IEEE Transactions on Energy Conversion. September 2011; Vol. 26 (Issue 3); 990 – 992.

[11] Patterson, M., Sky Song, Scottsdale, Macia, N.F., Kannan, A.M, "Hybrid Micro grid Model Based on Solar Photo voltaic Battery Fuel Cell System for Intermittent Load Applications", IEEE Transaction on Energy Conversion. Feb 2015; 359-366.

[12] Traube, J., Fenglong Lu, Maksimovic, D. Mossoba, J. Kromer, M.; Faill, P. Katz, S. Borowy, B. Nichols, S. Casey, L, "Mitigation of Solar Irradiance Intermittency in Photovoltaic Power Systems with Integrated Electric Vehicle Charging Functionality", IEEE Transactions on Power Electronics, June 2013; Vol 28 (Issue 6); 3058 – 3067.

[13] Udawatta, L. Madawala, Muthumuni, D. Vilathgamuwa, M, "Control of solar powered micro-grids using electric vehicles", Sustainable Energy Technologies (ICSET) IEEE Conference. Sept 2012; 270 – 275.

[14] Zahedi, A, "Electric Vehicle as distributed energy storage resource for future smart grid", Universities Power Engineering Conference (AUPEC), Sept. 2012; 1 – 4.

[15] M. Lu, X. B. Zhou and W. Zhang, "Research on Development of Charging Facilities for Electric Vehicles at Home and Abroad Central China Electric Power" ,Vol. 23, No. 5, 2010, pp. 16-30