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SOLAR POWERED HYBRID CHARGING STATION FOR ELECTRICAL VEHICLE

R.Pradhap
R.Radhakrishnan
P.Vijayakumar
R.Raja
Dr.S.Saravanan
Department of Electrical &Engineering, Muthayammal Engineering College, Rasipuram,Tamil Nadu, India

ABSTRACT

In this paper, a control strategy for power flow management of hybrid PV-AC based system with an efficient MPPT DC-DC (Buck-Boost) converter is presented. The proposed system aims to satisfy the load demand, reduce power interruption and manage the power flow from different sources, inject surplus power from the grid to charge the battery when power from the PV panel not harvested, it is achieved with the help of Microcontroller connected to hybrid supply with the help of Relay. A transformer coupled bridge converter is used to harness power from AC grid, while buck-boost converter is used to harness power from PV along with battery charging/discharging control and it is connected to relay. The relay act as open circuit when the energy from the solar panel is harvested or else it act as closed circuit when the energy from solar panel is not harvested. When the relay is closed circuited the power the AC grid is used via rectifier. Simulation results obtained using MATLAB/Simulink show the performance of the proposed control strategy for power flow management under various modes of operation. The simulation model and efficacy of the proposed system are verified through detailed experimental studies, to demonstrate the capability of the system operation in different modes with the help of MATLAB/Simulink and hardware model.

KEYWORDS:
Photovoltaic; electrical vehicle; carbon reduction; charging station; inverter

INTRODUCTION

This project based on developing charging station for Electric Cars using combination of solar and grid power to encourage the use of Electrical Vehicle and to decrease power demand. Rapid depletion of fossil fuel reserves, ever increasing energy demand and concerns over climate change motivate power generation from renewable energy sources. Solar photovoltaic (PV) have emerged as popular energy sources due to their eco-friendly nature and cost effectiveness. However, these sources are intermittent in nature. Hence, it is a difficult to supply stable and continuous power using these sources. This can be addressed by efficiently integrating with energy storage elements. The interesting complementary behavior of PV power insulation and Grid power minimum utilization pattern coupled with the help of DC-DC converter, has led to the research on their integration resulting in the hybrid PV systems. To achieving the integration of multiple renewable sources to overcome the power interruption and power demand in our proposed system, the traditional approach involves using dedicated single-input converters one for each source, which are connected to a common DC-DC converter for maximum the efficiency of the system. However, these converters (DC-DC) Buck-Boost are not effectively utilized, due to the intermittent nature of the renewable sources. In addition, there are many power conversion stages which reduce the efficiency of the system.

WORKING

PV panel is connected to the MPPT, which act as Buck-Boost. When the power supply from PV panel is not enough then MPPT act as an Boost converter, When the power supply from PV panel is more than the optimum voltage then the MPPT act as Buck converter and fed to rechargeable battery. The microcontroller is connected to the system to monitor the voltage rating and display the values with the help of LCD display. Another part of this system has AC supply converted to DC supply with the help of the Full wave rectifier and given to the relay module. When the voltage from the battery is low the microcontroller triggers the

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relay module to open contact. The supply from battery or from the rectifier is given to the inverter to convert DC supply to AC supply. Microcontroller simultaneously monitor the voltage from the PV panel when it is not sufficient then it on relay to charge battery and then give the supply to inverter. Then the inverter produced 230v as output. We can now charge the electrical vehicles using separate adapter regarding to the capacity of the vehicles battery.

METHODOLOGY

MPPT (Maximum Power Point Tracking) is utilized to obtain the extreme power from sun irradiance. MPPT cooperates with DC-DC boost converter to control the duty cycle of the boost converter by following the maximum current and voltage of solar PV system. Incremental Conductance (INC) based MPPT algorithm for solar PV system is developed here. The equation for implementing the INC algorithm can be easily gotten from the basic power equation. The equation for power is given as, differentiating the above equation with respect to voltage. So the equivalent load is not linear and because of the varieties in accessible energy source, load can fluctuate over a wide scope of bends. That's why a nonlinear examination is required for a stable operation.

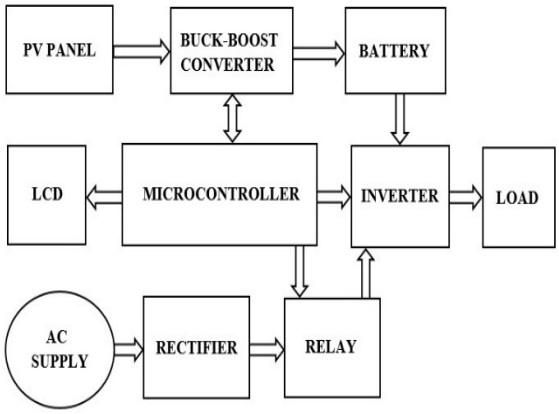

Fig.1. Block diagram

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The supply from battery or from the rectifier is given to the inverter to convert DC supply to AC supply. Microcontroller simultaneously monitor the voltage from the PV panel when it is not sufficient then it on relay to charge battery and then give the supply to inverter. Then the inverter produced 230v as output. We can now charge the electrical vehicles using separate adapter regarding to the capacity of the vehicles battery. The EV charging schedules are calculated according to EV owner requirements and charging characteristics: Energy requirements, connection duration, EV battery efficiency, charger's power rating and charger's efficiency. In an isolated system, excessive electricity is usually stored in batteries during the day and the batteries are used to power the appliances in times when PV panels do not absorb enough energy. Bidirectional DC-DC converter (also known as electronic charge controller) plays an important part in an isolated solar system. The goal is to ensure the battery charging cycle is working at optimal conditions, mainly to prevent overcharging and deep discharge.

SIMULATION

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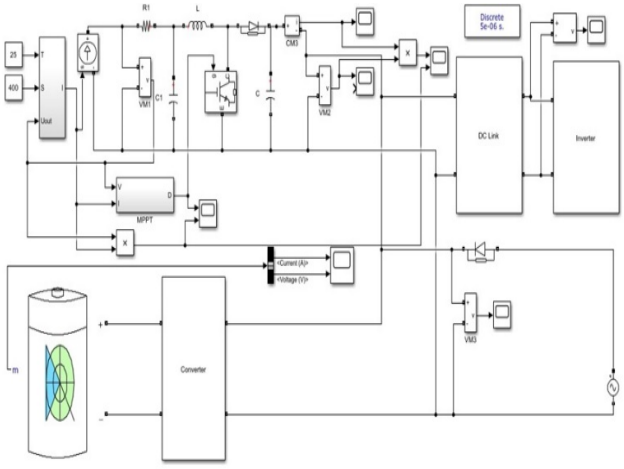

Fig.2. Simulation Model

The above is the simulation model of our proposed system which helps to design and implement our proposed model. The simulation model has all the components that are connected to give the proposed model of our system.

Fig.3. Output Waveform

. The output waveform from the Simulation results obtained using MATLAB/Simulink show the performance of the proposed system under various modes of operation. The simulation model and efficacy of the proposed system are verified through detailed experimental studies, to demonstrate the capability of the system operation in different modes with the help of MATLAB/Simulink and hardware model

EXISTING SYSYTEM

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There are some power stations for charging the electrical vehicle but not much more because there is heavy power demand for electricity and due to the usage of electrical vehicle is also lesser. The existing system use only grid supply that is main disadvantage because to manage the power demand it is quite difficult. The existing system does not contain hybrid source of energy to manage the power demand.

PROPOSED SYSTEM

In an isolated system, excessive electricity is usually stored in batteries during the day and the batteries are used to power the appliances in times when PV panels do not absorb enough energy. The DC-DC buck-boost converter plays an important part in an isolated solar system. The goal is to ensure the battery charging cycle is working at optimal conditions, mainly to prevent overcharging and deep discharge. The existing electronic charge controller only utilizes a single power source to charge the batteries, either the renewable source or non-renewable source. To overcome the limitation, some hybrid electronic charge controllers have been developed to incorporate multiple sources to charging sources such as AC grid power and PV power. Nonetheless, some controllers are having still lack of perfect techniques for proper utilization of multiple charging sources. Hence MPPT powerful DC-DC converters are used.

Some charge controllers were used a timer to switch-on or cut-off the power supply. Besides, the charging time taken was longer. In this paper, a development of a hybrid charge controller for the battery and its implementation are discussed. One of the main purposes of the hybrid charge controller is to supply a continuous charging power source to the battery. Furthermore, the hybrid charge controller was developed to shorten the battery charging time taken. The solar energy is utilized whenever the solar irradiation is high. The main grid supply will be only consumed whenever the solar irradiation is low. In realization of the present work, actual relevant studies have been identified regarding the design, the optimization, the simulation of solar charging stations for electrical vehicles, different approaches being critically analyzed, but also the current state of the global implementation of these energy generating systems, based upon the green charging solar station concept for green electrical vehicle.

IMPLEMENTTION

The power supply stage is composed of a rectifying circuitry in which 220V AC is rectified to a regulated and filtered DC using a full-wave bridge network. The charge controller circuit comprises of electronic components such as capacitors, resistors, op- amps, diodes, transistors and light emitting diodes. The charge controller circuit in conjunction with the microcontroller is manipulated such that it can detect presence or absence of battery at the charging terminal, wrong battery polarity connection at the charging terminals, charging status of the battery, full charge status of the battery and float charge.

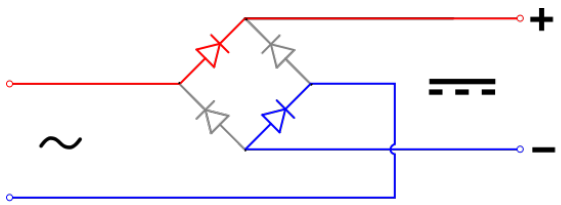

Fig.4. Rectifier for secondary supply

The Arduino microcontroller was used in the work to monitor the battery charge status and to further drive the liquid crystal display to enable the user have a deep knowledge of the system functionalities. The design uses a combination of constant current and constant voltage to charge batteries connected across its terminals for 12V batteries. It is a common problem to always overcharge batteries thereby shortening the life span of the batteries and increasing the Mean Time to Failure of such batteries.

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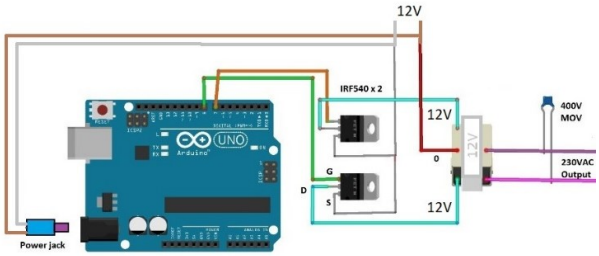

Fig.5. Controlled inverter

The charge controller circuit in conjunction with the microcontroller is manipulated such that it can detect presence or absence of battery at the charging terminal. The battery charger is used to put energy into a secondary cell by forcing electric current through it. An efficient battery charger requires a charge controller whose main function is to keep the batteries properly charged and safe for the long term and prevent it from deep discharging.

The simple inverter circuit consists of Arduino, step up transformer 12-230v and two MOSFET. A voltage regulator, which give constant voltage to Arduino board regardless of battery voltage (Battery voltage must not drop below 11.90V). The two capacitors connected to voltage regulator gives stability which act as filter to convert DC to pure AC. The input capacitor 1000uF helps the inverter to start softly and provide immunity against sudden input voltage fluctuations. Two MOSFETs are employed which can handle around 300 Watt power with heat sink mounted. By turn off and on each MOSFET alternatively we can develop alternating flux to produce alternating current. The transformer is a step down one, which is used in reverse to step-up the voltage and it its center tapped. The transformer's voltage and current parameter also decides maximum output power.

HARDWARE

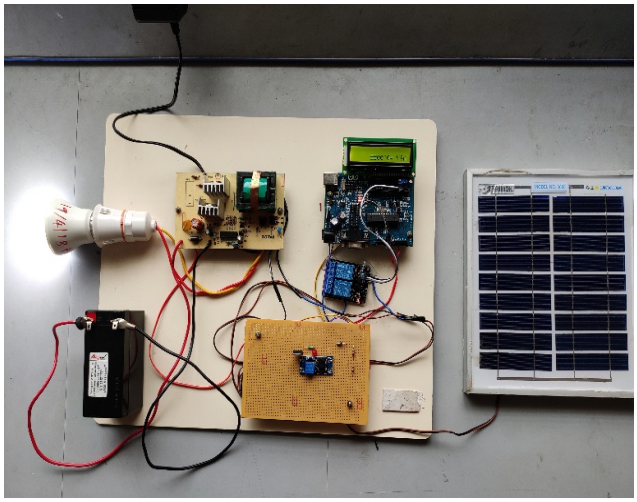

Fig.6. Hardware model

PV PANEL

As the demand for solar electric systems grows, progressive builders are adding Solar Photo Voltaic (PV) as an option for their customer's emphasis will be placed on information that will be useful in including a grid-connected. PV system in a bid for a residential or small commercial building. We will also cover those details of the technology and installation that may be helpful in selecting subcontractors to perform the work, working with a designer, and directing work as it proceeds.

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Fig.7. Solar panel

Arrays are most commonly mounted on roofs or on steel poles set in concrete. In certain applications, they may be mounted at ground level or on building walls. Solar modules can also be mounted to serve as part or all of a shade structure such as a patio cover. On roof-mounted systems, the PV array is typically mounted on fixed racks, parallel to the roof for aesthetic reasons and stood off several inches above the roof surface to allow airflow that will keep them as cool as practical.

POWER SUPPLY

The power supply is provided inverter and microcontroller. The DC power supply with both positive and negative output voltages, a step-up transformer is used and Arduino operates at low power. A relay is an electrically operated switch. Where many relays are used to an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a low-power signal where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers they repeated the signal coming from one circuit and retransmitted it on another circuit. It is a common problem to always overcharge batteries thereby shortening the life span of the batteries and increasing the Mean Time to Failure of such batteries.

BATTERY

The EV battery charging schedules set by the EV Parking Manager (EVPM) are followed by the EV`s chargers. A two way communication between the EV`s chargers and the EVPM is assumed. The EV Parking Manager has the kW loading capacity limits of the distribution network to which the parking facility's charging infrastructure is connected to (according to the distribution network technical constraints). The loading capacity limits are assumed to be made available by the DSO. The EV batteries are considered as purely resistive loads that charge at a constant power rating.

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MPPT

MPPT (Maximum Power Point Tracking) is utilized to obtain the extreme power from sun irradiance. MPPT cooperates with DC-DC boost converter to control the duty cycle of the boost converter by following the maximum current and voltage of solar PV system. Incremental Conductance (INC) based MPPT algorithm for solar PV system is developed here. The equation for implementing the INC algorithm can be easily gotten from the basic power equation. The equation for power is given as, differentiating the above equation with respect to voltage. So the equivalent load is not linear and because of the varieties in accessible energy source, load can fluctuate over a wide scope of bends. That's why a nonlinear examination is required for a stable operation.

The loading capacity limits are assumed to be made available by the DSO. The EV batteries are considered as purely resistive loads that charge at a constant power rating. The EV Parking Manager calculates and assigns battery charging schedules to EV`s on a first-come first-served basis. The EV charging schedules are calculated according to EV owner requirements and charging characteristics: Energy requirements, connection duration, EV battery efficiency, charger's power rating and charger's

efficiency. In an isolated system, excessive electricity is usually stored in batteries during the day and the batteries are used to power the appliances in times when PV panels do not absorb enough energy. The DC-DC buck-boost converter plays an important part in an isolated solar system. The goal is to ensure the battery charging cycle is working at optimal conditions, mainly to prevent overcharging and deep discharge.

CONCLUSION

The PV-powered EV battery-buffered EV charging station with intelligent energy management has been demonstrated for more than a year on a workplace charging station at UC Davis West Village. The operation results show that the system control, PV electricity estimation, EV charging load projection, and battery SOC optimization are executed as expected. A PV integrated EV charging station equipped with a buffer battery and with intelligent energy management can almost eliminate the station's peak power demand and reduce the energy exchange with the utility grid by a factor of 2. The estimated PV electricity based on the extracted weather information reflects the actual PV electricity generation. More complicated PV electricity forecasting models with more accurate hour-by-hour weather information could improve the accuracy of the estimated PV electricity. The linear fit of the historical EV charging load data for each day of the week for the latest six-week period seems appropriate for extracting the charging pattern of a workplace EV charging station. Since the current charging station has only one outlet, the uncertainty and contingency will affect the result of the load demand projection. The intelligent energy management strategy is best suited for charging station systems having one large energy storage battery and multiple charging outlets.

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