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MPPT BASED SOLAR POWERED WIRELESS CHARGER FOR ELECTRIC VEHICLE

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Abstract— In the fast-changing world the form of fuel for cars is also changing from petrol/diesel to battery. In the Electric cars and bikes there is a major drawback that it could not travel more than few hundred miles. Once the battery capacity increases then the weight and size increases, thus it is not possible. So, the development of charging stations along the roadside should be increased. This system gives an experimental setup to develop wireless charging station using solar system. In this system presents the different approaches and techniques for electric vehicle charging methods. In thus system review the techniques are fast charging station with integration of solar pv system, predictive controllers-based charging station, PV-assisted EV fast charging stations, MPPT Algorithms for Solar PV based Charging Station and Boost Converter based EV Charging Station. This system will be useful for future research scholar and students those interested for working in the field of solar pv based fast charging station for electric vehicle design.

Keywords – Photovoltaic system, maximum power point tracking, boost converter, inverter, electric vehicle

I. INTRODUCTION

Solar energy has emerged as a promising renewable energy technology due to its cost-efficient and eco-friendly nature. The energy generated by the photovoltaic (PV) solar cells relies upon a few variables including solar irradiation and temperature. The solar cell has a specific Maximum Power Point for each value of irradiation and temperature.

Maximum Power Point Tracking (MPPT)[1] method extracts the solar power in that point from the solar cells Therefore, an improved method needs to be developed which provides more stable output power and exhibits less oscillatory behaviour. In recent times, the MPPT has become the most popular method to control battery charging. The lead-acid battery is commonly used as rechargeable batteries because of its low cost and simple to manufacture. On the other hand, lithium-ion battery has a longer depth of discharge than other batteries and has no negative effect on the environment. Though nearly all large rechargeable batteries are lead-acid type, a few lithium-ion types are starting to make their appearance. The wireless charging of electric vehicles is based on the inductive power transfer between two mutually coupled coils, one is “primary” connected to charging station with solar, wind and main supply and the other “secondary” connected to the battery of E-vehicle.

The advantages provided by the wireless charging are in terms of safety and comfort, as the driver can avoid danger by using power cord and he needs to park the vehicle without the need of plug-in operation to start charging the battery. The WPT can also occur in reverse direction, so that the power could again be send from the vehicle battery to the grid in times of need. Thus, the wireless power transfer also fit for bi-directional power flow [9],[10],[11],[12]. This system mainly keen on the concepts of wirelessly charging the electric vehicle[4],[8]. The wired charging can be mainly four types and all are explained in [3], [7]. The charging can be done through PV solar grid connected system. The use of solar is pollution free and eco-friendly in use. However, the battery charging need to be taken care and an algorithm is also developed for PV-solar system. The various configurations for solar systems have been presented. Models of a PV array and their MPPT power tracking controllers and adaptive voltage controllers and supervisory controller and Standalone PV solar system is studied [2],[6]. The charging stations for electric vehicle using solar-pv is given [1],[5]. Practically all existing high power wireless energy transfer systems use a resonant magnetic induction method as this approach currently provides the highest efficiency over an air gap. The first applications of WPT concern the electric buses charging. The first generation of electric vehicles using the WPT charging technology concern the buses. The German Wampfler and then continued as Conductix was spun off started in January 2014 1996 to charge the first electric buses equipped with IPT Technology. The static WPT systems are able to charge while the buses are stopped or parked over powered (primary inductor). The pads embedded in the roadway or in the garage floor and the secondary coil are on the vehicle.In 2009, the Korean Advanced Institute of Science and Technology (KAIST) research university in the South Korea, has developed the OLEV green design concept to power electric vehicles wirelessly. KAIST has obtained more than 180 patents according to the technologies developed and describe the design for WPT bus applications based in several technical papers.

The power obtained from the solar panel is boosted using boost converter for charging the electrical vehicle. The wired method of charging a vehicle undergoes many problems. The need for an adaptor for charging each vehicle and also the place for storage of wires and chargers which undergoes wear and tear. Periodic maintenance is required for maintaining the chargers in working condition and also if the position of charging port in a vehicle reduces the accessibility of charging. The man power required for physical connection also increases. And if the power obtained from the solar panel reduces, even when the boost converter boosts the voltage the charging time will become high.

II. Related Work

In 2010, Christopher Hamilton, Gustavo Gamboa reviewed System Architecture of a Modular Direct-DC PV Charging Station for Plug-in Electric Vehicles [3]. In recent years, the improvement in battery technology has allowed car manufacturers to design more affordable plug-in electric vehicles. As PHEVs are being introduced into the market, renewable energy sources such as solar power are taking a larger part in the energy sector. A need for high efficiency battery charging is required to decrease the amount of time it takes to charge these cars in order for them to become a viable means of transportation. A novel solar carport architecture is proposed that will provide a three port interface to PHEVs, solar panels and the utility grid to create a seamless power flow between the three ports. Current battery chargers rely heavily on AC/DC conversion from the grid to the car battery, however a direct DC/DC interface is made in this solar carport thus increasing the overall efficiency. This system will prove this concept and show the improved performance over available battery charging schemes.

In 2011, M. J. Neath, Udaya K. Madawala and D. J. Thrimawithana reviewed A New Controller for Bi-directional Inductive Power Transfer Systems [9].Inductive Power Transfer (IPT) technology is gaining popularity as an efficient technique for supplying contactless power to numerous applications. In contrast to unidirectional IPT systems, bi-directional IPT systems invariably require more sophisticated and effective control strategy to regulate the power flow within the limits of power capability of converters. This system proposes a new controller that uses power-frequency droop characteristics to regulate the power flow of the system without any additional communications. Simulated results of a 2 kW bi-directional IPT system with a single pick-up are presented with discussions to show that the proposed droop controller can effectively be used regulate the power flow, while limiting the power flow at maximum level when necessary.

In 2013, Udaya K. Madawala reviewed A Power–Frequency Controller for Bidirectional Inductive Power Transfer Systems [12]. Analysis, together with both experimental and simulated results, of a 1-kW single-load bidirectional IPT system is presented with discussions to show that the proposed droop controller can successfully be used to regulate the two-way power flow.In 2016,Mustapha DEBBOU reviewed Inductive Wireless Power Transfer for Electric Vehicle Dynamic Charging[8]. The system is to present an overview of inductive wireless power transfer (WPT) technologies for the application of electric vehicles (EVs) wireless charging. The basic principles of this technology are introduced followed by a classification of power electronic architectures and the magnetic coupler design. The advantages and limitations of each technology for EV dynamic charging are discussed. In 2018, Li Wang reviewed Design of Electric Vehicle Charging Station Based on Wind and Solar Complementary Power Supply[5]. The low-carbon economy in the world has integrated into the mainstream awareness of society. In this context, electric vehicles show a bright future. This article is proposed to further promote the development of new energy vehicles. Apart from that, the redefinition of the relationship between new energy and power grids is made. Combined with the current development of new energy vehicles, this way breaks the traditional concept of new energy grid, which will provide a new way for the utilization of new energy in the future. It is of great significance for solving the serious environmental pollution and depletion of resources in the whole world.

III. The Proposed MECHANISM

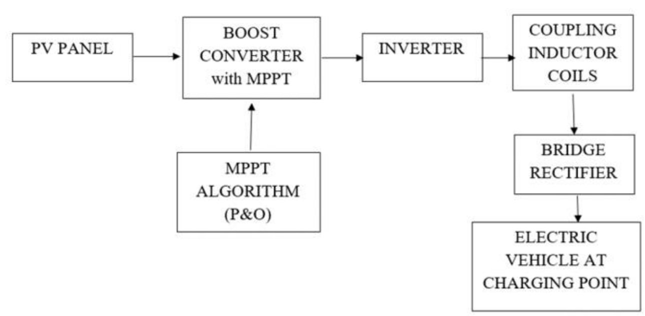

Figure 1.Block diagram of the proposed system.

Proposed system consists of a solar panel connected to a boost converter and the output of boost converter is connected to an inverter. The output of inverter is connected to coupling coil which consists of two coils coupled by magnetic flux linkage without the physical connection. The bridge rectifier converts the obtained output from AC to DC and charges the electrical vehicle[5]. The solar panel uses MPPT (Maximum Power Point Tracking) using Perturb and Observe Method. The output of the Boost converter is adjusted based on the pulses

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generated from this Perturb and observe method. Based on the pulses the output of boost converter is boosted till the output reaches a maximum value. Then the maximum value of DC voltage is given to an inverter which converts the DC to AC.then the frequency of AC supply is increased so that it is given to the primary coil of wireless power transfer coupling coils. The high frequency AC cretes a flux linkage with the secondary coil of coils and generates an emf which in turn leads to a potential difference thus causing wireless power transfer. Then the obtained AC voltage is converted into DC using a rectifier and that DC voltage is provided to electrical vehicle for charging.

A. PV Array

A single cell generate very low voltage (around 0.4), so more than one PV cells can be connected either in serial or in parallel or as a grid (both serial and parallel) to form a PV module . When we need higher voltage, we connect PV cell in series and if load demand is high current then we connect PV cell in parallel. Usually there are 36 or 76 cells in general PV modules. Module we are using having 54 cells. The front side of the module is transparent usually buildup of low-iron and transparent glass material, and the PV cell is encapsulated. The efficiency of a module is not as good as PV cell, because the glass cover and frame reflects some amount of the incoming radiation. A photovoltaic array is simply an interconnection of several PV modules in serial and/or parallel[2]. The power generated by individual modules may not be sufficient to meet the requirement of trading applications, so the modules are secured in a grid form or as an array to gratify the load demand. In an array, the modules are connected like as that of cells connected in a module. While making a PV array, generally the modules are initially connected in serial manner to obtain the desired voltage, and then strings so obtained are connected in parallel in order to produce more current based on the requirement.

B. MPPT

Perturb and observe (P&O) is one of the direct MPPT techniques, which is used for tracking the MPP[6]. In this technique, a minor perturbation is introduced to, cause the power variation of the PV module. The PV output power is

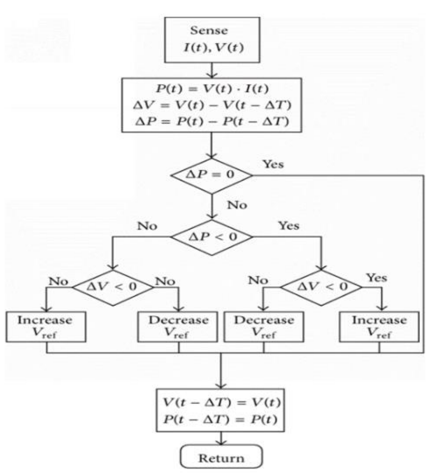


Figure 2. flow chart of P&O Algorithm

periodically measured and compared with the previous power. If the output power increases, the same process is continued otherwise perturbation is reversed. In this algorithm perturbation is provided to the PV module or the array voltage. The PV module voltage is increased or decreased to check whether the power is increased or decreased. When an increase in voltage leads to an increase in power, this means the operating point of the PV module is on the left of the MPP . Hence further perturbation is required towards the right to reach MPP. Conversely, if an increase in voltage leads to a decrease in power, this means the operating point of the PV module is on the right of the MPP and hence further perturbation towards the left is required to reach MPP. The flow chart of the adopted P&O algorithm for the charge controller is given in Figure 2. When the MPPT charge controller is connected between the PV module and battery, it measures the PV and battery voltages. After measuring the battery voltage, it determines whether the battery is fully charged or not. If the battery is fully charged (12.6 V at the battery terminal) it stops charging to prevent battery over charging. If the battery is not fully charged, it starts charging by activating the DC/DC converter. The microcontroller will then calculate the existing power Pnew at the output by measuring the voltage and current, and compare this calculated power to the previous measured power Pold. If Pnew is greater than Pold, the PWM duty cycle is increased to extract maximum power from the PV panel. If Pnew is less than Pold, the duty cycle is reduced to ensure the system to move back to the previousmaximum power[1]. This MPPT algorithm is simple, easy to implement,low cost with high accuracy.

C. Boost converter

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current by creating and destroying a magnetic field. In a boost converter, the output voltage is always higher than the input voltage.

(a) When the switch is closed, current flows through the inductor in clockwise direction and the inductor stores some energy by generating a magnetic field. Polarity of the left side of the inductor is positive.

(b) When the switch is opened, current will be reduced as the impedance is higher. The magnetic field previously created will be destroyed to maintain the current flow towards the load. Thus the polarity will be reversed. As a result two sources will be in series causing a higher voltage to charge the capacitor through the diode D.

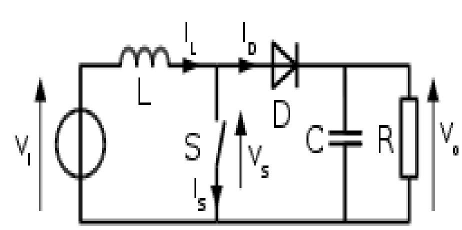


Figure 3. Boost converter schematic

If the switch is cycled fast enough, the inductor will not discharge fully in between charging stages, and the load will always see a voltage greater than that of the input source alone when the switch is opened. Also while the switch is opened, the capacitor in parallel with the load is charged to this combined voltage. When the switch is then closed and the right hand side is shorted out from the left hand side, the capacitor is therefore able to provide the voltage and energy to the load. During this time, the blocking diode prevents the capacitor from discharging through the switch. The switch must of course be opened again fast enough to prevent the capacitor from discharging too much.

D. Wireless power transmission

Wireless power transfer (WPT), wireless power transmission, wireless energy transmission (WET), or electromagnetic power transfer is the transmission of electrical energy without wires as a physical link. In a wireless power transmission system, a transmitter device, driven by electric power from a power source, generates a time-varying electromagnetic field, which transmits power across space to a receiver device, which extracts power from the field and supplies it to an electrical load. The technology of wireless power transmission can eliminate the use of the wires and batteries, thus increasing the mobility, convenience, and safety of an electronic device for all users[8]. Wireless power transfer is useful to power electrical devices where interconnecting wires are inconvenient, hazardous, or are not possible.

Wireless power techniques mainly fall into two categories, near field and far-field. In near field or non-radiative techniques, power is transferred over short distances by magnetic fields using inductive coupling between coils of wire, or by electric fields using capacitive coupling between metal electrodes. Inductive coupling[8] is the most widely used wireless technology; its applications include charging handheld devices like phones and electric toothbrushes, RFID tags, induction cooking, and wirelessly charging or continuous wireless power transfer in implantable medical devices like artificial cardiac pacemakers, or electric vehicles.In far-field or radiative techniques, also called power beaming, power is transferred by beams of electromagnetic radiation, like microwavesor laser beams.

IV. Performance Evaluation

Matlab/Simulink has been chosen to carry out the computer simulation studies .Figure 4 shows the Matlab Simulink of the proposed system.

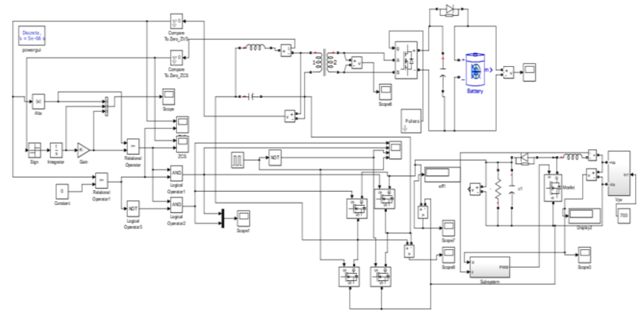


Figure 4. Matlab simulink

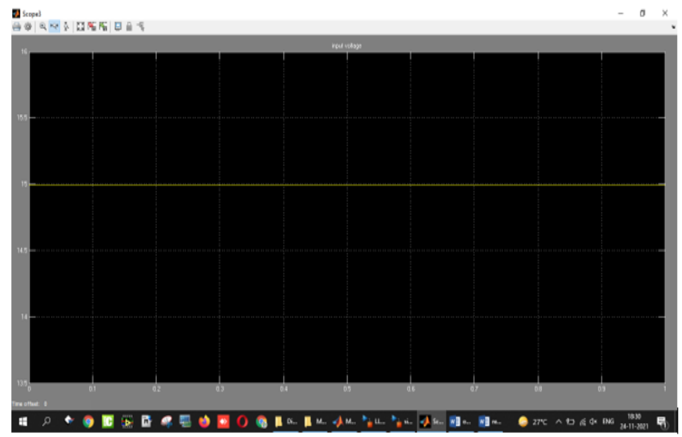
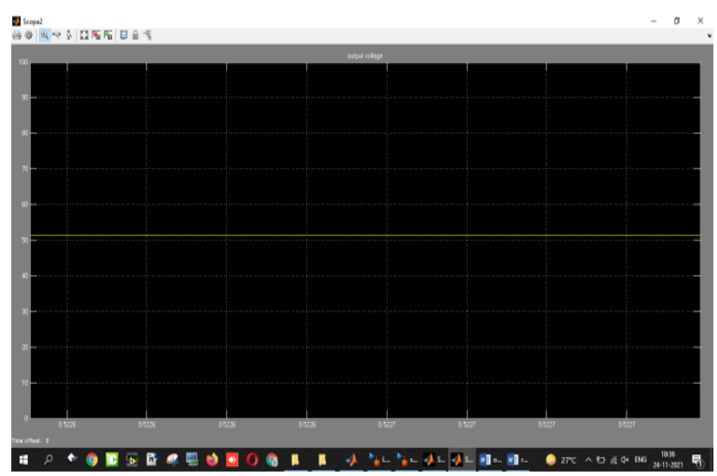


Figure 5. Input DC Voltage to the Boost converter.

Figure 5.shows the input DC voltage which is given to the Boost converter. This input DC voltage is obtained from



the solar panel.

Figure 6. Output voltage of Bridge rectifier.

Figure 6. shows the output voltage of Bridge Rectifier. This DC output voltage is provided to electrical vehicle for charging.

V. Conclusion

This System presented a comprehensive review on EVs in terms of charging technology, various EV impacts and sizing. To provide enhanced understanding about this technology, this study presented different energy transfer modes and techniques in addition to the standards currently being utilized for EV charging worldwide. In this system presents the different approaches and techniques for electric vehicle charging methods. In thus system review the techniques are fast charging station with integration of solar pv system, predictive controllers-based charging station, PV-assisted EV fast charging stations, MPPT Algorithms for Solar PV based Charging Station and boost Converter based EV Charging Station. This system will be useful for future research scholar and students those interested for working in the field of solar pv based fast charging station for electric vehicle design. Therefore, this work will help provide most relevant and significant information about existing studies. It will also provide an opportunity to research further on battery performance optimization and intelligence systems related to the integration of multipower sources, stability, reliability analysis of distribution networks, and location and sizing optimization in consideration of power quality issues.

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