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A REVIEW OF THE DESIGN AND CURRENT IMPLEMENTATION OF A SMART SOLAR AIDED EV CHARGING STATION

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Abstract - The main goal of this project is to provide a solar-powered charging station for urban people living in metropolitan areas. Better EV load estimates are created by taking into account the most popular commercial EV available. The suggested solar-powered charging station would be situated in specific urban areas and is based on the defined EV load models. In this study, a power board and the sun are used to charge an electric car's battery. The EV will use electricity off the power board in the event that the sun isn't accessible (during wintertime or during a storm, for example).
This essay examines the effectiveness of electric vehicles in various electrical components and discusses the drawbacks and advantages of adopting them as a sensible first step toward a sustainable, eco-friendly, and effective system.

Index Terms: EV battery, phase-locked loop detector (PLL) with PID control, buck converters with PI control, MPPT controller, PFC rectifier, and solar panel.

I. Introduction

From small electronics to electric automobiles (EVs), batteries are a common and dependable source of power used in a wide range of products. The first significant electric vehicle (EV) was developed in the middle of the 1800s, which sparked interest in EV batteries. Batteries for electric vehicles are again a competitive choice in the automotive industry. This is due to the possibility that utilizing electric vehicles might reduce petroleum use by 75%. The global market for modern batteries for electric automobiles is predicted to reach $25 billion by 2020, which is several times bigger than the market for consumer electronics lithium-particle batteries at the moment. This information comes from the Boston Consulting Group.

Less objectives for battery quality (HEVs) have been set by the USA's Committee for Automobile Research (USCAR) and the United States Advanced Battery Collaboration (USABC) for the "long-term deployment of cutting-edge battery in EVs and crossover electric cars." When it comes to increasing the size of the EV and HEV sectors overall, the clients' top priorities are the cars' dependability and safety. That being stated, they share equal responsibility for the management system and development of the battery. A battery management program, or BMS for short, aims to improve the performance of the battery while also optimizing the reliability and safety of vehicle operation. The car and the battery are connected via the system.

Considering how rapidly the markets for electric and hybrid automobiles are expanding, it is essential to design a comprehensive and well-developed BMS, similar to the vehicle administration system found in a gas-powered car. The BMS is in the position of supplying Or in EVs and HEVs. The usage, performance, and residual life of the battery should all be indicated by the BMS's signals, in addition to its overall health. Mishandling lithium-particle batteries can result in fire because they are combustible, unpredictable, and susceptible to entropy fluctuations. This is a serious problem because a rupture could lead to a deadly collision, especially in applications where EVs and HEVs are combined. Additionally, since many chemical processes are irreversible, excessive release lowers the cell's limit. In this instance, a BMS is required to monitor the battery's state in order to manage it effectively. About the hardware pertaining to health that is contained within the battery packs The BMS should identify abnormal situations, such as an increase in voltage or temperature, and notify the customer and initiate the pre-programmed treatment method.

To improve power consumption graphs for EVs and HEVs, the BMS should include temperature data in addition to communications with specific components and administrators. BMS indicators should display the battery's security, utilization, execution, and lifespan. A lithium-particle battery's instability, combustibility, and entropy changes allow it to be fooled into lighting. "Especially in EV and HEV applications, because a burst might result in a fatal accident," this is a serious worry. Moreover, over-release lowers the cell limit because of irreversible synthetic processes. Based on the security hardware integrated inside the battery packs, a BMS is required to screen and manage the battery in this way. Any problematic conditions—such as an abnormally high voltage or temperature—that are detected will be addressed by the BMS. Changes must follow the regular operating procedure and the consumer must be fully aware. In addition to these features, the BMS analyses the system temperature and establishes connections with certain administrators and components. It also monitors the system's temperature to provide a more accurate power utilization graph.

II. Literature Survey

[1] Muhammad Syed Amrr et coll. "Load shedding" is a common technique in many developing countries to reduce excessive electricity use. It is standard procedure to save a low-power backup source for the household loads that are most crucial, including the lights and fans. Nevertheless, during load shedding hours, a vital backup power supply for residential applications must always be available. Installed on roofs and connected to the grid, solar photovoltaic (PV) inverters are gaining popularity as a home backup power source. Power can only pass through these inverters in one direction: from the producing side—which includes both the utility grid and the PV source—to the home-load side. Solar energy can only be used in the daytime to meet the need for power supply. The suggested controller will decide on the best course of action in the event of intermittent load shedding over a lengthy period of time. a steady mode of operation that permits the battery pack to be charged simultaneously by the utility grid and solar photovoltaic modules. Power can only pass through these inverters in one direction: from the producing side—which includes both the utility grid and the PV source—to the home-load side. Solar energy can only be used in the daytime to meet the need for power supply.

The general control of the system may be adjusted to suit various real-world situations, such severing the grid, battery, and PV array from the system [2]. The detailed design and control of the proposed system are given. A "laboratory prototype with a power rating of 2.2kW that is linked to the utility grid" is used to examine the viability of the proposed system. It has been concluded that the system performs well under a variety of disruptions, and the recorded outcomes are shown. The general control of the system may be adjusted to suit various real-world situations, such severing the grid, battery, and PV array from the system. The detailed design and control of the proposed system are given. The validity of the proposed system is evaluated on a 2.2kW laboratory prototype connected to the utility grid. It has been concluded that the system performs well under a variety of disruptions, and the recorded outcomes are shown. A variety of real-world occurrences may be accommodated by modifying the system's overall control, including disconnecting the system from the grid, the battery, and the PV array. This document presents the system's comprehensive design and management. A prototype system with a 2.2 kW power rating that is linked to the utility grid is used to test the feasibility of the suggested system in a lab environment. Despite the numerous interruptions that have been made, it has been determined that the system functions satisfactorily, and the recorded results have been presented.

Electric vehicles (EVs) are becoming more and more popular as modes of transportation in a rising number of nations worldwide, according to Saadullah Khan et al. [3]. It has been demonstrated that compared to internal combustion engine vehicles, electric automobiles are both more environmentally friendly and energy efficient. The global dearth of charging facilities, however, is impeding the mainstream use of electric vehicles. As the demand for electric cars increases, more and more public spaces are setting up charging stations. Using the current utility grid, which is powered by fossil fuels, to charge electric cars would have an impact on the distribution system and could not be environmentally friendly. Photovoltaic (PV) panels can generate power from solar energy, therefore using PV panels to charge electric automobiles would be a terrific option and a step in the right direction for the environment. This paper delves deeply into the subject of solar energy. The infrastructure and use of solar electric car charging across the world. There have been presentations of analytical approaches for gathering data on the charging habits of electric vehicles (EVs), the operational procedures of charging stations, and the moves of station users. Academics and learners with an interest in this subject matter will discover that the methods offered are not only very beneficial, but also cost- and time-effective.

According to Mahdi Shafaati Shemami and associates [4], the generation of electrical power in emerging nations and those with poor living standards is insufficient to meet the demand for energy. Load shedding is most common when there are no peak load control methods in place or when such strategies don't work. One of the things that makes a residential micro grid necessary is the requirement for a backup power source that may be located within the home. The frequent incidence of unplanned power outages lasting several hours is another problem. For loads categorized as critical or emergency, a small capacity stand-by inverter power supply is frequently utilized. "During load shedding or blackouts, the batteries in electric cars may be utilized as a backup power supply for most household loads due to their substantial energy storage capacity. The enormous amount of space that the batteries occupy makes this feasible. Another possible application for solar energy is the charging of plug-in electric vehicles (PEVs), which might enhance backup power for household loads and aid in the creation of a home micro grid. This study supports efficient power management and V2H application by implementing a fuzzy logic inference system. This was carried out to enhance earlier efforts. It does this by emphasizing power management and emergency backup power supply more than in developed countries like India, where a typical home's charging and draining of a PEV battery is comparable.

The home energy management system (HEMS) is a helpful tool for assisting residential consumers in navigating the complexity of variable power tariffs, according to Fengji Luo and colleagues [5]. This study proposes novel HEMS in the context of huge household solar penetration rates and real-time electricity pricing. First, user-specified operational limits for home energy resources are received by the HEMS as inputs. To aid in decision-making, an optimal scheduling model for household energy resource (RES) activities is then developed. The base around which this model was built was the expected solar power outputs and energy expenses. Before scheduling the heating, ventilation, and air conditioning system, the user's level of satisfaction with the interior thermal environment is ascertained using an advanced adaptive thermal comfort model. To provide the user the best possible level of thermal comfort, this is done. A statistic called "user disturbance value" was developed to assess the psychological impact of controlled appliances. Disturbances to an appliance's usual operation that the user finds undesirable. The goal of the suggested scheduling strategy is to reduce future energy costs for the user and the frequency of disruptions to their routine. The authors have recently proposed to use a natural aggregation method, a novel met heuristic technique inspired by biological self-aggregation intelligence. The model was solved using this algorithm. A number of extensive simulations are conducted to confirm that the suggested approach works as intended.

In this study, Subham Sahoo and colleagues [6] use plug-in electric vehicles (PEVs) connected to a solar-assisted charging station (CS) to demonstrate a novel handshaking approach to prevent transformer and line overloading. The V2G control mechanism was developed by the National Renewable Energy Laboratory (NREL). When a plug-in electric vehicle (PEV) receives an aggregator instruction, its battery is depleted using a priority index function. Both quick and regular charging are the two primary customer requests that can be used. The procedure is also carried out in an optimal manner to maximize aggregator profit by broadcasting to each CS and arranging their dispatch based on available power feedback from each CS. Because of this, you can be sure that this will be completed. Because PEVs exhibit unpredictable mobility behavior, a (N 1) contingency mechanism is used to ensure that the energy command compliance for handshaking is provided in a reliable manner. For instance, a novel distributed consensus-based power restoration method is put forth here to maintain handshaking in the event that the (N 1) contingency fails for any CS because of the incredibly improbable travel behavior of PEVs. It does this by averaging the power contributions from all other CSs in the fleet. Using a one kilowatt-voltage-ampere field-programmable gate array, experiments were conducted to evaluate the proposed control mechanism under various situations.

According to Jun Cao et al. [7], hybridization combines the benefits of using a range of energy sources to provide heat power, electricity, and energy for transportation. This research proposes the use of fuel cells, combined heat and power units (CHP), hot water storage tanks, gas boilers, and photovoltaic (PV) generators in combination to meet the energy demands of transportation, thermal, and electrical electrification in an environmentally friendly multi-energy micro-grid. In order to boost the capacity of fuel cells, combined heat and power plants, gas boilers, and solar cells, the best energy balancing approach is shown here. With this method, the overall yearly expenses and emissions are reduced based on an hourly profile of electrical and thermal demand. This method might be applied to develop a planning tool for many energy systems.

According to Siddhartha A. Singh et al. [8], solar energy is now the most widely used renewable energy source in residential and light business settings. Energy storage devices can be used to reduce variations in the quantity of solar energy gathered due to atmospheric conditions. Electric cars' reliance on the grid may be lessened if their batteries were charged by solar energy. A restricted number of conversion steps and isolation are two of the many conditions that these converters must fulfill. There is no longer a need for several stages thanks to the Z-source inverter architecture (ZSI), which enables direct current (DC) power to alternating current (AC) power in a single stage. Energy storage devices can also be incorporated into the design thanks to the usage of passive components (ESS). Direct current (DC) charging of electric vehicle (EV) batteries is accomplished by coupling a modified Z-source inverter (MZSI) with a split main isolated battery charger. This article describes the process of designing, building, and using these devices. Simulation and experimental data have been supplied to show that the suggested converter can fulfill its intended function.

Monteiro, Vtor et al. [9]. This work provides the experimental validation of a revolutionary off-board, three-phase quick battery charger concept for electric vehicles (EVs). This charger is designed for use with electric cars. Currently in the planning stages, the EV quick battery charger will share a dc-link and utilize a dual-stage power converter (ac-dc and dc-dc). The dc link and the power grid can interact with each other thanks to the ac-dc connection point. The grid current and the dc-link voltage are controlled by a pair of full-bridge voltage-source converters connected in parallel. The dc-dc stage acts as a connection between the batteries and the connected dc-link. A voltage source converter that can control the current flow through the charging system in both directions at three different degrees of asymmetry is necessary while charging an electric vehicle. The proposed design functions as an interleaved converter to reduce the size of the passive filters and grid current harmonic distortion while keeping the switching frequency the same as in conventional EV fast battery charger topologies. The interleaved converter in the proposed architecture makes this possible. Throughout the entire inquiry, the ac-dc and dc-dc phases as well as digital control algorithms are examined in great detail. A prototype electric car quick battery charger was used in a laboratory setting for the experimental validation. This charger operated in the grid-to-vehicle (G2V) mode and the planned charger-to-grid (C2G) mode, respectively, exchanging reactive and active energy with the power grid.

Mouli, Gautham Ram Chandra et al. [10]. By utilizing photovoltaic (PV) panels for EV charging, a sustainable transportation future may be guaranteed. This study examines the construction of a 10-kW solar array with a three-phase, grid-connected alternating current (AC) electric vehicle (EV) charger. In order to meet the requirements for charging EVs specified by Chemo and CCS/Combo, the goal of this project is to design a three-port power converter that combines EVs, PV systems, and the grid. Because the electric vehicle connection is divided and bidirectional, it may be used for both vehicle-to-grid (V2G) communication and charging. Consistent with the nature of both these energy sources (DC), the converter uses a central DC-link to increase efficiency and allow power transmission between PV and EVs. Structures utilizing silicon carbide devices Electronics and inductors with powdered metal cores provide high switching frequency and power densities. A closed-loop control system may sustain four different power flows: grid EV, PVEV, EV-grid, and PV grid, in that order. This directly translates to the converter's ability to serve as a charger for electric vehicles (EVs) that can run in either direction or as an inverter for photovoltaic (PV) systems, or any combination of the two. For your review, we have included the experimental waveforms and measured efficiency of a 10kW prototype that have been successfully tested and validated. It offers three times greater power densities than conventional systems, along with enhanced efficiency under peak and partial loads.

III. Conclusion

Electric cars are a zero-emissions mode of transportation. Electric vehicles, which are powered by renewable energy and emit no tailpipe emissions, are a type of personal vehicle that can help to mitigate environmental change while also providing a variety of benefits. EV innovation, particularly in the area of batteries, is advancing at a rapid pace, and costs are continuing to decline. We are rapidly approaching a point when the lifetime costs of ices will be more than those of electric cars. Furthermore, the development of a diverse range of electric individual versatile devices, such as electric motorcycles and bikes, has exploded. The vehicle area is concurrently charging and increasing. When feed-in duties are lower than retail power costs, EV charging promotes PV self-utilization, which results in increased PV income. Along these lines, the dual benefits of lower fuel costs and emission make PV-powered EV charging both efficient and environmentally friendly. If sunshine isn't available, electricity can be drawn from a power supply board, resulting in a continuous power source. This essay discusses the benefits and drawbacks as well as how they can be a sensible step towards an efficient, environmentally responsible, and sustainable system.

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