International Journal of Research Publication and Reviews, Vol (5), Issue (3), March (2024), Page -5833-5839

WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review: Hybrid Charging Station

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ABSTRACT :

The imperative shift towards decarbonizing the transportation sector across many nations underscores the significance of embracing e-mobility as a key solution for a greener, cleaner, and more economically viable future. However, this transition is impeded by the absence of a robust EV charging infrastructure. This encompasses various EV charging station (EVCS) types, technologies, methodologies, and equipment. To address this, a charging station tailored for small EVs for on-campus usage, incorporating solar energy input, is proposed. The station operates by harnessing solar power, converting it into electricity, and storing it in a battery bank, ensuring environmental sustainability. This approach is pivotal for the endurance of electric vehicles, emphasizing the importance of charging them from renewable energy sources like solar or wind power. The design integrates battery storage, enabling off-grid functionality. Furthermore, DC charging directly utilizes the photovoltaic panels' DC power for efficient vehicle battery charging without the need for an AC charging adapter. This holistic approach aims to provide a comprehensive solution for sustainable and efficient EV charging infrastructure.

Keywords: Sunlight, Solar Panel, Charging Station, EV charging etc.

INTRODUCTION :

In an attempt to decarbonize the transportation sector, among many countries, is option for e-mobility as an optimal solution, to create a greener, cleaner, and more affordable future for everyone. However, it is missing a crucial prerequisite, which is a strong EV charging infrastructure. The various EVCS types, technologies, techniques, and equipment. It also includes the design of a charging station for small EVs for on campus use, with a solar energy system input. Next, a mechanical 3D design for the final product. As well as a proof-of-concept implementation. Lastly, some conclusions, limitations, and recommendations for further research. Inverters are widely used in the domestic as well as industrial environments to serve as second line of source in case of power cut form the electricity utility grids. However, due to low capacity of the battery the inverter dies out with the use of heavy load appliances. This project is designed in such a way that it overcomes this limitation by the use of solar energy. Hybrid Inverter with Solar Charging System consists of an inverter powered by a Solar / Sunlight. This inverter generates up to 110V AC with the help of driver circuitry and a heavy load transformer. This Energy Generate from two sources, first being the mains power supply itself. If the mains power supply is available, the relay switches to the connection using mains power supply to supply to the load. This power supply also charges from Solar by using its as back up the next time there is power outage. The use of solar panel to charge the gives an additional advantage of surplus power in case the power outage of mains is prolonging. Thus this inverter can last for longer duration’s and provide uninterrupted power supply to the user.

LITERATURE REVIEW :

Brief History: Contrary to common belief, electric cars were invented before gasoline combustion ones, as early as the 1830s by Robert Davidson. However, they were not very practical since, at the time, batteries could not be recharged yet. In 1859, rechargeable batteries came along, which made the idea of EVs more viable. Over the following couple of years, EVs were starting to make appearances across the United States from different manufacturers. Moreover, in New York, electric taxis were becoming more and more common. In the early years of the 20^{Th} century, EVs were at an all-time high, with advancements in the electric field and wider accessto electricity, it became increasingly easier to charge EVs which made them very popular. However, around the same years, advancements in gasoline-powered vehicles were also beingmade, adding to their advantages and attraction compared to their counterparts.

Comparative Study: Different Types of Charging Stations

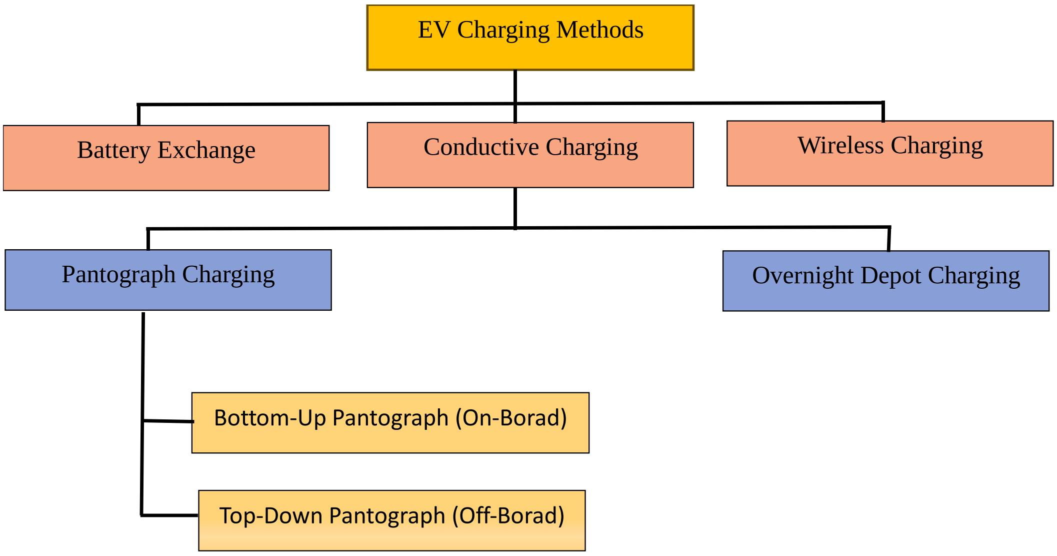
We can distinguish between 3 levels of charging stations:

Level 1 charging (120-Volt): A standard 120-volt household outlet is used for Level 1 charging.By putting the charging equipment into a conventional wall outlet, any electric vehicle or plug-in hybrid can be charged on Level 1. The slowest way to charge an electric vehicle is witha Level 1. It increases range by 3 to 5 miles per hour. Plug-in hybrid electric vehicles (PHEVs)benefit from Level 1 charging because their batteries are smaller, often less than 25 kWh. Because EV batteries are significantly larger, Level 1 charging is too slow for most everyday charges, unless the car isn't driven very far on a daily basis.

Level 2 Charging (208-Volt to 240-Volt): The most common charging level for everyday EV charging is Level 2. Level 2 charging stations can be installed at home, at work, and in public places such as shopping malls, railway stations, and other sites. Depending on the power outputof the Level 2 charger and the vehicle's maximum charge rate, Level 2 charging can replace between 12 and 80 miles of range per hour. The majority of BEV owners opt for Level 2 charging equipment since it charges the vehicle up to ten times faster than Level 1 charging. Even if you plugged in with a virtually empty battery, charging from a Level 2 source frequentlyresults in the vehicle being fully charged overnight.

Level 3 charging (400-Volt to 900-Volt DC Fast Charge & Supercharging): Level 3 charging is the fastest available and can recharge an electric vehicle at a rate of 3 to 20 miles per minute.Level 3 charging, unlike Level 1 and Level 2, uses direct current (DC) instead of alternating current (AC). Level 3 chargers have a far higher voltage than Level 1 and 2 chargers, which iswhy you won't find them in most homes. Level 3 charging requires a high-voltage source, whichis only available in a few residential locations. Furthermore, DC Fast Chargers are quite expensive, costing tens of thousands of dollars . EV charging techniques can also be classified into three main categories: Battery exchange, wireless charging, and conductive charging. Conductive charging, itself, is divided into two sub-categories: pantograph and overnight charging.

EV CHARGING METHODS:



The description of each charging method, and the differences between the three types can be elaborated as follows:
Battery Exchange: Battery Exchange, or battery swapping technique (BSS) relies on the BSS owner receiving monthly rent for the battery. The BSS's charging is very slow which aids in lengthening its battery life. Locally generated Renewable Energy Sources (RESs) such as solarand wind are easier to connect with the BSS system. One of the key benefits of this procedure is that the drivers do not have to exit the car and can swiftly replace the drained battery. Furthermore, the station's battery can participate in the V2G (vehicle-to-grid) project.

However, because the BSS owner owns the EV batteries, this type of EV charging strategy canbe more expensive than fueling the ICE engine due to significant monthly rental rates levied bythe BSS owner. This method necessitates several expensive batteries as well as a large storagearea, which may necessitate expensive real estate in a high-traffic region. Furthermore, the station may have a specific battery model, while the vehicles may have different battery requirements .

Wireless Power Transfer: Two coils are used in this technology, which is based on electromagnetic induction. The primary coil is installed on the road, while the secondary coil isinstalled inside the vehicle. WPT technology has recently gained popularity in EV applicationsdue to its ability to allow EVs to recharge securely and conveniently. It also doesn't require a standard connector (but does require standard coupling technology) and may charge while driving. However, inductive power transfer is often weak, and for efficient power transmission, the air space between the transmitter and receiver coils should be in the range of 20 to 100 cm. Furthermore, if the transmitter coil is not turned off, eddy current loss is a problem with the WPT. Communication latency may happen since the transfer of information between the transmitter and the EV is conducted in real-time .

Conductive Charging: Conductive charging necessitates an electrical connection between the car and the charging inlet and offers several charging options, such as level 1, level 2, and level3 charging, as well as high charging efficiency due to the direct connection. For a public charging station, two power charging levels (Levels 2 and 3) are used. The distribution systemis less affected by the first two levels (Levels 1 and 2).

Conductive charging reduces grid loss, maintains voltage, minimizes grid power overloading, provides active power support, and can regulate reactive power using the vehicle's battery. Level 3 has a variety of effects on the distribution system, including voltage variation, system reliability, and transfer/power loss. It impacts the transformer life as well as increasing peak demand. A complex infrastructure, limited access to the power grid, and a standard connector/charging level are also required. The V2G technology necessitates a high level of connectivity between the grid and the vehicle. In addition, the V2G operation shortens the battery's lifespan due to frequent charging and discharging.

BLOCK DIAGRAM AND METHODOLOGY :

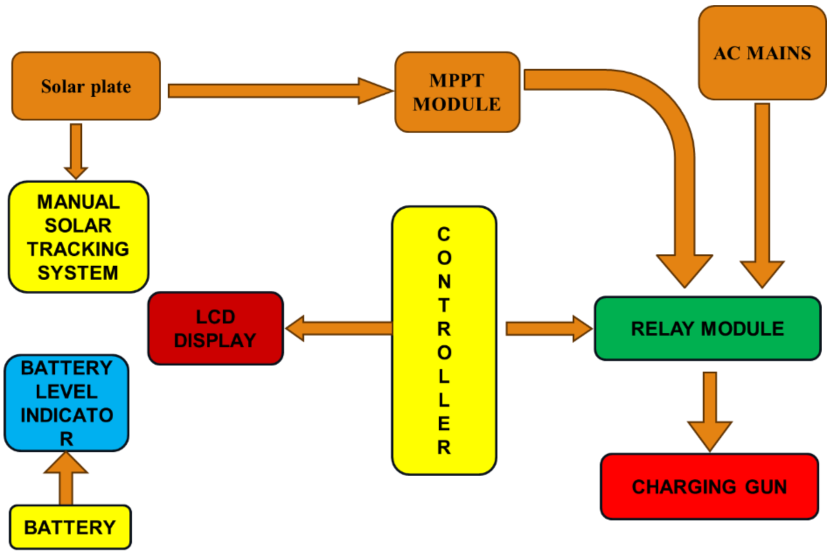


Figure 2: Block diagram and methodology

WORKING PRINCIPLE :

Here in this project, we are going to make Ev charging station. Which powered by solar power. Solar power is arranged in such a way that it will collect maximum power. We make manual arrangement of solar plate adjustment in both axis. Power From solar plate coming at input of MPPT module. Here the power is boosted as per required voltage. The input come over here is feed to controller compare it with rated voltage and switches relay either side as per coding. When solar input is below rated voltage, it will shift automatically towards AC mains solar provision.
At the charging end we put battery level indicator to show battery status. Also, in future we work for how much power consumed in charging and its tariff visually.

COMPONENTS REQUIRED :

ATMEGA328p-pu controller , Solar plate, MMPT Module, IC, Relay, Relay Driver IC, Voltage Regulator IC, IC Socket, LCD display, Crystal Oscillator, Resistors, Capacitors, Transistors, Cables & Connectors, Diodes, PCB, LED's , MS square pipe, MS round pipe, Other.

1) Solar Panel

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that produce excited electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules.

2) MPPT 90volt

1500W DC-DC 12-48V to 24-72V Boost Step-Up Converter For Car Laptop Solar Battery is a non-isolated DC power converter module. With high power and stable output, it converts 10-60VDC to 12-97V DC. High-quality components ensure high conversion efficiency, up to 97%. Designed with a smart temperature control fan, which will automatically work when the temperature reaches about 60%, and stop when the temperature drops below 60%. Widely used for high power solar street lamp driving, various LED lighting CV driving, vehicle-mounted and mobile device power supply, DIY adjustable CV CC power supply, solar power charging, and various battery charging.

3) ATMEGA328p-pu controller

This is original version of **ATmega328P-PU IC** which also known as ATmega328P-U. So you may receive IC with printed name ATmega328P-U. The ATMEGA328P- U is a low-power CMOS 8-bit micro-controller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P-PU achieves through puts approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers

4) Mechanical relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

5) Crystal Oscilator

A crystal oscillator is an electric oscillator type circuit that uses a piezoelectric resonator, a crystal, as its frequency-determining element. Crystal is the common term used in electronics for the frequency-determining component, a wafer of quartz crystal or ceramic with electrodes connected to it.

6) E-Bike charger

To charge this battery, an adapter is therefore needed to convert the alternating current (AC) from a standard 240V socket into direct current (DC) to charge the battery – typically 42V. The rate at which the battery is charged depends on the charging current (Amps) and the power draw of the charger (Watts).

ADVANTAGES, DISADVANTAGES AND APPLICATIONS :

Advantages

1. Use Of free Energy.
2. Getting power source with no cost.
3. Simple Installation.
4. Low Maintenance service.
5. Easily repairable.
6. Used for different bikes

Disadvantages

1. During rainy season solar panel does not operate at full efficiency.

Applications

1. School/College campus
2. Marriage halls
3. Garden parking
4. Playing ground parking
5. Hospital parking
6. Food court parking

CONCLUSIONS :

The main aim behind this capstone project was to design a charging station for small EVs for on-campus use.This report includes on the state-of-the-art review of electric vehicles and EV charging. It also focuses on the system design and theoretical calculations. Namely, for the Solar energy input and the requirements of our chosen EV, the analysis and design of a DC-DC converter with isolation and a DC-AC Inverter. Furthermore, on the control aspect, it includes both a PWM Control and an Access control using Arduino and RFID. It also contains a 3D design of our final product and a small) scale implementation to concretely apply the design and theory.

FUTURE SCOPE :

It is undeniable that there is still work to be done and further research to be made. The largest challenge or limitation that we faced during this project was the unavailability of some important equipment. In the future, this project can be developed further at a larger scale with the availability of all necessary parts. That being said, this capstone project was an amazing and fun experience overall, it allowed me to put to practice a large array of concepts that I have learnt throughout my degree, as well as to discover some new ones and apply them.

ACKNOWLEDGEMENT :

The acknowledgment section for a solar charging station project typically includes recognition of those who contributed to the project's success, such as financial supporters, technical advisors, and research participants. This section may also express gratitude to institutions that provided resources or facilities for the project. Research papers often include this section to give credit to individuals, organizations, or agencies. It is an important part of scholarly writing, highlighting the collaborative nature of scientific work.

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