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SMART EV CHARGING STATION WITH ON-GRID GREEN POWER

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***Abstract*— Instead of using fossil fuels like petrol or diesel, electric vehicles use electrical energy to charge their batteries. Electric vehicles are more efficient, and cost-wise electrical vehicle charging is cheaper than filing petrol for travel requirements. Charging stations, unlike petrol bunks, are not available everywhere. There always exists a fear as to what might happen if the vehicle's battery drains. Well, here this paper describes an EV charging station that solves these problems with uniquely innovative solutions that is a Smart EV charging station with on-grid green power. This system demonstrates how electric vehicles are charged in a charging station with on-grid green power.**

***Index Terms*—Electric Vehicle; Solar panel; Solar Charge Controller; Batteries; Boost Converter.**

1. INTRODUCTION

Electrical vehicles are used for transportation. There are so many varieties of the electrical station. Electrical vehicle does not need any fossil fuels like petrol or diesel, they consume only electrical energy through batteries. For charging electric vehicles there are many ways of charging like wireless charging and charging station like petrol bunks. An electrical vehicle takes one to three hours for charging. Fig.1. show the design of the charging station.

Fig.1. Design of Solar Charging Station

2. ELECTRICAL VEHICLE CHARGING STATION

The electrical charging station is used to charge an electric vehicle. This station supplies power for charging plug-in EVs. Electrical charging stations are divided into two types one is AC charging stations and another one is DC charging stations. Fig.2. shows the electric vehicle charging in a station

Fig.2. EV Charging Station

3. SOLAR CHARGING STATION: STRUCTURES AND TYPES

Solar charging stations can come in various power capacities, sizes, and shapes. The common shapes of solar charging stations are:

- Tree and pole structure
- carport-roof structures

Other renewable sources station sources are available in the following four types:

- **Residential charging stations**:
  These are charging stations set up at home for the private use of an owner. These types of charging will take a longer time to fully charge and will be suitable for overnight charging. Residential charging does not require metering. These have different sizes and forms.

- **Charged-in parking stations** are operating at vehicle parks, for example near parking stations, shopping malls near residential areas, railway stations, shopping malls, railway stations, and in some petrol bunks. The charging may be fast or slow. A fee for this is charged by the operator. Electric vehicles can be charged while the owners are away shopping or somewhere else.

- **Fast charging** at powers greater than 40kW normally charging can be done in half an hour. This type of charging is mostly suitable for locations where quick stops and goes for example, on highways. Here normally three-phase high voltage will be used.

3.1.TYPES OF CHARGING STATION

1) On-grid solar charging station

This type of charging is the easiest way to charge an electric vehicle. It generates power using a solar power system and is then connected to the utility power grid. This system transfers an extra amount of power generated by solar power systems to the grid and when they need power from the grid they can also use it from the grid. For sending extra power they will be compensated also.

2) Off-grid solar charging station

This system is also known as an Electric vehicle autonomous charger. This system does not require any external grid support or other external support. The station itself produces a sufficient amount of energy for charging the electric vehicle. This system is easy to install.

3. LITERATURE SURVEY

Road transport is undoubtedly the most common and affordable form of commute for people around the world. However, recently, it has faced much criticism due to its dependence on fossil fuels and its relatively low operational inefficiency [1]. This has opened the doors for the electric mobility industry, and the world has witnessed a drastic surge in the acceptability of EVs.

As India aims to decrease its carbon footprint like other nations and step into the world of sustainability, the government is consistently introducing transport sector reforms that aim at the electrification of all effective forms of commute. As a result, according to a study conducted between 2020–2027, the average annual growth rate for the EV sector in India is estimated to be around 44% [2].

Articles published by various research scholars and authorities mainly focus on the importance of shifting towards EVs, the technical aspects of charging stations, and the government’s policies to develop the necessary infrastructure for EVs [3,4,5]. Topics such as the need for India to move away from its crude oil imports, fight climate change to reduce its carbon footprints, and reduce pollution have been discussed in detail, and conclusions regarding India moving into the EV space following its global peers have been made [6]. Moreover, new energy storage and transfer technologies that can be used to implement the charging infrastructure have been studied according to the requirements [7,8,9].

It is essential to differentiate between what ‘looks sustainable’ and what ‘is sustainable’ to implement sustainability. EVs are a formidable example of decreasing instantaneous emissions, but they shift the energy demand from crude oil to electricity. This ultimately increases the pressure on the grid infrastructure that is already facing an energy deficit [3]. In India, nearly 61% of the grid electricity is from coal-based thermal power plants, 15% is from hydropower, 8% is from solar PV, 5% is from wind energy, 9% is from natural gas, and 2% is from nuclear energy [10]. Upon considering three categories of vehicles, EVs running on electricity from the grid, internal combustion engine-based vehicles (ICEVs), and EVs running on electricity from solar photovoltaics (PV), and calculating their well-to-wheel CO_2 emissions, EVs running on electricity from solar PV turned out to be the least polluting. Such an EV would lead to only 0.6 kg of CO_2 emission per 100 km traveled. In contrast, a 5-seater gasoline-based ICEV would produce about 13 kg of CO_2 in covering the same distance, and an EV running on grid electricity would cause 10 kg of CO_2 emissions per 100 km traveled (considering a similar share of the different sources, as listed above). The unavailability of charging stations at regular intervals is another matter of concern, and nearly all of the available ones are grid-tied. Hence, grid availability becomes a crucial point when deciding the location of a charging station.

India is a sun-drenched country, which makes it ideal for the utilization of solar energy for electricity production. When most of our energy requirements revolve around electricity, solar PV has proven to be an excellent solution for localized electricity generation, even for large-scale applications. Although renewables such as solar are climate dependent and the Indian climate varies with geography, the flexibility of solar PV as stand-alone systems with battery backup makes them quintessential for remote cities. Moreover, integrating solar PV with charging stations can help us achieve power autonomy, generate electricity more responsibly, and spare the land and marine ecosystem from the mining of coal and crude oil [11].

Utilizing solar energy for charging electric vehicles is an evolving idea and has taken the ground over the past few years [12]. However, EVs have been in the market since the 1990s and the literature related to charging station designs indicates the concern for grid availability while designing and siting charging stations [5,7,13,14]. Over the past ten years, researchers have tried to include solar energy in charging stations to ensure energy autonomy and reduced emissions. Countries like the Netherlands, Macau, and Romania are opting for solar energy to charge their EVs [15,16,17]. This has led to the development of smart and efficient hybrid PV systems for charging stations that can predict the load requirement and the energy generation [7,18,19]. However, most of them are for charging two-wheelers, which have a smaller battery bank than four-wheeler EVs [7,18,19,20,21]. Moreover, these plans and designs are suited to urban commercial buildings [7,12].

In the context of the previous literature reported it is evident that there is a considerable gap in designing the aspects of a solar-powered EV charging station. A feasibility analysis has been done on the Indian market for EVs, and it proves the viability of a renewable-based charging station for the country [22]. This paper aims to fulfill those gaps and thus specifically focus on the following objectives:

- To design and develop an EV charging station with a Renewable source which is Solar Energy, the energy consumption for the station is directly from the sunlight and the excess amount of energy will be given to the grid.
- To be able to achieve a significant level of energy security in terms of power generation.

5. EXISTING SYSTEM

All the Electric vehicle charging system in India comes with a port installed at home/workplace or from a charging station. The time taken for a complete charge depends on the drive train capacity. An EV charger pulls an electrical current from either a 240-volt outlet or the grid it's hardwired to and delivers that electricity to the vehicle. In Fig.3.shows the allocation of the charging station under FAME-I & FAME-II by DHI.

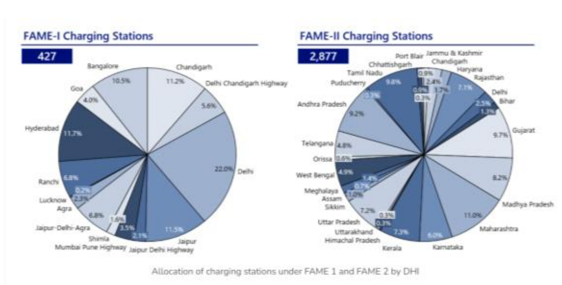

Fig.3. Allocation of charging station under FAME-1 & FAME-II by DHI

6. PROPOSED SYSTEM

This project focuses on several EVs that can be charged at a time, pollution-free, have lower maintenance costs than gas-powered vehicles, have 80% reduced operating cost than equivalent gas-powered vehicles, is electrically safe and charging is convenient. It directly consumes the energy from sunlight, apart from the electricity board. Excess amount of energy will be given to the grid. It is economically beneficial to the people and the government**.**

7. SYSTEM DESCRIPTION

A. Inverter circuit

The inverter circuit is used to convert direct current to alternating current. Inverter is internally made up of a battery, a switch, a transformer, an amplifier, and a MOSFET. The switches play an essential role, where they are continuously turned ON and OFF. The transformer, a MOSFET, also consistently turns ON and OFF the DC voltage, making an opposite voltage, an AC voltage. Fig.3. shows the circuit diagram of the inverter circuit.

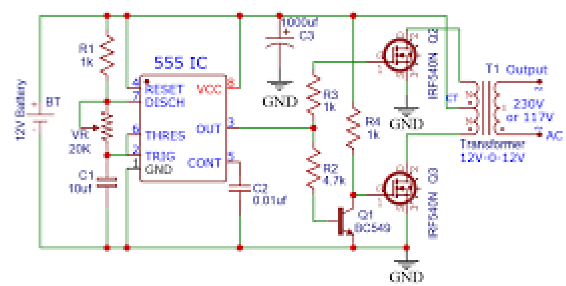

Fig .3. Inverter circuit

B. Converter circuit

A **boost converter** (also known as a **step-up converter**) is one of the simplest types of switch-mode converter. As the name suggests, the converter takes an input voltage and boosts it. In other words, it's like a step-up transformer i.e. it steps up the level of ***DC voltage*** (while the transformer steps up / down the level of AC voltage) from low to high while decreasing the current from high to low while the supplied power is the same. All it has is an inductor, a semiconductor switch, a diode, and a capacitor. The boost converter is very simple and requires very few components, this is because they were originally designed and developed in the 1960s to power electronics on aircraft. The biggest advantage of a boost converter is it offers very high efficiency. Some of the **boost converters** can go up to 99% efficiency. That means of the input voltage only 1% of the power is wasted. Fig.4. shows the circuit diagram of a 12 to the 24-volt boost converter.

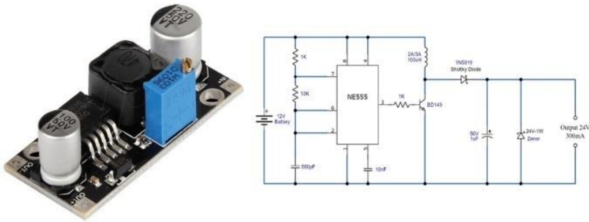

Fig.4. 12-24V Boost converter

C. Solar panel

A solar panel is a group of photovoltaic cells (PV cells) placed in a framework for installation. Solar panels are renewable energy in the form of sunlight converts into electricity and then stores electricity in specified loads. Fig.5. shows the picture of 12 volts, 10 watts solar panel.

Fig.5. Solar panel

D. Solar controller

A PWM controller is also ideal for these types of devices as it's a low-cost option and can only handle small loads as it is. On the other hand, large devices, like grid solar panel systems, requires an MPPT controller. These technologically advanced and expensive controllers are much more suitable for large loads. A solar system is incomplete without a solar charge controller if wants to ensure maximum protection for appliances. Solar panels can suffer from heating issues over time. However, a Luminous range of solar charge controllers can ensure that does not happen. Fig.6. shows the picture of the solar charge controller and Fig.7. shows the system connection of the solar charge controller.

Fig.6. Solar charge controller

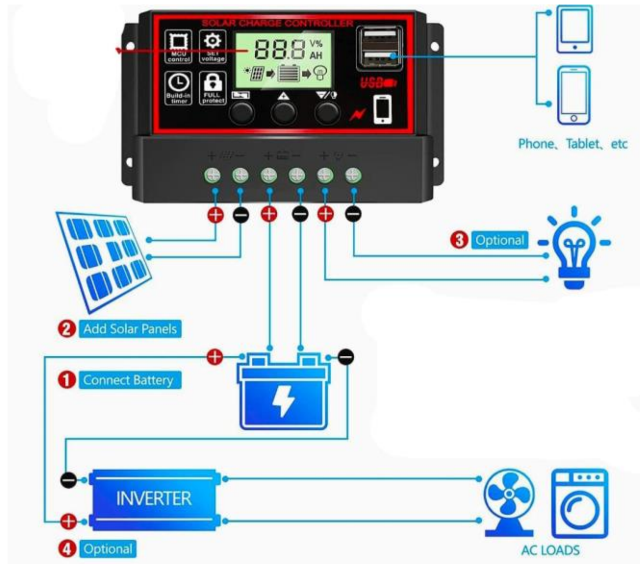

Fig.7. System connection diagram

E. Battery unit

The 12-volt battery is distinct and different in its use, as it comes in different shapes and sizes. In some instances, they might be large and heavy or small and light. They may be cylindrical or square batteries. Furthermore, they are also used for transportation purposes in vehicles, boats, and other gadgets. 12-volt battery sizes are often influenced by their uses and the amount of amp-hour they are built to produce. Therefore, a 12 V battery implies that a voltage of 12 V is supplied within the nominal load by a battery.Fig.8. shows the picture of the 12v battery.

Fig.8. 12 V Battery

F.Transformer

Step-up transformer:

The output voltage is greater than the input voltage.

Step down transformer:

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The output voltage is lesser than the input voltage. Well, here 12v transformer is used for this process. In Fig.9.shows the 12 v transformer pictures.

Fig.9.12 V transformer

8. BLOCK DIAGRAM

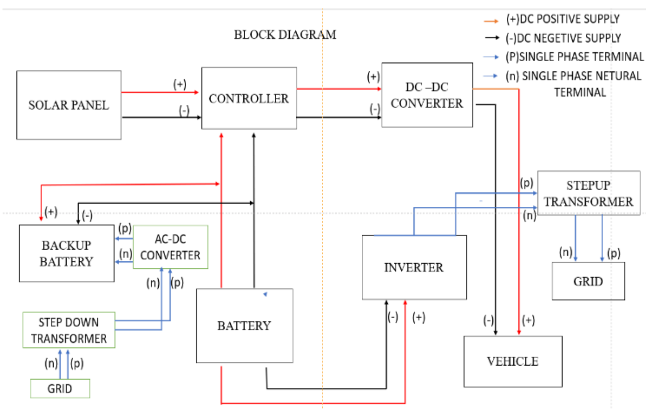

Fig.10. Block diagram of the charging station

In Fig.9. the Block diagram explains that solar energy is directly getting from the sun that is captured by the solar panel then the solar panel is connected to two modules, one with a controller and another with a battery. This MPPT controller is used to monitor and control the process. The supply is fed to the DC-DC converter. This converter efficiently converts direct current from one voltage to another voltage. DC is then fed to the electric vehicle for charging. The intimation will be given after the vehicle gets charged. When the vehicle is not in the charging station, the power generated by the solar panel gets stored in the primary battery. When the primary battery exceeds the storage limit the backup battery will be in the charging position. When the storage limit is exceeded the backup battery too. The power present in the primary battery flows to the inverter (which converts direct current into alternating current). With the help of a step-up transformer, the converted Alternative current gets boosted and that power is fed to the grid. Solar power generation is significantly less during the winter than it is during the summer. So power generation by solar panels generally produces about 40-60% less energy during the month of December and January than they do during the month of July and August. So during these months, the power for the charging station will be obtained from the Grid.

9. RESULT

By connecting all the required components with perfect connections then we can get the required output. When the boost converter is connected across the battery then it converts the battery output voltage i.e. DC to DC. That boosted voltage is used for DC charging. So below picture is the result of testing an AC bulb by connecting its terminals to converter terminals to the bulb.Fig.11. shows the final output of the DC charging and AC charging.

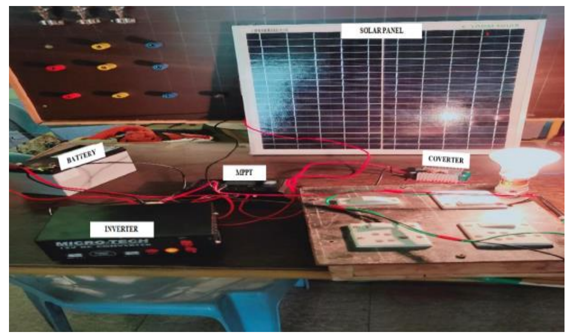

Fig.11. Final output

10. CONCLUSION

This paper is to make customers more comfortable while using the charging station. Though it's a budget-friendly plan the major goal is to implement this project in remote areas. The seasonal change is not going to be a big issue and that is overcome by this charging station. From the future perspective, the Integration of Smart solar flowers in the charging station is applicable. The space occupied by the solar panel in the charging station can be replaced by this smart solar flower. This is applicable even on agricultural land There is no need for maintenance in the charging station. Separate stores can be set up to get the battery so the customer can purchase the battery whenever they need it.

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