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A Study on Electric Vehicles Charging System Utilizing with Solar Energy

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Abstract:
Electric vehicles (EVs) are a viable solution for lowering greenhouse gas emissions. EVs not only reduce fossil fuel reliance, But they minimize ozone depleting compounds and facilitate large-scale renewable deployment. Despite extensive study on the qualities and properties of electric cars, as well as the nature of their charging infrastructure, electric vehicle manufacturing and network modeling continue to change and be restricted. This article addresses the numerous modeling approaches and optimization strategies used in studies of Electric Vehicle, Hybrid Electric Vehicle, Plug-in-Hybrid Electric Vehicle, and Battery Electric Vehicle penetration rates in the market. The study is unique in that it addresses crucial hurdles and insufficient charging facilities for a growing country like India. When renewable energy sources are unavailable, the development of the innovative Vehicle-to-Grid concept has provided an additional power source.

KEYWORDS- Electric vehicles, hybrid electric vehicles, types, charging methods, optimization

1. INTRODUCTION

India is one of the top ten automotive markets in the world today and having highly increasing middle-class population with buying potential and the steady economic growth. But petrol price has increased more than 50% in 13 different steps in the last two years. Here comes the potential need for alternative technologies in automobiles such as electric vehicles (EVs) in India.

An electric vehicle (EV) is one that uses an electric propulsion system rather than an internal combustion engine (ICE). The vehicle's entire power comes from an electric motor, which also serves as the vehicle's primary drive source. The key benefit is the great efficiency of power conversion via the electric motor propulsion system. There has been a lot of research and development activity reported recently, both in academia and in industry. With the commercialization of electric vehicles, several governments have offered customers with incentives such as lower taxes or tax refunds, free parking, and low-cost/free charging stations. A hybrid electric vehicle (HEV), on the other hand, is a viable option. In recent years, it has received a lot of attention.

Major car manufacturers across the globe have at least one model that uses hybrid technology or is completely converted to electric.

Globally electric vehicles (EVs) are a novel concept in the transportation sector. In 2030, EVs are projected to make up 24% of the U.S. light vehicle fleet, compared to 64% of light vehicle sales in 2018. In this context, the battery charging process of EVs must be managed in order to maintain the power quality of the power grids. With the spread of Evs, however, a substantial quantity of energy

will be stored in the batteries, hence increasing the likelihood of energy transfer in the other direction. Interaction with electric vehicles will be one of the important technologies in future smart grids, contributing to the autonomous functioning of the power grid. The notion of an on-board bidirectional charger utilizing V2G and V2H technologies is presented. Due to lower carbon dioxide emissions and increasing fossil fuel prices, the electric vehicle has become more competitive than the conventional internal combustion engine vehicle. However, the EV was not generally embraced on the market due to restrictions such as expensive car costs; Limited charging infrastructure and limited all-electric driving range. EVs are cars that are partially or completely electric-powered. Electric vehicles offer minimal operating expenses since there are fewer moving parts that need to be maintained, and they are also very environmentally friendly because they consume little or no fossil fuel.

2. ELECTRIC VEHICLE

A vehicle that propels itself using one or more electric motors or traction motors is referred to as an electric vehicle (EV). Electric vehicles can be self-contained using a battery, solar panels, fuel cells, or an electric generator to convert gasoline to electricity, or they can be fueled by electricity from sources outside the vehicle through a collector system. Electric vehicles (EVs) include, but are not limited to, surface and underwater craft, electric Aero plan's, and electric spaceships. EVs initially appeared in the middle of the 19th century, when electricity was one of the preferred forms of motor vehicle propulsion. At the time, gasoline-powered cars were unable to match the comfort and ease of operation that electric vehicles offered. While modern internal combustion engines have dominated motor vehicle propulsion for almost a century, electric power has remained prevalent in other vehicle types, such as railways and smaller vehicles of various kinds.

An electric motor replaces the internal combustion engine in all-electric vehicles, also known as battery electric vehicles (BEVs). The electric motor of the vehicle is powered by a sizable traction battery pack, which must be plugged into a wall outlet or charging apparatus, also known as electric vehicle supply apparatus (EVSE). The car does not have a tailpipe or any typical liquid fuel components like a fuel tank, fuel line, or fuel pump because it is an electric vehicle. Find out more about electric cars.

Electric vehicle (EVSE) are experiencing rapid growth because of five key global trends.

1. Fossil fuel depletion.
2. Growing public awareness.
3. Advances in technology.
4. The development of electric motors and electronic control systems.
5. Advances in EV supporting technologies

3 Types of electric vehicles

3.1 Battery Electric Vehicle (BEV)

BEVs are also referred to as all-electric cars (AEV). Electric drivetrains powered solely by batteries are used in BEV-based electric vehicles. The large battery pack that houses the electricity needed to power the car can be charged by plugging it into the power grid. One or more electric motors are then powered by the fully charged battery pack to drive the electric vehicle. It is fully electrically powered. When compared to hybrid and plug-in hybrid vehicles, these are more efficient.

Main Components of BEV:

Electric motor, Inverter, Battery, Control Module, Drive train

3.2 Hybrid Electric Vehicle:

HEVs are also referred to as parallel or series hybrids. HEVs have an electric motor in addition to an engine. Fuel powers the engine, while batteries provide electricity for the motor. Both the engine and the electric motor turn the transmission at the same time. Wheels are then propelled by this. Both the internal combustion (typically gasoline) engine and the battery-powered motor power train are utilised by the vehicle. When the battery is dead, the petrol engine is used to both propel and charge the vehicle. Compared to fully electric or plug-in hybrid vehicles, these cars are less efficient.

Main Components of HEV:

Engine, Electric motor, Battery pack with controller & inverter, Fuel tank, Control module

3.3 Plug-in Hybrid Electric Vehicle (PHEV)

Uses a battery that is charged by an external socket and an internal combustion engine (they have a plug). This implies that electricity, rather than the vehicle's engine, can be used to recharge the battery. While less efficient than BEVs, PHEVs are more efficient than HEVs. The term "series hybrid" also applies to PHEVs. Both an engine and a motor are present. You have a choice of two types of fuels: conventional fuel (like gasoline) and alternative fuel (such as bio-diesel). A battery pack that can be recharged can also power it. The battery can receive external charging.

Main Components of PHEV:

Electric motor, Engine, Inverter, Battery, Fuel tank, Control module, Battery Charger (if onboard model)

3.4 Fuel Cell Electric Vehicle (FCEV)

Another name for FCEVs is zero-emission vehicles. To create the electricity needed to power the vehicle, they use "fuel cell technology." The fuel's chemical energy is directly converted into electric energy. Chemical energy is converted into electric energy. Consider an FCEV powered by hydrogen.

Main Components of FCEV:

Electric motor, Fuel-cell stack, Hydrogen storage tank, battery with converter and controller

4. EV Charging Methods

Battery exchange, wireless charging, and conductive charging are the three main charging techniques. The conductive charging is further divided into pantograph (Bottom-up and Top-down) and overnight charging, as shown in Figure 1.

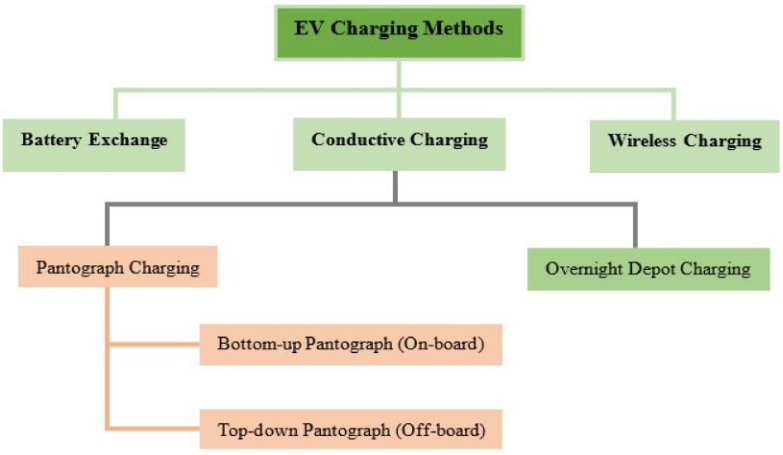

Fig 1. EV charging methods

Battery Swap Station (BSS)

The battery swapping technique is also known as "Battery Exchange," and it is based on the BSS owner receiving monthly rent for the battery. The BSS's slow charging mechanism helps to extend battery life. Locally produced Renewable Energy Sources (RESs) such as solar and wind are easier to connect into 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

Wireless Power Transfer (WPT)

Two coils are used in this technique, which is based on electromagnetic induction. The primary coil is installed on the road, while the secondary coil is installed inside the car. WPT technology has recently gained popularity in EV applications due to its abilityto allow EVs to recharge securely and easily

Conductive Charging (CC)

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

Conductive charging lowers grid loss, maintains voltage level, prevents grid power overloading, offers active power assistance, and can provide reactive power adjustment by using the vehicle's battery. Level 3 has a variety of effects on the distribution system, including voltage variation, system dependability, and transfer/power loss.

Overnight Depot Charging

The overnight depot charging mechanism may be set up to charge slowly or quickly. It's commonly found at the end of the lines and is utilized for charging at night. Slow charging is thus the most advantageous choice because to its little impact on the distribution system. The Pantograph charging approach, on the other hand, is appropriate for applications that demand a large battery capacity and rapid charging.

Pantograph Charging

This type of charging is one of the opportunities for charging options. This kind of charging infrastructure is used for higher battery capacity and power requirement applications, such as buses and trucks. Pantograph charging is further divided into the following two categories

5. SOLAR ENERGY

Solar energy, the sun's rays that can ignite chemical reactions, produces heat, or creates electricity. The total solar energy incident on Earth far exceeds both the present and future energy needs of the planet. This highly diffused source might potentially provide all of the energy required in the future if properly harnessed. Due to its limitless supply and lack of environmental impact compared to the finite fossil fuels coal, petroleum, and natural gas, solar energy is predicted to gain popularity as a renewable energy source in the twenty-first century.

Although the Sun is a very potent energy source and sunlight is by far the most abundant energy that Earth receives, the intensity of sunlight at the planet's surface is actually rather low. The massive radial radiation radiating from the far-off Sun is mostly to blame for this. Earth's atmosphere and clouds cause up to 54% of the incoming sunlight to be absorbed or scattered, which results in a relatively small additional loss. Nearly half of the sunlight that reaches the earth is composed of visible light, while the other half is made up of infrared radiation, with smaller amounts of ultraviolet and other electromagnetic radiation.

Since the Earth receives solar energy every day in the amount of nearly 200,000 times the world's daily electric generating capacity, the potential for solar energy is huge. Even though solar energy is free in itself, the high expense of gathering, converting, and storing it prevents widespread use of it. Although the former is simpler to achieve, solar radiation can be transformed into electrical energy as well as thermal energy (heat).

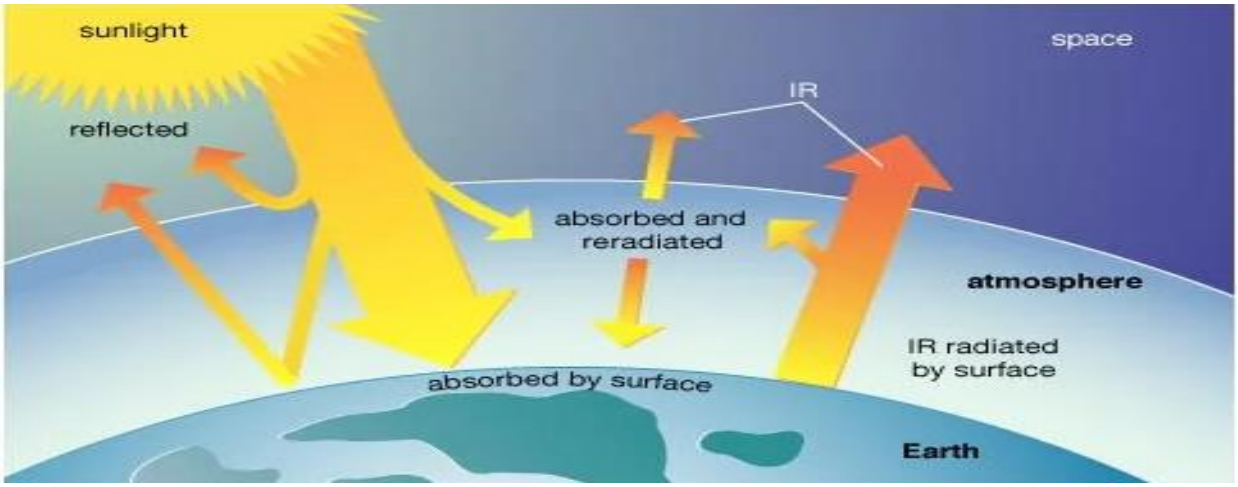

Figure 2: Solar Energy

Advantages of Solar Energy	Disadvantages of Solar Energy
Renewable Energy Source	Cost
Reduces Electricity Bills	Weather Dependent
Diverse Applications	Solar Energy Storage is Expensive
Low Maintenance Costs	Uses a Lot of Space
Technology Development	Associated with Pollution

Table 1: Advantages and Disadvantages of Solar Energy

5.1 SOLAR POWERED ELECTRIC VEHICLE CHARGING STATION

5.1.1 Meaning

One of the most effective ways to lessen India's reliance on fossil fuels for the powering of various modes of transportation is through solar charging stations for electric vehicles. This is because electric vehicles typically use electricity generated from fossil fuels, which is a major cause for concern It is essential to implement solar charging for electric cars and bikes as the popularity of electric vehicles rises. There are currently two types of solar charging stations for electric vehicles, depending on the configuration

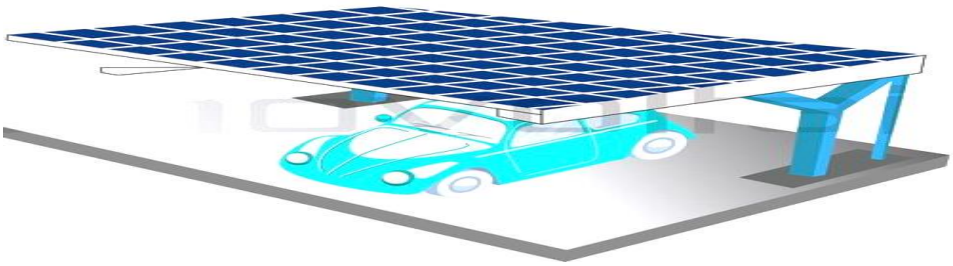

Figure 3: Solar Energy Charging for Electric Vehicles

We can investigate the viability of developing a PV-based infrastructure for electric vehicle charging. The technology is made to be used at workplaces to charge employees' electric vehicles while they are left parked during the day. The goal is to use PV energy as much as possible for EV charging while utilizing the grid as little as possible. Such an EV-PV charger's benefits include:

- Because EV charging uses locally produced, environmentally friendly power from solar panels, there is a decreased need for energy from the grid.
- EV batteries also serve as energy storage for PV, which lessens the detrimental effects of integrating large amounts of PV into the distribution network.
- An extension of Vehicle-to-Grid (V2G) technology, in which an EV serves as a controllable spinning reserve for the smart grid, is made possible by the long parking times of EVs.

5.1.2 Types of Solar Based Electric Vehicle Charging Station

The key to significantly lowering our reliance on fossil fuels is the integration of solar energy and EV charging. There are many different ways to get electricity, so it's essential that electric vehicles run on renewable energy sources. A solar charging station will likely be installed at every home that has a solar energy system in the coming years as electric cars become increasingly popular. For this to happen, we will need to think about refuelling our cars differently and for our energy infrastructure to naturally evolve

Off-grid Solar Based Electric Vehicle Charging Station

The charging station is not connected to nearby utilities in this configuration. As a result, it is also known as an autonomous EV charger. Here, the battery storage system is fueled by the solar panel array. Additionally, this battery storage system meets the charger's entire power requirement. This kind of charging station can be installed almost anywhere because it doesn't require a connection to the grid. Additionally, they are simple to install because the majority of them have a sturdy steel foundation.

"Electric Vehicle Autonomous Renewable Charger" is another name for an off-grid auto charger. No local utility connection is necessary. The entire system's power requirements are met by this energy storage system, which is powered by the solar panel array. Since there is no requirement for a connection to the electrical grid, off-grid electrical car chargers can be installed almost anywhere. A sturdy foundation is necessary because the independent solar array canopy attracts a lot of wind. Some off-grid solar energy chargers have a large, ballast-serving base plate made of steel. Since there is no foundation or digging involved, installation of those is incredibly simple and quick.

On-grid Solar Powered Charging Stations for Electric Vehicles

Because the energy produced by the solar array is stored in the grid rather than in batteries, the cost of an on-grid solar EV charger is unquestionably lower than that of the off-grid version. You receive credits

from the utility provider when you feed the grid, which you can use to charge your electric vehicle. Your excess energy is sold to the utility company.

The simplest way to power your electric car with solar energy is with a grid-tied solar energy system. Whether or not your home requires the power at the time, a grid-tied solar energy system will feed the energy into the grid. Therefore, the electricity generated at home is sold to the utility company when your solar energy system is feeding the grid and you are at work. That power will be returned to you by the utility company in the form of a credit. You can use that credit to recharge your car at home after leaving work and leaving it parked there**.**

5.1.3 Components Needed for a Solar EV Charging Station

- an EV charger
- a strong base for a standalone solar charger
- Software that is sufficiently intelligent for billing and other tasks
- battery-based energy storage (exclusively for solar energy charging stations that are off grid)
- Solar panel array installed on the ground or roof for capturing solar

6. LITERATURE REVIEW

Ram Vara Prasad, Bugatha et. al (2022) This study outlines the concept of a solar-powered charging station for electric vehicles that eliminates the major drawbacks of fuel and air pollution. Globally, electric vehicles are currently on the road, and their number is gradually increasing. In addition to their positive effects on the environment, electric vehicles have been shown to reduce travel expenses by substituting petrol with energy, which is significantly less expensive. Consequently, we create an electric vehicle (EV) charging system that offers a novel and revolutionary solution. This method of recharging electric automobiles wirelessly, there is no need to stop for recharging, as the car charges while in motion. Solar energy is used to power the charging system; thus, no other power source is required. The system is constructed using a solar panel, battery, transformer, regulator circuitry, copper coils, an AC-to-DC converter, an at mega controller, and an LCD display. The device displays how electric vehicles may be charged while in motion, eliminating the need for charging stops. Consequently, the technology exhibits an integrated solar-powered wireless charging solution for electric automobiles.

Dighe, Amol & Rakesh et. al. (2022) the charging infrastructure for electric vehicles (EV) could be the most crucial aspect in ensuring a smooth transition to e-mobility. This study focuses on five developments that have the potential to play an alphabetical role in this regard: shrewd charging, vehicle-to-matrix (V2G), charging of electric vehicles using solar panels (PV), and. Contactless and on-street charging alternatives are available for EVs. Smart charging of EVs is anticipated to allow a large number of EVs to enter the market, supply environmentally friendly electricity, reduce the cost of charging, and provide more. The application of a lattice design; Bidirectional EV antennas will pave the way for the V2G era, in which EVs will be able to exchange energy and request future activities. Sun-oriented EV charging will have an effect on reasonable mobility and the use of EV batteries. Alternatively, the work area is constrained. Contactless and inductive charging of electric vehicles on the road will eliminate any strains and range tension; Concerns and preparations for updated application. This research examines the electromagnetic and energy engine strategy for contactless power move structures in future streets.

Kumar, Rajan & Bharj et. al (2021) As part of their strategy to combat climate change and rising urban pollution, a developing nation such as India is rapidly adopting technologies connected to electric vehicles (EVs) and phasing out fossil fuel-powered vehicles. The Government of India (GoI) intended in April 2017 to have all EVs on the market by 2030. Also pursued is the promotion under the faster adoption and production of electric vehicles (FAME) scheme. The infrastructure for electric charging is a crucial component of the electric mobility ecosystem. It is crucial for EV charging station markets to match the acceptance and expansion of EVs. Electric vehicles are limited in range and speed. The availability of charging stations and their network on the road is essential for facilitating the transition from fossil fuel vehicles to electric vehicles. Consequently, the accessibility of a plug points for charging remains an ongoing challenge for the majority of EV producers and users. Certainly, it is necessary to transition from grid-based charging stations to autonomous off-grid options for charging. Utilizing abundant renewable energy sources like solar energy is the key to resolving this issue. This chapter provides a comprehensive assessment of the infrastructure, technique, and implementation of EV charging systems and solar-based EV charging systems in India. Various obstacles and social obstacles to the adoption of electric vehicles are also explored.

7. CONCLUSION

In general their decreased consumption of petroleum and increased productivity offers economic benefit to buyers, society, automakers and policymakers over the lifetime. This paper provides a detailed overview of the literature, overview, and guidelines for HEV, PHEV and BEV penetration rate studies into the Indian Market. The recent initiatives and various subsidies by the Indian Government will help push the e-mobility drive in India

It will be concluded that the three sub-converters will be coupled on a 750V central DC-link as part of the converter's modular design: an interleaved boost converter for solar energy, a three-phase inverter for the AC grid and an interleaved fly back converter for electric vehicles. This will demonstrate how the use of Sic devices in a QR mode fly back converter can achieve excellent efficiency even at high powers, despite though the fly back will be typically thought to be only suited for low powers.

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