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A REVIEW ON RENEWABLE ENERGY BASED ELECTRIC VEHICLE CHARGING

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ABSTRACT:

Electrified transportation will contribute to lower greenhouse gas emissionsand higher gasoline prices. The main driver for moving to electric vehicles is because they have no tailpipe emissions and more efficient than combustion engine vehicles. however, if the electric vehicles are only sustainable, if the electricity are used to charge them comes from renewable sources of energy and not from fossil fuels. To encourage adoption of electrified transportation, a variety of charging networks must be established in a user-friendly environment. As the demand for electric vehicles grows, so does the need for a dependable charging infrastructure to accommodate the rapid public adoption of this mode of transportation. The purpose of this work is to provide an overview of electric vehicle charging by using sustainable energy.

INTRODUCTION:

Transportation is one of the significant emission sectors, contributing to 22% of total CO2 emissions. Now a days peoples using conventional vehicles (Internal Combustion Engines) which are run by fossil fuels, these fossil fuels are one of the main threats to earth's environment as they contribute to many CO2 emissions, which can be considered as one of the major causes of climate change and the world is falling pressure on fossil fuels, so most countries are moving towards sustainable, reliable, efficient, economic and green energy resources.

Global emission problems can be reduced by using renewable energy based electric vehicles. So, the rapid adoption of electric vehicles (EVs) has resulted in a massive rise in global demand for electric energy. Electric vehicle technologies is one of the prominent technology that has rapid growth and one of the best replacement for fossil fuels as they are depleting the environment. On the other hand, EVs do not directly emit CO2 or less susceptible to the high oil price.

EV are a key element in the development of a sustainableurban transport system and charging would be a huge solution because solar energy from photovoltaic (PV) panels and wind sources have so much potential to provide electricity. The charging facility's electricity output can be either inferior (less than the needed power) or very high (above the power consumption) depending on the available energy sources (solar radiation and wind speed). The advancement of RCI technology has increased the social and economic benefits in both the transportation and energy sector.

NEED OF RENEWABLE ENERGY-BASED EV CHARGING

The percentage of natural resources has been reduced due to usage in transportation, industrial, power generation. According to academics, humanity will face a major problem in the year 2100. Renewable energy sources such as wind, water, and solar are becoming more popular around the world. The transportation system, on the other hand, has seen significant modifications, such as the introduction of electric vehicles.

Wind and solar energies are considered to be reliable substitution sources ofconventionalenergy sources because of their economic and environmental benefits. Use of renewable energy is promoting in reductions of greenhouse gases, most of sustainable, performance, energy efficient, safer, recovery of some energy via regenerative braking and Electric Vehicles has an efficiency of 80-95%, making them more appealing choice than CVs, which have an efficiency less than 20%.

Electric cars are entirely charged by the electricity provided by wind and photo voltaic, meaning you don’t need to buy any gas ever again. It does not emit toxic gases or smoke in the environment as it runs on a clean energy source and they are even better than hybrid cars as hybrids running on gas produce emissions and desired to combat climate change and electric cars run on electrically powered engines, hence there is no need to lubricate the engines and they have less maintenance costs and use substantially less energy than conventional vehicles.

ISSUES AND SOLUTIONS

The major issues to be considered in renewable energy-based electric vehiclecharging includes:

- Power quality

- Stability
- Power balance
- Charging prices
- Charging time
- Locations

There are some solutions that can be provided to overcome these issues possible through following ways. According to changing nature of wind and solar generating power is intermittent to control the large amplitude fluctuations with pulse width modulation.

Ensure that the implementation is profitable, the relevant planning businesses must take long-term energy prices into account by deploying DCFC, such as Free Wires Boost Charger recycling of batteries, recovery of critical materials, testing battery standards and consider smart charging.

For wind farms, it was noticed that urban areas are not suitable for installing the turbines as the wind energy-based system. The large buildings are the major obstacles in wind directions, so it requires optimal planning of location and optimal scheduling of charging.

LITERATURE SURVEY:

S. No	Title of the Paper	Description
1.	Renewable energy-based charging infrastructure for electric vehicles	In this paper,the integration of renewable energy and EVs draws the future mode of transportation and the more penetrationof EVs and RCIs more reduction of carbon emissions and fossil fuel consumption.
2.	Developments in electric vehicle charging station infrastructure and present scenario of India	EV charging will be very helpful in maintaining the energy balance of the power system and effective utilization of available renewable energy.

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3.	Design and analysis of a solar-powered electric vehicle charging station forIndian cities	This paper presents out of all the array sizes selected,the 8.1 kW solar PV system with two days of battery autonomy (129.6 kWh battery capacity) has the fewest unused energy losses.
4.	Electric Vehicle Technologies, Charging Methods,Standards and Optimization Techniques	This paper provided a review of the EV technologies,including EV charging methods such as BSS, WPT, and CC, EV charging standards, and optimization techniques for the design of optimal EV charging strategies.
5.	Using renewable energy sources for electric vehicles charging	The policies to use and encourage renewable energy in order to establish the technically and financially feasibility of the system, stations have the possibility of connection to the national/grid network.
6.	Wind-Energy-Powered Electric Vehicle Charging Stations: Resource Availability Data Analysis	The benefits of this approach can be seen from the reduced dependency on electricity grids, battery storage systems, and energy conversion power electronics.

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EV CHARGING FROM SOLAR ENERGY:

INFRASTRUCTURE

Energy Storage and Fast Charging Systems

Unregulated charging, it was reported, would contribute to the overloading allocation of transformers and feeders, and, eventually, the power supply. As a result, the majority of the literature has suggested stationary energy storage and fast charging systems to overcome this difficult problem. By serving electric vehicles during the system's maximum load intervals, energy storage reduces charging infrastructure and operating costs.Energy storage can also improve the stability of electric vehicles by supplying the necessary and sufficient energy to reach charging stations in the event of an emergency.

Storage Battery and Controller

Solar-powered batteries can fulfil unreliable grid electricity demands, which arestrong charge, discharge, and intermittent full-charging periods. A range of battery typesfulfils these specific criteria. The major battery storage subgroups reviewed for solarenergy include a lead-acid battery, lithium-ion battery, and flow battery.To save the additionalenergy produced by photovoltaics, a central controller is requiredto redirect the generated power to the battery.

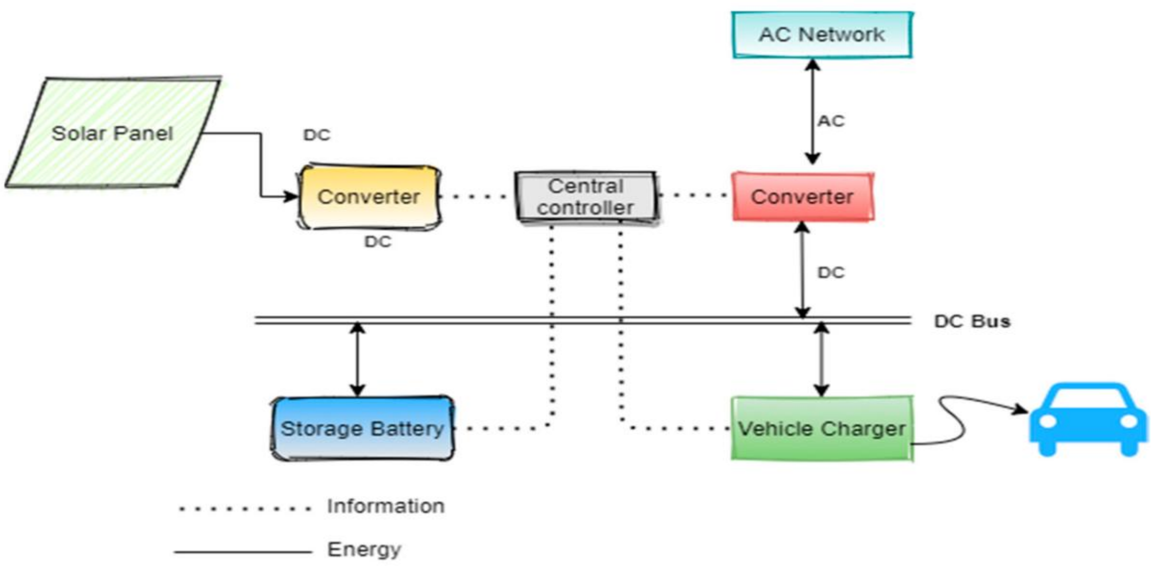

Figure 1 EV charging infrastructure with a solar PV charger

Converters

When it comes to a solar converter, the PV arrays are connected to a DC/DCconverterthat allows for full power point tracking control. The AC/DC converter is in charge of convertingDC/AC power in a bidirectional fashion. The power used from the grid isprimarilyAC. It must be converted into DC to charge the electric vehicles. The conversion of poweroccurs before the charging begins or relays the power from the grid to electricity networks.Therefore, the converters have unique roles in photovoltaic systems based on balancedenergy conversion.

OPERATION OF SOLAR POWERED EV CHARGER

First solar panels have the benefit that they can be installed on the rooftop of buildings besides just being installed as solar farms therefore solar power can be generated close to where the electric vehicles will be charged thus reducing the transmission losses.Second, rooftop of Solar PV systems are typically rated in the same order of KW which is similar to the power rating of an EV charger. Finally solar generation is maximum in the daytime and in summer. Then solar generation is ideally suited for charging cars at the working places during the day.

The simplest way to realise a solar powered EV charging station is to use solar PV Inverter, inside the inverter a DC-DC power converter operates the solar panels at the maximum power point then a DC-AC inverter converts the DC to 50 Hz / 60 Hz AC power for ac charging of EV. And a more efficient way to charge EVs from photovoltaics is to use an isolated DC-DC converter and directly charge the electric vehicles from the photovoltaics using dc charging.

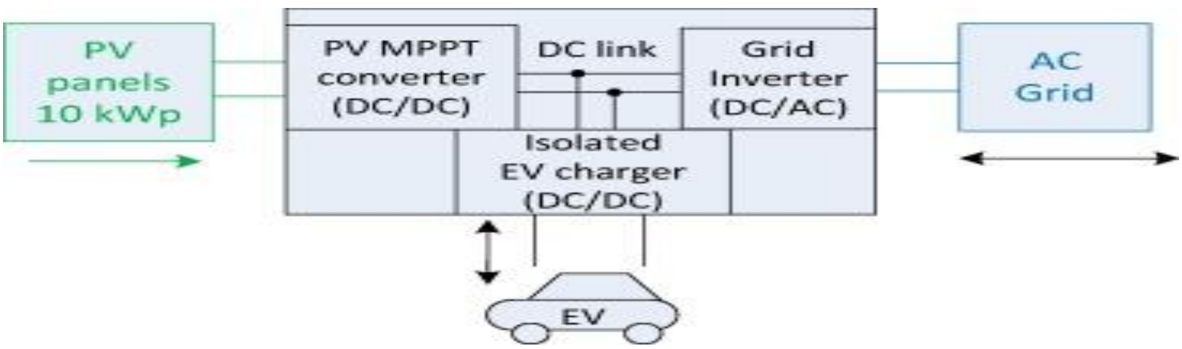

Figure 210 kW Solar Powered EV Charger

A 10 KW solar powered dc charger (6) has been developed it has three power converters inside, a DC-DC converters for solar panels, a DC-DC isolated converter for the electric car and a DC-AC inverter to connect the ac grid. Using this design firstly direct dc charging of the EV from the photovoltaics can be realised, secondly if there is no electric car then the system acts like a solar inverter and directly feeds the PV power back to grid, third if there is no solar power the system operates as conventional dc charger and charges the EV from grid. Finally, the charger is bidirectional i.e., the EV can not only charge from the grid but it can also send the power to the grid as well.

EV CHARGING FROM WIND ENERGY:

INFRASTRUCTURE AND POWER CONVERSION

Wind power is typically generated today using on shore and off shore wind farms that are located far away from where the electric vehicles are charged, this means that the power must be transported long distance between supply and the electric vehicle load. Wind turbine is typically rated in the order of MW while EV charger in the order of KW, this shows a big difference in the power scales that means potential of wind turbine to charge several hundred vehicles. Finally, wind generation is maximum in winter and in the night time hence wind generation is ideally suited for charging electric cars at the homes in the night.

From a power conversion perspective, generators used in wind turbines typically produce variable frequency ac power which is given to two back-to-back AC-DC converter and DC-AC power inverter are used to convert the variable frequency ac power to high voltage or medium voltage 50 Hz or 60 Hz ac power used for long power transmission and this power is stepped down to low voltage ac power and then EV can be charged using either ac or dc charging.

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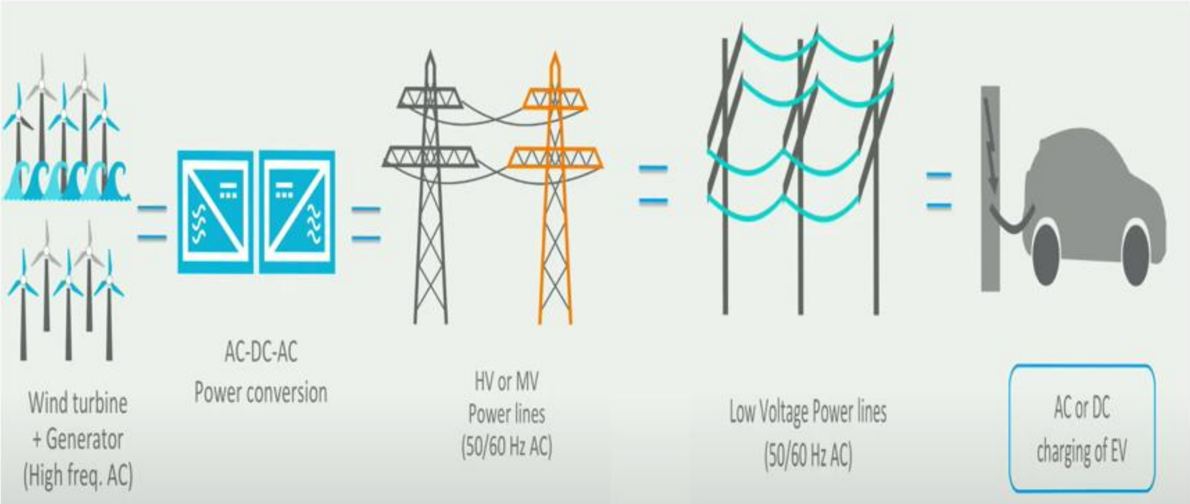

Figure 3Infrastructure of wind energy-based charging EV system

SITING, PLANNING AND ENERGYMANAGEMENTSYSTEM:

SITING

Home Charging

Home charging involves private and public charging points in residential areas. Few survey studies have found that the EV's drivers consider home charging as a motivationalfactor for buying EV where it is easy to access. The implementation of more homecharging (HC) infrastructure could increase EVs' adoption rate, especially in cities.Deploying more solar-based charginginfrastructure in residential areas could, therefore, lower reliance on the grid, encourageEV adoption rate, and extend the use of clean energy sources. As a result, that could lowergreenhouse gas emissions and air pollution.

Workplace Charging

Companies are starting to implement an electric infrastructure for their employees or workplace charging (WC), to demonstrate their commitment to the green environmentconcept. Because of the extended parking period, the workplace is considered as thesecond location for employees with a higher opportunity to charge EVs outside homes,where 15–25% of charging events occur at the workplace. Few companies providerenewable energy charging in the workplace, offering to charge at a shallow or sometimesfree rate (e.g., Google and DirectTV).

PublicCharging

The public charging infrastructure (PCI) consists of charging stations that EV drivers can easily access when necessary. They are better suited to the implementation of renewable energy facilities than residential areas. The deployment of renewable energy facilities in residential areas faces several challenges, including parking availability, building constraints (e.g., insufficient space for solar panels), and governance issues (e.g., wind farms are, as a rule, sparse out of cities). The public charging stations include the following:

Opportunity charging stations (OCSs) present EV drivers' opportunity to rechargeduring the parking time at public locations. They are locations like shopping malls, airports,supermarkets, schools, parks, and restaurants. Drivers are expected to park for at least 30minutes. The network charging agreement can include OCS to establish a favourable cost model, where EVs drivers can pay a fixed amount monthly as a subscription, pay-as-you-go plans, or for free.

Fast Charging Stations

Fast charging stations (FCSs) can solve the charging time issue, which is critical in the adoption and deployment of EVs. Fast charging works by quickly charging EVs in the same way that conventional vehicles are charged at gas stations. By having FCS along the way, fast-charging plays a critical role in increasing the travelling distance of EVs. The off-board fast charging module is essential for fast-charging stations with outputs of 35 kW or greater. The respective current and voltage ratings are 20–200 A and 45–450 V. Because they are both so high, such infrastructure must be installed in supervised stations.

Battery Exchange Station

A battery exchange station (BES) is a system that EV drivers can replace their dischargedbattery with a fully charged battery at BES. The implementation of BES can provide

several benefits, such as its very fast exchanging time. For example, Tesla, a well-knownelectric vehicle maker, swap EV batteries in 90 s.

OPTIMAL PLANNING

Planning a charging station is a difficult task. It takes into account the availability of renewable sources, traffic demand uncertainties and the complex nature of location design. Thus, there is a need to link long-term planning decisions (e.g., location, size, and operation hours) with short-term operation decisions (e.g., grid power usage, the number of batteries charged/discharged, energy storage, V2G, and renewables) in a charging station to form a planning framework.

Furthermore, energy system planning models in built-environment applications should have data standardisation, interpretability, scalability, flexibility and reconfigurability. These characteristics can form the basis for future modelling research in order to develop and deploy models in IoT-based systems as digital twins of real-time processes. Rather than being designed for individual and separate applications, digital twins will be developed in a hierarchical and interconnected manner.

S. No	Modelling Technique	Source	Station Type
1.	Stochastic Programming	Grid, Solar	Charging Station
2.	Mixed-Integer Linear Programming	Grid, Wind, Vehicle to Grid (V2G)	Charging Station
3.	Two Stage Stochastic MILP	Grid, Solar	Battery Exchange Station & Charging Station
4.	Two Stage Stochastic MILP	Grid, Wind, V2G	Charging Station
5.	Stochastic Optimization	Grid, Wind	Charging Station
6.	Probabilistic Model	Grid, Wind, Solar	Charging Station
7.	Two Stage Stochastic MILP	Grid, Solar	Battery Exchange Station
8.	MILP	Grid, Wind	Charging Station

Table 4 Charging station planning

OPTIMAL SIZING

In recent years, the transportation sector has witnessed a rapid growth of electric vehicles (EVs). The aim is to achieve sustainability of system therefore the EVs demand increases, thus introducing additional load to power systems. There is need to upgrade and increase the capacities of the electricity distribution systems to contain the overloading challenge and integrate renewable energy sources into the charging station. So, the Hybrid Optimization Model for Electric Renewables (HOMER) software was employed for sizing the renewable energy source and for power sharing to the loads.

With one 200 kW capacity WT unit and PV panels (1), a total power of 250 kW, a total energy generation of 843,150 kWh was realised and charging station has the capacity 5 EVs in 1 hour. A 200-kW wind generator and a 10-kW charge and discharge machine were used to power both EVs and the overall system's energy balance. The MATLAB simulation results provided theoptimal size of charging stations for the number of EVs based on the optimal load factor,power loss, and voltage profile. Similarly, a hybrid improved optimization algorithm basedon Genetic Algorithm-Particle Swarm Optimization (GA-PSO) was used for theoptimal sizing of renewable energy sources (RES) and EVs' charging demand.

CONTROL AND ENERGY MANAGEMENT

The promising approach for balancing the generation of electricity fromrenewable energy sources can be achieved using configurable dispatch loads or energystorage systems, as it can provide electricity in low power generation. The energystorage system's utilization to stabilize the power grid is no longer a new technology.

Other energy sources, such as concentrated solar energy, flywheel, dedicated battery, andhydro-pumped storage systems, are some of the technologies that have been utilized.

The goal of energy management is to monitor and optimize electricity usage to lower costs and reduce emissions without disrupting operations.While some aspects of energy management can be performed manually, it is most effective when aided by behind-the-meter on-site technologies such as sensors, software and other monitoring tools.Concerning energy management for EVs associated with renewable energy sources by the method of maximum power point tracking technique and Smart charging by pulse width modulation (e.g., Free Wires Boost Charger which enablesa site host to manage energy costs while not impacting the drivers charging experience).

CONCLUSION:

The integration of renewable energy and EVs draws the future mode of transportation.The greater the adoption of EVs and RCIs, the lower the carbon emissions and consumption of fossil fuels. However, there are some obstacles to the deployment of renewable energy-based infrastructures due to their natural fluctuations.For wind turbines, thelocation and environmental factors are critical issues for installation. Urban areas havebeen found to be unsuitable because of their noise and requirement for spacious premises.For solar systems, the focus of electricity production is only on the daytime; As a result, its supply is limited in meeting the high typical electricity demand. As the concept of V2G, siting, and optimal planning are raised to overcome these obstacles.

Wind and solar energy are considered to be good sources for EV charging infrastructure.However, their integration with EVs, V2G charging facilities, and ESS can form RCIwith a microgrid plan for network charging.RCI planning is challenging becauseof the availability of renewable sources, uncertainties in traffic demands, the complexnature of location design, and other factors affecting the hourly power management such asrenewable source, grid peak hours and V2G. In renewables charging infrastructure that use real-time data to improve control strategies, sizing, energy management and real-time control like energy storage controller and finally,charging pricing approaches show that there are only a few utility programmes that support renewable charging, and they are only for residential customers. New chargingprogrammes for heavy-duty vehicles and retail customers at public charging loads must be implemented.

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