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Critical Review and Analysis of Solar Powered Electric Vehicle Charging Station

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Abstract- Electric vehicles (EV) are the future medium of transportation system due to the heightening of conventional fuel costs of petrol or diesel-based vehicles. Hence the energy demand will be higher when EVs are brought into the public transportation system. In this review paper, the solar-powered charging station for an electric vehicle is evaluated by tilting the solar panel at a different angle, then the maximum efficiency and power that can be obtained from the solar light depending on the wavelength of the sunlight are analyzed. Photovoltaic (PV) panels can be able to charge electric vehicles (EVs) sustainably. Then using the solar potential in office buildings for EV charging at work, as well as taking the long parking time at work, open the route for the deployment of vehicle-to-grid (V2G) technology. Various types of system architectures for an EV-PV charger are researched and compared in this paper. A comparison of power converters that integrate the EV and PV for V2G operation is done and based mainly on the system architecture, converter topology, isolation, and bidirectional power capability. The fundamental terminologies of charging stations, such as charging station types and levels, are reviewed in this paper. To tackle these issues, a variety of technologies are reviewed, as well as a brief overview of lithium-ion type battery for charging methodologies and the Battery Management energy System (BMS). The advantages of the EV over fuel vehicles have been outlined and the impact of the coil design and coil detection system for EV is also discussed here. Prospects and challenges involved in recent technologies for efficient systems in wireless charging systems are also emphasized in this article.

Keywords Electric vehicle (EV), Electric vehicle charging, wireless power transmission, Battery, Solar panels, Battery Energy Storage System, converters, Coil design.

1. Introduction

Solar energy and electric vehicle charging combine and reduce the usage of fossil fuel dependence. The electric vehicle charging station will form a crucial role in the improvement of EVs in the market. The lack of charging facility infrastructure is a major argument not for purchasing an electric vehicle (EV). By enhancing solar energy, the most dependable of using the charging station is to be reduced and the charging facilities can be made at home, offices, hospitals, parking, etc. The facility that improves the energy to reload the electric vehicles is called the E-vehicle refilling charging station or Electric vehicle charging station, electric vehicle energy supplier (EVSE). The hybrid buses or electric buses, electric cars are charged by the plug-in charging method. Using solar energy, the best way is to obtain the maximum amount of energy intensity from the solar panel and the angle of rotation can be changed accordingly in feedback to the force of light that will shatter the solar panel. In this way, we can capture more amount of energy received from the solar panel and on the different ways of angles of the slope present [1]. The tilt angle of the solar panel can be found by the sunlight present. Meanwhile, the tracking of several energy produced by the solar panel and then, the number of loads utilized by the electric vehicle charging station. By using different projection angles, we can get the maximum intensity from the solar panel, the intensity generated by the PV solar panel is higher than that if the PV solar panel is based rigidly. An electric car or an electric vehicle can be charged where the vehicle can be set in a particular circle is strained on every electric vehicle for charging. If we want to monitor the charging of the electric vehicle means we can use the technique called the internet of things. Then the different types of charging channels are going to the usual partition area and to produce the people realm can be freely attainable. Normal cars having gasoline engines can draw the fuel consumption at a gas station only, similarly then electric vehicles are charged in the vehicles stations.

Likewise, if the current extended outlook provokes the nonrenewable sources, to gratify for more E-Vehicle requirements, furthermore intensity used to be equipped, and thus transfer the issue from one part of the hue cycle to one another is the graphite footstep moves the energy/power generating sector from the transportation sector. Accordingly, another intensity cause's wish to outlook oppressed stable with creative requirement feedback and scheduling system [2]. However, the wind or solar intensity (recurrent energy sources) needs to be exactly concluded. An additional threat in load setup is the urge-side anxiety. Especially, for a charging station, it is tough to find the intensity claim of forthcoming time slots for the mobility of EVs present. Therefore, organizing the given load in a charging station will abort to allow optimal operation and beyond seeing future requirements.

The widespread use of Internal Combustion Engine (ICE)- depend on cars in the transportation system results in the discharge of toxic pollutants into the environment, contributing to climate change and global warming, which are major concerns for the international community. As a result, alternative options such as electric vehicles powered by renewable energy sources are needed to minimize reliance on fossil fuel-based energy sources and their adverse effects on the environment. [3] – [5].

Batteries typically have a low energy density, making them heavy, expensive, and bulky. Furthermore, it is sluggish to charge and has a limited lifespan. Mostly, batteries like Lithium-ions are now employed in electric vehicles. The cruising range is limited by battery capacity. Adding the batteries will extend the cruising range, but it will also raise the vehicle's weight and cost. Some writers [3], [6] proposed quick battery charging solutions that reduce complete charging time to less than 30 minutes. Fast charging solutions are now available, however, they are expensive and difficult to operate. Still, the time it takes to charge a battery is longer than the time it takes to refill a car that runs on fossil fuel. Another option is to employ "swapping stations," where the drained batteries of EVs are swapped for completely charged [3]. Charging systems are critical to the advancement of electric vehicles. Plug-in type charging (conductive charging or wired type charging) and wireless type charging (contactless method) are the two types of EV battery charging technologies now available. Based on charging platforms, plug charging systems are further divided into Off-Board and On-Board chargers. Fig. 1 shows a general charging concept for a conductive charging system.

High-power cables, which are used to plug-in electric vehicles, are one of the key concerns with conductive charging. Damaged wires or improper handling might pose a threat. Furthermore, conductive charging techniques are vulnerable to theft and vandalism. WPT is an alternative new technology that was first offered by Nikola Tesla in the nineteenth century and has now evolved into a competitive option for charging stations that are connected wired. This type of technique has the potential to substitute transmitters and receivers with plug-in interfaces, allowing electricity to propagate in the manner of electromagnetic or static waves without making a connection, as shown in Fig. 2.

WPT systems utilize the power electronic converters to transfer power from the receiver towards the batteries or driving device. The usage of battery systems is widely used in many manufacturing industries, production, export, and import, for energy storage devices, etc. for millions and millions of years.

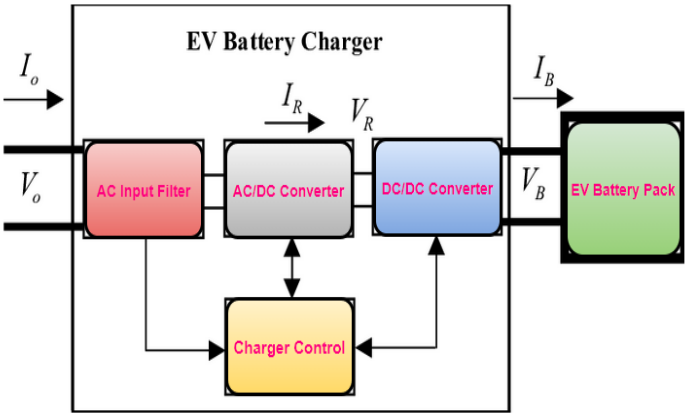

Fig. 1. Plug-in charging system block diagram.

The applications of the battery storage devices that are analyzed for permissive automation for conveying rectification and for a smart/micro grid application and the structure present in the battery management can more activate the intensity among electric vehicles (EVs) and the electric grid.

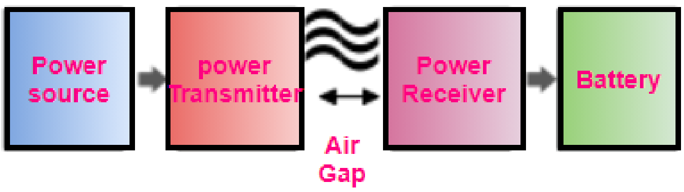

Fig. 2. WPT system's basic architecture.

The battery pack is normally organized by a battery module and the solar cells are linked together with the series connection to invoke the level of voltage and the PV cells are linked in parallel connection to invoke the capacitance level for the operations requiring a huge amount of power, such as electric vehicles and plug-in hybrid electric vehicles (PHEVs)[3]. Moreover, usable energy can be decreased, as the induced manufacturing variations and by the varying operative condition inequality. The charging and discharging process can be neglected because there is an inequality in a battery pack that may result in a negative level. The battery cells can be overcharged or over-discharged which leads to serious issues. Due to this reason, the inequality problems of battery packs can be overcome with the different battery topologies and control algorithms that have been used and reviewed.

In general, the battery management energy system uses the Passive balancing technique for the energy that balances present in the electric vehicle. Passive balancing is used in the battery management system due to its low cost [7]. When compared to the other battery management system, passive balancing has a simple fundamental operating principle. Furthermore, the charge voltage level in the cell or a module reaches the maximum level means it will be automatically disconnected by a power resistor and it grant the other cells to be charged in the system. Although, the passive balancing method is the ancient method that can offer to imply in the charging process rather than for the pair of charging and discharging. However, the total capacity available in the battery system present in the passive balancing type is comparatively low because the heat is exhausted in the balancing energy. In addition, active balancing circuits are used instead of all energy blown as heat in the passive balancing circuits. In these balancing circuits, during the charging and discharging process energy from these cells is conveyed with a maximum state of charge and voltage to the battery cells with the minimum state of charge (SOC) and voltage to the battery cells.

The particular size and the location are more important for the ratification the solar energy in EV charging stations. In addition, for the solar power charging system design, a large amount of solar power can be stored in a place and it may cause a huge rise in development and conservation rate. A small solar power system has been entirely used but furthermore, it could not satisfy the user demand. The ideal design has necessary to see the combination of rate and the intensity amount potential of the system present in the solar energy. Another main issue is more problematic when taking into account expanding the system of solar energy for electric vehicle charging in a particular location. When taking the user demand for various sectors, it is more important to see the charging stations' locations and size [8]. The climatic conditions and the surrounding situation is varied day by day and the possessed solar energy is damaged due to this condition. So the main threat to developing solar energy charging stations is very difficult to construct.

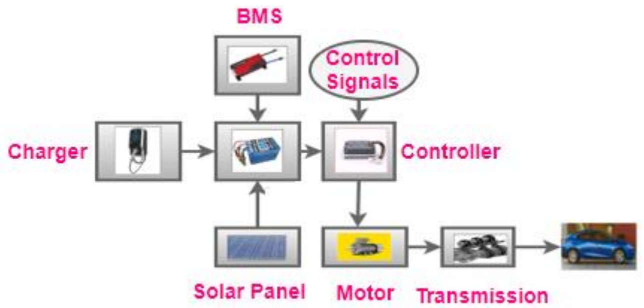

Fig. 3. Simplified block diagram for EV using a solar panel.

In modern days, there is more countless criterion that induces the battery's growth, fulfillment, efficiency, and power. All these countless criteria can be overcome by using the battery management system that controls and guides the battery power and intensity; henceforth it is called a Battery Management System (BMS). Fig. 3 shows the simplified block diagram for an electric vehicle using a solar panel. The Battery management and energy system controls and guides the battery power that it sends the entire energy when needed and it enlarges the battery's life and battery power. Fig. 3 demonstrates the simplified block diagram for EV using a solar panel. The battery management system has some criteria to guide such as current value, voltage value and temperature value can be monitored and then only the life of the battery can be maintained stable. And in the charging process, when the criteria present in the battery go below the settled values then the system already provides the feedback to the charge devices and hence it will produce the alarm sound and will cut off the load or otherwise battery from the charger. The BMS is mainly used to maintain the stability and life of the battery, it helps the battery cells to avoid damage, and whenever it is needed the battery is in the constantly ready position [9].

The plug-in hybrid electric vehicle (PHEVs or EVs) gives the battery storage operations and the energies are passed over the bidirectional dc-dc chargers combined with a system called conventional PV such consists of a very high-voltage dc bus among the sub-combinations present and the inverter part. The combination of dc-dc electric vehicle chargers provides the convenient point in the DC bus and it takes the input of the before inverter values for the grid connection. The connected grid and the islanding modes are used as a switch in the signaling medium in the dc bus. The combination of the PV and the charger gives a huge amount of power convenience that contains the potential and powerful dc charging from a renewable source or the network. The ability for the cost reduction in the PV and Charger function is likely related to the bi-directional inverter [10] [11].

In this review paper, the author looks at the problem domain of finding the location and determining the size of solar-powered Electric vehicle charging stations in urban and rural areas. In the face of the aforementioned issues, the goal is to improve revenue by using renewable electricity in charging points to satisfy charging needs. In this paper, the author explains a method for jointly deciding the locations of the area and sizes of charging stations, as well as developing the architectural style of the EV-PVs system and conducting comparative analyses.

This paper provides a brief overview of recent work in the field of PV solar array DC charging stations for EVs. There is a brief discussion part and a study available of the various charging station components. To conclude, grid operators and carmakers will give more importance to and invest in PV-EV chargers that use V2G technology in the future. To summarize, as even more operations are incorporated into the process, the photovoltaic- voltaic charging configuration becomes much more complicated, requiring smart control system for each component and legitimate efficiency of the overall station.

In this review paper, the existing solar panel can be tilted at various angles to get the solar-powered charging station for the electric vehicle has been reviewed in detail in section 2. Furthermore, the EV-PV system architecture and its topology is to be studied and a comparative analysis is shown in detail for the solar charging station design in section 3. Comparative analysis of power converter topology in EV-PV charger is shown and explained in section 4. A charging station for electric vehicle wireless power transmission (WPT) technology has been detailed research in section 5. A study can be made in the form of a flow chart model for the coil detection system are illustrated in section 6. This paper gives knowledge about what are all the factors for purchasing electric vehicles in section 7. The comparison between the electric vehicle and the fuel vehicle can be studied in detail in the form of the graph in section 8. Section 9 explains the recent system technology in detail study. The detailed conclusion part is presented in section 10.

2. Solar-Powered Electric Vehicle

The main aspects such as low graphite, power consumption, evergreen, natural conservation, and pure zero radiation by using the solar electric vehicle (SEV) and by using the solar electric battery (SEB) for the upcoming prospects. In a solar electric vehicle (SEV) the dual-mode battery can be used for power saving and the solar panels are to be used. They could be attained by applying photovoltaic (PV)-driven and battery-driven separately. The solar electric vehicle (SEV) has the components such as solar Photovoltaic panels, electric motor, battery, motor (vehicle) controller, and motor (vehicle) body. Solar Photovoltaic panels are panels that can be attached to the sides of the vehicle and on the top of the vehicle. The batteries and the solar PV panels are linked over the controller of the vehicle body. Solar PV panels do not charge the batteries directly but they can give energy flow to the motor. The major function of the vehicle controller is to keep the vehicle running and the electricity flowing [12].

2.1 EV Charging Station Design With Solar Power

2.1.1. Solar irradiance on an inclined plane

The important two factors present in the solar emission (Hg) in the ground surfaces are the first factors that get the source exactly from the light of the sun shafts (beam produced from the solar emission or Hb) beyond any diffusion and the next factors that start from the exact solar emission that's get scattered from the climatic bumps (impart solar emission or Hd). The comprehensive solar emission subsists of the beam and imparts solar emission that is taken as the equation by:

$$Hg = Hb + Hd \tag{1}$$

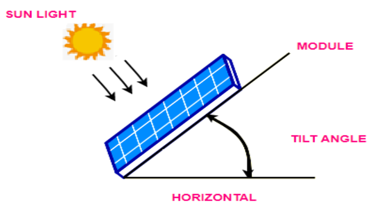

Fig. 4. Tilt angle for the solar module.

The solar power that gets incident on a solar board purely depends on two factors. The first factor is the inclined sun radiation and the second factor is the tilt angle built in between the sun and the board. Then fig. 4 demonstrates the tilt angle for the solar module. The maximal solar power that is consumed by the element and the sun's radiation is horizontal to one another. Furthermore, the tilt angle builds in among the sun and a rigid perpendicular surface that will be modified frequently all over the day. Hence the solar power that gets incident further differs along the direction of the sun [13]. Accordingly, the factors of solar emission that gets incident on a tilted area (HT) at a tilted slant angle (β) can be derived by a:

$$HT = Hg - HdRb + \frac{Hg(1-\cos\beta)}{2} + \frac{Hd(1-\cos\beta)}{2} \tag{2}$$

2.2 Estimate Production at Various Tilt Angle

The sum of power intensity development using a solar array is exactly resting on the solar emittance or solar irradiance; hence two important points determine everyday development. Then the first important angle is the Azimuth angle. The azimuth angle is having the cardinal points with that sunlight is predestined. The azimuth angle is having a cardinal route with North position = 0° and South position = 180°. Then the other angle is the Tilt angle and which has the angle of bearing or a solar array. The generation of electricity from a ten-kilowatt solar array present at different tilt angles is depicted below in fig. 5.

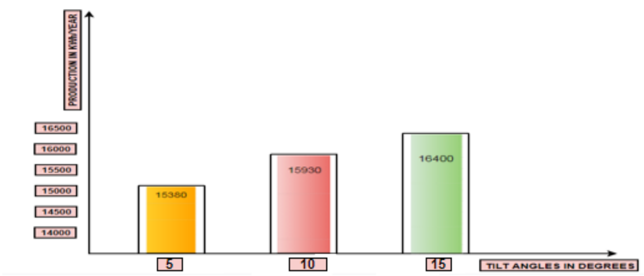

Fig. 5. 10 kW solar annual energy production vs. tilt angle.

2.3 Storage Battery and Controller

Solar-operated storage batteries can satisfy the unrestraint control grid electricity requirements, which is energetic charge and discharge, and periodic saturated charging time is taken. A variety of battery kinds satisfies these particular requirements. The main aspects of battery storage depository sub-clusters have examined that solar power contains a lead-acid battery type, lithium-ion battery type, and hence the conduction of battery occurs. To protect the extra power generated by photovoltaics, a mid-controller is essential to divermdivertroduced energy to the battery, as illuminated in Fig. 6.The number of controllers that are mainly applied in photovoltaic.

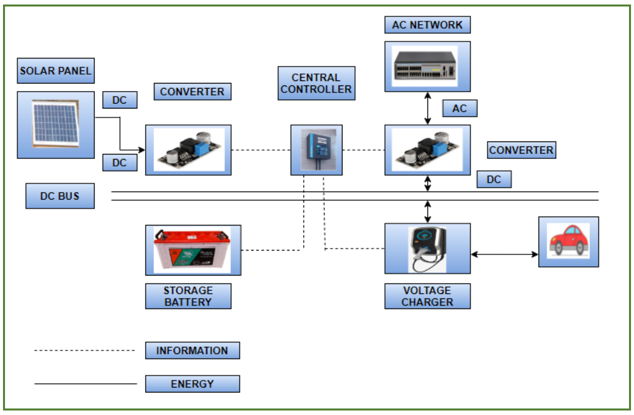

Fig. 6. Electric vehicle charging framework with a solar PV charger.

Fig. 6 depicts the electric vehicle charging framework with a solar PV charger. The maximum power point tracking (MPPT) and pulse width modulation (PWM) methodologies are necessary to develop the improvement of solar power generation [11].

3. The EV-PV System's Architecture

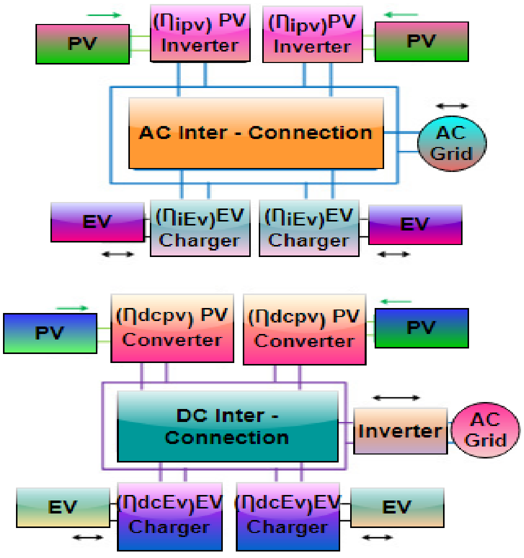

Fig. 7. For the EV-PV charger, System Based Architecture 1 (top) and 2 (bottom).

With the main motivation of charging the EV directly from PV electricity, the PV system, the supply of electric vehicle equipment (EVSE), and the network grid are all incorporated into an EV-PV charger. DC link charging system passing through CHAdeMO systems and hereby the standard like Combined Charging Standard (CCS) will be used in Europe in the future to provide dynamic charging, rapid charging, and V2X compatibility [14], [15]. Using changeable charging power, or adjusting the charging power range over a long time duration, is referred to as dynamic charging. As a result, EV charging will be able to precisely track fluctuating PV power generation.

Two distinct system configurations are available to incorporate EV, PV, and the grid [16]:

1. EV, PV, and Grid are all integrated into a single multiport converter (MPC).

2. Grid Network, PV, and EV power converters that are interconnected through a shared DC bus. The common type shared bus is employed to distribute the solar PV electricity among EVs and to interchange power between EVs and the grid. The system's design may be one of the 4 versions available depending yet if the interconnecting bus is AC (1 230V 50Hz or 3 400V, 50Hz grid) or DC using the two system layouts discussed above.

3.1. PV and EV converters are connected to the AC grid separately.

The architecture 1 schematic diagram is shown in Fig. 7. Solar photovoltaic panels and EV charging/discharging are handled by using separate converters. The PV converter is like a type of maximum power point tracking (MPPT) DC/AC inverter, whereas the Electric Vehicle charger is a type of AC/DC converter. This type of architecture's backbone is the current 50Hz AC grid, via which all electricity is routed. The downside is that the PV electricity cannot be utilized to charge the EV directly in DC form. This mandates the PV inverter's unneeded transformation from DC charging to AC charging, in the same way, as the EV charger's conversion from AC to DC.

3.2. PV and EV converters are connected on a DC (micro) grid separately.

The design structure for architecture 2 is shown in Fig. 7, which employs a Grid (micro) DC to connect the EV, Photovoltaic panels, and the grid. Both the Photovoltaic and Evs converters are DC/DC converters that seem to have MPPT technique and charging management. The DC bus link allows for the usage in a direct mode of PV DC electricity for the EV DC charging, resulting in increased performance of efficiency [17]–[19]. The (optional) mid inverter that links the grid of AC and DC enables the operation of V2G and the energy differential among PV systems and EV consumption is fed/drawn. The architecture's disadvantage requires the construction of a (microgrid) DC as well as its management and protection.

3.3. Interconnected on the AC grid multiport converter that combines the grid, PV, and EV.

Fig. 8(a) shows the architecture 3 schematic diagram (a), in which the system employs a multiple-port converter (MPC) as depicted in Fig. 8(b). Using a mid-DC-link, the multi-port converter interconnects the Photovoltaic solar array, the Electric Vehicle, and the network grid (AC). The AC grid is used to link many MPCs together. The combination of PV, EV, and network grid power electronic converters into a single MPC results in increased power density, lower costs, and easier control [20], [21]. The MPC controller can regulate EV charging from PV, but in the previous two architectures, forming the communication between the PV and EV converters that are distinct had to be created. The sole drawback is that DC link solar PV electricity from one type of MPC is unable to utilize the charging of the EV of one another MPC that make without first being converted to the grid (AC).

3.5 Multiport converter (MPC) that interconnected the grid, PV and EV; combines on a DC (micro) grid

The block representation diagram of architecture 4, that is having the combination of architectures 2 and 3, is shown in Fig. 8(a). It integrates the PV array and the EV via a multiple-port converter, as illustrated in Fig. 8(b). By using a DC (micro) grid, a large number of MPCs are linked together. To interconnect the AC grid, a maximum-power mid inverter is needed. This single inverter is preferable to design 3's use of multiple tiny inverters integrated inside the MPC.

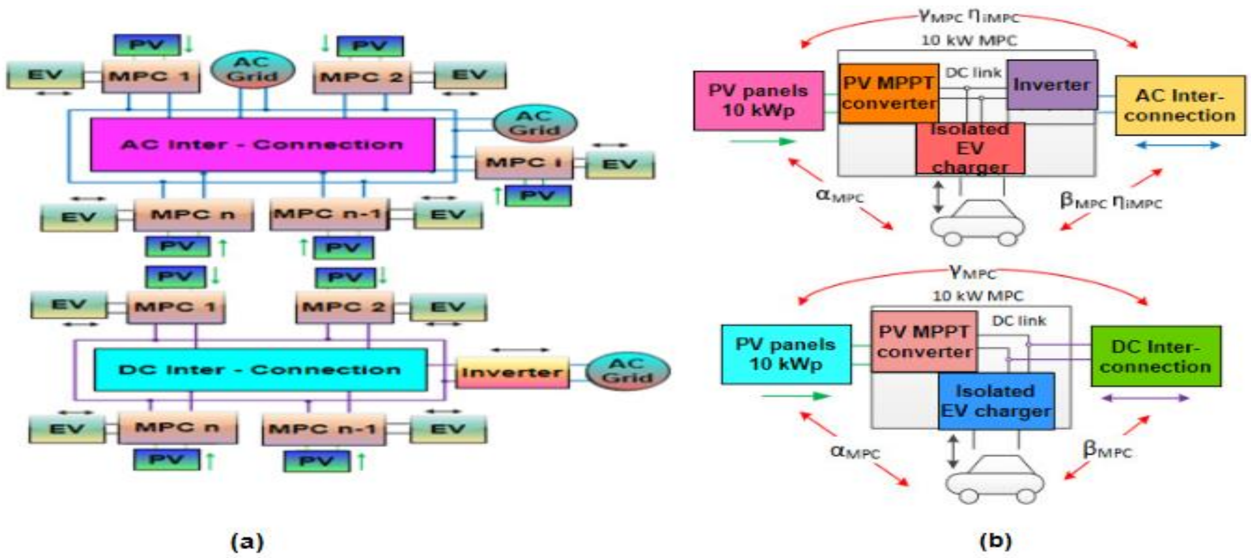

Fig. 8. (a) EV-PV charger by using multiport converters system type Architecture 3(top) and 4(bottom).
(b) Diagrammatic Representation of multiport converter for architecture 3 (top) and 4 (bottom).

3.4 Comparison Analysis of System Architectures

TABLE 1 compares the four system architectures in terms of quality. Those in red and green represent the architecture's drawbacks and benefits, respectively. The adoption of architectures 2 and 4 is hampered by the need to build an independent DC grid and create its management and security systems. When PV DC electricity is utilized directly for EV charging in an MPC, better energy power density and reduced maximum amount of losses are achieved, as depicted in TABLE 1. The table also depicts that design 3 has various benefits when compared to the other architectures, including the need for MPC, there is a DC connection in between the EV and PV particularly in direct mode, simplicity of the controlling method, and the ability to connect multiple EV-PV chargers to the current AC grid. As a result, architecture 3 is the best in terms of qualitative comparison.

4. Comparison Analysis Of Power Converter Topology For Ev-Pv Charger

It's critical to have a few conversion steps as possible in between the solar PV panels and electvehiclesicle when designing a high-efficiency EV-PV charger. One way to do this is by DC connections between PV and EV. The EV charging standards [14], [15] demand in the EV charger to be simple to control EV charging with a solar panel and the grid. The need for an EV charger in bidirectional also makes V2G technology easier to adopt. TABLE 2 gives the comparison results of EV-PV chargers which have been described in previous research based on system design, EV and PV power ratings, EV charger isolation and bidirectional power flow capabilities, and power converter topology.

Table 1. Comparison Analysis of EV-PV System Architectures on a Scale Based and merits and demerits of different types of architecture.

	Archi. 1	**Archi. 2**	**Archi. 3**	**Archi. 4**
DC (micro) grid structure	Low	High	Low	High
DC (micro) grid security and control	Low	High	Low	High
Direct correlation of EV and PV DC electricity results in increased efficiency (with no AC conversion)	Low	High	High	High
Potential of charging EVs directly utilizing PV DC electricity between several EV-PV chargers	Low	High	Low	High
Because of MPC, there is a higher power density and a lower cost.	Low	Low	High	High
Controlling EV charging using a solar panel with minimal communication infrastructure is simple.	Low	Low	High	High

TABLE 2 shows that research on EV-Photovoltaic chargers has been concentrating on all four possible architectures.

In architecture 1, standards present in commercially accessible AC Electric Vehicle chargers and Solar PV inverters are frequently employed.

Table 2. Literature comparison analysis of topology, system architecture, and EV charger layout .

Architecture	**[PV, EV] Power (kW)**	**EV Isolation/ Bidirectional charging**		**Design and Topology for Power converter**	**Paper**
1	[2.0, 2.3]	**-**	**-**	The inverter is a standard 93 percent efficient PV inverter. The charger is a standard Electrical AC EV charger.	**[22]**
1	[2, -]	**-**	**-**	EV charging station with on-site storage.	**[23]**
1	[51.4, 3.7]	**-**	**-**	SMA Sunny boy solar PV inverters and standardized Electrical AC EV chargers are employed.	**[24]**
1	[46, -]	**-**	**-**	Solar PV inverters and standard AC EV chargers were used.	**[25]**
2	[4x1.4, 2x6]	**Low**	**Low**	PV-powered EV charging through direct DC. On a 210V DC bus, a ZVT-PWM buck converter for PV and EV, as well as a distinct 5kW inverter and 8kW rectifier for the grid network, are all interconnected. When compared to architecture 1, efficiency increased by up to 5%.	**[17]** **[18]**
2	[100, -]	**-**	**-**	Direct DC charging of an electric vehicle from a solar panel utilizing a common DC bus.	**[26]** **[27]**
2	[-, 3]	**High**	**High**	For electric vehicles, 3kW bidirectional contactless charging is available. Because of the air-core transformer employed, there is inherent isolation.	**[28]**
2	[9.8, 10]	**Low**	**-**	A shared DC-link connects the batteries and the electric vehicle. PV is connected to DC-link via a buck converter with MPPT.	**[29]**
3	[6, 7]	**Low**	**High**	The inverter has a quasi-Z supply, a 680V DC link, and three grid connections. Local storage of 96kWh integrated into an EV-PV charger. A total of four electric vehicle chargers can be used at the same time.	**[31]**
3	[2, 2]	**Low**	**High**	With a 350V DC link and three grid connections, this is a quasi-Z-source inverter. Convertor for charging batteries (and not for EV).	**[32]**
3	[5.5, 4.5]	**Low**	**Low**	MPC is made up of a boost converter for PV, a 1-phase H-bridge inverter for the network grid, and a buck converter for the electric vehicle, all of which are interconnected by a 400V DC link.	**[33][34]**
3	[, 10]	**Low**	**High**	Charge an electric vehicle with a Z-source converter. A three-	**[35]**

				phase bidirectional inverter links the EV to the grid.	
4	-	**Low**	**High**	PV, battery, and load are all connected by a three-port converter. The load has been isolated. Designed for use in the charging of batteries (Not specifically for EV).	**[21]**
4	-	**Low**	**High**	PV, battery, wind, and load converter with four ports. The load has been isolated. Designed for use in the charging of batteries (Not specifically for EV).	**[20]**
4	-	**High**	**High**	By enhancing a high-frequency AC transformer link, a three-port isolated DC-DC-DC converter is created.	**[36]**

This basic architecture is used in many publicly available PV-powered EV charging stations, such as [24], [25]. Architecture 4 has received the least attention, owing to its usage of a future DC grid. The usage of architecture 4 is indirectly dependent on the need of [20], [21], in which they employ a solar Photovoltaic system to charge the batteries. The converter's DC load port in [20], [21] can be linked to a mid-DC-grid, and for the battery charger, a separate DC converter is used and can be utilized to facilitate Electric Vehicle charging. The most popular architecture for PV converters and EV chargers is a buck or boost converter. A key point to note is that, except [28]-[30], neither of the designs has included an isolated bidirectional electric vehicle charger. Almost all research efforts, except [28]- [30]- [37], have ignored or ignored the EV's isolation criteria. In the cases of [28], [37], the isolation is caused by the usage of an air-core transformer for contactless EV charging.

5. EV Smart Charging Using PV and Grid

Several researches have been carried out to investigate the benefits of a Photovoltaic EV charging station. Source [38] shows the benefits of using PV to start charging the EV and how much it contributes to increased infiltration between both Photovoltaic and Electric cars. Vehicles can also help to mitigate the negative consequences of excess PV generation [39]. Allusion [40] contributes to a better understanding of European explorers, the United States, where it is illustrated that charging an EV from the grid is feasible. PV is much less expensive and has a lower carbon footprint lower Carbon footprint than charging EVs from the power system. Particular instance research made in Reference [41] equates EV charging mechanisms: only grid architecture, just PV with energy storage, and grid-connected system PV and reveals that grid-connected system PV performed best commercially than some other two methods. The researchers of Reference [42] explain the use of Solar PV and Electric cars as a storage technology system is to reduce maximum grid load capacity. This research shows that PV-based EV charging is superior to grid-based Electric vehicle charging. There is a plethora of literature on various charging methodologies or accomplishing numerous financial, analytical, or socioeconomic goals in addition to Photovoltaic- voltaic EV charging. Table 3 contains the main smart rechargeable tends to work for the grid-integrated EV-PV system.

Table 3. A review of the literature on smart charging of energy grid-connected EV-PV systems.

References	Objectives	Model of Optimization	Implementation of Software	Important Conclusions
[38]	Valley filling and peak shaving	Linear programming formulation	MATLAB Programming	The suggested algorithm's efficiency is dependent on a wide amount of possible parking spaces.
[39]	Profit potential and PV consumption	Linear Programming formulation in Multiple Integers	GAMS Programming	V2G is not economically viable due to the cost of battery degradation unless there is a high level of PV production.
[40]	System cost reduction	Linear Mixture Programming	CPLEX Programming	Smart charging has the potential to save you money. charging and PV operational expenses parking lot owner's usage
[41]	lowering the cost of charging	Fuzzy logical system	MATLAB Programming	Because the algorithm is not based on optimization, it aims to achieve several goals: deduction in charging costs and system losses, and improvement level in voltage profile.
[42]	Increasing PV consumption	Met heuristic	MATLAB	The suggested heuristic algorithm produced the best goals at a low operating complexity without the need for forecasting unknown parameters.

5.1 Charging Station for Electric Vehicle

EVCS is a location where the electric vehicles are charged with suitable safety, monitoring, and conversion systems, as well as maximum current and voltage for rapid charging. The following stations are a few of the core EVCS terms.

5.1.1. Different Types of Electric Vehicle Charging Station

5.1.1.1. Residential Household Charging Station

As we go into the EV age, residential charging stations are critical since they lessen the demand on the grid significantly. Residential car charging may be accomplished by using lowering the range of current from the DC network grid, which will assist the DC grid in meeting the requirement for more extra power during loading in peak hours. Furthermore, in [43], charging electric vehicles throughout the night is the most cost-effective and has the least grid impact. Because it is the baseload peak hours, it decreases the load on the grid, and charging vehicles at night lowers the per-unit cost of power. Level 1 charging at a home charging station may readily charge vehicles in 7 to 8 hours, as shown in Table 4.

5.1.1.2. Charging Station based on Parking

When Charging a vehicle it takes time duration, but by utilizing that time duration when a vehicle is parked, you may lessen the type of strain on which the public charging station and the DC grid. Moreover, in the National Household Travel Survey, the parking of vehicles is carried at work for almost five hours every day [44]. Apart from workplaces, this service is available in restaurants, shopping malls, libraries, and other locations with appropriate charging infrastructure laws. Existing parking lots have been transformed into smart charging-based parking lots by using internet access for booking the slot and information about the traffic at the parking zone [45]. Level 2 charging, which includes both single and three-phase slots, is commonly employed in such locations [46].

5.1.1.3. Public Charging Stations

Public charging stations are available to enable quick charging for automobiles, while traditional charging takes longer to charge a battery. Fast charging is accomplished using a variety of charging topologies and fast charger configurations. The charger in a charging station is typically made up of an AC-DC converter present in the front end and a DC-DC converter present on the rear end. Both converters are linked by a DC link capacitor [47].

5.1.1. 4. Station for swapping the batteries

In this, to address the issue of time taken to charge and the pressing need for a charged car, the Battery Swapping Station (BSS) was created. In a BSS vehicle, an expired vehicle battery or vehicle battery pack can be replaced with an entire charged one immediately away, reducing the amount of time spent having to wait for the vehicle's battery to charge. Hence, the BSS looks after the life span of the battery by utilizing BMS to monitor it. It evaluates the battery's power density as well as the SOC level [47]. When it comes to implementing a BSS, there are several obstacles to overcome. One of the primary challenges that may be handled is the design of battery packs in such a manner that they can be simply and quickly removed from cars and re-attached. Another issue is the battery packs' brand compatibility. Manufacturers may utilize a single standard structure to create interchangeable battery packs present for both the BSS and EVs. In this system, it is also some issues of battery deterioration and sovereignty, which is the biggest roadblock available in the technology of BSS.

5.1.2. Charging Levels

The degree of charge is listed in Table 4 [48] according to various international standards and norms for charging automobiles.

5.1.3. Electric Vehicle Charging System

Electric Vehicle charging systems may be divided into two categories based on how they transmit energy: conductive wireless charging systems and inductive wireless charging systems.

5.1.3.1. Conductive Wireless Charging System

In a conductive wireless charging system, the charging methodology employs a cable or connection to make both the car and the charger are in direct touch. This is the charging station's basic infrastructure right now. Depending on the charge level, onboard or off-board charging is available. This form of charging is more efficient, and practically every electric car manufacturer offers it. Vehicles using conductive charging systems include the Nissan Leaf, Chevrolet Volt, Mitsubishi i-MiEV, and Tesla Roadster [48], [49].

Table 4. Charging Levels

Charging Levels	Type of Phase Level	Type of Charger	Usage and Location	Power (kW) and current(A)
As per SAE standard for AC and DC charging				
Level 1: Vac= 220 V (EU) Vac=130 V (US)	Single	On-Board Type	Residential and commercial facilities	1.5 kW/13 A, 1.8 kW/20 A

Level 2: Vac= 400 V (EU) Vac= 220 V (US)	Single/Three	On-Board Type	Both the public and private sectors	5 kW/18 A, 6 kW/33 A
Level 3- Fast: Vac:=207-600 V	Three	Off-Board Type	Fuel Station and Commercial	50 kW, 100 kW
Level of DC Power 1: Vdc= 220-450 V		Off-Board Type	Stations for Specialized Charging	40 kW/80 A
Level of DC Power 2: Vdc= 220-400 V		Off-Board Type	Stations for Specialized Charging	90 kW /200 A
Level of DC Power 3: Vdc= 220-600 V		Off-Board Type	Stations for Specialized Charging	240 kW /400 A
As per IEC standards for AC and DC Charging				
Level of AC Power 1	Single	On-Board Type	Residential and commercial facilities	4-8.5 kW/17 A
Level of AC Power 2	Single/Three	On-Board Type	Public and Private	8-16 kW/33 A
Level of AC Power 3	Three	On-Board Type	Fuel Station and Commercial	60-120 kW/250 A
Dynamic DC Charging		Off-Board Type	Stations for Specialized Charging	1000-2000 kW/400 A
CHAdeMo Charging Standard				
Dynamic DC Charging		Off-Board Type	Stations for Specialized Charging	63.5kW/125 A

5.1.3.2. Inductive Charging

Inductive charging, often known as wireless charging, is a novel developing idea in which there is no physical touch or interaction between the car and the charger. It operates on the same concept as transformers, which is electromagnetic induction. [49] and [50]. The wireless transmission charging is calculated using the spacing between the primary and secondary coils. Energy is transferred through thin air using a magnetic field. The sole disadvantage is that it has a minimum efficiency and energy density when compared to the conductive charging, as well as in the case of maximum cost [48]. However, it is handy in the sense that charging may be done without having to deal with the inconveniences of plugging and removing the plug while in charging. Automobiles may be charged regardless due to the size of the connectors or sustainability.

Vehicles may get charged during driving if charging strips are installed along the roadway. Dynamic wireless charging is the term for this. Electrified roads or charging lanes are highways that can give power intensity to electric vehicles utilizing wireless power technology (WPT) [48], [51]. The available charging time of automobiles in a position where it is not moving will be reduced using the charging while driving approach [48]. This approach is being tested in several nations, and further study is being done to improve the performance of efficiency [52].

5.1.4. Charging Time

One of the most difficult aspects of EV technology is charging time. In ICE automobiles, the battery recharging time is longer than the oil refilling period. There are primarily five aspects that determine the rapid charging of a system [53] that may be used to minimize charging time.

- *Battery Size:* As the capacity or size measured in kWh improves, so does the charging time. A larger battery will take longer to charge because it takes longer to charge a smaller battery.
- *State of Charge (SOC):* The vehicle battery's SOC indicates whether it is fully charged or discharged, partially charged or discharged, and the time taken to charge the battery changes accordingly.
- *The maximum charging rate of the vehicle:* The electric vehicle may only be charging up to a certain amount before it must be turned off. A battery with a maximum amount of charge of 22kW, for example, cannot be charged up to a 50kW charging station.
- *The maximum charging rate of the charge point:* The charging time duration is determined mainly by the wattage of the outlet to which the vehicle battery is attached. When a 7kW outlet is used to charge a 22kW battery, it will charge at the same pace as a 7kW battery, increasing the charging time [53]. When the vehicle's battery is charged by using a charger in the range of 7kW, the charging period is typically 8 hours, and the battery may be utilized for up to 60 kilometers. Table 5 shows the time it takes to charge a battery in various corporate vehicles using various charger rates. Model I is the Nisan Leaf 2018, Model II is the Tesla Model S 2019, and Model III is the Mitsubishi Outlander PHEV 2018.

Table 5: Vehıcle's Chargıng Time

Model Type	The capacity of the Battery (kWh)	Range (miles)	Vehicle's Charging Time(hours)				
			3.7 kW	7 KW	22 kW	43-50 kW	150 kW
I	41	144	12	7	7	2	NA
II	76	237	22	12	6	3	1
III	13.7	23	5	5	5	0.67	NA

6. The Coil Detection System

In this coil detection system, they are using both sensor and sensorless techniques. The coil detection system depends on sensor type means they are having minimum durability and maximum response time for functioning. While the coil detection system depends on sensorless type means they are having maximum efficiency regulating and therefore the coil winding can be identified in minimum range. Hence, there are huge losses present in the system and the system has to operate separately and constantly. The essential demands for the coil detection system for wireless power transfer usage can be reviewed as follows:

- The coil can be detected on the elementary position and spontaneously switch on the elementary coil in the
  Dynamic wireless power transfer (DWPT) utilization.
- Greater stability of the coil detection system
- No transmission is necessary for sensing type.
- Capable to notice an electric vehicle (EV) and when the EV is arriving from a slope channel to the charging
  Channel.
- Minimum energy is used to deduct the uphold losses

The electric vehicle (EV) coil detection and observation system comprise two coil winding and it is firmed on elementary position and thus single transmitting coil winding formed on the end of subsequent secondary energy pad to find out the location of the electric vehicle (EV) together with the value to the elementary pad as depicted in Fig. 9. In this system, coil winding is firmed on the secondary energy pad having a value of 5V, 1W with handling the frequency range of about 460 kHz. The winding of the coil firmed on the secondary coil energy pad is electrostatically connected with the two coil winding firmed on the elementary energy pad. Then the two coil winding firmed on the elementary energy pad that produced a voltage level is equal to the junction in X and Y indications. As a result, the character of preference in X and Y coil winding, X coil that produces voltage level. Although, when the electric vehicle transfers in the X indication. Likewise, in the Y coil winding that produces voltage level and when the electric vehicle accesses in the Y indication. Moreover in the coil winding voltage that has been worked for the operation of switch-ON, switch-OFF condition and thus, additionally to run and transfer of power to the EV should be processed [50]-[55].

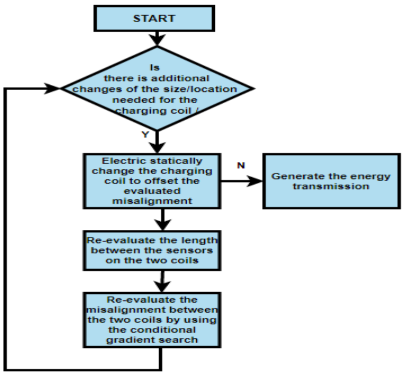

Fig. 9. Flowchart for the coil detection system.

6.1 Coil Resonators

The design of advanced wireless power transfer (WPT) technology arises by the magnetized inductance among inductors or insulators which can be done and made full of metallic windings. At present, the magnetized resonating coil of WPT methods will come more familiar and important and is mainly integrated with a four-turn-winding system [56] & [57]. Hence, the propulsive coil, sender/receiver resonating and accepts oil.

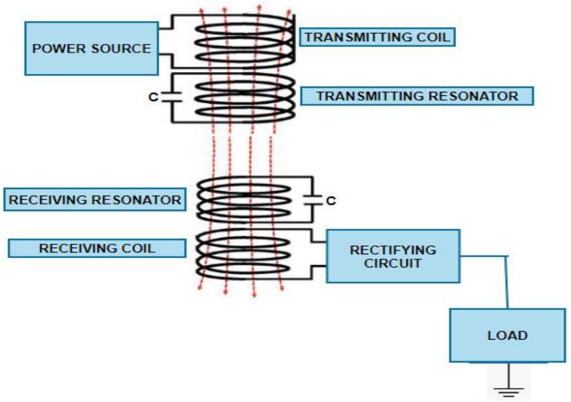

Fig. 10. Methods to improve the coil resonators.

Fig.10 demonstrates the wireless power transfer (WPT) resonating medium that contains the coils such as self-resonance winding and inductor-capacitor (LC) resonating winding. Furthermore, the various patterns of self-resonating winding and the resonators are correlated and then the wireless power transfer (WPT) parameters are reviewed. The main coil used in the resonators applied in the wireless power transfer (WPT) method collects the kind of helix coil, planar spiral form, and square helix coil. Moreover, the efficiency parameter of those varieties is the same, the cohesion during wavelength variation is dissimilar. When a variation of 200 kHz is approximately the resonating wavelength, the wavelength reduction for helix coil, planar spiral, and square helix coils is 3%, 8%, and 13%, accordingly. Self-resonating coil winding and the resonators type that commonly collects a huge size that is essential because of their generated electric condenser that gives using the special arrangement among very rotation. Currently, more targets have been attached to the minimum dimension of size in the WPT resonating coil. The main usage of protective coil resonating in open-circuited for the wireless power transfer (WPT).

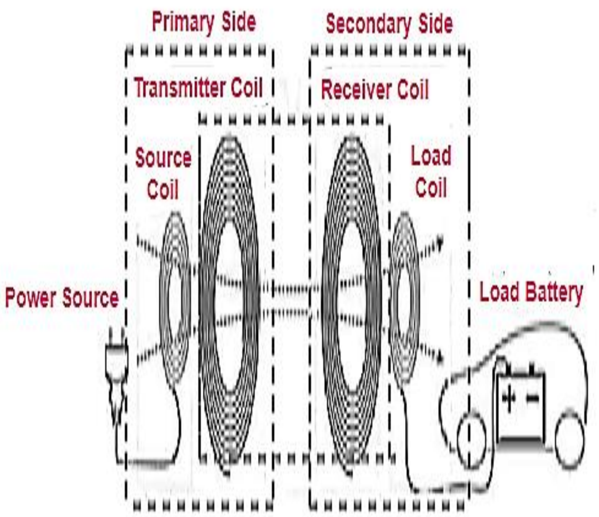

Fig. 11. Conventional symmetric four-coil resonator.

Figure11 depicted a basic frameworks of a protected mode of resonating coil that contains a segment of coaxial electric cable. Hence, a coil attached to the self-resonance resonating, which the coil contains, and the open-circuited observation indicate the inductance and capacitance (LC), commonly. Fig.1 depicts the WPT system analytically built-up and it contains two individual rotation protective coil resonators and together with the coil radius of 10.7 cm are located with the width of 35 cm and the evaluated energy transmission efficacy of 41% close to the resonating wavelength of 38 MHz Since the usage of protective coil resonators, planar coil resonators were recommended for WPT systems [58] & [59] and this system is not just an easier and permitted propagation line attribute. It exhibits the conventional structure of the self-paired planar protective coil framework. The main benefit of this planar resonating coil is that the specific features present in the resistance can be simply modified by supervising the coil performance, which would be comfortably completed by applying the microlayer boundary decent advanced methodology. Hence, it is simple to deceit and coordinates the resistance pairing grid in the coil layout, forming the entire network with higher convenience. It demonstrates the analytical build-up which two self-paired planar resonating coils and having a radius range of 9 cm and it can be fixed at the length of 15 cm. For the length of 15 cm among two resonating coils, the pairing grid was specially constructed because of varying the slot. By this approach, the evaluated WPT efficacy of 91 % was observed at the wavelength of 38 MHz [60]-[63].

6.2 Reducıng The Coil Impedance

1. Low AC Resistance Conductor: The scheduling of MCM including particular materials is to upgrade the parameters of loops, just like by decreasing the faults and modifying the conditional varieties of loops. The major characteristic method is to generate loops with semiconducting elements. Furthermore, when correlated to usual material requirements, semiconducting conductors cause lower impedance, smaller winding inflaming fault, and greater capability factors, that should enlarge the TE and TD [64]–[72]. In [73], the efficiency of MCM made up of semiconducting winding and iron windings are correlated and examined. Moreover, the transmission winding contains semiconducting conductors that are efficient in generating harder and larger magnetized foil coils. In this magnetized pairing capacity, the MCM formulated of the transmission windings that contains iron composites and the accepting winding that contains semiconducting conductors is the smallest and continued by MCM and then the generating coil loop and accepting coil loop that contains the iron conductors. Hence, the generating and accepting windings consist of semiconducting conductors, the MCM having the maximum paired capacity. The parameters that may be importantly better enhanced by semiconducting conductors exploited in both the transmission and accepting coil loops [74]-[77].

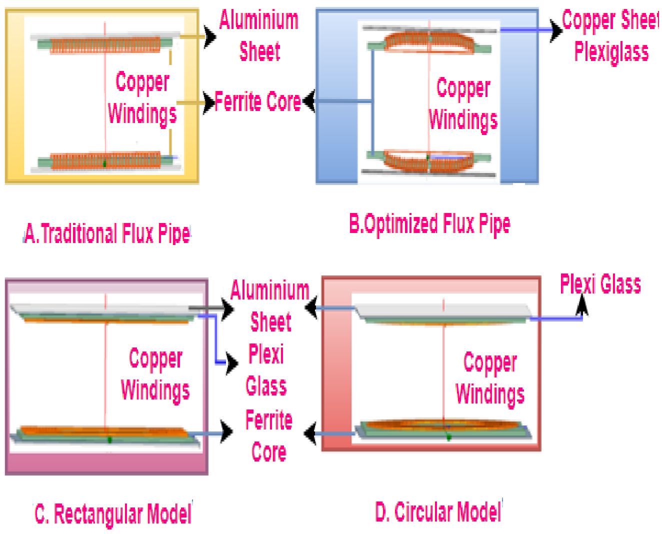

Fig. 12. Coil Of MCM **(a)** Hollow Copper Tubes.

The handling wavelength of the Wireless Power Transfer process has a wavelength area range of kHz to MHz. Hence, because of the consequences of the skin issue and the proximity issue on the loop coil that contains usual conducting materials and the efficient exploitation value of conducting materials is extremely small.

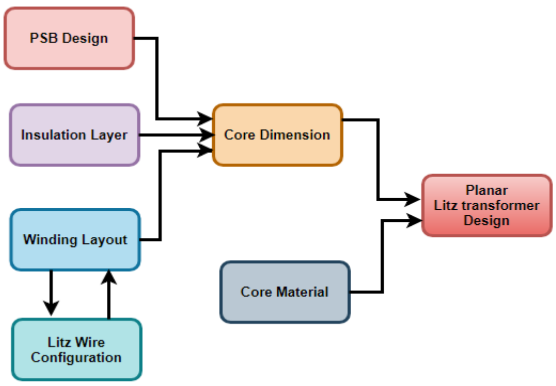

Fig. 12. Coil of MCM **(B)** Litz Wire.

The ac impedance will have the maximum range and then the heating fault will also increase [78]-[84]. The ideal iron pipes or litz cable normally enable to generate of the coil winding of MCM, by this way the issue can be resolved and as depicted in Fig. 12(a). The ideal iron loop coil contains ideal iron pipes and is normally made up of an individual-turn loop coil. The dimension of the density of pipe barriers is used to determine with the reference to the handling wavelength, the compressibility, and the strength of conductors. The ideal iron loop coils are generally that are employed in the traditional study of wireless power transfer. Furthermore, this is generally exploited as the generate loop coil and the load loop coils of the four-loop coil framework. The framework of ideal iron loop coils and the limitation of TE and TP can be generated [85]-[90]. Then the framework is normally exploited in the small-power intensity wireless power transfer device. The Litz cable is a cable that is mantled with a coating of isolating thread surfaces and having plenty of delicate lustrous cables as depicted in Fig.12 (b). Although the lit channels are exploited for WPT, the width of all single lustrous cables is depend on the handling wavelength, and then the skin intensity is 0.1 mm width per lustrous cable which is more general. Generally the demands of resist potential and electric current, the number of lustrous cables are estimated. When correlated with ideal iron pipes, the Litz cables have transparent benefits in elasticity and energy strength. In the framework of MCM, the Litz cables have a greater rate-function proportion. Thus, this forms the benefit exploited in the cable present in the loop coils of MCM, generally.

The design of the WPT MCM is normally with the minimum ac impedance materials, which can decrease the fault of the loop coils and the issue can be resolved by overheating and the usual line is the litz field. Except for micro-power intensity WPT, minimum ac impedance conducting materials and is generally exploited in very small, intermediate, and very high power intensity WPT like cell phones, vending machines, electric vehicles (EV), etc. [91]-[93].

2. Flexible Conductor: Furthermore, the wireless power transfer(WPT) advanced method is exploited in certain specific surroundings like human ingrained equipment, vesture equipment, etc., the loop coils of MCM require to have separate premises like extraordinary durability, low weight, and computability [94], [95]. The source and destination loop coils are generally contained superconducting materials. A malleable stamped loop coil is depicted in [96].

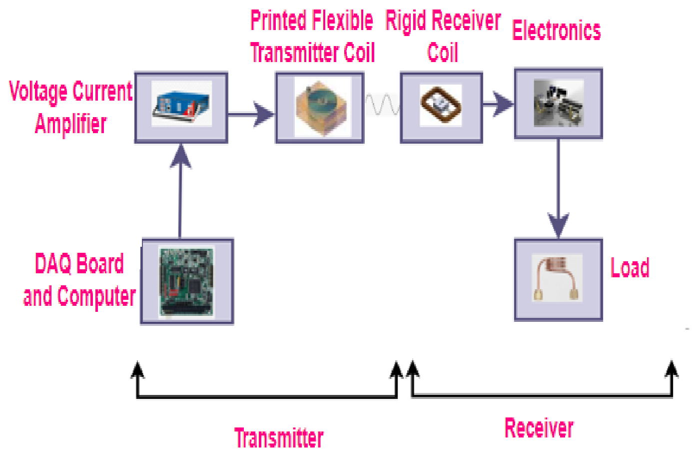

Fig. 13. Flexible Printed Coil.

Fig. 13 demonstrates the flexible coil description. In [97]-[99] a cable having the collection of threads and conducting materials is demonstrated. Malleable threads of loop coils of different sizes can be constructed by this cable, as depicted in fig. 13. Hence, the loop coils are very convenient for human realizing analysis utilization. The loop coils can be integrated into the system and do not disturb the presentation and permit power intensity generation. The analysis to justify which the circular loop coil can generate power intensity for approximately 5mm further than the rectangular loop coil. Malleable conducting material is advanced for appropriate situations or directions and can produce electric power intensity and have elasticity. Although, the particular factors are combined with the conductor's arrangements that can decrease the loop coils resistance and sustain durability. The feedback obtained is generally exploited in the framework of wireless power transfer (WPT) MCM for electric equipment. MCM can be enhanced from various patterns by the magnetized concealing, the Meta conductors, and the superconducting materials. In normal advanced techniques, different ways are normally correlated to increase the parameters of MCM. The ultimate way is to produce by the association of loop coils that contain Litz-cables and a magnetized concealing of ferromagnetic conducting materials. The exploitation of semiconducting particles that needs regulation and increased amount. The framework and monitoring of effective concealing estimations are widely difficult. Metal conductors are having a wide range to formulate and have certain drawbacks in handling wavelength and generation intensity power [100].

7. Factors for Purchasing Electric Cars

Power economical is the unique reason that the human view during transferring to an electric vehicle in India. Although, there are various characteristics that humans could view if getting is the price of fuel, maintenance, and the entire buy cost of the electric vehicle in according to the electric vehicle mart in India. Hence, electric cars cause to be costlier and this type of electric vehicle is appropriate and more familiar with a type of model choices to select from [101]-[107]. Additionally, the locality is the main cause for the price of buying and functioning the current electric vehicle and at the same time the brand title and group. Another important characteristic that is contemplated to obtain the variation among electric and traditional vehicles is where it is rapid and fast a vehicle that leads among two sources and boarding point. Though electric vehicles produce more power the car can drive the car very faster.

The common dissimilarity among electric vehicles which the pair is known as EV and fuel which are classified as Standard Internal Combustion Engine. Model types or ICE is which the gasoline exploited by fuel vehicles and charging is needed for electric vehicles. The concept of a mile per gallon or MPG is exploited to observe the fuel efficacy of ICE vehicles. Moreover, the cost of gas or fuel deviates from point to point. Thus, the fuel vehicles requires to be loaded up around every 250-300 miles of traveling. Furthermore, there are plenty of sources obtainable for Electric vehicles to be energized by charging. The electricity is generated by heating gas or coal, or from biogas resources like hydropower, wind power, and solar power [108]-[113].

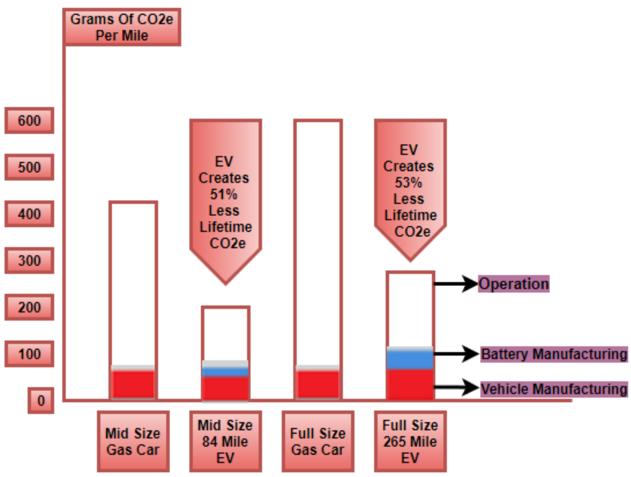

Fig. 14. Lifecycle global warming emissions.

8. Gas Vehicle vs Electric Vehicle

The electric vehicles are more familiar, that could encounter the appropriate charging stations in common areas specifically in non-rural localities or at roadway stops. Concerning the guidelines of the Ministry of energy, providing different charger groups to be perfected at public charging stations, fixed the emit of charging standards. The Development of Heavy Industries plan of framing up higher than 2,600 public charging stations in different cities and greater than 1,700 on roadways is a measure in the right orientation. Therefore the plans and strategies will give positive energy for EV installation in the country to be launched [114]-[116]. But, for long traveling more than one charger is required. Fig. 14 demonstrates the lifecycle of global warming emissions. The advantage of an electric vehicle is minimum maintenance when compared to the ICE vehicles requires to fill it up the liquid generation, cooling agent, and engine oil. Furthermore, the pair of EV and ICE vehicles require to give electric motor insurance, fundamental adjustment, electric brake, and tire modifications. Moreover, when we consider purchasing an electric vehicle or fueling one and the factors such as overall price, vehicle emissions, and selection should be carried out.

9. Recent System Technologies

The installation of a significant number of Stages in charging stations raises the electricity demand. As a result, as more electricity is consumed from the grid, the system will become overloaded, resulting in fluctuation in voltage, voltage control difficulties, and demand in peak concerns, dependability, and forecasting in load, among other issues. All of these concerns have an impact on the system's overall efficiency, which is incompatible with the development of EVs and EVCS. As a result, numerous technologies have been introduced to tackle these issues, such as:

9.1. Smart Grid Technology

Smart grid technologies can help to mitigate the lack of coordination is a concern in power supply and dependability to some extent. The smart grid is established in between the grid and the user, there is a communication path to allow for accurate load controlling in this region [117]. The safe functioning of the system may be secured with the deployment of a smart grid since remote control terminal units are being installed at each feeder, in which they convey accurate information about any type of fault conditions as same as the power intensity used at each of the feeders. This type of technology might provide previous load parameter information to the grid, ensuring smooth generation at the generation end and thereby avoiding reliability issues [118], [119]. Furthermore, because this technology is linked to the car, the battery SOC may be communicated with this type of grid, and this grid can track over the local vehicle charging station in which the feeder in the vehicle of the variable load is being sent to calculate based on the SOC % [120]. Nowadays, when energy generation distributed is present at its highest, an innovative microgrid network serves as an exceptional tool for estimating the grid generation type and load available.

9.2. Technology for Renewable Energy

Fossil fuels are the main energy source and it is the primary cause of environmental damage, yet they are also the primary source of electrical generation today. Greater electric vehicle use needs more electrical power. As a result, it is not considered a prudent idea to make a need of these energy sources in a new way to meet the necessities. Renewable radiation energy sources are the greatest option for charging electric vehicles since they minimize carbon emissions and grid load [121], [122]. Solar is the most simple and cost-effective option of renewable energy accessible now in various parts of the world. Installing a solar panel at home is also the simplest and safest way to obtain electricity. Solar PV panels can be mounted on the top of roofs of public EVCS, retail big shops, offices, and additional structures with a big surface area to reduce direct grid load conditions [122]. Although constructing a solar PV panel on a roof is additionally pricey, its ongoing costs are low, lowering the operating costs of EVs in comparison to ICE-depend vehicles.

9.3. Vehicle to Grid Technology

Between active power intensity and frequency, there might be a balancing condition to maintain the power system balanced, since overloading and underloading can cause a misalignment of frequencies that can impact the system's stability. As a result, it is advised to adopt a system for simultaneous bidirectional flow of energy in which the DC grid supplies electrical power to the car and the vehicle feeds electricity back to the grid when it's not being used. G2V, or V2G, is another name for this technology [123]. According to statistics, 90% of electric cars remain idle every day, and they may assist fulfill high energy demand by supplying the return of electricity to the grid [124]. Automatic generation control (AGC) was developed to maintain the balance of fluctuating load in today's power network. AGC regularizes the producing unit to respond to load fluctuations traditionally. Small solar plants in the home that aren't charging that are not charging the vehicles at a similar time can assist to reduce the strain on the grid by transmitting power that can be given return to the grid. This is considered a clean or green source of electricity that is also economically effective [125].

9.4. Intelligent Transportation System

To improve the Transport system's intelligence the intelligent type Transportation System (ITS) was introduced. This type of system, which consists of electrical sensors, actuators, and an integrated CPU, aids in the tracking of traffic congestion in a specific location. In other words, it established a channel of the communication process between two or more vehicles and the type of charging station or parking IoT. This communication may be readily accomplished through the internet or a mobile network, as well as on-board Geographical Information Systems (GIS), Global Positioning Systems (GPS), and advanced traffic flow modeling techniques [126], [127]. The Internet of Things may be used to monitor and control the process (IoT). IoT may also be used to determine the state of charge (SOC) of an EV battery and relay the parameter information provided to the grid, allowing for correct load monitoring. Apart from that, this technology may be used to pre-book a space at an available charging station and to examine the status of an open slot [127], [128]. This method improved load forecasting and made it easier to interact with renewable-energy-based producing plants, whether at home, at the workplace, in a parking lot, in a shopping mall, or at a charging station.

After all of the research and analysis, we can conclude that the number of charging stations, particularly solar-powered EVST, will increase. The energy demand from the grid will then decrease. Eventually, carbon emissions will be reduced, and environmental pollution will be minimized. The energy intensity gap between the power supply and demand should be closed, and everyone will have access to daily electricity consumption. As India is considered as a developed and developing nation, it will also need to grow the nation’s economy; as the vehicle charging stations increase, so will the need for EVs, and more production units will create. Then, it will increase employment opportunities while also strengthening the nation’s economy. For electric vehicles, a solar PV array, rechargeable batteries of storage, renewable grid, and DG set-depend on charging station has been realized.

The future mode of transportation is defined by the integration of Evs and renewable energy. The greater the penetration of EVs and RCIs, the lower the carbon emissions and consumption of fossil fuels. However, due to natural fluctuations, there are a few obstacles to the deployment of solar architecture. Wind turbine configuration is heavily influenced by position and external conditions. Because of the noise and the need for spacious premises, it has been discovered that urban areas are inappropriate. Because solar cells generate electricity even during the day too, their production is insufficient in having met the considerable normal power demand. The adoption of electric vehicles requires the implementation of intelligent charging / discharging strategies. Thus according to charging valuation strategies, there are only a few electricity need that supports renewable charging, and they are only available to residential users. At charging stations tons and tons, new charging programs for large vehicles and commercial outlets must be accomplished.

10. Conclusion

For a solar-powered charging station in EV, several system designs and the power converter topologies are evaluated and analyzed. In the system Architecture 3, the system uses three different types of the port converter to interconnect the electric vehicle, PV panel, and smart grid has many advantages when compared to the other architectures, including the need for Photovoltaic DC power for charging the EV in direct mode, the easiest way of controlling and needs maximum energy density is attained by using an integration of the converter, and thus, the usage of the existing type AC grid for connecting the multiple chargers of EV-PV. EV charging in the country of Europe will be assisted in the need of future by the use of DC charging via the CHAdeMO and the available Combination of the Charging Standard, which allows for dynamic wireless charging, rapid fast charging, and compatibility of V2X. An examination did base on the published research article based on the subject of electric vehicles and photovoltaic charging reveals that most studies overlook the EV charger's isolation and bidirectional capabilities. The focus has been on designs 1 and 2, which employ individual converters for both the PV and EV. The obstacles of implementing a charging station are examined in this study in terms of grid overloading, battery charging time, and traffic congestion caused by longer wait times at EVCS. Various technologies are discussed to overcome these obstacles. The entire electrical system for transportation may be needed for more dependable and effective with the planned usage of these technologies. This page also discusses several charging procedures, as the vehicle's battery is the most important element of an electric vehicle and must be able to be charged effectively without making any internal damages. This study provides an in-depth look at the most important aspects of WPT systems for EV charging. This article provides a quick overview of the coil detecting method, coil design, and several coil types utilized in electric cars. An enormous difference in the environment may be witnessed by adopting a 100 percent electric vehicle. This will make a significant contribution to a more sustainable future. However, before they are used, authorities must construct more charging stations that can charge the batteries more quickly and use renewable energy sources. There is now a lot of research being done to improve the overall system's reliability.

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