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A REVIEW ON WIRED AND WIRELESS TECHNOLOGIES OF EV AND IMPACTS ON GRID INTEGRATION

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Abstract:

In transportation sector due to the increase in conventional vehicles usage the emissions from these vehicles also increased, And due to this environment pollution increasing day-by-day. So to decrease this pollution, electric vehicles are the best way to replace conventional vehicles. Now a days around the globe the demand for electrified cars are increasing so to reach this increase in using electric vehicles, we must install charging stations because the major drawback of these electric vehicles is these cannot be used to travel large distances as these charging capacity is less so if we install more charging stations the vehicles can charge and travel long distances.

This paper consists unidirectional and bidirectional power flows of charging stations. Classifications of electric vehicle charging. The on board charger restricts power flow and this off board chargers designed for high power. The three levels of charging (i.e. Level1, Level2, and Level3), Wired and wireless charging technologies of electric vehicles, Fast charging stations and their integration with grid, Role of v2g technology, extreme fast charging. Impacts of grid integration and role of aggregators.

Keywords:
Electric vehicles, charging stations, off board and on board chargers, grid integration, Wired charging and wireless charging, power electronics, developments.

Introduction:

As the conventional vehicle has major effects on pollution so to replace them electric vehicles came into picture. The major drawback is lack of charging stations so to overcome this problem more charging stations must be installed. Electric vehicles were developed as a replacement for conventional automobiles because they have significant negative environmental effects. The main issue is a lack of charging stations, hence additional charging stations must be created to solve this issue. Because of its prospective qualities like Over the past few decades, EVs have drawn more attention due to their low emissions of greenhouse gases, low emissions of free pollutants, and great efficiency. Commonly available electric vehicles use cables to connect to the grid, but this has certain drawbacks, including the potential for damage, the need for more user effort, and potential safety concerns owing to the open contacts and dangling charging wires in public places. Batteries that aren't charged due to unplugged wires reduce mobility. It is unacceptable for electric vehicle range to be further reduced. Resonant inductive energy transfer-based wireless charging is an option. This technique enables automatic, trustworthy, and secure charging by providing galvanic isolation, eliminating open connections and hanging charging wires that could be hazards in public areas and are vulnerable to vandalism. Automatic resonant inductive charging will thereby increase consumer acceptance of electric vehicles generally, aid in their market integration, and assist the full realisation of the advantages offered by electro-mobility. [2],[3].

An electric car can be charged at one of Level 1, Level 2, and Level 3 are the three levels. The main difference between these levels is in the voltage ratings. Level 1 EV charging at 120 volts, level 2 EV charging at 240 volts, and level 3 EV charging at between 300 and 600 volts are all suggested voltages. If the amount of charging is higher at these levels of EV, the maximum power output is produced, and the EV charges more quickly. Therefore, level 3 is the most powerful and charges more quickly than level 1 or level 2.[1].

Classification of electric vehicle charging:

Single-phase or three-phase chargers with the capacity for unidirectional or bidirectional power flow are necessary for EV charging. Conductive and inductive chargers are the two types of EV chargers. Conducted charging technology is more advanced, even if inductive charging technology is still a hot topic for research.

Conductive charging:

Since it involves a direct electrical connection between the car and the charging input as illustrated in figure -1, conductive charging has a high charging efficiency and offers a variety of charging capabilities, including level 1, level 2, and level 3 charging. The two power charging levels (Level 2 and Level 3) are utilised for public charging stations. The first two layers do not have as much of an impact on the distribution system (Levels 1 and 2). In addition to providing a V2G facility, conductive charging also provides active power, reduces grid loss, maintains voltage, prevents grid overload, and can offset reactive power by using the vehicle's battery..[1],[4].

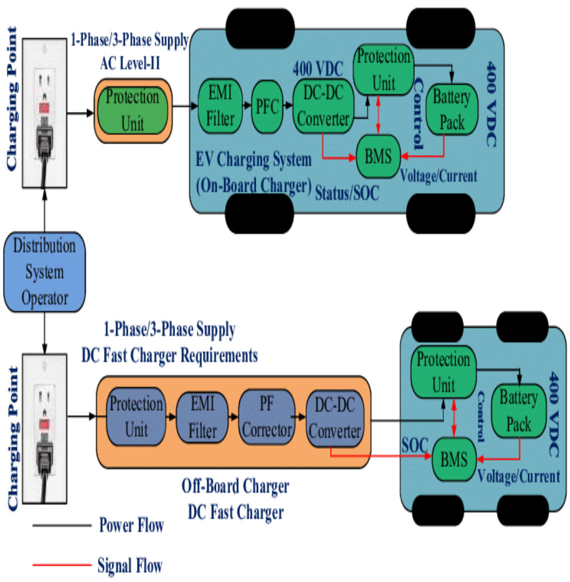

Figure -1: On board and off board infrastructures for conductive charging

Conductive charging requires direct metal-to-metal contact between the utility grid and the EV in order to transmit power. It has been discovered that this charging technique is quite reliable and effective.

Infrastructures for on- and off-board charging are classified as having conductive chargers. On-board chargers are incorporated into electric vehicles because to restrictions on weight, volume, size, and price. These chargers' power output is restricted, though. Off-board EV chargers, however, are not subject to the same size, weight, or space limits because they are placed in public parking lots like those at hospitals, shopping centres, and colleges rather than being an integral part of EVs.[1],[4].

Inductive charging:

To feed the EV with power from the utility grid, inductive or wireless chargers use the IPT, or mutual induction, principle. It doesn't call for any direct interaction between the EV and the utility grid. Additionally, they could or might not need isolation. transformers for safety reasons; as a result, it is smaller than conductive chargers. However, Inductive chargers are usually less efficient since the power transferring coils are out of alignment. According to Figure -2, Static inductive chargers, dynamic inductive chargers, and quasi-dynamic inductive chargers are the three types of inductive chargers. Figure 3 illustrates the concept for static and roadbed inductive chargers for wirelessly recharging EVs.[1]

Two coils are used in static inductive chargers; The other coil is a crucial part of the EV and is located either within the charger or outside. The alignment of both coils is correct to produce optimum efficiency. The EV may be charged while it is moving thanks to roadbed inductive charging. In this charging technique, specialised charging tracks that can charge the EV and lessen range anxiety and ESS capacity are built out on the roads (often motorways). Whenever an electric car stops for a moment, like at a traffic signal, it is charged while employing quasi-dynamic inductive charging.[1].

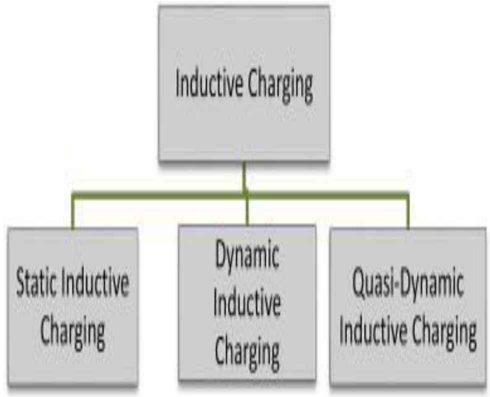

Figure -2: Classification of inductive charging

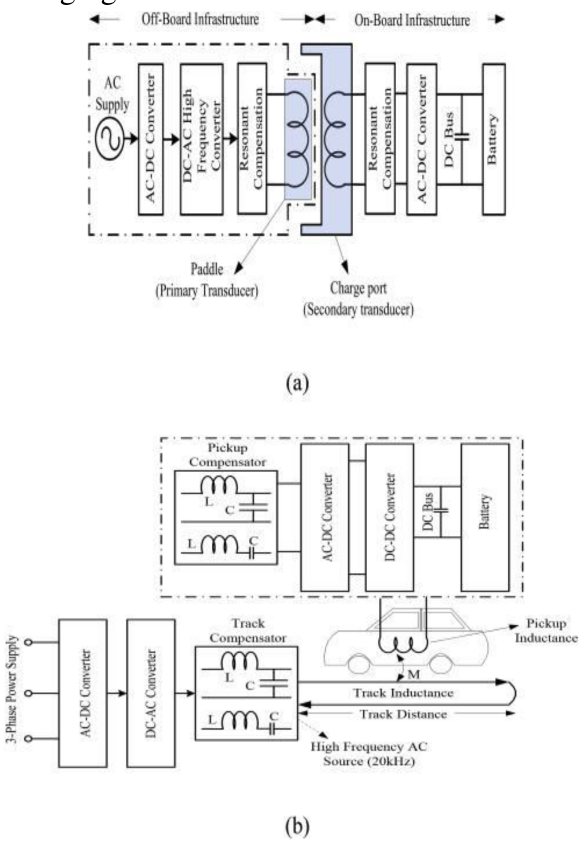

Figure -3: (a) Stationary inductive charging (b) Roadbed inductive charging

Unidirectional and bi directional charging:

Figure -4 depicts two potential types of power transmission between the electric vehicle and the grid. Electric vehicles (EVs) with unidirectional chargers only add energy to their own batteries, not the utility grid. These chargers often include a

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filter and dc-dc converters in addition to a diode bridge rectifier (DBR). Since these converters are now produced in a single step, their size, weight, cost, and losses are constrained.

By adjusting the current phase angle, active front-end chargers can offer reactive power without discharging the batteries. Due to higher EV penetration in the utility grid and active charging current control, unidirectional chargers seem to be a promising approach to accomplish the majority of utility goals while avoiding the costs, safety concerns, and performance issues associated with bidirectional chargers. In contrast, a bidirectional charger features two power stages: an active grid-connected bidirectional ac-dc converter that provides unity power factor and a bidirectional dc-dc converter that regulates the charging current (PF).[1]

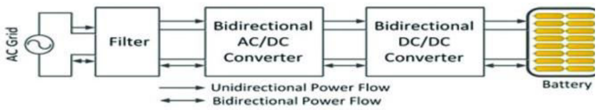

Figure -4: Unidirectional and Bidirectional charging

Wired and wireless charging networks:

Wired and wireless battery chargers are the two different types of charging networks Ac and DC charging technologies are two additional categories for wired charging stations. In this ac charging technique, onboard chargers are used to power these electric vehicles rather than directly charging the batteries. As the batteries in EVs can only be charged by dc power, a converter is installed in the charging station to convert ac power to dc power so that the car can be charged using the converted dc power. These ac chargers are used to charge electric vehicles at home. The automobiles can be immediately charged using this dc charging technique. These are employed in industrial settings.[2],[3]. This wired charging technology is showed in figure -5

In dc-dc converters, the current is first taken and passed through a switching element. Next, the signal is converted to a square wave, which is actually an ac supply. Finally, the wave is passed through another filter to create a dc signal.

Vehicles can be charged wirelessly using antennas and no wires at all due to recent technological advancements. Energy is transferred between transmitter and receiver pads in WCT. There are three different categories for them. They are called WCTs for far, medium, and close fields. Lasers or microwave radiation are employed as energy conveyors in far field WCT. Long transmission lengths are possible with them, and big antennas are employed as a result. These are employed in military and satellite applications in space. Electric and magnetic fields are employed as energy conveyors in near field or inductive WCT. These are employed in applications for tablets, smart watches, and smartphones.[2],[3].

The two main WPT technology categories are far-field and near-field. The energy carrier for far-field technology is either a laser or microwave radiation. They can transmit a lot of electricity over a lot of distance. But complex tracking methods and a direct line of sight transmission link are needed. Furthermore, when the frequency of operation rises, the EM

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specifications become more demanding. As a result, the antennas would need to be very huge, which is not viable for EV WPT applications. Due to these factors, far-field WPT technologies are mostly used in aerospace and defence industries, such as solar power satellites. Both electric and magnetic fields are used for energy transmission in the near-field WPT systems. Energy transmission utilising electric fields is unaffected by metallic obstacles and results in less electromagnetic interference (EMI) than its magnetic field equivalent. However, because air has a low intrinsic permittivity, there is insufficient coupling capacitance.

To improve coupling, specific dielectric materials can be used. It is nevertheless, however, quite sensitive to the coupling plates' displacement and air gap length. WPT technologies based on near-field magnetic fields have achieved a lot in both short- and mid-range applications. Pairs of ferrite cores are used in early short-range EV applications to create robust coupling. Although the air gap is only a few millimetres wide and the vehicle mobility is severely constrained, the charging power can transfer tens of kilowatts. Later studies modify the core/winding configurations to accommodate significant lateral misalignment and use resonance to lengthen the air gap. The size of the transmitting coil determines the air gap, which can reach tens of millimetres. By removing the ferrite cores, mid-range applications increase the transmitting distance to many times or even on the order of the coil diameter. The transmitting distance is increased to several metres with a power level up to hundreds of watts thanks to the use of magnetic resonance and a multicoil design.[3]. This wireless charging technology is shown in figure -6.

Figure -5: Wired charging

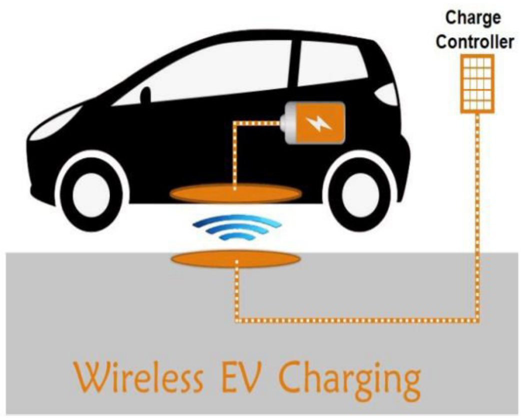

Figure -6: Wireless charging

Levels of charging:

Electric car charging at level 1 uses a 1-phase, 120v, 16A supply that produces 2.3KW of output power. 2.3 KW is equivalent to 4 to 5 miles per hour. These are utilised for short-distance travel due of their lower battery charge. These level 1 chargers charge batteries through sockets and are plug-type chargers. This level 1 battery is charged by a plug at home. Figure -7 depicts the infrastructure flow chart for EV charging.

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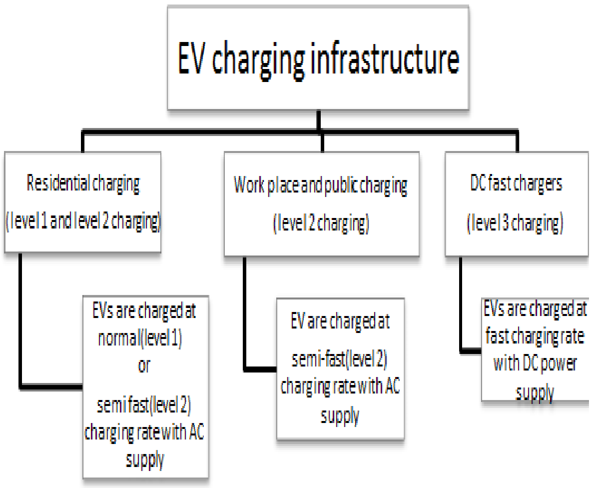

Figure -7: Infrastructure for charging electric vehicles

In level 2 electric car charging, which is 1-phase, 240V, (12-180), an A supply provides output power ranging from 2.9 to 19.2 kW, charging the vehicle 5 to 15 times faster than with a standard connection. Both residential and business venues have these charging stations. To charge EVs, these chargers can be positioned close to walls, poles, or stands on the ground. These avoid using public charging stations and can charge more quickly than level 1 devices.

Level 3 fast chargers for electric vehicles are also referred to as fast chargers. The output power of 3-phase, 400V, and (32-63) A supply AC chargers ranges from 22.1 to 43.1KW. And these 400A, 300 to 600V DC fast chargers produce 240 KW of electricity. These are put at public locations to charge vehicles and can charge batteries faster than the other two tiers. For charging purposes, this electricity is supplied directly to the EV; it is converted from AC to DC within the charging station; whereas, the other two levels rely on on-board chargers.[1].

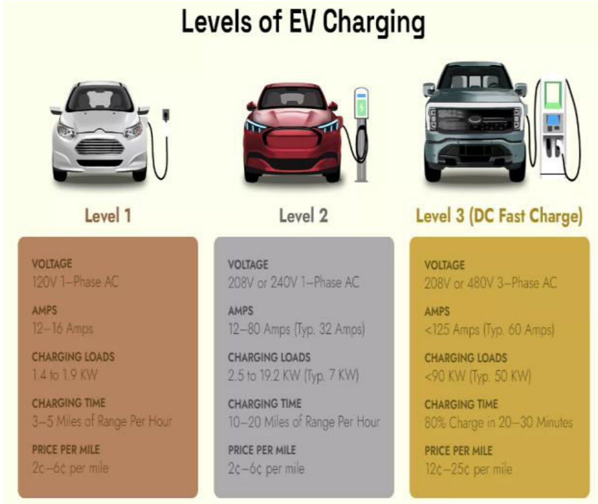

Figure -8: Levels of electric vehicle charging

Charging time:

The amount of time it takes to charge a battery is mostly determined by its capacity, power density, and charging power. If the battery's capacity is higher, it can keep more charge (analogous to the size of a fuel tank). With a higher power density, the battery can hold a charge for longer per unit time (the size of the tank opening). Similar to the flow rate of a pump, higher charging powers yield more energy per unit of time. Fast charging has a number of drawbacks, one of which is increased demand on the primary electrical grid.

Charging time can be obtained by,

Charge time $=\frac{Battery\ capacity(KWH)}{charging\ power(KW)}$

Battery power:

With an useful battery capacity of about 20 kilowatt-hours (kWh), a first-generation electric car like the Nissan Leaf has a range of about 100 miles (160 km). Tesla was the first company to provide longer-range vehicles, initially releasing its Model S with battery capacity of 40 kWh, 60 kWh, and 85 kWh, with the latter lasting for roughly 480 km (300 mi). The typical range of a plug-in hybrid car is 20 to 80 kilometres, and its battery capacity ranges from 3 to 20 kWh (12 to 50 miles).

Table -1: Levels of charging

Levels	Voltage rating	Charger type	Power rating	Time for charging	Cost c instal
AC level -1	120V(US) 230V(EU)	On board charger	1.4 KW (12A)	14 – 17 Hours	$500-$8
AC level -2	240V(US) 400V(EU)	On board charger	4KW (17A)	4 – 6 Hours	$2000 -
AC level -3	208V 415V	On board charger	>20KW	0.4 – 1 Hour	$30,000- $160,00
DC level -1	200 – 450V	Off board charger	36KW (80A)	0.4 – 1 Hour	$8,500 -
DC level – 2	200 – 450 V	Off board charger	90KW (200A)	10 – 20 min	_
DC level – 3	200 – 600 V	Off board charger	240 KW (400A)	< 10 min	_

Fast charging EV:

Standards and Implementations

Regarding the utility-customer connectivity, groups like the IEEE, The Society of Automotive Engineers (SAE), and the Infrastructure Working Council (IWC) (SAE) establish norms and standards. Fast charging is divided into different categories according to the charging power needed for electric vehicle use. IEC standards define EV charging into four different modes, with Mode 4 being designated as DC Fast Charging (DCFC). According to the Society of Automotive Engineers (SAE), a quick charging is defined as "Level-3 DC" and requires between 90 and 240 kW of electricity to charge EVs. CHAdeMO, a Japanese fast charging standard for electric cars, is also rising in popularity globally.[6].

Integration of fast charging stations with the grid:

Several difficulties in integrating EV charging stations with the grid have been explored in the literature. The charging station's high power requirements have a number of detrimental effects on the power system, including voltage alterations, higher distribution losses, and deterioration of power quality. When integrating EV charging, there is also a problem with increased network loading because of its erratic nature. In addition, it is necessary to consider the worry that overloading would shorten the transformer's lifespan. Even with four charging slots, a rapid charging station would require a Megawatt-range charging capacity. Therefore, in order to have a working integrated fast-charging station for the grid, a number of conditions must be met.[6].

Function of V2G technology:

Undoubtedly, EVs may serve as independent, scattered energy sources that assist the electrical grid in the future. Figure -9 shows vehicle to grid technology. Numerous studies have revealed that the majority of parked cars spend roughly 95% of their time idle. They can then continue to be connected to the grid and use Kempton's utilising the vehicle to grid (V2G) transfer the energy that has been stored in their batteries to the grid. Many of the common grid-related issues can be solved in a smart grid environment with the help of the V2G idea. The power market has been given a viable solution by V2G tactics. The majority of recent research on the use of the V2G idea have concentrated on the operations of the deregulated electricity market. The viability of V2G transactions, both commercially and technically possible through a number of studies devoted to lowering the Cost of distribution and V2G infrastructure investments, as well as the price of charging and pricing variation optimization. Both the EV aggregator and the consumer may benefit economically from taking part in the electricity reserve market.[6].

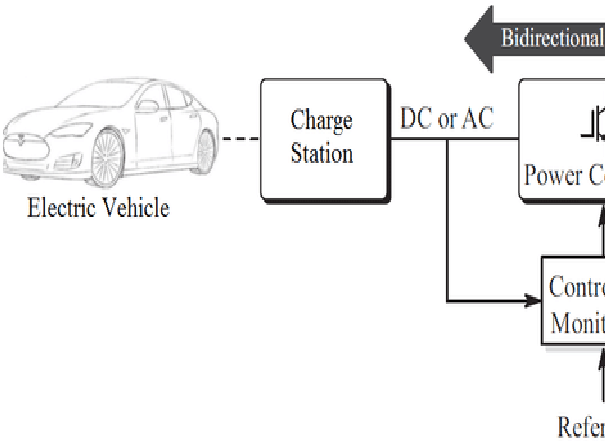

Figure -9: V2G technology

Extremely fast chargers:

Because it takes so long for them to refuel with electricity, most people choose not to use the environmentally friendly alternative of an EV. Customers are used to the concept of entering a gas station, filling up their vehicles in under five minutes, and then leaving. A typical internal combustion engine vehicle (ICEV) has a range of 300–400 miles after fuel, making this technology profitable. Therefore, the only goal of study on the placement and planning of EV charging stations must be to make the stations more similar to petrol stations. The Medium Voltage (MV) line must be connected to service transformers in order to use the present quick charging architecture, which increases size, cost, and labour costs as well as complicates installation .

Level 1 and level 2 chargers are the most common EV charging technologies, and they can be found in homes and workplaces. The daily average distance travelled by Americans is 30 miles, with commute times of 46 minutes. As a result, they just require level 1 and level 2 charging for daily needs. Long-distance excursions in EVs are still difficult, though. For the EV to travel without charging for a few days, unplanned journeys and days when there can be an unexpected blackout or power loss must also be taken into account. XFC is a crucial technique to solve this issue. Since buses, trucks, and other shared fleet vehicles are larger and require more kWh of power and more time to charge from level 1 or 2 charging, their charging at the moment is protracted, long-distance commercial transportation will also benefit from XFC. In addition to working for the aforementioned instances, XFC can be beneficial for multi-unit homes in cities.[7]

Grid stability:

A significant issue that needs to be solved is the significant burden that charging places on the electricity infrastructure. Recently developed XFC technology may even draw 350 kW for a single car. Fast-charging voltage will increase even more when commercial heavy-duty cars with 1.2 MW battery packs are introduced, which will have a negative effect on the grid. The development of EVs and the accompanying charging infrastructure benefits the environment and the ensuing economic expansion, but it can be bad for the power system. Before looking at potential treatments or techniques to lessen these impacts, it is important to understand these consequences. High charging load

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related challenges include rising peak demand, shrinking reserve margins, unstable voltage, and reliability difficulties.[7]

Impacts on EV grid integration:

There are two types of EVGI they are of positive impacts and negative impacts as shown in figure -10.

Positive impact, although too many EVs on the grid might lead to problems with power quality, increased peak load, and power regulating problems using reducing power management techniques, all of these challenges can be overcome.

Negative impacts, Electric utilities face a big competition from EVs. excessive electric vehicle integration into the distribution network might affect voltage, frequency, load profile, and component capacity of the distribution system imbalances, disproportionate harmonic insertion, power losses, and the distribution's stability grid.

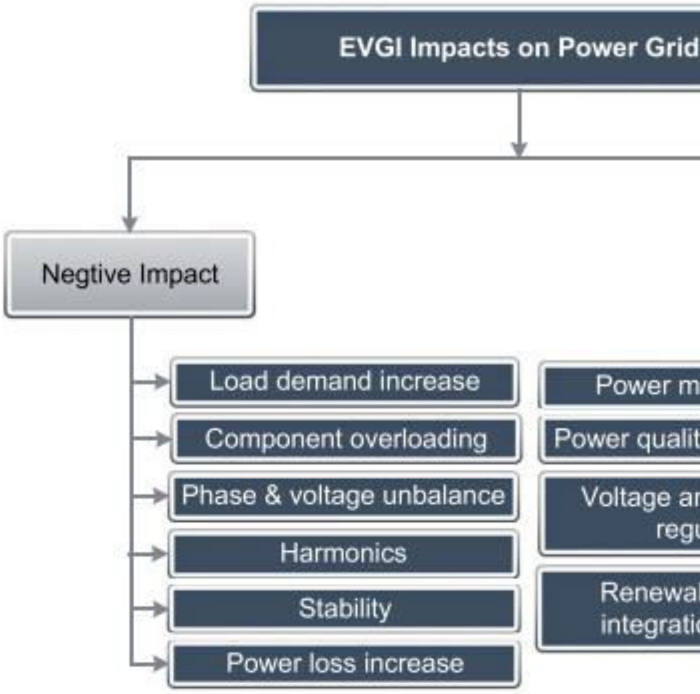

Figure -10 : Electric vehicle grid integration impacts on power grid

Traditionally, the main function of the EVGI has been to charge an EV's batteries. However, EVs can serve a second purpose in the present or future smart grid environment, which is to offer electricity back to the grid and support activities such as peak power reduction, reactive power supply, and harmonic mitigation. A broad EVGI framework that covers the technical and market operation areas is necessary to fulfill these goals.[5].

Role of aggregator:

The EV aggregators act as a bridge from EVs to the grid and constantly feed grid operators the data provided by EV drivers, such as the amount of electricity needed for charging and the length of time it takes to connect. Additionally, EV aggregators provide EV owners with information on the cost of electricity and the locations of charging stations. When multiple aggregators may coexist on the market, an EV owner will profit from selecting the one that best suits his needs. Through the assistance of DSO, In order to set their buy/sell prices, the aggregators will estimate how the electricity demand would behave the next day. DSO examines and analyses if the demand projection is technologically possible. The aggregator can move forward if the prediction is good.

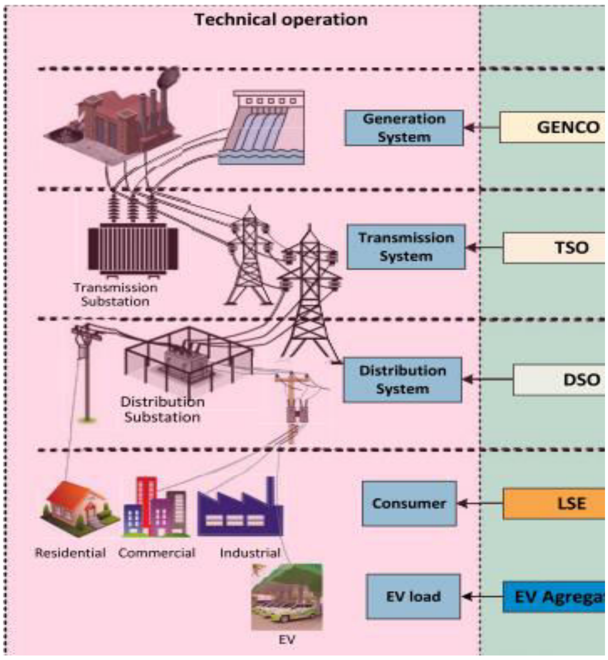

Figure -11: Role of aggregator

Aggregators on the grid side will purchase electricity at reduced costs from the marketplace and might sell it throughout the day, during peak hours, by using their for their own customers' EV storage capacity. Then, aggregators will engage in direct competition for customers' energy purchases with electricity retailers and/or with GENCO for energy sales. Through the connection of the aggregators with TSO, it will also be possible with this strategy to have EVs participate in secondary frequency regulation. The aggregators might also bargain with other organisations that provide EV battery services and parking.[5].

Conclusions:

In this paper we observe various classification of electric vehicle charging like inductive charging, conductive charging and unidirectional and bidirectional types and also seen about wired and wireless charging technologies and various levels of charging technologies and describes about grid integration and various impacts of grid integration. vehicle to grid technologies. As the pollution is increasing day by day these conventional vehicles must be replaced by electric vehicle for the safety of us otherwise we may suffer with many problems like health issues, lack of petrol and diesel etc. so to overcome these problems electric vehicles came into existence. If we know the benefits of these EV then everyone start using electric vehicles.

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