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Review Paper on Charging of Electrical Vehicle

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A B S T R A C T

This paper discuss about electrical vehicle battery and it's charging stations. Most of Electric vehicles (EVs) use electric motors powered by electrical energy stored in a battery for propulsion. This type vehicles are available in a variety of models with varying ranges and capabilities and are plugged in to a source of electrical power to recharge. Now in market two major battery technologies used in EVs are nickel metal hydride (NiMH) and lithium ion (Li-ion).this paper also evaluates the batteries and challenge of deploying an expanded network of EV charging system.

Keywords: Electrical Vehicle, Battery, Charging Methods

1. Introduction

The advantage of EVs (Electric Vehicles) extend beyond reducing the pollution and increasing the dependency on renewable energy sources, especially more progress made in the power electronics field. In fact, most of research papers have shown that the massive integration of grid-connected vehicles such as EVs, PHEVs (Plug-In Electric Vehicles), and FCVs (Fuel Cell Vehicles) provides help to the electric grid. Batteries of the vehicles act as storage element for renewable energy source when it connected to the grid that are being used in an increased rate of today's electricity production. This paper shows the review of the current and emerging EVSE technologies and an assessment of common codes and standards associated with EVSE.

Most of fundamental EV design concept actually predate gasoline internal combustion engine. Now days due to advance battery storage technology, lightweight vehicle construction, electric grid automation and other factors will increase the attractiveness of EVs for consumer, business and government agencies and support the long term shifts to more efficient transportation options.

There are two basic types of EVs:

1. Due to energy stored in battery system all EV are powered solely but there is no backup power generation in vehicle, when charging is over means battery runs out of charge it recharging before operation again.
2. For certain distance PHEV are capable of operating solely on electric energy, after that which an auxiliary internal combustion engine is engaged to offer additional range. According to their range in electric mode PHEV are after categorized.

There are a unit variety of various ways in which to charge your electrical car's battery pack. Being featured with traditional and quick charging strategies, and completely different connector sorts, is a bit intimidating initially. However really its way easier than it 1st appears! During this short guide we'll allow you to in on all the key info you wish to grasp. Essentially, it comes right down to 2 main considerations: wherever you opt to charge and the way quick you opt to charge. These area unit interconnected, and also the charging speed can rely on that specific heat unit you own, its battery capability and what form of charging system you're victimization.

2. Basic Terms of Battery Performance

A. Cell, Module, and Pack: Cell means the complete battery with two current leads and separate compartment holding electrodes, separator, and electrolyte. Module means is composed of a few cells either by physical attachment or by welding in between cells. For thermal management pack of

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batteries composed of modules and placed in single containing. Every electrical vehicle may have more than one pack of battery situated in different location in the car

B. Ampere-hour Capacity: It is total charge that can be discharged from a fully charged battery under specified condition. As per the manufacturer predefined condition the rated Ah capacity is nominal capacity of a fully charged new battery.

C. C-rate: In one hours capacity of battery is equal to charge or discharge is represent by using C rate. If the 1.6Ah battery,then C is equal to charge or discharge the battery at1.6 A.

D. Specific Energy: How much energy can be stored in battery per unit mass that can be defined with help of specific energy. It is also called as gravimetric energy density. It is expressed in watts hours per kilo gram (Wh/kg).Gravimetric energy density is the key parameter for determining the total battery weight for given mile range of EV.

E. Specific Power: It is the ratio of rated peak power to battery mass in kg. It is also called as gravimetric power density and it is expressed in W/kg.

Specific Power = Rated Peak Power/Battery Mass in kg

F. Cut-off Voltage: the voltage which is defined by manufacturer and it can be expressed as the "empty" state of the battery.

G. State of Charge (SOC): it is the ratio of reaming capacity of battery to rated capacity, SOC is affected by its operating condition such as load current and temperature.

SOC =Remaining Capacity /Rated Capacity

3. Battery Charging Methods

Batteries performance, safety, durability are highly dependent on how they are charged or discharged. Life of battery can be reduce and can be dangerous if abuse of battery. A current BMS includes both charging and discharging control on board.

Charging Methods:

There are the following common charging methods for electrical vehicle batteries

1. *Constant Voltage*- At which voltage battery will charge this voltage known as constant voltage.it is simplest charging schemes and it suitable for all kinds of battery. In this method current can be varies in charging process, at initial stage large current flow then it gradually decreases to zero when battery is full charged. At early stage very high power is required this is main drawback of this method. It is not available for most residential and parking structures.
2. *Constant Current*- In this method current is constant and voltage is vary which is applied to battery. For constant current SOC is increase linearly versus time. Cutoff can be determined with the help of combination of temperature rise, voltage increase, minus voltage change, and charging time.
3. *The combination of constant voltage and constant current methods*- In this method both constant current and constant voltage are used. Fig shows the charging profile of a Li-ion cell. At initial condition CC is less if cell is not recharged before, then constant current goes to higher value when it switched to charge. At a certain point when battery voltage reaches certain threshold point that time charging is changed to constant voltage charge.

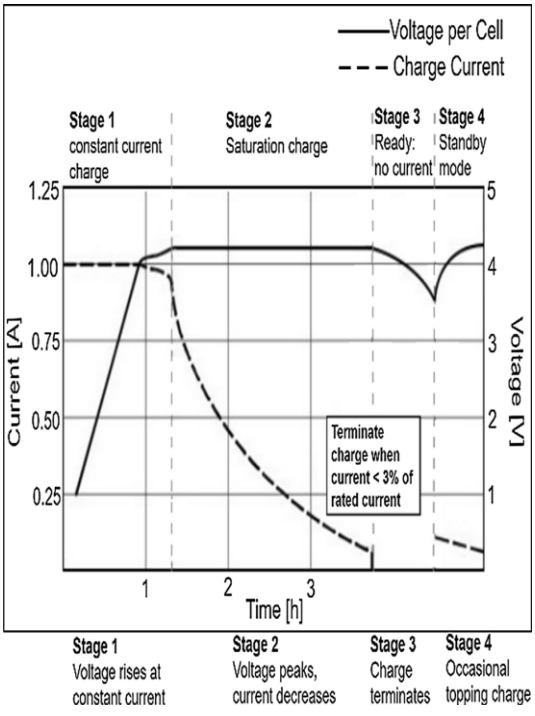

Fig:1 Typical Li-ion cell charge profile

HYBRID CONCEPT:

Another key thing to know from the outset: There are three categories or types of charging:
Trickle Charge, AC Charge and DC Charge.

Option 1: Home charging
Around eightieth of all energy unit charging is presently done reception. Sometimes nightlong whereas house owners sleep – waking to a completely charged battery consecutive morning that nearly invariably provides over enough energy unit vary for many people's daily travel wants. There square measure 2 styles of home charging available: victimization Trickle Charge together with your social unit current or AC social unit Charge with associate degree put in wall box. Here square measure the key variation.

Trickle Charger:
•Provides charging through a regular (three-prong) 220V plug that comes together with your eV. The opposite finish is solely blocked directly into your eV
Doesn't need installation of extra charging instrumentality
•Can deliver thirteen to sixteen kilometer of vary per hour of charging
•Charging speed: approx. sixty five kilometer of point five hours (overnight), or two hundred kilometer in fourteen hours
•Using Trickle Charge is simply suggested in imperative cases once you have low battery charge and can't drive to a public station or access associate AC wall box reception. This is often as a result of the employment of home electricity might cause issues related to electricity bills and electrical hundreds, therefore continuously use this charge answer with caution and seek advice from your electricity supplier before 1st use. Buying associate ICCB (In Cable management Box) cable once mistreatment Trickle Charge is usually recommended, for optimum dependability and peace of mind.

Ac Household Charging With Wallbox:
•The commonest and recommendable home charging choice
•Provides charging through a 230V outlet that permits charging three to four times quicker than Trickle Charge – betting on the acceptance rate of your specific model and also the charger
•Especially helpful if you have got time to prime up your electrical vehicle overnight: it takes around six hours to completely charge a forty kWh battery automotive
•Requires the installation of an ardent work unit charging wall box, that ought to be fitted by a trained trained worker
•Ideal if you have got a garage or drive within which it are often positioned
•There can also be money incentives in your native region or country to minimize purchase and installation prices.
Option 2: Public charging stations:
Increasingly convenient thanks to the ever-growing network, these stations can often be located throughout urban centers in particular and allow you to top up your battery on the go if you need to travel longer distances.

4. Ev Charging Scheme

The achievement of electrical vehicle or success of EV will be highly depend on whether charging stations can be built for easy access. Home and workplace is first place considered for charging station. Gas station, shopping centers, restaurants, and highway rest areas are other potential location with high populations. For energy transfer, connection interface and communication for EV charging various standards are regarding.

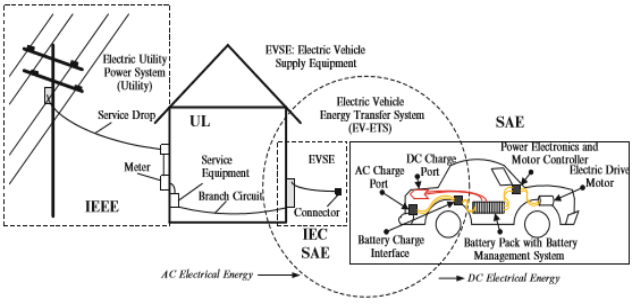

Fig:2 Electric vehicle energy transfer system

Table1: EV charging power level

Charging level	Typical charging power
Level 1	1.5-3kw
Level 2	10-20kw
Level 3	40 kw and up

Level 1, 120 Volt Charging:

It is simplest form of charging uses a 120V AC connection to a standard residential/commercial electrical outlet capable of supplying 15-20 amps of current, for a power draw usually around 1.4 kW when charging.

Figure shows AEVs with 60-80 miles of range will require 10-14 hours for a full charge using Level 1 EVSE. At Vermont's average residential electric rate of $0.16/kWh5, one hour of Level 1 charging costs about $0.25.

Advantages:

1. Cost of installation is less.
2. Low impact on electric utility peak demand charges which are often applied to commercial accounts

Disadvantages:

1. Slow charging around 3or 5 miles of range added per hour of charging.

Level 2, 208/240 Volt Charging:

This type of charging required 208/240 ac power connection and significantly reduce charging time. The J1772standard connector used by most EV, can be theoretically provide up to 80amp of current (19.2kw) although most vehicles present available only use up to 30 amps for 3.3 to 6.6kw charging.

Advantages:

1. Charge time is significantly faster than Level 1. EVs will get between 10 and 20 miles of range per hour of charge
2. More energy efficient than Level 1 for short duration charge events less than one hour
3. Variety of manufacturers provides differentiated products for distinct markets and requirements.

Disadvantages:

1. Installation costs are higher than Level 1 and are highly variable depending on equipment and installation issues.
2. Potentially higher impact on electric utility peak demand charge.

DC Fast Charging:

This is level 3 in which equipment delivers high power directly in to an EV battery system enabling rapid charging. In 30monutes or less 80% charge can be provided for many electrical vehicle.

Advantages:

1. Charge time is reduced drastically – typically 30 minutes for an 80% charge.

Disadvantages:

1. Equipment and installation costs are higher than level 1 and level 2 charging, $20,000$100,000 depending on equipment and power availability at site
2. Potential for increased peak power demand charges from electric utility.

5. Electrical Ac Charging Equipment

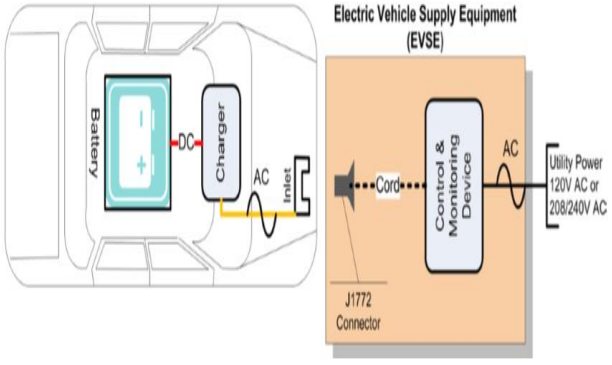

Fig:3 Electric Vehicle AC Charging Equipment Diagram

EVSE: Electrical vehicle supply equipment

When equipment connected to an electrical power source that provides ac or dc current supply to electrical vehicle. That is needed to charge the vehicles traction batteries. For fast batteries recharged EVSE charging capacity is important consideration. For example-level 2 EVSE is available in 20,30and 40amp capacities and higher amp equates to faster recharge times. The ability to match the full output of the EVSE and PEV on board charger, to realize the fastest recharge times

Electric Vehicle Connector:

EVSE and PEV provides the physical connection between each other when it attached to EVSE cable. Today we use three predominant connectors the SAE J1772 based connector (developed by the U.S. auto standards development organization SAE), the CHAdeMO connector (developed by the Japanese auto standards development organization), and the Tesla developed Supercharger connector that is used exclusively for charging Tesla electric automobiles.

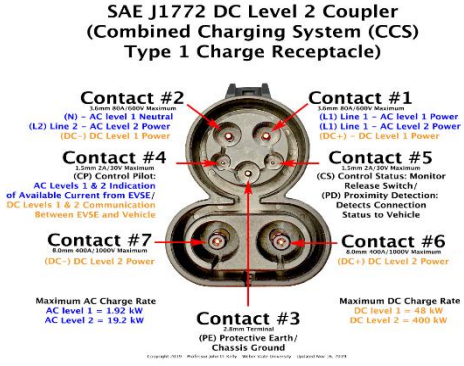

Fig: 4 SAE J1772 connector

You might be asking yourself if you wish AN adapter for various charging strategies and kinds. At the instant, there isn't a universal instrumentality for all EVs and every one chargers. However the various instrumentality sorts do correspond with the various levels of charging, creating things easier for eV drivers.

Here's an outline of the most instrumentality sorts

	TYPE 1	**TYPE 2**	**CHAdeMo**	**TYPE 2 CCS**
Charging Type	Ac charging	Ac charging	DC fast charging	DC fast charging
No. of pins	5	7	4	9
Capacity	Up to 11kW	Up to 43 kW	50kW-100kW	Up to 170kW
Voltage	230V	230/400V	500V	450V
Current Rating	Up to 32A	Up to 63A	125A	125A
Compability with KIA EV'S	Yes	Yes	No	Yes

Battery Charger:

To convert EVSE ac supply to direct current (dc) uses the PEV internal battery charger it need to charge the cars traction batteries. High current supply directly to PEV traction batteries with the help of dc fast chargers. When DCFC used that time onboard charger is by passed, when the purchasing a PEV on board battery charger options are an important consideration.

6. Charging Capacity, Speed and Load Balancing

The different factors like the capacity of vehicle battery, power and charging station which is depend upon charging time. In upcoming years charging time is expected to decrees rapidly.

Regular power charging point
Charging point in EV allow for a transfer of electricity to electric vehicle with a power of more than 20kw.

High power charging point
EV needs charging point that allows for a transfer of electricity to an electric vehicle with a power of more than 22 kW. Fast charger delivers 50 kW power which is common. Nowadays development of fast charging is ongoing and there are fast charges delivering 175kw and more. (For heavy duty vehicles there are chargers which deliver 450 kW of power).

Load balancing / charging plazaxi
Several charging points available in charging plaza which is share a single connection to the electricity network.as per the demand of charging point, charging plaza allocates the available capacity, allowing EV drivers to charge their vehicle optimally. This is called as "load balancing". If maximum capacity is reached then charging speed is adjusted automatically.

7. Smart Charging

Electrical vehicle is charge by smart charging which can be externally controlled (means altered by externally), which is allowing for adaptive charging habits, providing the electrical vehicle with ability to integrate into the whole power system in a grid and user friendly way. While the mobility constraints and requirements of uses, the smart charging must facilitate the security of supply.
Grid-to-vehicle (GV 2): G2V technology is transfer energy from grid to vehicle it is a technology enables vehicle to feed electricity back into the grid. Battery of electric vehicle can be charged in smart way to prevent peak load on the grid, this can be based on energy demand and available capacity on a local level.

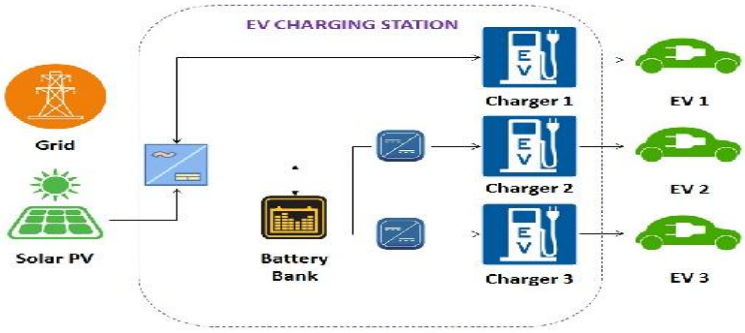

Fig: 5 Grid-to-vehicle (GV 2

Vehicle-to-grid (V2G): in V2G technology vehicle enables to feed electricity back into the grid. To store energy in times of high (sustainable) energy production. The battery in vehicle can be used as buffer. But it also act as an energy supplier in times of low energy production. Vehicle to grid contributes for optimizing sustainable energy usage V2G technology.

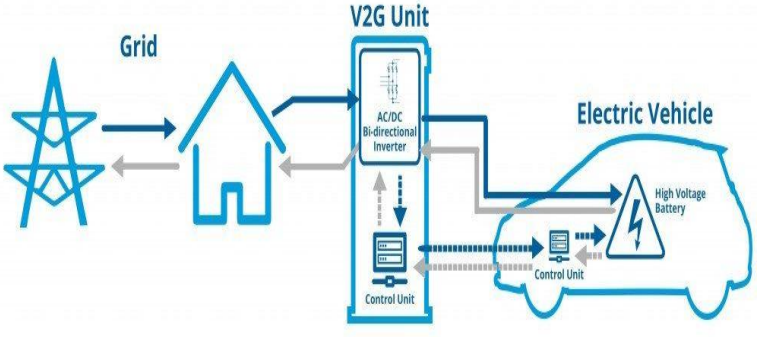

Fig: 6 Vehicle-to-grid (V2G)

8. Wireless Ev Charging

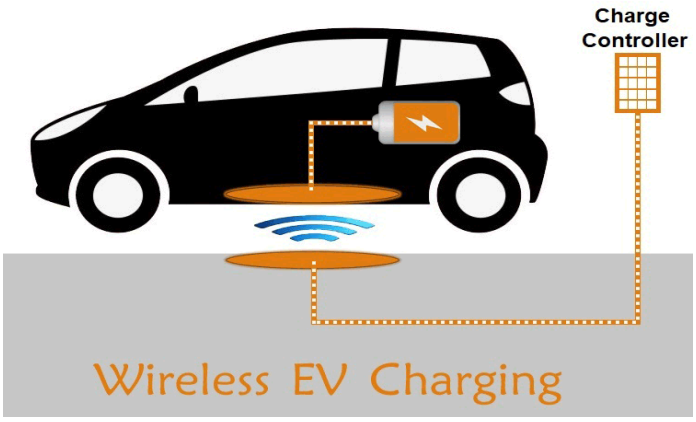

Fig:7 Wireless EV charging

To nice scientist electrical engineer for his limitless superb inventions within which wireless power transfer is one in all them. He started his experiment on wireless power transmission in 1891 and developed Tesla coil. In 1901 with the first goal to develop a brand new wireless power gear Tesla started developing the Wardenclyffe Tower for big high-voltage wireless energy transmission station. The saddest half is to satisfy Tesla's debts, the tower was dynamited and destroyed for scrap on Gregorian calendar month fourth 1917.

Basic principle of wireless charging is same as electrical device regulation. In wireless charging there are transmitter and receiver, 220V 50Hz AC offer is reborn into High frequency electricity and this high frequency AC is provided to transmitter coil, then it creates alternating magnetic flux that cuts the receiver coil and causes the assembly of AC power output in receiver coil. However the necessary issue for economical wireless charging is to keep up the resonance frequency between transmitter and receiver. To keep up the resonant frequencies, compensation networks are other at either side. Then finally, this AC power at receiver facet corrected to DC and fed to the battery through Battery Management System (BMS).

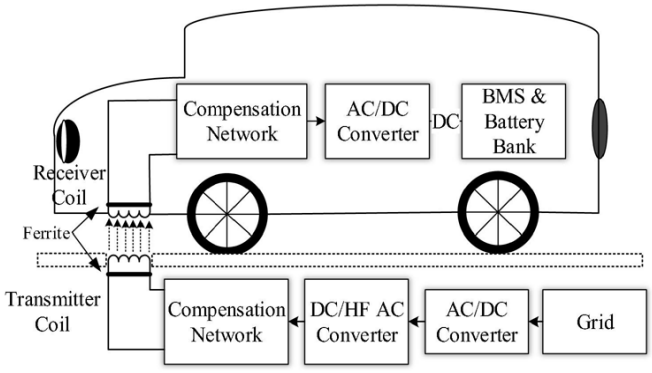

Fig: 8 Wireless system

Based on the application, Wireless charging systems for EV can be distinguished into two categories,

1. Static Wireless Charging
2. Dynamic Wireless Charging

1.**Static Wireless Charging**

As the name indicates, the vehicle gets charged once it remains static. Thus here we tend to might merely park the work unit at the parking spot or in garage that is incorporated with WCS. Transmitter is fitted beneath the bottom and receiver is organized in vehicles beneath. To charge the vehicle align the transmitter and receiver and leave it for charging. The charging time depends on the AC provide power level, distance between the transmitter & receiver and their pad sizes.This SWCS is best to make in areas wherever work unit is being set for a definite quantity.

2. Dynamic Wireless Charging

As the name indicates here vehicle get charged whereas in motion. The facility transfers over the air from a stationary transmitter to the receiver coil during a moving vehicle. By victimizations DWCS EV's travel vary may well be improved with the continual charging of its battery whereas driving on roadways and highways. It cut backs the requirement for giant energy storage that additional reduce the burden of the vehicle.

9. Charging Limitation

The charging mode chosen for this model is that the mode two, for the vehicle to charge reception throughout the night-time, that incorporates a most charging power allowed of roughly seven kW (FleetCarma, 2018). The vehicle is charging at most power in any respect times that it's charging. If the energy desires for complete the charging are below the utmost charging power, then the vehicle is taken into account to be charging at most power for a period below the interval. As associate example, if a vehicle desires 3 and a 0.5 intervals to charge, it'll charge at most power for the period of the 3 and a 0.5 intervals, rather than charging at most power for 3 intervals and five hundredth of the utmost for the remaining interval, or the other variation of this.
With regards to charging potency, no info is specifically given for every model by the manufacturer or the other obtainable supply. For that reason, constant charging potency of eighty nine.4% was chosen for each vehicle (Sears et al., 2014).

10. Conclusion

Due to high voltage and current in system the sophisticated charging algorithms, the charging of these batteries becomes very complicated. From this paper shows various charging equipment and charging schemes and battery charging modes of electric vehicle. Also shows the infrastructure of EV charging as a key action to meeting greenhouse gas reduction target established by state legislature. EV helps to these goals by providing low carbon, highly efficient and cost effective. With the help of electric motor electric vehicle propelled and that is supplied with power from a rechargeable battery. Electric vehicles area unit expected to enter the world market such that by 2030, 100% of the vehicles can be of heat unit kind. To have a higher understanding on heat unit technology, this study outlines the varied sorts of heat unit, battery chargers and charging stations. A comprehensive review has conjointly been created on the standards presently adopted for charging heat unit worldwide. For higher understanding on the state of the art heat unit technology, a comparison is created on the industrial and model electrical vehicles in terms of electrical vary, battery size, charger power and charging time

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