EV Fast Charging Grid

Ashutosh Jangam[1], Pratham Kurekar[2], Sakshi Kudke[3], Anirudh Mhettar[4], Ankit Kulkarni[5], Prof. Mrs Puja Pohakar[6]
[6]Asst.Professor, Dept of Electrical Engineering
[1, 2, 3, 4, 5, 6] P.C.E.T's P.C.C.O.E, Pune, India.

Abstract- *As a result of the rapid growth of the electric vehicle (EV) market, DC fast charging infrastructure is being exponentially deployed all around the globe. Ultra-fast charging (UFC) stations are starting to become more efficient and effective than the electric power system operation. It is generally due to their high peak power demand and deregulated interrupted operation. To address these issues, local energy storage can be installed, which would ensure an effortless grid power absorption profile and allow grid-supporting features. For this task, a control solution for the grid-side AC or DC converter of next-generation EV, UFC stations is suggested. Along with the ever increasing number of electric vehicles on the market and pressure from governments around the world to reduce vehicle emissions to zero by 2050, there is a strong requirement for more efficient charging solutions. As numerous consumer studies show, the acceptance of electromobility would highly depend on the availability and duration of the charging process. High power DC charging stations would be the solution to these current market requirements. At present, a typical EV can charge about 80% of its battery capacity in less than 10 minutes. This is comparable with refuelling a standard car having an internal combustion engine (ICE). But this won't be possible with the 240/440v outlet supply provided to us at our homes.*

Keywords- electric vehicles (EVs); battery chargers; ultra–fast charging (UFC); grid–connected converters; three-phase supply; single phase supply

I. INTRODUCTION

Despite the constantly increasing performance and energy density of Lithium-ion batteries, their cost and weight still poses a major limit to electric vehicle (EV) driving range. This limitation of Driving Range of EV can be solved by having a DC fast charging infrastructure at our place, capable of charging vehicles at a rate similar to refuelling an internal combustion engine (ICE) vehicle. This infrastructure would allow in-city vehicle charging for apartment, society dwellers (i.e., without the possibility of home charging) and extend vehicle drive range during long trips, solving the EV range issue for most of the population in the city. Building such an infrastructure has yet proven to be a big challenge, mainly due to available technology, competing industry standards. Nevertheless, according to the most recent forecasts, the electric mobility market is starting to rise exponentially in the upcoming few years. In particular, thousands of fast-charging stations are being installed all around the globe at an incredible pace.

But this system cannot be applied in houses and apartments as the infrastructure cost is very high and high energy consumption is a problem. There is a way out of this problem and EV’s can be efficiently charged while being parked in the parking lot.

This project overcomes the problems of fast charging the EV’s in residential areas and public parking and saves time wasted in charging halts with a low power charging system provided by the automobile dealer.

II. OVERVIEW

Every EV owner faces problems with time required to charge the vehicle and range anxiety that comes with it. Our project will help the owners to reduce the time of charging cycle by almost 50%. This project is about using the normal 440v ac supply and converting it into dc fast charging with minimum output of 10-15kva.

III. OBJECTIVE

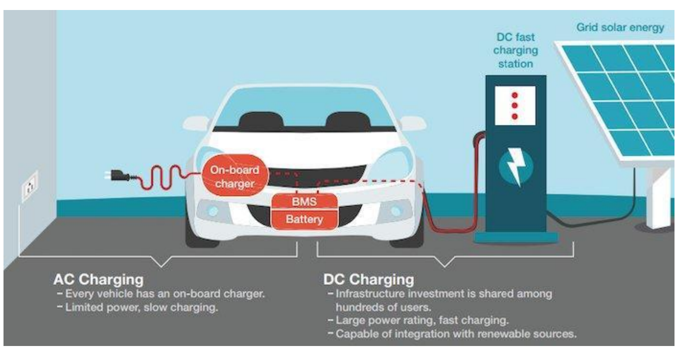
- To reduce the charging time of EV’s in residential areas and cooperative societies.
- Provide hotels and malls with fast chargers for the customers.
- To make EV’s more feasible option the IC cars.
- To support the Make in India campaign.
- to reduce the use of environmental hazards by using renewable energy.

IV. METHODOLOGY

For charging we can prefer home charging or public charging. Home charging is widely prefered by users, it is done overnight to be used next morning. For this purpose trickle or AC charging is used. In case of trikle charging, it is quite slow, approximate range is 65 km in 5 hours (overnight), or 200 km in 14 hours. So, its use is recommended in urgent cases only because the use of household electricity may cause problems associated with electricity bills and electrical loads, so always use this charge solution with caution and discuss with your electricity provider before first use. Purchasing an ICCB (In Cable Control Box) cable when using Trickle Charge is recommended, for maximum reliability.

- Public charging offers DC fast charging which is currently the fastest way of charging EVs. Which provides charging power above 50kW through a voltage above 450V and current up to 125A and is capable of charging from 20 to 80% of charge in approx. 40 minutes.
- The power distribution grid generates AC; it is supposed to be converted to DC as the onboard chargers are typically slow. A DC fast charger bypasses the onboard charging device, supplying power directly to the EV's battery. The DC charger is external to the car, so it isn't constrained in size or cost. Meaning that charging is typically much faster.

Over the years use of electric vehicles has increased as the market is expanding globally. Electric cars could transform this high-emissions sector. A study showed that electric cars generate half or less than half of the emissions of comparable gasoline-powered cars from manufacturing to disposal. Though electric vehicles (EVs) still emit carbon emissions through the manufacturing process and from the fossil fuels used to generate the electricity they need to recharge, their enhanced energy efficiency secures significant emission reduction.



Charging time: The time taken by EVs can be from 30 min to 12 hours. It depends on the battery size and charging point. For bigger batteries and slower charging point it takes longer time. Also there are some factors affecting charging speed;

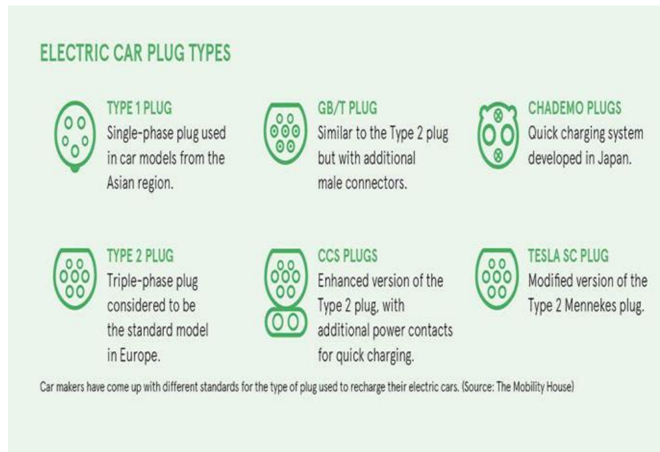
Size of battery: The bigger the battery is the longer it will take to charge fully.

State of battery: If the battery is empty it will take longer to charge fully.

Maximum charging rate of charge-point: The time it takes to charge will also be limited by the max charge rate of charge-point you are using.

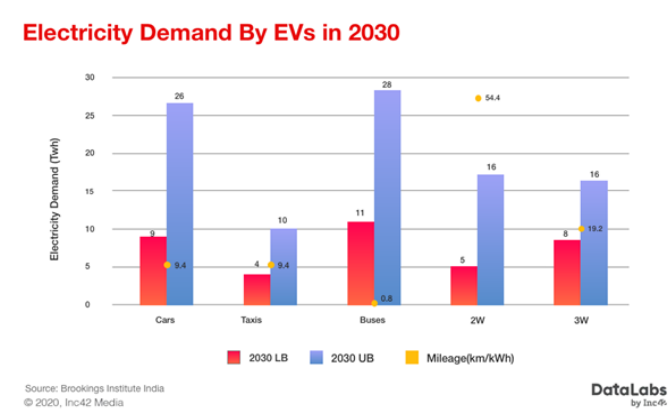
Environmental factors: Cold temperature can make it longer to charge particularly when using a rapid charger.

Charging compatibility: Type 1 and Type 2 connectors are the most commonly used AC sockets – typically for AC Household Charging. For DC fast chargers are used by different auto manufacturers: the SAE Combined Charging System (CCS), used by most manufacturers; CHAdeMO, used by Nissan and Mitsubishi; and the Tesla Supercharger (only available to Tesla drivers).

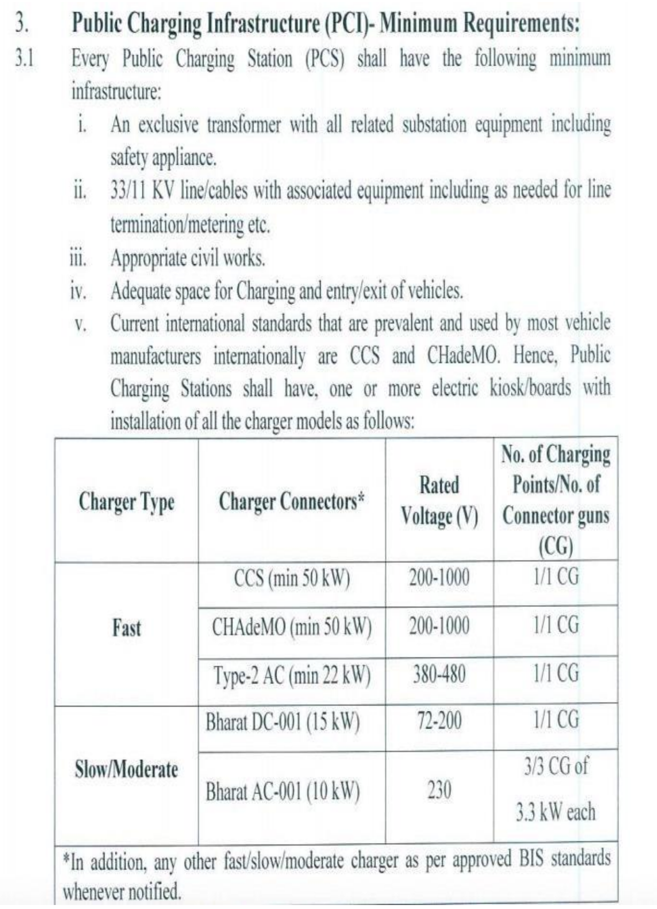


Car makers have come up with different standards for the type of plug used to recharge their electric cars. (Source: The Mobility House)

Grid capacity: As the electric vehicle is gaining popularity, demand for electricity is increasing. Currently, consumers have to either utilise less electricity during peak hours or pay more for usage. By 2030 electricity demand for EV may increase to 37 and 97 TWh under 33 per cent and 100 percent penetration of EVs in sales.



Thermal management system: Temperature and humidity levels highly affect the performance, safety, and lifetime of battery cells. Increase in temperature may also be influenced by driving or charging. Excessive increase in temperature can damage the battery severely.



3. Public Charging Infrastructure (PCI)- Minimum Requirements:

3.1 Every Public Charging Station (PCS) shall have the following minimum infrastructure:

i. An exclusive transformer with all related substation equipment including safety appliance.
ii. 33/11 KV line/cables with associated equipment including as needed for line termination/metering etc.
iii. Appropriate civil works.
iv. Adequate space for Charging and entry/exit of vehicles.
v. Current international standards that are prevalent and used by most vehicle manufacturers internationally are CCS and CHadeMO. Hence, Public Charging Stations shall have, one or more electric kiosk/boards with installation of all the charger models as follows:

Charger Type	Charger Connectors*	Rated Voltage (V)	No. of Charging Points/No. of Connector guns (CG)
Fast	CCS (min 50 kW)	200-1000	1/1 CG
	CHAdeMO (min 50 kW)	200-1000	1/1 CG
	Type-2 AC (min 22 kW)	380-480	1/1 CG
Slow/Moderate	Bharat DC-001 (15 kW)	72-200	1/1 CG
	Bharat AC-001 (10 kW)	230	3/3 CG of 3.3 kW each

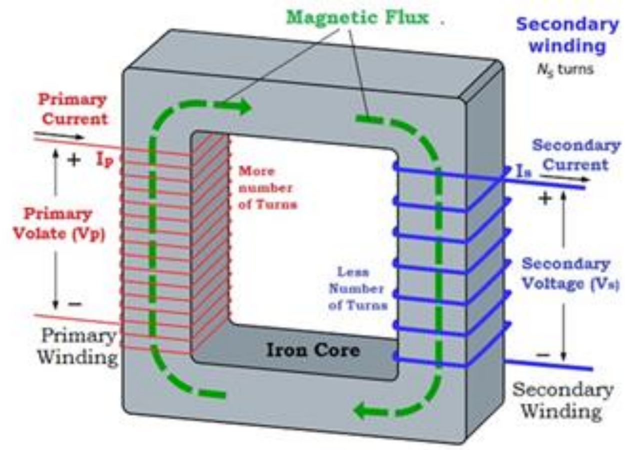
*In addition, any other fast/slow/moderate charger as per approved BIS standards whenever notified.

Construction and Mechanism:

The fast-charging system that we are proposing here will work on 440v ac.And will be implemented in various locations such as apartments and hotels and public parking. It will charge the EV's in much less time than the normal chargers provided with the vehicles. Which will help indirectly in increasing the range of the vehicle.

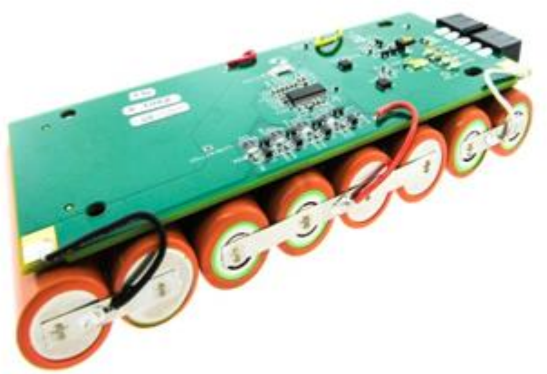
MAIN COMPONENTS OF CHARGER:

- step down transformer
- exhaust fans and cooling system
- battery management system(bms)
- diodes
- controlling system (plc)
- rectifiers
- capacitors

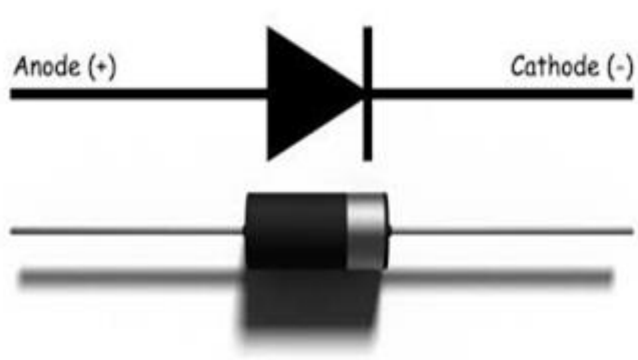


Step down transformer will step down the voltage from 440v to 76v (the numbers are with respect to the charging voltage of Tata Nexon EV). The drop in voltage will increase the current to 144-145 amps. The transformer is the main component of the circuit and will give a single defined output. To change the output the transformer change will be required.

Exhaust fans will be placed on the top and bottom of the system which will dissipate the heat generated into the system during step down and conversion of AC to DC into the air and will cool down the entire system and keep a constant flow of air into the system. If the temperature in the system increases above a given value even if he fans are working the system should go into emergency power cut except for the fans



The charging of a vehicle is not just about the power supply to the vehicle but charging each cell of the battery to its max limit and not overcharging it and switching between the cells to completely charge the battery pack. The charger has to be connected to the bms of the car and should interact with it and respond to the inputs provided by the bms itself.



Diodes will assure that the current will flow in one direction and will not drain the battery itself when the charger is left plugged in after the charging is completed. And will also secure the flow of current through the system. System can also be equipped with mcbs, fuse, relays to avoid the damage to the system if excess load is applied on the circuit.

The capacitor will store excess current and will be used in case of uneven flow of current after passing through the rectifier and change in ac to dc supply. The capacitor will provide the required charge to maintain uniform current and will recharge itself after a specified time or whenever suitable (that can be programmed). As it has less losses as compared to any other device and is easily available in required specifications is the easiest solution to the requirement.