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Research Article

IMPACT OF ELECTRIC VEHICLE ON DISTRIBUTION GRID

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A R T I C L E I N F O

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A B S T R A C T

The main objective of presenting this paper is to enlighten the impact of integration of new type of load i.e. Electric vehicles when they interactwithdistribution grid in G2V & V2G modes and also when large scale penetration take place & yes it's about to happen because the government is aiming big for its EV adoption roadmap for mitigating adverse environmental impacts because of the existing transport system which is using traditional fuel. As this new load features charging & discharging hence the impact of power quality , operational difficulties from utility point of view in meeting the additional demand as well as taking the distributed mobile generation into grid at distribution level. The impact has to be looked after by the stake holders i.e. distribution utilities, regulatory bodies

INTRODUCTION

Considering the growing concern over environmental issues of pollution i.e. increased greenhouse gases emission because of the use of traditional fuels year on year by transport sector. All over the world the focus has shifted to new clean technology i.e. Electric Vehicles for transportation. No doubt large scale penetration of electric vehicles will need to focus both on demand side management also improving charging infrastructure and integrated distribution management system assuring reliable & quality power for the consumers. Over the few years the whole world is focusing on faster adoption of electric vehicles for transportation sector but at the same time focus has been on developing standards, charging infrastructure, dealing with additional load, Power quality issues allied due to nonlinear type load characteristic of electric vehicles & V2G mode where EV acts as a distribute d energy source making distribution utility difficult to accommodate the large variations taking place on distribution grid because already other distributed decentralized generation like solar roof top & wind mill are gaining significant momentum.

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Driving range, Charging Time, Battery capacity Public charging infrastructure & most importantly different charging slots as per customer'srequirement makes it more complicated to accommodate large penetration of electric vehicles into distribution grid. Also as Electric vehicles load is considerably higher as compare with other regular loads in use the increased demand must also needs to be cope up by enhancing existing infrastructure at distribution level and because of the different SOC of EV battery as well different patterns adopted by individual owners & with slow charging in place particularly in residential segments which is going to have larger share makes it more complicated for distribution utility to manage the demand and simultaneously it does create other power quality related parameters like voltage unbalance , Harmonic distortion and definitely affects the equipment's in use of distribution system like transformers etc.

Types of Electric Vehicles

The Electric vehicles can be categorized into Hybrid electric Vehicles (HEV's), Plug in Hybrid Electric Vehicles (PHEV) & All Electric Vehicles (EVs).

Atypical architecture of Electric Vehicle is as shown below

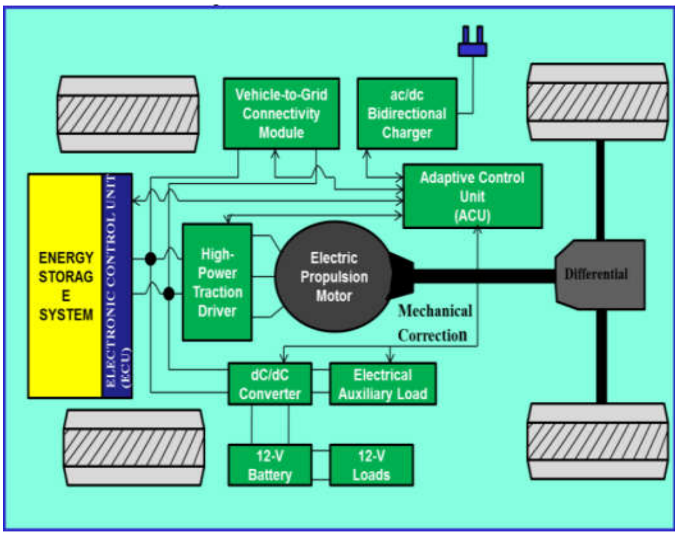

Fig 1 Architecture of Electric Vehicle

Power demand of EV is a function of voltage & current and its energy requirement depends on the battery size. Also the EVs or PEVs will be connected to the distribution network in specifically designed charging points. The batteries used by PEVs are characterized by its storage capacity and by the power required to charge them in a predefined period of time

Charging Infrastructure for EVs

EV Charging stations when categorized in terms of voltage rating, power ration and place of application, can be classified into three different types namely

1. Domestic chargers at residential area
2. Off street & robust chargers at Commercial & office area
3. Rapid chargers at strategic locations

AC & DC Charging architecture as below

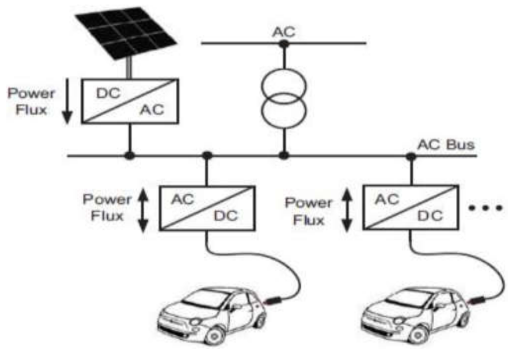

Fig 2 EV Charging infrastructure with AC Bus

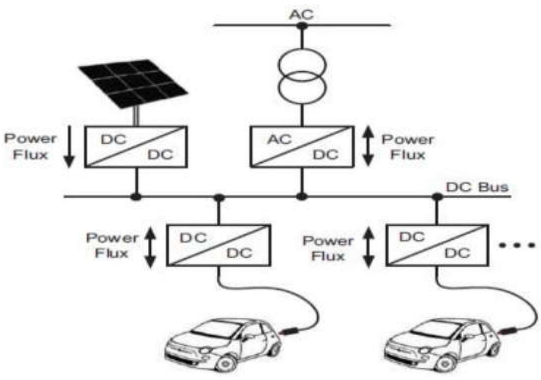

Fig 3 EV Charging infrastructure with DC Bus

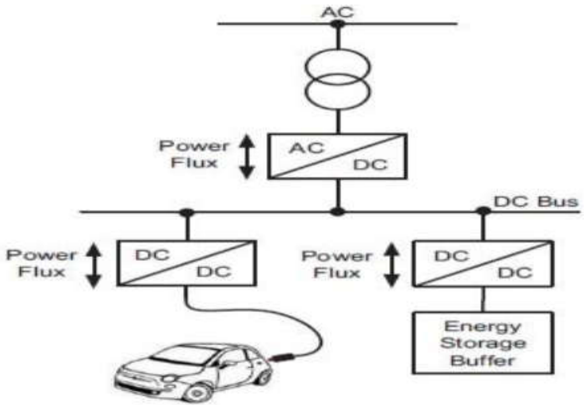

Fig 4 EV Charging infrastructure with buffer

Table 1 IEC 61851-1 Charging modes

Charging Mode	Max Current per phase	Charging Time	Vehicle Battery Charger
Mode 1	16 *A*	4÷8 *h*	On Board
Mode 2	32 *A*	2÷4 *h*	On Board
Mode 3	63 *A*	1÷2 *h*	On Board
Mode 4	400 *A DC*	5÷30 *min*	Off Board

Impact Son Distribution System

The impacts of electricity vehicles integration to distribution grids have been studied by several authors .Here below is the consolidated list of the impacts /issues that the distribution system will have due to large scale integration of EVs to distribution grid

Transformer degradation and failure

The addition of EV load can have a more significant impact on the individual distribution transformer than on the system as a whole. Though exceeding normal ratings will not result in immediate DTC failure, it effectively reduces the operation life span of transformer

Power Quality Issues

Normally PEVs front end draws low voltage AC power convert it to DC also in vehicle to grid operation again it inverts DC to AC These nonlinear elements such as inverter and battery chargers leads to significant increase in voltage distortion and current harmonics on power distribution networks .These harmonics cause problems on the power system and excessive neutral current and transformer hot spots

Grid Load Level

Thermal overloading due to high currents leads to critical damages to infrastructure. In order to cope with the new load profiles shaped by EVs the need is to determine total maximum load levels for lines where EV charging stations are connected to and also level of simultaneity for the charging level process

Voltage Control

Regarding the operation of EV charging stations, voltage control requires prognosis of the maximum total load level and variation range for those lines where EV charging stations are connected to. Voltage control involves the prevention of transient voltage variations & collaboration between distributed generation and EV charging stations require special attention for the increased range of voltage variation

PhaseImbalance

In EV context phase balancing becomes more relevant when using single phase chargers. Connecting a number of single phase chargers to different phases won't help, if cars with different charging times & profiles are connected

Integration of Ev with Distribution Grid Ensuring Power Quality

To overcome power quality issues arising as mentioned above are overcomes by proposed designing of charging system model particularly for fast DC charging of multiple EVs & Inverter of the same interfaced to the network through an LCL filter and transformer here by accurate designing & modeling of LCL filter & charger power quality issues are addressed well within limits. Also for avoiding Simultaneity of EV charging real time pricing, Time off day tariff are to be introduced by regulatory bodies

CONCLUSION

This paper highlighted impacts of electric vehicle integration on distribution grids in different scenarios as well on different feeders which are there in distribution system. As mentioned in paper the key problems/impacts of EV integration is power quality and to overcome the same in DC Fast charging for commercial vehicles we have modeled Charging station in association with state of the art passive LCL filter which helps to maintain power quality parameters THD well within the permissible limits as per the standards. Also other problems like simultaneity of charging & additional load demand, Unbalancing, grid overloading can be overcome by system infrastructure enhancement, Real time pricing, TOD tariff etc.

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