Impact of Electric Vehicle Charging Station on Distribution Grid with Preferable Solutions

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Abstract— This study represents the impact of electric vehicles on environment and on distribution grid. The growth of electric vehicles (EV) in the market has a potential to increase the risk of the distribution grid as the electric vehicle owners may charge the electric vehicle battery on demand which may causes unexpected power quality problems. This paper proposed many ways for reducing the load on distribution grid by using electric vehicle battery as energy storage system that can reduce the impact of home photovoltaic systems and using renewable energy as a source for charging, will reduce load on local grid.

Keywords: Electric Vehicle Charging Station, Impact on Distribution Grid, Charging Station, Scope of Renewable Energy

I. INTRODUCTION

Nowadays, transportation becomes the main user of oil and largest source of co2 emission in the world thereby causing global warming and climate change.

In India, 80% crude oil is consumed by road transportation alone. Among these, on-road diesel vehicles are the main reason for nearly 50% of the health impact through air pollution worldwide and in India, 27% part of air pollution is contributed by vehicles. The concerns about environmental pollution and escalating energy consumption accompanied by the advancements in battery technology become the main motivation for the electrification of transportation sector.

Due to the climate change and the need to reduce CO2 emissions, the demand for electric vehicles (EVs) is an indicator for the future. In addition to the environmental factor, this type of transport reduces the dependence on fossil fuels and therefore contributes towards clean environment.

As a measure to reduce the carbon footprint researchers have emphasized on replacement of Internal Combustion Engine (ICE) driven vehicles with EVs.

The electric vehicle (EV) has become center of attraction in recent years after the immense efforts of the governments, automakers and environmental activists.

EVs have many environmental and economic advantages over conventional vehicles and provide economic solution to reduce consumption of fossil fuels and consequently can reduce the air pollution and global warming. [1]

Since the increasing numbers of these type of vehicles increases the charging demand. Hence, there is need of charging infrastructure for EVs. Since, charging infrastructure is categorized into three categories. On the basis of charging rate, slow charging level I and II are used at home and office while fast charging level is used during emergency conditions or for long trips.

Recently, Indian government has approved phase-II of FAME (Faster Adoption and Manufacturing of Electric vehicle) for a period of three years commencing from April1, 2019 with budgetary support of Rs 10,000 crore. The main focus of this phase is to electrify the public and shared transportation. The government have target to setup one charging station every three Km in cities. However, installing charging station faces many problems, most important, due to lack of reliable and convenient charging infrastructure that includes availability of station, power supply capacity, charging rate and time of charging.

A fast charging network can be the solution of this problem but creates more problems at power grid because for charging we might use grid power.

Since we know that grid power is generated through conventional methods, hence EVs would not create any difference. Second, the increasing access of EVs can bring negative impacts to the distribution grid.

An increasing number of electric vehicles are a potential problem for the electrical grid because the uncontrolled charging of a large number of vehicles requires a major investment in upgrading and expanding grid capacity.

The degradation of voltage regulation, increase in peak load, harmonic distortions and frequency variation are some of the impacts that bring significant challenges to the traditional load growth planning and management of the power utilities.

II. ANALYTICAL METHODS

The voltage stability, reliability, and power losses are the three important operational parameters of the distribution network that affect working of distribution grid. An overview of the methodology to compute voltage stability, reliability and power losses of the distribution network is discussed in this section.

A. Voltage Profile

In the voltage profile, there are many factors that can be considered in it. Voltage stability is the foremost among them.

Voltage stability is defined as the power system's capability to maintain steady acceptable voltages at all the system buses under normal and abnormal operating conditions.

There may be much reason for a system for being unstable like sudden disturbances, fault conditions, single or multiple contingencies, line overloading or load increments. For voltage stability analysis, voltage sensitivity factor and voltage stability index can be used. [3]

B. Reliability

The reliability of the distribution network is closely related with the satisfaction of utility users. Reliability is defined as the ability of a power system to provide adequate, stable, reliable supply to distribution and gives measure to decide whether the system is operating satisfactorily or not.

For analysis of reliability, sufficient data of failure rate, repair rate, average output duration and numbers of consumer connected with system are required. [3]

C. Power Losses

As we know, power losses refer to the typical I^2R losses of the line in the power system. That means increase in load demand, whether it will be on one bus or all buses, will eventually increase the power losses in the distribution network. [3]

III. SUGGESTIVE SOLUTIONS

Increasing number of electrical vehicles promotes an uncontrolled and unregulated charging that can gives rise to an unexpected peak load at a specific time, which may exceed the capacity of the distribution grid. Therefore, the distribution grid needs to be upgraded its capacity to meet the new demand from EV charging. [4]

Use of renewable energy sources can be a perfect solution for electrical vehicle charging station in India. As of 2019, 17% of total electricity is generated in India by renewable sources.

So using an electric vehicle (EVB) battery as storage of energy for driving the electric vehicle rather than using home photovoltaic system (HPV), could be a better idea. EVBs can act as an energy storage system (ESS), that can be charged from the solar PV, when there is excess power and inject power to the grid when needed. The stored energy in the EVBs can help stabilize the grid feeder during the peak demand by injecting power to the local feeders. [5]

Or we can use interface of HPV with EVB that will work as a fast DC charging connector. This type of system provide advantages like we can easily connect or disconnect battery from PV system, the integration of PV and EVB can support the grid during peak demand and more. Hence, these solutions can help to reduce the electric vehicle charging station load on grid.

IV. CONCLUSION

In this study, the advantages through electric vehicles and impact of charging station on grid is investigated and find that the impacts of charging stations are not positive on distribution system. Since it is known that for vehicles charging, fast charging station are more preferable that increases load on distribution network. Hence fast charging demand can be fulfilled and load on grid can be reduced by using renewable energy sources, a battery storage system or EVBs integrated with PV system.

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