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A Review: Power Quality Problems Associated with EV Charging Station

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Abstract: *Electrical Vehicles (EV's) are best option for conventional vehicles as it is free from CO2 emission. Electric vehicle charging stations are used to charge EVs. Nonetheless, there are significant differences in EV loads (while charging) depending on the battery technology used and the charging technique (slow, fast, ultra flash, or flash charging). EVs can be charged in less than a minute using flash charging mode, which uses more grid power. The distribution network is negatively impacted by widely disparate EV charging characteristics, including overloading, stability issues, power quality issues, bad voltage profiles with other users connected to the same distribution network, etc.*

Keywords: *Ev chargers, flicker, filters, harmonics*

INTRODUCTION

In the energy transition, electrical mobility is crucial. Massive EV chargers are being erected and linked to the grid as a result of the sharp rise in EV traffic. One difficulty is figuring out how to provide enough electricity to meet the charging demand. Another challenge is how to maintain a clean utility grid voltage while a large number of chargers are constantly turning on and off. Actually, there are currently no PQ guidelines specifically pertaining to EV charging. The IEEE PQ standards and the IEC 61000 series are frequently cited as a compromise [1].

There have previously been reports of power quality (PQ) problems with the neighboring EV chargers, including flicker, harmonics, voltage fluctuations, load imbalance, Power Factor Degradation etc. [4] [[7]. An investigation into the effect of EV charging on flicker was conducted in [4], and it was discovered that flicker problems are more likely to occur when the charging power per slot increases. A set of EV chargers was examined in [5], and the findings indicated that nearly all of them emit significant harmonics. Additionally, was demonstrated that the level of emissions is pertaining to the charging load.

It is evident that the relationship between EV chargers and the electrical grid causes the power quality problems listed above. Nevertheless, the chargers are frequently viewed as a "black box" in the literature's study, and their dynamics are typically not sufficiently captured. More precisely, in relation to flicker in EV charging, there has been little discussion of the effects of the charging ramping up time, the grid connection's short circuit ratio, and the X/R ratio of the grid impedance in addition to the charging power. Infrastructure for electric vehicle (EV) charging is crucial to the increasing use of EVs, but it can also cause a number of power quality issues that could compromise the reliability and effectiveness of electrical grids. The features of EV chargers and the additional strain they put on the grid are the causes of these problems.

POWER QUALITY PROBLEMS ASSOCIATED WITH EV CHARGING INFRASTRUCTURE

1. **Distortion of Harmonics**

• Cause: Power electronics like rectifiers and inverters are used by EV chargers, particularly fast chargers (DC fast chargers), to convert AC to DC (and vice versa). The typical sinusoidal waveform of the electrical supply can be distorted by the harmonic currents produced by these electronic components.
• Impact: Transformers, motors, and other electrical

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equipment may overheat as a result of harmonics. They may also lower electricity efficiency, maybe harm infrastructure, and malfunction delicate electronic gadgets.

2.Variations in Voltage

• Cause: Voltage fluctuations may result from the high-power demand of several EV chargers, especially in locations with a large number of charging stations or during peak charging hours.
• Impact: Other grid-connected devices may experience flickering lights or even equipment breakdowns as a result of voltage drops or surges. Commercial buildings or sensitive sectors that depend on steady power are especially vulnerable to voltage dips.[10]

3.The total harmonic distortion (THD) has increased

• Cause: When numerous EV chargers are running concurrently, the total harmonic distortion (THD) in the grid may rise in addition to the individual harmonic currents produced by the chargers. This happens when several chargers work together to introduce harmonic components into the electrical network.
• Impact: Elevated THD can raise operating expenses, decrease power distribution system efficiency, and possibly cause damage to motors, transformers, and other electrical equipment.

4. **Unbalanced Load**

• Cause: When a lot of EV chargers are connected to one grid phase, the load may become uneven throughout the phases. This is typical in neighborhoods or places where charging stations are not evenly spaced.
• Impact: Unbalanced loads can result in increased electrical system losses, transformer overheating, and decreased efficiency. Because it puts stress on the phases, it can also cause electrical equipment to fail too soon.[9]

3.Degradation of Power Factor

• Cause: Because they depend on non-linear loads, EV chargers, especially those with unidirectional power flow (like AC chargers), may have low power factors. The current that the chargers typically draw is out of phase with the voltage.
• Impact: When the power factor is low, more current is needed to supply the same amount of power, which raises system losses and lowers the grid's ability to support higher loads. Additionally, it may result in customers being penalized by utility companies for subpar power factor performance.[8]

4.Sags in Voltage and Flicker

• Cause: EV chargers may result in brief but severe voltage sags or flicker, particularly during the initial connection or disconnection phases. The strong inrush current that happens when chargers are turned on or off is the cause of this.
• Impact: Voltage flicker can impair the functionality of other equipment and provide unsightly visual effects (such as flickering lights) in adjacent residential or commercial spaces.

7. Stress on the Grid and Peak Demand

• Cause: The demand for power may increase when numerous EVs are charged simultaneously, especially during peak hours (such as after work hours). The grid may be severely strained by this abrupt rise in load, which could result in blackouts, transformer overload, and power shortages.
• Impact: Voltage drops, overloads, and grid breakdowns in certain areas could result from the electrical grid's inability to handle the spike in demand.

8. Accidental Islanding: Safety Issues

• Cause: EV chargers, particularly those equipped with solar panels or battery storage, may occasionally continue to function independently in the event of a main grid breakdown, a phenomenon known as islanding.
• Impact: Because electrical systems in an isolated state may still be electrified, islanding presents safety hazards for utility workers trying to restore power.

VARIOUS STRATEGIES AND SOLUTIONS TO MINIMIZE ADVERSE IMPACTS OF EV CHALLANGES

1. Smart charging:

By putting smart charging solutions into practice that take into account the capacity and load limits of the distribution network, the charging load may be distributed more uniformly and the risk of overloading can be decreased [5].

2. Demand response programs:

By providing incentives for EV owners to engage in demand response programs, which schedule charging during off-peak hours, the distribution network can be less stressed and peak load demands can be lessened.

3 .Grid-integrated charging infrastructure:

By creating charging stations that are connected to the grid and have the ability to communicate with the utility, the network impact of EV charging can be lessened through improved load control and coordination [6].

4. Advanced metering and monitoring:

In order to preserve stability and power quality, utilities can use advanced metering and monitoring systems to obtain real-time insights into network conditions and modify operations accordingly [7].

5. Integration of energy storage:

Adding more stability and mitigating load variations bro ught on by EV charging can be achieved by integrating e nergy storage systems into the distribution network.

6.Distribution network upgrades:

To safely and effectively handle the extra load in situations when EV demand is significant, specific distribution network upgrades may be required.

CONCLUSION

There are a number of difficulties in integrating EV charging infrastructure with the electrical grid, especially with regard to power quality. The grid and its equipment may be strained by harmonics, voltage swings, load imbalances, and other problems. However, many of these issues can be avoided with careful planning, including the use of power factor correction, smart charging technology, and harmonic filters, which will facilitate seamless integration and improve grid stability.

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