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*Corresponding Author:

Swaraag Hebbar N,
*Student, Department of
Electrical Engineering, RV
Institute of Technology and
Management, India*

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Impact of Electric Vehicle Charging Clusters on Local Renewable Grid Stability

Swaraag Hebbar N^{1*}, Manish Kumar²

¹*Student, Department of Electrical Engineering,
RV Institute of Technology and Management, India*

²*Assistant Professor, Department of Electrical Engineering,
RV Institute of Technology and Management, India*

ABSTRACT

With the increased number of electric vehicles in use, the energy consumption of electricity is slowly changing. This change in energy consumption of electricity is posing a challenge to the energy grid. Since a number of electric vehicles are normally charged at the same time in a region of the area, this has posed a serious challenge to the energy grid. Moreover, the energy grid is normally not producing enough energy from renewable sources of energy such as solar and wind energy. The aim of this paper is to discuss the impact that the charging of electric vehicles will have on the energy grid in a system that is based on renewable energy.

Keywords:- *increased number, electric vehicles, energy consumption, energy grid, charged, renewable energy*

INTRODUCTION

With the recent increase in the utilization of clean and green energy, this has accelerated the utilization of renewable energy and electric vehicles. The government and industries are promoting the utilization of electric vehicles to ensure a cleaner and greener future. This has resulted in a rapid increase in the number of electric vehicle charging points in urban cities. The charging points are normally located in residential areas, offices, and other commercial places.

This increase in the utilization of clean and green energy is a move in the right direction to ensure a sustainable future. However, this increase in the utilization of clean and green energy has posed a number of challenges to the energy system. The energy system has been designed to operate within a framework.

The charging of electric vehicles is a dynamic process. This process is normally dependent on the behavior of users and their timings. Since a number of electric vehicles are normally charged at the same time in the evenings, this has posed a serious challenge to the energy system.

In addition to this, the nature of renewable energy sources is another factor that contributes to the problem. As mentioned earlier, the power generated by the sun is usually available during the daytime. On the other hand, the charging of electric vehicles is usually high during the evenings.

This is another factor that contributes to the problem. With the advent of different kinds of charging stations for electric vehicles, it is noticed that the voltage level is reduced. This results in the loss of power, which further reduces the life of the transformers. In addition to this, the issue of the inefficient utilization of power generated from renewable energy sources

is another factor that contributes to the problem. This is because the power generated in excess from renewable energy sources during the daytime is not utilized, while the power demand increases during the latter part of the evenings. This is another issue that has to be considered.

Another issue that has to be considered is the impact of the increased number of electric vehicles on the distribution network planning. From the above discussion, it is evident that the infrastructure that is currently in place has not been designed to meet the requirement. With the increased number of electric vehicles, it is possible that the electric supply company will find it difficult to upgrade their infrastructure to meet the increased demand. This is not a feasible option because it will involve capital costs.

Another option that can be considered is the impact of the increased number of electric vehicles on the distribution network. From the discussion above, it is evident that the existing infrastructure is not designed for this. In addition, the electric supply company can face a challenge of not being able to upgrade their infrastructure to meet the increased demand. This is not a feasible option since it will require a capital cost.

Moreover, it is also possible that power quality issues can arise as a result of the increased power electronic devices. One of the main issues that power electronic devices face is the occurrence of harmonics. The increased number of electric vehicles will result in an increased number of power electronic devices, thereby reducing power efficiency. Voltage fluctuations, which are common in power electronic devices, can also be a problem, especially as a result of the increased number of electric vehicles, thereby posing a big challenge for other devices that will

be operating in the same grid. From the perspective of the electric supply company, it can be noted that the main problem is the uncertainty of power generated from renewable energy sources as well as electric vehicle charging. The electric supply company will be required to balance the demand and supply of power. In case of a lack of coordination, power outages can result, thereby forcing the electric supply company to undertake load shedding.

The rise in fast charging technologies is one of the major challenges to be resolved as quickly as possible. Fast charging technologies require a large amount of power to be consumed within a short span of time. Controlling such a large amount of energy consumption is a problem associated with various types of fast charging technologies being implemented.

In resolving such problems, it is important to integrate smart grid technology into the grid. Smart charging for electric cars can resolve such problems to a great extent. Time-of-day pricing can also help resolve such problems by allowing electric cars to charge their batteries at optimum times.

The role of energy storage systems is crucial in resolving various types of problems associated with electric cars' integration into the grid. Energy storage systems can store surplus energy generated by electric cars and supply it to the grid at peak hours. This will help optimize surplus energy and also improve the grid structure to a great extent. Another possible solution to resolve electric cars' integration into the grid can be vehicle-to-grid technology.

This technology can help electric cars supply energy to the grid and also consume energy from the grid to charge their batteries. In conclusion, electric cars' interaction with various types of energy resources is a crucial area of research for

current grid infrastructure. Designing a suitable grid to cater to energy demands efficiently requires a thorough knowledge of electric cars' interaction with energy resources.

With a suitable technology combination, it is possible to resolve such challenges, and users are eager to take part in resolving such problems.

METHODOLOGY

This research will make use of the simulation method to analyze the effect of EV charging clusters on the stability of the grid. The network will be designed, and different renewable energy sources will be included in the network. These energy sources will include solar power.

There will be different stations, including residential, commercial, and EV stations, which will be divided into clusters. The charging of the EVs will be made more realistic, where the EVs will be charged mostly during the evenings. The power at which the EVs will be charged will also be included, where level 2 will be used, which is mostly used during peak hours.

The renewable energy sources will also be included, where the amount of power generated will be determined using solar irradiance. The amount by which the power generated will change will also be included. The load flow analysis will be performed, where the instability of the grid will be observed due to the charging of the EVs. Various scenarios will be included to analyze the instability of the grid.

There will be a base case where no EVs will be charged, a moderate case where some EVs will be charged, and another case where the EVs will be charged in clusters. All parameters will be included, especially during peak hours when the grid is unstable. The effect of different percentages of renewable energy sources

will also be included, where different percentages will be used. These percentages will range from low, medium, to high percentages. All the scenarios will be included by considering different constraints.

The results will be compared to analyze different patterns. Time series simulation will also be conducted for a period of 24 hours. Furthermore, spatial distribution of EV stations will also be considered by conducting various clustering configurations to observe their effects on the grid. In addition to this, battery energy storage will also be considered to observe their effects on the grid. Demand response will also be considered to observe their effects on the grid. Various types of EV stations, such as slow, fast, and ultra-fast charging stations, will also be considered to observe their effects on the grid.

Results will also be validated by comparing them to existing studies. Besides, probabilistic modeling will also be considered to observe the effects of uncertainties associated with EV users' behavior as well as renewable energy generation. Moreover, the sensitivity analysis is carried out to study the impacts of various parameters such as changes in charging demand of EVs, number of EVs, and penetration level of RE. Besides, the effects of harmonic distortion, which is usually caused by different kinds of power electronic devices, are considered to assess their effects on the grid.

In addition, the effects of transformer aging, which is usually caused by different kinds of loadings, are considered to assess their effects on the grid. Moreover, the effects of smart charging are considered to assess their effects on the grid. Besides, the effects of vehicle-to-grid integration are considered to assess their effects on the grid. This will assist in assessing the effects of EVs as energy storage devices.

In addition, the effects of EV integration on the grid, both under normal and stressed conditions, are considered to assess their effects on the grid.

RESULTS AND DISCUSSION

From the results obtained in the simulation, it is very clear that the effect of the clusters in the stability of the grid is very significant. For example, in cases where the charging of the EVs is very high, it has been observed that the voltage drop is very high in the regions where the charging is very high. From the results obtained in the simulation, it has also been observed that in cases where the density of the charging of the EVs is very high, the loading of the transformer is very high.

This indicates that the infrastructure is not adequate enough to support the number of EVs that are expected in the near future. From the results obtained in the simulation, it has also been observed that the generation of the renewable energy and the demand for charging the EVs are not in sync. For example, in the results obtained from the simulation, it has been observed that the generation of solar energy is very high in the middle of the day, and the demand for charging the EVs is very high in the evenings.

This indicates that the utilization of the renewable energy is not very high, as the energy is in excess in the daytime and is very low in the evenings. From the results obtained in the simulation, it has also been observed that the effect of stability in the frequency is very high, especially in cases where the load is very high, as the charging of the EVs is done simultaneously. Apart from the above, it is also seen that there is an increase in the load in the power lines.

This leads to an increase in the losses. Moreover, it is also seen that there is an increase in the congestion in the power

lines. The increase in the occurrence of harmonics in the power system due to the utilization of power converters for charging electric vehicles leads to a degradation in the quality of power. Moreover, it is also seen that there is an increase in the level of thermal stress in the power system. This is due to an increase in the levels of loads in the power system.

This leads to a degradation in the transformers in the power system. From the results, it is evident that the power system is seen to have instability in the case of electric vehicles. Moreover, it is also seen that there is a smooth load curve and an increase in the peak demand levels due to smart techniques. Moreover, it is also seen that there is an increase in the utilization of battery energy storage techniques, resulting in an improvement in the stability in the power system.

In this case, the energy is stored in the power system in the off-peak hours and utilized in the peak hours through techniques. This indicates that people are charging their vehicles in hours other than peak hours. It is, therefore, concluded that the charging clusters of the electric vehicles are seen to have an impact.

CONCLUSION

This research also proves that the effect of the clustering of the charging of the EVs on the stability of the grid is also of great importance, especially in a scenario where there is penetration in the grid of different kinds of energy, where different kinds of issues related to voltage stability, overload of the transformers, and nature of renewable energy, along with the charging of the EVs, become more prominent, proving the limitations of traditional management in the grid, thereby necessitating the need to implement intelligent management techniques in the grid.

On the other hand, it is also evident from the research that the integration of the electric vehicles with the grid is also of great importance, especially with the aim of creating a better future for the power system sector, especially in a scenario where intelligent management is made possible by incorporating different kinds of intelligent techniques related to the smart charging of the electric vehicles, not only to prove the limitations of traditional management techniques, but also to create a better balance between the supply of energy and the demand for energy, especially while entering the future of the power system. While entering the future of the power system, it is evident that different kinds of upgrade mechanisms are essential.

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