279-21

Integration of the Electric Vehicle into the Electrical Grid of the Future

M. González-Pérez[1], J.I. San Martín[1], F.J. Asensio[1], I. Zamora[2], O Oñederra[2], G. Saldaña[2] and I.J. Oleagordía[2]
(1) Engineering School of Gizpukoa (Section of Eibar) – joseignacio.sanmartin@ehu.eus (2) Engineering School of Bilbao – gaizka.saldana@ehu.eus
Department of Electrical Engineering; Department of Systems Engineering and Automatic; Department of Electronic Technology - University of the Basque Country

ABSTRACT

Environmental issues are a major concern in society. To solve them, new technologies have appeared in the las few years, such as Renewable Energy Sources (RES) or Electric Vehicles (EVs). Nevertheless, all these technologies have a huge impact in the Electric System, and especially, in the electric grid, due to their technical characteristics. In this sense, the grid needs to evolve to assume the new electric scenario. In this context, this paper is focused on summarizing how the grid should evolve to correctly integrate these new elements into de system with a special focus on EVs, as they will be the ones with the greatest affection on the load profiles. Hence, how to integrate EVs into the grid considering charging profiles will be explained in order to design the electric grid of the future.

ELECTRIC VEHICLES

Advantages of EVs
- Improve air quality of cities.
- Facilitate RES integration.
- Have higher efficiency than Internal Combustion. Engine Vehicles.
- Have lower maintenance due to fewer mechanical elements.
- Enable Electrical Energy Storage (EES) integration.

EVs are gaining importance due to…
- Reduction of EV prices (especially due to the reduction in the price of batteries).
- Increase of the number of charging points.
- Public perceptions and subsidies.
- Favorable regulation.
- Increase of social environmental awareness

Problems of an uncontrolled integration of EVs
- Congestion of the distribution networks.
- Power losses.
- Compromising the safety and reliability of the
- power system.
- Frequency and voltage deviation.
- Harmonic distortion.

SOLUTION → Controlled charging + V2G

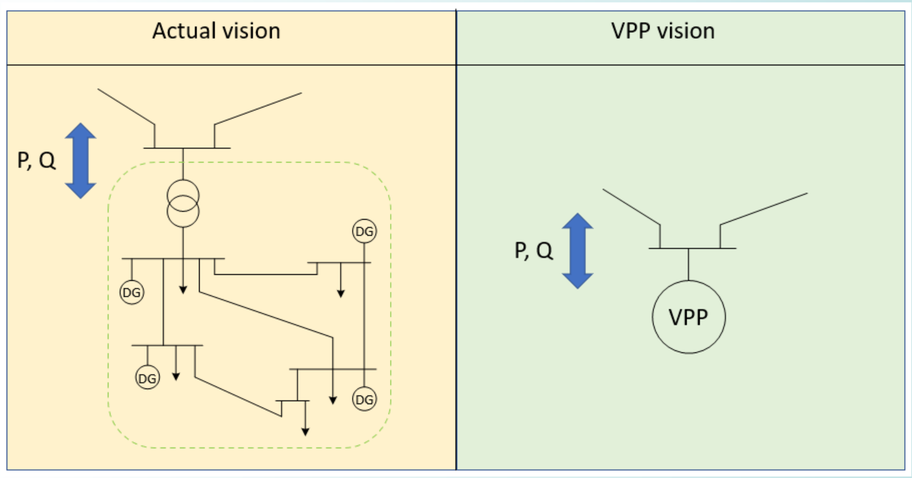
EVOLUTION OF THE ELECTRIC GRID

While new agents are being integrated into the system, the grid must be adapted to the new needs and characteristics towards digitization and automation.

Smart Grids (SGs)
- Enabling controlled bi-directional flow of electricity and information.
- Enabling active demand management in real time.
- Being fully sensorized, monitored and automated.
- Having a decentralized architecture and being autonomous and intelligent, with adaptive protections.
- Allowing the insertion of distributed generation (DG).
- Managing resources efficiently and focusing on Power Quality (PQ).

→
- The end users will no longer be just consumers but will become active agents that participate and interact with the grid.
- Individual objectives will be unified at the physical infrastructure level to achieve an overall benefit that goes beyond the individual level
- This overall benefit encompasses energy efficiency, sustainability, quality of life, safety and security, system resilience, etc.

New agents of the Electric System
- Demand Response: to shift demand in a controlled manner.
- Aggregators of EVs: as the effect of a single EV is negligible, the aggregator joins a group to have a real effect in the grid.
- Smart Meters: to reliably know the behavior of demand.
- Smart Homes: computerized homes to efficiently manage energy.
- Smart Consumers: consumers who are self-aware of their actions.
- Virtual Power Plants (VPP): are systems composed of different DER and loads that operate together and can behave as a power plant or as a load.
- Demand Side Management (DSM): its efficiency is obtained through a more active participation of the costumers, offering them more beneficial solutions.



System Operator's current vision of the DG vs. System Operator's vision under the VPP concept.

Passive element just for carrying electricity → **Intelligent, capable of real-time decision making and involving many different agents**

EV INTEGRATION INTO THE GRID

EV charging profiles estimation

Available information → **Assumptions** → **Profiles prediction**

1) Probability distribution of vehicle arrival times.
2) Probability distribution of vehicle departure.
3) Times during which the EVs remain connected to the network.
4) Distribution of the distances traveled by the users.
5) State of Charge (SoC) deduction.
6) Estimate the demand profile of the Evs.

Important factors
- Geography.
- Social-demographic and cultural habits.
- Season.
- Commercial / residential area.
- Labor days to weekdays.

CONCLUSIONS

The electric system paradigm is changing. Intermittent RES and DG are appearing. New consumption models are being introduced, such as prosumers, which can act as energy generators or consumers. In addition, the electrification process that many sectors are facing, will drastically increase the electrical demand. All this will completely change power flows through the electric grids, and hence, the network will need to evolve. This modernization will be achieved through the digitalization and automation of all agents participating in the electric system, giving rise to smart grids, VPP, DSM, etc.
However, to design the grid of the future, it is essential to know how the demand trends will be, especially, the ones that will most affect the power flows, such as EV charging profiles. Mostly, these profiles are obtained through statistical analysis of databases, and they may vary depending on the season, geographical site, demography, cultural habits, weekdays and holydays, residential and commercial areas, travelling purposes, etc.
Understanding them will be a key factor for EV integration and for de development of the electric grid of the future.

International Conference on Renewable Energies and Power Quality (ICREPQ'21)
Almería (Spain), 28th to 30th July, 2021
Renewable Energy and Power Quality Journal (RE&PQJ)
ISSN 2172-038 X, No.19 September 2021