Optimal management of an EV fleet to deliver flexibility to the electric power system

Duration: 12 months
Starting date: 2023,Q2
Location: University Paris-Saclay (30 km south of Paris)
Research team: Electric power system group
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Context

Objectives for reduction of CO2 emissions has driven the deployment of electric mobility with both the full electric vehicles and plug-in hybrid vehicles. Presently, the electrical distribution operators must connect more renewable sources and more charging systems while minimizing the reinforcement costs. Large integration of these distributed resources is physically limited by the operational constraints: thermal limits of the equipment, and voltage limits. The control of the flexible demand and the use of storage devices could enable a reliable grid operation with lower reinforcement costs.

If the valorization of the load flexibility for the global balancing (between generation and demand) is already used by the transmission system operators (through the participation of aggregators to reserve markets), it is much more complicated at the scale of the distribution grids: (i) the flexibility value depends on the load location from the constraint, and (ii) the lack of organized valorization markets as they exist for the global balancing.

Plug-in EV are seen as a solution with a great potential as it can be easily shift to the best hours, and the future V2X technology will enable a more dynamic control of an EV fleet to mitigate constraints in distribution grids.

Project

A first step toward a smart integration of EV in smart distribution grids has been proposed in [1] and [2], but much work has to be done to assess the contribution of EVs in case of large renewable energy sources integration. in this work, the scope of radial MV grid have been considered, and a toolbox has been developed to build large MV networks from French public data.

The objective of the project is to develop an EV fleet model that would be controlled for delivering flexibility services to a DSO. Optimization of the services could be modelled as in [3] with stationary batteries. An EV fleet can be seen as a virtual stationary storage and it could partially prevent the installation of stationary batteries. In case of constraints, P(U) control curve can be proposed and compared with more optimal strategies. As the availability of EV is uncertain, a probabilistic approach can be required.

Skills

Electrical systems, optimization, Matlab/Python, power grid

References

[1] Felipe Gonzalez Venegas (2021), "Electric vehicle integration into distribution systems : Considerations of user behavior and frameworks for flexibility implementation", PhD thesis, University Paris-Saclay, https://tel.archives-ouvertes.fr/tel-03338497/document
[2] F. Gonzalez Venegas, M. Petit, Y. Perez (2021), "Plug-in behavior of electric vehicles users: Insights from a large-scale trial and impacts for grid integration studies", eTransportation vol. 10, 100131.
[3] E. Grover-Silva, R. Girard, G. Kariniotakis (2018), "Optimal sizing and placement of distribution grid connected battery systems through an SOCP optimal power flow algorithm", Applied Energy, vol. 219
[4] M.J.E. Alam, K.M. Muttaqi, D. Sutanto (2016), "Effective Utilization of Available PEV Battery Capacity for Mitigation of Solar PV Impact and Grid Support With Integrated V2G Functionality", IEEE Transactions on Smart Grid, vol. 7, no.3, May 2016