**V2G Scheduling Optimization**

An algorithm is developed to schedule 500 electric vehicles (EV) using an electric charging station in such a way that the cost of recharging is minimized, and simultaneously, an arbitrary small number of those EVs are randomly scheduled to travel to designated house loads and discharge there and return to the charging station. Three different scenarios were tested for the simulation – first, customer satisfaction (i.e., EV owner satisfaction) is considered to be the total difference between the amount of money earned from discharging and the amount of money spent in charging, second, customer satisfaction is the same as that in the first scenario, but minus the total cost of unfulfilled charges by the end of the simulation, and third, customer satisfaction considers the profit from discharging, cost of charging, total cost of unfulfilled charges and the cost of switching from each EV throughout the entire simulation.

In order to simulate the EVs’ behaviour, many different time-based variables are used. The following are the most crucial variables and are the main factors in determining customer satisfaction:

1. X – state of charging (either 1 or 0)
2. Y – state of discharging (either 1 or 0)
3. SOC – state of charge (measured in percentage of maximum battery capacity)

Along with the variables, EVs are initialized with values like maximum battery capacity, number of maximum switches for the third scenario, etc. At every unit of time throughout the simulation, various system constraints on the x and y variables and energy constraints are implemented to ensure stability and a working vehicle-to-grid system. For example, a single EV in a single unit of time can only be in a state of charging or discharging when not in transit, not both (i.e., either x = 1 or y = 1, not both). Another crucial system requirement is that the charging station has enough energy to continue charging the vehicles currently recharging. An additional constraint is introduced in the third scenario, where each EV must stay within it’s limit of maximum number of switches allowed from a state of charging to discharging, from charging to idle, etc. The following research paper is used as a basis for initialization values, EV variables and the various constraint equations – Optimizing the Dynamic Scheduling of Electric Vehicle Charging and Discharging, by Shima Hosseinpour and Ona Egbue.

Once the simulation is completed, the final states of charge for the vehicles that took mid-simulation trips are compared to their states of charge when arriving the house loads and after finishing discharging at the house loads. Various plots and bar graphs are also made – number of switches made for each EV, State of charge vs time for a random EV, state of charge vs distance for those EVs that took mid-simulation discharging trips at their designated houses, etc.