1. Outline of the simulation of the distribution systems utilizing DER

In Japan, electricity demand is expected to decrease due to population decline or progress in energy conservaton, which requires DSOs to streamline the distribution facilities and control the cost to maintain or reinforce them. As a method for realizing efficient facility formation, it is expected to utilize the flexibility of DER in those distribution systems in which a lot of PV or EV have been introduced.

In this study, we focused on the distribution systems after removing the substation and conducted a simulation of the distribution systems to evaluate how introducing DER contributes to eliminate overload in distribution systems. In conducting the simulation, we assumed the distribution system shown in Fig.1, where the power is supplied from two substations. We simulated if facility reinforcement of distribution system can be avoided by utilizing EV resources when substation B is removed and overloads occur in distribution line A to E.

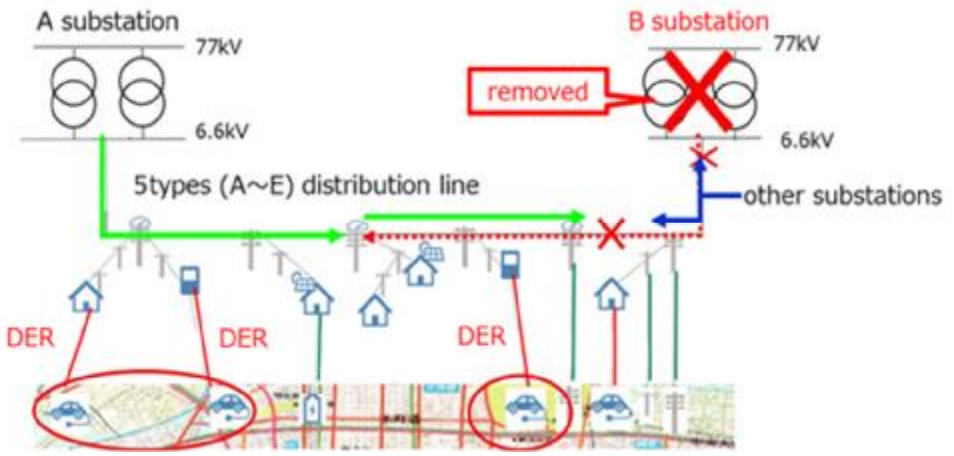

Fig.1 : Distribution system in the simulation

2. Simulation conditions

In this simulation, EV charging and discharging potential data was plot on the existing distribution system by linking map data, distribution system data and GPS tracking data of EV together.(Fig.2) In addition, simulation was conducted with different EV penetration rates of 15%, 30% and 45%.

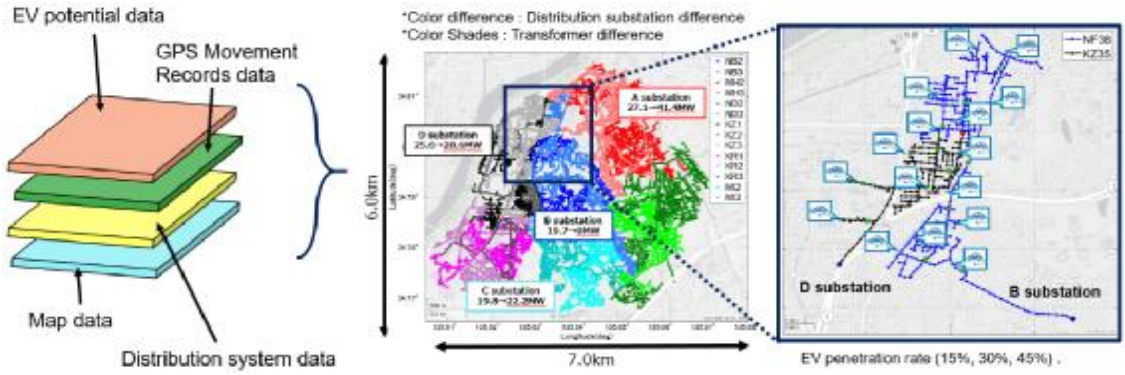

Fig.2 : Introduce of EV potential data on the map

3. Result of the simulation

Fig.3 shows the conditions required to eliminate overloads in distribution line E, where the highest market participation rates were required to eliminate overload in distribution system in all EV penestration rates of 15%, 30% and 45%. According to the result, it is necessary to raise both EV penetration rates and market participation rates in order to avoid facility reinforcement due to the removal of substation B.

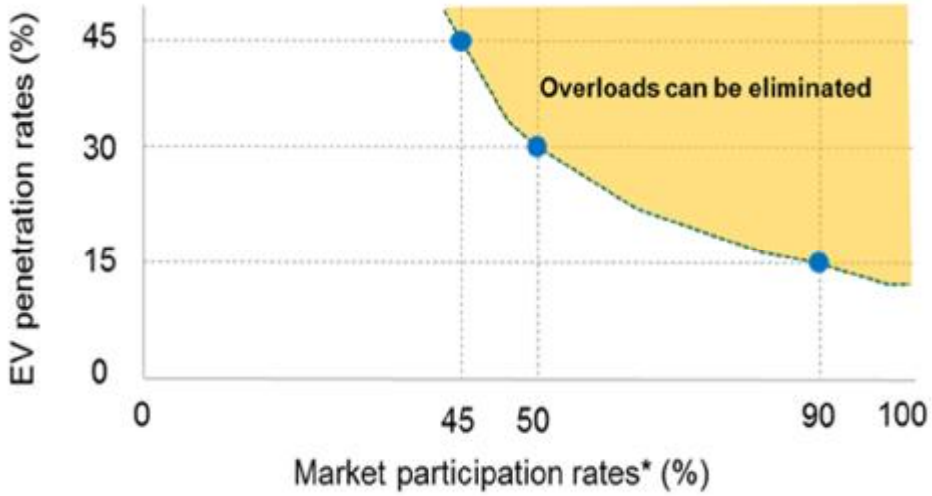

Fig.3 : The amount of EV required to eliminate overloads in distribution line E

Fig.4 shows the assumed transition of EV penetration rates in Japan. Fig.4 suggests, for example, that EV penetration rate is estimated to reach 30% around 2035, which means more than 50% of market participaion rate is required to avoid facility reinforcement at that point. Therefore, it seems to be difficult to remove substation B without expanding facilities by 2030 in this case.

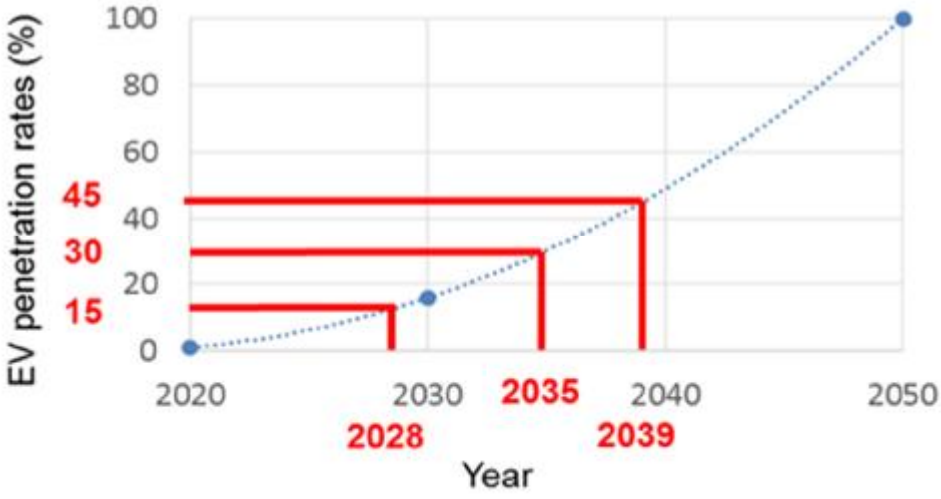

Fig.4 : Assumed EV penetration rates in Japan

In this study, we targetted only EV in motion as for the charging and discharging potential data. In order to consider with more realistic conditions, we plan to simulate using other data of EVs that are neither running or charging and household storage batteries.