**Objective Function:** Install EV chargers such that the average driving distance between demand nodes and charging stations is minimized while meeting as much demand as possible.

Subject to constraints (1-15) on page 3.

**Variables & Parameters**

|  |  |  |
| --- | --- | --- |
| **Variable** | **Unit\*** | **Description** |
| Decision Variables | | |
|  | - | Number of EV chargers to be installed at station *j* |
|  | - | Binary variable equal to 1 if station *j* is serving demand node *k* and equal to 0 otherwise |
|  | kW | Active power generated at station *j* |
|  | kVAr | Reactive power generated at station *j* |
|  | kVA | Apparent power generated at station *j* |
|  | p.u. | Squared voltage magnitude at station *j* |
|  | kW | Active power flowing on line *(i, j)* |
|  | kVAr | Reactive power flowing on line *(i, j)* |
|  | p.u. | Squared magnitude of complex current on line *(i, j)* |
| Constants | | |
|  | km | Grid length for all demand nodes |
|  | veh/day | Maximum daily serving cycle of a level 2 charger |
|  | kW | Power demand of a level 2 charger |
|  | p.u. | Minimum & maximum nodal voltage |
|  | - | Maximum number of chargers to install |
|  | - | Maximum percentage of station stalls that can be allocated to EVs |
|  | - | Set of station nodes *j* such that |
|  | - | Set of demand nodes *k* such that } |
|  | - | Adjacency matrix |
|  | - | Parent of node at station *i* |
| Station Specific Parameters | | |
|  | kVA | Apparent power generation capacity at station *j* |
|  | - | Number of parking spots at a given station *j* |
| Demand Node Specific Parameters | | |
|  | veh/day | Total demand at node *k* |
|  | veh/day | Demand supported by existing chargers at node *k* |
|  | veh/day | Residual demand at node *k* |
|  | veh/day | Annual average daily traffic (AADT) for demand node *k* |
|  | - | EV adoption rate for demand node *k* |
|  | - | Percentage of residential & commercial PG&E customers within demand node *k* |
| Station-Demand Node Parameters | | |
|  | km | Driving distance traveled from demand node *k* to reach station *j* |
| Transmission Linkage Parameters | | |
|  | p.u. | Resistance of line *(i, j)* |
|  | p.u. | Reactance of line *(i, j)* |
|  | p.u. | Maximum magnitude of complex current on line *(i, j)* |

\*p.u. stands for per unit with base parameters Sbase = 1 MW and Vbase = 4.17 kV

**Constraints**

|  |  |  |  |
| --- | --- | --- | --- |
| (1) |  |  | Non-negativity, integer constraint |
| (2) |  |  | Binary constraint |
| (3) |  |  | Installed EV chargers cannot exceed more than a fixed percentage of the number of parking spots at a given station |
| (4) |  |  | A total of at least W chargers must be installed |
| (5) |  |  | Chargers should not be underutilized at any given station |
| (6) |  |  | The total number of vehicles served must equal the total number of vehicles supported by the chargers |
| (7) |  |  | Active power flowing between node *i* & node *j* |
| (8) |  |  | Reactive power flowing between node *i* & node *j* |
| (9) |  |  | Non-negative active & reactive power for all nodes |
| (10) |  |  | The norm of active and reactive power cannot exceed the apparent power at any node |
| (11) |  |  | Apparent power for a given node must not exceed the apparent power generation capacity at that node |
| (12) |  |  | Squared voltage magnitude at node *j* |
| (13) |  |  | Squared magnitude of complex current between node *i* & node *j* |
| (14) |  |  | Squared magnitude of complex current for each line cannot exceed the squared maximum magnitude of complex current between node *i* & node *j* |
| (15) |  |  | Squared nodal voltage cannot exceed the maximum squared nodal voltage or be below the minimum squared nodal voltage |