Mathematical Optimization Model - Equations

Objective Function ([1], adapted)

|  |  |
| --- | --- |
|  | (1) |
|  |  |

Constraints

- Power of Charging/discharging of the EVs

|  |  |
| --- | --- |
|  | (2) |
|  |  |

- Parking period of the EVs ([2], adapted)

|  |  |
| --- | --- |
|  | (3) |
|  |  |
|  | (4) |
|  |  |
|  | (5) |
|  |  |
|  | (5) |
|  |  |
|  | (6) |
|  |  |
|  | (7) |
|  |  |
|  | (8) |
|  |  |
|  | (9) |
|  |  |
|  |  |
|  |  |
|  |  |

- Building constraints

|  |  |
| --- | --- |
|  | (10) |
|  |  |
|  | (11) |
|  |  |
|  | (12) |

- Variables constraint

|  |  |
| --- | --- |
|  | (13) |

Nomenclature:

Index

- : index of the number of vehicles parked range [1 to I]

- : index of time steps range [0 to T]

- : Efficiency of the installed charger (%)

- : Efficiency of the installed solar panel (%)

- : Time step scale (0,25h)

Parameters

- : Area of the PV panel (m2)

- : Charging tariff for the EVs (€/hour)

- : Discharging tariff for the EVs (€/hour)

- : Building electricity cost at time step t (€)

-: Cost of energy exported to the grid at time step (€/kWh)

- : Building electricity cost at time step t (€)

-: Cost of energy imported from the grid at time step t (€/kWh)

-: Cost of energy exported to the grid at time step (€/kWh)

- : Solar irradiation (W/m2)

-: Energy flow entering the building at time step t (kW)

-: Energy flow leaving the building at time step t (kW)

-: Baseload of the building at time step t (kW)

- : Maximum charging power allowed by the nth charger (kW)

- : Maximum discharging power allowed by the nth charger (kW)

- -: Solar power generated at the building at time step t (kW)

- : Performance ratio of the PV panel

- : State of Charge of the ith EV at time of departure desired by the owner (%)

- : Maximum State of Charge of the ith EV at time step t (%)

- : Minimum State of Charge of the ith EV at time step t (%)

- : Battery capacity of the ith EV (kWh)

- : Time of arrival of the ith EV (hour)

- : Time of departure of the ith EV (hour)

Variables

- : Total capacity of the ith EV at time step t (kWh)

- : Total EV charging energy at the building (kWh)

- : Total EV discharging energy at the building (kWh)

- : Power of charge of the ith EV at time step t (kW)

- : Power of discharge of the ith EV at time step t (kW)

- : Charging situation of the ith EV at time step t

- : Discharging situation of the ith EV at time step t

List of References

[1] A. El-Zonkoly, “Intelligent energy management of optimally located renewable energy systems incorporating PHEV,” *Energy Convers Manag*, vol. 84, pp. 427–435, Aug. 2014, doi: 10.1016/J.ENCONMAN.2014.04.050.

[2] J. A. Manzolli, J. P. F. Trovão, and C. Henggeler Antunes, “Electric bus coordinated charging strategy considering V2G and battery degradation,” *Energy*, vol. 254, p. 124252, Sep. 2022, doi: 10.1016/J.ENERGY.2022.124252.