Implementation

Saturday, November 19, 2022 12:09 PM

Simulation

- System Architect:
  - Load: Load Profile (load can account for additional EV, EV not registered) + EVs
  - Uncontrollable Assets: PV
  - Controllable Assets: Grid + EVs + (Genset) + (Battery)
- Tariff:
  - Energy
  - Power
  - Self-consumption

Convention:

- If power is drawn (leaving) from the element, then it assumes positive value. Hence,

  $\mathbf{P_{PV}} \geq 0$
  $\boldsymbol{P_{EV}} \leq 0$ (assuming unidirectional)
  $\boldsymbol{P^{G}} \geq 0$ (assuming no selling back)

- Decision variables are in **bold**

Constraints

- Power Balance

$$\boldsymbol{P_t^G} + \sum_{v=1}^{V} \boldsymbol{P_{t,v}^{EV}} + \boldsymbol{P_t^{BESS}} + P_t^{PV} + P_t^{Load} = 0$$

- Grid Power Separation

$$\boldsymbol{P_t^G} = \boldsymbol{P_t^{G+}} - \boldsymbol{P_t^{G-}}$$
$$P_t^{G+} \geq 0$$
$$P_t^{G-} \geq 0$$

- Demand Peak (relaxed to the objective function)

$$\boldsymbol{P_t^G} \leq P^{Peak}$$

Or

$$\boldsymbol{P_t^{SurPeak+}} - \boldsymbol{P_t^{SurPeak-}} = P^{Peak} - \boldsymbol{P_t^G}$$
$$\boldsymbol{P_t^{SurPeak+}} \geq \mathbf{0}, \boldsymbol{P_t^{SurPeak-}} \geq \mathbf{0}$$

- No Charging before arrival time

$$\boldsymbol{y_t^v} = 0 \; if \; t < TA_v \,, \qquad \forall v \in V$$

- Charging Activation:

$$\boldsymbol{y_t^v} = \begin{cases} 1, & if \; v \; is \; charged \; at \; time \; t \\ & 0 \end{cases}$$

  - If variable charging power is the case:

$$M \times \boldsymbol{y_t^v} \geq -\boldsymbol{P_t^{EV}} \text{ (complementary required in the objective function)}$$

$$P_{nom}^v \geq -\boldsymbol{P_{t,v}^{EV}}, \qquad \forall v \in V$$

  - If fixed charging power:

$$P_{nom}^v \times \boldsymbol{y_t^v} = -\boldsymbol{P_{t,v}^{EV}} \text{ with } P_{nom}^v \text{ is the nominal charing power of the vehicle } v$$

- Maximum EV Charged $<=$ number of sockets

$$\sum_{v=1}^{V} y_t^v \leq N_s \text{ , with } N_s = \text{number of sockets}$$

- EV's State of Charge: $\boldsymbol{soc_{t+1}^v}$ is the state of charge of vehicle v at the beginning of the interval $[t, t+1]$

$$\boldsymbol{soc_{t+1}^v} = \eta^v \times \frac{-\boldsymbol{P_{t,v}^{EV}}}{CEV^v} \times \Delta t + \boldsymbol{soc_t^v} \,, \qquad \forall t \in [1, T-1], \; \Delta t = Timestep/3600$$

$$\boldsymbol{soc_1^v} = soc_{init}^v \,, \qquad t = 0$$

$$\boldsymbol{soc_t^v} \geq socMin$$
$$\boldsymbol{soc_t^v} \leq \text{socMax}$$

  - [ ] Max is 1

- Departure Constraints:

  - Hard Constraint: SoC must be at the desired level at departure time (TD^v). This hard constraint will be <u>a problem if we have a fixed charging power level</u>.

$$\boldsymbol{soc_t^v} \geq soc_{desired}^v, \qquad if \; \forall t \geq TD^v \,, \qquad \forall v \in V$$

Notice that the equality constraint ($\boldsymbol{soc_t^v} \geq soc_{desired}^v$) make the solver take a lot longer to solve (even exceed time limit)

  - [ ] $P_{t,v}^{EV} = 0, \qquad \forall \; t \geq TD^v$

Tardiness is no longer required in the objective function

  - Soft Constraints

$$tard_v = soc_{desired}^v - soc_t^v, \qquad if \; t = TD^v$$

- Tardiness (with respect to the desired SoC)

- Socket Engagement: stop charging after tDeparture or desired SoC is satisfied

Objective Function

$$objFunc = Energy + Demand + Soft\ Constraint$$

$$Energy = \cdots$$

$$Demand = \sum_{t=1}^{T} Pr_t^{DCM} \times \boldsymbol{P_t^{SurPeak-}}$$

- Cost Energy
- Cost Power
- Tardiness
- Unmet service
- Socket Engagement

Remarks

- The coefficients for the tardiness and cost for demand peak may be a determining factor for the solvability (& solving time), thus choosing the suitable cost for tardiness is genuinely important.

  -> One more reason to separate into a peak problem with a sub problem for scheduling

Testing Scenarii

- With or without Demand Constraint
- Surplus PV
- Deficit PV