Sets

A Activities $\{1, \ldots, |A|\}$

$A^r \subseteq A$ Recurring activities

$A^o \subseteq A$ one-off activities

T Time periods in month $\{1, \ldots, 28800\}$

T^{bus} Time periods which fall in business hours

$T^{off} = T \setminus T^{bus}$

T^r Time periods for recurring activities $\{1, \ldots, 32\}$

T^o Time periods for one-off activities $\{1, \ldots, 96\}$

D^r Days of week $\{1, \ldots, 5\}$

D^o Days of month $\{1, \ldots 30\}$

K_a Set of feasible schedules for class $a \in A$

B Set of batteries

Data

n^{small}, n^{large} } # small/large rooms available

p_t^{base} base load @ time $t \in T$

p_t^{solar} solar supply @ time $t \in T$

$price_t$ grid price @ time $t \in T$

$small^k_{adt}$
$large^k_{adt}$ ...

$Value_a^k$ ...

P^k_{adt} power consumption class $a \in A$ at $t \in T^{o/r}$ in schedule $k \in K_a$

$prec^k_a$ Set of tuples $(a,k) \in A \times K_a$

$active^r_{dt}$ set of active schedules $(a,k) \in A^r \times K_a$ at $d \in D^r, t \in T^r$

$active^o_{dt}$ ...

$G^{r/o}_{ad}$ set of active schedules $k \in K_a$ for $a \in A^{r/o}$, on $d \in D^{r/o}$

eff_b Efficiency of battery $b \in B$

cap_b capacity of battery $b \in B$

m_b max power of battery $b \in B$

Functions

$T2Tr(T)$ Map a subset of T to the corresponding $(d,t) \in D^r \times T^r$ pairs used to index recurring activities

$T2To(T)$ " where $(d,t) \in D^o \times T^o$

Variables

$\varepsilon_a^k \in \{0,1\}$ 1 if schedule $k \in K_a$ is chosen

p_t^{grid} grid supply @ time $t \in T$

p_t^{class} Total class demand @ time $t \in T$

c_{bt} Power stored by battery $b \in B$ @ $t \in T$

$z_{bt}^d \in \{0,1\}$ 1 if battery $b \in B$ discharging at time $t \in T$

$z_{bt}^c \in \{0,1\}$ 1 if battery $b \in B$ charging at time $t \in T$

Objective

ignore for now

$$\min \sum_{t \in T} \frac{0.25}{1000} p_t^{grid} \cdot price_t + 0.05 \left(\max_t p_t^{grid} \right)^2 - \sum_{\substack{a \in A^o \\ k \in K_a}} \varepsilon_a^k \, value_a^k$$

Constraints

$$\sum_{k \in Ka} \varepsilon_a^k = 1 \qquad \forall a \in A^r$$

$$\sum_{k \in Ka} \varepsilon_a^k \leq 1 \qquad \forall a \in A^o$$

Classrooms available

$$\mathbb{I}((d^r,t^r) \in T^r) \sum_{\substack{a \in A^r \\ k \in Ka}} \varepsilon_a^k \cdot small_{ad^r t^r}^k \ldots$$

$$+ \sum_{\substack{a \in A^o \\ k \in Ka}} \varepsilon_a^k \, small_{ad^o t^o}^k \leq n^{small} \qquad \forall t \in T \text{ with mappings } (d^r,t^r) = T2Tr(t), (d^o,t^o) = T2To(t)$$

Same for large rooms

Power demand from classes

$$\mathbb{I}((d^r,t^r) \in T^r) \sum_{\substack{a \in A^r \\ k \in Ka}} \varepsilon_a^k \cdot p_{ad^r t^r}^h \left(small_{ad^r t^r}^k + large_{ad^r t^r}^k \right)$$

$$+ \sum_{\substack{a \in A^o \\ k \in Ka}} \varepsilon_a^k \, p_{ad^o t^o}^k \left(small_{ad^o t^o}^k + large_{ad^o t^o}^k \right) = p_t^{class} \qquad \forall t \in T \text{ with mappings } \ldots$$

Match supply and demand

$$p_t^{grid} + p_t^{solar} + \sum_{b \in B} m_b \left(\sqrt{eff_b} \, z_{bt}^d - \frac{z_{bt}^c}{\sqrt{eff_b}} \right) = p_t^{class} + p_t^{base} \qquad \forall t \in T$$

Precedence

$$|preca| \sum_{k \in \hat{G}_{ad}} \varepsilon_a^k \leq \sum_{\substack{a' \in preca \\ d' \subset d \\ k \in \hat{G}_{a'd'}}} \varepsilon_{a'}^k \qquad \forall a \in A^r, d \in D^r$$

Same for one-off activities

Starting Capacity

$$C_{b,1} = cap_b - m_b z^d_{b,1} \qquad \forall b \in B$$

Cannot charge & discharge at same time

$$z^c_{bt} + z^d_{bt} \leq 1 \qquad \forall b \in B, t \in T$$

Update storage

$$C_{bt} = C_{b,t-1} + m_b (z^c_{bt} - z^d_{bt}) \qquad \begin{matrix} \forall b \in B \\ t \in T \setminus \{1\} \end{matrix}$$

$$0 \leq C_{bt} \leq cap_b \qquad \begin{matrix} \forall b \in B \\ t \in T \end{matrix}$$