D. Objectives

$$\min_{a_{t,k}} \sum_{t=1}^{T}\sum_{k=1}^{K}(1-\beta)m_{t,k}^{\text{cost}} + \beta|p_{t,k} - p_t^{\text{total}}G_{t,k}| \tag{10}$$

$a_{t,k}$ is charging action of EV_k on time interval t;

$$\begin{cases} a_{t,k} \in [0,1] & t_k^a \le t < t_k^d \\ a_{t,k} = 0 & otherwise \end{cases} \tag{11}$$

β denotes the cost coefficient, when β gets larger, the model focuses more on the fairness between each EV other than minimizing the electricity cost. In particular, when $\beta = 0$, the model will only consider the cost;

$$\beta \in [0,1] \tag{12}$$

$m_{t,k}^{\text{cost}}$ represents the charging cost of EV_k on time interval t;

$$m_{t,k}^{\text{cost}} = \rho_t * p_{t,k} \tag{13}$$

Where $p_{t,k}$ is charging power of EV_k on time interval t;

$$p_{t,k} = a_{t,k} * p_k^{max} * \Delta t \tag{14}$$

p_t^{total} represents total charging power of all EVs on time interval t.

$$p_t^{\text{total}} = \sum_{k=1}^{K} p_{t,k} \tag{15}$$

$G_{t,k}$ represents the proportion of EV_k's charging urgency to all EVs' on time interval t.

$$G_{t,k} = \begin{cases} \frac{g_{t,k}}{g_t^{\text{total}}} & g_t^{\text{total}} > 0 \\ 0 & g_t^{\text{total}} = 0 \end{cases} \tag{16}$$

Where $g_{t,k}$ represents charging urgency of EV_k on time interval t;

$$g_{t,k} = \begin{cases} \frac{SoC_k^d - SoC_{t,k}}{(t_k^d - t)} \frac{C_k}{e * p_k^{max} * \Delta t} & t_k^a \leq t < t_k^d \\ 0 & otherwise \end{cases} \tag{17}$$

And g_t^{total} represents the total charging urgency of all EVs on time interval t;

$$g_t^{\text{total}} = \sum_{k=1}^{K} g_{t,k} \tag{18}$$

E. Constraints

There are several constraints in this model.

1) Update SoC:

$$SoC_{t,k} = \begin{cases} SoC_k^a, & t = t_k^a \\ SoC_{t-1,k} + a_{t-1,k} p_k^{max} e_k \Delta t / C_k, & t_k^a < t \leq t_k^d \end{cases} \tag{19}$$

Where $e = 0.95$ represents the charging efficiency;

2) Satisfy Customers' Requirments:

$$SoC_{t_k^d,k} = SoC_k^d \tag{20}$$

3) Constraint of SoC:

$$SoC_{\text{min}} \leq SoC_{t,k} \leq SoC_{\text{max}} \quad t \in [t_k^a, t_k^d], k \in K \tag{21}$$

4) Constraint of Station Capacity:

$$\sum_{k=1}^{K} p_{t,k} \leq P_{\text{max}} \quad t \in T \tag{22}$$

Where P_{max} represents the station's whole capacity;