Electric Bill Optimisation

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When the consumption of electrical energy is very large, it is necessary to specify what your consumption will be during different periods of time during a day. These time periods are defined by the electricity companies and take into account the total demand of all users. We will focus specifically on the 6.1 high voltage electric tariff.

In this tariff, the electric company defines six periods during the day:

$$\{P_1, P_2, P_3, P_4, P_5, P_6\} \tag{1}$$

These periods are defined taking into account the total demand of all users, so that the cost of energy in the period P_1 is more expensive than in the period P_6. For each of these periods P_i the company sets a constant c_i that we will call the cost of the period. Then, the user must choose a vector $p = (p_1, p_2, p_3, p_4, p_5, p_6)$ such that:

$$450 < p_1 < p_2 < p_3 < p_4 < p_5 < p_6 \tag{2}$$

So at the end of a month m you will be charged:

$$\Phi^m(p) = \sum_{i=1}^{6} \left(c_i p_i + 1.4064 \sqrt{\sum_{j \in J} (\pi_j^{i,m} - p_i)^2 \ \Theta(\pi_j^i - p_i)} \right) \tag{3}$$

Where $\pi_j^{i,m}$ is the maximum power that has been consumed in the period P_i for each day j of month m and where the function $\Theta : \mathbb{R} \Rightarrow \mathbb{R}$ is:

$$\Theta(x) = \begin{cases} 1 & if \ x > 0 \\ 0 & if \ x < 0 \end{cases} \tag{4}$$

It is proposed to minimize the cost throughout the year with respect to the

parameters p as follows:

$$\min_{p \in \mathbb{R}^6} \sum_{m=1}^{12} \Phi^m(p) \tag{5}$$

$$\text{suject to:}$$

$$450 < p_1 < p_2 < p_3 < p_4 < p_5 < p_6$$

Due to the discontinuities of the Φ function, the gradient-based optimization methods are not effective. Genetic algorithms are a good option for this type of problem since it does not take into account the gradient of the function.