$$\min. \sum_{t=1}^{T} \left[C^t P^t_{subs} + \alpha \sum_{j \in B} \{ \omega P^t_{c,j} + \omega P^t_{d,j} \} \right] \quad (f)$$

s.t.

$$\sum_L P^t_{jk} - (P^t_{ij} - r_{ij} l^t_{ij}) + (P^t_{Lj}) - (P^t_{Dj}) - (P^t_{dj} - P^t_{cj}) = 0 \quad (h1)$$

$$\sum_L Q^t_{jk} - (Q^t_{ij} - x_{ij} l^t_{ij}) + (q^t_{Lj}) - (q^t_{Dj} + q^t_{Bj}) - (q^t_{cj}) = 0 \quad (h2)$$

$$V^t_i - V^t_j - 2(r P^t_{ij} + x Q^t_{ij}) + (r^2 + x^2) l^t_{ij} \quad (h3)$$

$$(P^t_{ij})^2 + (Q^t_{ij})^2 - V^t_i l^t_{ij} = 0 \quad (h4)$$

$$-V^t_j \le -V^2_{min} \quad (g1)$$

$$V^t_j \le V^2_{Max} \quad (g2)$$

$$-q^t_{Dj} \le -0.44 P_{D,R,j} \quad (g3)$$

$$q^t_{Dj} \le 0.44 P_{D,R,j} \quad (g4)$$

$$B^t_j - \{ B^{t-1}_j + \Delta t \eta_c P^t_{cj} - \Delta t \frac{1}{\eta_d} P^t_{dj} \} = 0 \quad (h5) \text{ or } (h_{soc})$$

$$-P^t_{cld,j} \le 0 \quad (g5), (g7)$$

$$P^t_{cld,j} \le P_{B,R,j} \quad (g6), (g8)$$

$$-q^t_{Bj} \le -0.44 P_{B,R,j} \quad (g9)$$

$$q^t_{Bj} \le 0.44 P_{B,R,j} \quad (g10)$$

$$-B_j^t \le -soc_{min} \cdot B_{R,j} \quad (g11)$$
$$B_j^t \le soc_{max} \cdot B_{R,j} \quad (g12)$$

Full Problem:

$$\min \sum_{t=1}^{T} f(x^t)$$

s.t.

$$h_{cE}(x^t) = 0 \quad \forall t = 1 \dots T, \; cE = 1 \dots 4$$

$$g_{cI}(x^t) \le 0 \quad \forall t = 1 \dots T, \; cI = 1 \dots 10 \; (\text{or } 1 \dots 12?)$$

$$h_s(B_\cdot^t, B_\cdot^{t-1}, x^t) = 0 \quad \forall t = 1 \dots T$$

$$g_{11}(B^t) \le 0 \quad \forall t = 1 \dots T$$
$$g_{12}(B^t) \le 0 \quad \forall t = 1 \dots T$$

Formulating the Lagrangian:

$$L_{MPOPF} = \sum_{t=1}^{T} \Big[f(x^t) + \sum_{cI=1\dots10} \lambda_{cI}^t g_{cI}(x^t) + \sum_{cE=1\dots4} \mu_{cE}^t h_{cE}(x^t) \Big] + \sum_{t=1}^{T} \Big[\lambda_{11}^t g_{11}(B^t) + \lambda_{12}^t g_{12}(B^t) \Big]$$

$$+ \mu_s^1 \{ B^1 - \{ B^0 + \dots - P_k^1 - \{ P_d^1 \} \}$$
$$+ \sum_{t=2}^{T} \Big[\mu_s^t \{ B^t - \{ B^{t-1} + \dots - P_k^t + \dots - P_d^t \} \Big]$$

(L)

State Variables:

$$y^t = \begin{bmatrix} x^t \\ \lambda_{CI}^t \\ \mu_{CE}^t \\ B^t \\ \lambda_{12}^t \\ \lambda_{13}^t \\ \mu_S^t \end{bmatrix}$$

- $x^t \rightarrow P_{ij}^t, Q_{ij}^t, \ell_{ij}^t, V_j^t, P_{Cj}^t, P_{Aj}^t, Q_{Dj}^t, B_j^t$
- $\lambda_{CI}^t \rightarrow$ 10 ineq. constraints
- $\mu_{CE}^t \rightarrow$ 4 eq. constraints
- $B^t \rightarrow B_j^t$
- λ_{12}^t, $\lambda_{13}^t \rightarrow$ 2 ineq. constraints
- $\mu_S^t \rightarrow$ 1 eq. constraint

FONC:

$$\nabla L = 0$$

$$\nabla_{x^t} L = [0]_x$$

$$\nabla_{\lambda_{CI}^t} L = [0]_{CI}$$

$$\nabla_{\mu_{CE}^t} L = [0]_{CE}$$

$$\nabla_{B^t} L = [0]_1$$

$$\nabla_{\lambda_{11}^t} L = [0]_1$$

$$\nabla_{\lambda_{12}^t} L = [0]_1$$

$$\nabla_{\mu_S^t} L = [0]_1$$