计及混合储能的水光互补制氢双层优化调度-附录

下层模型拉格朗日函数

$$L=\sum_{t=1}^{T}\hat{}_{wa}P_{wa}^{t}+\hat{}_{pv}P_{pv}^{t}+\hat{\lambda}_{el}P_{el}^{t}+\hat{}_{phs}(P_{pump}^{t}+P_{ele}^{t})+\hat{}_{hs}(H_{hs\,c}^{t}+H_{hs\,dis}^{t})+\hat{}_{es}(P_{es\,c}^{t}+P_{es\,dis}^{t})+$$
$$\sum_{t=1}^{T}\mu_{P,\mathrm{buy}}P_{buy}^{t}+\sum_{t=1}^{T}\mu_{\mathrm{H,buy}}H_{buy}^{t}+\sum_{t=1}^{T}\lambda_{wa,aba}\left(P_{wa,pre}^{t}C_{wa}-P_{wa}^{t}\right)+\sum_{t=1}^{T}\lambda_{pv,aba}\left(P_{pv,pre}^{t}C_{pv}-P_{pv}^{t}\right)+$$
$$\lambda_{1}\left[P_{wa}^{t}+P_{pv}^{t}+P_{ele}^{t}+P_{es,dis}^{t}+P_{buy}^{t}-P_{es}^{t}-P_{pump}^{t}-P_{es,c}^{t}-P_{load}^{t}\right]+$$
$$\lambda_{2}\left[H_{com}^{t}+H_{hs,dis}^{t}+H_{buy}^{t}-H_{hs\,c}^{t}-H_{loaf}^{t}\right]+\lambda_{3}\left[\left|Q_{pump}^{t}-P_{pump}^{t}/0.75\right|\right]+\lambda_{4}\left[\left|Q_{ele}^{t}-0.75P_{e\,ke}^{t}\right|\right]-$$
$$\mu_{1}^{\min}P_{wa}^{t}+\mu_{1}^{\max}\left[P_{wa}^{t}-P_{wa,pre}^{t}C_{wa}\right]-\mu_{2}^{\min}P_{p\,v}^{t}+\mu_{2}^{\max}\left[P_{pv}^{t}-P_{p\,v,pre}^{t}C_{pv}\right]-$$
$$\mu_{3}^{\min}P_{el}^{t}+\mu_{3}^{\max}\left[P_{el}^{t}-P_{el,\max}\right]-\mu_{4}^{\min}P_{buy}^{t}+\mu_{4}^{\max}\left[P_{buy}^{t}-P_{buy,\max}\right]-\mu_{5}^{\min}H_{buy}^{t}+$$
$$\mu_{5}^{\max}\left[H_{buy}^{t}-H_{buy,\max}\right]-\mu_{6}^{\min}Q_{pump}^{t}+\mu_{6}^{\max}\left[Q_{pump}^{t}-Q_{\max}\right]-\mu_{7}^{\min}Q_{ele}^{t}+\mu_{7}^{\max}\left[\left|Q_{ele}^{t}-Q_{\max}\right|\right]-$$
$$\mu_{8}^{\min}P_{pump}^{t}+\mu_{8}^{\max}\left[P_{pump}^{t}-P_{phs,\max}\right]-\mu_{9}^{\min}P_{ele}^{t}+\mu_{9}^{\max}\left[P_{ele}^{t}-P_{phs,\max}\right]-\mu_{10}^{\min}H_{hs\,c}^{t}+$$
$$\mu_{10}^{\max}\left[H_{hs,c}^{t}-H_{hs,\max}\right]-\mu_{11}^{\min}H_{hs,dis}^{t}+\mu_{11}^{\max}\left[H_{hs,dis}^{t}-H_{hs,\max}\right]-\mu_{12}^{\min}P_{es,c}^{t}+$$
$$\mu_{12}^{\max}\left[P_{es,c}^{t}-P_{es,\max}\right]-\mu_{13}^{\min}P_{es,dis}^{t}+\mu_{13}^{\max}\left[P_{es,dis}^{t}-P_{es,\max}\right]$$

式中：λ_1、λ_2、λ_3、λ_4 分别为等式约束对应的拉格朗日乘子，$\mu_1^{\min}$、$\mu_1^{\max}$，$\mu_2^{\min}$、$\mu_2^{\max}$，$\mu_3^{\min}$、$\mu_3^{\max}$，$\mu_4^{\min}$、$\mu_4^{\max}$，$\mu_5^{\min}$、$\mu_5^{\max}$，$\mu_6^{\min}$、$\mu_6^{\max}$，$\mu_7^{\min}$、$\mu_7^{\max}$，$\mu_8^{\min}$、$\mu_8^{\max}$，$\mu_9^{\min}$、$\mu_9^{\max}$，$\mu_{10}^{\min}$、$\mu_{10}^{\max}$，$\mu_{11}^{\min}$、$\mu_{11}^{\max}$，$\mu_{12}^{\min}$、$\mu_{12}^{\max}$，$\mu_{13}^{\min}$、$\mu_{13}^{\max}$ 分别为不等式约束对应的拉格朗日乘子。

对 L 求 P_{wa}^{t}、P_{pv}^{t}、P_{el}^{t}、P_{buy}^{t}、H_{buy}^{t}、Q_{pump}^{t}、Q_{ele}^{t}、P_{pump}^{t}、P_{ele}^{t}、$H_{hs,c}^{t}$、$H_{hs,dis}^{t}$、$P_{\mathrm{es,c}}^{t}$、$P_{\mathrm{es,dis}}^{t}$ 的偏导可得：

1）水电站发电量

$$\frac{\partial L}{\partial P_{wa}^{t}}=\hat{\lambda}_{wa}-\lambda_{wa,aba}+\lambda_{1}-\mu_{1}^{\min}+\mu_{1}^{\max}\tag{A1}$$

2）光伏电站发电量

$$\frac{\partial L}{\partial P_{pv}^{t}}=\hat{\lambda}_{pv}-\lambda_{pv,aba}+\lambda_{1}-\mu_{2}^{\min}+\mu_{2}^{\max}\tag{A2}$$

3）电制氢设备耗电量

$$\frac{\partial L}{\partial P_{el}^{t}}=\hat{\lambda}_{el}-\lambda_{1}-\mu_{3}^{\min}+\mu_{3}^{\max} \tag{A3}$$

4）购电量

$$\frac{\partial L}{\partial P_{buy}^{t}}=\mu_{P,buy}+\lambda_{1}-\mu_{4}^{\min}+\mu_{4}^{\max} \tag{A4}$$

5）购氢量

$$\frac{\partial L}{\partial H_{buy}^{t}}=\mu_{H,buy}+\lambda_{2}-\mu_{5}^{\min}+\mu_{5}^{\max} \tag{A5}$$

6）抽水蓄能电站抽水量

$$\frac{\partial L}{\partial Q_{pump}^{t}}=\lambda_{3}-\mu_{6}^{\min}+\mu_{6}^{\max} \tag{A6}$$

7）抽水蓄能电站耗水量

$$\frac{\partial L}{\partial Q_{ele}^{t}}=\lambda_{4}-\mu_{7}^{\min}+\mu_{7}^{\max} \tag{A7}$$

8）抽水蓄能电站耗电量

$$\frac{\partial L}{\partial P_{pump}^{t}}=\hat{\lambda}_{phs}-\lambda_{1}-\frac{1}{0.75}\lambda_{3}-\mu_{8}^{\min}+\mu_{8}^{\max} \tag{A8}$$

9）抽水蓄能电站发电量

$$\frac{\partial L}{\partial P_{ele}^{t}}=\hat{\lambda}_{phs}+\lambda_{1}-0.75\lambda_{4}-\mu_{9}^{\min}+\mu_{9}^{\max} \tag{A9}$$

10）储氢设备充氢量

$$\frac{\partial L}{\partial H_{hs,c}^{t}}=\hat{\lambda}_{hs}-\lambda_{2}-\mu_{10}^{\min}+\mu_{10}^{\max} \tag{A10}$$

11）储氢设备放氢量

$$\frac{\partial L}{\partial H_{hs,dis}^{t}}=\hat{\lambda}_{hs}+\lambda_{2}-\mu_{11}^{\min}+\mu_{11}^{\max} \tag{A11}$$

12）储能设备充电量

$$\frac{\partial L}{\partial H_{es,c}^{t}}=\hat{\lambda}_{es}-\lambda_{1}-\mu_{12}^{\min}+\mu_{12}^{\max} \tag{A12}$$

13）储能设备放电量

$$\frac{\partial L}{\partial H_{es,dis}^{t}}=\hat{\lambda}_{es}+\lambda_{1}-\mu_{13}^{\min}+\mu_{13}^{\max} \tag{A13}$$