# Optimization of Hybrid Power Plants: When Is a Detailed Electrolyzer Model Necessary?

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## Online Companion

The following companion is supplementary to the paper *Optimization of Hybrid Power Plants: When Is a Detailed Electrolyzer Model Necessary?* and provides the changes in mathematical formulations of the MILP models with only two states, namely the On-Off and On-Standby in Section B and C respectively.

### B. The Simplified MILP with On-Off States

This Section provides the MILP where the on and off states of the electrolyzer are only modeled. This is a simplified model compared to the one proposed in Section III with three states of the electrolyzer.

$$\max_{\boldsymbol{\Omega}} \quad \sum_{t\in\mathcal{T}} p_t\lambda_t^{\mathrm{DA}} + d_t\lambda^{\mathrm{h}} - z_t^{\mathrm{su}}\lambda^{\mathrm{su}} \tag{B.1}$$

$$\text{s.t.} \quad p_t = P_t^{\mathrm{w}} - p_t^{\mathrm{e}} - p_t^{\mathrm{c}} \qquad \forall\, t\in\mathcal{T}, \tag{B.2}$$

$$p_t^{\mathrm{e}} \leq C^{\mathrm{e}} z_t^{\mathrm{oo}} \qquad \forall\, t\in\mathcal{T}, \tag{B.3}$$

$$p_t^{\mathrm{e}} \geq P^{\min} z_t^{\mathrm{oo}} \qquad \forall\, t\in\mathcal{T}, \tag{B.4}$$

$$z_t^{\mathrm{su}} \geq z_t^{\mathrm{oo}} - z_{t-1}^{\mathrm{oo}} \qquad \forall\, t\in\mathcal{T}\setminus\{1\}, \tag{B.5}$$

$$z_t^{\mathrm{oo}} = \sum_{s\in\mathcal{S}} z_{ts}^{\mathrm{h}} \qquad \forall\, t\in\mathcal{T}, \tag{B.6}$$

$$p_t^{\mathrm{e}} = \sum_{s\in\mathcal{S}} \hat{p}_{ts}^{\mathrm{e}} \qquad \forall\, t\in\mathcal{T}, \tag{B.7}$$

$$(12), (14)-(15), (18)-(25), \tag{B.8}$$

$$d_t, h_t, h_t^{\mathrm{d}}, p_t, p_t^{\mathrm{c}}, \hat{p}_{ts}^{\mathrm{e}}, s_t, s_t^{\mathrm{in}}, s_t^{\mathrm{out}} \in \mathbb{R}^+, \tag{B.9}$$

$$z_t^{\mathrm{su}}, z_{ts}^{\mathrm{h}}, z_t^{\mathrm{oo}} \in \{0,1\}, \tag{B.10}$$

$$\Omega = \{d_t, h_t, h_t^{\mathrm{d}}, p_t, p_t^{\mathrm{c}}, \hat{p}_{ts}^{\mathrm{e}}, s_t^{\mathrm{in}}, s_t^{\mathrm{out}}, z_t^{\mathrm{su}}, z_{ts}^{\mathrm{h}}, z_t^{\mathrm{oo}}\}. \tag{B.11}$$

### C. The Simplified MILP with On-Standby States

This Section presents the simplified MILP taking into account on and standby states of the electrolyzer.

$$\max_{\Gamma} \quad \sum_{t\in\mathcal{T}} p_t\lambda_t^{\mathrm{DA}} + d_t\lambda^{\mathrm{h}} - p_t^{\mathrm{in}}\lambda_t^{\mathrm{in}} \tag{C.1}$$

$$\text{s.t.} \quad p_t^{\mathrm{in}} \leq P^{\mathrm{sb}}(1 - z_t^{\mathrm{os}}) \qquad \forall\, t\in\mathcal{T}, \tag{C.2}$$

$$p_t^{\mathrm{e}} \leq C^{\mathrm{e}} z_t^{\mathrm{os}} + P^{\mathrm{sb}}(1 - z_t^{\mathrm{os}}) \qquad \forall\, t\in\mathcal{T}, \tag{C.3}$$

$$p_t^{\mathrm{e}} \geq P^{\min} z_t^{\mathrm{os}} + P^{\mathrm{sb}}(1 - z_t^{\mathrm{os}}) \qquad \forall\, t\in\mathcal{T}, \tag{C.4}$$

$$z_t^{\mathrm{os}} = \sum_{s\in\mathcal{S}} z_{ts}^{\mathrm{h}} \qquad \forall\, t\in\mathcal{T}, \tag{C.5}$$

$$p_t^{\mathrm{e}} = \sum_{s\in\mathcal{S}} \hat{p}_{ts}^{\mathrm{e}} + P^{\mathrm{sb}}(1 - z_t^{\mathrm{os}}) \qquad \forall\, t\in\mathcal{T}, \tag{C.6}$$

$$(6), (14)-(15), (18)-(25), \tag{C.7}$$

$$d_t, h_t, h_t^{\mathrm{d}}, p_t, p_t^{\mathrm{c}}, p_t^{\mathrm{in}}, \hat{p}_{ts}^{\mathrm{e}}, s_t, s_t^{\mathrm{in}}, s_t^{\mathrm{out}} \in \mathbb{R}^+, \tag{C.8}$$

$$z_{ts}^{\mathrm{h}}, z_t^{\mathrm{os}} \in \{0,1\}, \tag{C.9}$$

$$\Gamma = \{d_t, h_t, h_t^{\mathrm{d}}, p_t, p_t^{\mathrm{c}}, p_t^{\mathrm{in}}, \hat{p}_{ts}^{\mathrm{e}}, s_t^{\mathrm{in}}, s_t, s_t^{\mathrm{out}}, z_t^{\mathrm{su}}, z_t^{\mathrm{os}}\}. \tag{C.10}$$