A. Traditional RT scheduling

The traditional RT scheduling for the EPS is expressed as outlined in Eqs. (A.1)-(A.9) and it is implemented for each time step separately [13, 14, 20]. The objective function is to minimize the operational cost of CHP, cost of load shedding and wind spillage. It is subject to the nodal power flow in Eq. (A.2), maximum operating limits of CHP units in Eq. (A.3), transmission line capacity in Eq. (A.4), ramp rate limits of the CHP units in Eqs. (A.5)-(A.6), and maximum and minimum wind spillage and load shedding in Eqs. (A.8)-(A.9).

$$C_{total}^{RT}(t) = \min\left(\sum_{j=1}^{n_g} C_j^{\mathrm{CHP,P}} P_{j,t}^{\mathrm{CHP,RT}} + \sum_{e=1}^{n^{\mathrm{ED}}} C_e^{VOLL} D_{e,t}^{\mathrm{ED,shed,RT}} + \sum_{k=1}^{n^{\mathrm{ED}}} C_k^{spill} W_{f,t}^{spill,RT} \right) \tag{A.1}$$

Subject to:

$$\sum_{j\in\Omega_n^{\mathrm{CHP}}} P_{j,t}^{\mathrm{CHP,RT}} + \sum_{f\in\Omega_n^{\mathrm{WT}}} W_{f,t}^{RT} - \sum_{d\in\Omega_n^{\mathrm{ED}}} D_{d,t}^{\mathrm{ED,RT}} = \sum_{m\in\Lambda^{EPS}} B_{nm}\left(\delta_{n,t}^{RT} - \delta_{m,t}^{RT}\right), \ \ \forall n\in\Lambda^{\mathrm{EPS}}, \forall t\in T \tag{A.2}$$

$$P_j^{\mathrm{CHP,min}} \le P_{j,t}^{\mathrm{CHP,RT}} \le P_j^{\mathrm{CHP,max}}, \ \ \forall j\in\Omega^{\mathrm{CHP}}, \forall t\in T \tag{A.3}$$

$$-P_{nm}^{\max} \le B_{nm}\left(\delta_{n,t}^{RT} - \delta_{m,t}^{RT}\right) \le P_{nm}^{\max}, \ \ \forall n,m\in\Lambda^{\mathrm{EPS}}, \forall t\in T \tag{A.4}$$

$$P_{j,t-1}^{\mathrm{CHP,RT}} - P_{j,t}^{\mathrm{CHP,RT}} \le RLD_j^{\mathrm{CHP}}, \ \ \forall j\in\Omega^{\mathrm{CHP}}, \forall t\in T \tag{A.5}$$

$$P_{j,t}^{\mathrm{CHP,RT}} - P_{j,t-1}^{\mathrm{CHP,RT}} \le RLU_j^{\mathrm{CHP}}, \ \ \forall j\in\Omega^{\mathrm{CHP}}, \forall t\in T \tag{A.6}$$

$$\delta^{RT}{}_{\mathrm{REF},t} = 0, \ \ \forall t\in T \tag{A.7}$$

$$0 \le W_{f,t}^{spill} \le W_{f,t}^{RT}, \ \ \forall f\in\Omega^{\mathrm{WF}}, \forall t\in T \tag{A.8}$$

$$0 \le D_{e,t}^{\mathrm{ED,shed}} \le D_{e,t}^{\mathrm{ED}}, \ \ \forall e\in\Omega^{ED}, \forall t\in T \tag{A.9}$$

The total cost of the traditional RT scheduling which takes into account the deviation from DA pre-scheduled values is presented in (A.10) based on a two-price settlement scheme [13].

$$\begin{aligned} C_{total}^{DA+RT} &= \sum_{t=1}^{T}\left\{ \sum_{j=1}^{n_g} C_j^{\mathrm{CHP,P}} P_{j,t}^{\mathrm{CHP,RT}} \right\} \\ &+ \sum_{e=1}^{n^{\mathrm{ED}}} C_e^{VOLL} D_{e,t}^{\mathrm{ED,shed}} + \sum_{k=1}^{n^{\mathrm{ED}}} C_k^{spill} W_{f,t}^{spill} \\ &+ C_j^{penalty}\left| P_{j,t}^{\mathrm{CHP,RT}} - P_{j,t}^{\mathrm{CHP,DA}} \right| \end{aligned} \tag{A.10}$$