Objective Function:

$$\min c^{\mathrm{UL}} = \sum_{s} \frac{1}{(1+\gamma)^{y \cdot s}} (c_s^{\mathrm{INV}} + c_s^{\mathrm{OP}} + c_s^{\mathrm{MAI}} + c_s^{\mathrm{D}}), \tag{1}$$

$$c_s^{\mathrm{INV,type}} = \alpha^{\mathrm{type}} \sum_{i} m_s^{\mathrm{INV,type}} \Delta C_{i,s}^{\mathrm{type,in}}, \tag{2a}$$

$$c_s^{\mathrm{OP,type}} = \beta \sum_{i} \sum_{d} \omega_d \sum_{t} (m_s^{\mathrm{OP,type}} P_{i,t,d,s}^{\mathrm{type}} + m_s^{\mathrm{ON,type}} C_{i,d,s}^{\mathrm{ON,type}} + m_s^{\mathrm{OP,UHV}} P_{i,t,d,s}^{\mathrm{UHV}}), \tag{2b}$$

$$c_s^{\mathrm{MAI,type}} = \beta \sum_{i} m_s^{\mathrm{MAI,type}} C_{i,s}^{\mathrm{type}}, \tag{2c}$$

$$c_s^{\mathrm{D}} = \beta \sum_{i} \sum_{d} \omega_d \sum_{t} (m_{i,t,d,s}^{\mathrm{P,D}} P_{i,t,d,s}^{\mathrm{D}} + m_{i,t,d,s}^{\mathrm{R,D}} R_{i,t,d,s}^{\mathrm{D}}). \tag{2d}$$

$$\mathrm{type} \in \{\mathrm{hydro}, \mathrm{nu}, \mathrm{pv}, \mathrm{wind}, \mathrm{coal}, \mathrm{gas}, \mathrm{ess}, \mathrm{line}\}$$

Planning Constraints:

$$C_{i,s}^{\mathrm{type}} = C_{i,s-1}^{\mathrm{type}} + \Delta C_{i,s}^{\mathrm{type,in}} - \Delta C_{i,s}^{\mathrm{type,de}}, \tag{3}$$

$$0 \le \Delta C_{i,s}^{\mathrm{type,in}} \le \Delta \bar{C}_{i,s}^{\mathrm{type,in}}, \tag{4a}$$

$$0 \le \Delta C_{i,s}^{\mathrm{type,de}} \le \Delta \bar{C}_{i,s}^{\mathrm{type,de}}, \tag{4b}$$

$$0 \le C_{i,s}^{\mathrm{type}} \le \bar{C}_{i,s}^{\mathrm{type}}, \tag{5}$$

$$\sum_{i} \sum_{d} \omega_d \sum_{t} \sum_{\mathrm{type}} e_{i,s}^{\mathrm{CO_2,type}} P_{i,t,d,s}^{\mathrm{type}} \le \bar{E}_s^{\mathrm{CO_2}}, \tag{6}$$

$$\mathrm{type} \in \{\mathrm{hydro}, \mathrm{nu}, \mathrm{pv}, \mathrm{wind}, \mathrm{coal}, \mathrm{gas}, \mathrm{ess}, \mathrm{line}\}$$

Operation Constraints:

$$0 \le P_{i,t,d,s}^{\mathrm{type}} \le \bar{P}_{i,t,d,s}^{\mathrm{type}} \bar{C}_{i,t,d,s}^{\mathrm{type}}, \ \mathrm{type} \in \{\mathrm{pv}, \mathrm{wind}\} \tag{7}$$

$$0 \le P_{i,t,d,s}^{\mathrm{type}} \le C_{i,t,d,s}^{\mathrm{type}}, \ \mathrm{type} \in \{\mathrm{hydro}, \mathrm{nu}, \mathrm{coal}, \mathrm{gas}\} \tag{8}$$

$$-\xi_i^{type} C_{i,t,d,s}^{\mathrm{type}} \le P_{i,t,d,s}^{\mathrm{type}} - P_{i,t-1,d,s}^{\mathrm{type}} \le \xi_i^{type} C_{i,t,d,s}^{\mathrm{type}}, \tag{9}$$

$$P_{i,1,d,s}^{\mathrm{type}} = C_{i,d,s}^{\mathrm{ON,type}}, \tag{10}$$

$$\underline{\varpi}_{i,s}^{\mathrm{type}} C_{i,s}^{\mathrm{type}} \le \sum_{d} \omega_d \sum_{t} P_{i,t,d,s}^{\mathrm{type}} \le \overline{\varpi}_{i,s}^{\mathrm{type}} C_{i,s}^{\mathrm{type}}, \tag{11}$$

$$\mathrm{type} \in \{\mathrm{hydro}, \mathrm{nu}, \mathrm{pv}, \mathrm{wind}, \mathrm{coal}, \mathrm{gas}\}$$

$$\mathrm{SOC}_{i,t,d,s}^{\mathrm{ess}} = \mathrm{SOC}_{i,t-1,d,s}^{\mathrm{ess}} + (\eta^{\mathrm{ess,c}} P_{i,t,d,s}^{\mathrm{ess,c}} - \frac{P_{i,t,d,s}^{\mathrm{ess,d}}}{\eta^{\mathrm{ess,d}}}), \tag{12}$$

$$0 \le \mathrm{SOC}_{i,t,d,s}^{\mathrm{ess}} \le \overline{\mathrm{SOC}}_{i,t,d,s}^{\mathrm{ess}}, \tag{13}$$

$$\mathrm{SOC}^{\mathrm{ess}}_{i,24,d,s} = \mathrm{SOC}^{\mathrm{ess}}_{i,0,d,s}, \tag{14}$$

$$0 \le P^{\mathrm{ess,c}}_{i,t,d,s} + P^{\mathrm{ess,d}}_{i,t,d,s} \le C^{\mathrm{ess}}_{i,s}, \tag{15}$$

$$0 \le P^{\mathrm{ess,c}}_{i,t,d,s}, P^{\mathrm{ess,d}}_{i,t,d,s}, \tag{16}$$

$$P^{\mathrm{ess}}_{i,t,d,s} = P^{\mathrm{ess,c}}_{i,t,d,s} - P^{\mathrm{ess,d}}_{i,t,d,s}, \tag{17}$$

$$-C^{\mathrm{line}}_{k,s} \le P^{\mathrm{line}}_{k,t,d,s} \le C^{\mathrm{line}}_{k,s}\,. \tag{18}$$

$$\sum_{\mathrm{type}} P^{\mathrm{type}}_{i,t,d,s} + \sum_{k_{to}=i} P^{\mathrm{line}}_{k,t,d,s} - \sum_{k_{from}=i} P^{\mathrm{line}}_{k,t,d,s} + \sum_{k_{to}=i} P^{\mathrm{UHV}}_{k,t,d,s} = P^{\mathrm{fix}}_{i,t,d,s} + P^{\mathrm{D}}_{i,t,d,s}, \tag{19}$$

$$r^{\mathrm{fix}}_i P^{\mathrm{fix}}_{i,t,d,s} + r^{\mathrm{pv}}_i P^{\mathrm{pv}}_{i,t,d,s} + r^{\mathrm{wind}}_i P^{\mathrm{wind}}_{i,t,d,s} \le \sum_{\mathrm{type}} Ru^{\mathrm{type}}_{i,t,d,s} + Ru^{\mathrm{D}}_{i,t,d,s} \tag{20a}$$

$$r^{\mathrm{fix}}_i P^{\mathrm{fix}}_{i,t,d,s} + r^{\mathrm{pv}}_i P^{\mathrm{pv}}_{i,t,d,s} + r^{\mathrm{wind}}_i P^{\mathrm{wind}}_{i,t,d,s} \le \sum_{\mathrm{type}} Rd^{\mathrm{type}}_{i,t,d,s} + Rd^{\mathrm{D}}_{i,t,d,s} \tag{20b}$$

$$0 \le Ru^{\mathrm{type}}_{i,t,d,s} \le \min\{C^{\mathrm{type}}_{i,s} - P^{\mathrm{type}}_{i,t,d,s}, \xi^{\mathrm{type}}_i C^{\mathrm{type}}_{i,s}\}, \tag{21a}$$

$$0 \le Rd^{\mathrm{type}}_{i,t,d,s} \le \min\{P^{\mathrm{type}}_{i,t,d,s}, \xi^{\mathrm{type}}_i C^{\mathrm{type}}_{i,s}\}, \tag{21b}$$

$$\mathrm{type} \in \{\mathrm{hydro}, \mathrm{nu}, \mathrm{wind}, \mathrm{pv}, \mathrm{coal}, \mathrm{gas}, \mathrm{ess}\}$$

$$\eta^{\mathrm{EV}}_{i,d,s} \sum_{t=T^{\mathrm{EV}}_{i,s}}^{T^{\mathrm{EV}}_{i,e}} P^{\mathrm{EV}}_{i,t,d,s} = D^{\mathrm{EV}}_{i,d,s}, : (\alpha^{\mathrm{EV}}_{i,d,s}) \tag{22}$$

$$0 \le P^{\mathrm{EV}}_{i,t,d,s} \le \bar{P}^{\mathrm{EV}}_{i,d,s}, : (\bar{\beta}^{\mathrm{EV}}_{i,t,d,s}) \tag{23}$$

$$0 \le Ru^{\mathrm{EV}}_{i,t,d,s} \le \xi^{\mathrm{EV}} P^{\mathrm{EV}}_{i,t,d,s}, : (\bar{\gamma}^{\mathrm{EV}}_{i,t,d,s}) \tag{24}$$

$$0 \le Rd^{\mathrm{EV}}_{i,t,d,s} \le \xi^{\mathrm{EV}} \min\{\bar{P}^{\mathrm{EV}}_{i,d,s} - P^{\mathrm{EV}}_{i,t,d,s}, \frac{D^{\mathrm{EV}}_{i,d,s}}{\eta^{\mathrm{ess,c}}_{i,d,s}} - \sum_{\tilde{t}=T^{\mathrm{EV}}_{i,s}}^{t} P^{\mathrm{EV}}_{i,\tilde{t},d,s}\}, : (\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,1}, \bar{\delta}^{\mathrm{EV}}_{i,t,d,s,2}) \tag{25}$$

$$\nu^{\mathrm{IDR}}_{i,d,s} D^{\mathrm{IDR}}_{i,d,s} \le \sum_{t=T^{\mathrm{IDR}}_{i,s}}^{T^{\mathrm{IDR}}_{i,e}} P^{\mathrm{IDR}}_{i,t,d,s} \le D^{\mathrm{IDR}}_{i,d,s}, : (\underline{\alpha}^{\mathrm{IDR}}_{i,d,s}, \bar{\alpha}^{\mathrm{IDR}}_{i,d,s}) \tag{26}$$

$$0 \le P^{\mathrm{IDR}}_{i,t,d,s} \le \bar{P}^{\mathrm{IDR}}_{i,d,s}, : (\bar{\beta}^{\mathrm{IDR}}_{i,t,d,s}) \tag{27}$$

$$-\chi \bar{P}^{\mathrm{IDR}}_{i,d,s} \le P^{\mathrm{IDR}}_{i,t,d,s} - P^{\mathrm{IDR}}_{i,t-1,d,s} \le \chi \bar{P}^{\mathrm{IDR}}_{i,d,s}, : (\underline{\gamma}^{\mathrm{IDR}}_{i,t,d,s}, \bar{\gamma}^{\mathrm{IDR}}_{i,t,d,s}) \tag{28}$$

$$0 \le Ru^{\mathrm{IDR}}_{i,t,d,s} \le \xi^{\mathrm{IDR}} P^{\mathrm{IDR}}_{i,t,d,s}, : (\bar{\delta}^{\mathrm{IDR}}_{i,t,d,s}) \tag{29}$$

$$0 \le Rd^{\mathrm{IDR}}_{i,t,d,s} \le \xi^{\mathrm{IDR}} (\bar{P}^{\mathrm{IDR}}_{i,d,s} - P^{\mathrm{IDR}}_{i,t,d,s}), : (\bar{\epsilon}^{\mathrm{IDR}}_{i,t,d,s}) \tag{30}$$

$$E^{\mathrm{HVAC}}_{i,t+1,d,s} = \kappa^{\mathrm{HVAC}}_{i,d,s} E^{\mathrm{HVAC}}_{i,t,d,s} + \eta^{\mathrm{HVAC}}_{i,d,s} P^{\mathrm{HVAC}}_{i,t,d,s}, : (\alpha^{\mathrm{HVAC}}_{i,t,d,s}) \tag{31}$$

$$\underline{E}^{\mathrm{HVAC}}_{i,d,s} \le E^{\mathrm{HVAC}}_{i,t,d,s} \le \bar{E}^{\mathrm{HVAC}}_{i,d,s}, : (\underline{\beta}^{\mathrm{HVAC}}_{i,t,d,s}, \bar{\beta}^{\mathrm{HVAC}}_{i,t,d,s}) \tag{32}$$

$$0 \leq P^{\mathrm{HVAC}}_{i,t,d,s} \leq \bar{P}^{\mathrm{HVAC}}_{i,d,s}, \ : (\bar{\gamma}^{\mathrm{HVAC}}_{i,t,d,s}) \tag{33}$$

$$\nu^{\mathrm{HVAC}}_{i,d,s} D^{\mathrm{HVAC}}_{i,d,s} \leq \sum_{t=T^{\mathrm{HVAC}}_{i,s}}^{T^{\mathrm{HVAC}}_{i,e}} P^{\mathrm{HVAC}}_{i,t,d,s} \leq D^{\mathrm{HVAC}}_{i,d,s}, \ : (\underline{\delta}^{\mathrm{HVAC}}_{i,d,s}, \bar{\delta}^{\mathrm{HVAC}}_{i,d,s}) \tag{34}$$

$$0 \leq Ru^{\mathrm{HVAC}}_{i,t,d,s} \leq \xi^{\mathrm{HVAC}} \min\{P^{\mathrm{HVAC}}_{i,t,d,s}, P^{\mathrm{HVAC}}_{i,t,d,s} - \frac{\underline{E}^{\mathrm{HVAC}}_{i,d,s} - \kappa^{\mathrm{HVAC}}_{i,d,s} E^{\mathrm{HVAC}}_{i,t,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}}\}, \ : (\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,1}, \bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2}) \tag{35}$$

$$0 \leq Rd^{\mathrm{HVAC}}_{i,t,d,s} \leq \xi^{\mathrm{HVAC}} \min\{\bar{P}^{\mathrm{HVAC}}_{i,d,s} - P^{\mathrm{HVAC}}_{i,t,d,s}, \frac{\bar{E}^{\mathrm{HVAC}}_{i,d,s} - \kappa^{\mathrm{HVAC}}_{i,d,s} E^{\mathrm{HVAC}}_{i,t,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}} - P^{\mathrm{HVAC}}_{i,t,d,s}\}, \ : (\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,1}, \bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2}) \tag{36}$$

$$P^{\mathrm{D}}_{i,t,d,s} = P^{\mathrm{EV}}_{i,t,d,s} + P^{\mathrm{IDR}}_{i,t,d,s} + P^{\mathrm{HVAC}}_{i,t,d,s} + P^{\mathrm{UN}}_{i,t,d,s}, \ : (\zeta_{i,t,d,s}) \tag{37}$$

$$Ru^{\mathrm{D}}_{i,t,d,s} = Ru^{\mathrm{EV}}_{i,t,d,s} + Ru^{\mathrm{IDR}}_{i,t,d,s} + Ru^{\mathrm{HVAC}}_{i,t,d,s} + Ru^{\mathrm{UN}}_{i,t,d,s}, \ : (\eta_{i,t,d,s}) \tag{38}$$

$$Rd^{\mathrm{D}}_{i,t,d,s} = Rd^{\mathrm{EV}}_{i,t,d,s} + Rd^{\mathrm{IDR}}_{i,t,d,s} + Rd^{\mathrm{HVAC}}_{i,t,d,s} + Rd^{\mathrm{UN}}_{i,t,d,s}, \ : (\theta_{i,t,d,s}) \tag{39}$$

$$R^{\mathrm{D}}_{i,t,d,s} = Ru^{\mathrm{D}}_{i,t,d,s} + Rd^{\mathrm{D}}_{i,t,d,s}, \ : (\vartheta_{i,t,d,s}) \tag{40}$$

$$c^{\min} \leq c^{\mathrm{D}} - c^{\mathrm{P}}, \ : (\underline{\iota}) \tag{41}$$

$$\eta^{\mathrm{EV}}_{i,d,s}\alpha^{\mathrm{EV}}_{i,d,s} + \bar{\beta}^{\mathrm{EV}}_{i,t,d,s} - \xi^{\mathrm{EV}}\bar{\gamma}^{\mathrm{EV}}_{i,t,d,s} + \xi^{\mathrm{EV}}\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,1} + \xi^{\mathrm{EV}}\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,2} + \zeta_{i,t,d,s} + \beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{42}$$

$$\bar{\gamma}^{\mathrm{EV}}_{i,t,d,s} + \eta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{43}$$

$$\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,1} + \bar{\delta}^{\mathrm{EV}}_{i,t,d,s,2} + \theta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{44}$$

$$\begin{aligned}\underline{\alpha}^{\mathrm{IDR}}_{i,d,s} + \bar{\alpha}^{\mathrm{IDR}}_{i,d,s} + \bar{\beta}^{\mathrm{IDR}}_{i,t,d,s} + \underline{\gamma}^{\mathrm{IDR}}_{i,t,d,s} + \bar{\gamma}^{\mathrm{IDR}}_{i,t,d,s} - \underline{\gamma}^{\mathrm{IDR}}_{i,t+1,d,s} - \bar{\gamma}^{\mathrm{IDR}}_{i,t+1,d,s} \\ - \xi^{\mathrm{IDR}}\bar{\delta}^{\mathrm{IDR}}_{i,t,d,s} + \xi^{\mathrm{IDR}}\bar{\epsilon}^{\mathrm{IDR}}_{i,t,d,s} + \zeta_{i,t,d,s} + \beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}},\end{aligned} \tag{45}$$

$$\bar{\delta}^{\mathrm{IDR}}_{i,t,d,s} + \eta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{46}$$

$$\bar{\epsilon}^{\mathrm{IDR}}_{i,t,d,s} + \theta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{47}$$

$$\kappa^{\mathrm{HVAC}}_{i,d,s}\alpha^{\mathrm{HVAC}}_{i,t,d,s} - \alpha^{\mathrm{HVAC}}_{i,t-1,d,s} + \underline{\beta}^{\mathrm{HVAC}}_{i,t,d,s} + \bar{\beta}^{\mathrm{HVAC}}_{i,t,d,s} - \xi^{\mathrm{HVAC}}\frac{\kappa^{\mathrm{HVAC}}_{i,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}}\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} + \xi^{\mathrm{HVAC}}\frac{\kappa^{\mathrm{HVAC}}_{i,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}}\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} \geq 0, \tag{48}$$

$$\begin{aligned}\eta^{\mathrm{HVAC}}_{i,d,s}\alpha^{\mathrm{HVAC}}_{i,t,d,s} + \bar{\gamma}^{\mathrm{HVAC}}_{i,t,d,s} + \underline{\delta}^{\mathrm{HVAC}}_{i,d,s} + \bar{\delta}^{\mathrm{HVAC}}_{i,d,s} - \xi^{\mathrm{HVAC}}\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,1} - \xi^{\mathrm{HVAC}}\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} \\ + \xi^{\mathrm{HVAC}}\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,1} + \xi^{\mathrm{HVAC}}\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} + \zeta_{i,t,d,s} + \beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{P,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}},\end{aligned} \tag{49}$$

$$\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,1} + \bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} + \eta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}} \tag{50}$$

$$\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,1} + \bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} + \theta_{i,t,d,s} + \vartheta_{i,t,d,s} + \beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}\underline{\iota} \geq \frac{\beta\omega_d m^{\mathrm{R,D}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{51}$$

$$\zeta_{i,t,d,s} - \beta\omega_d m^{\mathrm{P,L}}_{i,t,d,s}\underline{\iota} \geq -\frac{\beta\omega_d m^{\mathrm{P,L}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{52}$$

$$\eta_{i,t,d,s} + \vartheta_{i,t,d,s} - \beta\omega_d m^{\mathrm{P,R}}_{i,t,d,s}\underline{\iota} \geq -\frac{\beta\omega_d m^{\mathrm{P,R}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{53}$$

$$\theta_{i,t,d,s} + \vartheta_{i,t,d,s} - \beta\omega_d m^{\mathrm{P,R}}_{i,t,d,s}\underline{\iota} \geq -\frac{\beta\omega_d m^{\mathrm{P,R}}_{i,t,d,s}}{(1+\gamma)^{y\cdot s}}, \tag{54}$$

$$\begin{aligned}
&\sum_s \sum_d \Big(\sum_{i\in\Omega^{\mathrm{EV}}} (D^{\mathrm{EV}}_{i,d,s}\alpha^{\mathrm{EV}}_{i,d,s} + \bar{P}^{\mathrm{EV}}_{i,d,s} \sum_t (\bar{\beta}^{\mathrm{EV}}_{i,t,d,s} + \xi^{\mathrm{EV}}(\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,1} + \frac{D^{\mathrm{EV}}_{i,d,s}}{\eta^{\mathrm{ess,c}}_{i,d,s}\bar{P}^{\mathrm{EV}}_{i,d,s}}\bar{\delta}^{\mathrm{EV}}_{i,t,d,s,2}))) \\
&+ \sum_{i\in\Omega^{\mathrm{IDR}}} (D^{\mathrm{IDR}}_{i,d,s}(\bar{\alpha}^{\mathrm{IDR}}_{i,d,s} + \nu^{\mathrm{IDR}}_{i,d,s}\underline{\alpha}^{\mathrm{IDR}}_{i,d,s}) + \sum_{t=2}^{T} \chi\bar{P}^{\mathrm{IDR}}_{i,d,s}(\bar{\gamma}^{\mathrm{IDR}}_{i,t,d,s} - \underline{\gamma}^{\mathrm{IDR}}_{i,t,d,s}) + \bar{P}^{\mathrm{IDR}}_{i,d,s}(\bar{\gamma}^{\mathrm{IDR}}_{i,1,d,s} + \underline{\gamma}^{\mathrm{IDR}}_{i,1,d,s}) \\
&+ \sum_t (\bar{P}^{\mathrm{IDR}}_{i,d,s}\bar{\beta}^{\mathrm{IDR}}_{i,t,d,s} + \xi^{\mathrm{IDR}}\bar{P}^{\mathrm{IDR}}_{i,d,s}\bar{\epsilon}^{\mathrm{IDR}}_{i,t,d,s})) + \sum_{i\in\Omega^{\mathrm{HVAC}}} (\sum_t (\bar{E}^{\mathrm{HVAC}}_{i,d,s}\bar{\beta}^{\mathrm{HVAC}}_{i,t,d,s} + \underline{E}^{\mathrm{HVAC}}_{i,d,s}\underline{\beta}^{\mathrm{HVAC}}_{i,t,d,s} + \bar{P}^{\mathrm{HVAC}}_{i,d,s}\bar{\gamma}^{\mathrm{HVAC}}_{i,t,d,s} \\
&- \xi^{\mathrm{HVAC}}\frac{\underline{E}^{\mathrm{HVAC}}_{i,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}}\bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} + \xi^{\mathrm{HVAC}}(\bar{P}^{\mathrm{HVAC}}_{i,d,s}\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,1} + \frac{\bar{E}^{\mathrm{HVAC}}_{i,d,s}}{\eta^{\mathrm{HVAC}}_{i,d,s}}\bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2})) + D^{\mathrm{HVAC}}_{i,d,s}(\bar{\delta}^{\mathrm{HVAC}}_{i,d,s} - \nu^{\mathrm{HVAC}}_{i,d,s}\underline{\delta}^{\mathrm{HVAC}}_{i,d,s}))) \\
&+ c^{\min}\underline{\iota} = \sum_s \frac{1}{(1+\gamma)^{y\cdot s}}(c^{\mathrm{D}}_s - c^{\mathrm{P}}_s),
\end{aligned} \tag{55}$$

$$\begin{aligned}
&\bar{\beta}^{\mathrm{EV}}_{i,t,d,s}, \bar{\gamma}^{\mathrm{EV}}_{i,t,d,s}, \bar{\delta}^{\mathrm{EV}}_{i,t,d,s,1}, \bar{\delta}^{\mathrm{EV}}_{i,t,d,s,2}, \bar{\alpha}^{\mathrm{IDR}}_{i,d,s}, \bar{\beta}^{\mathrm{IDR}}_{i,t,d,s}, \bar{\gamma}^{\mathrm{IDR}}_{i,t,d,s}, \bar{\delta}^{\mathrm{IDR}}_{i,t,d,s}, \bar{\epsilon}^{\mathrm{IDR}}_{i,t,d,s}, \\
&\bar{\beta}^{\mathrm{HVAC}}_{i,t,d,s}, \bar{\gamma}^{\mathrm{HVAC}}_{i,t,d,s}, \bar{\delta}^{\mathrm{HVAC}}_{i,d,s}, \bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,1}, \bar{\epsilon}^{\mathrm{HVAC}}_{i,t,d,s,2}, \bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,1}, \bar{\varepsilon}^{\mathrm{HVAC}}_{i,t,d,s,2} \geq 0
\end{aligned} \tag{56}$$

$$\underline{\alpha}^{\mathrm{IDR}}_{i,d,s}, \underline{\gamma}^{\mathrm{IDR}}_{i,t,d,s}, \underline{\beta}^{\mathrm{HVAC}}_{i,t,d,s}, \underline{\delta}^{\mathrm{HVAC}}_{i,d,s}, \underline{\iota} \leq 0 \tag{57}$$