NOMENCLATURE

A. Indices and Sets

$f \in \mathcal{F}$	Indices and set of boundary conditions
$s \in \mathcal{S}_f$	Indices and set of typical scenarios
$i \in \mathcal{I}$	Indices and set of buses.
$l \in \mathcal{L}$	Indices and set of branches.
$\mathcal{I}_{\mathrm{dc}} \setminus \mathcal{I}_{\mathrm{es}}$	Set of candidate locations for MSOPs\ESSs.
$\mathcal{I}_{\mathrm{res},f}$	Set of RES installation buses at boundary condition f.
$\mathcal{J}$	Set consisting of the iterations at which the subproblem is infeasible.
m 、 $\mathcal{M}$	Indices and set of MSOP ports.

B. Parameters

$\phi_f \setminus \phi_s$	Probability of boundary condition f \typical scenario s.
S_{Mu}	Rated capacity of the converter module.
$P_{\mathrm{Eu}} \setminus E_{\mathrm{Eu}}$	Power rating and energy capacity of the battery module.
ϑ_s	Electricity prices at typical scenario s.
o	Confidence level of chance constraints.
ξ	Lowest annual investment return rate.
π_{iter}	Maximum profitability of planning decisions.
$E_s^{\mathrm{bef}} \setminus B_s^{\mathrm{cb}}$	Total traded electricity and carbon footprint costs prior to assets being put into service.
Δt	Unit time duration.
$\varpi_{\mathrm{res}} \setminus \varpi_{\mathrm{g}}$	Carbon dioxide equivalent per kWh for RES generation and main grid.
ϑ_{c}	Cost of carbon footprint quantity.
$\gamma \setminus \rho_k \setminus c_k^{\mathrm{inv}} \setminus c_k^{\mathrm{use}}$	Discount rate\Useful lifespan of assets\ Investment cost\O&M cost.
$r_l \setminus x_l$	Resistance\Reactance at branch l.
$P_{s,t,i}^{\mathrm{load}} \setminus Q_{s,t,i}^{\mathrm{load}}$	Load active\reactive power at bus i.
$V_{i,\min} \setminus V_{i,\max} \setminus I_{l,\max}$	Lower\Upper bounds for bus voltage, and maximum branch current.
$V_{\mathrm{n}}^{\mathrm{dc}}$	Rated voltage of DC links.
$e_{\min} \setminus e_{\max}$	Lower\Upper limit of the state of charge of ESSs.
μ	Penalty for power losses in ESSs and MSOPs.
$M_{i,l}^{\mathrm{s}} \setminus M_{i,l}^{\mathrm{r}}$	Association matrix of branch l with its upstream\ downstream bus i.
$P_{\min}^{\mathrm{net}} \setminus P_{\max}^{\mathrm{net}} \setminus Q_{\min}^{\mathrm{net}} \setminus Q_{\max}^{\mathrm{net}}$	Active and reactive power available for main grid.
$r_{s,t,i}^{\mathrm{res}}$, P_i^{resn}	Generation profile of RES, sum of existing and future installation capacity of RES.

C. Decision Variables

$\alpha_i^{\mathrm{MT}} \setminus \alpha_i^{\mathrm{ES}}$	Number of converter\battery modules at bus i, which are integer variables.
$\beta_i^{\mathrm{MT}} \setminus \beta_i^{\mathrm{ES}}$	Whether to configure MSOPs\ESSs at bus i, which are binary variables.
S_i^{MTn}	Rated capacity of MSOP ports.
$P_i^{\mathrm{ESn}} \setminus E_i^{\mathrm{ESn}}$	Power rating and energy capacity of ESSs.
$\Delta E_s \setminus B_s^{\mathrm{c}}$	Electricity variation in distribution networks trading with main grids and reduced carbon footprint costs after assets are in service.
$B_k^{\mathrm{inv}} \setminus B_k^{\mathrm{use}}$	Investment costs and operation and maintenance costs.
$P_{s,t}^{\mathrm{net}}$	Interaction power between distribution networks and main grids.
S_k^{n}	Power rating of MSOP or ESS.
$\tilde{V}_{s,t,i} \setminus \tilde{I}_{s,t,l}$	Square of bus voltage\branch current magnitude.
$\mathcal{H}_l^{\mathrm{tem}}$	Even level of branch l.
$P_{s,t,i}^{\mathrm{MT}} \setminus Q_{s,t,i}^{\mathrm{MT}} \setminus P_{s,t,i}^{\mathrm{ES}} \setminus Q_{s,t,i}^{\mathrm{ES}}$	Active\Reactive power injected into distribution networks by MSOPs\ESSs.
$P_{s,t,i}^{\mathrm{res}} \setminus Q_{s,t,i}^{\mathrm{res}}$	Active\Reactive power of RESs.
$P_{s,t,i} \setminus Q_{s,t,i}$	Net load power of bus i.
$P_{s,t,l}^{\mathrm{f}} \setminus Q_{s,t,l}^{\mathrm{f}}$	Active\Reactive power flow of branch l.
$I_{s,t,m}^{\mathrm{dc}}$	Current amplitude of the DC link injected into the m th MSOP port.
$I_{s,t}^{\mathrm{ES}}$	Amplitude of the current injected into DC links by DC energy storage systems.
$E_{s,t}^{\mathrm{ES}}$	Energy state of ideal ESSs with losses neglected.
$P_{s,t,i}^{\mathrm{ESlo}} \setminus P_{s,t,i}^{\mathrm{MTlo}}$	Power Losses in MSOPs\ESSs.