

AGM – Distribution System Resilience Improvement

Optimization Model Formulation

- **Goal:** Optimal Priority-weighted Load Restoration for Resilient Operation of DER-integrated Distribution Systems
- **Objective function:**

$$\mathbf{Max:} \left\{ \sum_{i \in N} \sum_{t \in T} \omega_i P_l(i, t) - \left(\alpha \sum_{t \in T} P_{wt-curt}(t) - \beta \sum_{t \in T} P_{pv-curt}(t) \right) \Delta t \right\}$$

Where,

N	Number of load nodes/buses
T	Optimization horizon (number of look-ahead time steps)
i	Node index
t	Time step index
Δt	Length/duration of time step
ω_i	Priority weight of load at node i
α	Penalty for wind power curtailment
β	Penalty for PV power curtailment
$P_l(i, t)$	Load restored/served at node i and time t
$P_{wt-curt}(t)$	Wind power curtailed at time t
$P_{pv-curt}(t)$	PV power curtailed at time t

- **Constraints:**

- **Power balance** ($\forall i \in N, \forall t \in T$)

$$P_{wt}(t) - P_{wt-curt}(t) + P_{pv}(t) - P_{pv-curt}(t) + P_{mt}(t) - P_{es}^{ch}(t) + P_{es}^{dch}(t) = \sum_{i \in N} P_l(i, t)$$

- **Load picked up** ($\forall i \in N, \forall t \in T$)

$$0 \leq P_l(i, t) \leq P_{l,demad}(i, t)$$

- **Microturbine** ($\forall t \in T$)

$$0 \leq P_{mt}(t) \leq P_{mtMAX}$$

$$\sum_{t \in T} P_{mt}(t) \cdot \Delta t \leq E_{mtMAX}$$

- **Energy storage (ES)/battery constraints** ($\forall t \in T$)

$$0 \leq P_{es}^{ch}(t) \leq b_{es}^{ch}(t) P_{es}^{ch,max}$$

$$0 \leq P_{es}^{dch}(t) \leq b_{es}^{dch}(t) P_{es}^{dch,max}$$

$$b_{es}^{ch}(t) + b_{es}^{dch}(t) = 1, b_{es}^{ch}(t), b_{es}^{dch}(t) \in \{0,1\}$$

$$SOC_{es}^{min} \leq SOC_{es}(t) \leq SOC_{es}^{max}$$

$$SOC_{es}(t) = SOC_{es}(t-1) + \Delta t \left(\frac{\eta_{es}^{ch} P_{es}^{ch}(t)}{C_{es}} - \frac{P_{es}^{dch}(t)}{\eta_{es}^{dch} C_{es}} \right)$$

- **RE Curtailment** ($\forall t \in T$)

$$0 \leq P_{wt-curt}(t) \leq P_{wt}(t)$$

$$0 \leq P_{pv-curt}(t) \leq P_{pv}(t)$$

- **Optimization/decision variables:**

- $P_i(i, t)$ - power served at node i and time t
- $P_{mt}(t)$ - power output of the microturbine at time t
- $P_{wt-curt}(t)$ – wind power curtailment
- $P_{pv-curt}(t)$ – pv power curtailment
- $P_{es}^{ch}(t), P_{es}^{dch}(t), b_{es}^{ch}(t), b_{es}^{dch}(t), SOC_{es}(t)$ – charging/discharging power, charge/discharge status & SOC of battery at time t