

## I. CASE STUDY DEMONSTRATION

### A. Simulation Data: IEEE 123 Bus Test System

We're using a Balanced Three-Phase version of the IEEE 123 Bus Test System, which has 85 Load Nodes. Additionally, 20% (17) and 30% (26) of these load nodes also contain reactive power controllable Solar photovoltaics (PVs) and Batteries respectively. Their ratings are as per Table I. To demonstrate the effectiveness of the proposed algorithm, the Test System has been divided into four areas on similar lines as [?]. The full test system along with the area-wise division is shown in Figure 1.

It is assumed that a horizon-wide forecast for loads  $p_L^t$ , solar power output  $p_D^t$  and cost of substation power  $C^t$  is available to the distribution grid operator. Figure 2 shows the forecasted profiles for load, solar irradiance and cost of substation power over a 5 time-period horizon.

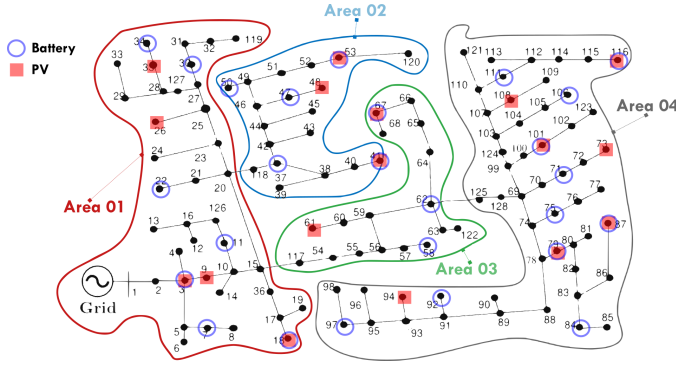


Fig. 1: IEEE 123 Node System Divided Into Four Areas

To showcase the workflow of the proposed algorithm, simulations were run for a 5 time-period horizon.

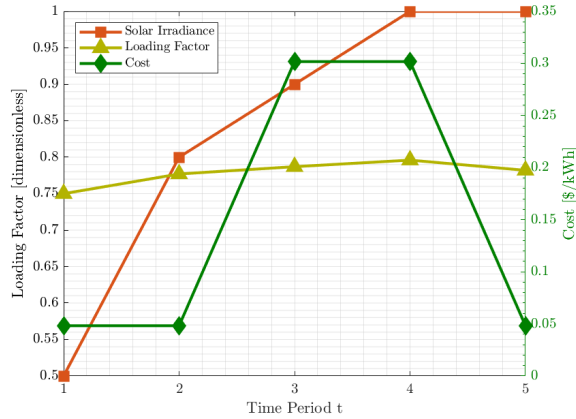


Fig. 2: Forecasts for Demand Power, Irradiance and Cost of Substation Power over a 5 Hour Horizon

### B. Simulation Workflow

All simulations were set up in MATLAB 2023a including both the high level algorithms as well as calls to the optimization solver. MATLAB's `fmincon` function was used to

TABLE I: Parameter Values

Parameter	Value
$V_{min}, V_{max}$	0.95, 1.05
$p_{DR_j}$	$0.33p_{LR_j}$
$S_{DR_j}$	$1.2p_{DR_j}$
$P_{BR_j}$	$0.33p_{LR_j}$
$B_{R_j}$	$T_{fullCharge} \times P_{BR_j}$
$T_{fullCharge}$	4 h
$\Delta t$	1 h
$\eta_C, \eta_D$	0.95, 0.95
$soC_{min}, soC_{max}$	0.30, 0.95
$\alpha$	0.001

parse the nonlinear nonconvex optimization problem described by ??–?? in tandem with the SQP optimization algorithm to solve it. From the completed simulations, the resultant optimal control variables were obtained, and were passed through an OpenDSS engine (already configured with system data and forecast values) in order to check for the feasibility of the results. The associated code may be found here.