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 photovolatics (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.

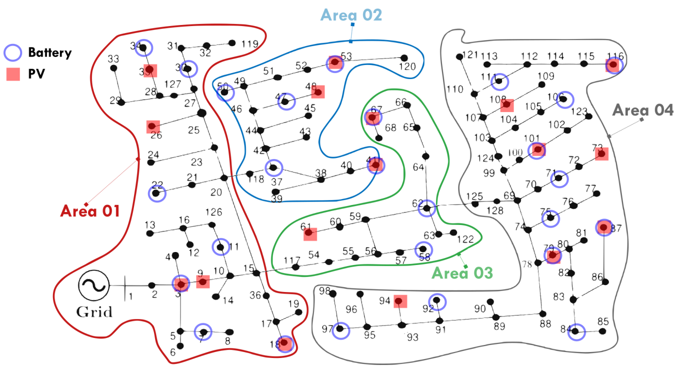

Fig. 1: IEEE 123 Node System Divided Into Four Areas

Change figure to display battery buses and PV buses

To showcase the workflow of the proposed algorithm, simulations were run for a 5 time-period horizon. Figure 2 shows the forecasted profiles for load, solar irradiance and cost of substation power over the horizon.

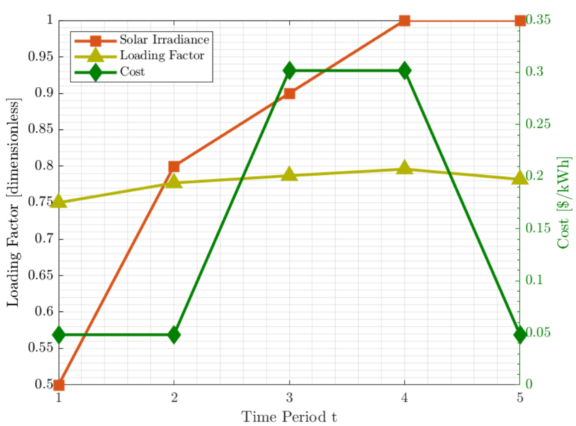

Fig. 2: Forecasts for Demand Power, Irradiance and Cost of Substation Power over a 5 Hour Horizon

B. Simulation Workflow

We use MATLAB 2023a to set up our simulations. This includes both the high level algorithms as well as calling the optimization solver. We use MATLAB's `fmincon` function to parse nonlinear nonconvex optimization problem described by

TABLE I: Parameter Values

Parameter	Value
V_{min}, V_{max}	0.95, 1.05
$p_{D_{R_j}}$	$0.33 p_{L_{R_j}}$
$S_{D_{R_j}}$	$1.2 p_{D_{R_j}}$
$P_{B_{R_j}}$	$0.33 p_{L_{R_j}}$
B_{R_j}	$T_{fullCharge} \times P_{B_{R_j}}$
$T_{fullCharge}$	4 h
Δt	1 h
η_C, η_D	0.95, 0.95
soc_{min}, soc_{max}	0.30, 0.95
α	0.001

??–**??** and the SQP optimization algorithm to solve it. Once the simulations are completed and resulting optimial control variables obtained, they are passed through an OpenDSS engine (which already has the known system data configured) in order to check for the feasiblity of the results. The associated code may be found here.