

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.

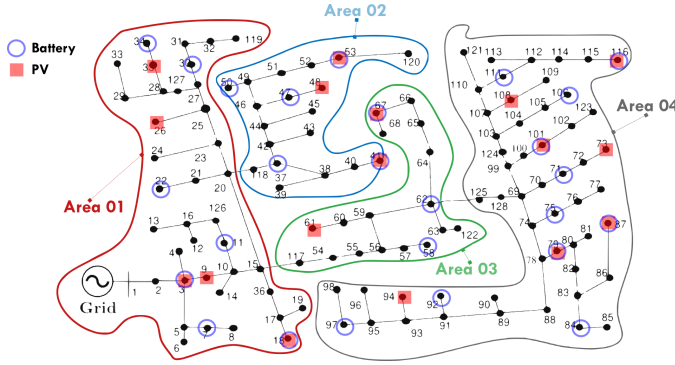


Fig. 1: IEEE 123 Node System Divided Into Four Areas

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

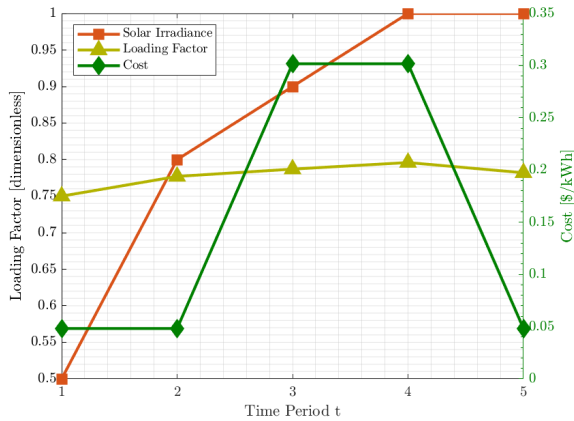


Fig. 2: Forecasts for Demand Power, Irradiance and Cost of Substation Power over a 5 Hour Horizon

B. Simulation Workflow

We use MATLAB 2023a to set up our simulations. This includes both the high level algorithms as well as calling the

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
Δt	1 h
η_C, η_D	0.95, 0.95
soc_{min}, soc_{max}	0.30, 0.95
α	0.001

optimization solver. We use MATLAB's `fmincon` function to parse nonlinear nonconvex optimization problem described by ??-?? and the SQP optimization algorithm to solve it. Once the simulations are completed and resulting optimal control variables obtained, they are passed through an OpenDSS engine (which already has the known system data and forecasted values configured) in order to check for the feasibility of the results. The associated code may be found here.