

In the following subsections, the proposed algorithm is compared against the centralized (MPCOPF) algorithm in terms of resultant optimal control variables, optimality gap in objective function and computational performance. Secondly, the resultant control variables are tested for ACOPF feasibility against OpenDSS. Section -A describes the comparison over a 5 time-period horizon with an additional focus on describing the workflow of the MPDOPF algorithm. Section -B describes the comparison over a 10 time-period horizon to test for the scalability of the MPDOPF algorithm.

#### A. Simulation Results

##### The Test System

1) *Comparison between MPCOPF and MPDOPF*: In this section, comparative analyses are carried out between MPCOPF and MPDOPF considering 5-hour time steps.

TABLE I: Comparative analyses between MPCOPF and MPDOPF - 5 time-period horizon

Metric	MPCOPF	MPDOPF
Biggest subproblem size		
Decision variables	3150	1320
Linear constraints	5831	2451
Nonlinear constraints	635	265
Simulation results		
Substation power cost (\$)	576.31	576.30
Substation real power (kW)	4308.28	4308.14
Line loss (kW)	75.99	76.12
Substation reactive power (kVAR)	574.18	656.24
PV reactive power (kVAR)	116.92	160.64
Battery reactive power (kVAR)	202.73	76.01
Computation		
Number of Iterations	-	5
Total Simulation Time (s)	521.25	49.87

Further, here the

TABLE II: ACOPF feasibility analyses - 5 time-period horizon

Metric	MPDOPF	OpenDSS
Full horizon		
Substation real power (kW)	4308.14	4308.35
Line loss (kW)	76.12	76.09
Substation reactive power (kVAR)	656.24	652.49
Max. all-time discrepancy		
Voltage (pu)		0.0002
Line loss (kW)		0.0139
Substation power (kW)		0.3431

Boundary Variable Plots are too tall, make them slightly shorter, like 25% of the page only.

#### B. Scalability Analysis

To demonstrate the effectiveness of the proposed algorithm over a bigger horizon to demonstrate scalability, simulations were run for a 10 time-period horizon. Figure 4 shows the forecasted profiles for load, solar irradiance and cost of substation power over the horizon.

1) *Comparison between MPCOPF and MPDOPF*: In this section, comparative analyses are carried out between MPCOPF and MPDOPF considering 10-hour time steps with 20% PV penetration and 30% battery penetration.

Further, here the

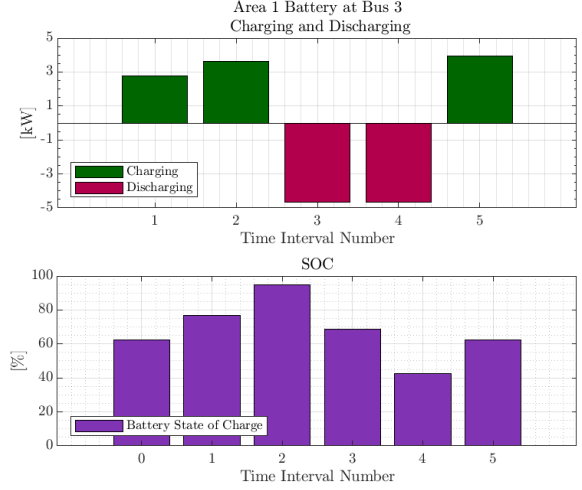


Fig. 1: Charging-Discharging and SOC graphs for Battery at Bus 3 located in Area 1 obtained by MPDOPF

TABLE III: Comparative analyses between MPCOPF and MPDOPF - 10 time-period horizon

Metric	MPCOPF	MPDOPF
Biggest subproblem size		
Decision variables	6300	2640
Linear constraints	11636	4891
Nonlinear constraints	1270	530
Simulation results		
Substation power cost (\$)	1197.87	1197.87
Substation real power (kW)	8544.28	8544.04
Line loss (kW)	148.67	148.94
Substation reactive power (kVAR)	1092.39	1252.03
PV reactive power (kVAR)	222.59	139.81
Battery reactive power (kVAR)	388.52	310.94
Computation		
Number of Iterations	-	5
Total Simulation Time (s)	4620.73	358.69

TABLE IV: ACOPF feasibility analyses - 10 time-period horizon

Metric	MPDOPF	OpenDSS
Full horizon		
Substation real power (kW)	8544.04	8544.40
Line loss (kW)	148.94	148.87
Substation reactive power (kVAR)	1252.03	1243.36
Max. all-time discrepancy		
Voltage (pu)		0.0002
Line loss (kW)		0.0132
Substation power (kW)		0.4002

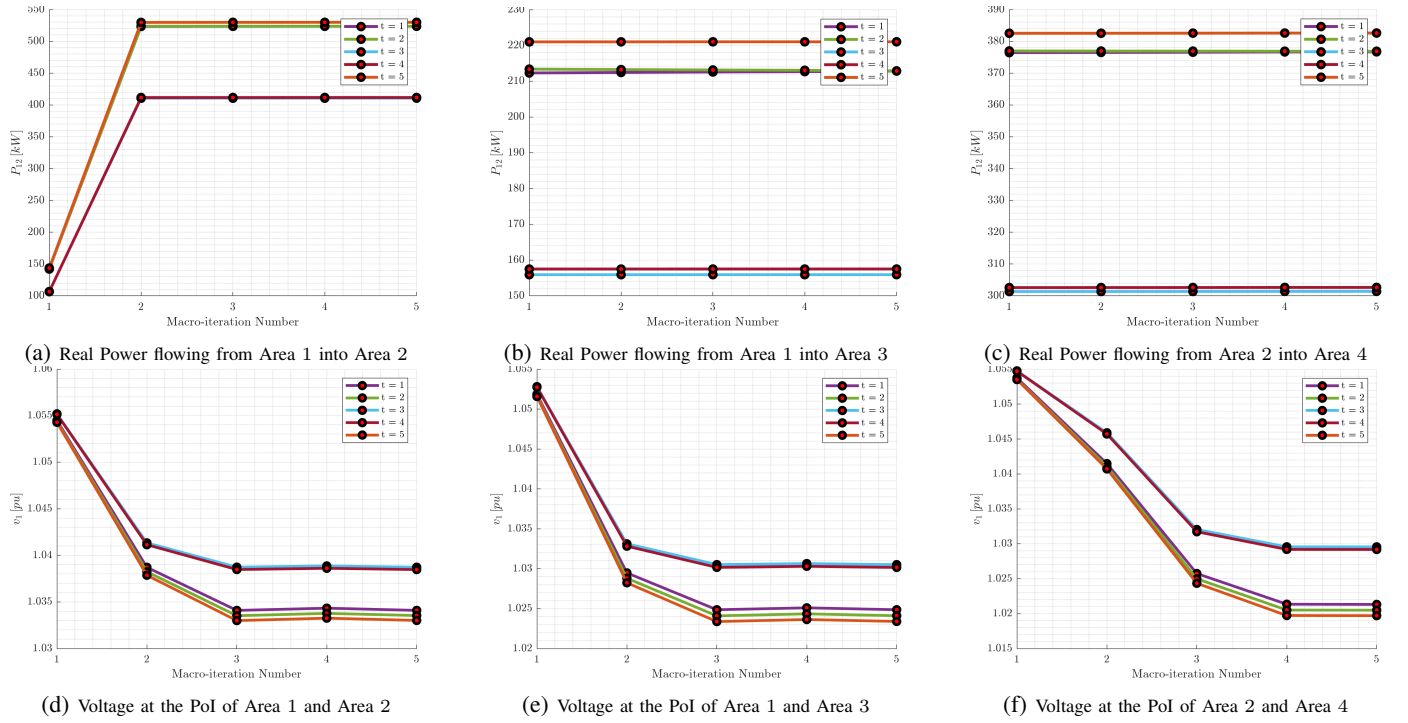


Fig. 2: Convergence of Boundary variables with every iteration. Each plot represents a particular variable exchanged between a pair of connected areas. Each line graph within a plot represents a particular time period.

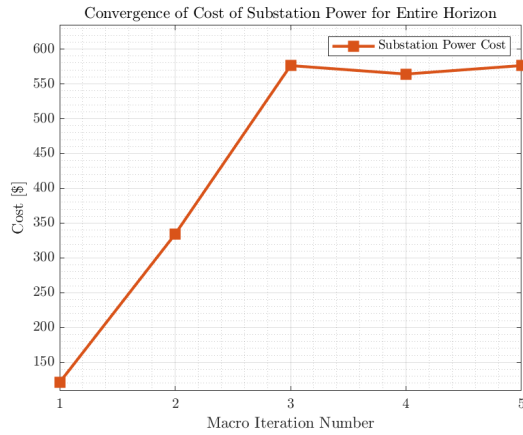


Fig. 3: Convergence of Objective Function Value with each MPDOPF iteration

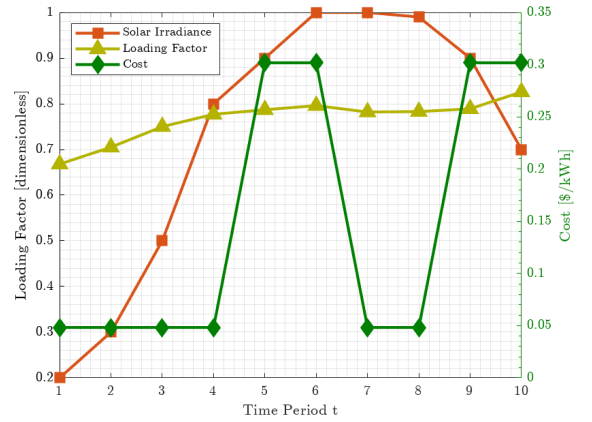


Fig. 4: Forecasts for Demand Power, Irradiance and Cost of Substation Power over a 10 Hour Horizon

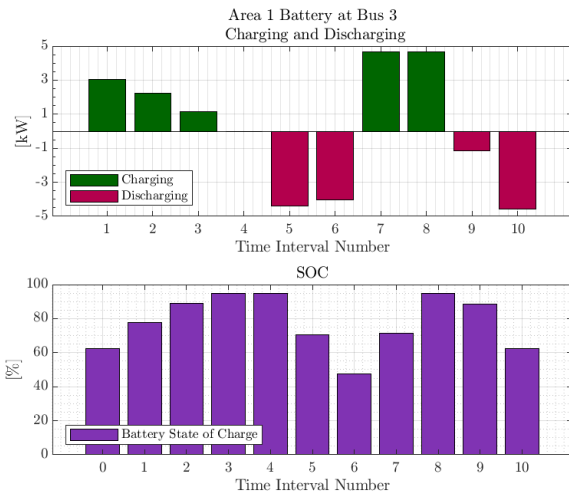


Fig. 5: Charging-Discharging and SOC graphs for Battery at Bus 3 located in Area 1 obtained via MPDOPF