WASHINGTON STATE
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Scalable Multi-Period Optimal Power Flow
for Active Power Distribution Systems

or simply, Scalable MP-OPF in ADS

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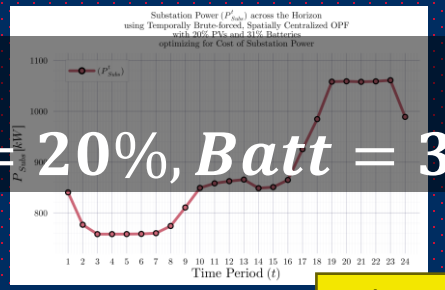
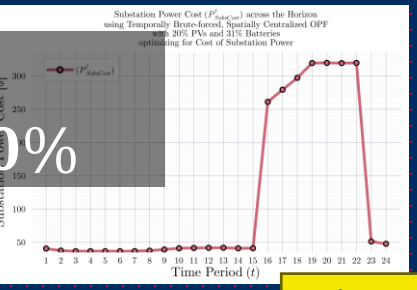
OpenDSS Def Profiles | Substation Power Cost

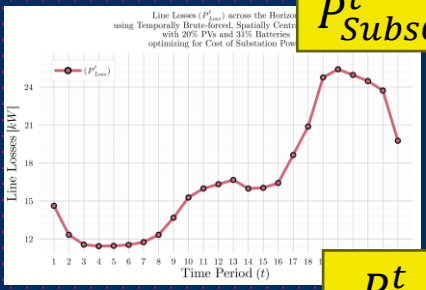
IEEE123_1ph: MPCOPF Run for $T = 24$, $PV = 20\%$, $Batt = 30\%$



P^t_{Subs}



$P^t_{SubsCost}$



P^t_{Loss}

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1. Machine ID: surface9Win11
2. Solver Used: Ipopt
3. System Name: ieee123_1ph
4. Horizon Duration: 24
5. Nature of Optimization Simulation: Temporally Brute-forced, Spatially Centralized
6. Objective: Cost of Substation Power
7. GED Configuration: pv_20_batt_31
8. Maximum Substation Power Allowed: Inf kW
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MPCOPF Simulation Results

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Full 24 Hour Horizon
9. Horizon Total Cost of Substation Power: $ 2799.05
10. Horizon Total Line Loss: 406.01 kW
11. Horizon Total Substation Power: 21191.19 kW + 8499.6 kVAr
12. Horizon Total Load: 21357.46 kW + 11751.26 kVAr
13. Horizon Total Generation: 572.28 kW + 4070.57 kVAr
14. Horizon Total Static Capacitor Reactive Power Generation: 0.0 kVAr
15. Horizon Total PV Generation: 607.46 kW + 1972.33 kVAr
16. Horizon Total Battery Generation: -35.18 kW + 2098.24 kVAr
17. Horizon Total Battery Transaction Magnitude: 686.36 kW + 2098.24 kVAr
18. Horizon Total SCD Observed: 0.02 kW
19. Horizon-end Battery Energy Deviation from Reference: 0.0 kWh
20. Horizon-Total All time Substation Power Peak: 1061.07 kW

21. Number of Macro-Iterations: 1
22. Simulation Time: 2.45 s
23. Time to solve with sequential (non-parallel) computation: 2.45 s
24. Time to solve if OPF computation parallelized: 2.45 s
```

Objective

$P_{SubsPeak}$

Timings

OpenDSS Powerflow Results

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Full 24 Hour Horizon Validation Results
6. Horizon Total Substation Power Cost: $2799.02
7. Horizon Total Line Loss: 405.72 kW
8. Horizon Total Substation Power: 21190.88 kW + 8476.36 kVAr
9. Horizon Total Load: 21357.44 kW + 11751.26 kVAr
10. Horizon Total Generation: 572.26 kW + 4070.56 kVAr
11. Horizon Total Static Capacitor Reactive Power Generation: 0.0 kVAr
12. Horizon Total PV Generation: 607.44 kW + 1972.33 kVAr
13. Horizon Total Battery Generation: -35.18 kW + 2098.23 kVAr
14. Horizon Total Battery Transaction Magnitude: 0.0 kW + 0.0 kVAr
15. Horizon Total SCD Observed: N/A
16. Horizon-end Battery Energy Deviation from Reference: 0.01 kWh
17. Horizon-Total All Time Substation Power Peak: 1061.09 kW

Discrepancies (Maximum All Time):
18. Maximum All Time Voltage Discrepancy: 6.2e-5 pu
19. Maximum All Time Line Loss Discrepancy: 0.019392 kW
20. Maximum All Time Substation Borrowed Real Power Discrepancy: 0.117384 kW
21. Maximum All Time Substation Borrowed Reactive Power Discrepancy: 1.011584 kVAr
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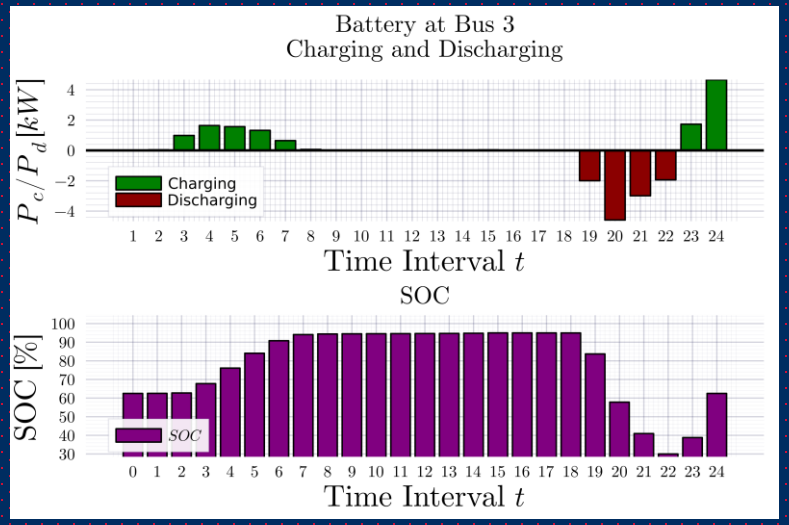
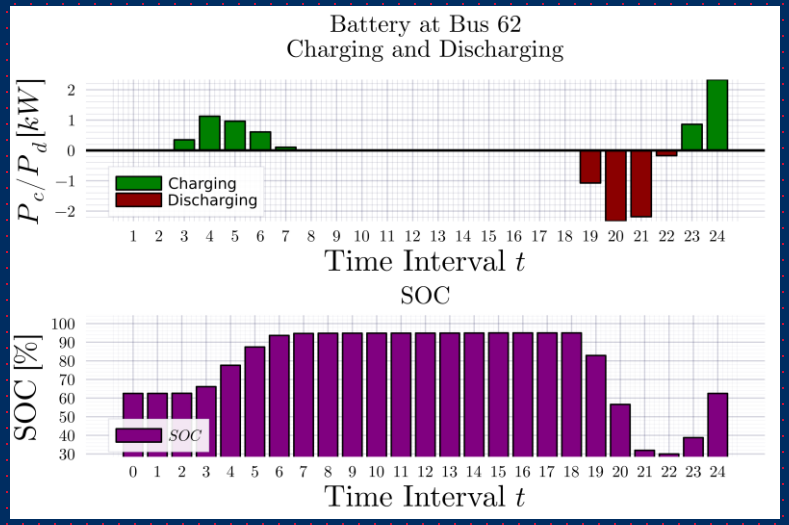
Objective

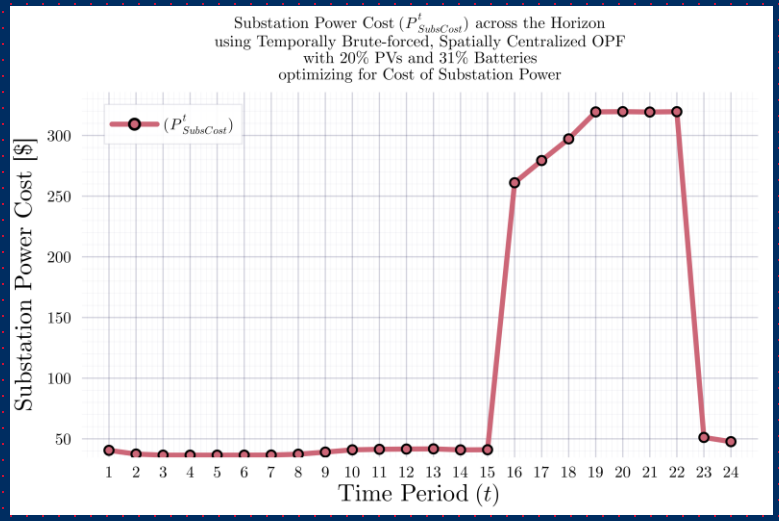
Miscomputation - will be fixed later

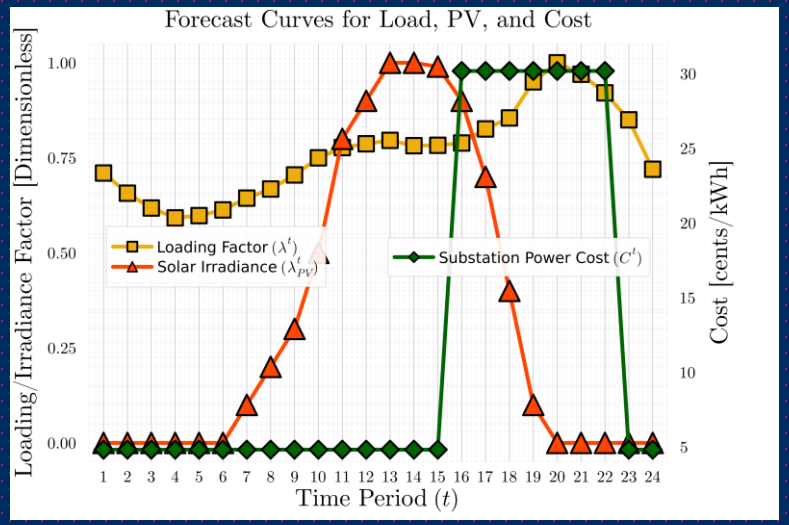
Discrepancies

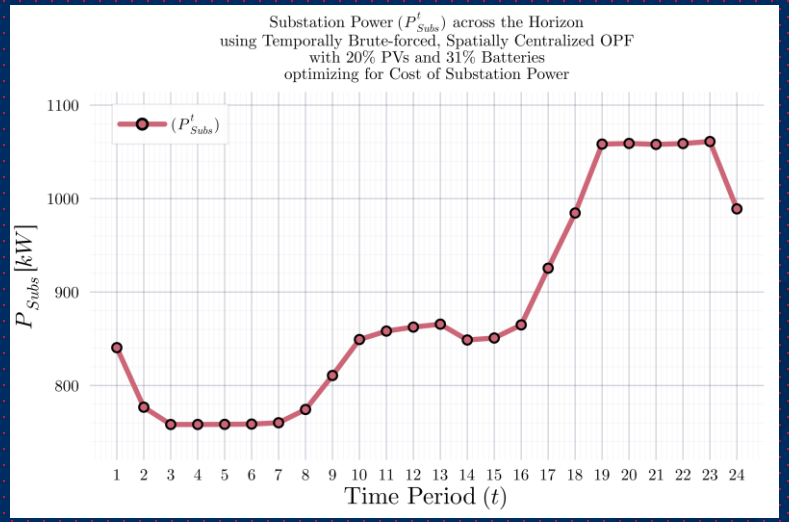
IEEE123_1ph: MPCOPF Run for $T = 24, PV = 20\%, Batt = 30\%$

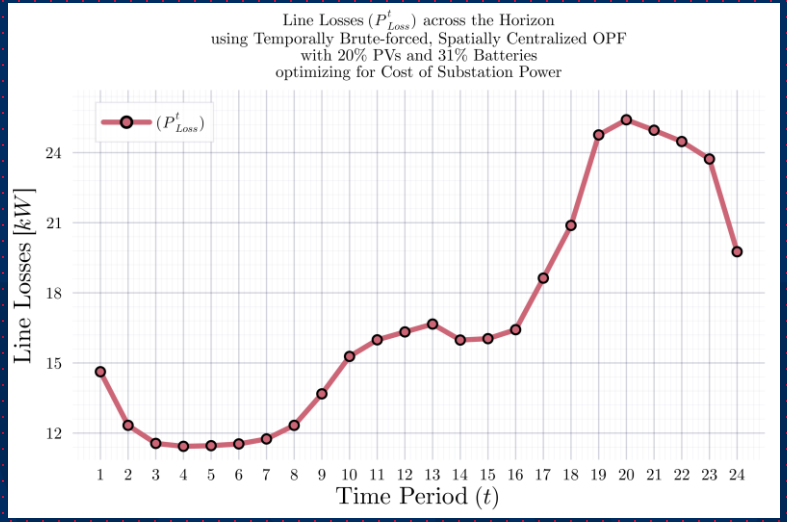












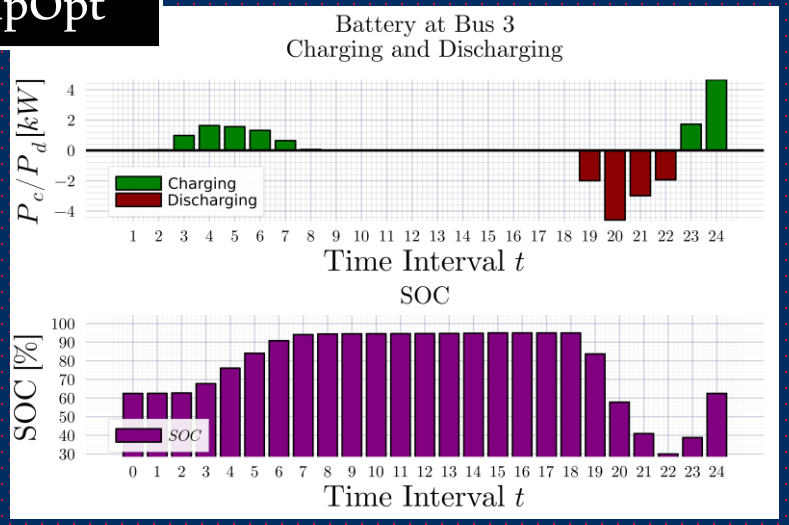
OpenDSS Def Profiles

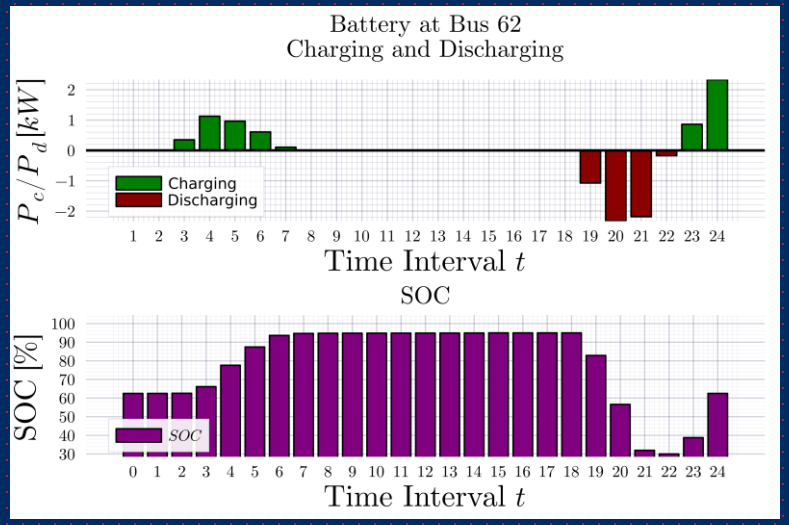
Substation Power Cost

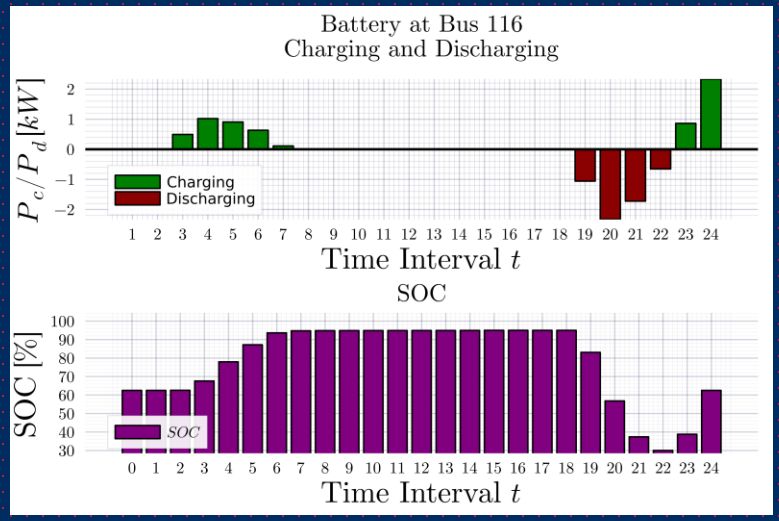
Minor difference between solver optimal decision variables

IEEE123_1ph: MPCOPF Run for $T = 24, PV = 20\%, Batt = 30\%$

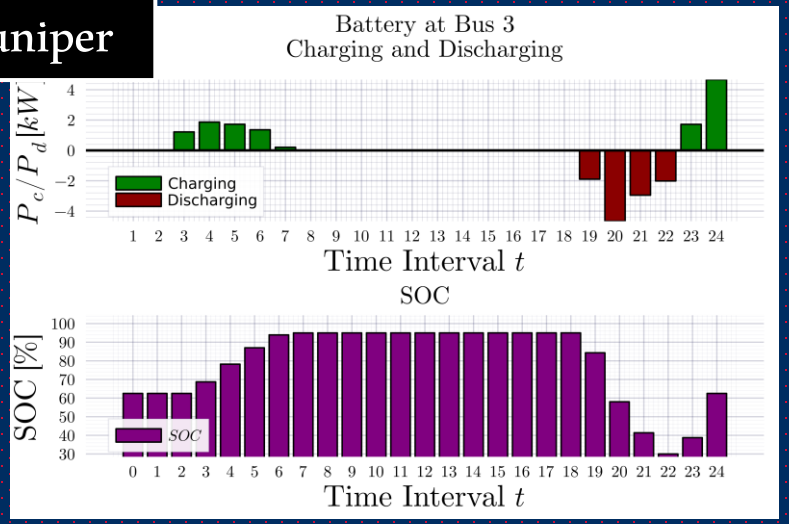
IpOpt

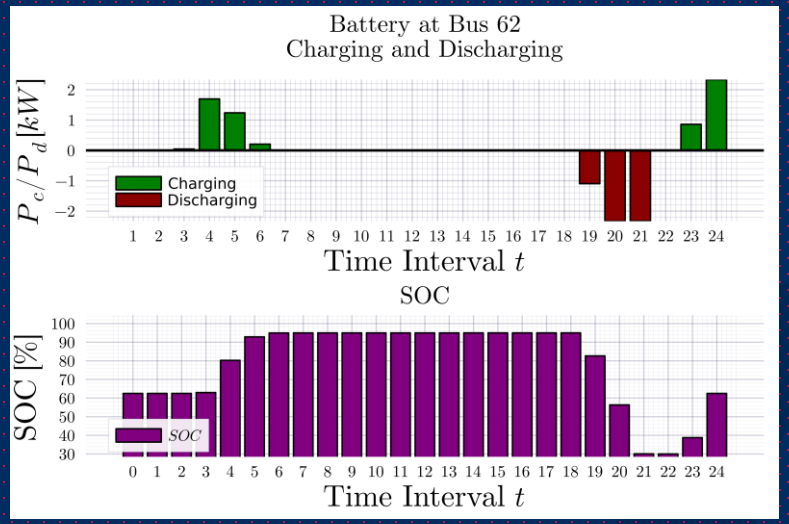


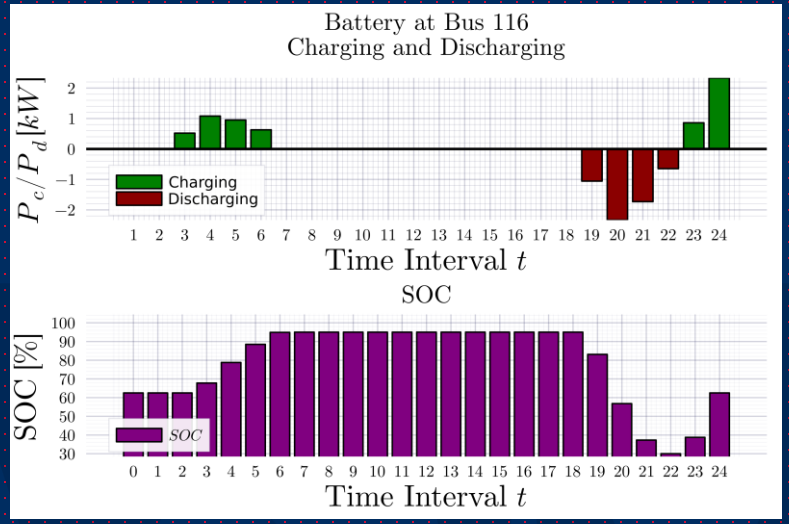




Juniper

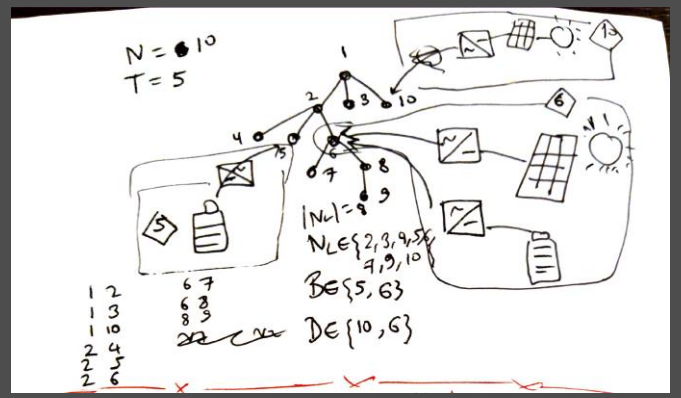






Three Steps for Optimization Implementation (and what will be different for DDP):

1. [No change] Loading Simulation Configuration from OpenDSS (.dss) files, Pre-optimization housekeeping
2. [Some change] Optimization Routine (Temporally brute forced optimization now verified, can be used as 'Benchmark' result for checking Optimality Gap)
3. [No change] Post Optimization result validation via OpenDSSDirect



Initial Test System: ADS10_1ph with 8 Loads, 2 PVs and 2 Batteries

Now onto writing the script for DDP optimization routine ..