Multi-Period Optimal Power Flow

for Active Power Distribution Systems

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IEEE 123 $X\%$ PVs, 0% Batteries. COPF. $T\ =\ 1$

Objective Function values (Real Power Losses P_{Loss}) and **System-wide Voltage snapshots** (shown in the next slides) match.

This slide: $X = 0$

Multi-Period Simulation, T = 1, Batteries at 0%, DERs at 0% (0 buses)

```
Machine ID: ETRL204-ARYAN
Horizon Duration: 1
    "Nature of Simulation: "    "Centralized-OPF"
Line Loss: 29.1779 kW
Substation Power: 1192.3749 kW
Total Load: 1163.197 kW + 640.012 kVAr
Total Generation: 0 kW + 350 kVAr
Total PV Real Power Generation: 0 kW
Total PV Reactive Power Generation: 0 kVAr
Total Static Capacitor Reactive Power Generation: 350 kVAr
Total Reactive Power Generation: 350 kVAr
Substation Power Cost: 41.7331 $
Number of Macro-Iterations: 1
Simulation Time: 4.0309 s
Time to solve with sequential (non-parallel) computation: 2.3441 s
Time to solve if OPF computation paralellized: 2.3441 s
```

OpenDSS Powerflow with DERs at 0% (0 buses)

```
Line Loss: 29.1561 kW
Substation Power: 1192.353 kW + 347.5389 kVAr
Total Load: 1163.197 kW + 640.012 kVAr
Total Generation: 4e-06 kW + 350 kVAr
Total PV Real Power Generation: 4e-06 kW
Total Reactive Power Generation: 350 kVAr
```

IEEE 123 $X\%$ PVs, 0% Batteries. COPF. $T = 1$

Objective Function values (Real Power Losses P_{Loss}) and **System-wide Voltage snapshots** (shown in the next slides) match.

This slide: $X = 50$

Multi-Period Simulation, T = 1, Batteries at 0%, DERs at 50% (43 buses)

```
Machine ID: ETRL204-ARYAN

Horizon Duration: 1

    "Nature of Simulation: "    "Centralized-OPF"

Line Loss: 18.8584 kW
Substation Power: 958.082 kW

Total Load: 1163.197 kW + 640.012 kVAr

Total Generation: 223.9734 kW + 464.5222 kVAr

Total PV Real Power Generation: 223.9734 kW

Total PV Reactive Power Generation: 114.5222 kVAr

Total Static Capacitor Reactive Power Generation: 350 kVAr

Total Reactive Power Generation: 464.5222 kVAr

Substation Power Cost: 33.5329 $

Number of Macro-Iterations: 1

Simulation Time: 7.6467 s

Time to solve with sequential (non-parallel) computation: 6.2645 s

Time to solve if OPF computation paralellized: 6.2645 s
```

OpenDSS Powerflow with DERs at 50% (43 buses)

```
Line Loss: 18.8466 kW
Substation Power: 958.0696 kW + 212.2898 kVAr

Total Load: 1163.197 kW + 640.012 kVAr

Total Generation: 223.974 kW + 464.5212 kVAr

Total PV Real Power Generation: 223.974 kW

Total Reactive Power Generation: 464.5212 kVAr
```

IEEE 123 X% PVs, 0% Batteries. COPF. $T\;=\;1$

Objective Function values (Real Power Losses P_{Loss}) and **System-wide Voltage snapshots** (shown in the next slides) match.

This slide: $X = 100$

Multi-Period Simulation, T = 1, Batteries at 0%, DERs at 100% (85 buses)

OpenDSS Powerflow with DERs at 100% (85 buses)

```
Machine ID: ETRL204-ARYAN
Horizon Duration: 1
     "Nature of Simulation: "    "Centralized-OPF"
Line Loss: 12.0986 kW
Substation Power: 768.1766 kW
Total Load: 1163.197 kW + 640.012 kVAr
Total Generation: 407.119 kW + 514.2544 kVAr
Total PV Real Power Generation: 407.119 kW
Total PV Reactive Power Generation: 164.2544 kVAr
Total Static Capacitor Reactive Power Generation: 350 kVAr
Total Reactive Power Generation: 514.2544 kVAr
Substation Power Cost: 26.8862 $
Number of Macro-Iterations: 1
Simulation Time: 7.0278 s
Time to solve with sequential (non-parallel) computation: 5.785 s
Time to solve if OPF computation paralellized: 5.785 s
```
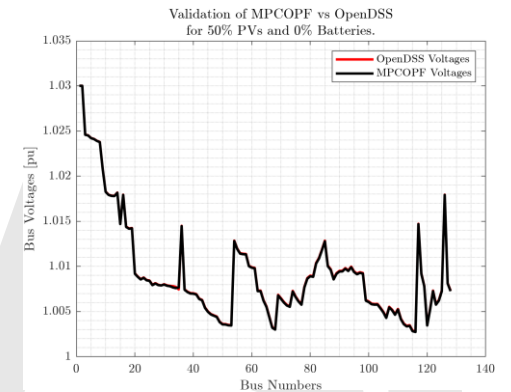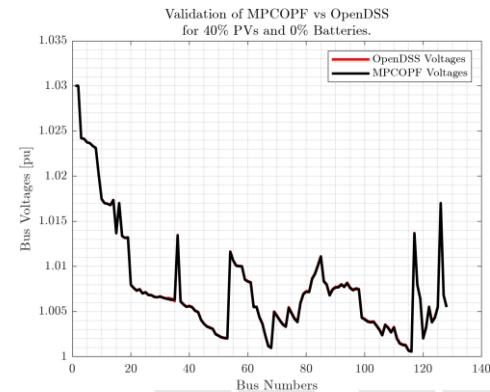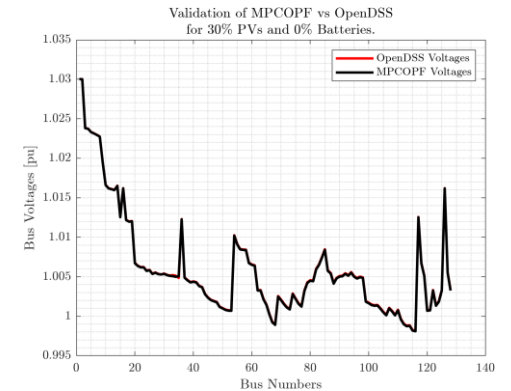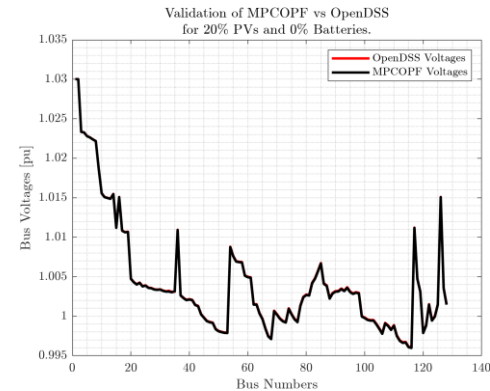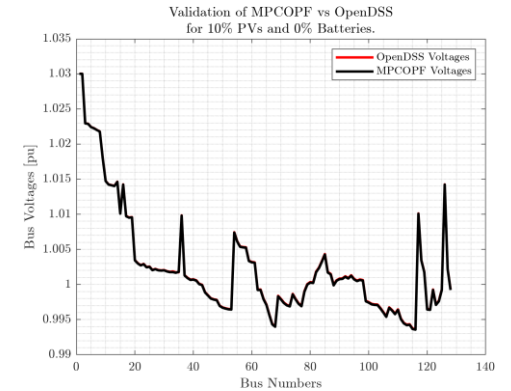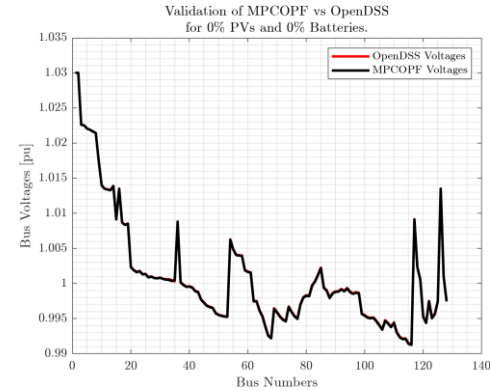
```
Line Loss: 12.0904 kW
Substation Power: 768.167 kW + 149.0344 kVAr
Total Load: 1163.197 kW + 640.012 kVAr
Total Generation: 407.1205 kW + 514.2525 kVAr
Total PV Real Power Generation: 407.1205 kW
Total Reactive Power Generation: 514.2525 kVAr
```

Comparison with OpenDSS:

System-wide Voltage Snapshots
PV = 0%, 10%, 20%, 30%, 40%, 50%
Battery = 0%
$T = 1$

Comparison with OpenDSS:

System-wide Voltage Snapshots
PV = 60%, 70%, 80%, 90%, 100%,
Battery = 0%
$T = 1$