Trying to benchmark the "Benchmark" Simulation against the "Original" Simulation

T: Number of Time-Periods (tunable)

$numAreas$: Number of Areas the system is divided into. The simulation becomes:
CMPOPF if $numAreas = 1$
DMPOPF if $numAreas > 1$ (4)

DERs (tunable): $[0, 100\%]$ (0 to 85 buses)
Batteries# (tunable*): $[0, 100\%]$ (0 to 85 buses)

"Benchmark" Simulation: MP-(C/D)-OPF

No Time-dimension: Equivalent to $T = 1$

$numAreas$: Number of Areas the system is divided into. The simulation becomes:
CMPOPF if $numAreas = 1$
DMPOPF if $numAreas > 1$ (4)

DERs (fixed): 100% (85 buses)
No Batteries: Equivalent to 0% (0 buses)

"Original" Simulation: (C/D)-OPF

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"Original" Simulation: (C/D)-OPF

*Note: The way the batteries are currently modeled, they can only be placed at a bus where there is already a DER. (So only 85 buses are eligible to have a battery)

#Batteries add more than just 4 new decision variables (which are B, P_c, P_d, q_B) to the simulation.

Incorporating them (while avoiding mixed-integer programming) requires specifying additional 'soft-constraint' objective functions to the optimizer, including an "SCD penalty" function and a "Deviation of terminal SOC from a reference SOC penalty" function, which require additional unknown parameters (such as α, γ in my simulation). Ideally, these 'soft-constraint' function values in the result should be zero, but if this doesn't happen, they cannot be truly compared to a 'battery-free' simulation.

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But, if batteries are removed (unmodeled) from the MPOPF simulation, the previously mentioned complications are also avoided, and thus the two simulations can be compared toe-to-toe. This is what I've been doing recently.

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$numAreas$: Number of Areas the system is divided into. The simulation becomes:
CMPOPF if $numAreas = 1$
DMPOPF if $numAreas > 1$ (4)

DERs (tunable): $[0, 100\%]$ (0 to 85 buses)
Batteries# (tunable*): $[0, 100\%]$ (0 to 85 buses)

"Benchmark" Simulation: MP-(C/D)-OPF

$T = 1$
$numAreas = 1$ (COPF)
$\%DER = 100$
$\%Batteries = 0$

No Time-dimension: Equivalent to $T = 1$

$numAreas$: Number of Areas the system is divided into. The simulation becomes:
CMPOPF if $numAreas = 1$
DMPOPF if $numAreas > 1$ (4)

DERs (fixed): 100% (85 buses)
No Batteries: Equivalent to 0% (0 buses)

"Original" Simulation: (C/D)-OPF

IEEE 123 100% DER, 0% Batteries. COPF. $T = 1$

Problem: These values should be the same. This is an OPF modelling issue.

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

```
------------------------------------------------------------
Machine ID: ETRL204-ARYAN
Horizon Duration: 1
    "Nature of Simulation: "    "Centralized-OPF"
Line Loss: 12.1648 kW
Substation Power: 768.2428 kW
Substation Power Cost: 26.8885 $
Number of Macro-Iterations: 1
Simulation Time: 17.6817 s
Time to solve with sequential (non-parallel) computation: 6.1632 s
Time to solve if OPF computation paralellized: 6.1632 s
------------------------------------------------------------
```

Original Simulation* DERs at 100% (85 buses)

```
------------------------------------
Line Loss: 12.0986 kW
Substation Power: 768.1766 kW
Time to Solve: 7.481sec
------------------------------------
```

* Original Simulation = Simulation used by Rabayet to model DOPF on IEEE 123 Bus System with 100% DERs (85 buses). Obviously, there's no element of time (not modeled, so $T = 1$) and no batteries (not modeled, so 0%)

Current Approach: Validating OPF decision variables with OpenDSS

By setting

$$P_{Load\_OpenDSS} = P_{Load} - P_{DER} - P_{disch} + P_{chr}$$

$$Q_{Load\_OpenDSS} = \mathrm{Q}_{\mathrm{Load}} - \mathrm{q}_{\mathrm{DER}} - \mathrm{q}_{\mathrm{Batt}} - \mathrm{Q}_{\mathrm{Cap}}$$

Running Powerflow in OpenDSS, obtaining $V_{OpenDSS}$ and comparing against my simulation $V_{results}$ (checking for physical violations, but also, just checking the two V vs bus-number curves in general).

I'm writing an OpenDSS validator function, which takes busData, branchData, $P_{Load}, P_{DER}, P_{disch}, P_{chr}, Q_{Load}, q_{DER}, q_{Batt}, Q_{cap}, V_{results}$ for a given time-interval t and plots its powerflow voltages $V_{OpenDSS}$ against my $V_{results}$.