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# Multiple Source Optimal Power Flow

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- Provision to 'test' BFM solutions into OpenDSS incorporated.
- In place of Substation 2 (Vsource 2), a generator (Gen 2) is placed with fixed values of voltage  $V$  and dispatch  $P, Q$  as per BFM-NL optimization values.
- The angles of Substation 1 and Generator 2 are then retrieved post-powerflow to obtain  $\delta = \delta_1 - \delta_2$ .

Note to self: While  $\delta$  here is the fixed angle difference between the two substations, actually check for the bus angles from OpenDSS after Powerflow. OpenDSS does internally only ever have one slack bus, bus 2 voltage angle may have to cower.

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Total loading: 50000.0 kW, 37500.0 kVAr				
Substation voltages (pu): grid1=1.07, grid2=1.07				
Substation BasekV: grid1=11.5470, grid2=11.5470				
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$\delta$ [°]	PSubs1 [kW]	PSubs2 [kW]	QSubs1 [kVAr]	QSubs2 [kVAr]
-----				
-10.0	-111097.19	170886.48	109388.77	-69928.60
-5.0	-44422.26	97120.57	64022.41	-25982.91
-2.0	-2982.79	53696.05	36842.94	801.97
-1.5	4015.26	46528.31	32320.92	5287.74
-1.0	11040.58	39384.45	27804.09	9780.82
-0.5	18090.70	32263.18	23291.32	14279.33
-0.4	19503.51	30841.55	22389.15	15179.53
-0.3	20917.43	29420.99	21487.29	16080.06
-0.2	22332.31	28001.37	20585.62	16980.78
-0.1	23748.15	26582.68	19684.12	17881.70
0.0	25164.94	25164.94	18782.82	18782.82
0.1	26582.68	23748.15	17881.70	19684.12
0.2	28001.36	22332.31	16980.78	20585.61
0.3	29420.99	20917.42	16080.05	21487.29
0.4	30841.54	19503.50	15179.52	22389.14
0.5	32263.03	18090.54	14279.19	23291.18
1.0	39384.32	11040.45	9780.72	27804.00
1.5	46528.11	4015.06	5287.59	32320.77
2.0	53693.93	-2984.99	800.24	36841.25
5.0	97119.79	-44423.10	-25983.29	64022.04
10.0	170883.99	-111100.13	-69930.61	109386.89
'BFM-NL'	28571.43	21428.57	12984.81	24515.19
-----				
$\delta$ [°]	PSubs1 [kW]	PGen2 [kW]	QSubs1 [kVAr]	QGen2 [kVAr]
-----				
0.1246	28915.08	21426.93	13050.38	24515.87
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- We can see that there's a little mismatch between  $P_{Subs1}$  for the two cases (although  $Q_{Subs1}$  is almost same), despite identical dispatch from bus 2. (May have to check if voltage magnitudes  $V_2$  are exactly abided by in the two scenarios or not)

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$\delta$ [°]	PSubs1 [kW]	PGen2 [kW]	QSubs1 [kVAr]	QGen2 [kVAr]
0.1246	28915.08	21426.93	13050.38	24515.87

From BFM-NL optimization: Angle constraints relaxed, solution angle unknown

OpenDSS simulation where Substation 2 is converted a Generator with same values of  $P$ ,  $Q$ ,  $V$  as BFM-NL

- Hmm, even using exact value of  $\delta = 0.12452868971865128$ , for substation 2 gives a different value of  $P_{Subs_1}, Q_{Subs_1}$ .

-----  
 Total loading: 50000.0 kW, 37500.0 kVAr  
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 Substation BasekV: grid1=11.5470, grid2=11.5470  
 -----

$\delta$ [°]	PSubs1 [kW]	PSubs2 [kW]	QSubs1 [kVAr]	QSubs2 [kVAr]
-8.0000	-84809.12	141200.57	91250.28	-52469.62
-5.0000	-44422.36	97120.48	64022.34	-25982.98
-2.0000	-2982.79	53696.05	36842.94	801.97
-1.5000	4015.26	46528.31	32320.92	5287.74
-1.0000	11040.58	39384.45	27804.09	9780.82
-0.5000	18090.70	32263.18	23291.32	14279.33
-0.4000	19503.51	30841.55	22389.15	15179.53
-0.3000	20917.43	29420.99	21487.29	16080.06
-0.2000	22332.31	28001.37	20585.62	16980.78
-0.1000	23748.15	26582.68	19684.12	17881.70
0.0000	25164.94	25164.94	18782.82	18782.82
0.1000	26582.68	23748.15	17881.70	19684.12
0.2000	28001.36	22332.31	16980.78	20585.61
0.3000	29420.99	20917.42	16080.05	21487.29
0.4000	30841.54	19503.50	15179.52	22389.14
0.5000	32263.03	18090.54	14279.19	23291.18
1.0000	39384.32	11040.45	9780.72	27804.00
1.5000	46528.11	4015.06	5287.59	32320.77
2.0000	53693.93	-2984.99	800.24	36841.25
5.0000	97119.79	-44423.10	-25983.29	64022.04
8.0000	141196.36	-84813.90	-52472.71	91247.36
0.1245	26933.10	23403.30	17661.96	19906.49
BFM-NL	28571.43	21428.57	12984.81	24515.19

OpenDSS simulation where Substation 2 has been assigned the angle from the Generator 2 simulation

OpenDSS simulation where Substation 2 is converted a Generator with same values of  $P, Q, V$  as BFM-NL

$\delta$ [°]	PSubs1 [kW]	PGen2 [kW]	QSubs1 [kVAr]	QGen2 [kVAr]
0.1245	28916.45	21428.62	13053.55	24515.31

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