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Milestone 2: Jacobian

Below see the results of a verification of our simulator for one iteration of the Newton Raphson Power Flow solver.

Code Output:
Flat Start:

```
Bus Voltages for System 1
1       2       3       4       5       6       7
1       1.0     1.0     1.0     1.0     1.0     1.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0
```

$\Delta P \; and \; \Delta Q$ for all 7 buses, Mismatch

```
0.0
0.0
-110.0
-100.0
-100.0
0.0
200.0
0.0
0.06
-49.93
-69.89
-64.89
0.05
0.0
```

Jacobian with only essential terms after removal of slack bus terms, and Q and V terms from PV buses:

2	3	4	5	6	7	2	3	4	5	6
115.87	-28.93	-72.31	0.0	0.0	0.0	30.26	-8.23	-20.57	0.0	0.0
-28.93	65.08	0.0	-36.16	0.0	0.0	-8.23	18.51	0.0	-10.28	0.0
-72.31	0.0	129.13	-20.66	-36.16	0.0	-20.57	0.0	36.73	-5.88	-10.28
0.0	-36.16	-20.66	129.13	-72.31	0.0	0.0	-10.28	-5.88	36.73	-20.57
0.0	0.0	-36.16	-72.31	127.45	-18.98	0.0	0.0	-10.28	-20.57	32.43
0.0	0.0	0.0	0.0	-18.98	18.98	0.0	0.0	0.0	0.0	-1.58
-30.26	8.23	20.57	-0.0	-0.0	-0.0	115.76	-28.93	-72.31	0.0	0.0
8.23	-18.51	-0.0	10.28	-0.0	-0.0	-28.93	64.93	0.0	-36.16	0.0
20.57	-0.0	-36.73	5.88	10.28	-0.0	-72.31	0.0	128.92	-20.66	-36.16
-0.0	10.28	5.88	-36.73	20.57	-0.0	0.0	-36.16	-20.66	128.92	-72.31
-0.0	-0.0	10.28	20.57	-32.43	1.58	0.0	0.0	-36.16	-72.31	127.35

ΔX Changes in angles of all non slack buses and changes in all voltages of non slack and non PV buses:

```
-0.07
-0.09
-0.07
-0.08
-0.06
0.04
-0.05
-0.07
-0.06
-0.06
-0.05
```

Per Unit Bus Voltages after one Iteration:

```
Bus Voltages for System 1
1       2       3       4       5       6       7
1       0.946   0.929   0.938   0.936   0.949   1.0
0.0     -3.995  -4.995  -4.246  -4.365  -3.467  2.325
```

Below, see that the PowerWorld Outputs align with the results from the code, thus verifying our work so far on this simulator.

Powerworld Output:

Initial Bus Voltages, Flat Start:

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	1	1	1	20.00	1.00000	20.000	0.00			0.00	0.00
2	2	2	1	230.00	1.00000	230.000	0.00				
3	3	3	1	230.00	1.00000	230.000	0.00	110.00	50.00		
4	4	4	1	230.00	1.00000	230.000	0.00	100.00	70.00		
5	5	5	1	230.00	1.00000	230.000	0.00	100.00	65.00		
6	6	6	1	230.00	1.00000	230.000	0.00				
7	7	7	1	18.00	1.00000	18.000	0.00			200.00	0.00

ΔP *and* ΔQ for all 7 buses, Mismatch

	Number	Name	Area Name	Type	Mismatch MW	Mismatch Mvar	Mismatch MV
1	7	7	1	PV	200.00	0.00	200.00
2	3	3	1	PQ	-110.00	-42.66	117.98
3	4	4	1	PQ	-100.00	-59.40	116.31
4	5	5	1	PQ	-100.00	-54.40	113.84
5	2	2	1	PQ	0.00	5.71	5.71
6	6	6	1	PQ	0.00	4.89	4.89
7	1	1	1	Slack	0.00	0.00	0.00

Jacobian for all Buses:

	Number	Name	Jacobian Equation	Angle Bus 1	Angle Bus 2	Angle Bus 3	Angle Bus 4	Angle Bus 5	Angle Bus 6	Angle Bus 7
1	1	1	Real Power	1.00						
2	2	2	Real Power		115.87	-28.92	-72.31			
3	3	3	Real Power		-28.92	65.08		-36.16		
4	4	4	Real Power		-72.31		129.13	-20.66	-36.16	
5	5	5	Real Power			-36.16	-20.66	129.13	-72.31	
6	6	6	Real Power				-36.16	-72.31	127.45	-18.98
7	7	7	Real Power						-18.98	18.98
8	1	1	Slack							
9	2	2	Reactive Power		-30.26	8.23	20.57			
10	3	3	Reactive Power		8.23	-18.51		10.28		
11	4	4	Reactive Power		20.57		-36.73	5.88	10.28	
12	5	5	Reactive Power			10.28	5.88	-36.73	20.57	
13	6	6	Reactive Power				10.28	20.57	-32.43	1.58
14	7	7	Voltage Magnitude							

Volt Mag Bus 1	Volt Mag Bus 2	Volt Mag Bus 3	Volt Mag Bus 4	Volt Mag Bus 5	Volt Mag Bus 6	Volt Mag Bus 7
	30.26	-8.23	-20.57			
	-8.23	18.51		-10.28		
	-20.57		36.73	-5.88	-10.28	
		-10.28	-5.88	36.73	-20.57	
			-10.28	-20.57	32.43	-1.58
					-1.58	1.58
1.00						
	115.76	-28.92	-72.31			
	-28.92	64.93		-36.16		
	-72.31		128.92	-20.66	-36.16	
		-36.16	-20.66	128.92	-72.31	
			-36.16	-72.31	127.35	-18.98
						1.00

Final Bus Voltages after One Iteration:

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	1	1	1	20.00	1.00000	20.000	0.00			113.76	71.81
2	2	2	1	230.00	0.94646	217.687	-4.37				
3	3	3	1	230.00	0.93138	214.217	-5.56	110.00	50.00		
4	4	4	1	230.00	0.93953	216.091	-4.68	100.00	70.00		
5	5	5	1	230.00	0.93680	215.463	-4.82	100.00	65.00		
6	6	6	1	230.00	0.94909	218.290	-3.78				
7	7	7	1	18.00	1.00088	18.016	2.40			200.00	92.71