12-Bus Power Simulation in PowerWorld:

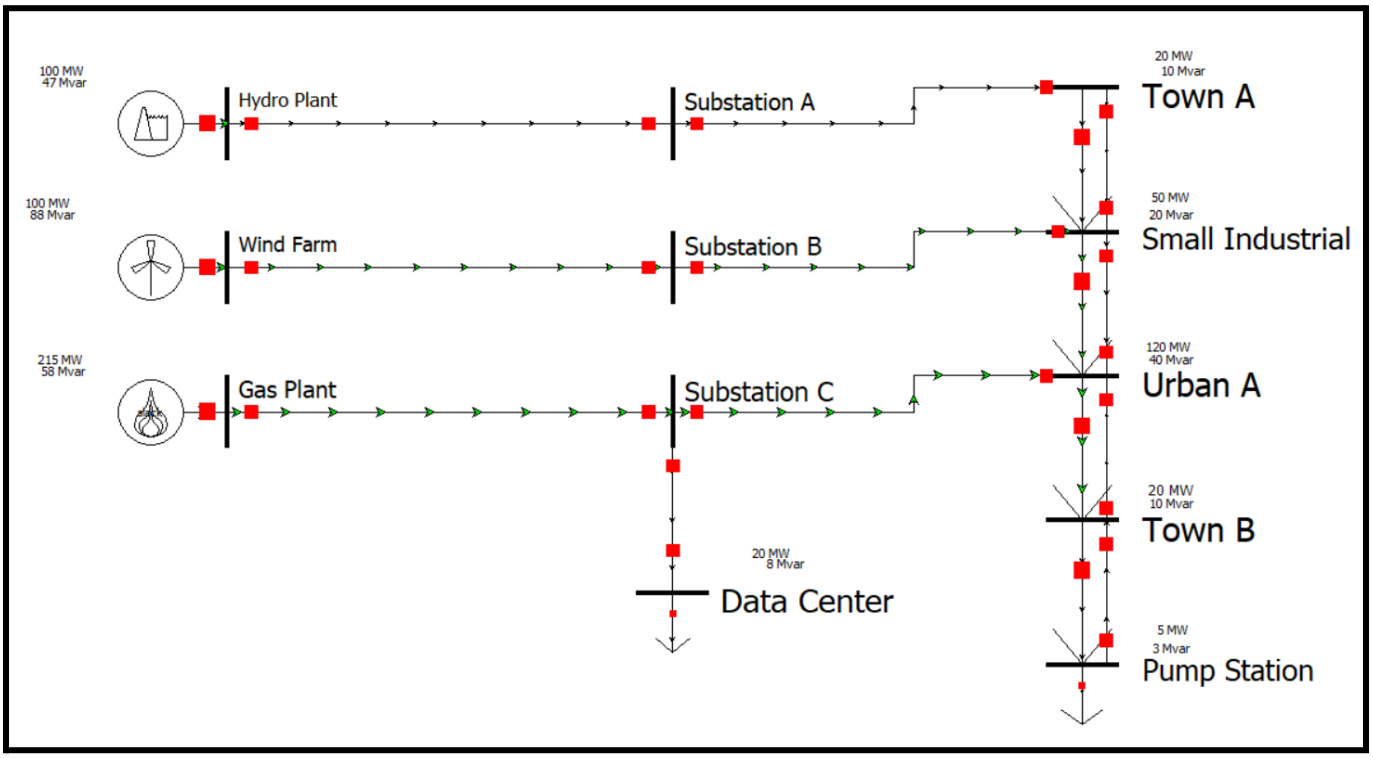
Objective:
The objective is to simulate a scenario of generators, loads, and transmission zones with contingency plans.

Side Note:
Please consider the values from the chart only. The MW and MVAR in the diagram have not been updated due to software issues.

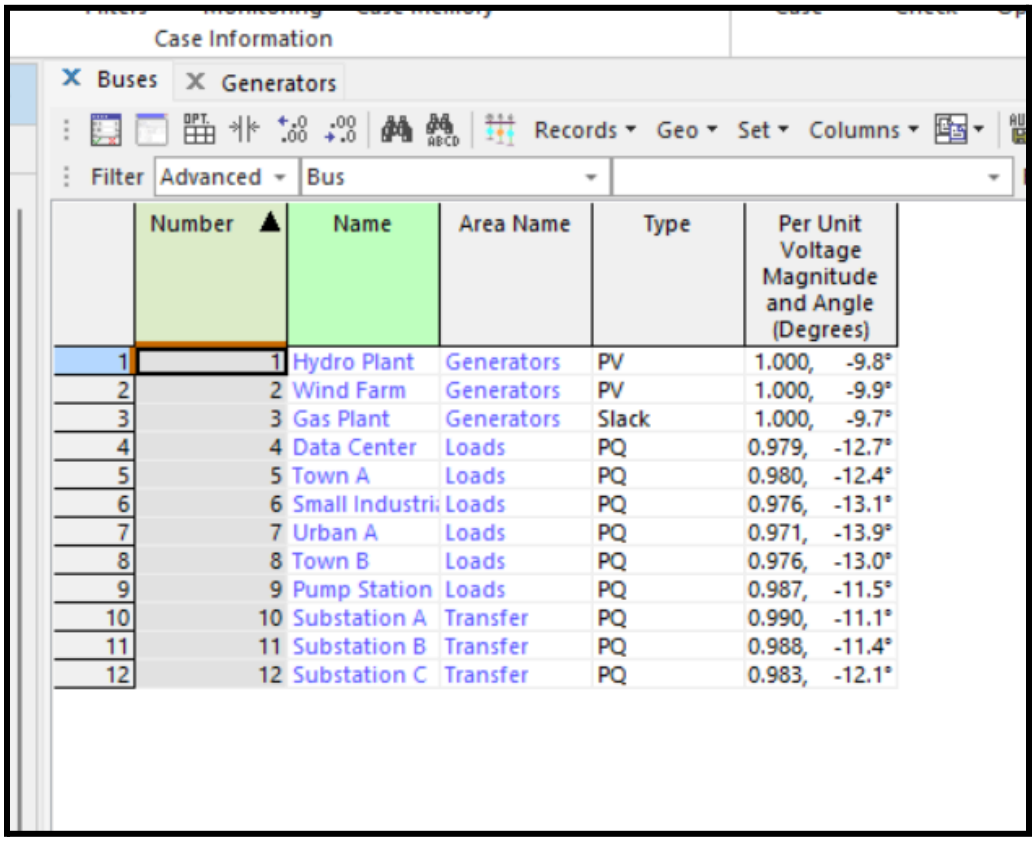
System Overview:

- 12 Buses
- 3 Generators: Hydro Plant, Wind Farm, and Gas Plant
- 3 Substations: Substation A, Substation B, and Substation C
- 6 Loads: Data Center, Town A, Small Industrial, Urban A, Town B, and Pump Station

Base Case:
Base Diagram -

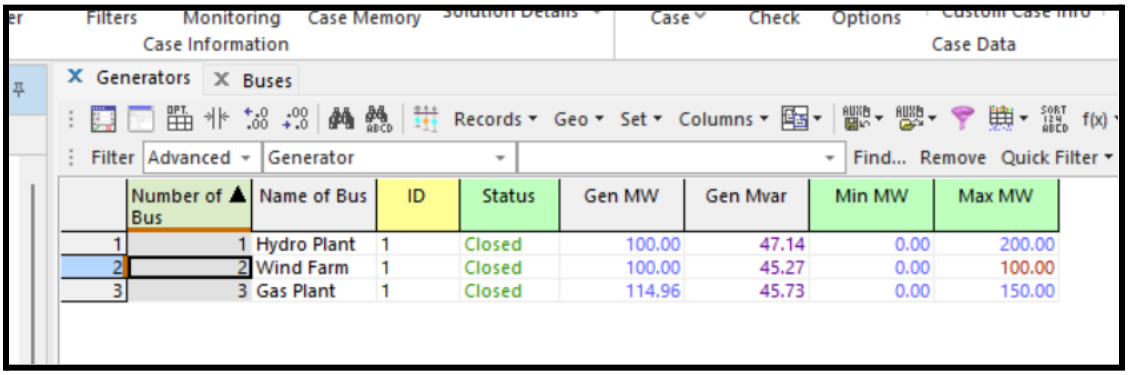


Bus Info Base -



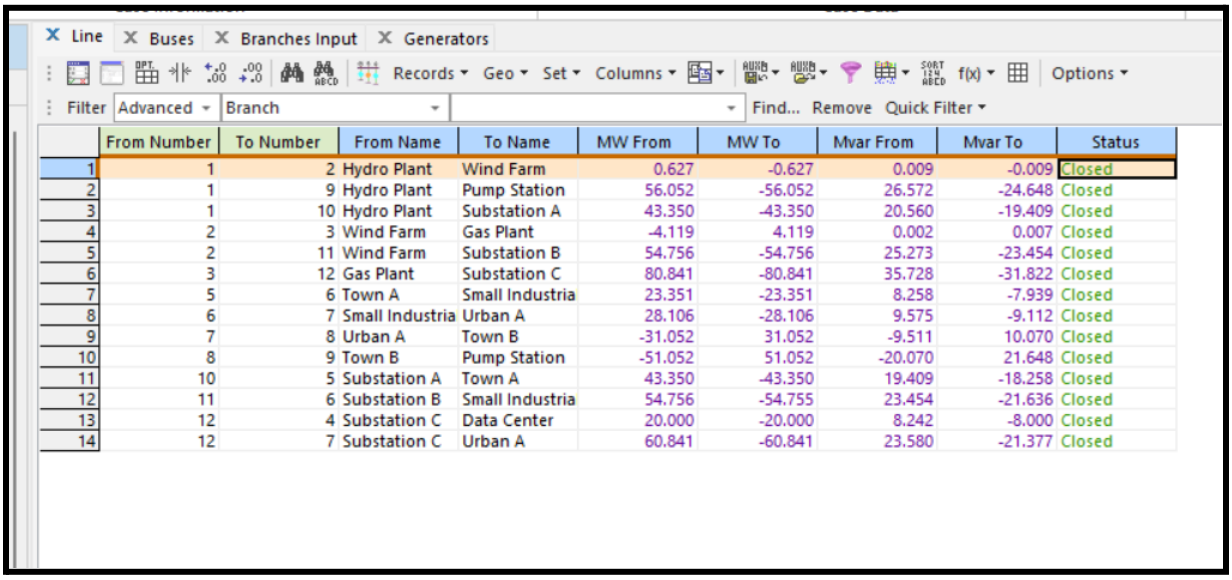
	Number	Name	Area Name	Type	Per Unit Voltage Magnitude and Angle (Degrees)
1	1	Hydro Plant	Generators	PV	1.000, -9.8°
2	2	Wind Farm	Generators	PV	1.000, -9.9°
3	3	Gas Plant	Generators	Slack	1.000, -9.7°
4	4	Data Center	Loads	PQ	0.979, -12.7°
5	5	Town A	Loads	PQ	0.980, -12.4°
6	6	Small Industri	Loads	PQ	0.976, -13.1°
7	7	Urban A	Loads	PQ	0.971, -13.9°
8	8	Town B	Loads	PQ	0.976, -13.0°
9	9	Pump Station	Loads	PQ	0.987, -11.5°
10	10	Substation A	Transfer	PQ	0.990, -11.1°
11	11	Substation B	Transfer	PQ	0.988, -11.4°
12	12	Substation C	Transfer	PQ	0.983, -12.1°

Generator Info Base -



	Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Min MW	Max MW
1	1	Hydro Plant	1	Closed	100.00	47.14	0.00	200.00
2	2	Wind Farm	1	Closed	100.00	45.27	0.00	100.00
3	3	Gas Plant	1	Closed	114.96	45.73	0.00	150.00

Line Info Base -



Line | Buses | Branches Input | Generators

Records | Geo | Set | Columns | Options

Filter: Advanced | Branch | Find... | Remove | Quick Filter

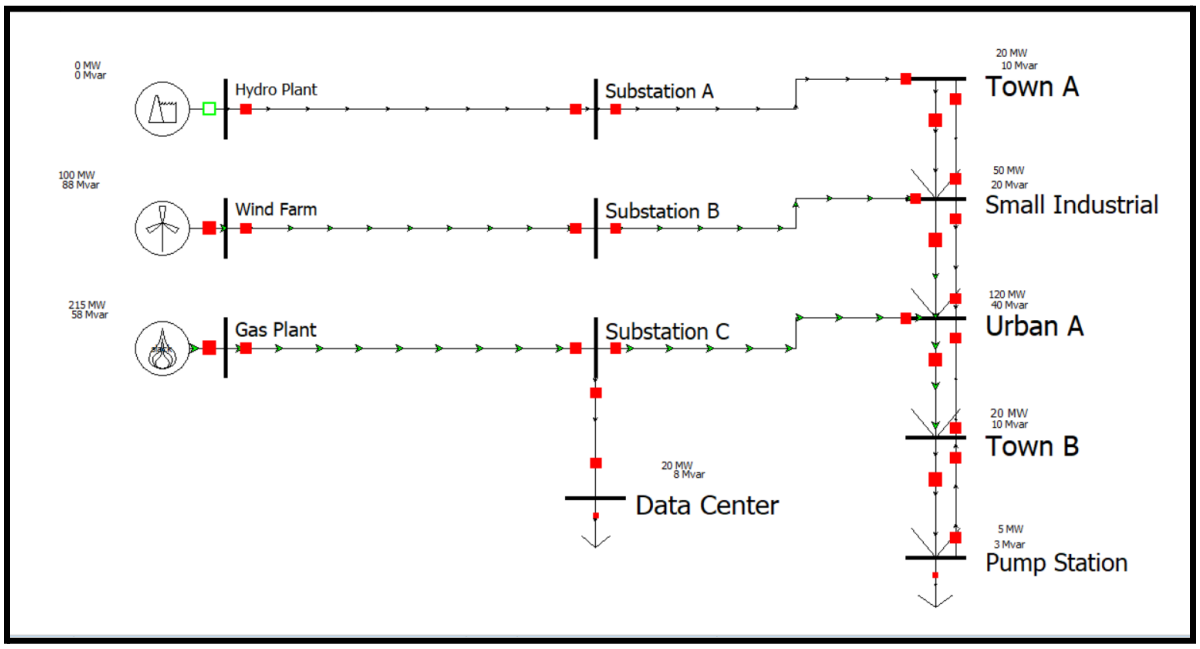
	From Number	To Number	From Name	To Name	MW From	MW To	Mvar From	Mvar To	Status
1	1	2	Hydro Plant	Wind Farm	0.627	-0.627	0.009	-0.009	Closed
2	1	9	Hydro Plant	Pump Station	56.052	-56.052	26.572	-24.648	Closed
3	1	10	Hydro Plant	Substation A	43.350	-43.350	20.560	-19.409	Closed
4	2	3	Wind Farm	Gas Plant	-4.119	4.119	0.002	0.007	Closed
5	2	11	Wind Farm	Substation B	54.756	-54.756	25.273	-23.454	Closed
6	3	12	Gas Plant	Substation C	80.841	-80.841	35.728	-31.822	Closed
7	5	6	Town A	Small Industria	23.351	-23.351	8.258	-7.939	Closed
8	6	7	Small Industria	Urban A	28.106	-28.106	9.575	-9.112	Closed
9	7	8	Urban A	Town B	-31.052	31.052	-9.511	10.070	Closed
10	8	9	Town B	Pump Station	-51.052	51.052	-20.070	21.648	Closed
11	10	5	Substation A	Town A	43.350	-43.350	19.409	-18.258	Closed
12	11	6	Substation B	Small Industria	54.756	-54.755	23.454	-21.636	Closed
13	12	4	Substation C	Data Center	20.000	-20.000	8.242	-8.000	Closed
14	12	7	Substation C	Urban A	60.841	-60.841	23.580	-21.377	Closed

Base Results -

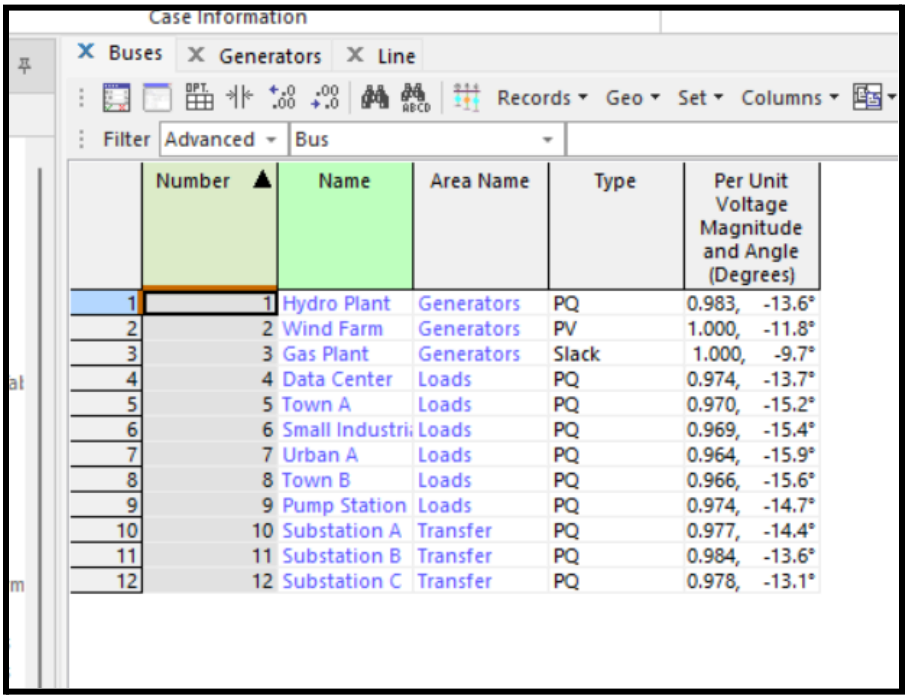
- Voltage Range: 0.97pu-1.00pu
- Total Load: 235MW (Look at chart)
- Total Generation: 315MW

Contingency 1 - Generator Failure:

Diagram Contingency 1 -

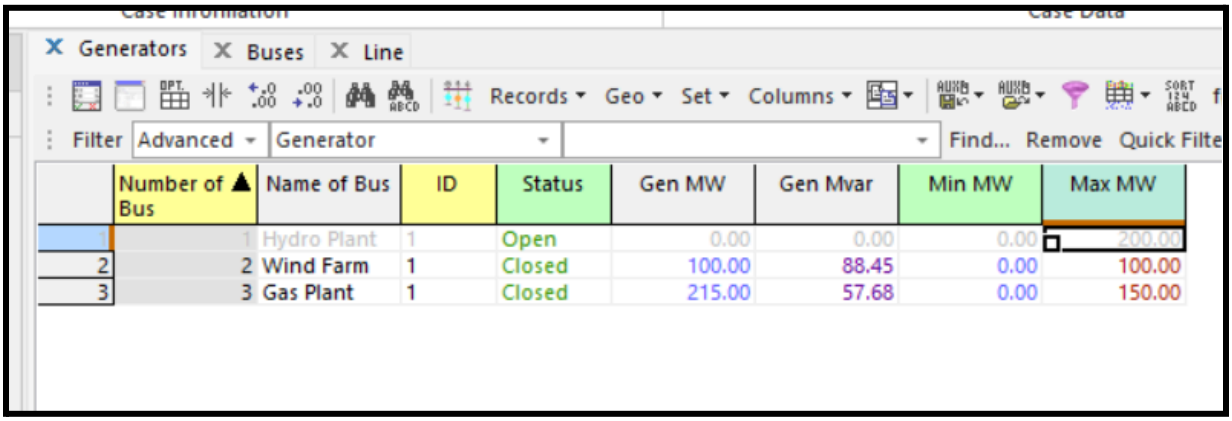


Bus Info Contingency 1 -



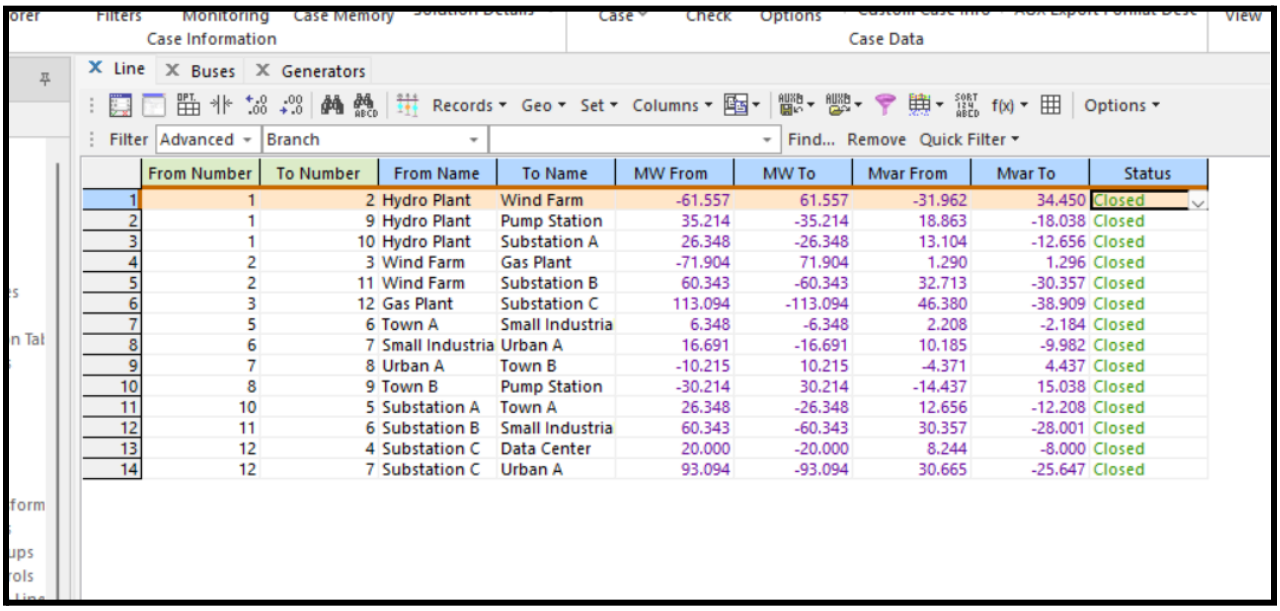
	Number	Name	Area Name	Type	Per Unit Voltage Magnitude and Angle (Degrees)
1	1	Hydro Plant	Generators	PQ	0.983, -13.6°
2	2	Wind Farm	Generators	PV	1.000, -11.8°
3	3	Gas Plant	Generators	Slack	1.000, -9.7°
4	4	Data Center	Loads	PQ	0.974, -13.7°
5	5	Town A	Loads	PQ	0.970, -15.2°
6	6	Small Industri	Loads	PQ	0.969, -15.4°
7	7	Urban A	Loads	PQ	0.964, -15.9°
8	8	Town B	Loads	PQ	0.966, -15.6°
9	9	Pump Station	Loads	PQ	0.974, -14.7°
10	10	Substation A	Transfer	PQ	0.977, -14.4°
11	11	Substation B	Transfer	PQ	0.984, -13.6°
12	12	Substation C	Transfer	PQ	0.978, -13.1°

Generator Info Contingency 1 -



	Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Min MW	Max MW
1	1	Hydro Plant	1	Open	0.00	0.00	0.00	200.00
2	2	Wind Farm	1	Closed	100.00	88.45	0.00	100.00
3	3	Gas Plant	1	Closed	215.00	57.68	0.00	150.00

Line Info Contingency 1 -



	From Number	To Number	From Name	To Name	MW From	MW To	Mvar From	Mvar To	Status
1	1	2	Hydro Plant	Wind Farm	-61.557	61.557	-31.962	34.450	Closed
2	1	9	Hydro Plant	Pump Station	35.214	-35.214	18.863	-18.038	Closed
3	1	10	Hydro Plant	Substation A	26.348	-26.348	13.104	-12.656	Closed
4	2	3	Wind Farm	Gas Plant	-71.904	71.904	1.290	1.296	Closed
5	2	11	Wind Farm	Substation B	60.343	-60.343	32.713	-30.357	Closed
6	3	12	Gas Plant	Substation C	113.094	-113.094	46.380	-38.909	Closed
7	5	6	Town A	Small Industria	6.348	-6.348	2.208	-2.184	Closed
8	6	7	Small Industria	Urban A	16.691	-16.691	10.185	-9.982	Closed
9	7	8	Urban A	Town B	-10.215	10.215	-4.371	4.437	Closed
10	8	9	Town B	Pump Station	-30.214	30.214	-14.437	15.038	Closed
11	10	5	Substation A	Town A	26.348	-26.348	12.656	-12.208	Closed
12	11	6	Substation B	Small Industria	60.343	-60.343	30.357	-28.001	Closed
13	12	4	Substation C	Data Center	20.000	-20.000	8.244	-8.000	Closed
14	12	7	Substation C	Urban A	93.094	-93.094	30.665	-25.647	Closed

Contingency 1 Results -

Cause:

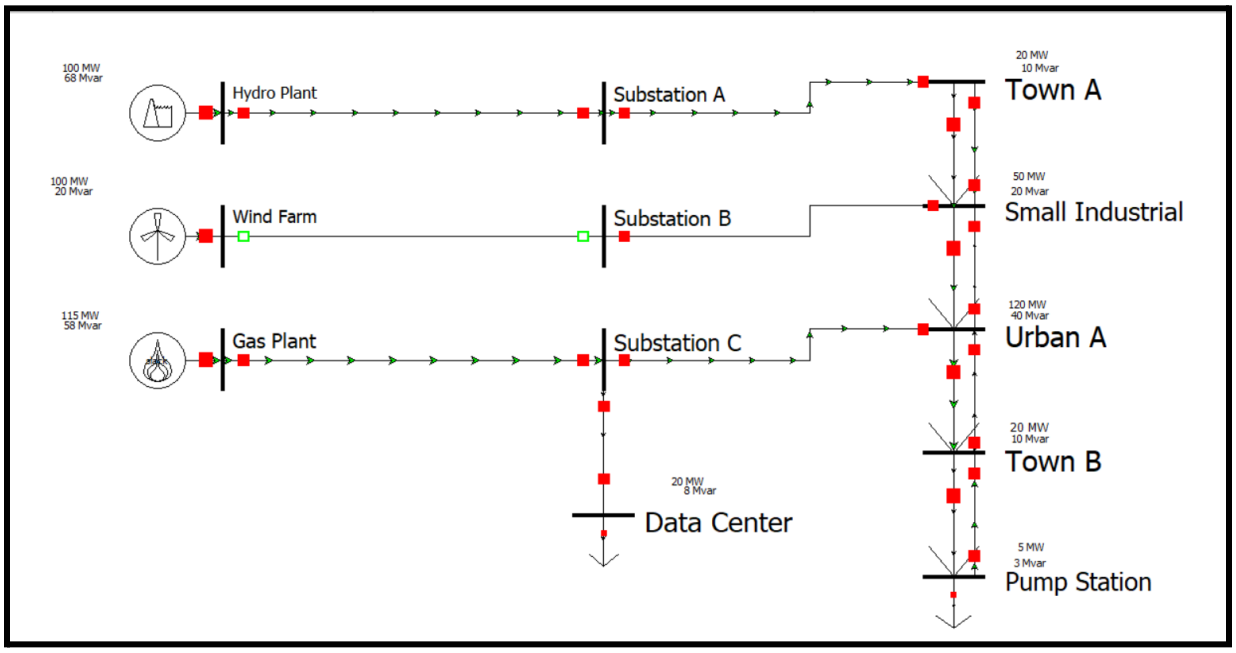
- Hydro Plant Disabled

Result:

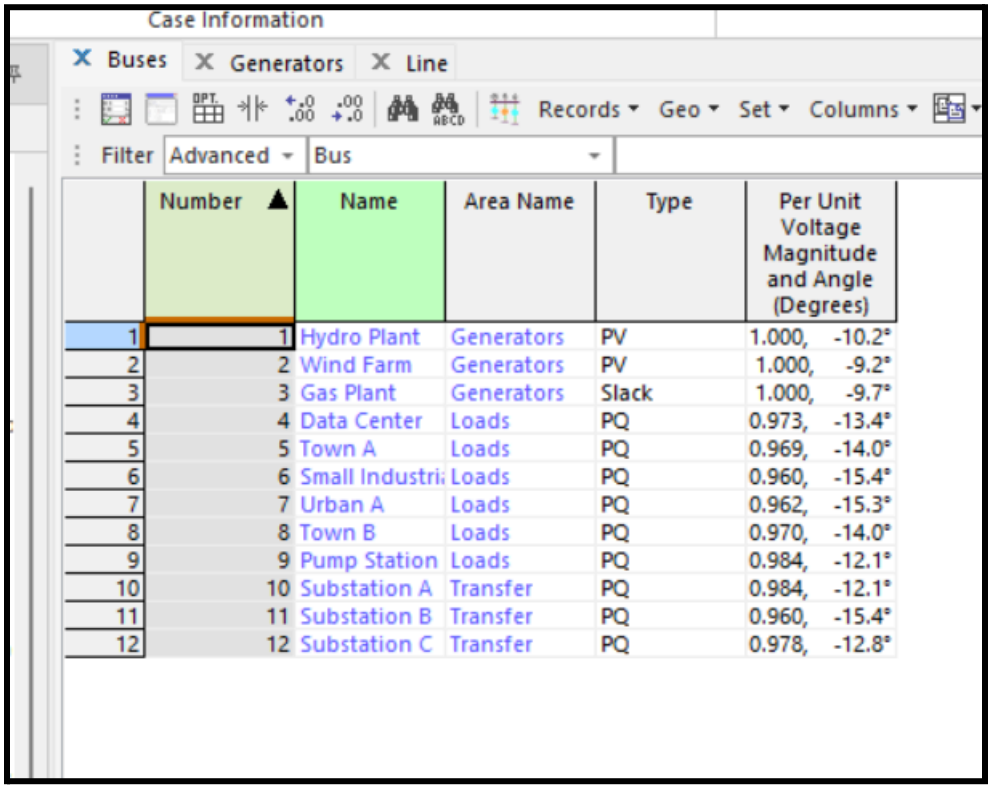
- The Gas Plant jumped from 115MW to 215MW since it was a slack bus. (Look at chart)
- The pu ranges for the loads and hydro plant decreased. The minimum pu range is 0.964pu for the bus 7

Contingency 2 - Transmission Line Failure:

Diagram Contingency 2 -



Bus Info Contingency 2 -



Case Information

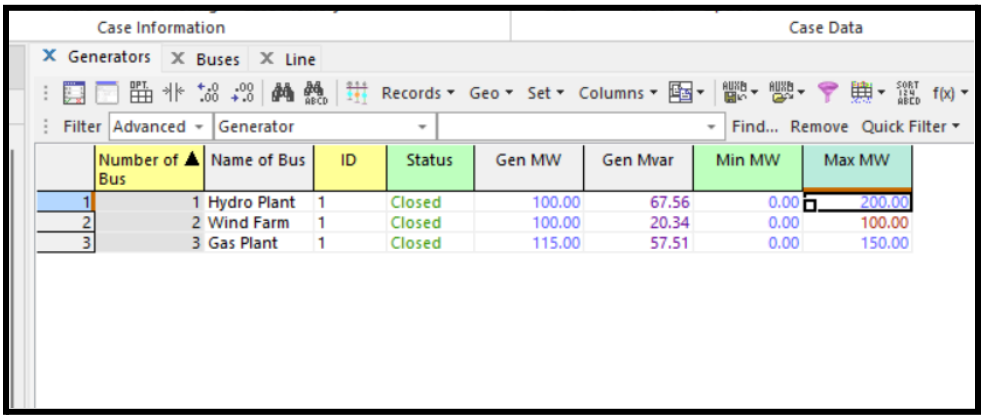
Buses | Generators | Line

Records | Geo | Set | Columns

Filter: Advanced | Bus

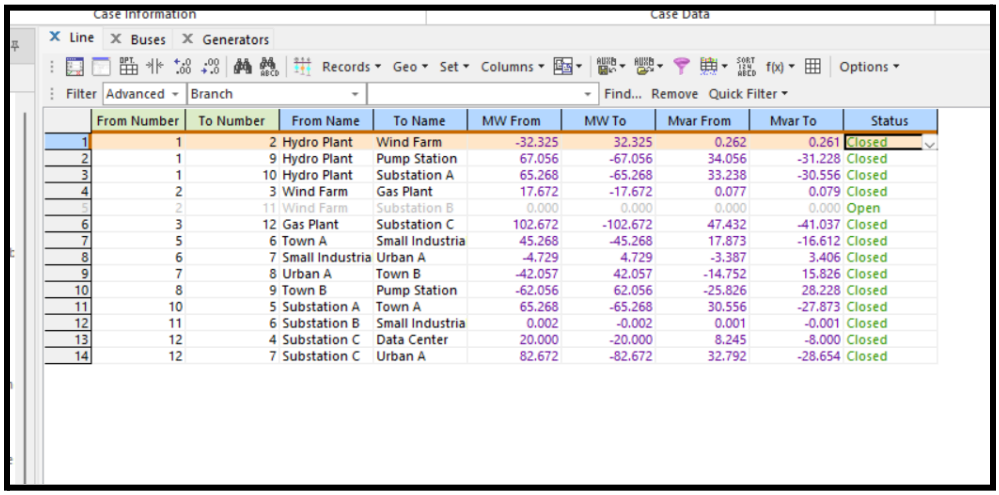
	Number	Name	Area Name	Type	Per Unit Voltage Magnitude and Angle (Degrees)
1	1	Hydro Plant	Generators	PV	1.000, -10.2°
2	2	Wind Farm	Generators	PV	1.000, -9.2°
3	3	Gas Plant	Generators	Slack	1.000, -9.7°
4	4	Data Center	Loads	PQ	0.973, -13.4°
5	5	Town A	Loads	PQ	0.969, -14.0°
6	6	Small Industri	Loads	PQ	0.960, -15.4°
7	7	Urban A	Loads	PQ	0.962, -15.3°
8	8	Town B	Loads	PQ	0.970, -14.0°
9	9	Pump Station	Loads	PQ	0.984, -12.1°
10	10	Substation A	Transfer	PQ	0.984, -12.1°
11	11	Substation B	Transfer	PQ	0.960, -15.4°
12	12	Substation C	Transfer	PQ	0.978, -12.8°

Generator Info Contingency 2 -



	Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Min MW	Max MW
1	1	Hydro Plant	1	Closed	100.00	67.56	0.00	200.00
2	2	Wind Farm	1	Closed	100.00	20.34	0.00	100.00
3	3	Gas Plant	1	Closed	115.00	57.51	0.00	150.00

Line Info Contingency 2 -



	From Number	To Number	From Name	To Name	MW From	MW To	Mvar From	Mvar To	Status
1	1	2	Hydro Plant	Wind Farm	-32.325	32.325	0.262	0.261	Closed
2	1	9	Hydro Plant	Pump Station	67.056	-67.056	34.056	-31.228	Closed
3	1	10	Hydro Plant	Substation A	65.268	-65.268	33.238	-30.556	Closed
4	2	3	Wind Farm	Gas Plant	17.672	-17.672	0.077	0.079	Closed
5	2	11	Wind Farm	Substation B	0.000	0.000	0.000	0.000	Open
6	3	12	Gas Plant	Substation C	102.672	-102.672	47.432	-41.037	Closed
7	5	6	Town A	Small Industria	45.268	-45.268	17.873	-16.612	Closed
8	6	7	Small Industria	Urban A	-4.729	4.729	-3.387	3.406	Closed
9	7	8	Urban A	Town B	-42.057	42.057	-14.752	15.826	Closed
10	8	9	Town B	Pump Station	-62.056	62.056	-25.826	28.228	Closed
11	10	5	Substation A	Town A	65.268	-65.268	30.556	-27.873	Closed
12	11	6	Substation B	Small Industria	0.002	-0.002	0.001	-0.001	Closed
13	12	4	Substation C	Data Center	20.000	-20.000	8.245	-8.000	Closed
14	12	7	Substation C	Urban A	82.672	-82.672	32.792	-28.654	Closed

Contingency 2 Result:

Cause:

- Substation B Disabled

Result:

- The slack bus maintains the same output even though the wind farm is not transferring power to the loads.
- The pu ranges for every load dropped. The minimum is 0.96pu for bus 6.

Contingency 1 and Contingency 2 Comparison:

- In contingency 1, buses 1, 4, 5, 6, and 7 were lower compared to their respective buses in contingency 2.
- Other than that, in contingency 1, every other bus was greater or equal to the buses in contingency 2.