

What is Power World?

Power World is a power system visualization, simulation, and analysis tool.

2. CREATING A NEW CASE

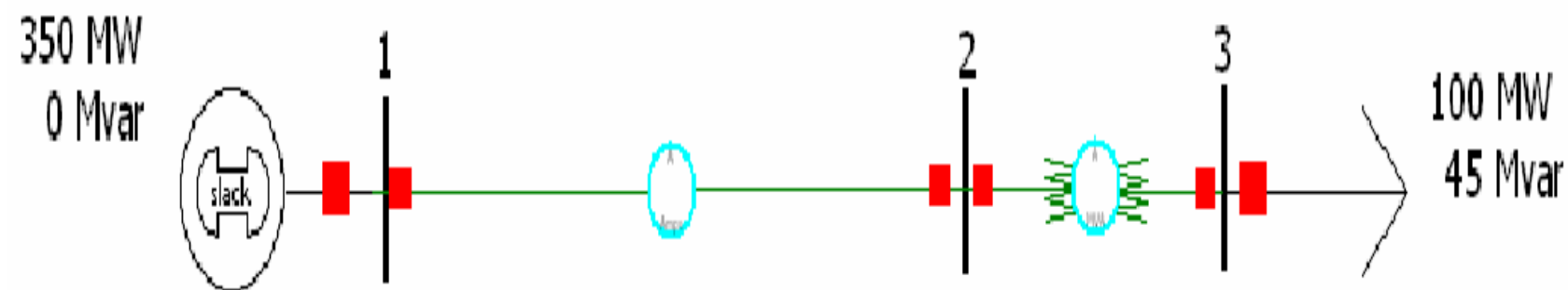
Generator: Rated voltage 66 kV
maximum active power generation:
350 MW, reactive power limits ± 90
MVar

Transmission line: $R = 0.01$ p.u., $X =$
 0.06 p.u, $B = 0.10$ p.u.

Transformer: 66/11 kV, $X = 0.05$ p.u.

Load: 100 MW, 45 MVar

ONE LINE DIAGRAM OF SAMPLE POWER SYSTEM



FROM THE FILE MENU SELECT NEW CASE

(a) Inserting a bus

From the Insert menu select Bus or click on the button in the “Insert” toolbar.

BUS OPTION

Bus Options



☒ Insert new bus in data model

Bus Number

1



Find By Number

Find ...

Bus Name

1

Find By Name

Nominal Voltage

138.00

kV

Labels ...

Area

Change

Number

1



Name

1

Zone

Change

1



1

Owner

Change

1



1

Substation

Change

Bus Information

Display

Attached Devices

Memo

Bus Voltage

Voltage (p.u.)

1.00



System Slack Bus

Angle (degrees)

0.00



OK

Save



Cancel

(B) INSERTING A GENERATOR

Generator Options ✖									
Bus Number	<input type="text" value="1"/>	<input type="button" value="Find By Number"/>	<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> Status <input type="radio"/> Open <input checked="" type="radio"/> Closed </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> Fuel Type Unknown </div> <div style="border: 1px solid #ccc; padding: 5px;"> Unit Type UN (Unknown) </div>						
Bus Name	<input type="text" value="1"/>	<input type="button" value="Find By Name"/>							
ID	<input type="text" value="1"/>	<input type="button" value="Find ..."/>							
Area Name	<input type="text" value="1"/>								
Labels ...	<input type="text"/>								
<input checked="" type="checkbox"/> Same Owner as Terminal Bus									
<div style="display: flex; justify-content: space-between; font-weight: bold; font-size: 0.9em;"> Display Information Power and Voltage Control Costs Fault Parameters Owner, Area, Zone, Sub Memo </div>									
Power Control									
MW Output	<input type="text" value=""/>	<input checked="" type="checkbox"/> Available for AGC	Part. Factor	<input type="text" value="10.00"/>					
Min. MW Output	<input type="text" value="0.000"/>	<input checked="" type="checkbox"/> Enforce MW Limits	MW Ramp Limit	<input type="text" value="20.0"/>					
Max. MW Output	<input type="text" value="1000.000"/>								
Voltage Control									
Mvar Output	<input type="text" value="0.000"/>	Regulated Bus Number		<input type="text" value="1"/>					
Min Mvars	<input type="text" value="-9900.000"/>	<input checked="" type="checkbox"/> Available for AVR	SetPoint Voltage	<input type="text" value="1.0000"/>					
Max Mvars	<input type="text" value="9900.000"/>	<input type="checkbox"/> Use Capability Curve	Remote Reg %	<input type="text" value="100.0"/>					
MW									
Min Mvar									
Max Mvar									
< >									
✔ OK Save ✖ Cancel ? Help									

(C) INSERTING A TRANSMISSION LINE

Transmission Line/Transformer Options

Number

1

Name

1

Area Name

1 (1)

Nominal kV

66.0

From Bus

1

To Bus

2

Circuit

1

Find By Numbers

Find By Names

Find ...

☒ From End Metered

☒ Default Owner (Same as From Bus)

Labels ...

Fault Info

Display

Owner, Area, Zone, Sub

Parameters

Memo

Series Capacitor

Status

☐ Open

☒ Closed

Length (mi)

0.00

Calculate Impedances >

Per Unit Impedance Parameters

Series Resistance (R)

0.00000

Series Reactance (X)

Shunt Charging (B)

0.0000

Shunt Conductance (G)

0.0000

☐ Has Line Shunts

Line Shunts

MVA Limits

Limit A

0.000

Limit B

0.000

Limit C

0.000

Limit D

0.000

Limit E

0.000

Limit F

0.000

Limit G

0.000

Limit H

0.000

Convert Line to Transformer

☒ OK

Save

☒ Cancel

? Help

(D) INSERTING A TRANSFORMER

Transmission Line/Transformer Options

From Bus

To Bus

Circuit

Number

Name

Area Name

Nominal kV

2

2

1 (1)

66.0

3

3

1 (1)

11.0

1

Find By Numbers

Find By Names

Find ...

☒ From End Metered

☒ Default Owner (Same as From Bus)

Labels ...

Fault Info

Owner, Area, Zone, Sub

Memo

Display

Parameters

Transformer Control

Series Capacitor

Status

☐ Open

☒ Closed

Length (mi)

0.00

Calculate Impedances >

Per Unit Impedance Parameters

Series Resistance (R)

0.00000

Series Reactance (X)

Shunt Charging (B)

0.0000

Shunt Conductance (G)

0.0000

Magnetizing Conductance

0.000000

Magnetizing Susceptance

0.000000

☐ Has Line Shunts

Line Shunts

MVA Limits

Limit A

0.000

Limit B

0.000

Limit C

0.000

Limit D

0.000

Limit E

0.000

Limit F

0.000

Limit G

0.000

Limit H

0.000

Convert Transformer to Line

☒ OK

Save

☒ Cancel

? Help

(E) INSERTING A LOAD

Load Options

Bus Number	<input type="text" value="3"/>	<input type="button" value="Find By Number"/>	Status <input type="radio"/> Open <input checked="" type="radio"/> Closed												
Bus Name	<input type="text" value="3"/>	<input type="button" value="Find By Name"/>													
ID	<input type="text" value="1"/>	<input type="button" value="Find ..."/>													
<input type="button" value="Labels ..."/>															
Area	<input type="button" value="Change"/>	<table border="1"><thead><tr><th>Number</th><th>Name</th></tr></thead><tbody><tr><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td></tr><tr><td></td><td></td></tr><tr><td>1</td><td>1</td></tr></tbody></table>	Number	Name	1	1	1	1			1	1			
Number	Name														
1	1														
1	1														
1	1														
Zone	<input type="button" value="Change"/>														
Substation															
Owner	<input type="button" value="Change"/>														
<input checked="" type="checkbox"/> Same Owner as Terminal Bus															
Load Information OPF Load Dispatch Memo															
<table border="1"><thead><tr><th></th><th>Constant Power</th><th>Constant Current</th><th>Constant Impedance</th></tr></thead><tbody><tr><td>MW Value</td><td><input type="text"/></td><td><input type="text" value="0.000"/></td><td><input type="text" value="0.000"/></td></tr><tr><td>Mvar Value</td><td><input type="text" value="0.000"/></td><td><input type="text" value="0.000"/></td><td><input type="text" value="0.000"/></td></tr></tbody></table>					Constant Power	Constant Current	Constant Impedance	MW Value	<input type="text"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	Mvar Value	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>
	Constant Power	Constant Current	Constant Impedance												
MW Value	<input type="text"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>												
Mvar Value	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>												
Display Information															
Display Size <input type="text" value="10.00"/>		Orientation <input type="radio"/> Right <input type="radio"/> Left <input type="radio"/> Up <input checked="" type="radio"/> Down													
<input checked="" type="checkbox"/> Scale Width with Size		<input checked="" type="checkbox"/> Anchored													
Display Width <input type="text" value="3.75"/>		<input type="button" value="Link To New Load"/>													
Pixel Thickness <input type="text" value="1"/>															
<table border="1"><tr><td><input checked="" type="checkbox"/> OK</td><td><input type="button" value="Save"/></td><td><input checked="" type="checkbox"/> Cancel</td><td><input type="button" value="Help"/></td></tr></table>				<input checked="" type="checkbox"/> OK	<input type="button" value="Save"/>	<input checked="" type="checkbox"/> Cancel	<input type="button" value="Help"/>								
<input checked="" type="checkbox"/> OK	<input type="button" value="Save"/>	<input checked="" type="checkbox"/> Cancel	<input type="button" value="Help"/>												

(F) INSERTING A SHUNT COMPONENT

Switched Shunt Options

Bus Number: Find By Number

Bus Name: Find By Name

Shunt ID: Find ...

Labels ...

Status

☐ Open

☒ Closed

	Number	Name
Area	<input type="text" value="1"/>	<input type="text" value="1"/>
Zone	<input type="text" value="1"/>	<input type="text" value="1"/>
Substation	<input type="text"/>	<input type="text"/>

Display
Parameters
Control Parameters
Fault Parameters
Memo

Nominal Mvar:

Control Mode

☒ Fixed

☐ Discrete

☐ Continuous

☐ Bus Shunt (Fixed)

Control Regulation Settings

☒ Voltage

☐ Generator Mvar

Reg. Bus #:

High Value:

Low Value:

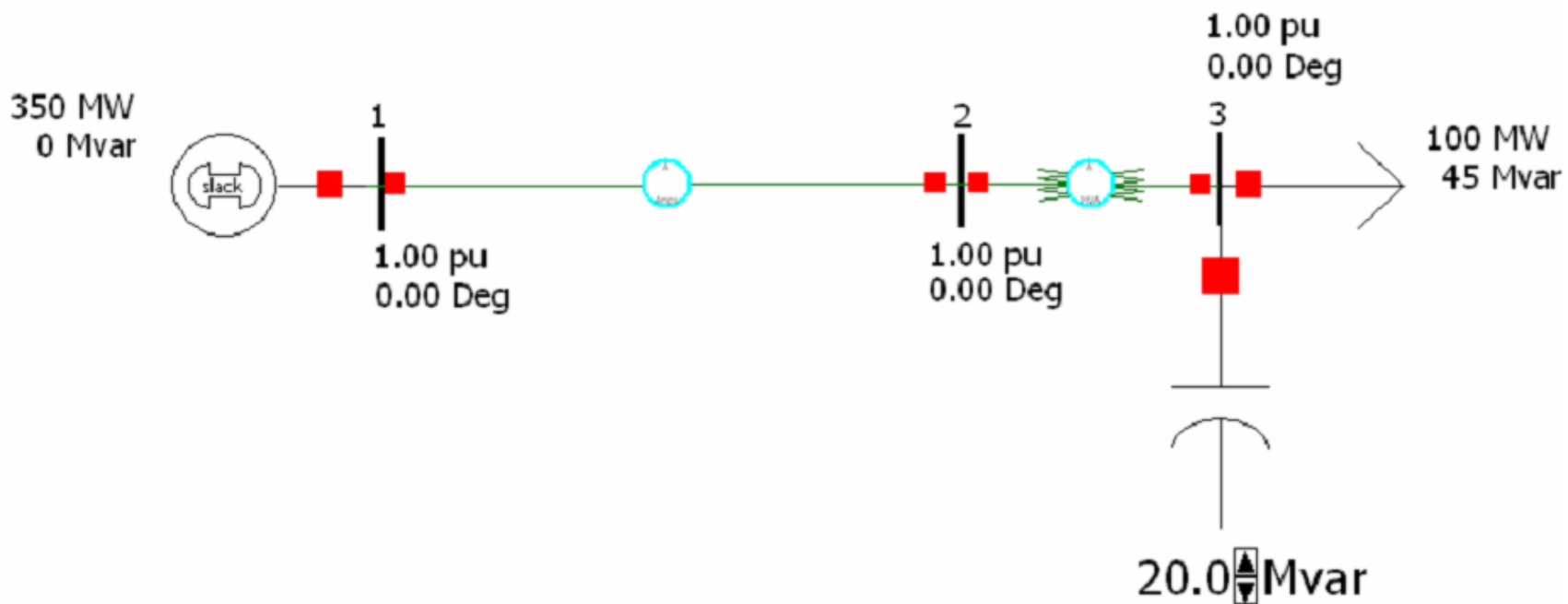
Target Value:

Switched Shunts Blocks

Number of Steps					
Mvars per Step					

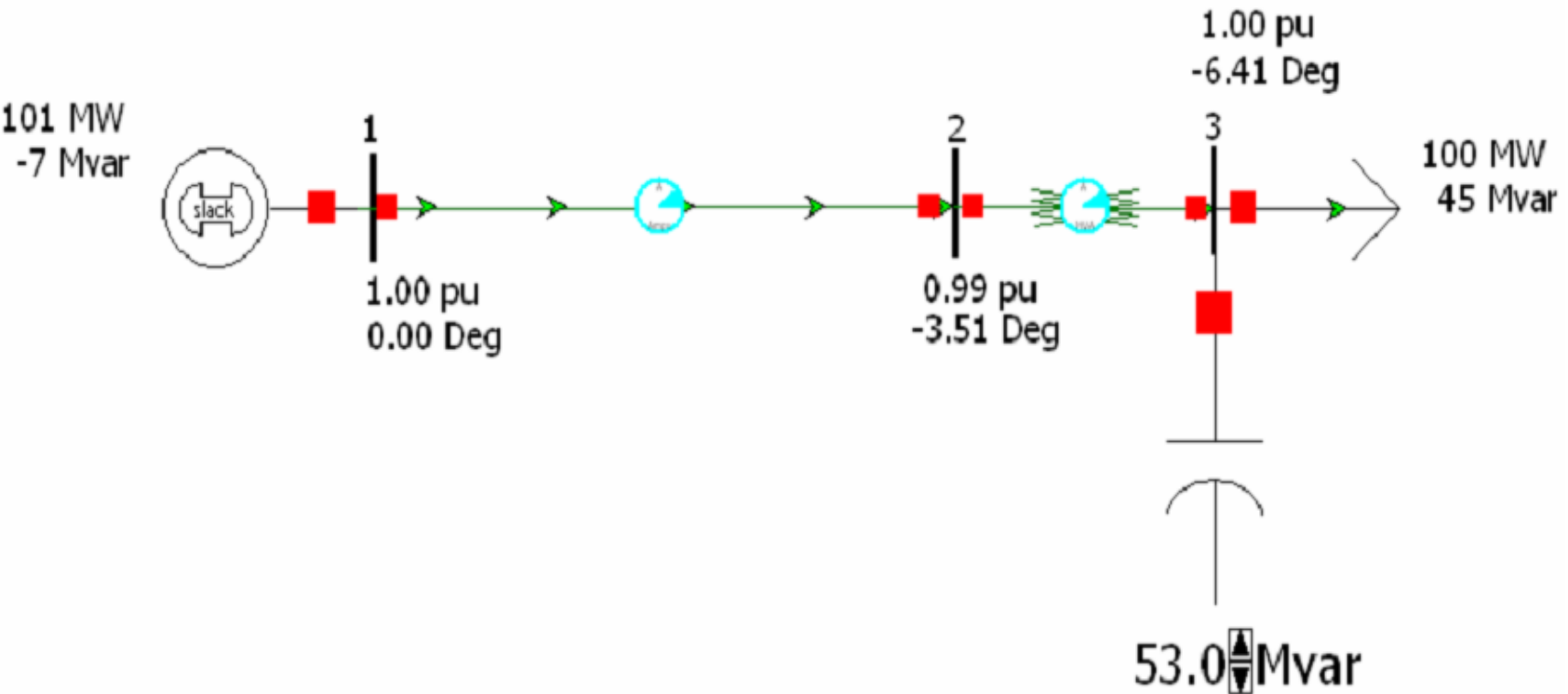
<
>

THE FINAL ONE LINE DIAGRAM SHOULD
LOOK LIKE THE DIAGRAM BELOW:



3-RUNNING A CASE

In order to simulate the case that we have designed, we select the Run Mode from the toolbar below the menu. Select Simulation - Solve and Animate.



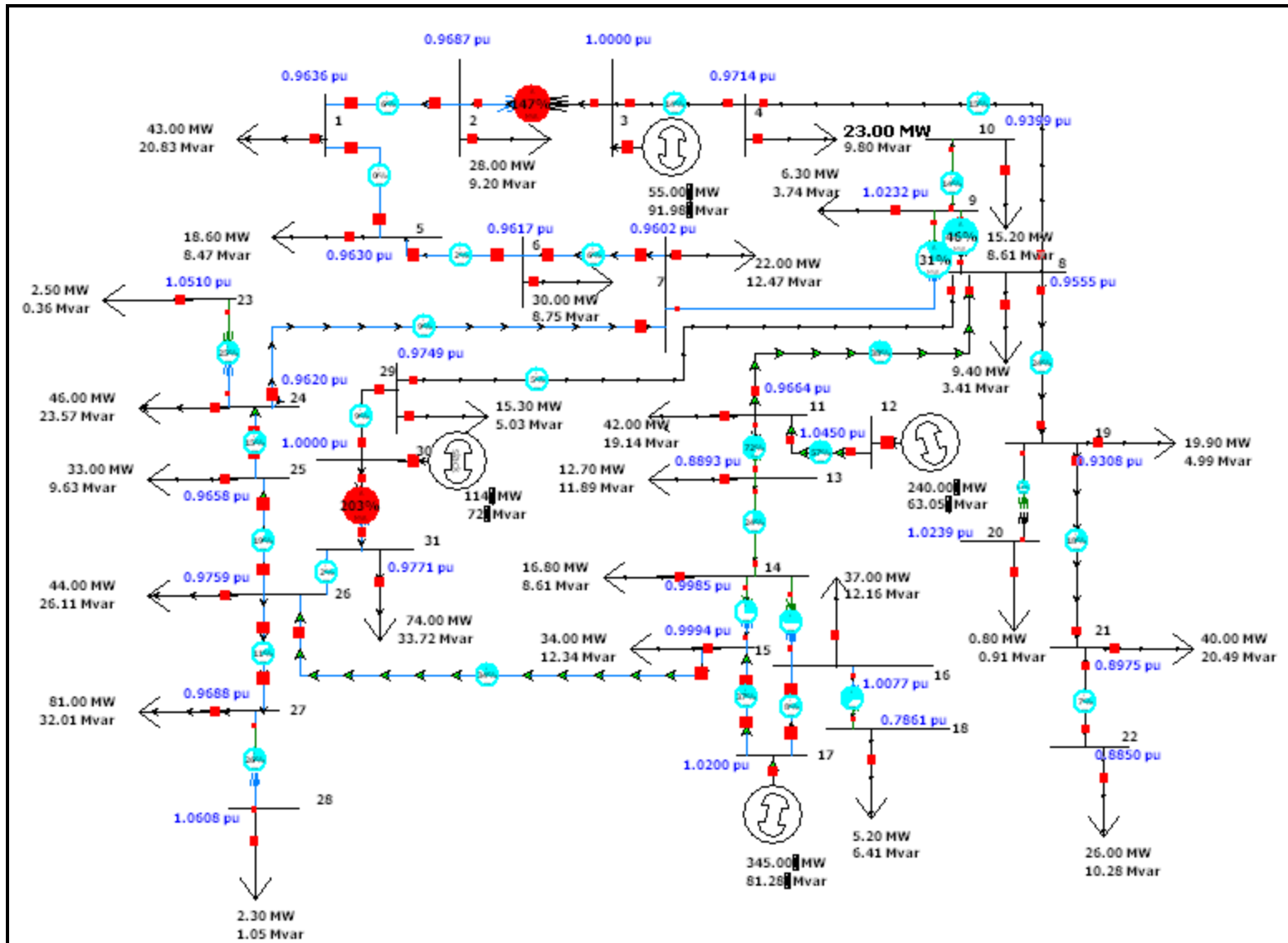
CALCULATED LINE PARAMETERS (PER UNIT SYSTEM)

NO	FROM	TO	KV Rating	Total MVA Rating	Tower Type	Length (km)	ZB (ohm)	B base	XL (pu)	Xc (pu)	R Line (pu)
1	13	14	69	120.707	69 Kv Single circuit Steel Tower	70	47.61	0.021004	0.60034	0.01332	0.103011
2	9	10	69			80	47.61	0.021004	0.60134	0.01543	0.117727
3	3	4	115	402.356	115 Kv Double circuit Steel Tower	35	132.25	0.007561	0.5555	0.036458	0.009271
4	4	8	115			25	132.25	0.007561	0.039457	0.026041	0.006622
5	11	12	115			65	132.25	0.007561	0.102589	0.067707	0.017218
6	19	21	115			50	132.25	0.007561	0.078915	0.052082	0.013244
7	21	22	115			55	132.25	0.007561	0.086806	0.057291	0.014569
8	8	11	115			60	132.25	0.007561	0.094698	0.062499	0.015893
9	8	19	115			30	132.25	0.007561	0.047349	0.031249	0.007947
10	8	29	115			55	132.25	0.007561	0.086806	0.057291	0.014569
11	29	30	115			65	132.25	0.007561	0.102589	0.067707	0.017218
12	1	2	230	804.71	230 Kv Double circuit Steel Tower	50	529	0.00189	0.021977	0.18619	0.003311
13	1	5	230			20	529	0.00189	0.008791	0.074476	0.001324
14	5	6	230			45	529	0.00189	0.01978	0.167571	0.00298
15	6	7	230			40	529	0.00189	0.017582	0.148952	0.002649
16	7	24	230			35	529	0.00189	0.015384	0.130333	0.002318
17	24	25	230			25	529	0.00189	0.010989	0.093095	0.001656
18	25	26	230			60	529	0.00189	0.026373	0.223429	0.003973
19	26	27	230			40	529	0.00189	0.017582	0.148952	0.002649
20	26	15	230			65	529	0.00189	0.028571	0.242048	0.004304
21	15	17	230			45	529	0.00189	0.01978	0.167571	0.00298
22	17	16	230			70	529	0.00189	0.030768	0.260667	0.004635
23	26	31	230			55	529	0.00189	0.024175	0.20481	0.003642

TRANSFORMER SELECTION

FROM BUS	TO BUS	FROM (KV)	TO (KV)	MVA RATING	X (pu)	X (pu new)
2	3	230	115	50	0.17	0.34
8	9	115	69	50	0.115	0.23
7	9	230	69	50	0.1525	0.305
19	20	115	69	10	0.115	1.15
16	18	230	69	15	0.1525	1.016666667
11	13	115	69	50	0.115	0.23
27	28	230	69	10	0.1525	1.525
23	24	69	230	10	0.1525	1.525
30	31	115	230	50	0.17	0.34
14	15	69	230	50	0.1525	0.305
14	16	69	230	50	0.1525	0.305

POWER FLOW SIMULATION



HIGH/LOW BUS VOLTAGES

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar
1	1	1	230	0.96364	221.637	-110.7	43	20.83
2	2	1	230	0.96869	222.798	-110.14	28	9.2
3	3	1	115	1	115	-94.45		
4	4	1	115	0.97138	111.709	-93.6	23	9.8
5	5	1	230	0.96302	221.495	-110.69	18.6	8.47
6	6	1	230	0.96166	221.182	-110.46	30	8.75
7	7	1	230	0.96025	220.857	-109.91	22	12.47
8	8	1	115	0.95553	109.886	-92.44	9.4	3.41
9	9	1	69	1.02322	70.602	-109.73	6.3	3.74
10	10	1	69	0.93992	64.854	-115.51	15.2	8.61
11	11	1	115	0.96639	111.135	-83.43	42	19.14
12	12	1	115	1.045	120.175	-69.99		
13	13	1	69	0.88925	61.358	-89.52	12.7	11.89
14	14	1	69	0.99845	68.893	-99.92	16.8	8.61
15	15	1	230	0.99936	229.853	-101.64	34	12.34
16	16	1	230	1.00767	231.764	-99.14	37	12.16
17	17	1	230	1.02	234.6	-98.43		
18	18	1	69	0.78615	54.244	-105.46	5.2	6.41
19	19	1	115	0.93078	107.039	-94.95	19.9	4.99
20	20	1	69	1.02394	70.652	-95.45	0.8	0.91
21	21	1	115	0.8975	103.212	-98.3	40	20.49
22	22	1	115	0.88501	101.776	-99.85	26	10.28
23	23	1	69	1.05098	72.517	-111.63	2.5	0.36
24	24	1	230	0.96201	221.262	-109.25	46	23.57
25	25	1	230	0.96581	222.136	-108.47	33	9.63
26	26	1	230	0.97593	224.464	-106.07	44	26.11
27	27	1	230	0.96879	222.822	-106.92	81	32.01
28	28	1	69	1.06083	73.198	-108.68	2.3	1.05
29	29	1	115	0.97493	112.117	-91.93	15.3	5.03
30	30	1	115	1	115	-90.42		
31	31	1	230	0.97708	224.729	-105.91	74	33.72

HIGH TRANSFORMER RATING

From Number	To Number	MW From	Mvar From	MVA From	Lim MVA	% of MVA Limit (Max)	MW Loss	Mvar Loss
1	2	-43.6	-24	49.8	805	6.2	0.08	-16.87
1	5	0.6	3.2	3.2	805	1.3	0	-6.91
2	3	-71.7	-16.3	73.5	50	163.2	0	22.63
3	4	-16.7	53	55.6	402	14.3	0.3	-1.73
4	8	-40	44.9	60.2	402	15.2	0.26	-0.86
5	6	-18	1.6	18.1	805	3.1	0.01	-15.43
6	7	-48	8.3	48.7	805	6.5	0.07	-13.27
7	9	-1.1	15.3	15.3	50	30.7	0	0.63
7	24	-69	-6.2	69.3	805	8.6	0.12	-11.24
9	8	-23	1.4	23	50	47.3	0	7.04
11	8	152.2	-5.4	152.3	402	37.9	3.94	17.73
8	19	88.5	35.5	95.3	402	23.7	0.8	1.98
29	8	12.9	16.9	21.3	402	6.3	0.08	-4.83
10	9	-15.2	-8.6	17.5	121	15.1	0.39	0.87
11	12	-230.2	-11.6	230.5	402	61.7	9.79	51.44
11	13	36	-2.2	36.1	50	73	0	3.87
13	14	23.3	-17.9	29.4	121	26.6	1.1	5.36
14	15	9.6	-7.9	12.4	50	25.5	0	0.5
14	16	-4.2	-24	24.4	50	52.8	0	2.1
15	17	-295.8	-60	301.8	805	37.8	2.69	0.79
26	15	-268.1	-41	271.2	805	34.1	3.28	-1.78
16	17	-46.4	-46.3	65.6	805	8.1	0.15	-25.81
16	18	5.2	8.1	9.6	15	64.1	0	1.68
19	20	0.8	0.9	1.2	10	12.2	0	0.02
19	21	67	27.6	72.4	402	18	0.82	0.54
21	22	26.1	6.5	26.9	402	7	0.14	-3.73
23	24	-2.5	-0.4	2.5	10	25.4	0	0.11
24	25	-117.6	-19	119.1	805	14.8	0.25	-6.98
25	26	-150.9	-21.6	152.4	805	18.9	0.97	-14.58
26	27	83.5	20.5	86	805	11.1	0.22	-12.65
31	26	11.3	-6.8	13.2	805	2.1	0.01	-19.5
27	28	2.3	1.1	2.6	10	25.7	0	0.09
29	30	-28.2	-22	35.7	402	8.9	0.21	-5.37
30	31	85.3	55.4	101.7	50	203.4	0	28.49

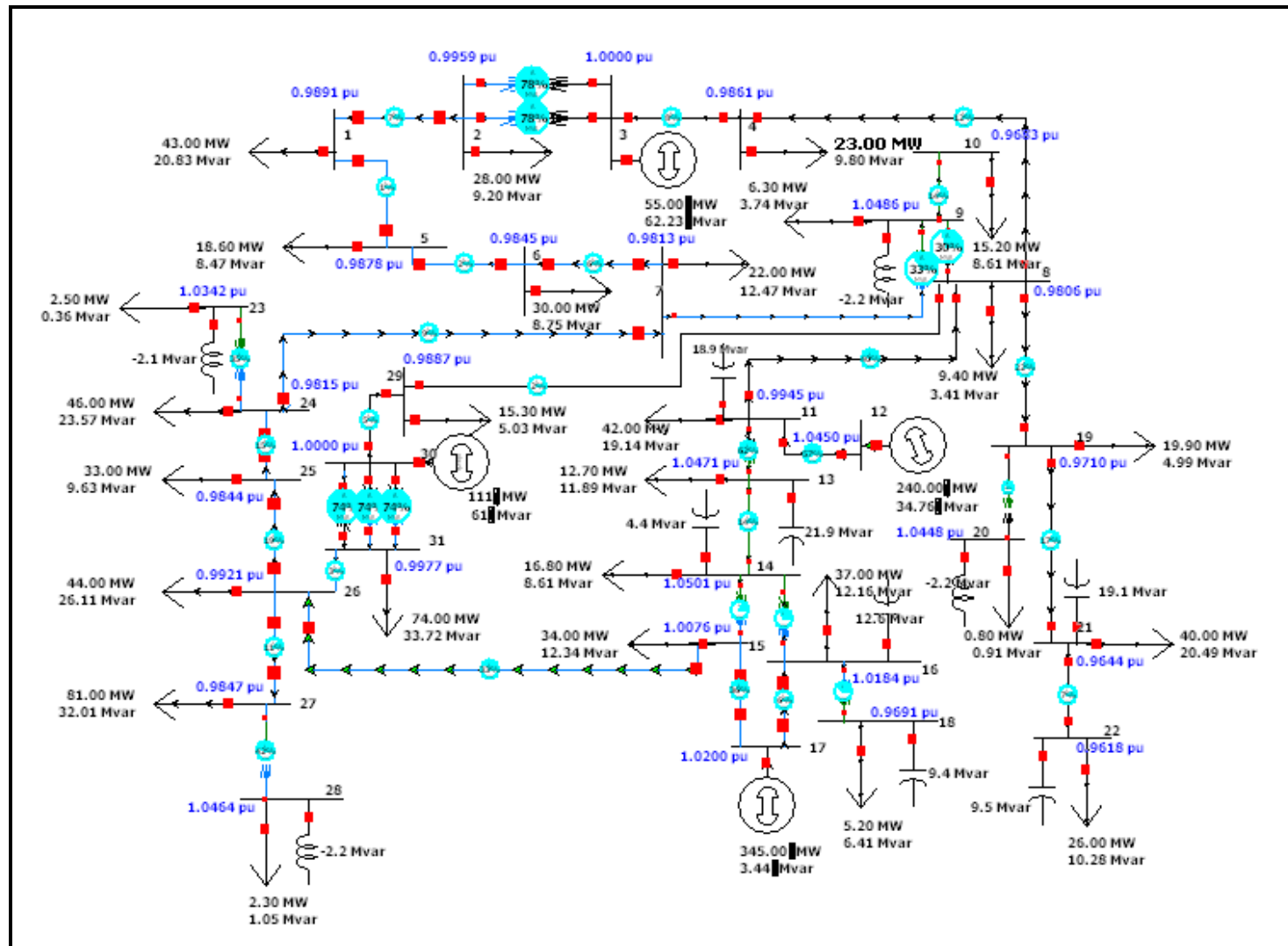
CORRECTION TO POWER FLOW

- ⦿ Installation of shunt capacitor - to increase the bus voltage
- ⦿ Installation of shunt reactor - to decrease the bus voltage
- ⦿ Addition of transformer to increase the total MVA rating

CORRECTION DETAILS

Compensation Made			
Bus	Nominal Voltage (kV)	Compensation Type	Value (MVAr)
9	69	Reactor	2.20
11	115	Capbank	18.90
13	69	Capbank	21.90
14	69	Capbank	4.40
16	230	Capbank	12.60
18	69	Capbank	9.40
20	69	Reactor	2.20
21	115	Capbank	19.10
22	115	Capbank	9.50
23	69	Reactor	2.10
26	230	Reactor	2.20
Bus	Nominal Voltage (kV)	Existing (MVA)	Correction (MVA)
2 - 3	115/230	1 x 50	2 x 50
30-31	115/230	1 x 50	3 x 50

POWER FLOW CORRECTION



BUS VOLTAGE AFTER CORRECTION

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar
1	1	1	230	0.98914	227.502	-101.25	43	20.83
2	2	1	230	0.99589	229.056	-100.7	28	9.2
3	3	1	115	1	115	-93.01		
4	4	1	115	0.98606	113.397	-92.23	23	9.8
5	5	1	230	0.98775	227.183	-101.26	18.6	8.47
6	6	1	230	0.98452	226.44	-101.05	30	8.75
7	7	1	230	0.98133	225.706	-100.54	22	12.47
8	8	1	115	0.98058	112.766	-91.14	9.4	3.41
9	9	1	69	1.04859	72.353	-101.62	6.3	3.74
10	10	1	69	0.96829	66.812	-107.1	15.2	8.61
11	11	1	115	0.99449	114.367	-82.23	42	19.14
12	12	1	115	1.045	120.175	-68.9		
13	13	1	69	1.04709	72.249	-85.84	12.7	11.89
14	14	1	69	1.05008	72.455	-91.23	16.8	8.61
15	15	1	230	1.00764	231.756	-92.34	34	12.34
16	16	1	230	1.01837	234.225	-89.97	37	12.16
17	17	1	230	1.02	234.6	-89.12		
18	18	1	69	0.96908	66.867	-95.04	5.2	6.41
19	19	1	115	0.97099	111.664	-93.62	19.9	4.99
20	20	1	69	1.0448	72.091	-94.09	0.8	0.91
21	21	1	115	0.96437	110.903	-96.85	40	20.49
22	22	1	115	0.96184	110.612	-98.26	26	10.28
23	23	1	69	1.03417	71.358	-102.21	2.5	0.36
24	24	1	230	0.98153	225.752	-99.85	46	23.57
25	25	1	230	0.98438	226.407	-99.05	33	9.63
26	26	1	230	0.99211	228.186	-96.64	44	26.11
27	27	1	230	0.98472	226.486	-97.45	81	32.01
28	28	1	69	1.0464	72.202	-99.21	2.3	1.05
29	29	1	115	0.98872	113.703	-91.23	15.3	5.03
30	30	1	115	1	115	-90.42		
31	31	1	230	0.99772	229.474	-96.37	74	33.72

LINE & TRANSFORMER RATING

From Number	To Number	Circuit	MW From	Mvar From	MVA From	Lim MVA	% of MVA	MW Loss	Mvar Loss
1	2	2	-46.6	-32.3	56.6	805	7	0.09	-17.73
1	5	2	3.6	11.4	12	805	2.4	0	-7.25
2	3	1	-37.3	-11.9	39.2	50	82.6	0	5.8
2	3	2	-37.3	-11.9	39.2	50	82.6	0	5.8
3	4	2	-19.7	26.9	33.3	402	8.9	0.11	-2.93
4	8	2	-42.8	20	47.2	402	12	0.16	-1.59
5	6	2	-15	10.2	18.2	805	3.8	0.02	-16.18
6	7	2	-45.1	17.7	48.4	805	6.8	0.07	-13.91
7	9	1	7.1	15	16.6	50	33.2	0	0.71
7	24	2	-74.2	4.1	74.3	805	9.4	0.14	-11.66
9	8	1	-14.8	-0.9	14.8	50	30.5	0	2.78
11	8	2	159.5	-2.8	159.5	402	39.7	4.09	18.27
8	19	2	88.1	5.4	88.2	402	22	0.65	0.87
29	8	2	-0.2	6.5	6.5	402	3	0.01	-5.48
10	9	1	-15.2	-8.6	17.5	121	15	0.37	0.65
11	12	2	-230.7	13.7	231.1	402	60.3	9.32	48.46
11	13	1	29.2	-11.1	31.2	50	64.1	0	2.15
13	14	1	16.5	-3.2	16.8	121	13.9	0.26	0.1
14	15	1	6.6	5.7	8.7	50	17.4	0	0.22
14	16	1	-7.2	-13.2	15	50	31.4	0	0.72
15	17	2	-293	-19.1	293.6	805	36.8	2.52	-0.46
26	15	2	-262.6	-16.5	263.1	805	33	3.01	-4.16
16	17	2	-49.4	-11.1	50.6	805	6.4	0.11	-26.35
16	18	1	5.2	-2.4	5.7	15	40	0	0.58
19	20	1	0.8	3.2	3.3	10	33	0	0.11
19	21	2	66.7	-3.6	66.8	402	16.6	0.63	-1.15
21	22	2	26.1	-3.9	26.4	402	6.6	0.11	-4.68
23	24	1	-2.5	-2.5	3.5	10	36.9	0	0.22
24	25	2	-122.8	-10.5	123.3	805	15.3	0.26	-7.27
25	26	2	-156.1	-12.9	156.6	805	19.5	1	-15.18
26	27	2	83.5	22.3	86.4	805	11.2	0.21	-13.15
31	26	2	22.1	9.6	24.1	805	4.6	0.03	-20.06
27	28	1	2.3	3.5	4.2	10	41.5	0	0.22
29	30	2	-15.1	-11.5	19	402	4.7	0.05	-6.38
30	31	1	32	18.7	37.1	50	74.1	0	4.22
30	31	2	32	18.7	37.1	50	74.1	0	4.22
30	31	3	32	18.7	37.1	50	74.1	0	4.22

CONCLUSION

- ◉ Power world software is able to simulate the unstable condition of the power flow for designed networks.
- ◉ The approach by adding shunt capacitor and shunt reactor, the low/high bus voltage can be maintained to nominal bus voltage hence the designed networks is stable.
- ◉ The fundamental concept of power system analysis and design give the better understanding of the concept by modeling the actual system.