

DATASETS: VOLTAGE CONTROL USING DEMAND-SIDE RESOURCES IN ACTIVE DISTRIBUTION NETWORKS

1. IEEE 13 NODE TEST FEEDER SINGLE LINE DIAGRAM

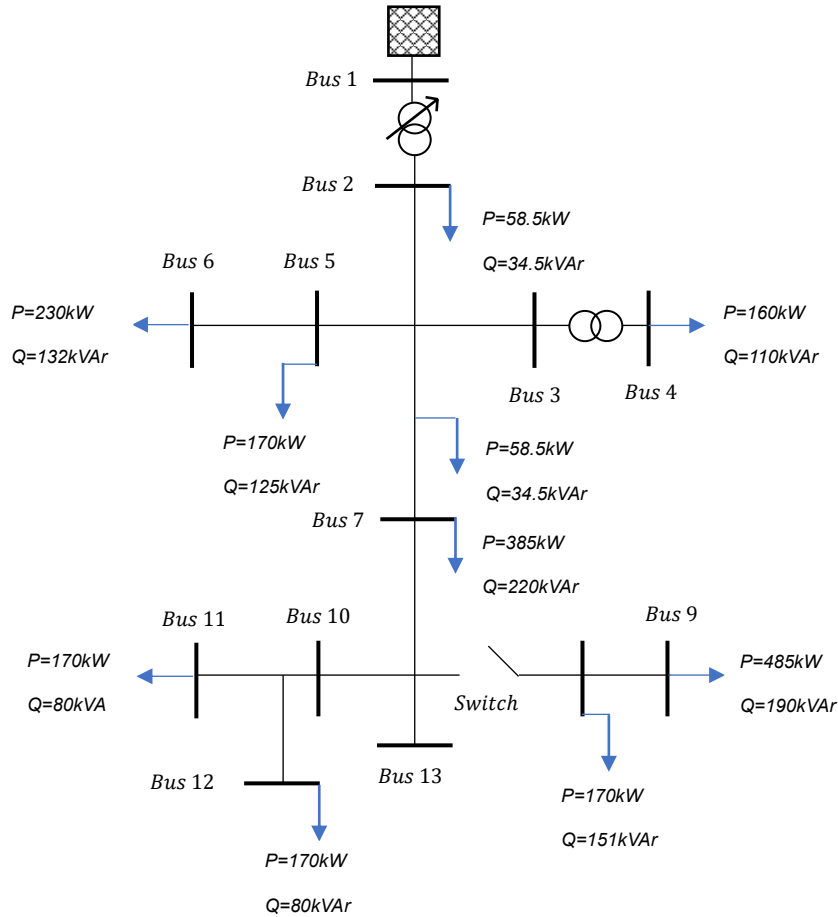


Figure 1. IEEE modified 13 Node Test Feeder

2. FEEDER DESCRIPTION

- Three-wire radial configuration.
- Three-phase $\Delta \rightarrow Y$ 115/4.16 kV OLTC transformer, which acts as the substation voltage regulating device and one $Y \rightarrow Y$ in-line 4.160/0.480 kV transformer.
- One spot load, four dynamic and 4 static loads, consisting of constant PQ, constant I and constant Z-type delta and star configuration. Dynamic loads are modelled as residential loads, which follows a typical residential load curve. The maximum load size is 485kW.
- All loads have been converted to balanced three phase loads.
- Two feeder and one substation shunt capacitor

3. FEEDER INPUT DATA

3.1 Distribution Line data

Table 1. Line Segment Data

Node A	Node B	Length(ft.)	Config.
632	645	500	603
632	633	500	602
633	634	0	XFM-1
645	646	300	603
650	632	2000	601
684	652	800	607
632	671	2000	601
671	684	300	604
671	680	1000	601
671	692	0	Switch
684	611	300	605
692	675	500	606

3.2 Substation voltage regulator

Table 2. OLTC transformer specification

Parameter	Value
S_{base}	5MVA
V_{prim}	115kV
V_{sec}	4.16kV
R_1	0.01pu
X_1	0.08pu
R_2	0.01pu
X_2	0.08pu
$V_{step/tap}$	0.0625pu
V_{ref}	1.05pu
$Tap_{min/max}$	-16, +16

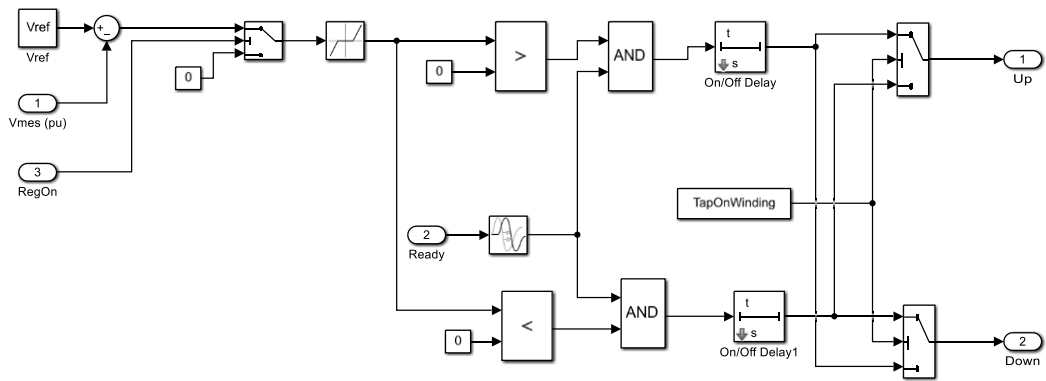


Figure 2. Voltage regulator block diagram

3.3 Solar PV data

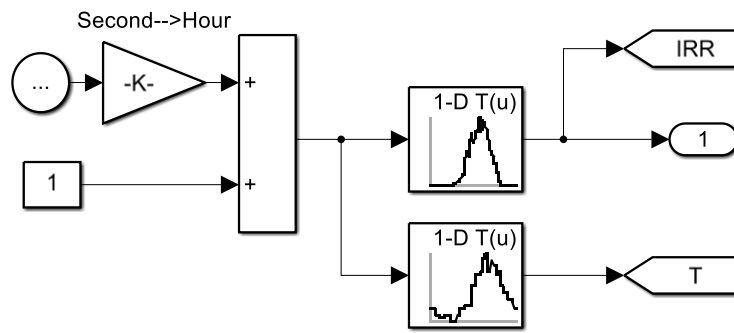


Figure 3. Irradiance & temperature input blocks

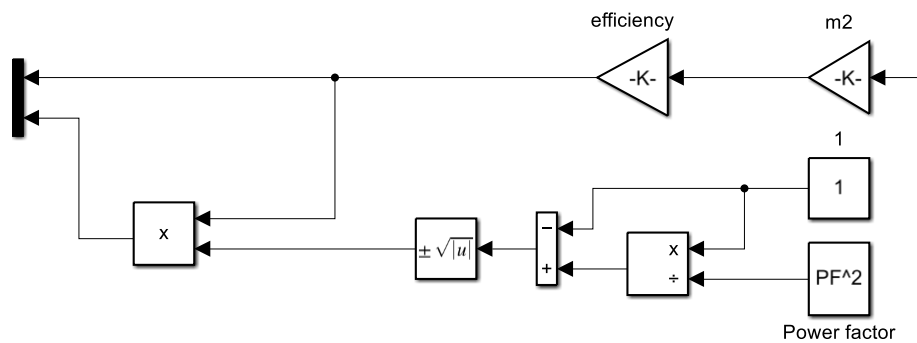


Figure 4. Simulink® power factor block diagram

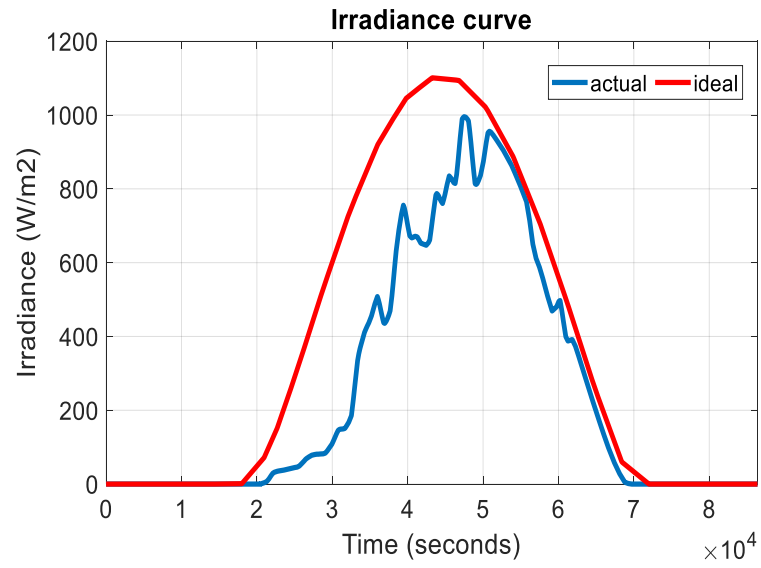


Figure 5. Solar irradiance curve (14 January 2014)

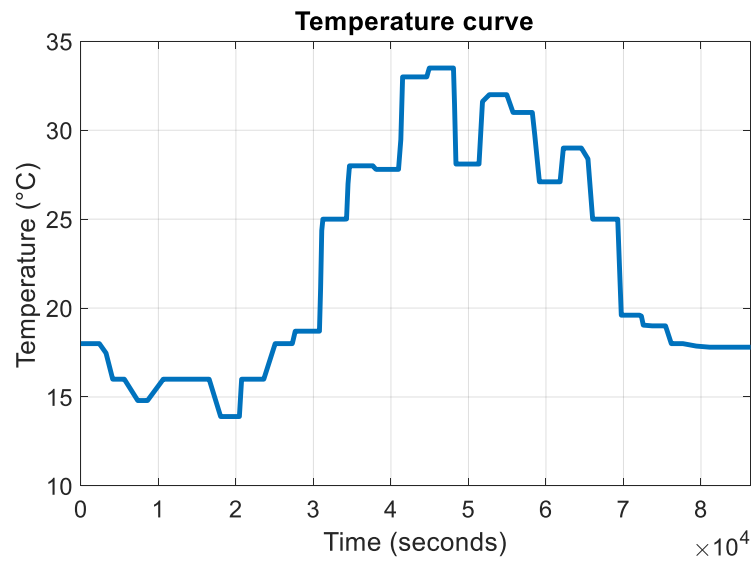


Figure 6. Temperature curve (14 January 2014)

Table 3. PV array input parameters

Parameter	Unit
Panel area	300m ²
System efficiency	15%
Power Factor	1.0
Peak Active Power	43kW
Peak Reactive Power	0kVAr

Table 4. Aggregated Rooftop PV array

Bus no	Load Size	Aggregated PV (kW)		
		25%	50%	75%
2	117	29.25	58.5	87.75
4	160	40	80	120
5	170	43	85	130
6	230	60	115	175
7	385	100	195	290
8	170	43	85	130
9	485	125	245	365
12	128	32	64	96
11	170	43	85	130

4. FEEDER OUTPUT DATA

4.1 Power & Power Factor profile

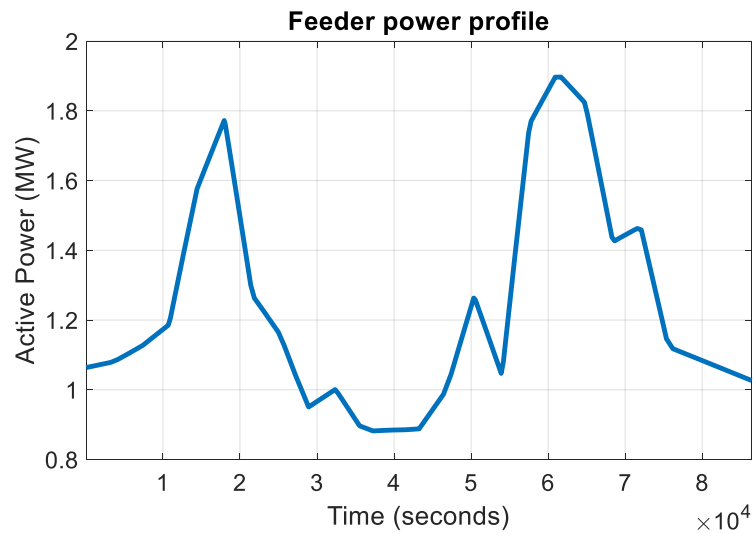


Figure 7. Feeder power profile

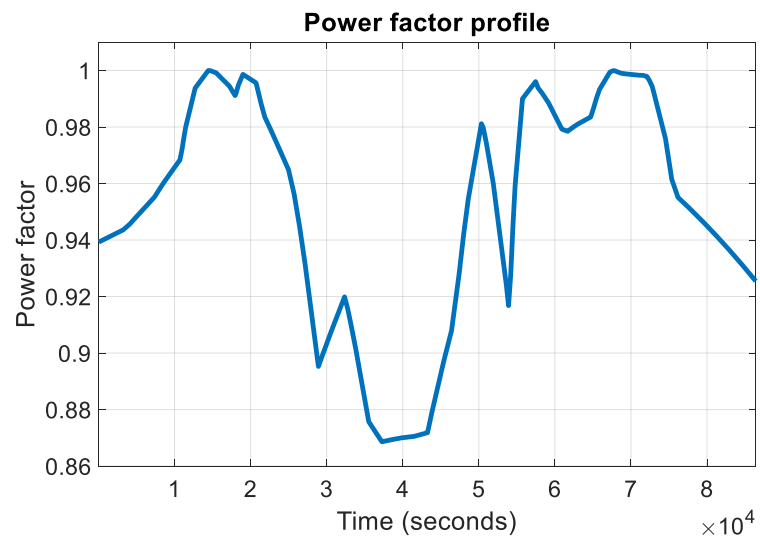


Figure 8. Power factor profile

4.2 Conventional control with Shunt Capacitor (SC)

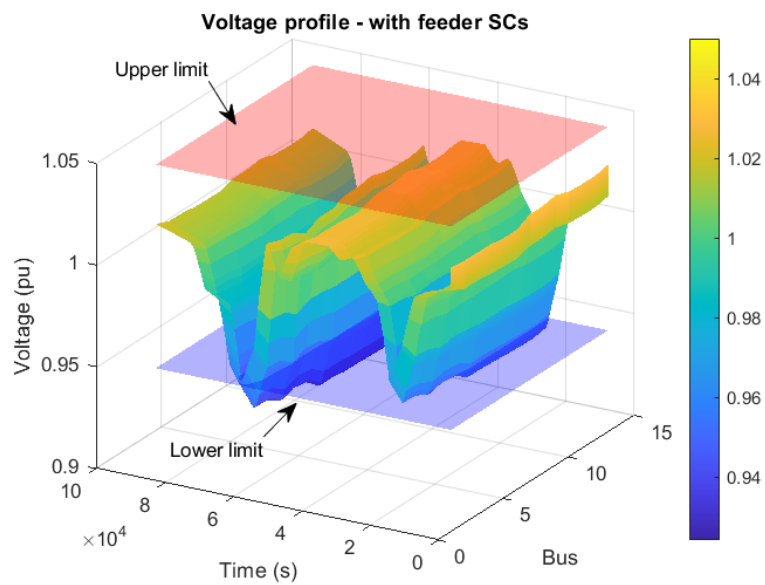


Figure 9. Voltage profiles with feeder SCs

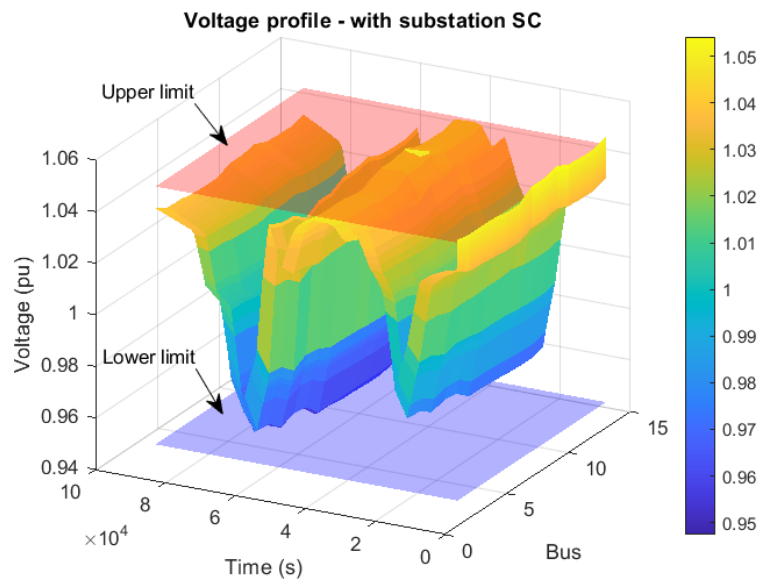


Figure 10. Voltage profile at substation bus

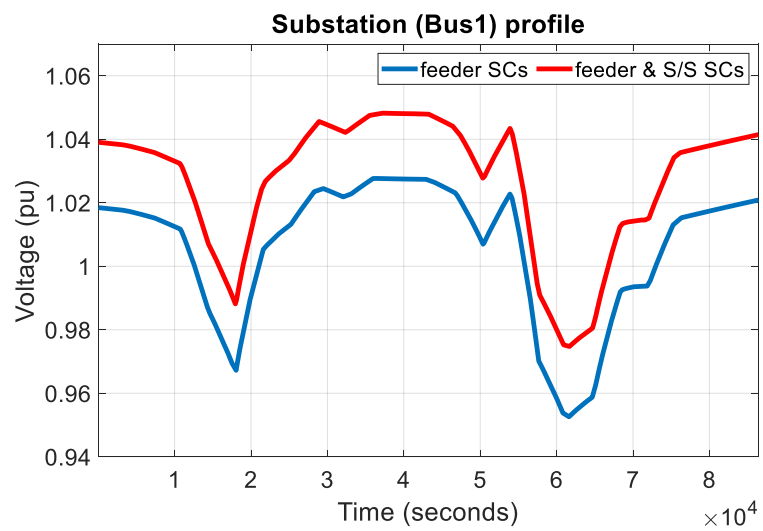


Figure 11. Substation profile after compensation

4.3 Conventional control with OLTC

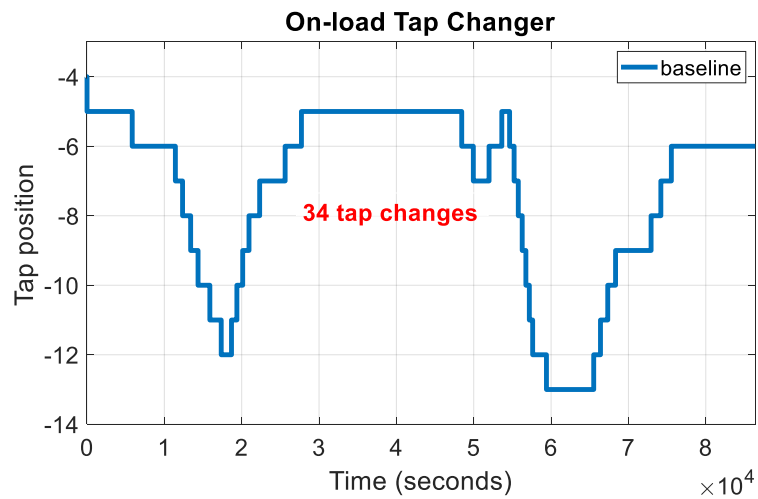


Figure 12. On-load tap changer profile

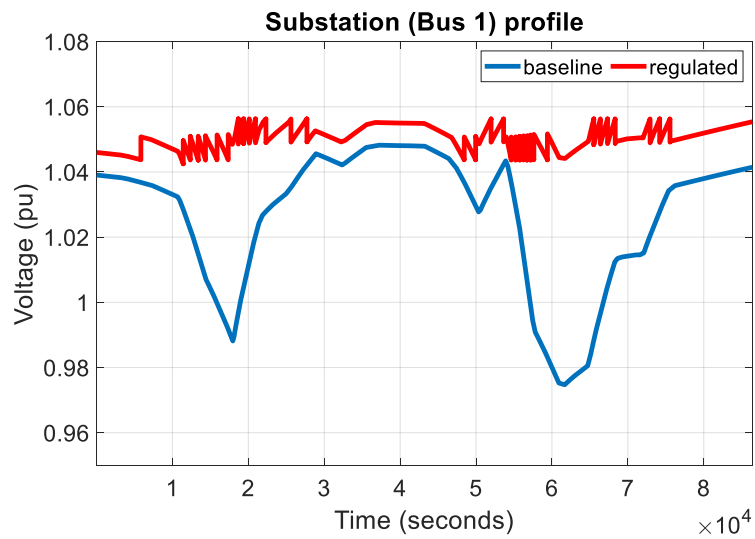


Figure 13. Regulated substation bus profile

4.4 Control with PV

4.4.1 Lagging Power Factor

Table 5. Voltage profile at substation with 25% PV penetration

Power factor	Baseline – no PV		25% PV		ΔV	
	Voltage (pu)				%	
	min	max	min	max	min	max
Unity	0.975	1.048	0.979	1.052	0.41	0.38
0.98	0.975	1.048	0.983	1.057	1.12	0.85
0.95	0.975	1.048	0.985	1.060	1.02	1.13

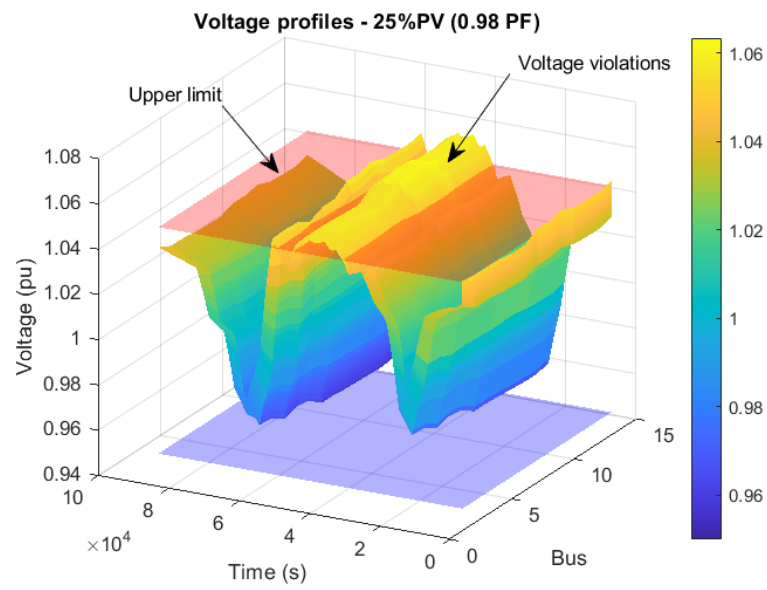


Figure 14. Voltage profiles with 25% PV (0.98 PF)

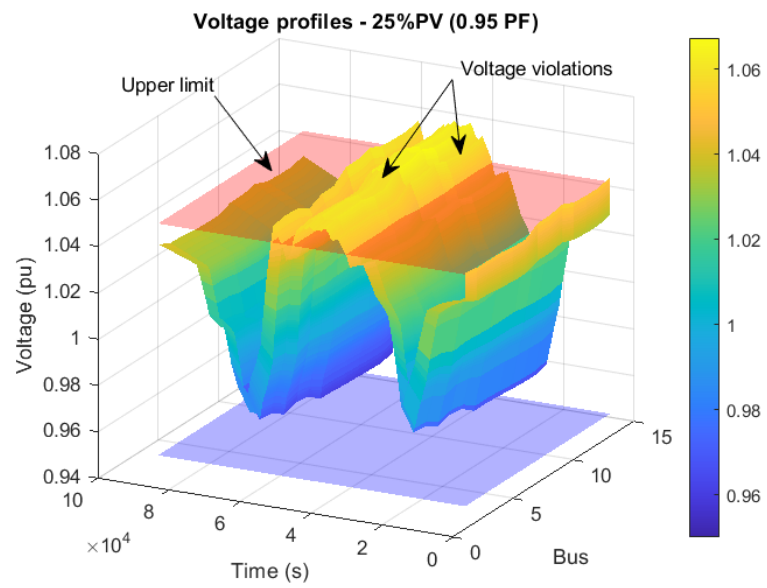


Figure 15. Voltage profiles with 25% PV (0.95 PF)

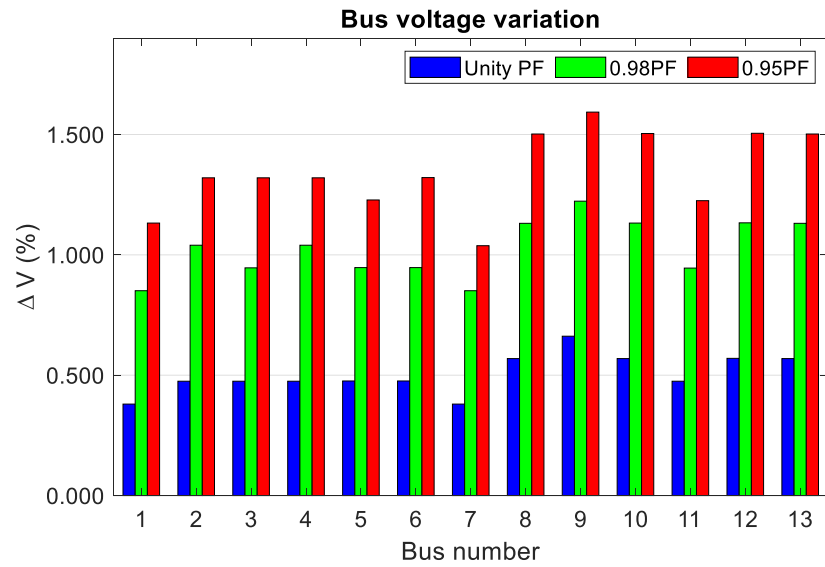


Figure 16. Bus voltage variations with 25% PV

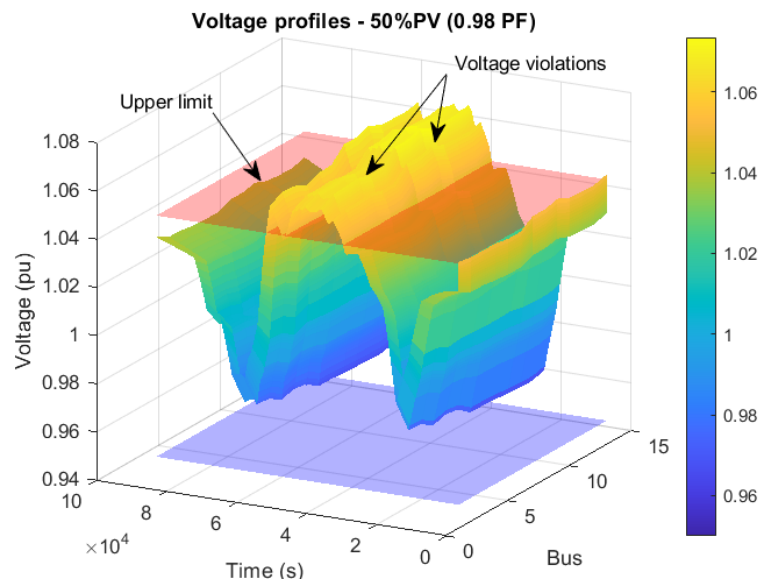


Figure 17. Voltage profiles with 50% PV (0.98 PF)

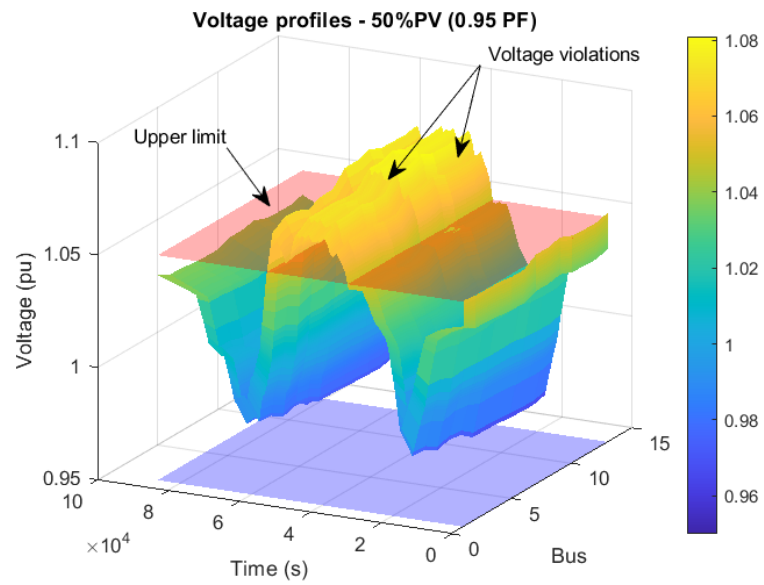


Figure 18. Voltage profiles with 50% PV (0.95 PF)

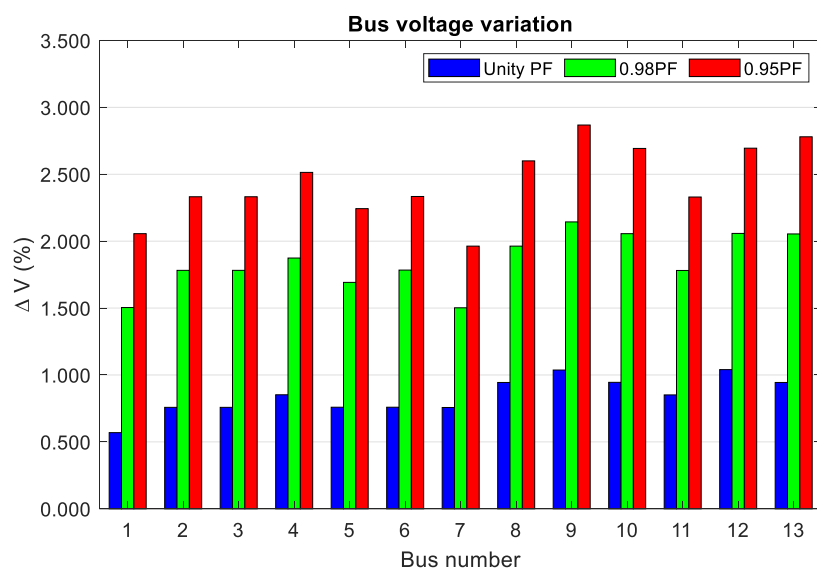


Figure 19. Bus voltage variations with 50% PV

4.4.2 Leading Power Factor

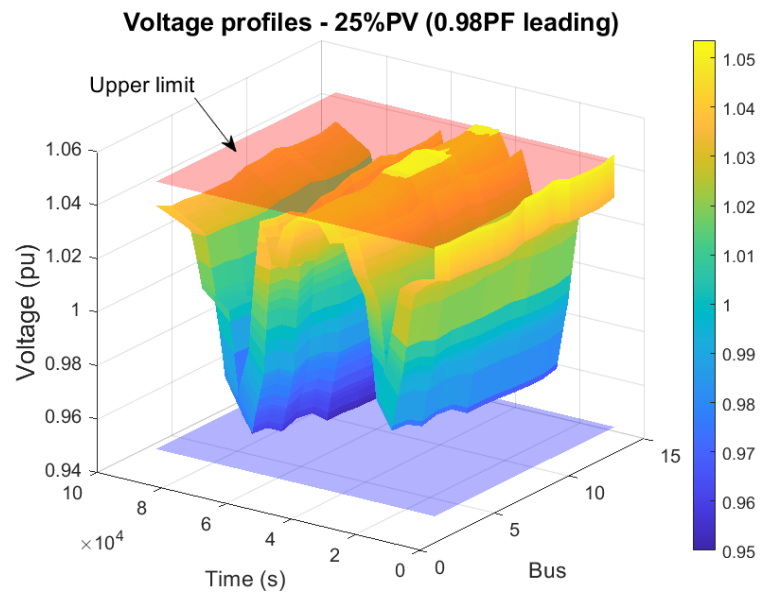


Figure 20. Voltage profiles with leading 0.98PF

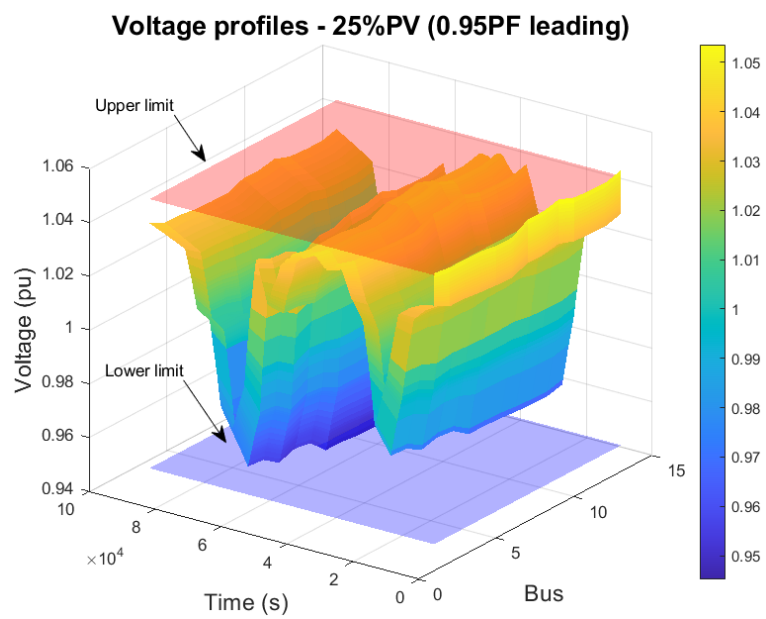


Figure 21. Voltage profiles with leading 0.95PF

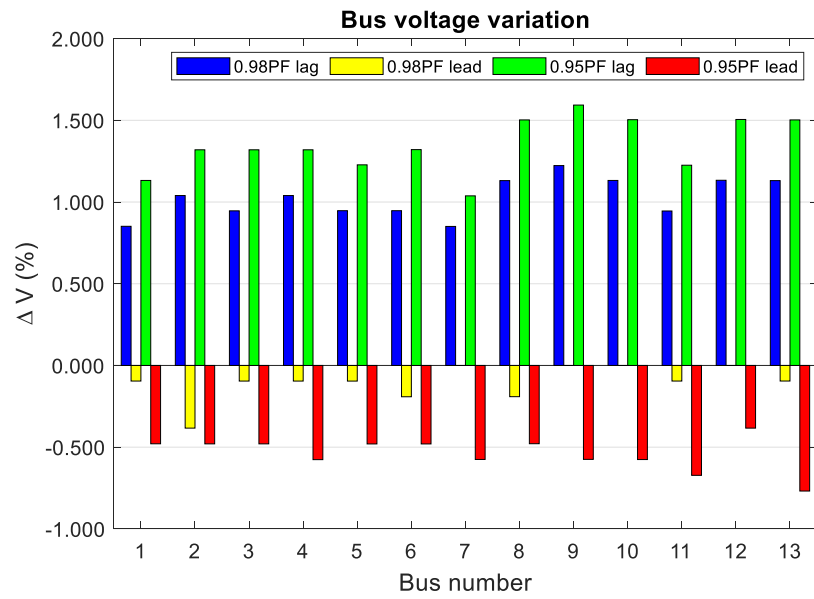


Figure 22. Voltage variation with 25% PV

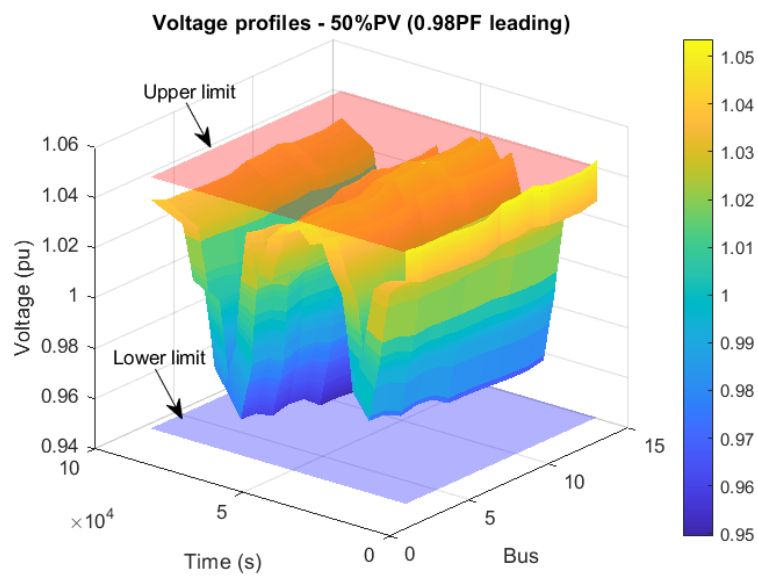


Figure 23. Voltage profile with 0.98 leading PF

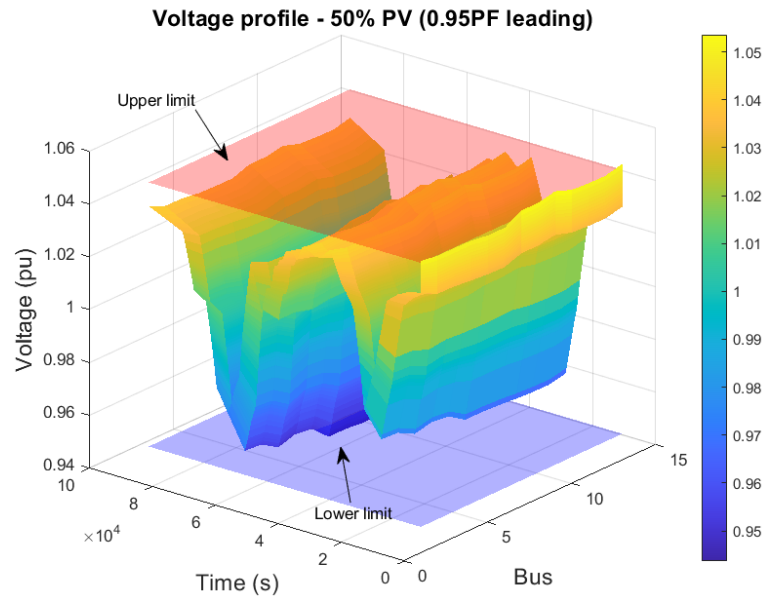


Figure 24. Voltage profile with 0.95 leading PF

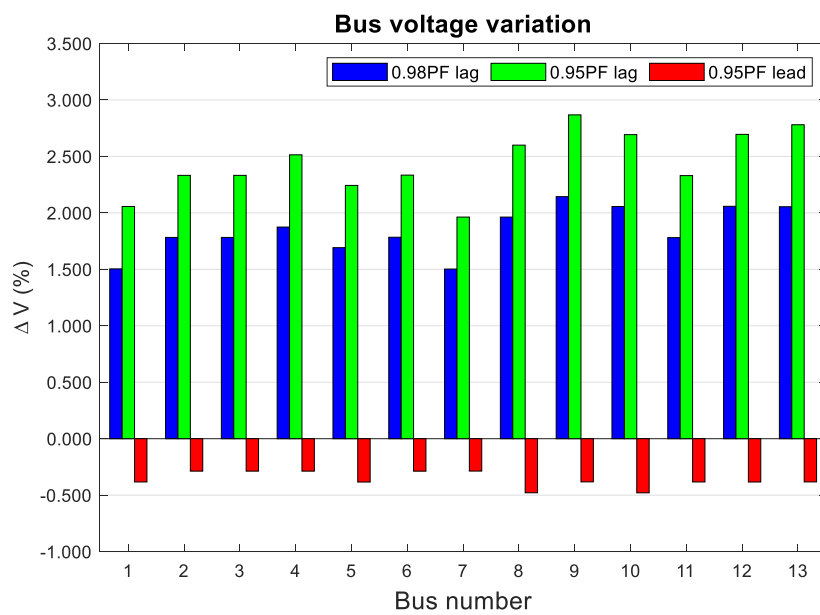


Figure 25. Voltage variation with 50% PV

4.4.3 Scheduled Power Factor

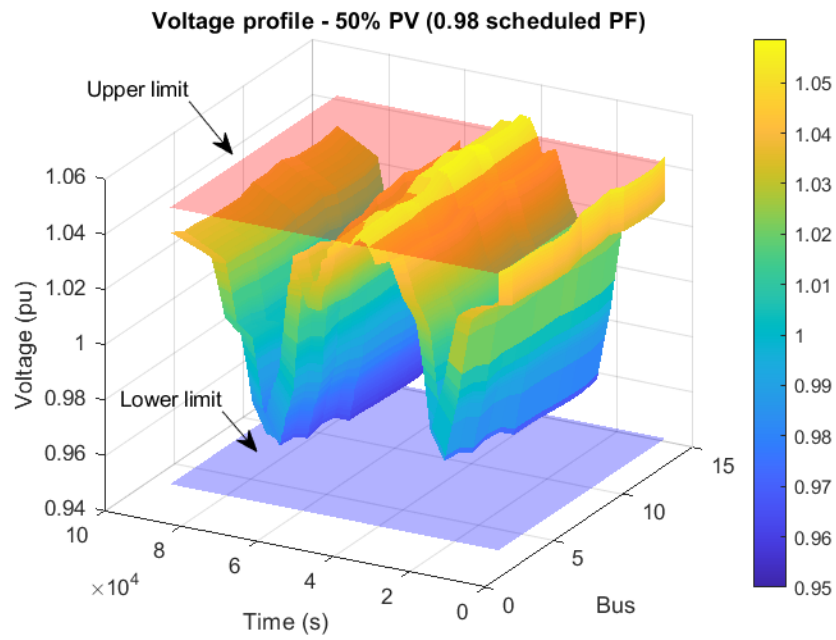


Figure 26. Voltage profile with 0.98 leading scheduled PF

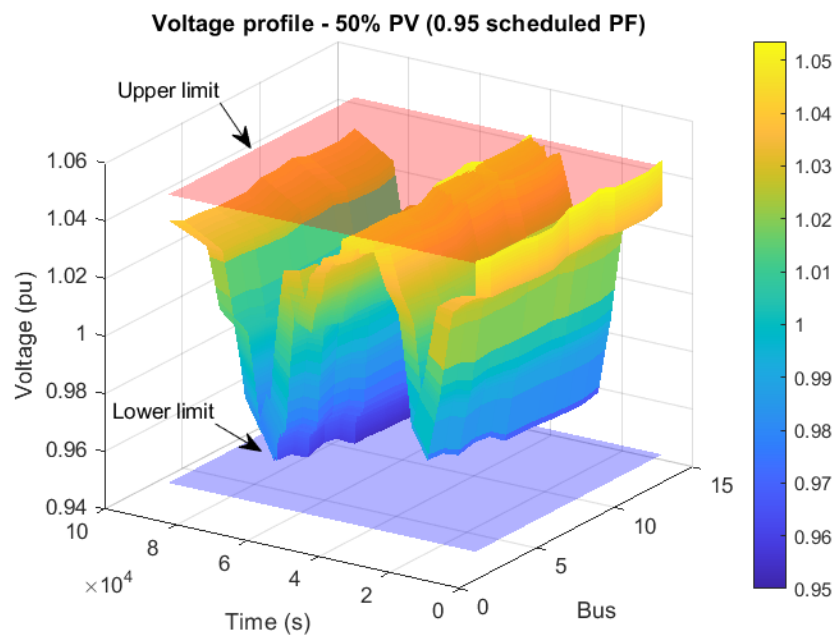


Figure 27. Voltage profile with 0.95 leading scheduled PF