ALTERNATIVE SOLUTIONS IN DISTRIBUTION NETWORK DUE TO INCREASING CONSUMPTION AND PEAK GENERATION

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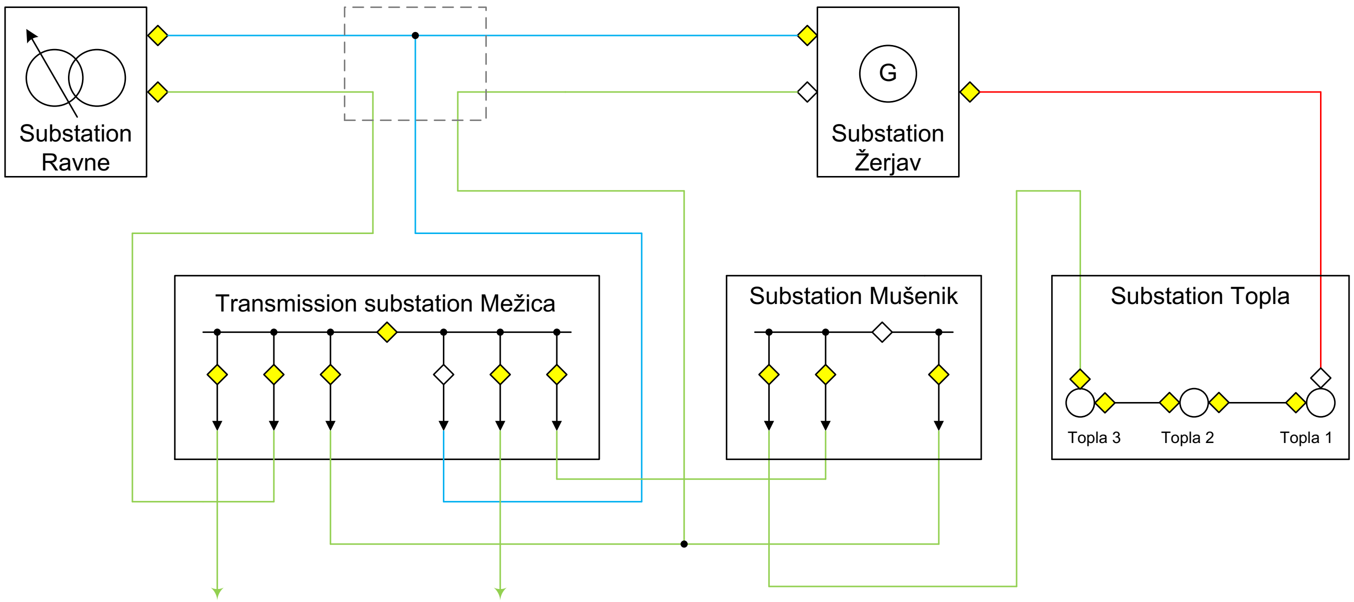
Introduction

- Real-life distribution network with distributed generation
- Problems with providing minimal allowed voltage – Operation near limit load
- A need to further increase installed power of two industrial consumers in network
- Additional problems with increased voltage in network during nightly hours at peak generation
- Long-term approach – new transmission line
- Short-term approaches are presented in this work

Distribution Network

- 20 kV distribution network
- 2 bigger industrial consumers
- over 2500 consumers connected to 53 20/0.4 kV transformers



Problems in Distribution Network

- Problems:
  - *distribution network already operating near the maximal allowed voltage drop*
  - *increase of installed power from 6.5 MW to 9 MW at Žerjav and from 6 to 6.5 MW at Topla*
  - *Increased voltage during peak generation of 3.6 MW at Žerjav*
- Approaches used:
  - *calculation of maximal acceptable power of industrial consumers at higher allowed voltage drop*
  - *operation in loop analysis*
  - *reconfigurations and reactive power generation*

Problems in Distribution Network

Calculation of Maximal Acceptable Power

- Maximal allowed voltage drop of ±3 %, ±5 % and ±8 %
- Worst-case scenario in network:
  - *no distributed generation*
  - *maximal point of yearly load profile*
- Reactive power generation impact:
  - *small hydropower plant in Žerjav*
  - *capacitor bank in Mežica*

Problems in Distribution Network

Calculation of Maximal Acceptable Power

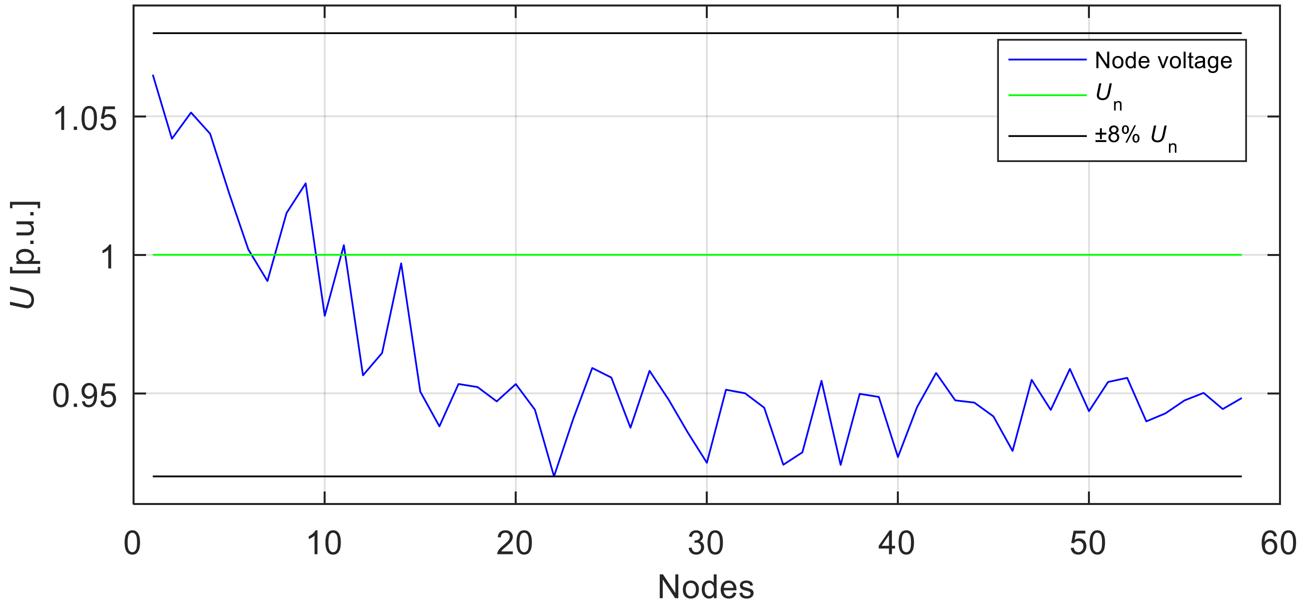
- Results:
  - *no distributed generation*

VOLTAGE ZONE	SWING VOLTAGE [KV]	POWER ŽERJAV [MVA]	POWER TOPLA [MVA]
±3%	20.6	/	/
±5%	21.0	7.46	3.56
±8%	21.3	10.57*	7.22

Problems in Distribution Network

Calculation of Maximal Acceptable Power

- Voltage profile



Problems in Distribution Network

Calculation of Maximal Acceptable Power

- Results:
  - *small hydropower plant*

VOLTAGE ZONE	SWING VOLTAGE [KV]	POWER ŽERJAV [MVA]			
		cosφ = 0.95	cosφ = 0.9	cosφ = 0.8	cosφ = 0.6
±3%	20.6	/	/	/	/
±5%	21.0	7.96	7.98	8.00	7.99
±8%	21.3	11.07*	11.06*	11.05*	10.99*

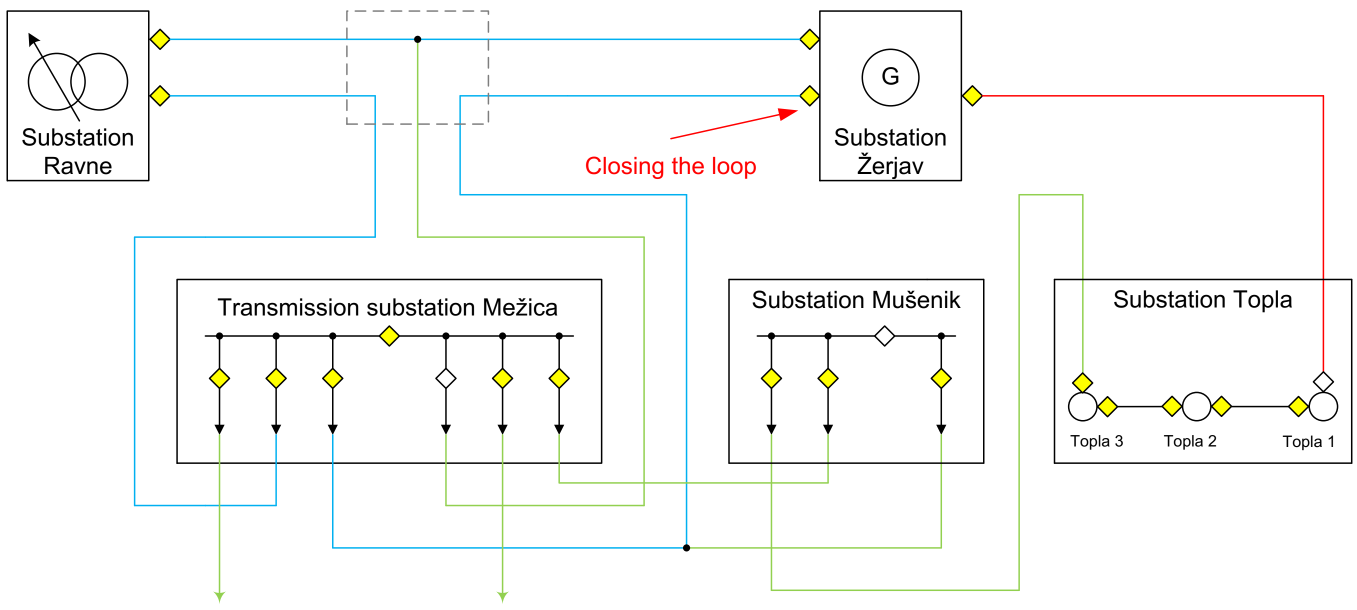
  - *Capacitor bank*

VOLTAGE ZONE	SWING VOLTAGE [KV]	POWER TOPLA [MVA]	
		Without capacitor bank	With capacitor bank
±3%	20,6	/	/
±5%	21	3.56	4.27
±8%	21.3	7.22	7.69

Problems in Distribution Network

Operation in Loop

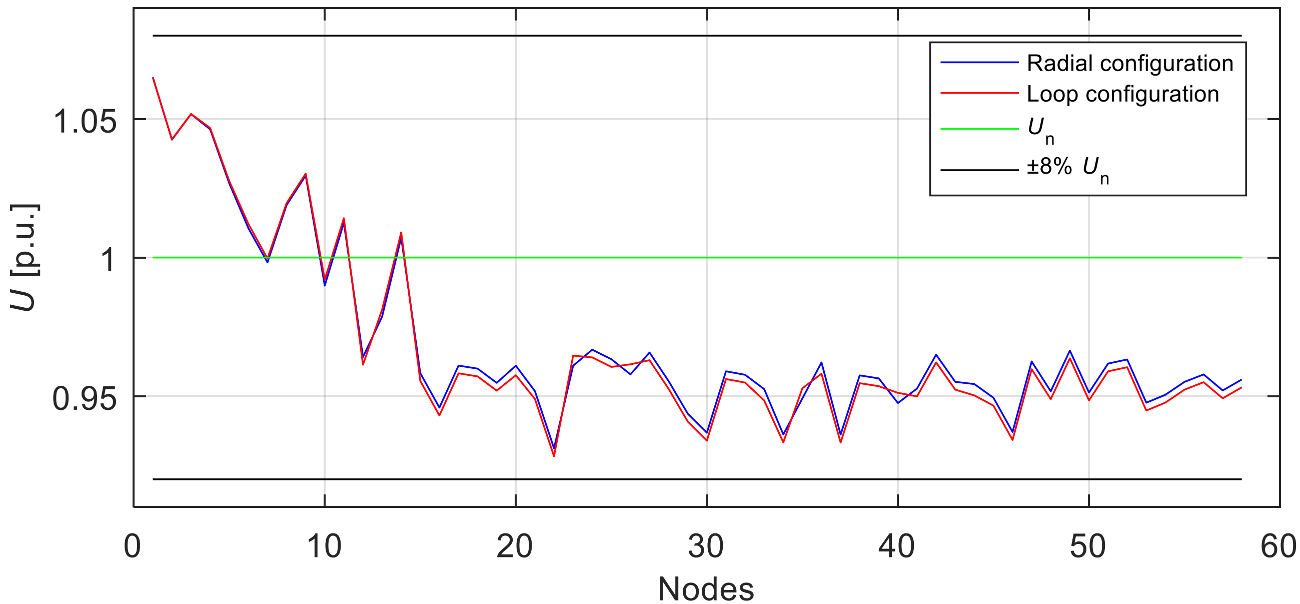
- Only to check if conditions in network are improved
- Loop closed in Žerjav



Problems in Distribution Network

Operation in Loop

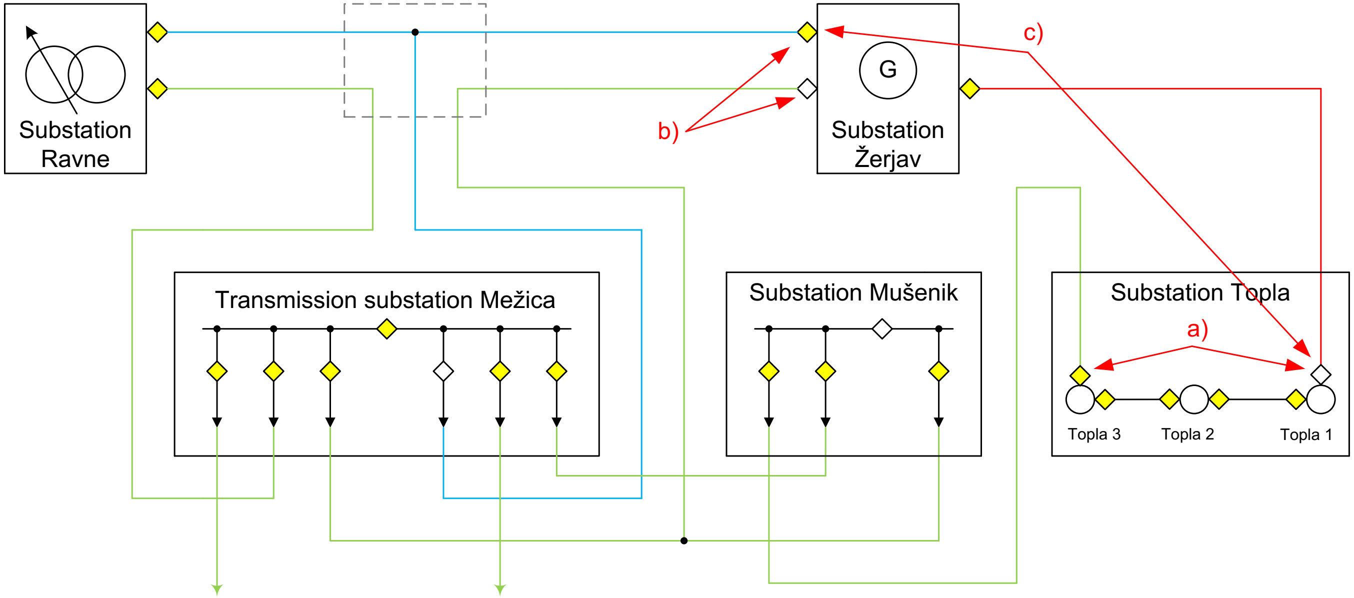
- Voltage profile comparison



Problems in Distribution Network

Increased Voltage in Network

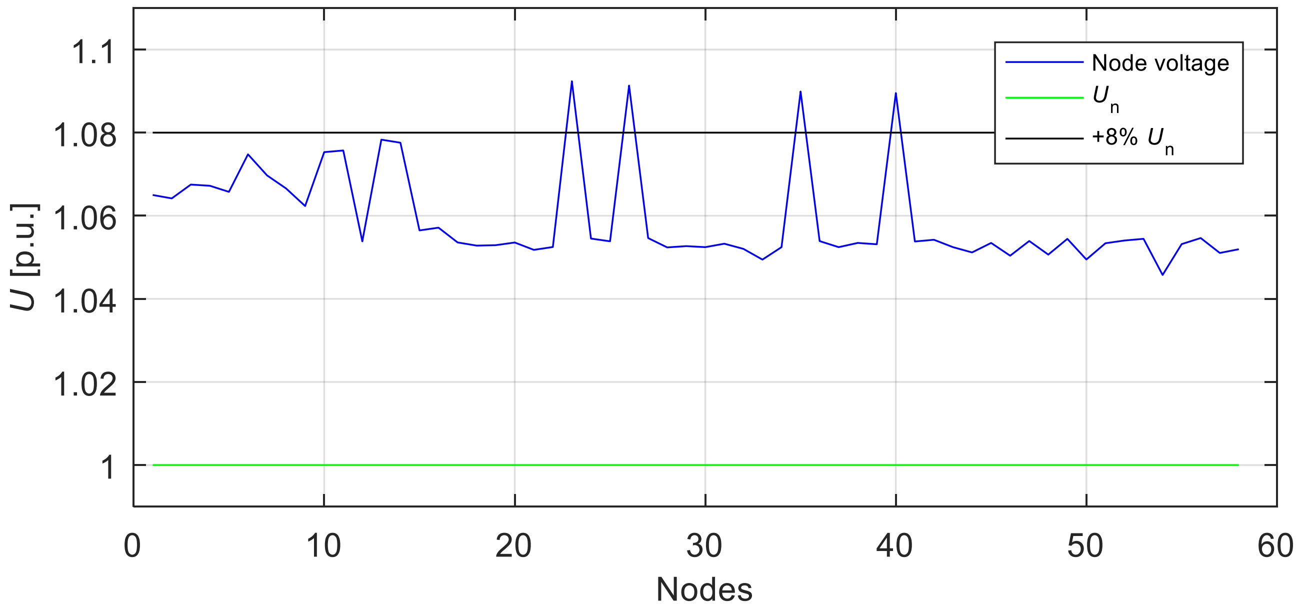
- Caused by peak generation in Žerjav at nightly hours
- Approaches used to reduce voltage:
  - *three reconfigurations*
  - *reactive power generation*



Problems in Distribution Network

Increased Voltage in Network

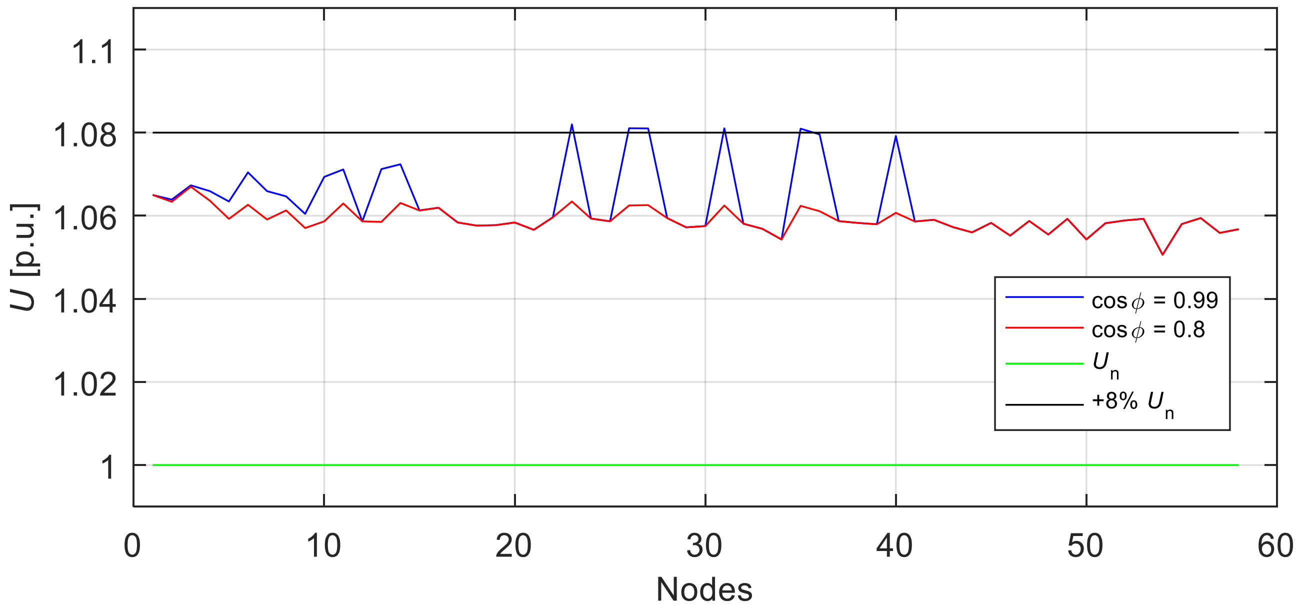
- Voltage profile at peak generation



Problems in Distribution Network

Increased Voltage in Network

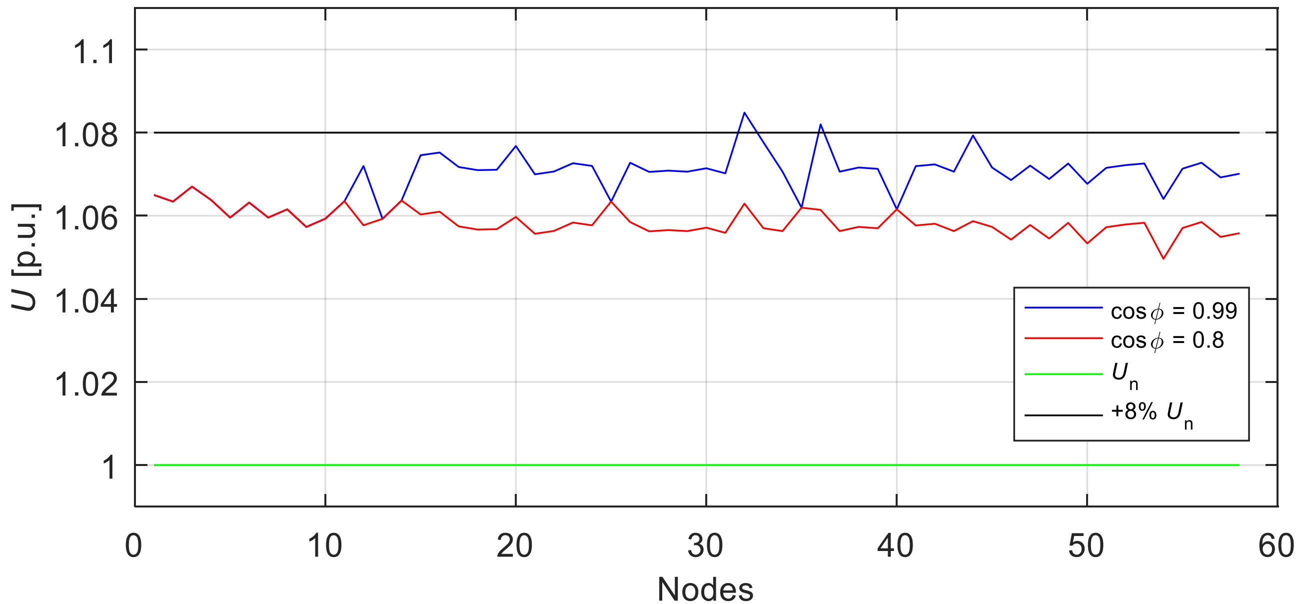
- Voltage profile at reconfiguration a)



Problems in Distribution Network

Increased Voltage in Network

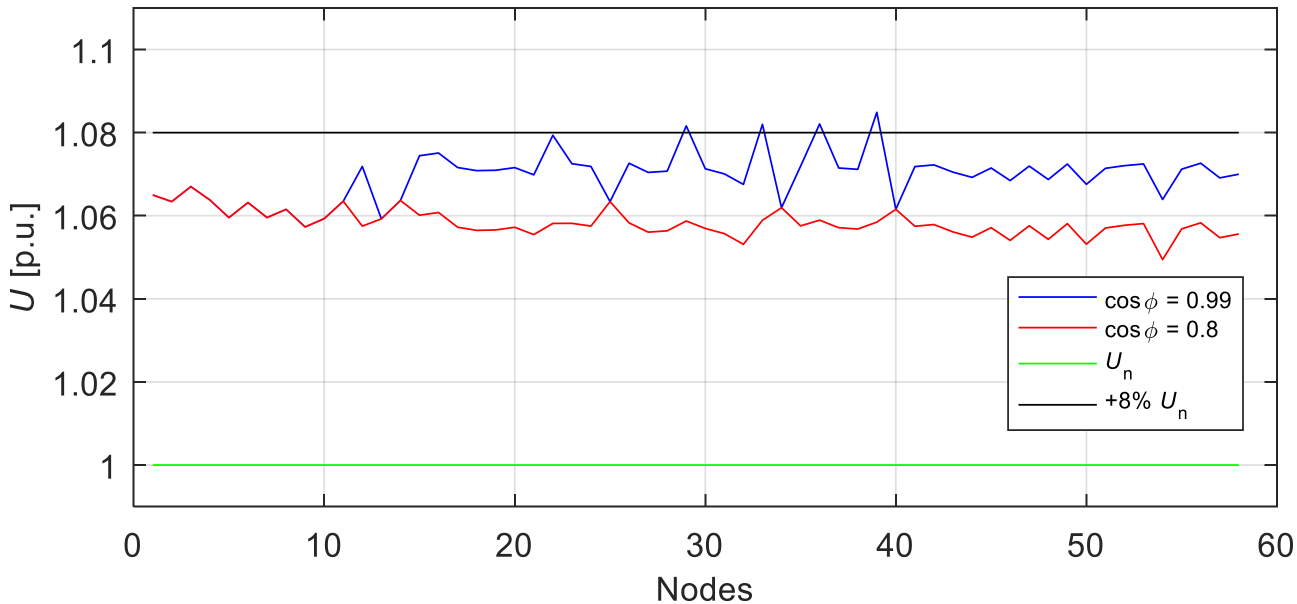
- Voltage profile at reconfiguration b)



Problems in Distribution Network

Increased Voltage in Network

- Voltage profile at reconfiguration c)



Problems in Distribution Network

Increased Voltage in Network

- Network losses:

RECONFIGURATION	NETWORK LOSSES [kW]	
	cosφ = 0.99	cosφ = 0.8
a)	76.1	92.2
b)	83.5	105.5
c)	86.8	114.7

Conclusion

- Evaluation of possible solutions for increased installed power:
  - *operation at increased allowed voltage drop*
  - *operation in loop*
- Evaluation of possible solutions for increased voltage:
  - *reconfigurations*
  - *reactive power generation*