The introduction of decentralized sources in the low voltage level of power grid in Germany and Kazakhstan

PhD Nassipkul Dyussembekova

Topic B - Smart Energy Systems:
Decentral Energy Systems & Smart Grids

EXPO 2017
• Future Energy •
Astana Kazakhstan

Germany and Kazakhstan

	Germany	Kazakhstan
Area	357.104 km^2	2.724.900 km^2
Population	approx. 82 mln	approx. 17 mln
population density	230 population per km^2	6,2 population per km^2

Source: www.welt-blick.de

Contents

Contents

Goal

Is it beneficial to implement mini-CHP
in low-voltage networks
of Germany and Kazakhstan?

- Investigation of the work of networks without mini-CHP
- Energy production by mini-CHP
- Investigation of mini-CHP impact on networks

Motivation

Increase in decentralized generators in the low-voltage network

Increase in energy consumption from 10 to 12% per year in Kazakhstan (forecast in KEGOC)

Minimization of grid losses mainly in rural network up to 15% (Almaty network)

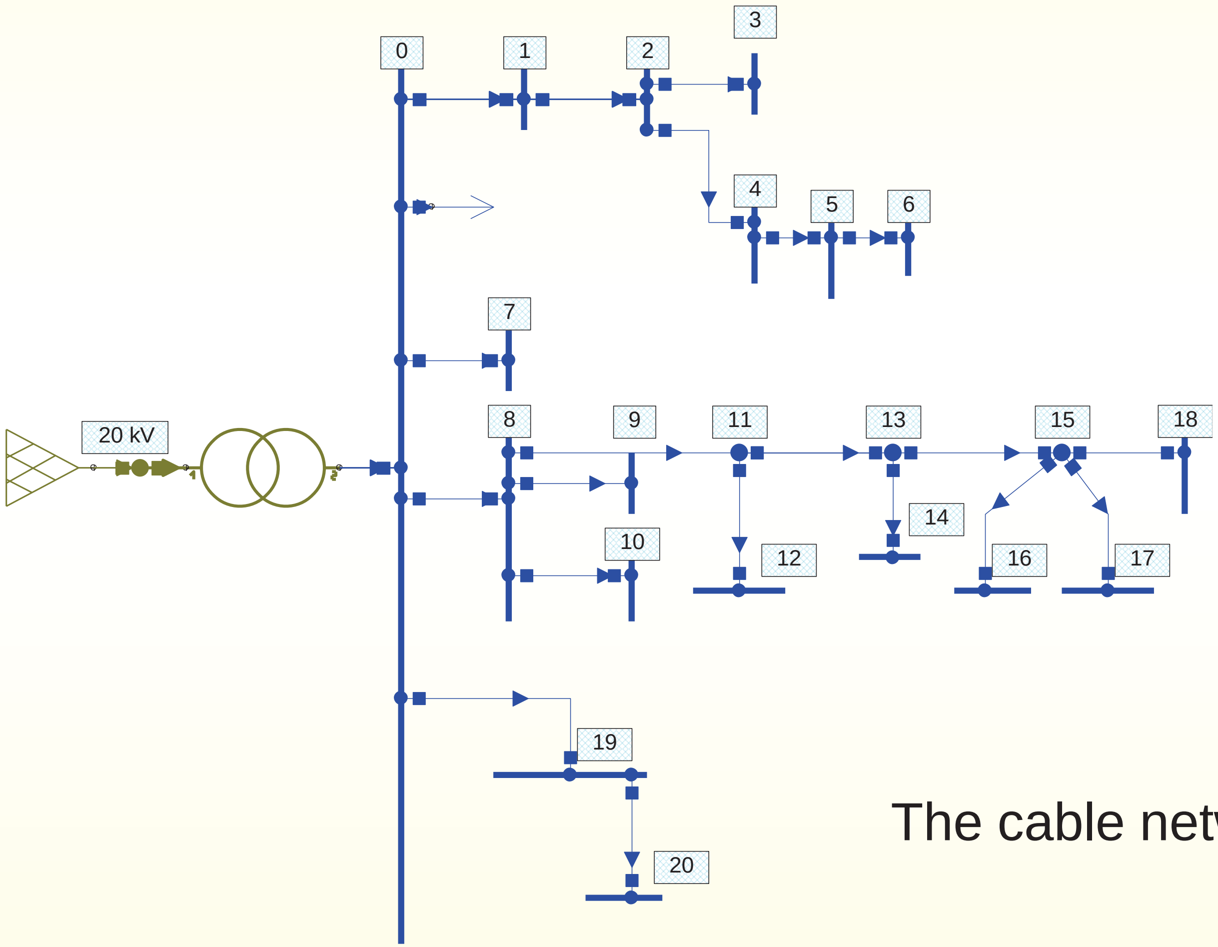
Research scenario

implementation of mini-CHP into networks by means of load flow calculations

Power Grid		Consumer		Decentralized producer	
network data	Load flow	Consumer data	Thermal load profiles	Conditions	Energy production plan

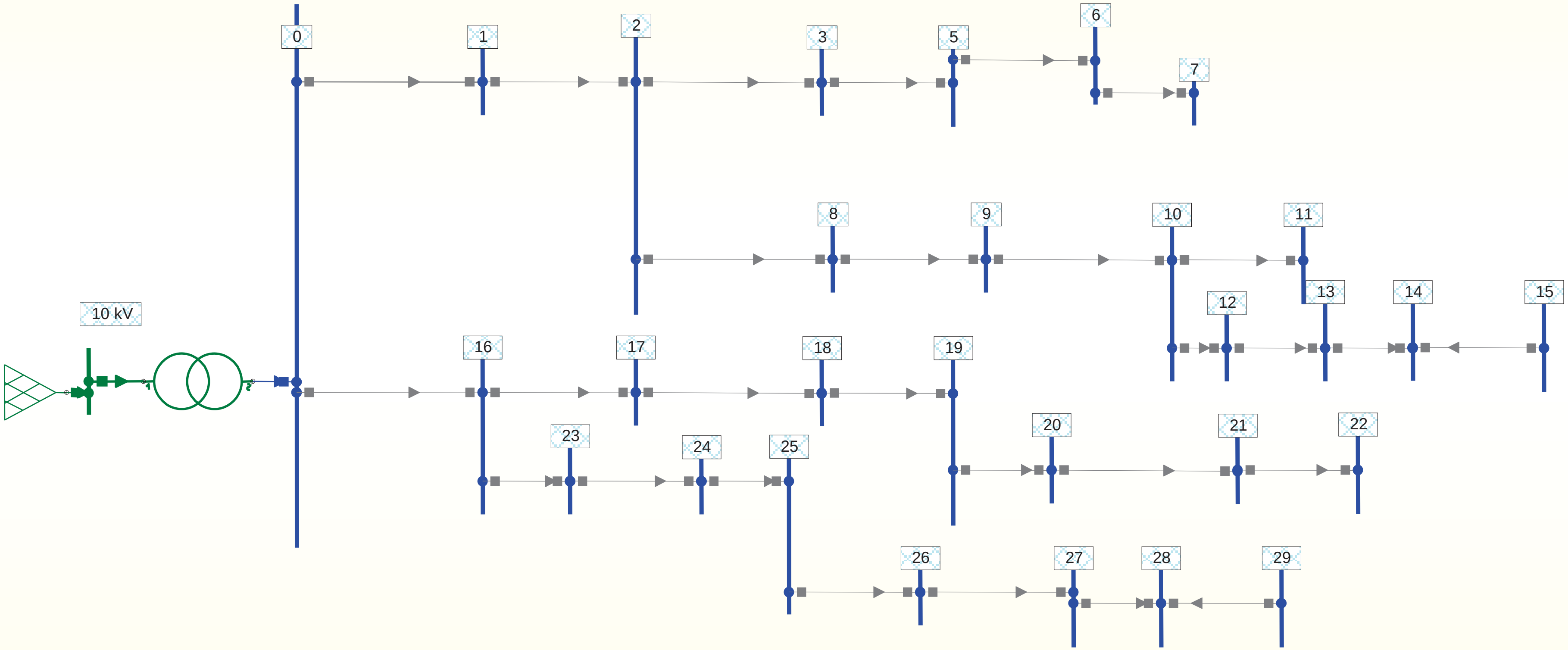
Contents

Municipal low-voltage network of Germany



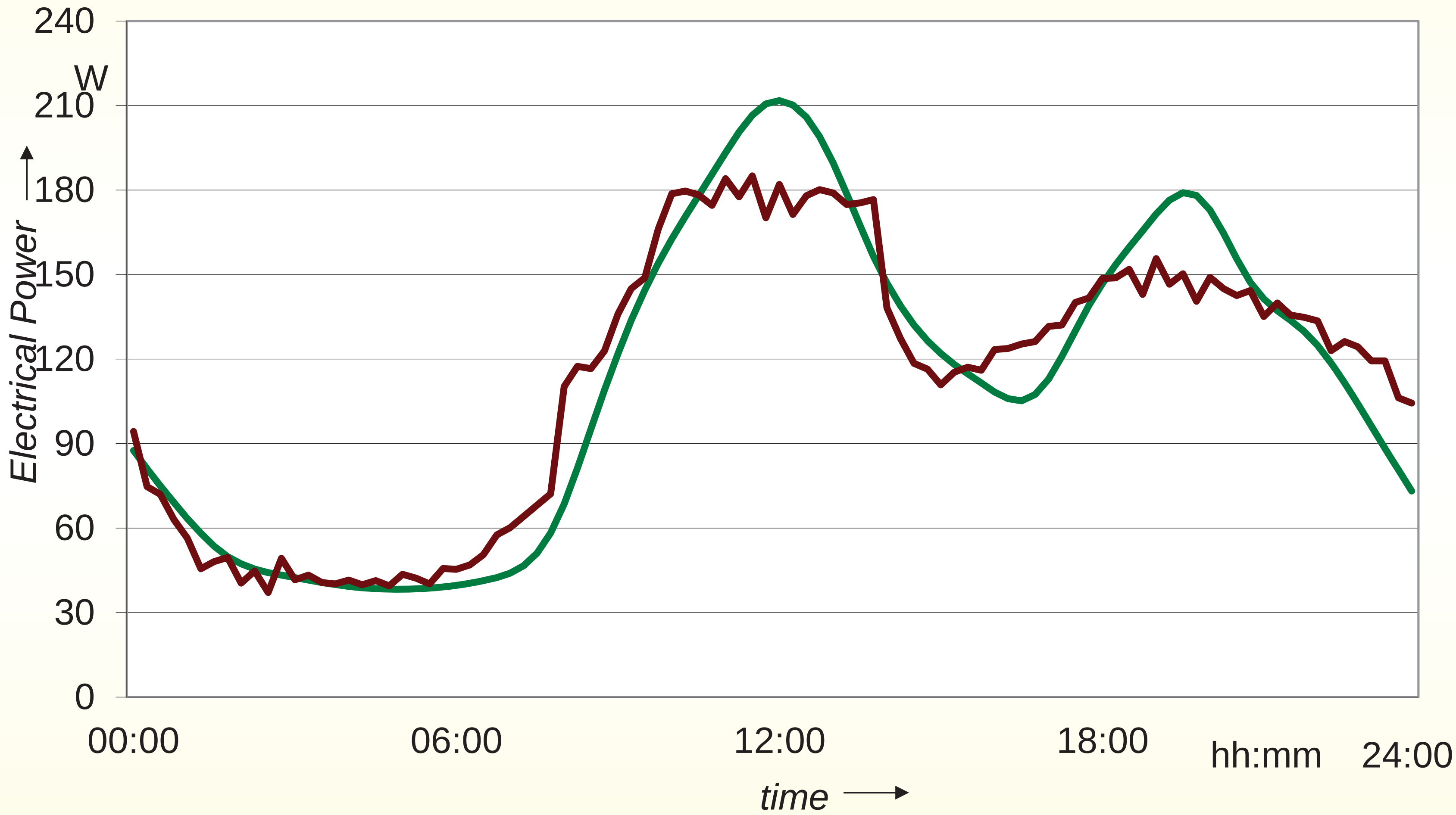
The cable network length is 1.9 km

Rural low-voltage network of Kazakhstan being investigated

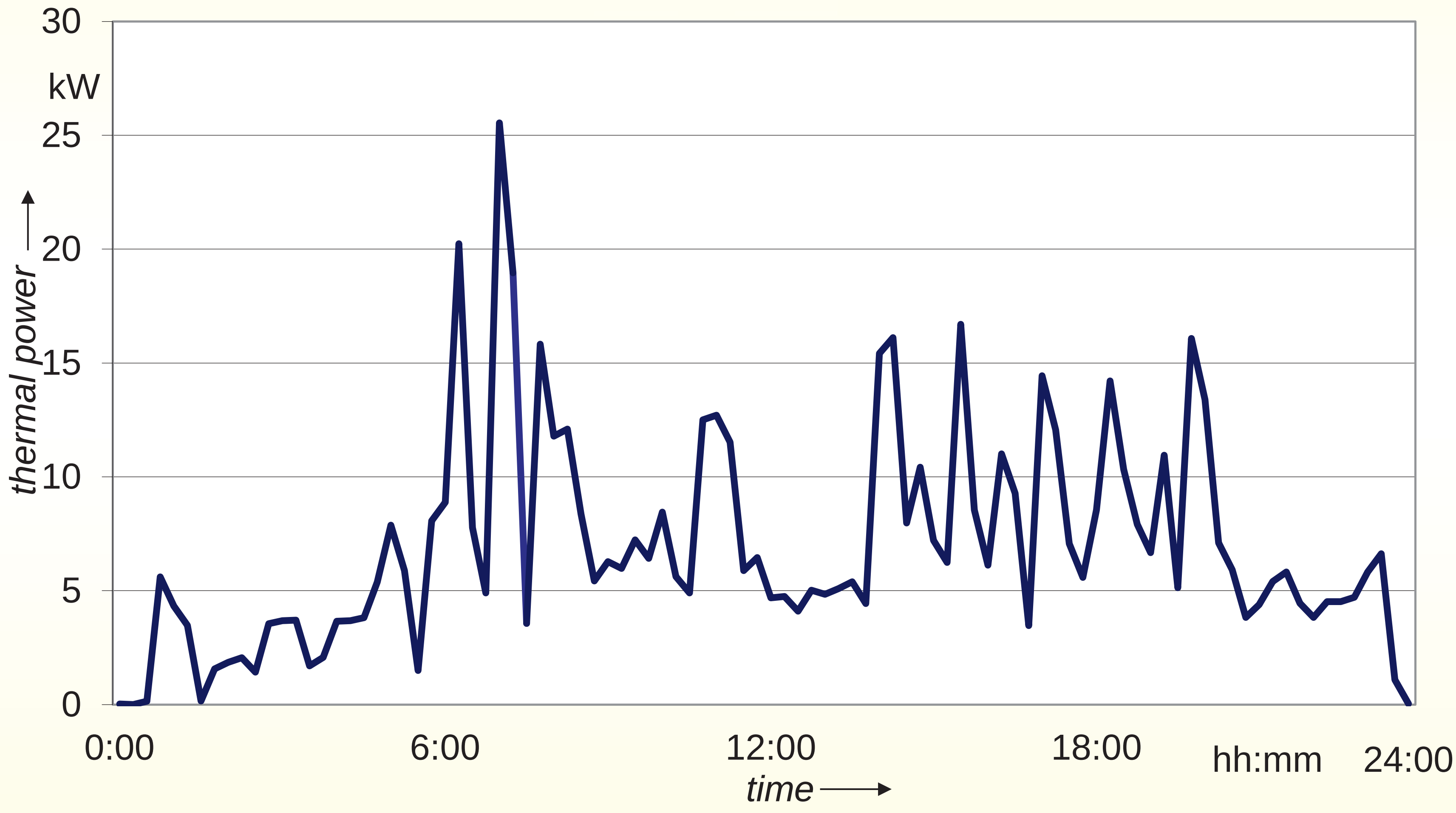


The total length of power grid line is 3.9 km

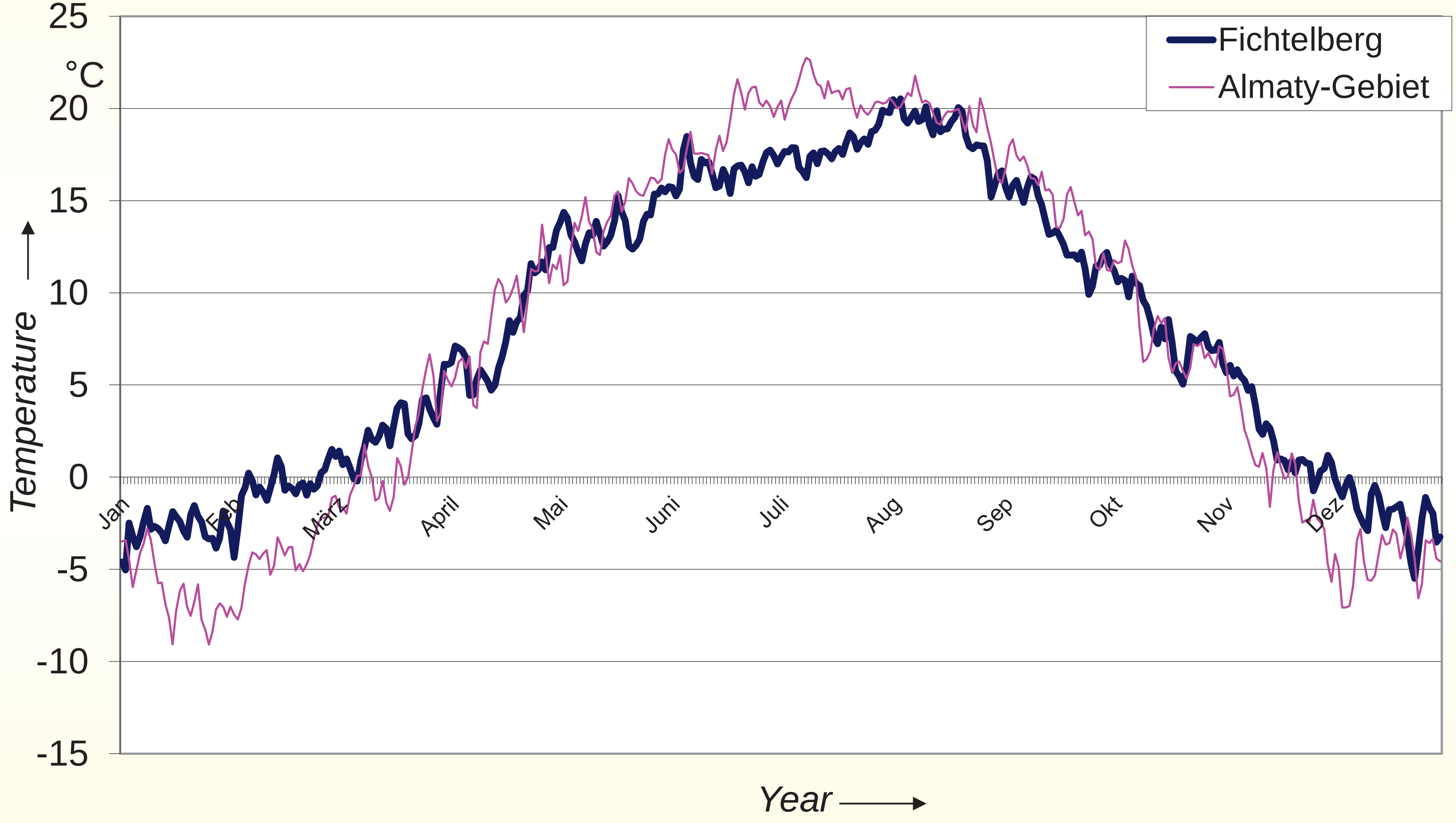
Measured electrical and standardized load profiles



Thermal load profiles for apartment blocks in accordance with VDI 4655

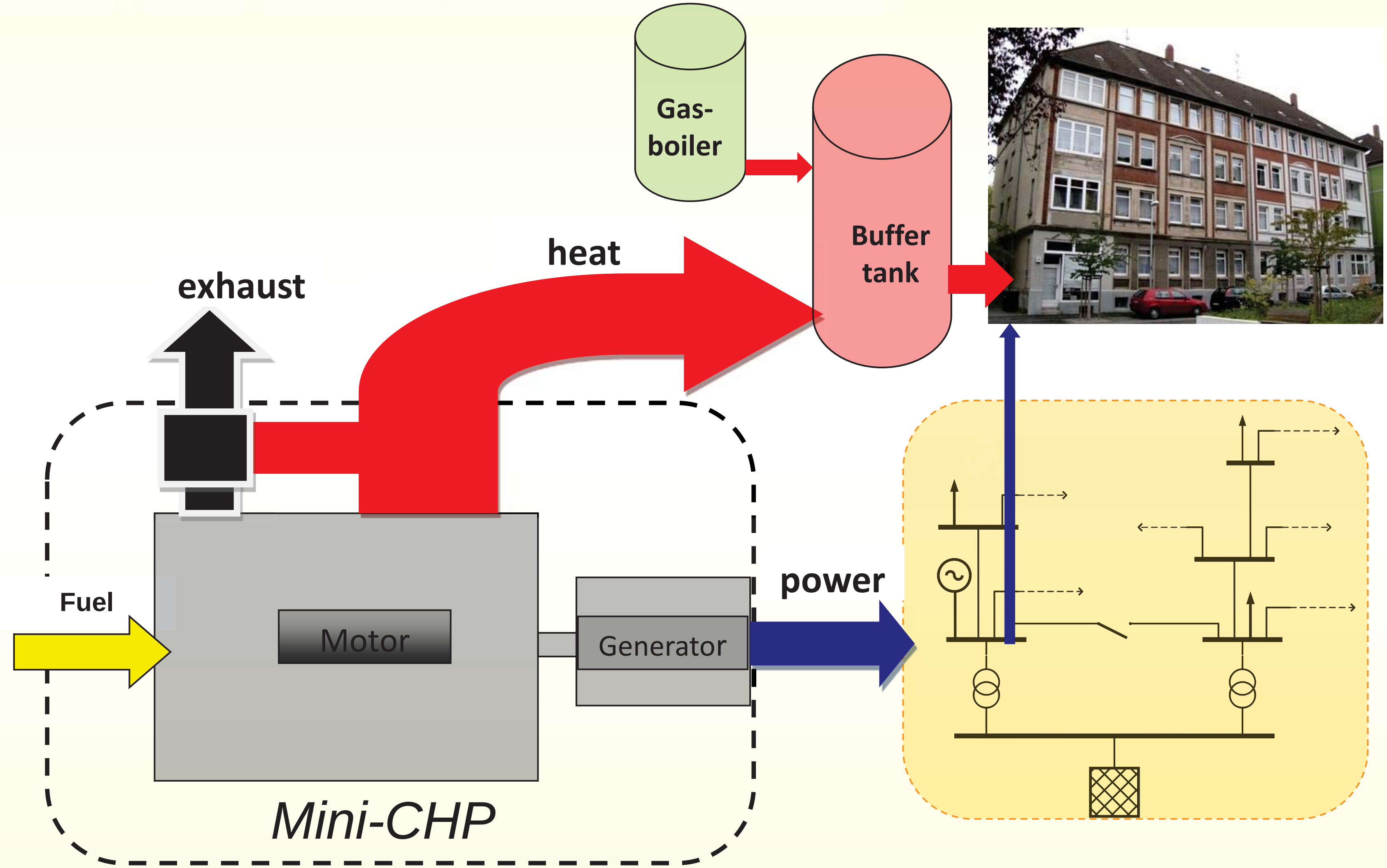


Comparison of temperature

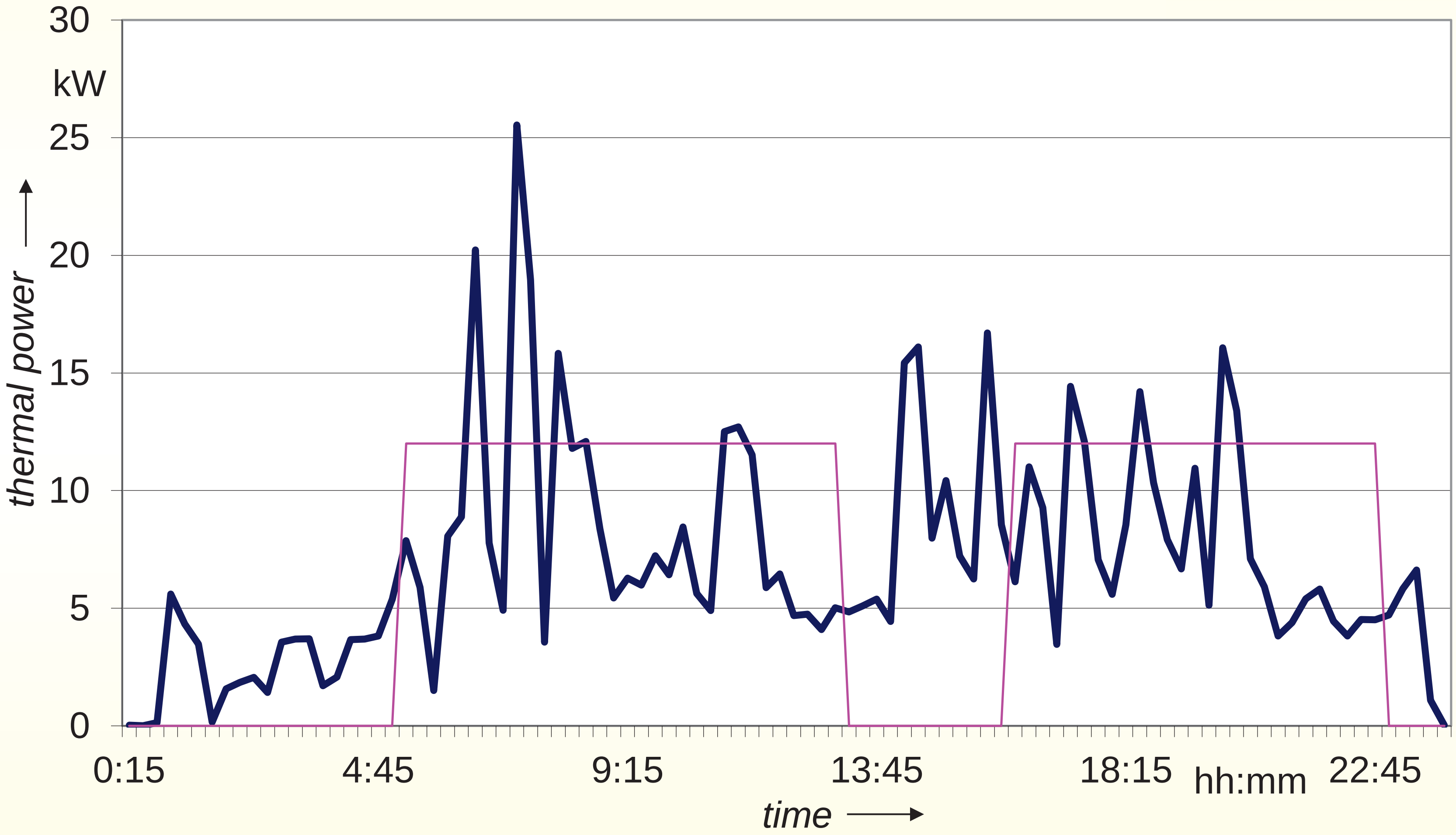


Contents

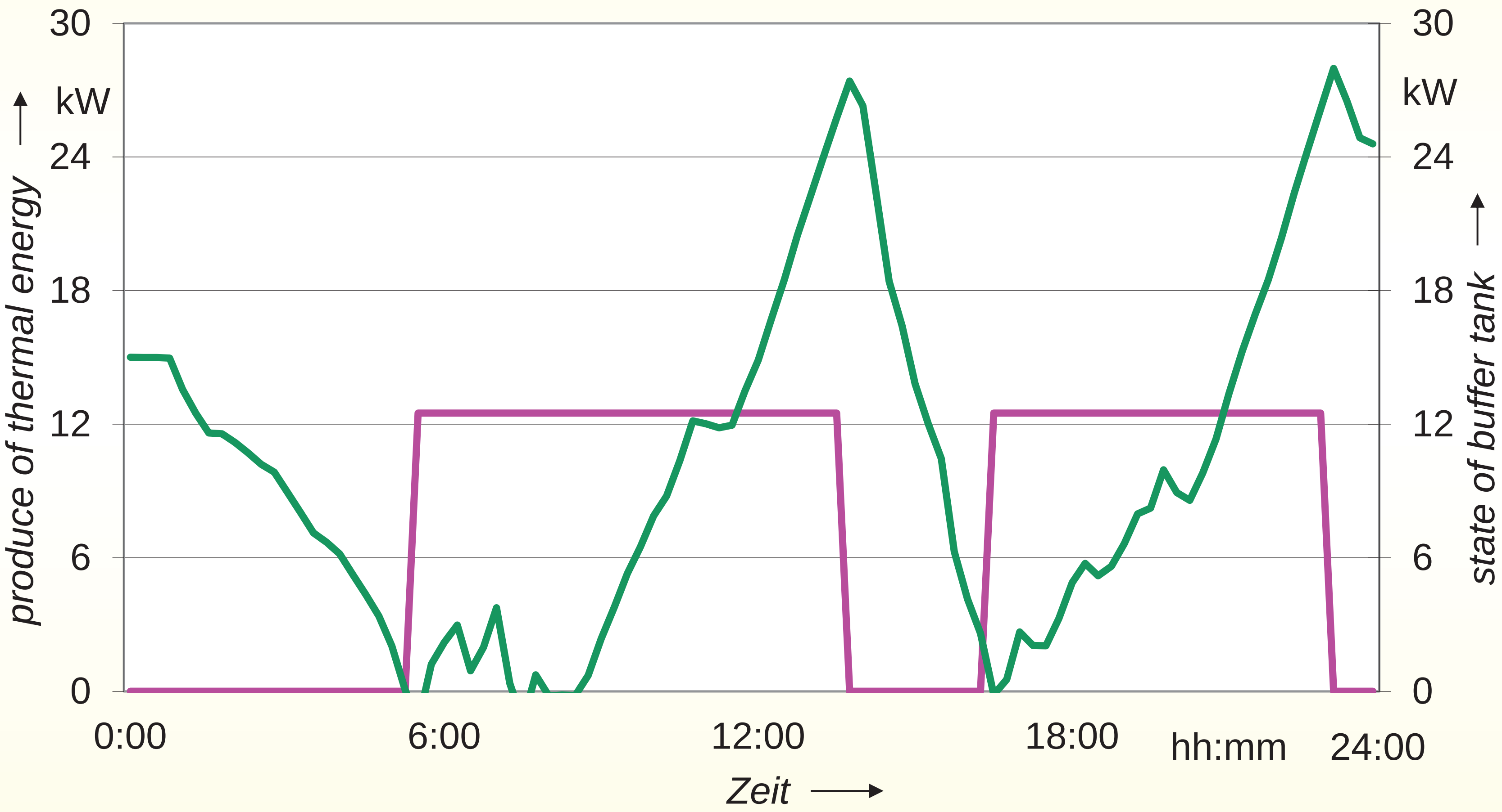
Use of mini-cogeneration plants



Thermal load profiles of an apartment block and energy production plan of a mini CHP



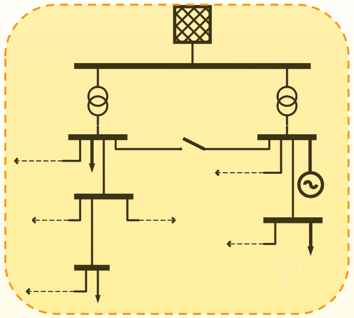
State of the buffer accumulator



Components of the study

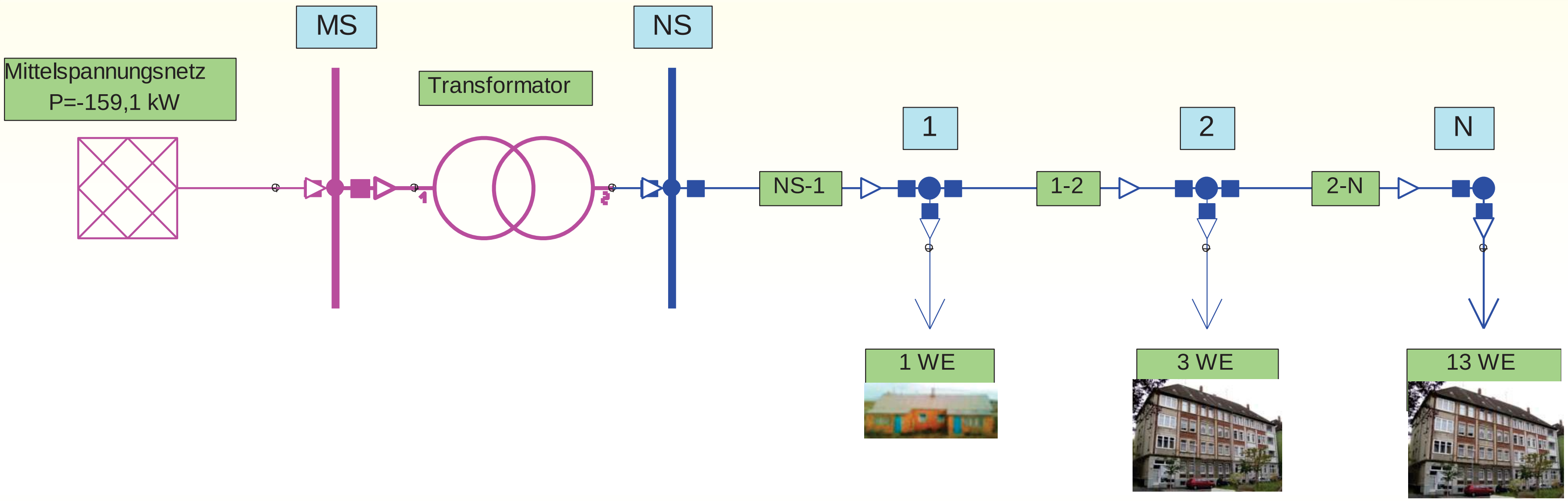
Construction of the study on the integration of mini-CHP into the networks by means of load flow calculations

Power Grid		Consumer		Decentralized producer	
network data	Load flow	Consumer data	Thermal load profiles	Conditions	Generations plan



Contents

Load distribution in the low-voltage network



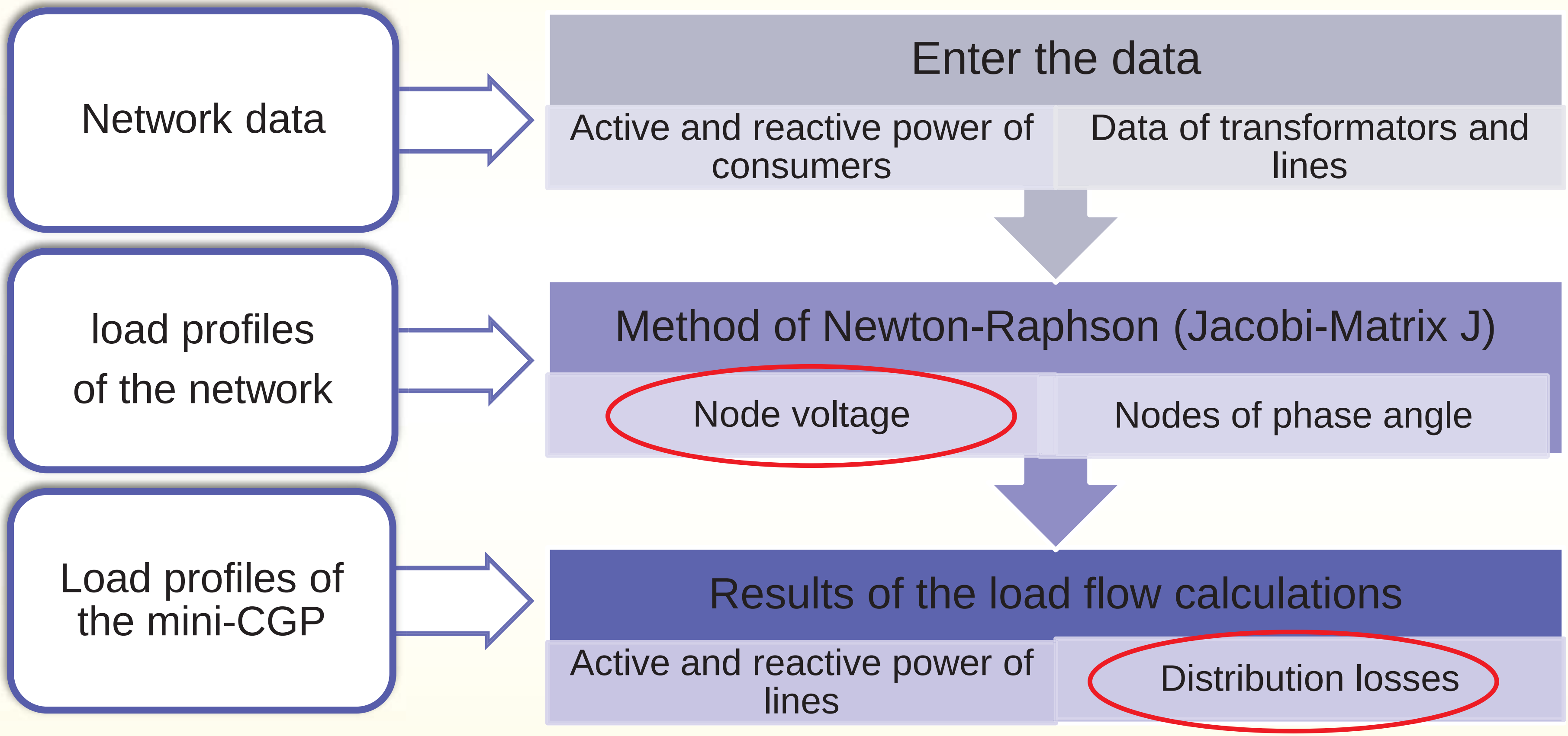
The peak load shares of the network depends on the number of residential units and their peak loads:

$$P_{SNetz}(n) = g(n) * P_S * n$$

G (n) - simultaneity factor
PS - Peak power of residential unit, kW
N - Number of residential units in the network

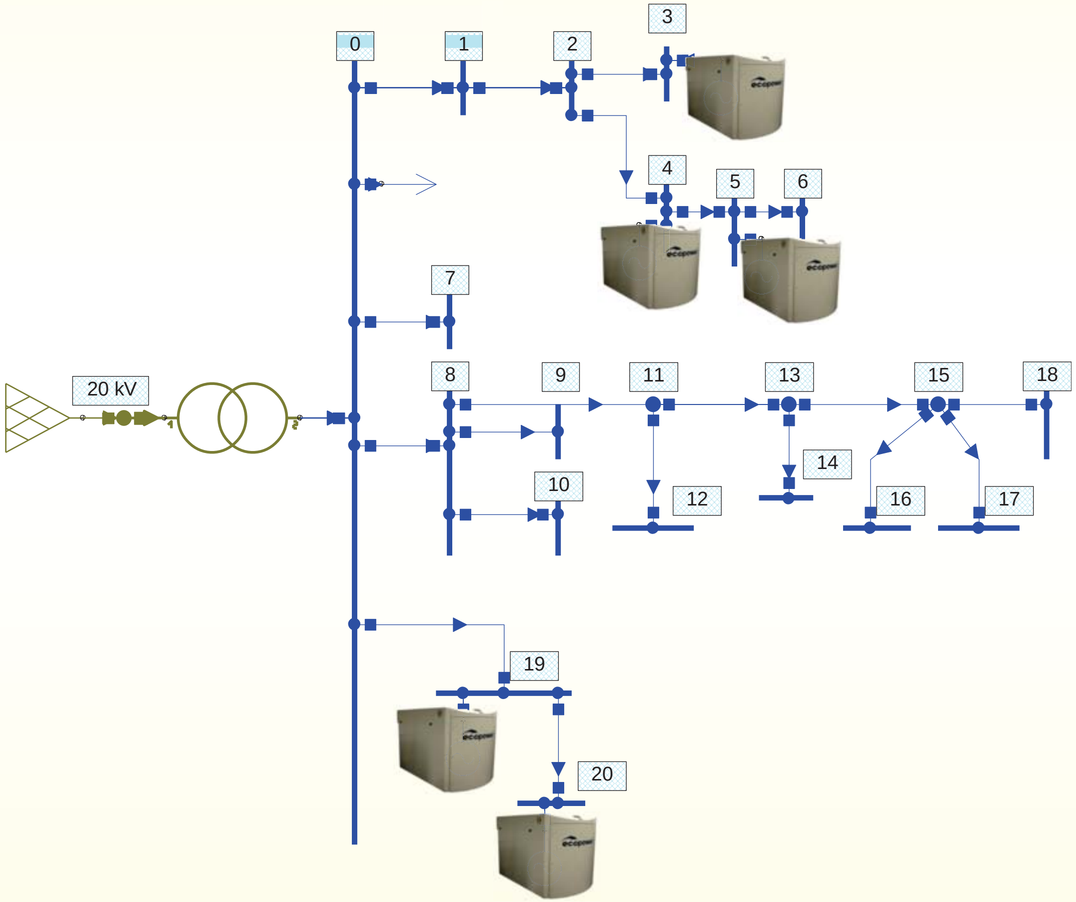
Source: Kaufmann

Load flow calculation

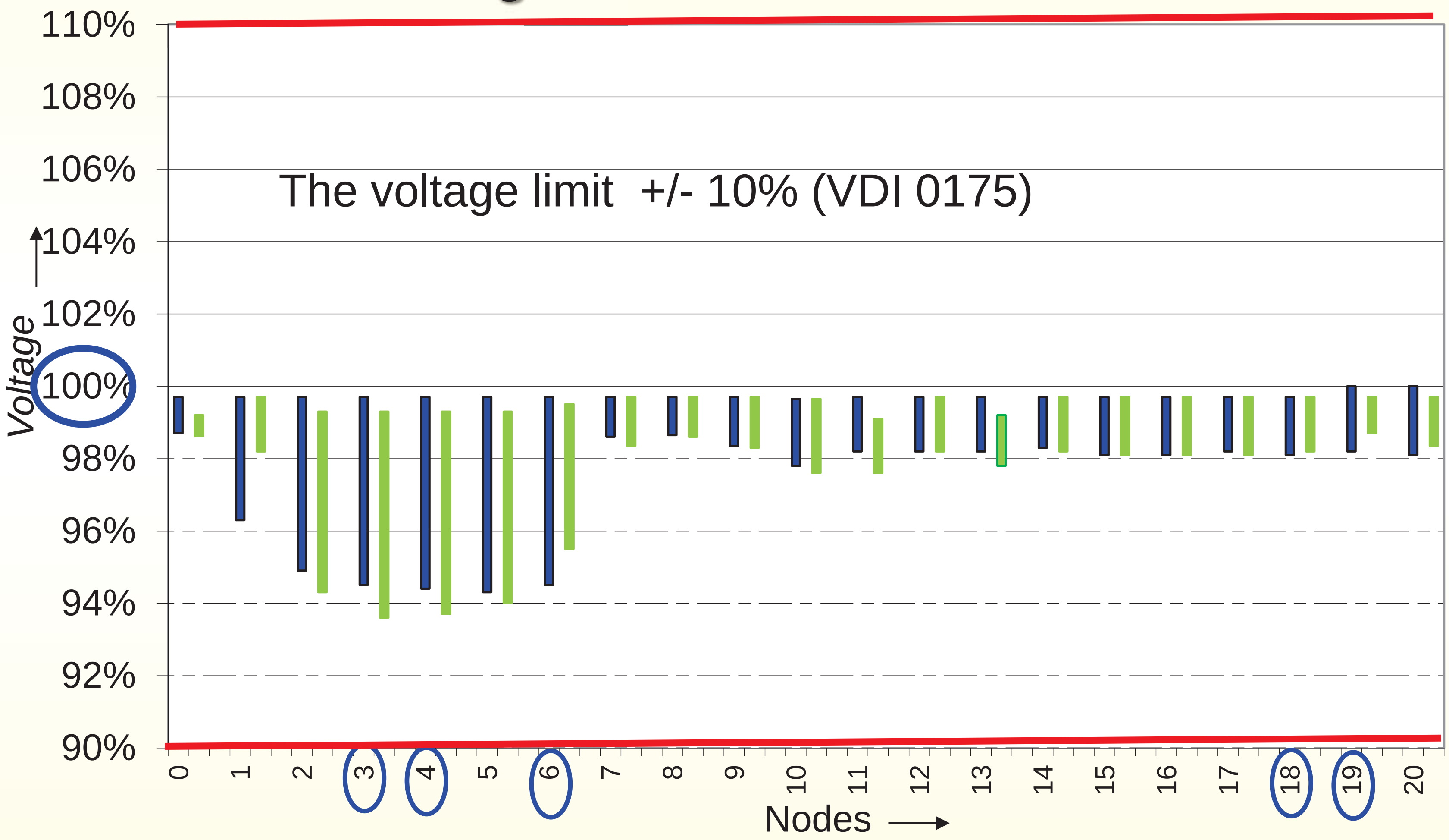


Contents

Calculation of the German urban network. Use of five mini CHP units



Calculation of the German urban network. Nodes of retention voltage



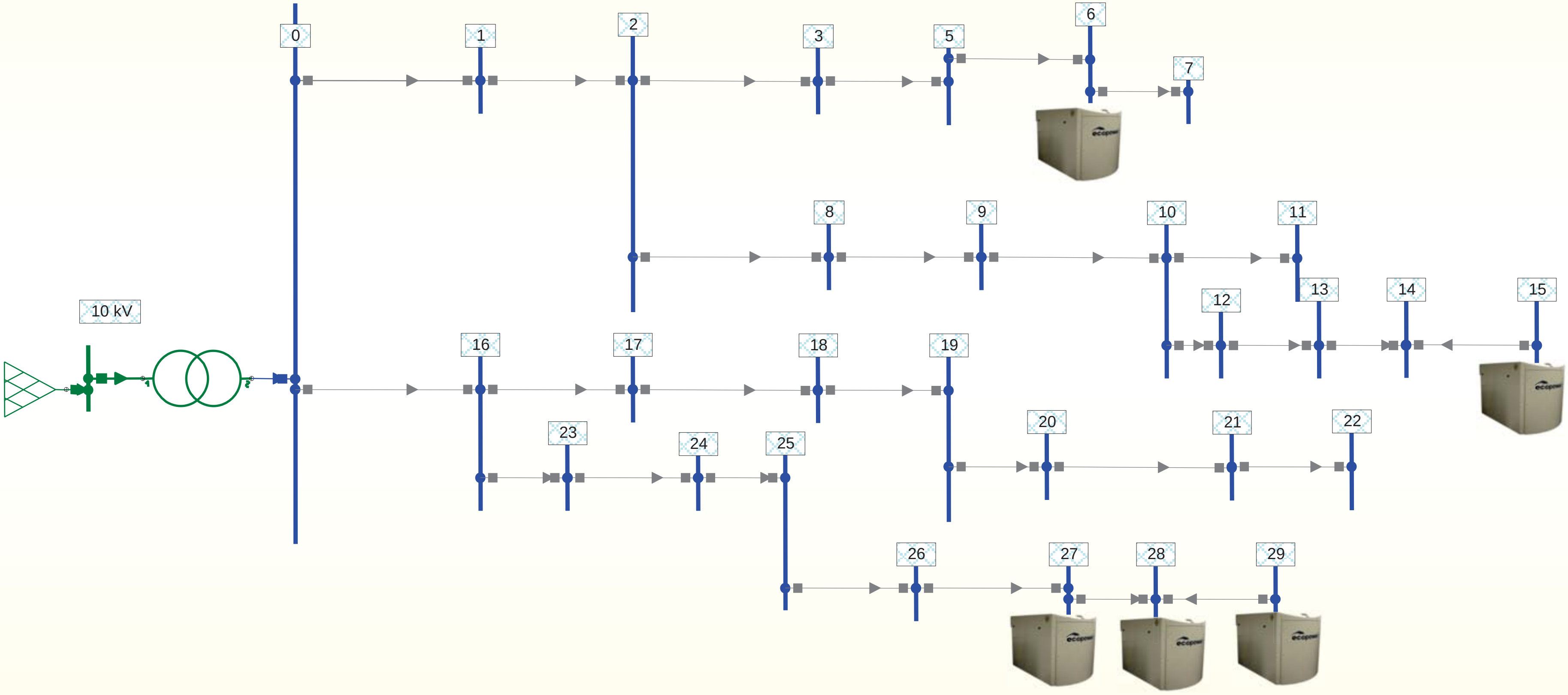
Calculation of the German urban network grid losses and transfer performance

	energy consumption, MWh	Network losses, MWh	Network losses, %	Power, kW
With NSP	834,0	11,7	1,4	218,8
Without NSP and mini-CGP	640,0	10,7	1,67	137,9
With 5 Mini-CGP and without NSP	507,9	7,7	1,52	118,6

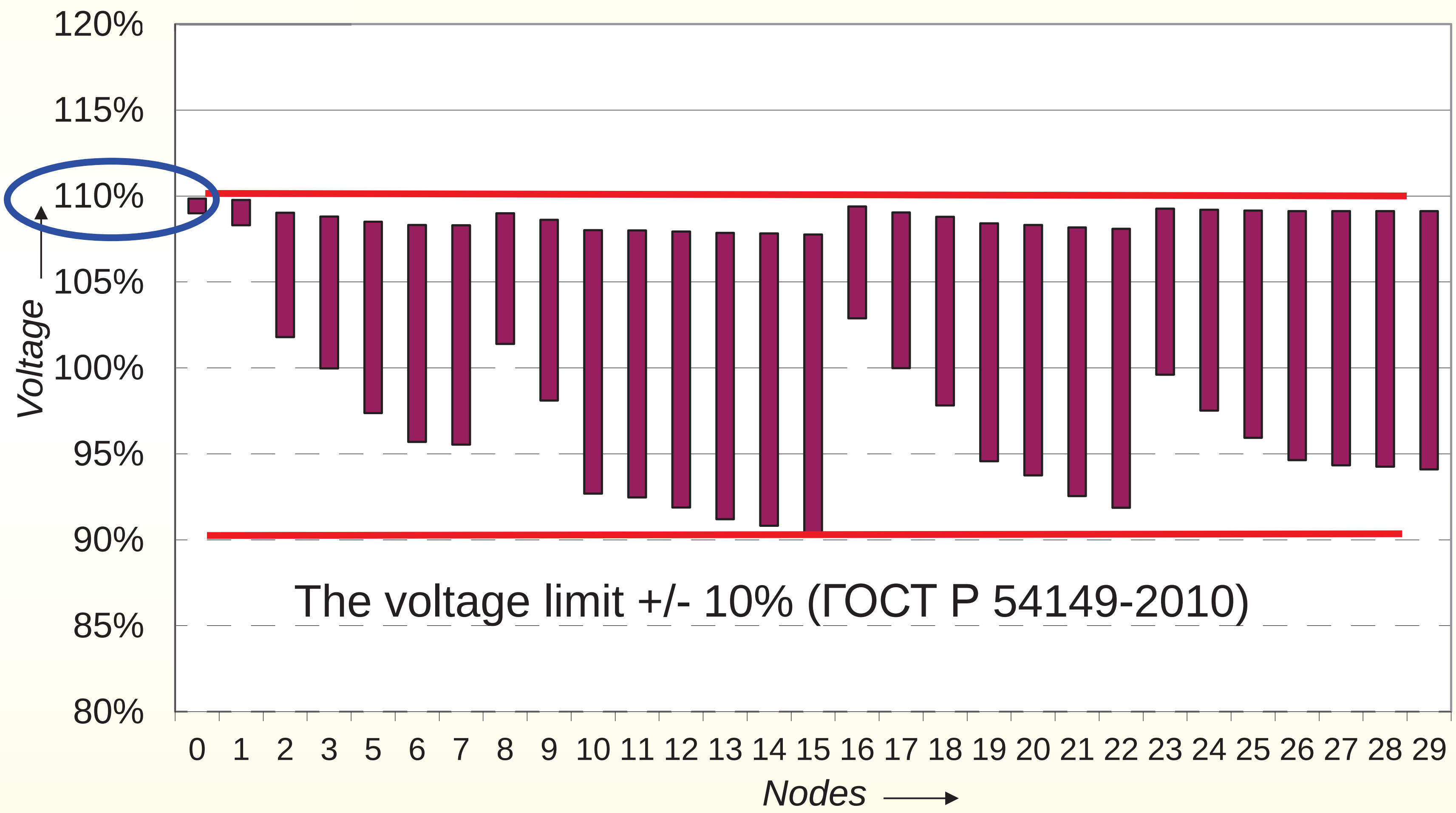
Reduction of peak power in the network without NSP by 14%

NSP – Night storage heater

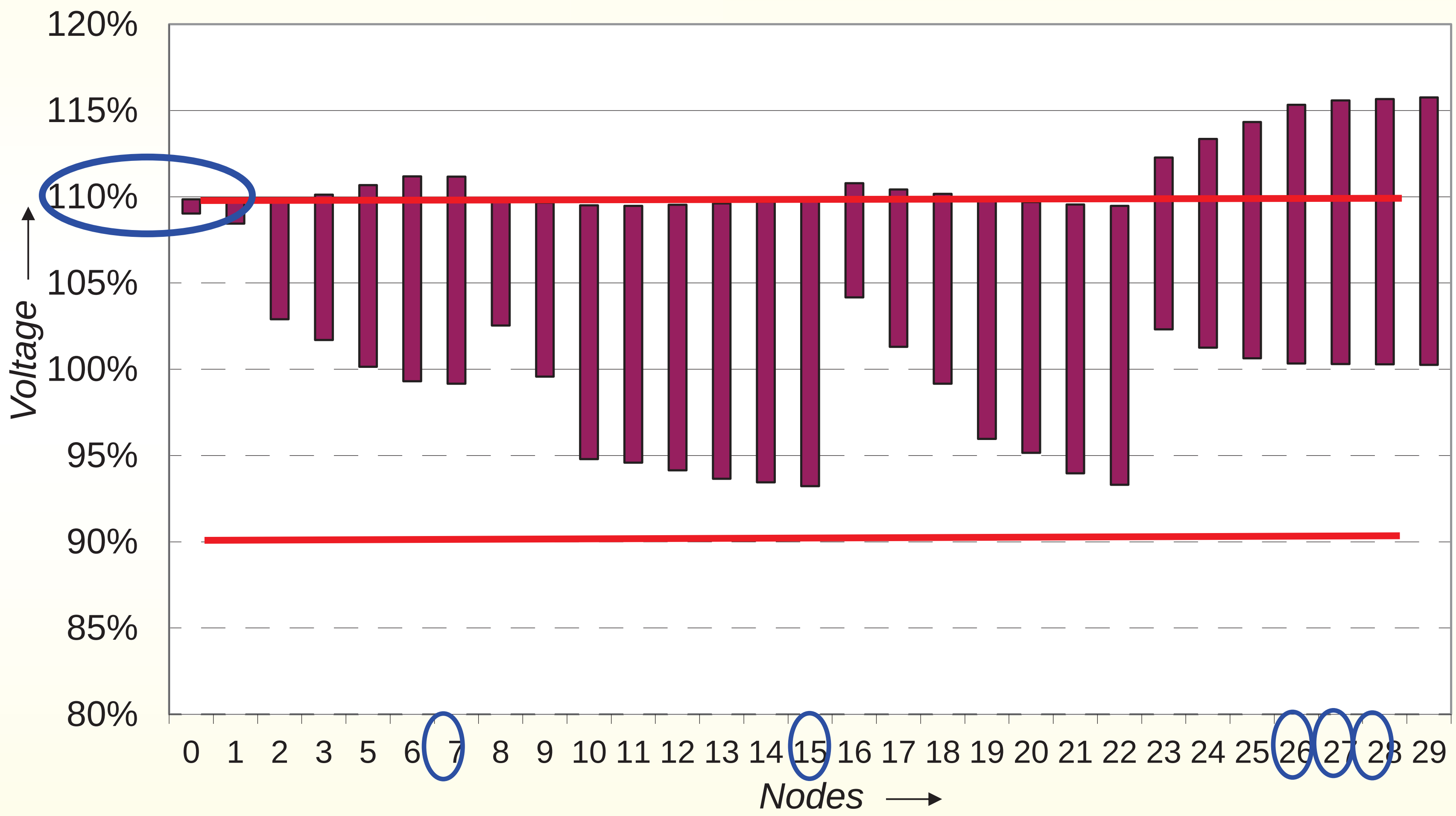
Calculation of the Kazakh rural network. Use of six mini CHPs



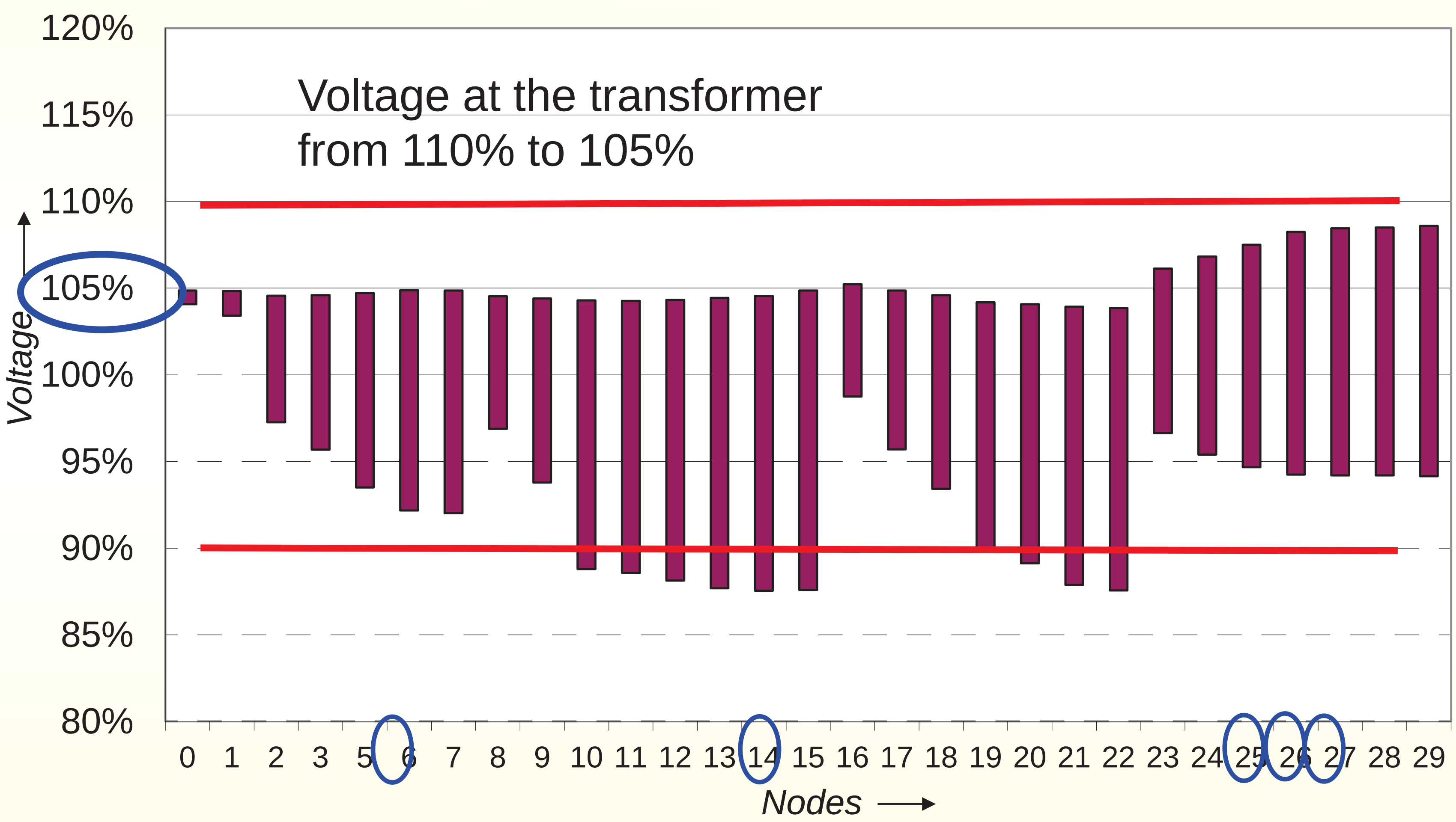
Calculation of the Kazakh rural network without mini-CHP



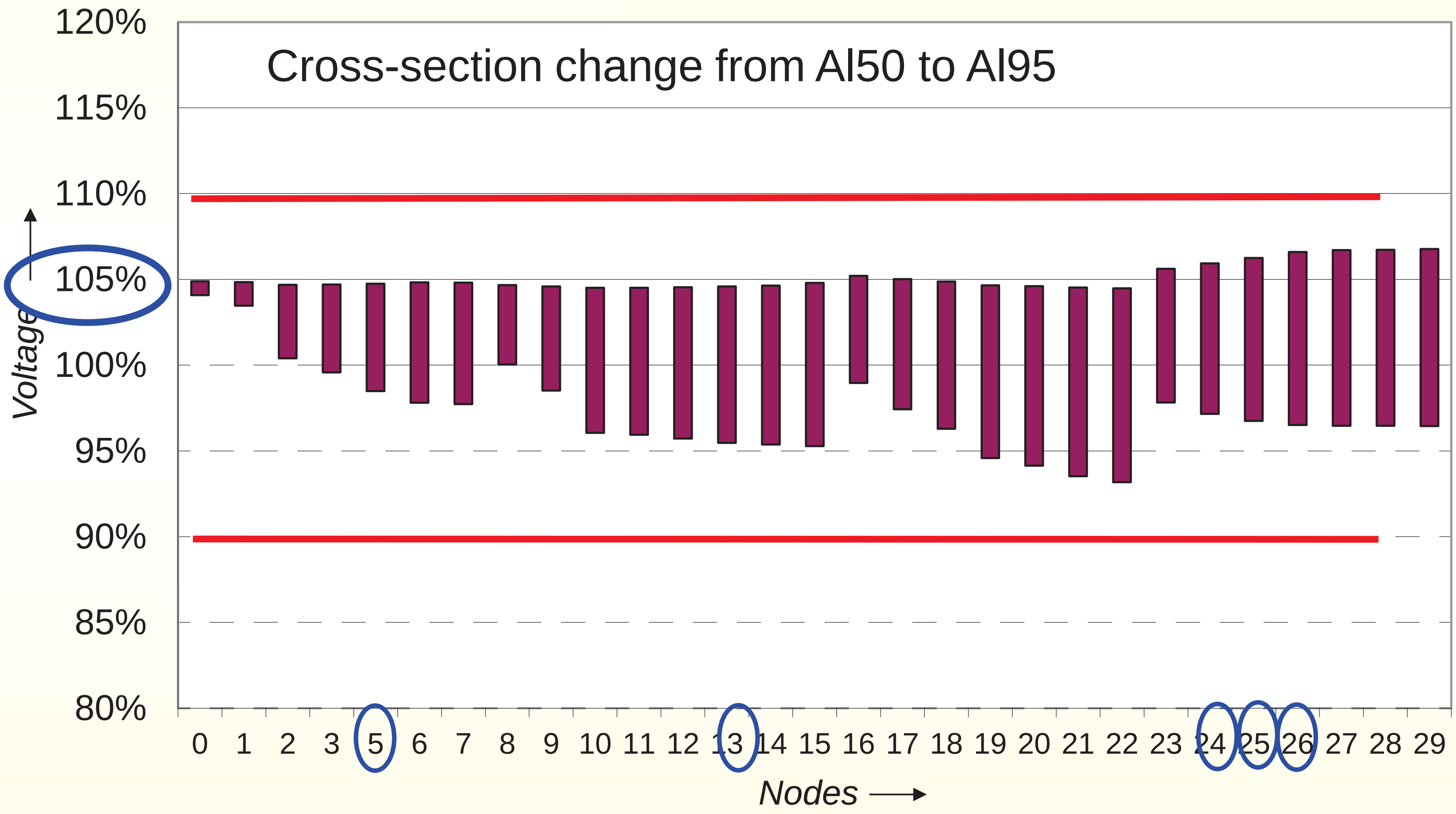
Calculation of the Kazakh rural network voltage level with six mini-CHP



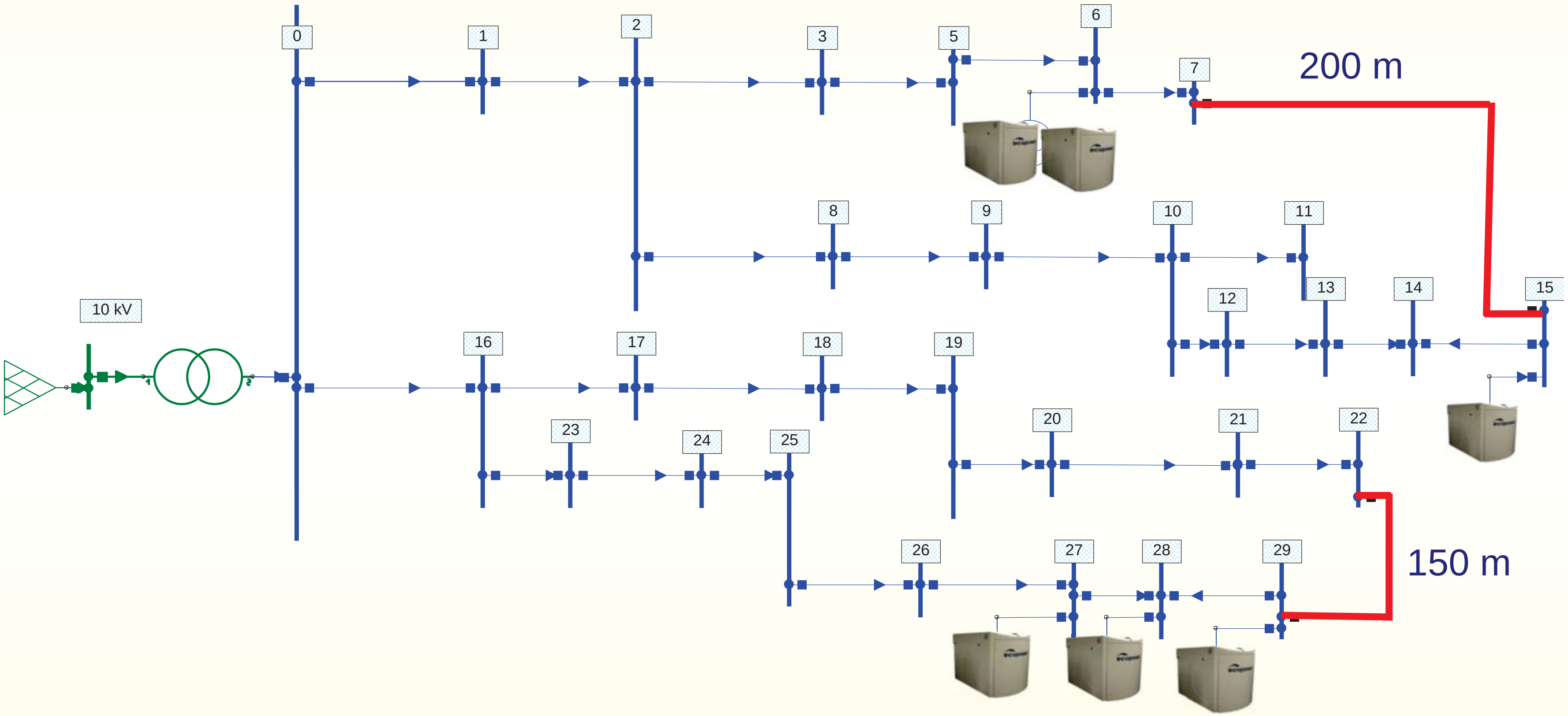
Calculation of the Kazakh rural network voltage level with six mini-CHP



Calculation of the Kazakh rural network. Changes in cross-section line

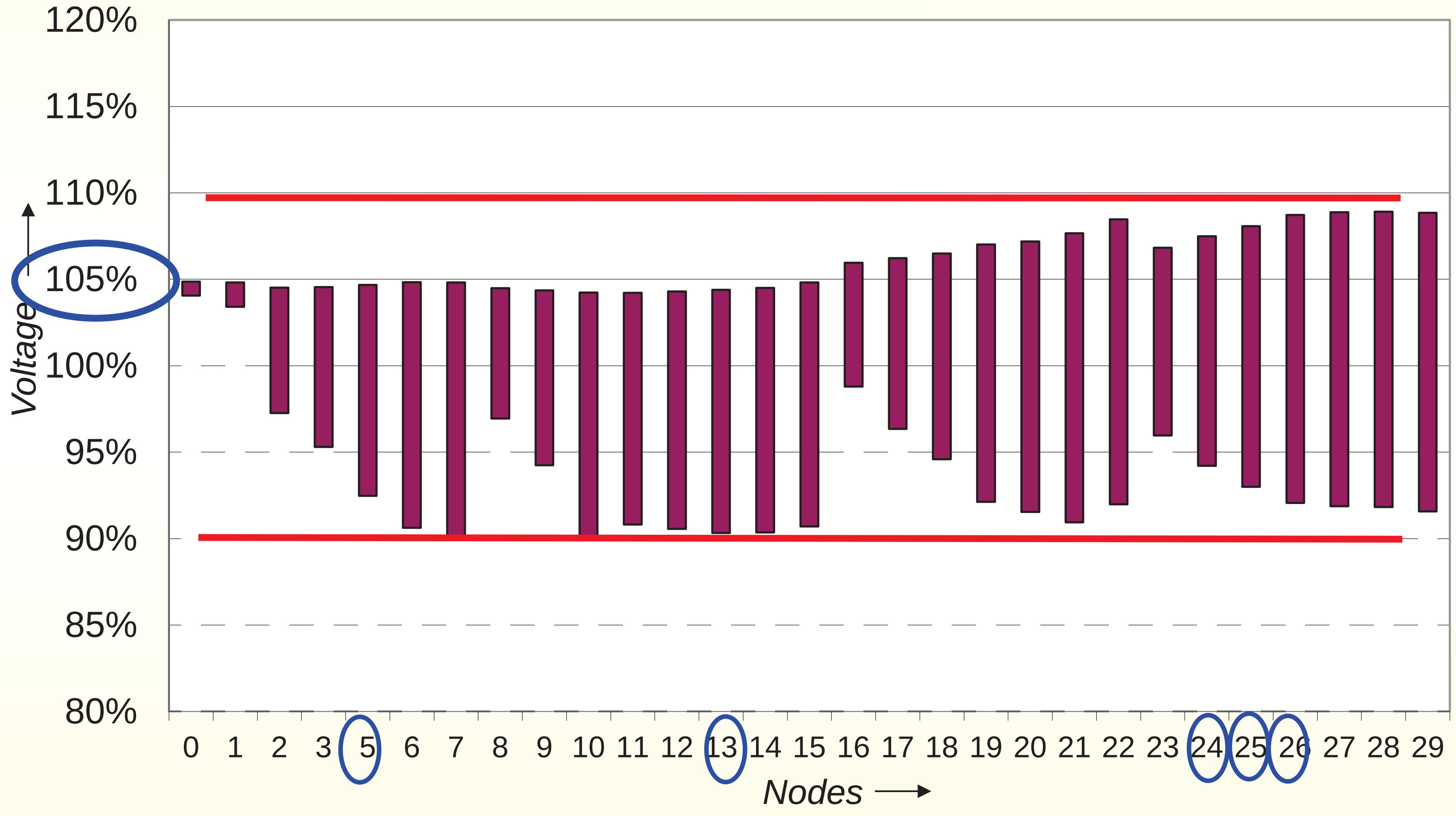


Calculation of the Kazakh rural network. Change in network structure



The protection devices are adapted.

Calculation of the Kazakh rural network. Voltage after network structure change



Calculation of the Kazakh rural network. Results

Concept		Minimal Voltage	Maximal Voltage	Note
Without mini-CHP, 110% of the rated voltage at the transformer		90,2%	109,8%	
6 mini CHP, 110% of the total rated voltage at the transformer		93,2%	115,8%	
6 Mini-CHP, 105% of nominal voltage on the transformer		87,6%	108,6%	
additional activities	Use of a line with larger cross-section	93,5%	107,0%	
	Network structure change	90,0%	108,9%	
6 mini CHP with cos φ = 0.9, 6 CHP, 105% of the nominal voltage at the transformer		87,8%	108,9%	
Connecting produced energy of all six mini-CHPs on transformer nodes		90,2 %	109,8 %	

Calculation of the Kazakh rural network. Network losses and peak power

	Energy consumption, MWh	Network losses, MWh	Network losses, %	Peak power, kW
Without mini-CHP	768,6	51,8	6,7	226
With 6 mini-CHP	613,0	36,9	6,0	191

Reduction of power grid losses by the integration of the six mini-CHPs approx. 15 MWh

Reduction of the peak power by 15.4%

Contents

Summary

Germany	Kazakhstan
Is the use of the mini-CHP in the low-voltage grid of Germany and Kazakhstan worth?	
Yes Peak power in the network is reduced. No major change in energy loss and voltage level.	**Yes** Peak power and network losses are reduced. **But** Additional changes to the network structure have to be carried out. Each network should be viewed individually.

Назарларыңызға Рахмет!
Thank you for your Attention!!!
Спасибо за внимание!
Vielen Dank für Ihre Aufmerksamkeit!

Email: nassipkuldyussembekova@gmail.com,
Mobile number: +77773055526