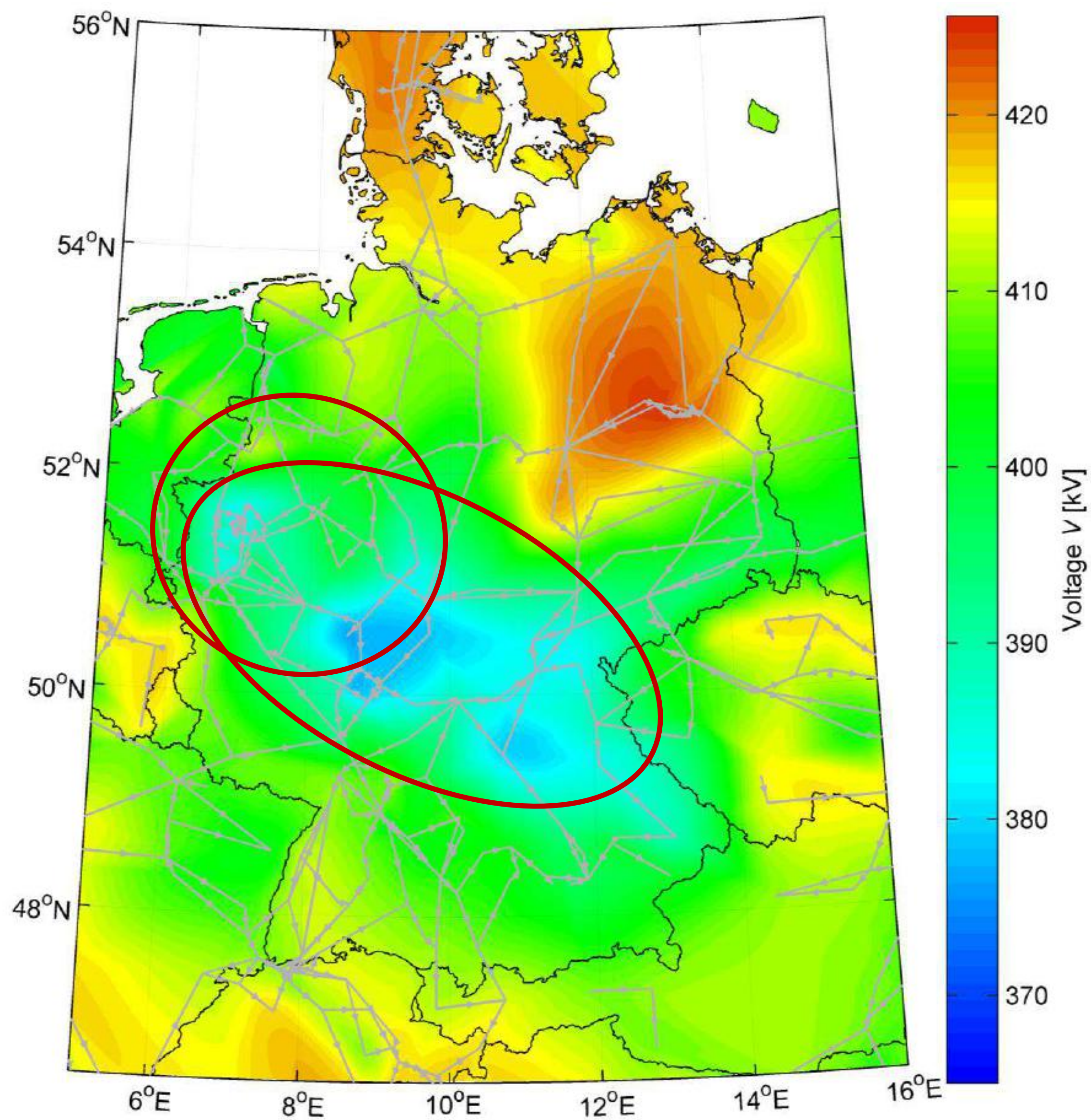
Voltage distribution (400 kV) – scenario 1

Scenario 1.a (2011):
- Voltages within limits

Scenario 1.b (2015):
- Severe voltage drop in western region
- Additional measures necessary, Redispatch actions

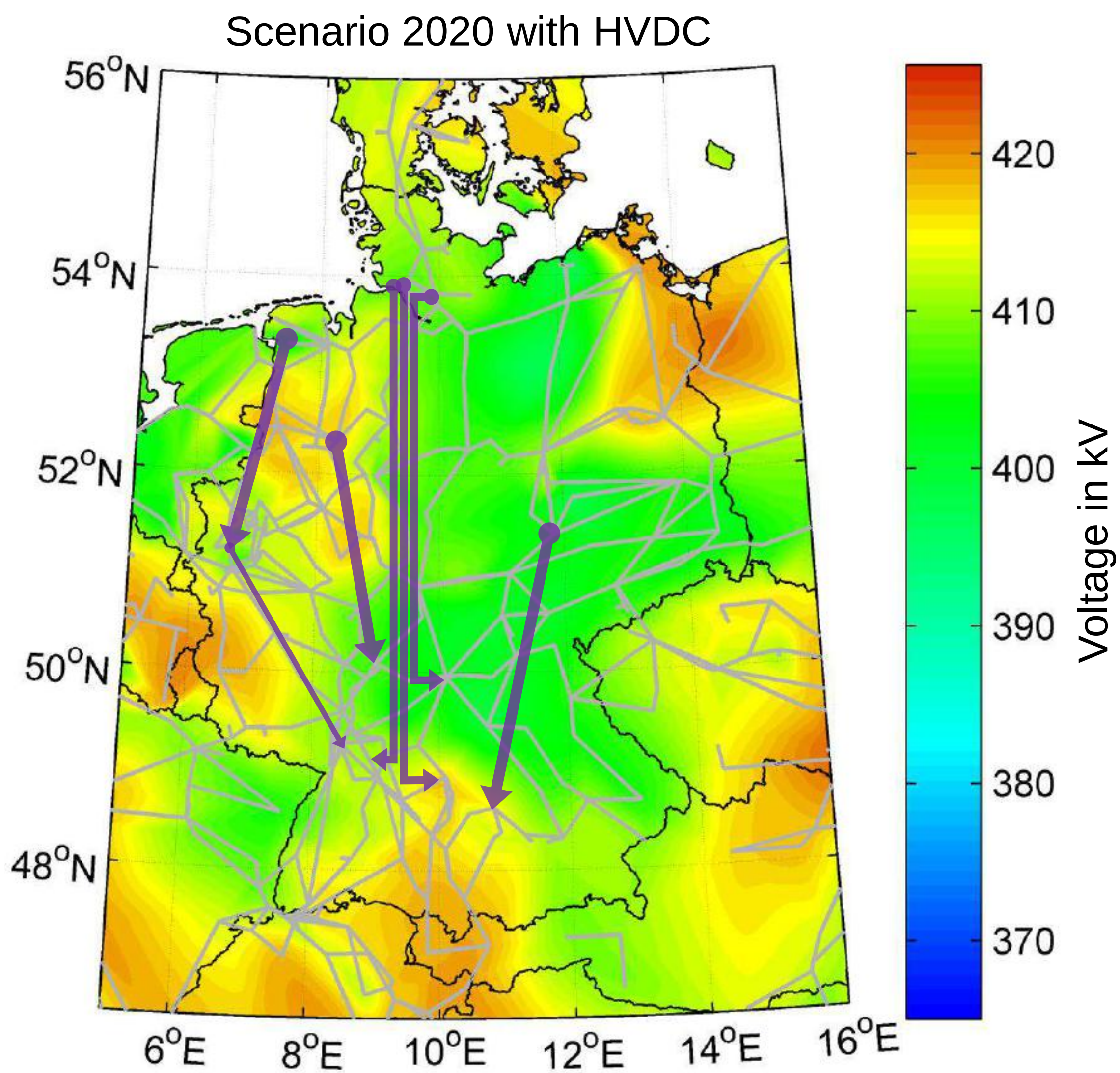
Scenario 1.c (2020):
- Severe voltage drop in Western and Southern region
- Additional measures necessary, 3 Gvar operational equipment



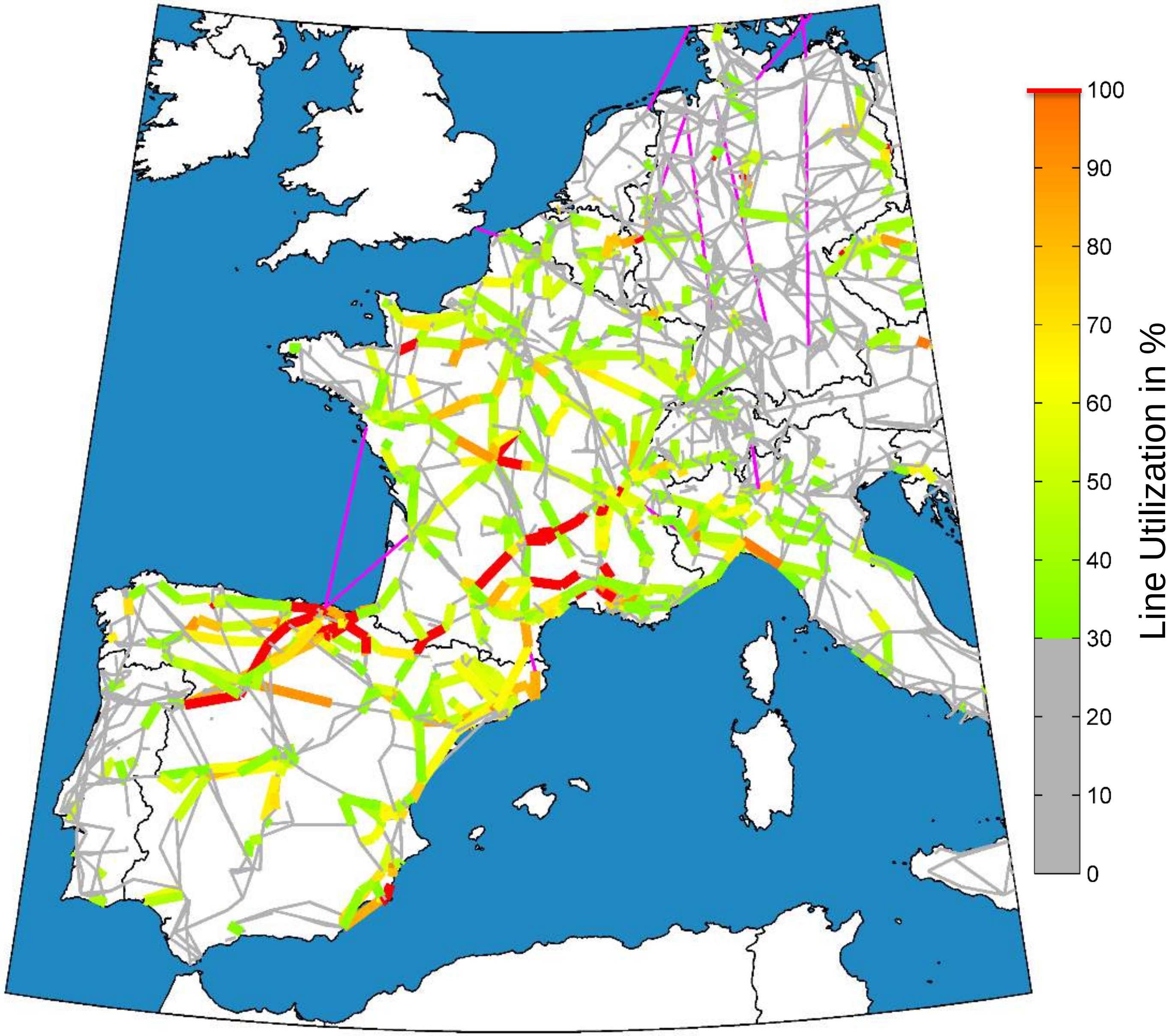
Stationary simulations

- Voltages within the transmission grid depend on line utilization
- Severe voltage drops within scenario 2020

- Grid calculation with optimized operation of HVDC lines
- Voltage increase by decreasing the load within the AC-grid



Scenario 2040



Overview

European power system

VGB research project

Stationary aspects

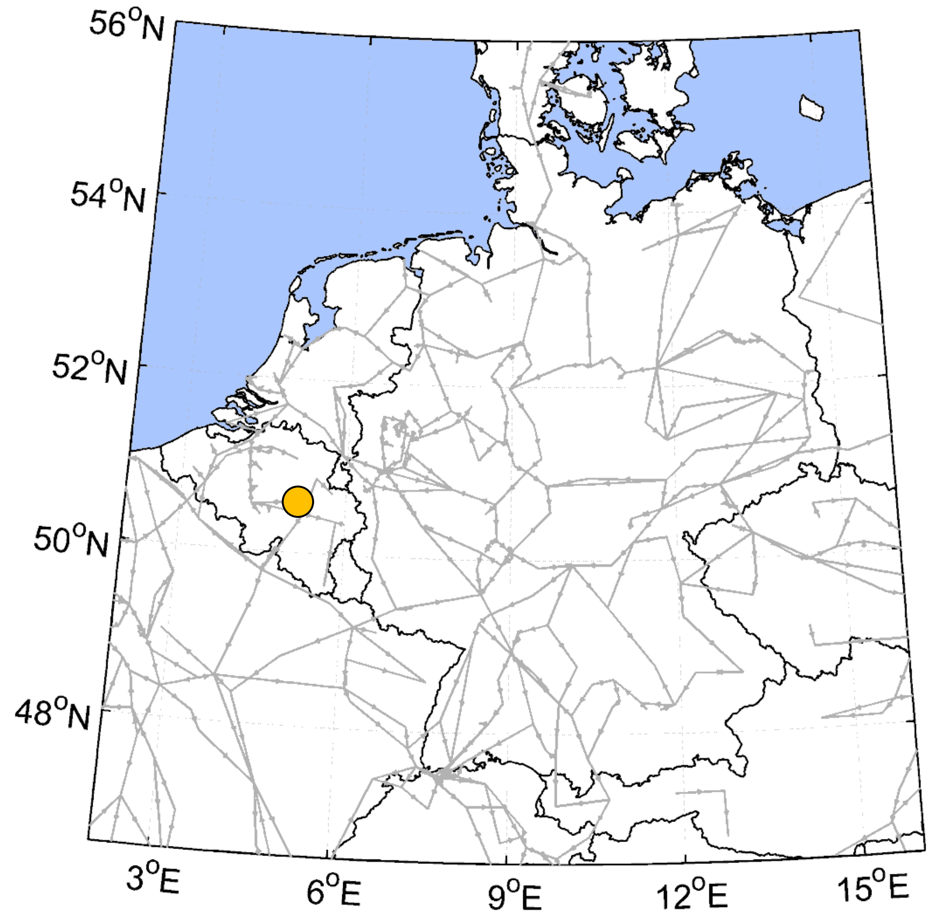
Dynamic aspects

Outlook

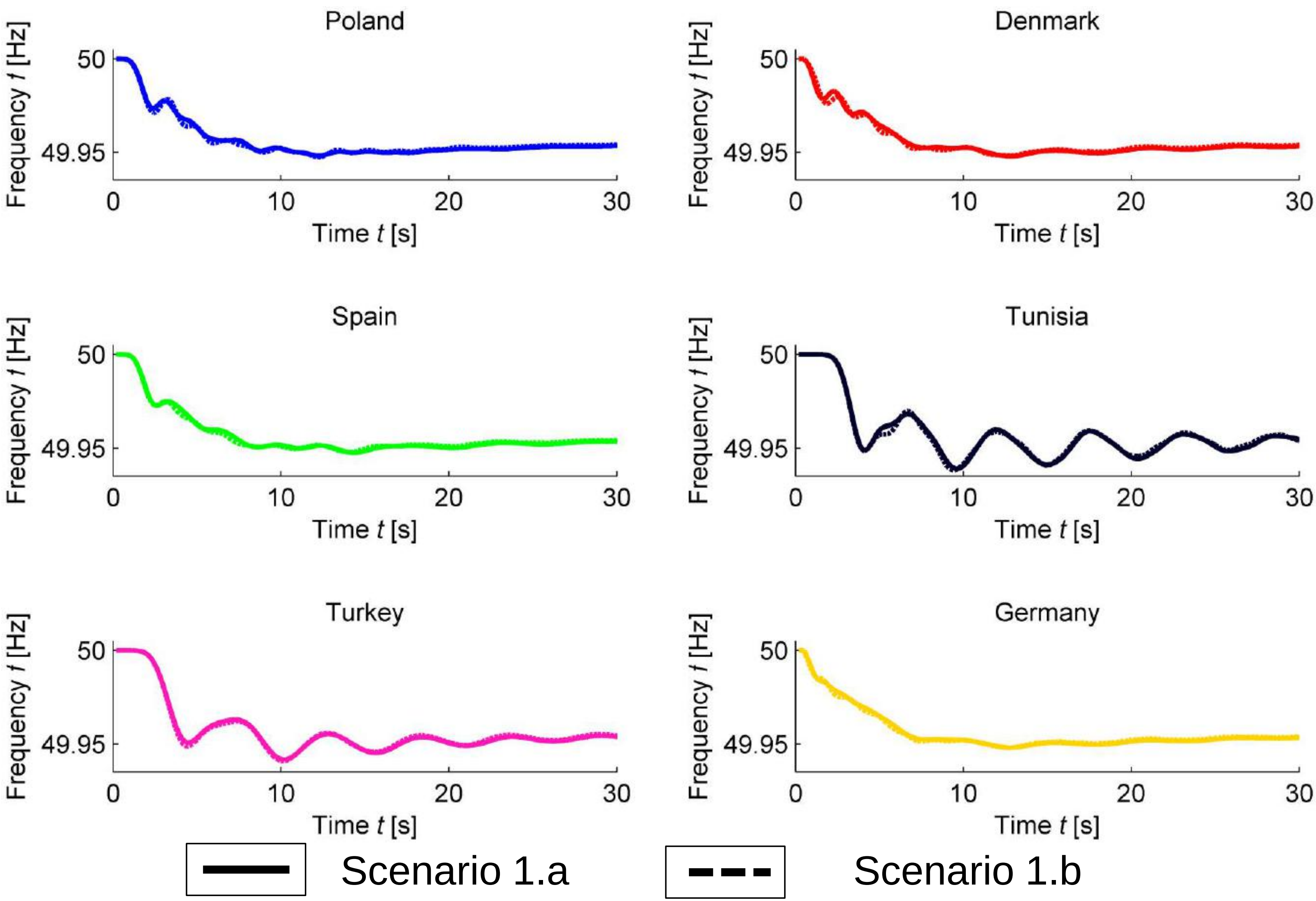
Conclusions

Dynamic simulations

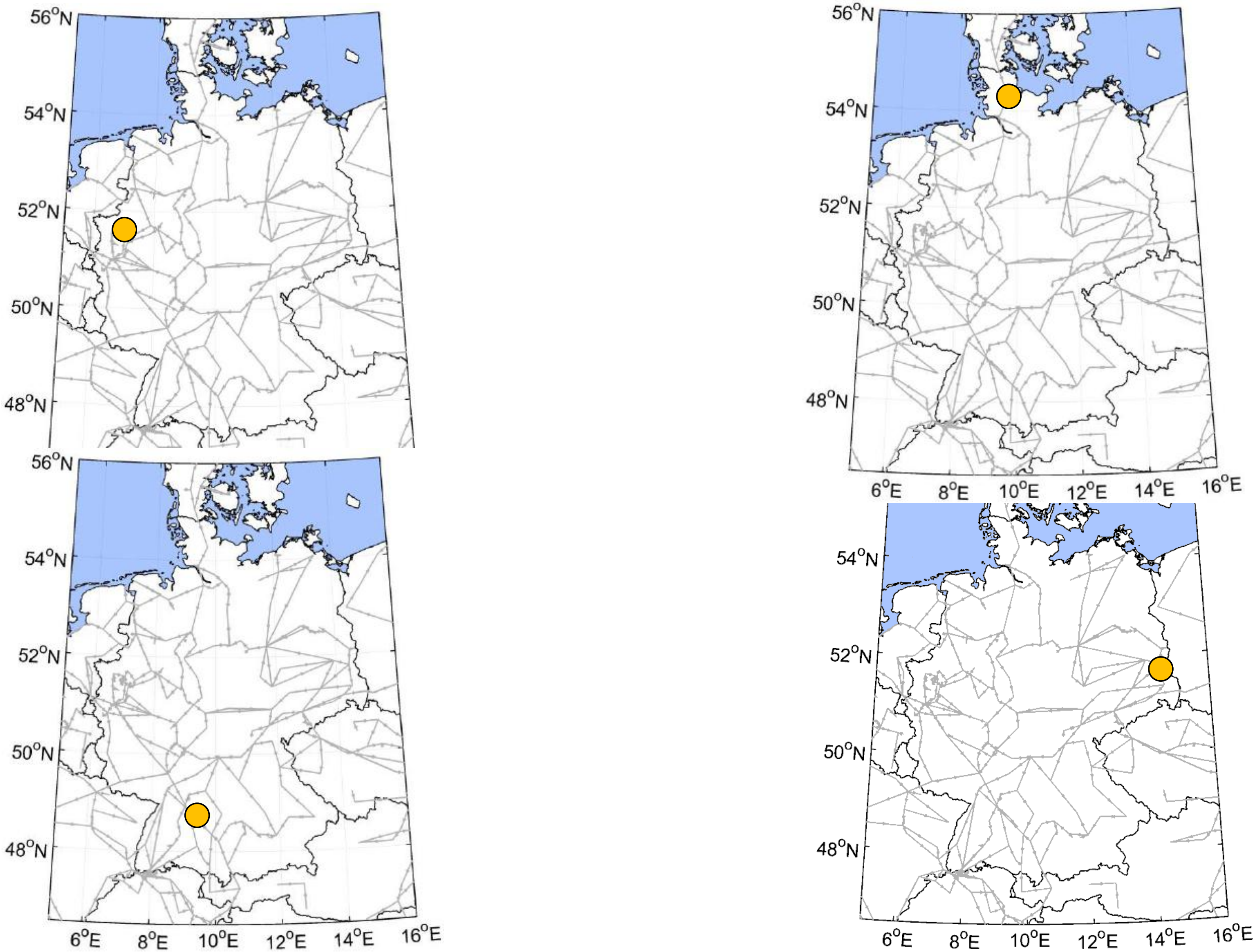
- Excitation of the system by a major power imbalance
- Simulation of the transient grid dynamics



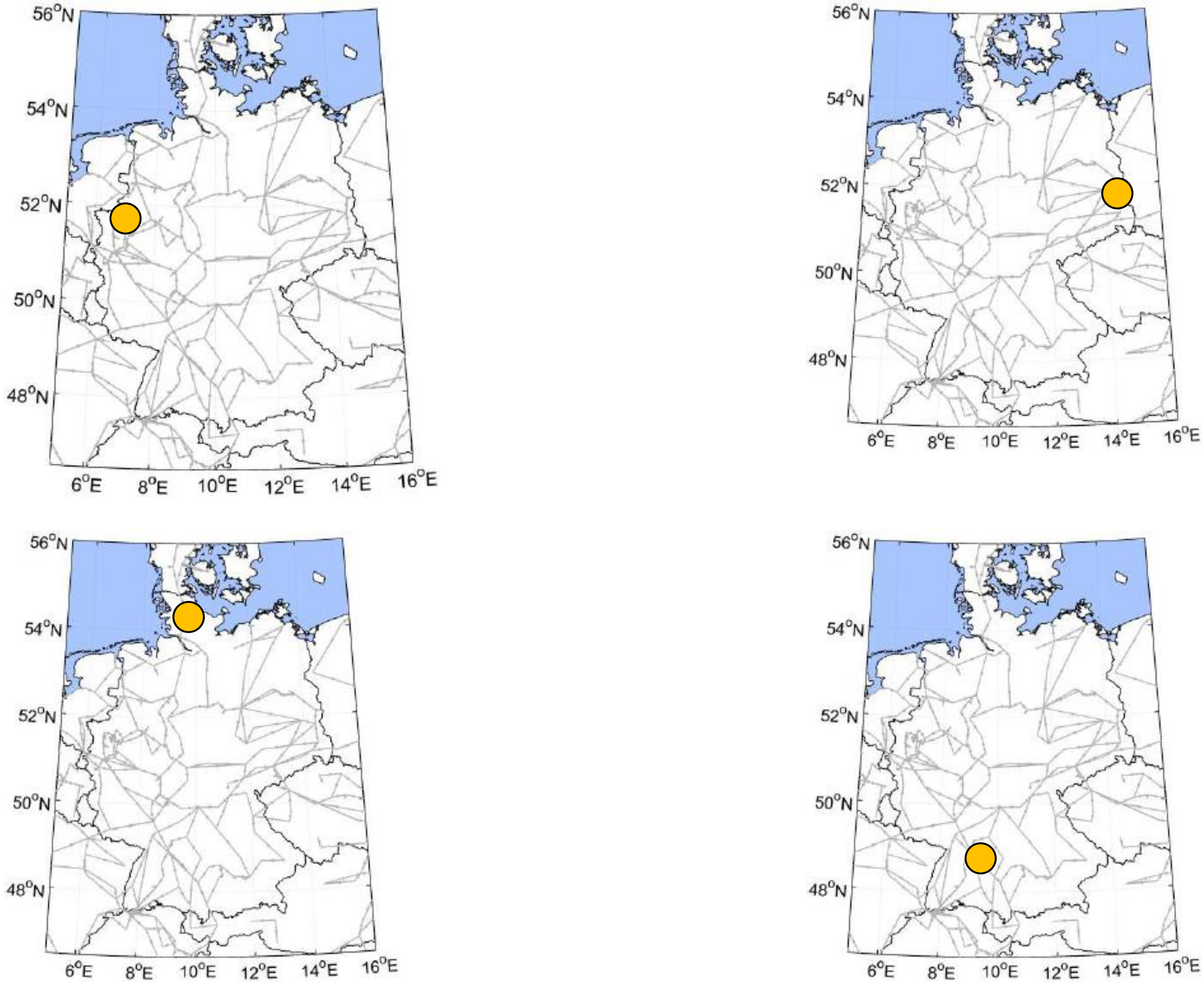
Comparison of transient frequency behavior – scenario 1



Transient frequency behavior – scenario 1
excitation within Germany



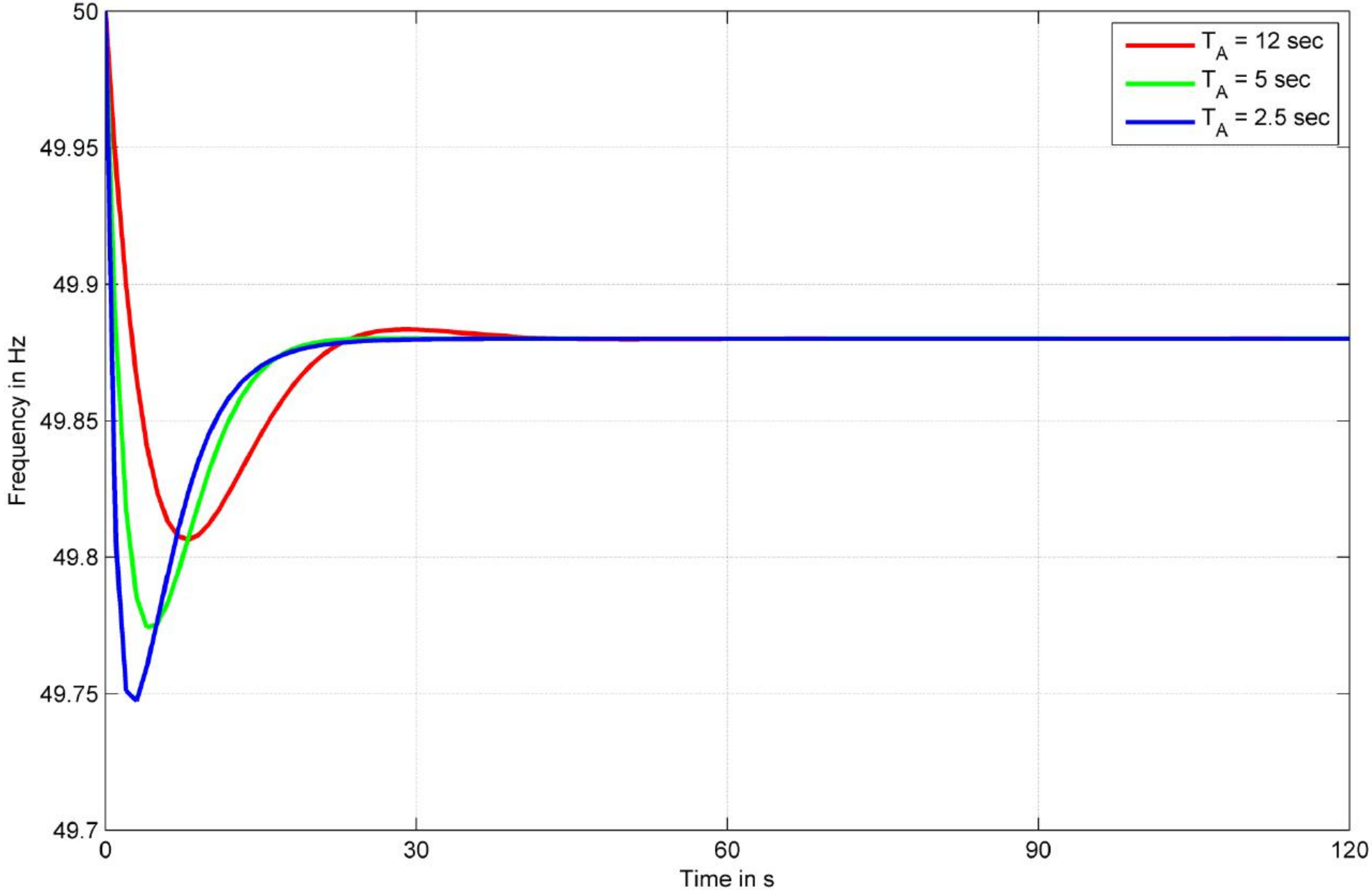
Transient voltage behavior – Scenario 1 excitation of 500 Mvar



- Significant impact of increasing intermittent generation on transient voltage behavior

Inertial response in future

- Increasing frequency drop with decreasing inertia



Conclusions

Stationary aspects

- Transmission limits violated on a few lines
- **Severe voltage drops** in different regions due to increasing power flows
- **Additional measures** necessary, especially for voltage control
- HVDC lines contribute to system stability

Transient system dynamics

- Transient frequency behavior shows no significant changes concerning the whole system by 2020 (joint-action)
- Local frequency deviations are increasing
- **Significant impact on transient voltage** behavior can be seen
- Possible impact on synchronous generators of power plants

Overview

European power system

VGB research project

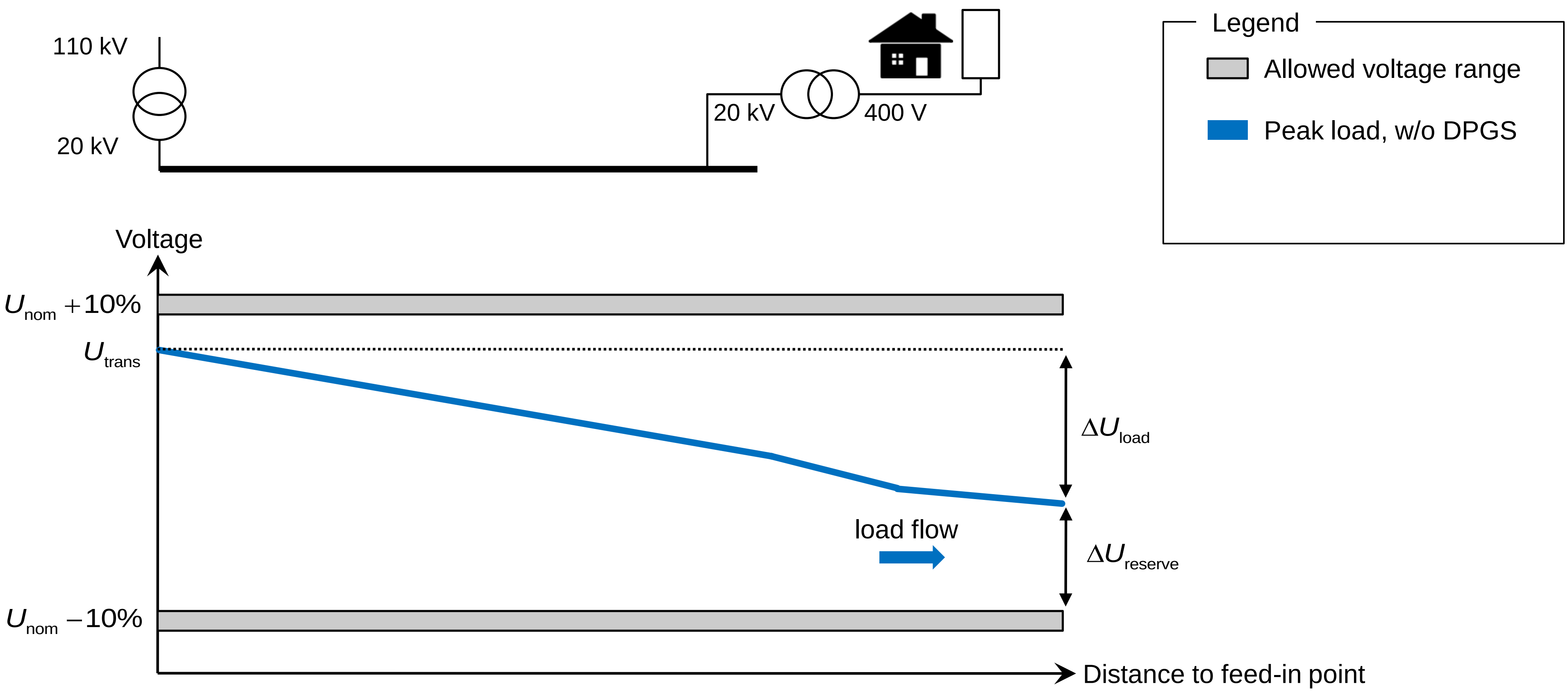
Stationary aspects

Dynamic aspects

Outlook

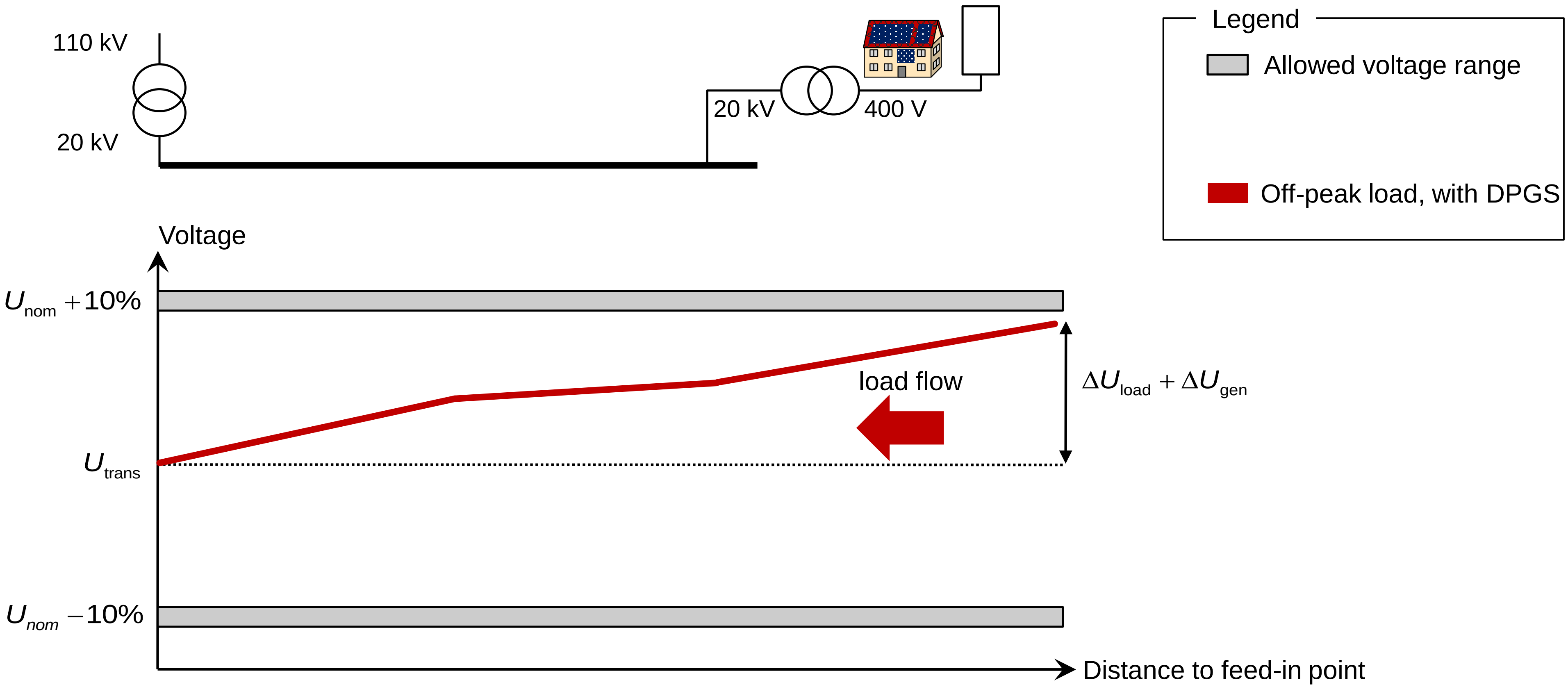
Conclusions

Bottleneck of DPGS-integration

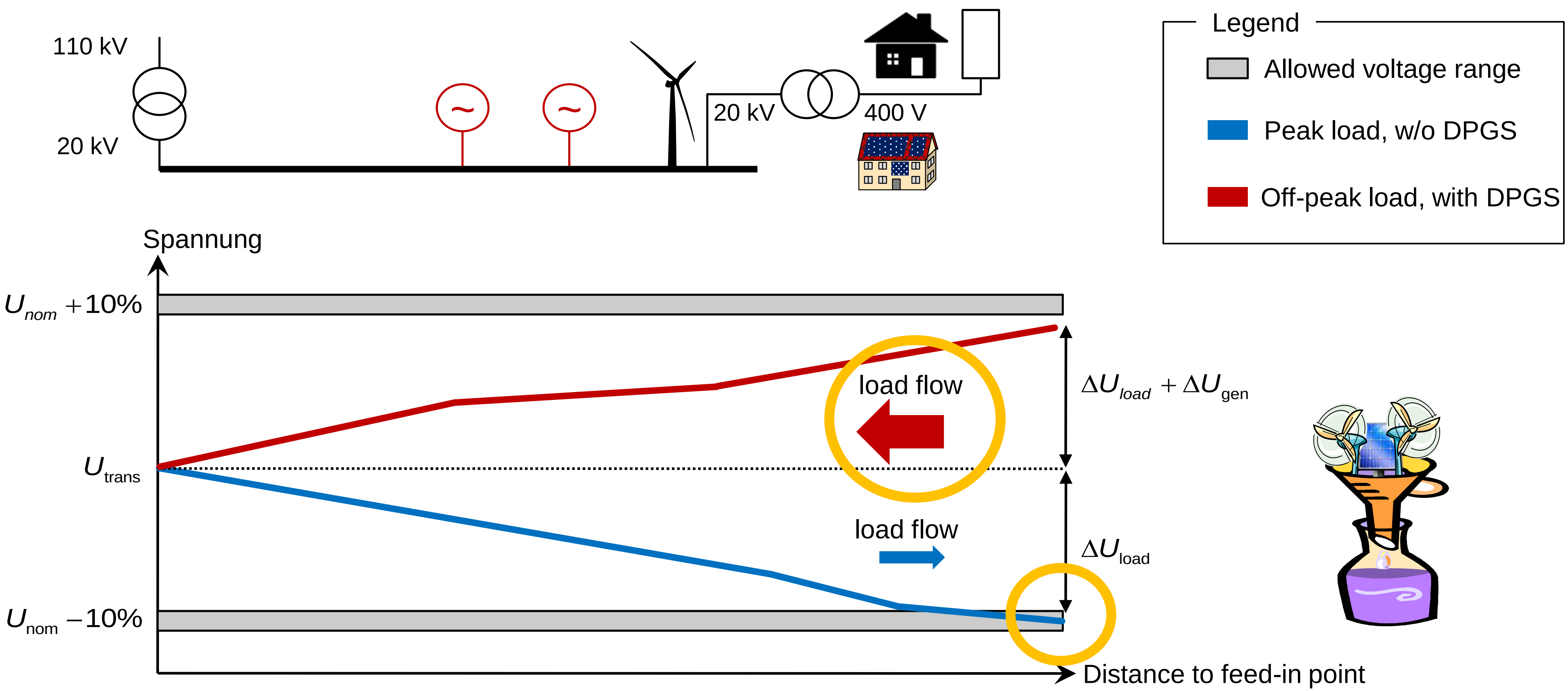


DPGS: Decentralised power generation systems

Bottleneck of DPGS-integration



Bottleneck of DPGS-integration



Thank you for your attention

Dipl.-Ing. Florian Gutekunst

Phone: +49 711 / 685 65580

florian.gutekunst@ifk.uni-stuttgart.de

University of Stuttgart
Institute of Combustion and Power Plant Technology
Department Power Generation and Automatic Control
Pfaffenwaldring 23
70569 Stuttgart
Germany