REAL TIME SIMULATION FOR PHIL APPLICATIONS IN A MICROGRID TESTBED

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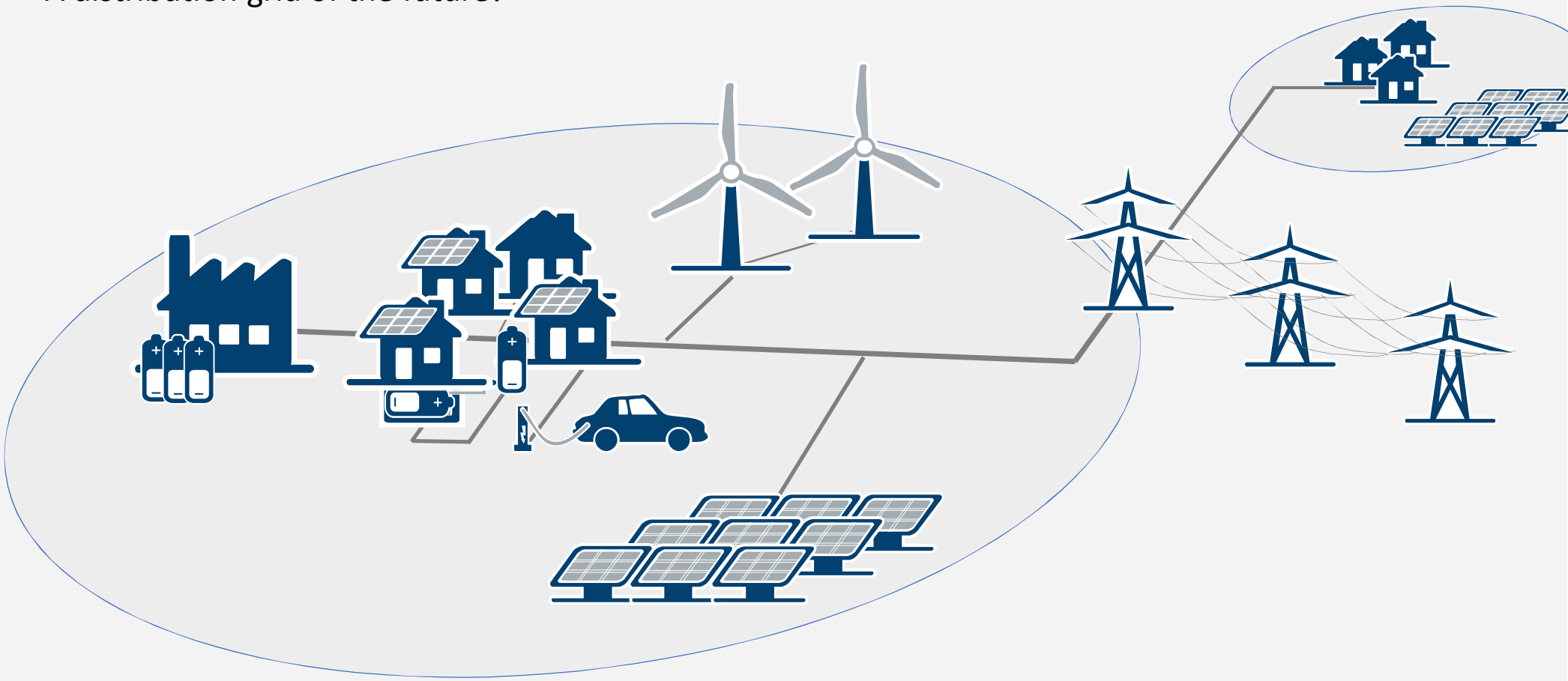
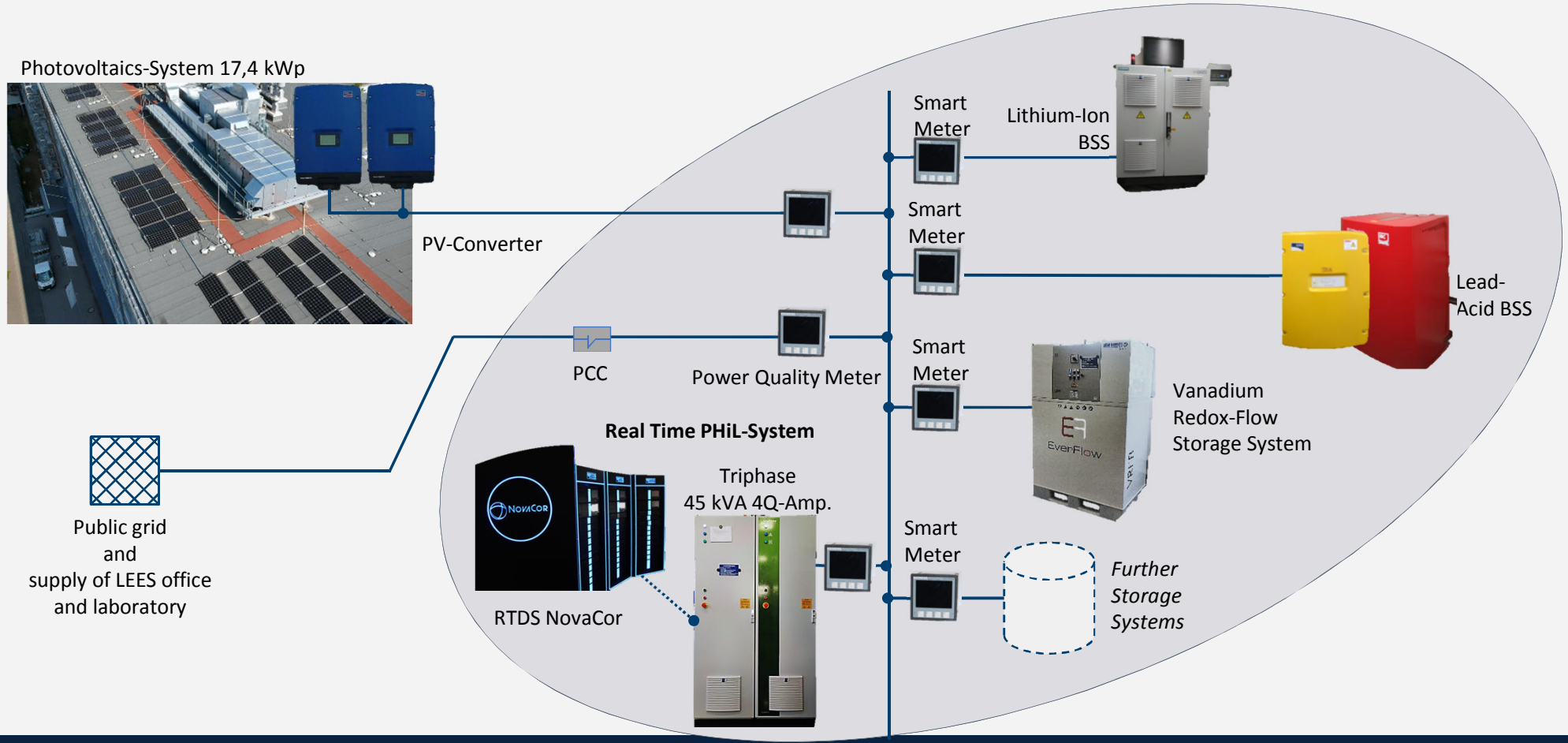
USER SPOTLIGHT SERIES BY RTDS Technologies

A distribution grid of the future?



THE MICROGRID LABORATORY AT THE FAU



THE MICROGRID LABORATORY AT THE FAU

- 3 Storage systems
- 17.42 kWp PV-system
- Fire proof battery container
- Measurement equipment

- Central Microgrid Controller

THE RTDS NOVACOR REAL TIME SIMULATOR

In January 2020 integration of an RTDS in the laboratory

- 1 RTDS NovaCor chassis
- 4 Cores licenced
- AURORA optical communication interface

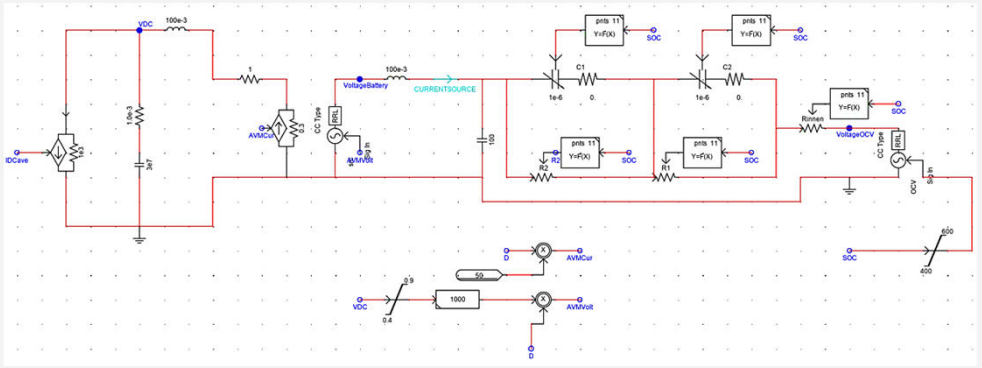
THE PHIL FOUR-QUADRANT AMPLIFIER

- 4 Quadrant nonlinear amplifier
- 45 kVA rated power
- Back-to-back structure for energy recovery into the grid
- 3 phase + neutral wire
- Current or voltage controlled source

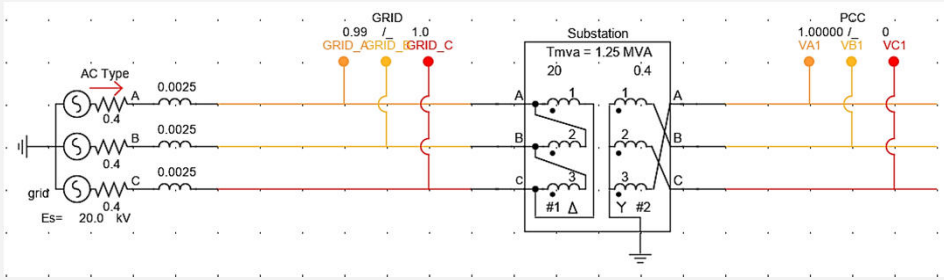
APPLICATIONS

Virtual hardware to augment the real microgrid

- Real-time model of a BSS/RES-system
- Implementation as average model
- Interfacing of virtual with real grid with 4Q-amp.
- Operation of 4Q-Amp. as **current source**
- PHiL over closed loop AURORA communication



APPLICATIONS

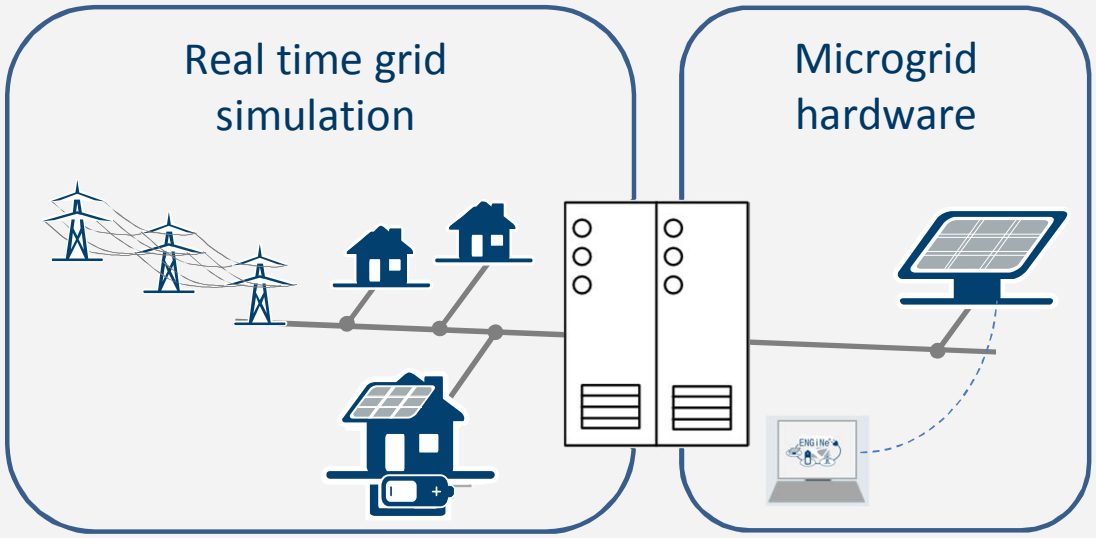


Microgrid hardware testing

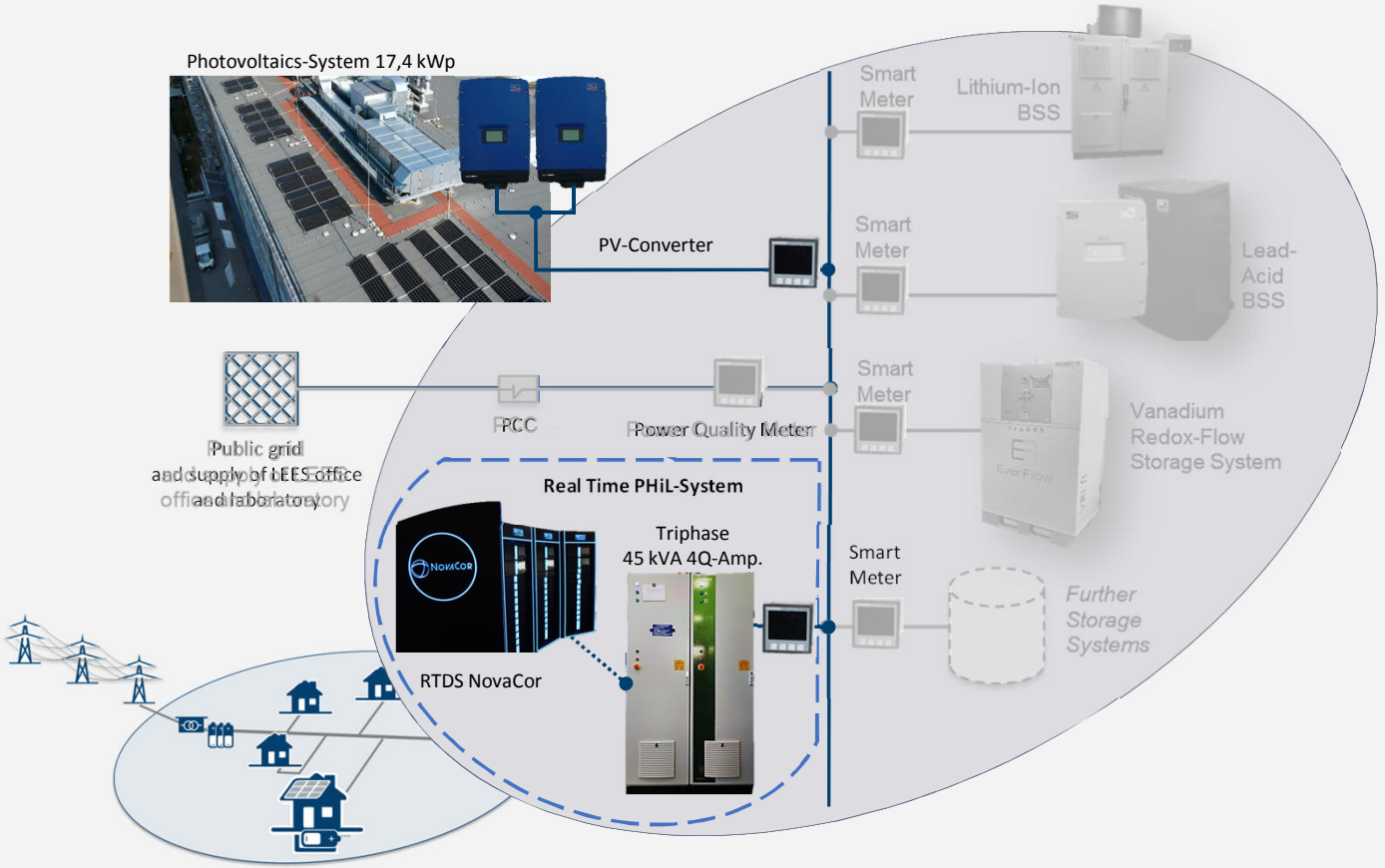
- Real-time model of a power grid
- Testing of power converters, controllers
- Interfacing of hardware and virtual grid with 4Q-amp.
- Operation of 4Q-Amp. as **voltage source**
- PHiL over closed loop AURORA communication

LABORATORY SETUP

- Experimental PHiL-setup of a hardware PV-system to connect to a real-time simulated grid
- Testing of German low-voltage grid standard (VDE AR 4105)



LABORATORY SETUP



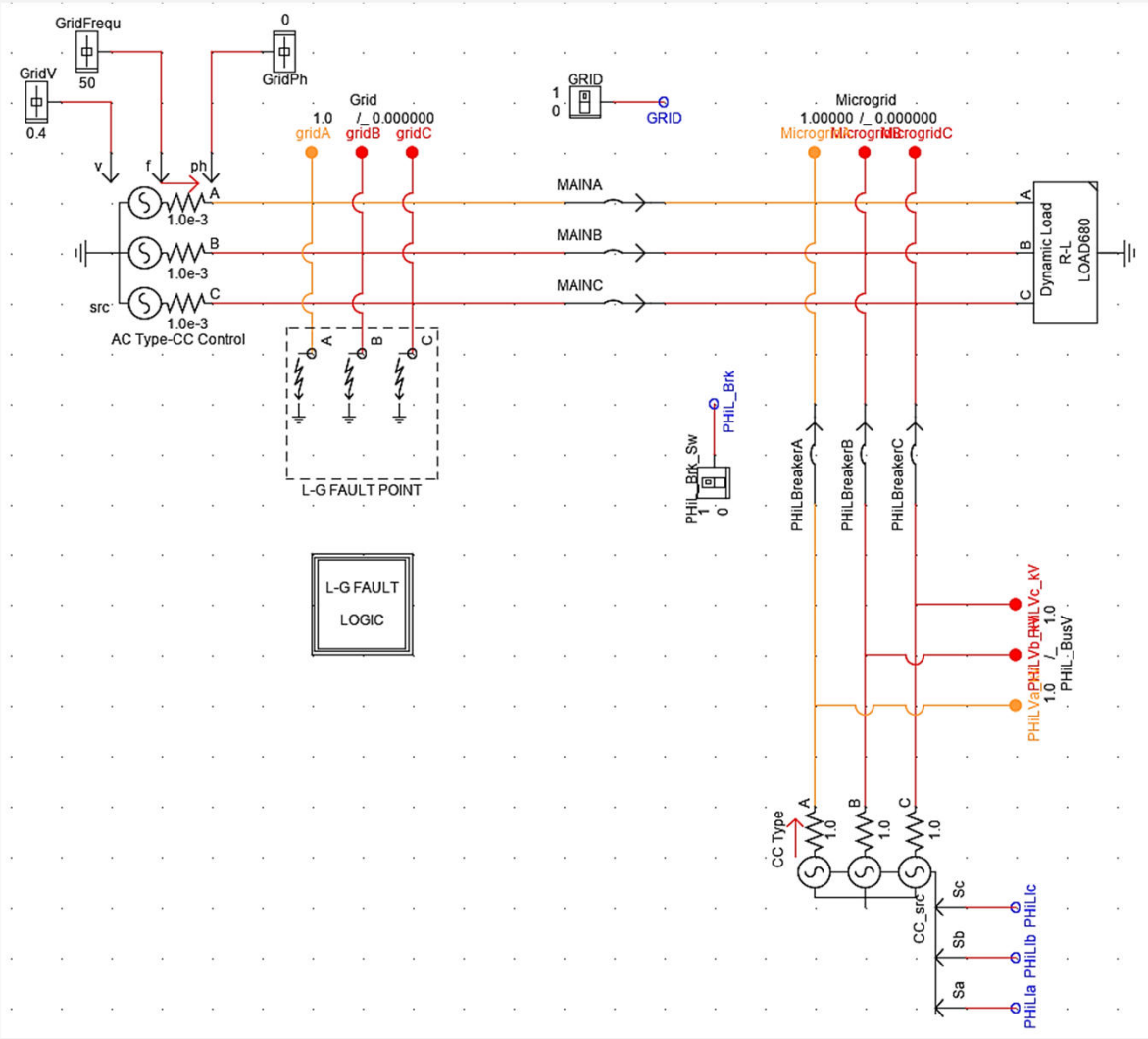
THE RSCAD MODEL

Virtual grid

- Real time simulation of a low voltage power grid
- 0.4 kV utility grid with supplies a load
- Adjustable voltage amplitude and frequency
- Grid fault simulation

PHiL interconnection

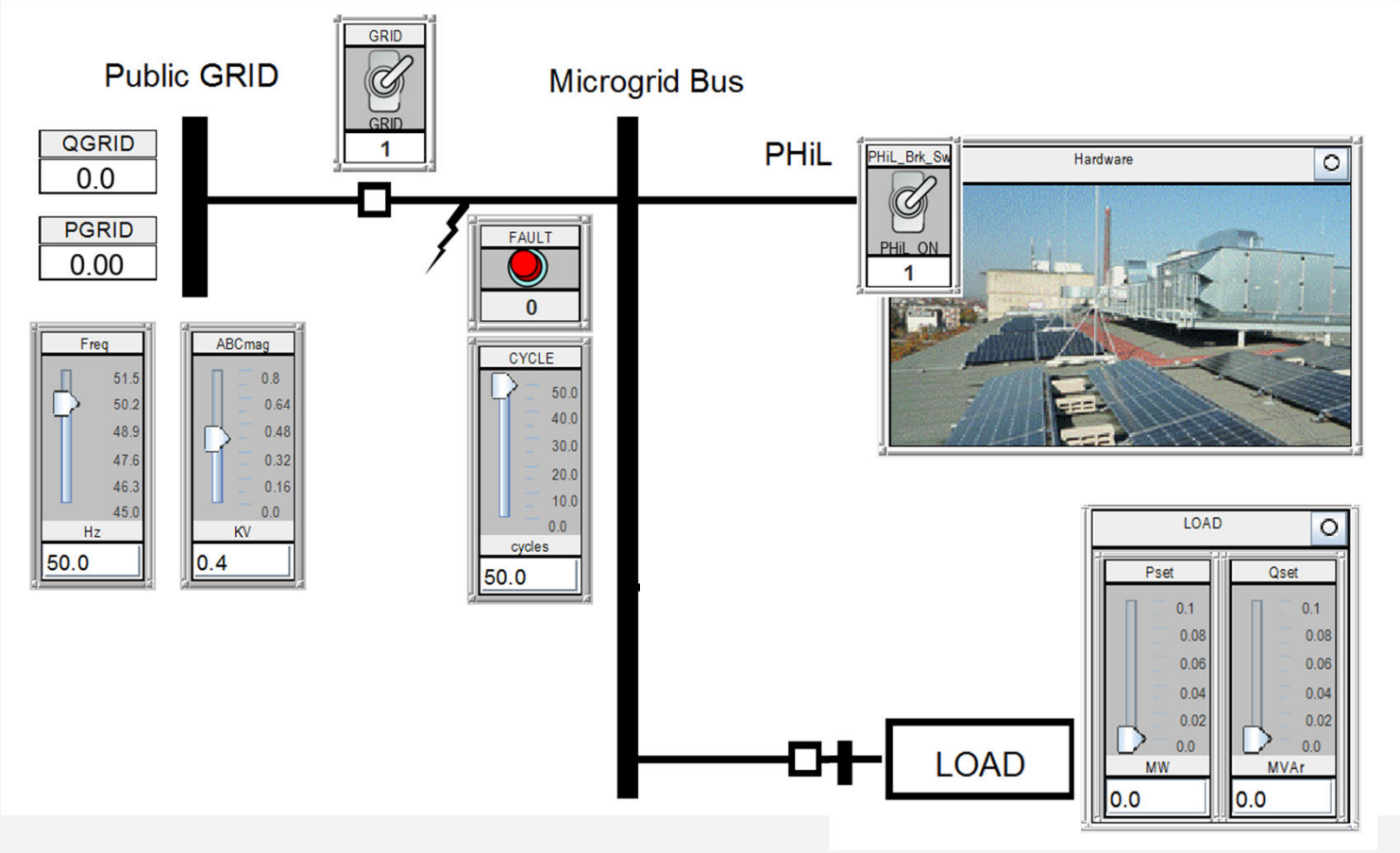
- three phase controlled current source



THE RSCAD MODEL

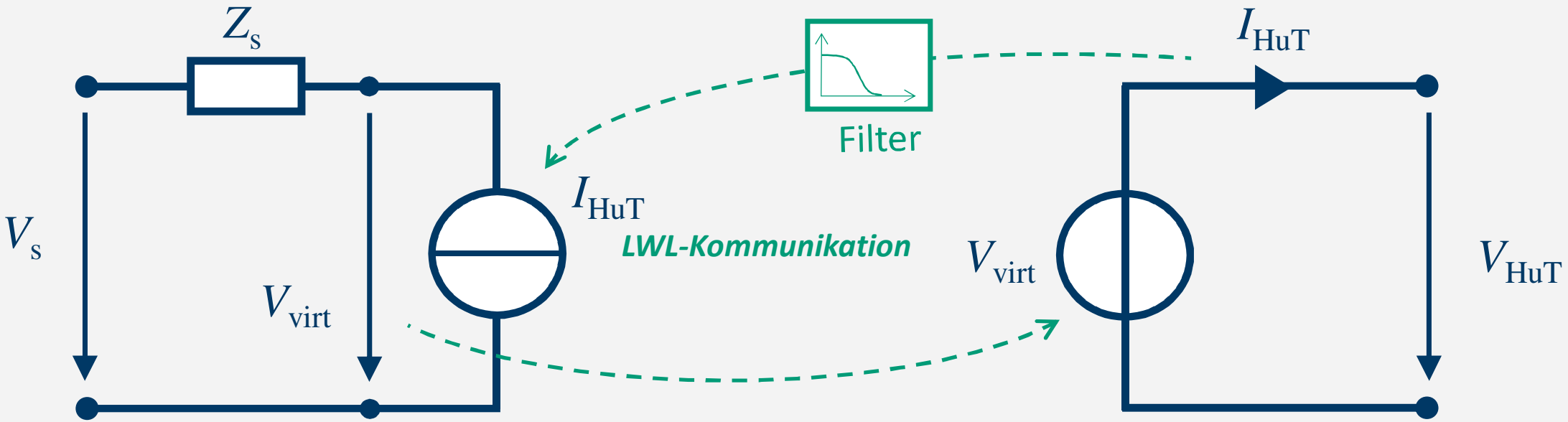
RSCAD Runtime

- Sliders to adjust grid voltage amplitude and frequency
- Push button for grid fault

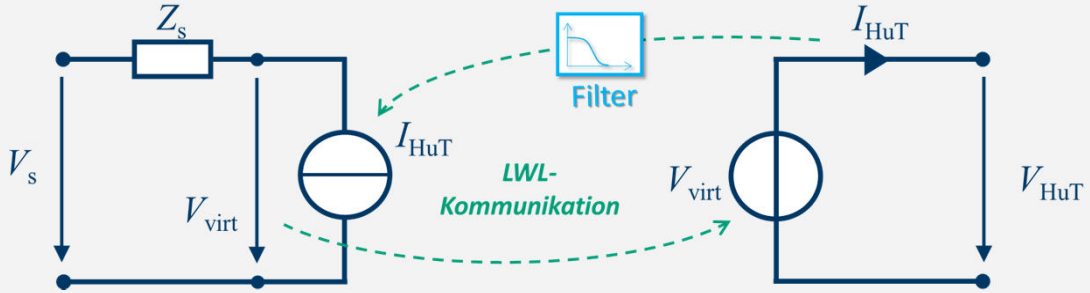


PHIL INTERFACING ALGORITHM

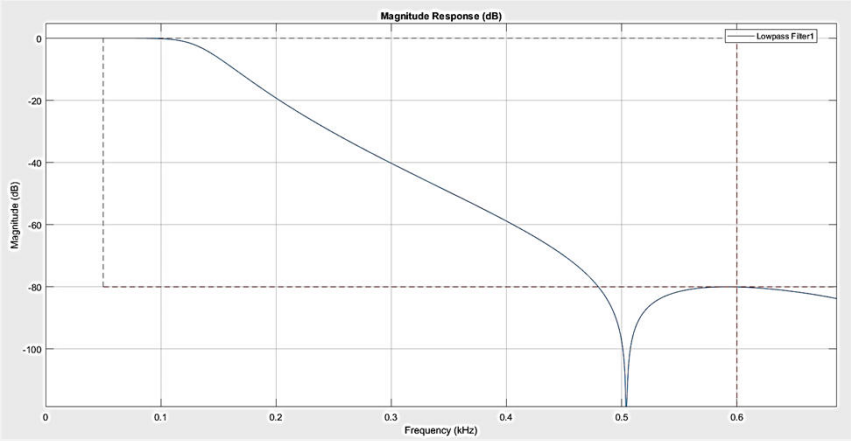
- Ideal transformer method



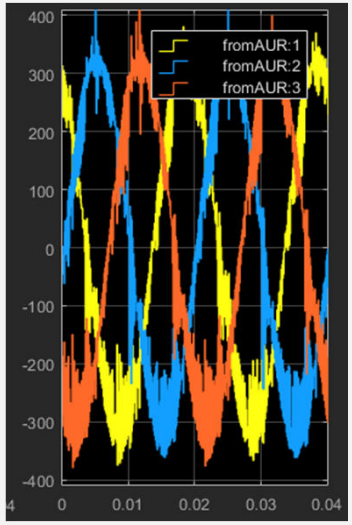
LOW PASS FILTER



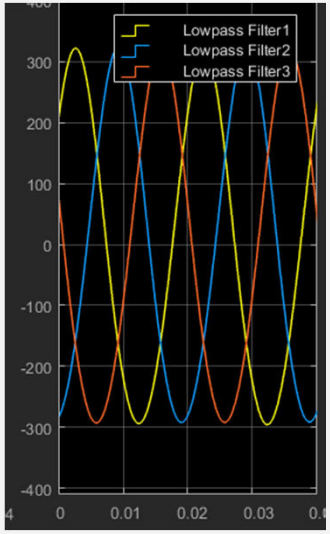
- Without a lowpass-filter instability can occur
- Filter design with MATLAB fdatool:
  - IIR-filter
  - Passband edge frequency: 50 Hz
  - Stopband edge frequency: 600 Hz



unfiltered signal

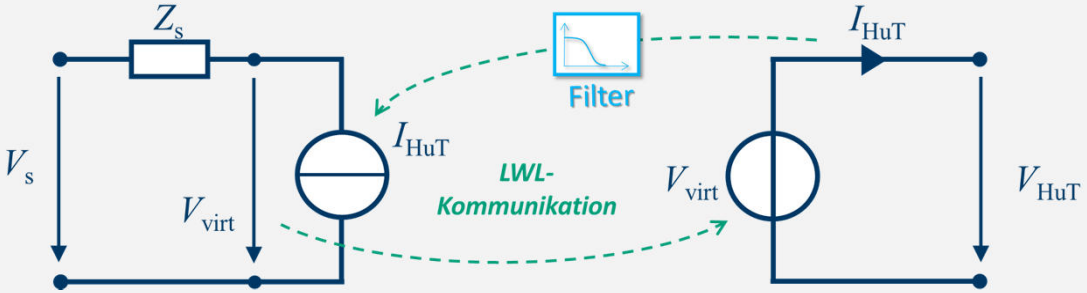


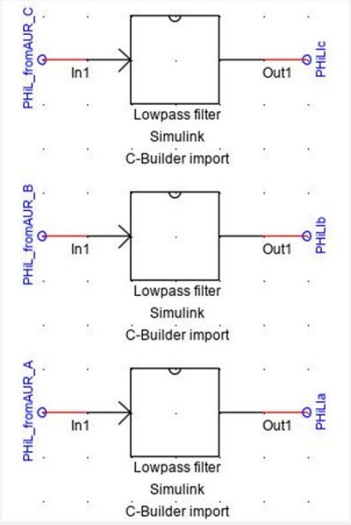
filtered signal



LOW PASS FILTER

- Without a lowpass-filter instability can occur
- Filter design with MATLAB fdatool
- Import in RSCAD via C-Builder





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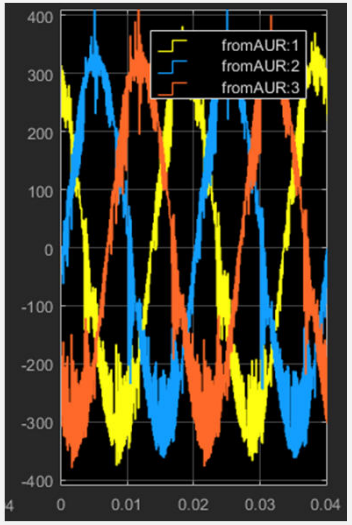
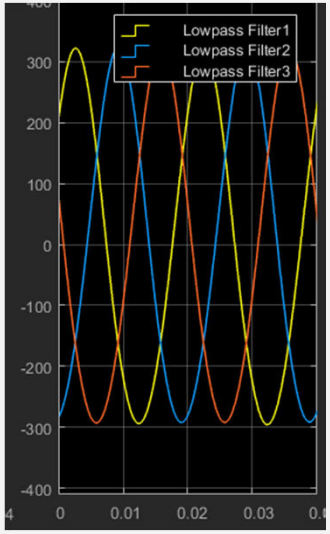
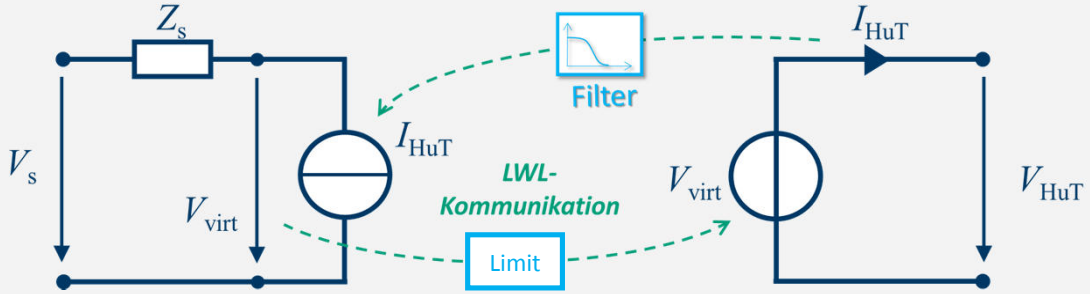


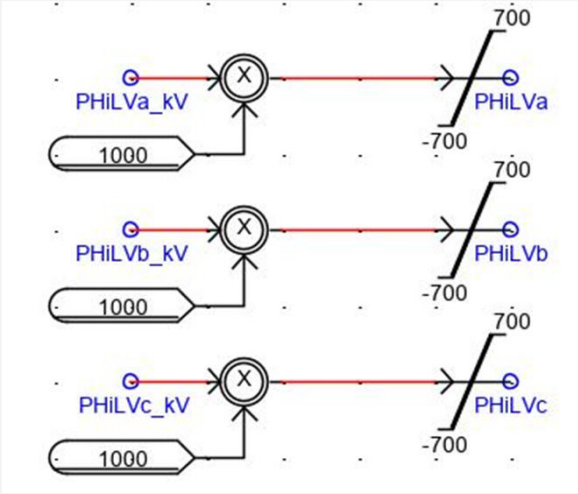
filtered signal



VOLTAGE LIMIT AND ADJUSTMENT

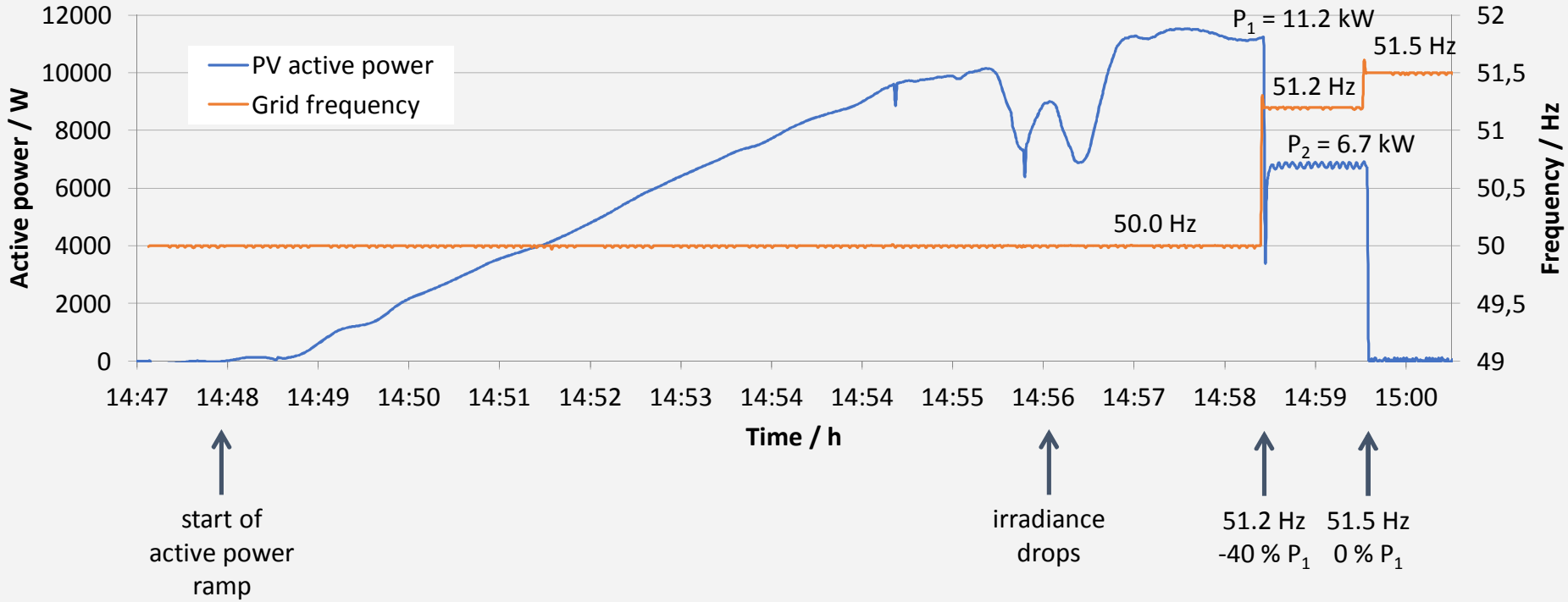


- Conversion from kilo volt to volt
- Limit the voltage setpoint of 4Q-ampl.
- Introduction of saturation blocks
- Reduce stress for the hardware in case of a malfunction



SIMULATION RESULTS

PHiL Simulation for validation of grid standards



CONCLUSIONS AND OUTLOOK

- The concept of a test laboratory for microgrid applications, storage systems and future distribution grids has been shown
- Real time simulation adds virtual components and power grids to the hardware setup to gain a flexible and comprehensive testing facility
- An exemplary PHiL-simulation of a real PV-system feeding into a real-time simulated grid has been shown
- Further testing applications are possible