ADC Labs

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Project Abstract

- Research of the fundamentals for the development of test methods to support the development and validation of DC components and systems based on P-HIL.

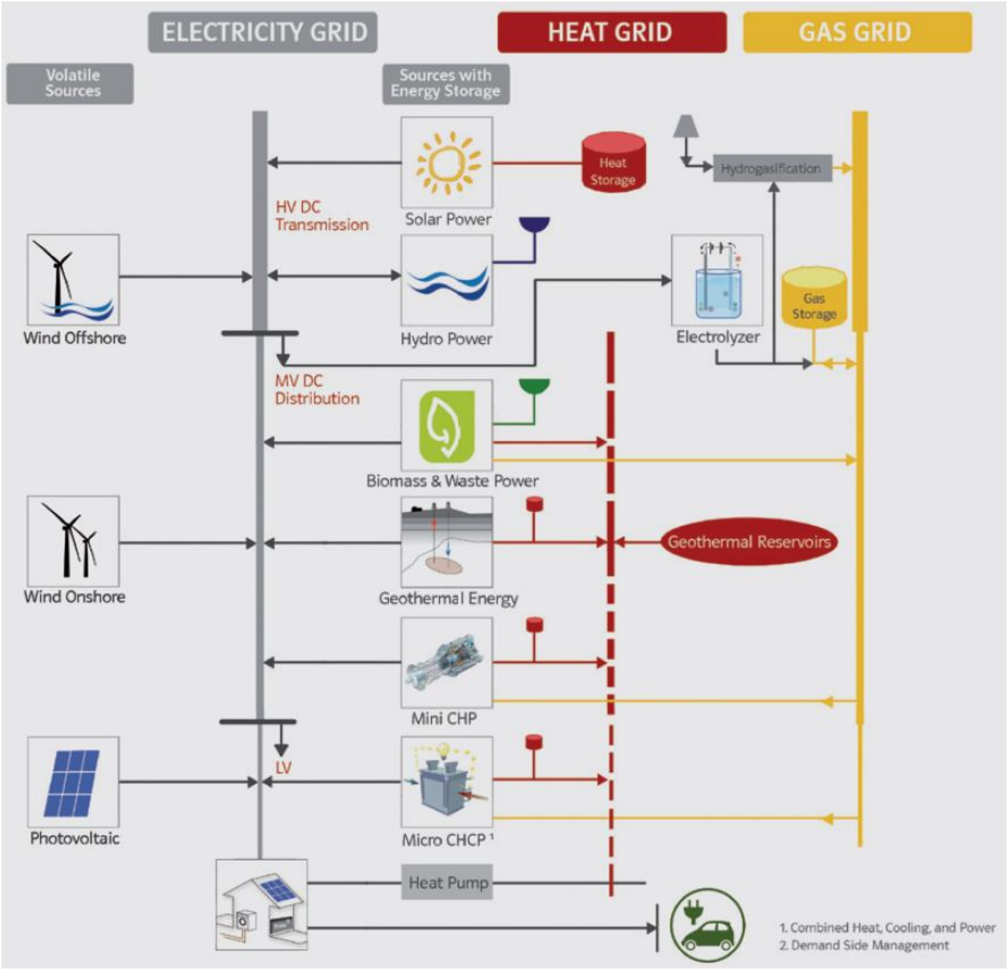
- The continuous increase of power electronic components and systems on various voltage levels in the electricity grid lead to an ongoing discussion of DC-grids in research and industry. Thereby the need for new testing methods for those systems is also increasing.
- The ADC Labs project develops the principles for system tests using highly complex grid topologies with multiple interfaces and applications within low voltage DC-grids
- The current knowledge for this method based on LVAC systems will be used to transform this method in higher voltage levels. The additional elements that need to be taken into account for HIL interfaces on these higher power levels lead to increased requirements where basic principles still have to be understood.

Funding Frame

- Funding Agency: Klima- und Energiefonds
- Topic Area 1 „Emerging Technologies“: Cooperative basic research
- Development and test methods (in correlation with research infrastructure) for DC-Systems:
- C-/P-Hardware-in-the-Loop (HIL), digital control for power electronics and rapid prototyping for product (time-to-market, energy density, reliability, efficiency) and technology development (wide bandgap, controller, etc.) for new applications in electricity grids and interfaces to other energy grids

The project idea

- The electric grid of the future will contain novel applications as well as interfaces to other energy grids (Hydrogen, Gas, Heat)
- A significant amount of applications will be coupled via DC Systems (PV, Storage, EV,…)
- The hierarchical topology of electricity grids result in a direct coupling of high voltage and currents. Thus system validations can only be executed with appropriately designed laboratory environments.
- Test requirements are getting more expensive due to the increased implementation of semi-conductors and the resulting increase in system complexity



R. DeDoncker "Energy Research for Sustainability" E.ON Energy Research Center, 2015

Common Project Goals

- Main Objective:

Extention of the P-HIL methodology to higher power levels as well as higher system complexity

- Secondary Objective:

Generation of synergies between involved laboratory infrastructures

Inclusion of industry stakeholders to be able to address the future need and use-cases in the methodology development

- Non-Objective:

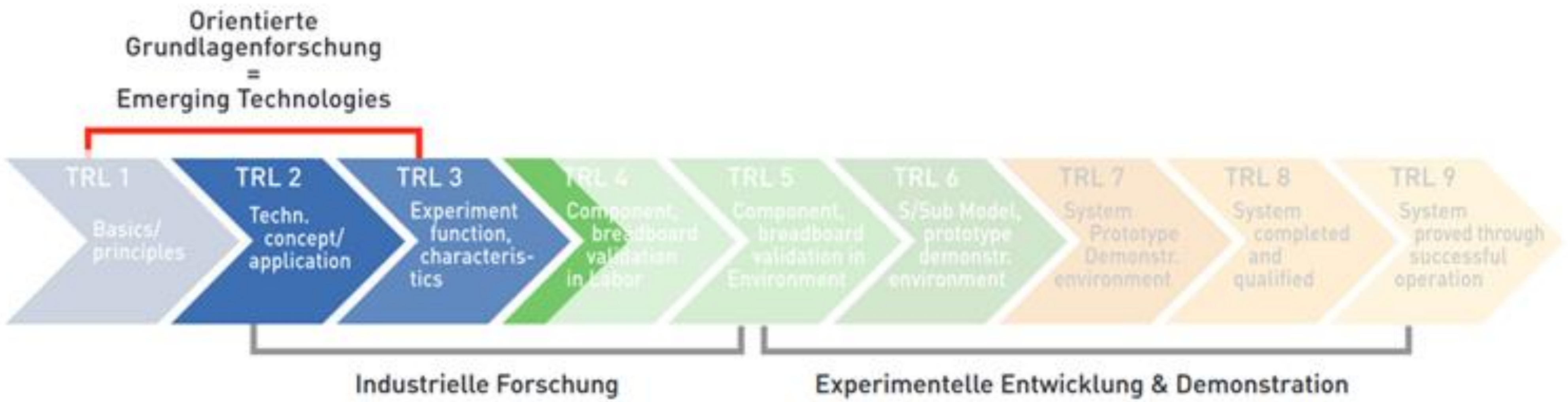
Test development

Low Voltage

Based on the concept of a multitermal DC-grid the basic functionalities of such a grid shall be achieved, considering the integration of renewables and novel loads (real or virtual)

In order to be able to evaluate the interactions of the different participants fully transient the model complexity and the emulation of Storage, PV and electric vehicle charging infrastructure must be adjusted

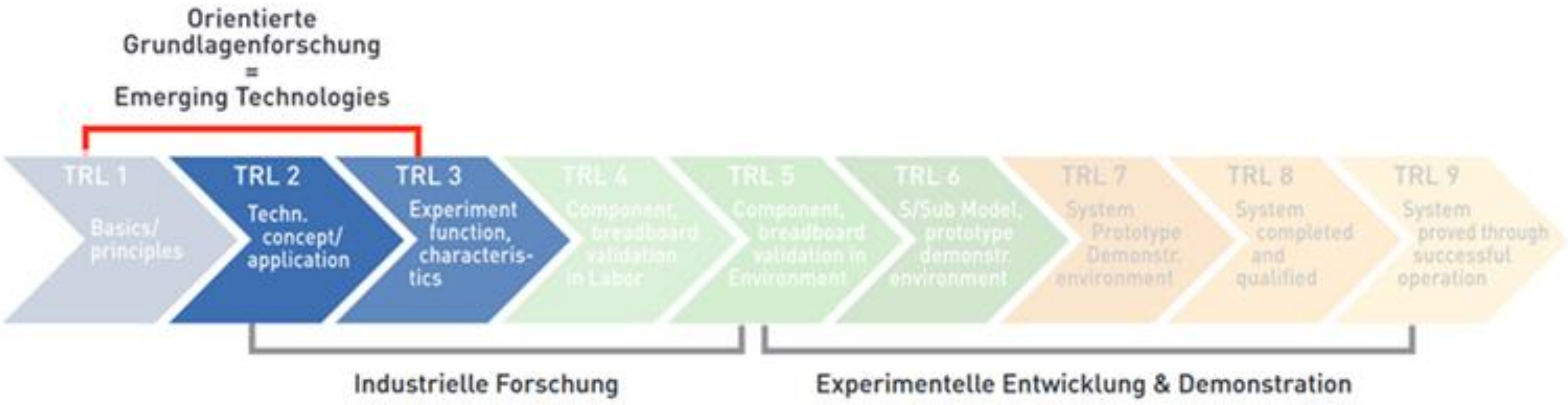
Addressed technologies: LV-Inverter, power semiconductors, transient error scenarios (e.g. LVRT)



Medium Voltage

Based on the methodology development in LV grids basic principles for the MV operation will be developed. The project therefore sets up a technological concept for a P-HIL set up on MV levels and will demonstrate the principal function of such a set up.

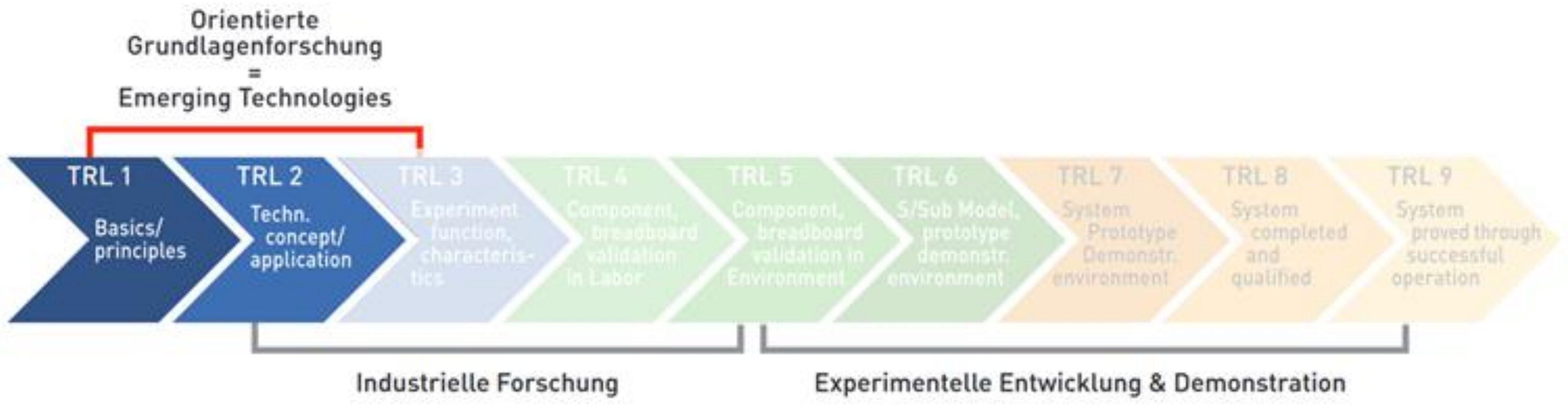
Addressed technologies: solid state transformers, „HV“ power semiconductors, insulation tests



High Voltage

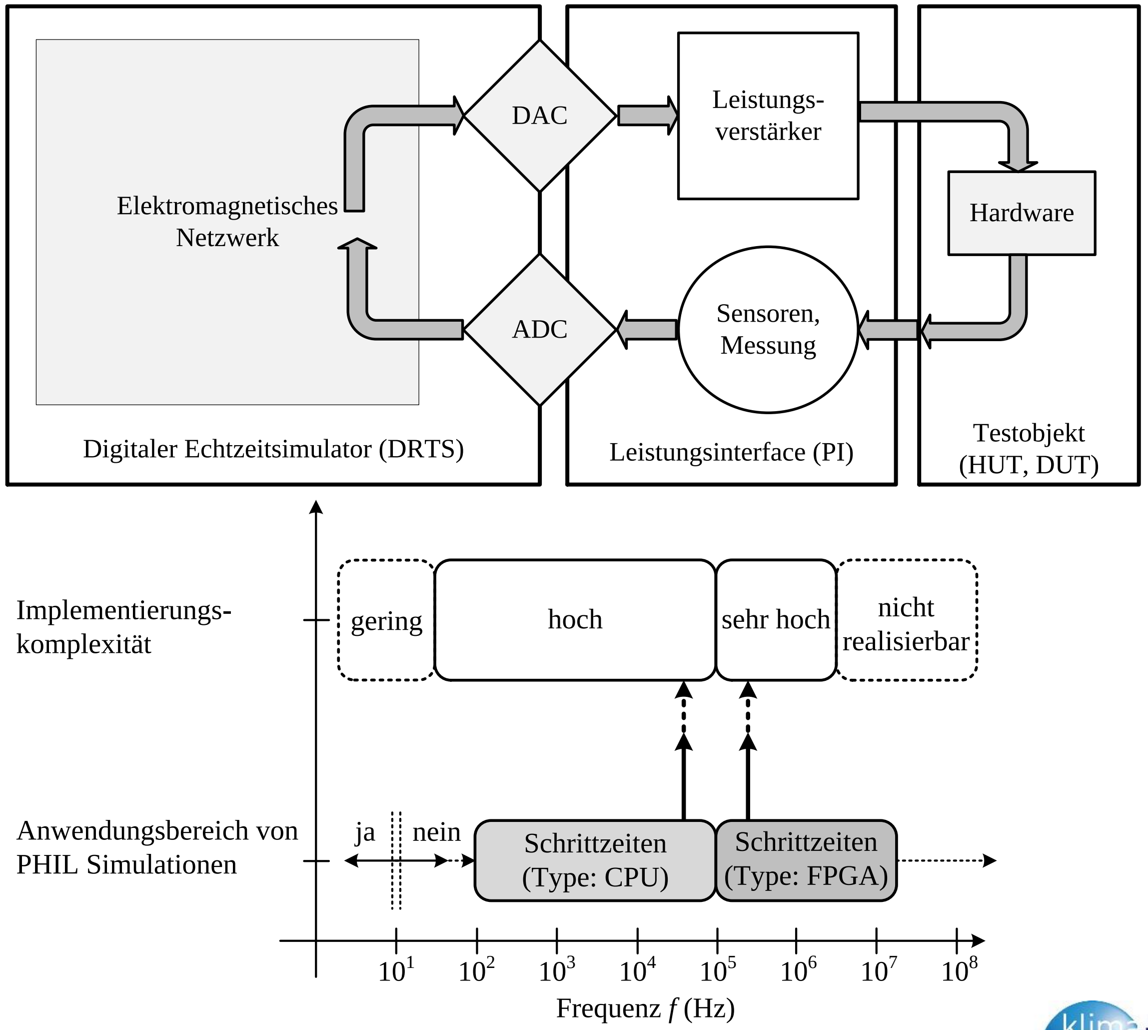
During the project the methodology development will be transferred to the HV domain . Concepts for P-HIL set-ups in the HV domain will be developed.

Addressed technologies: HV-Inverters, DC transmission lines, electric insulation systems



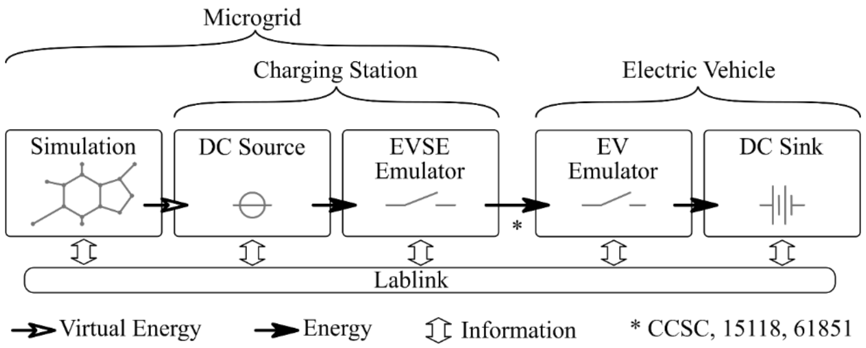
Power Hardware in the Loop

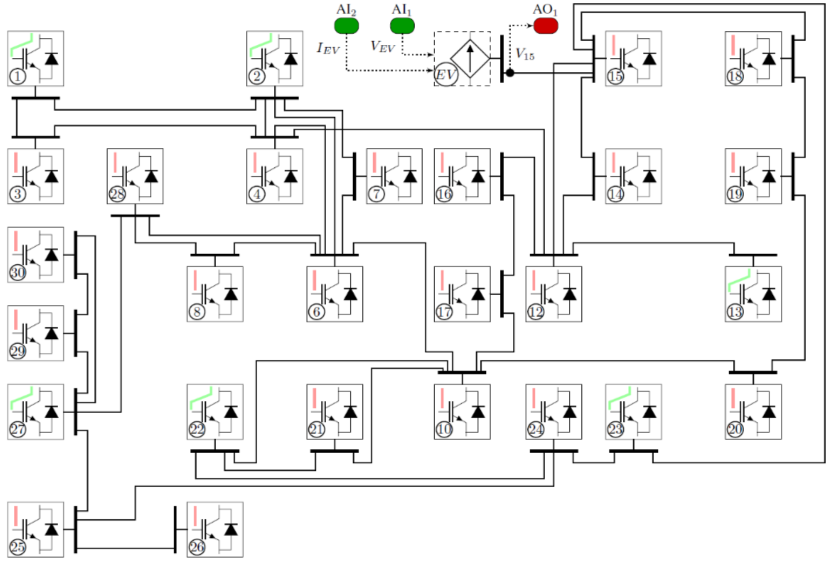
- PHIL extends Hardware in the Loop
  - Typically via the use of a power amplification unit
  - This results in the introduction of an additional control loop which leads to potential instability



Application EV Integration in Microgrids

- EV charging is one of the most promising DC applications (as of right now)
- A DC Microgrid is simulated
- A single connection point of the simulation is passed through to Lab Infraastructure
- A real charging station & EV are connected to the DC Microgrid

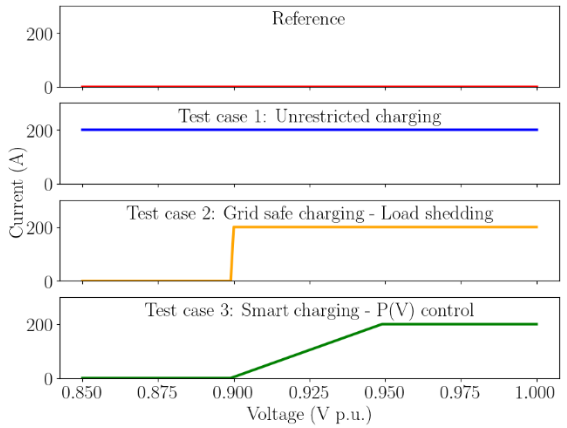


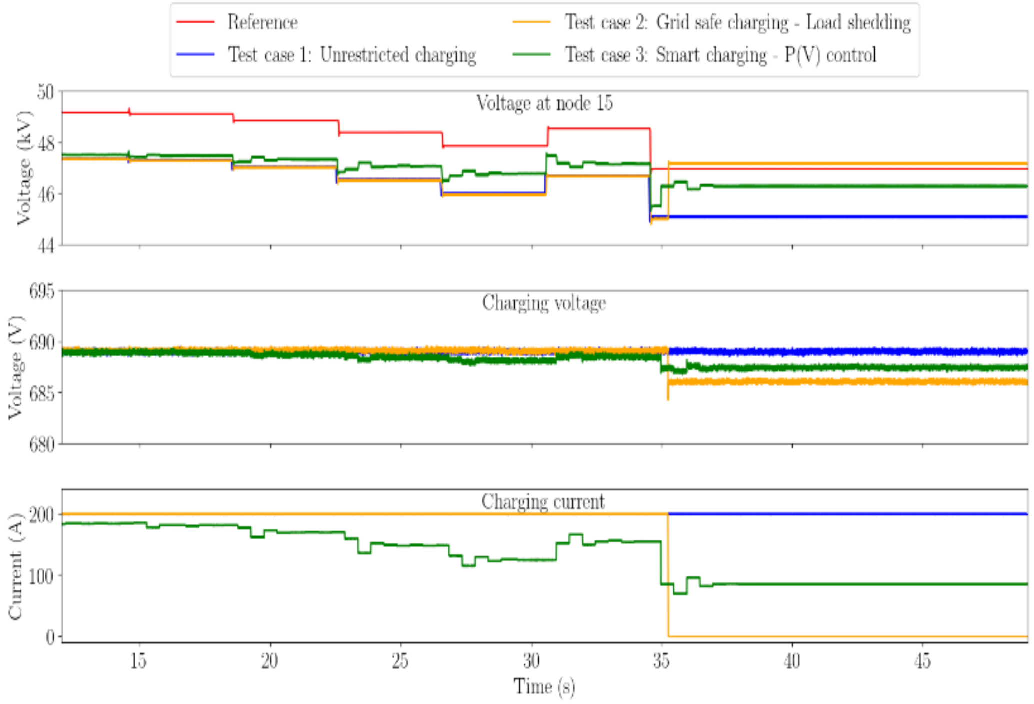


Application EV Integration in Microgrids

- 4 Scenarios have been evaluated
  - Refference
  - Unrestricted Charging
  - Grid Save Charging (Load shedding)
  - Smart Charging (P(V) control)

- Results show the validity of using PHIL to test different charging scenarios





AUSTRIAN LABORATORIES

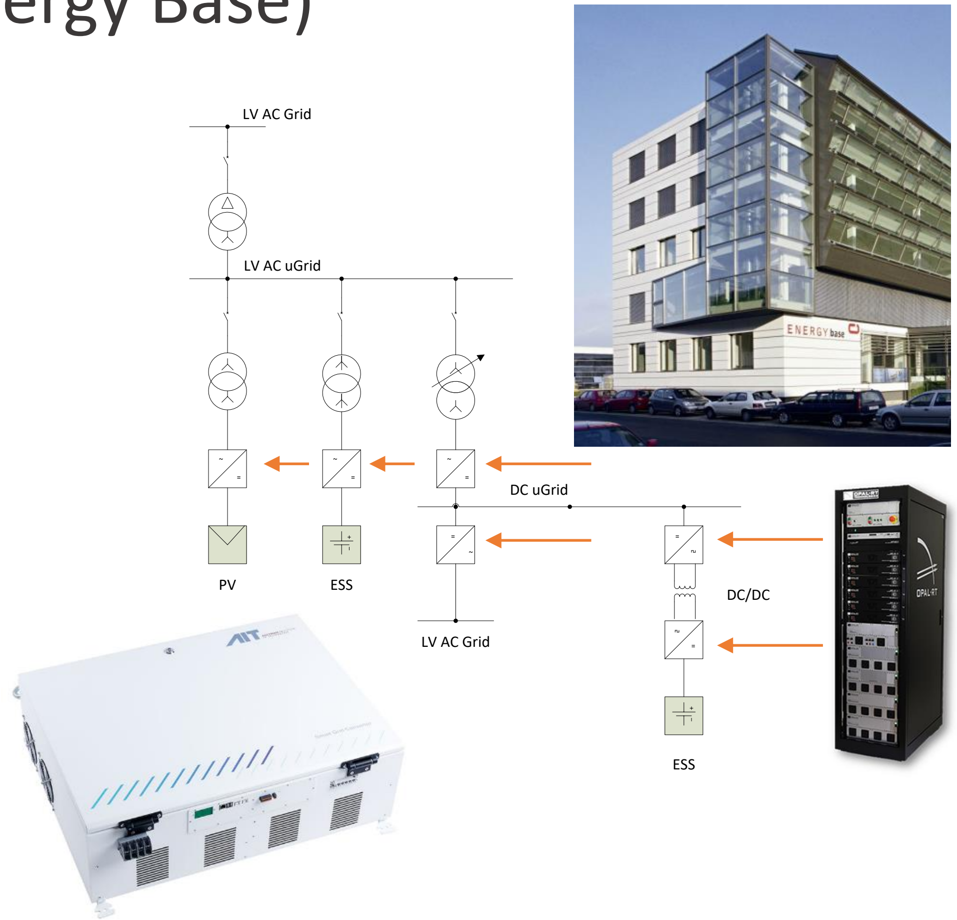
AUSTRIAN INSTITUTE OF TECHNOLOGY

TU Graz

klima+ energie fonds

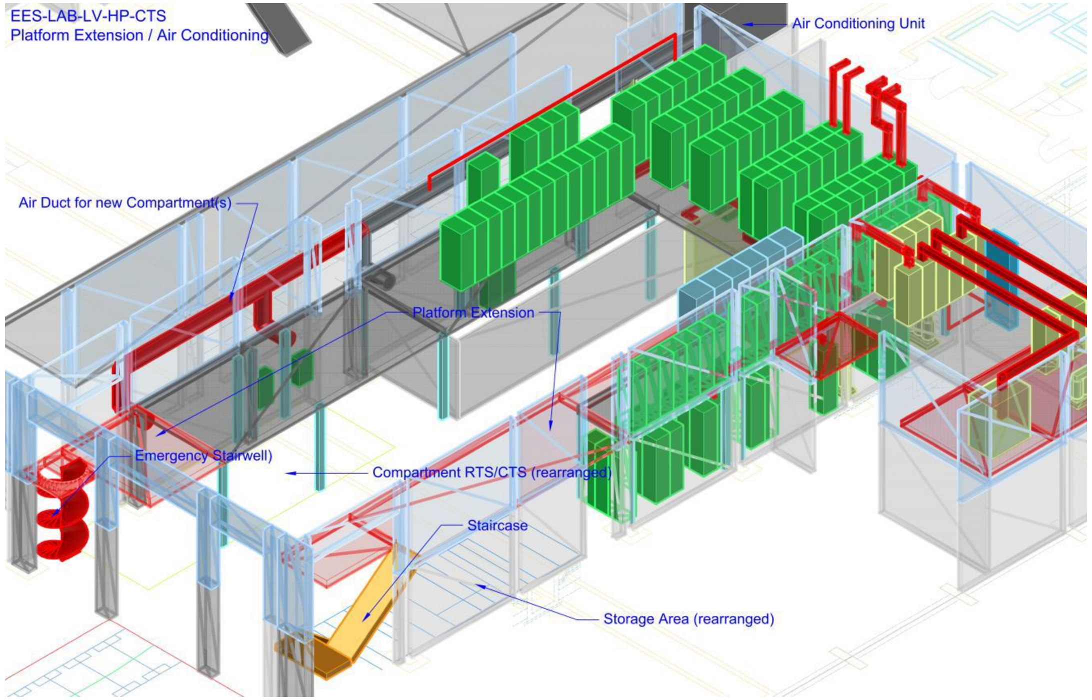
Next steps for DC-Laboratories

- LVDC-Laboratory extension @ AIT (Energy Base)
  - Microgrid setup with
    - Real converter
    - HIL coupling (digital lab)
  - DC-µGrid with storage and PV
  - Based on AIT Smart Grid Converter
  - Status: concept development



Next steps for DC-Laboratories

- LVDC-Laboratory extension @ AIT (SmartEST)
  - Extended DC capabilities
    - EV infrastructure
    - Storage
    - DC grids
  - Status: Construction in 2020

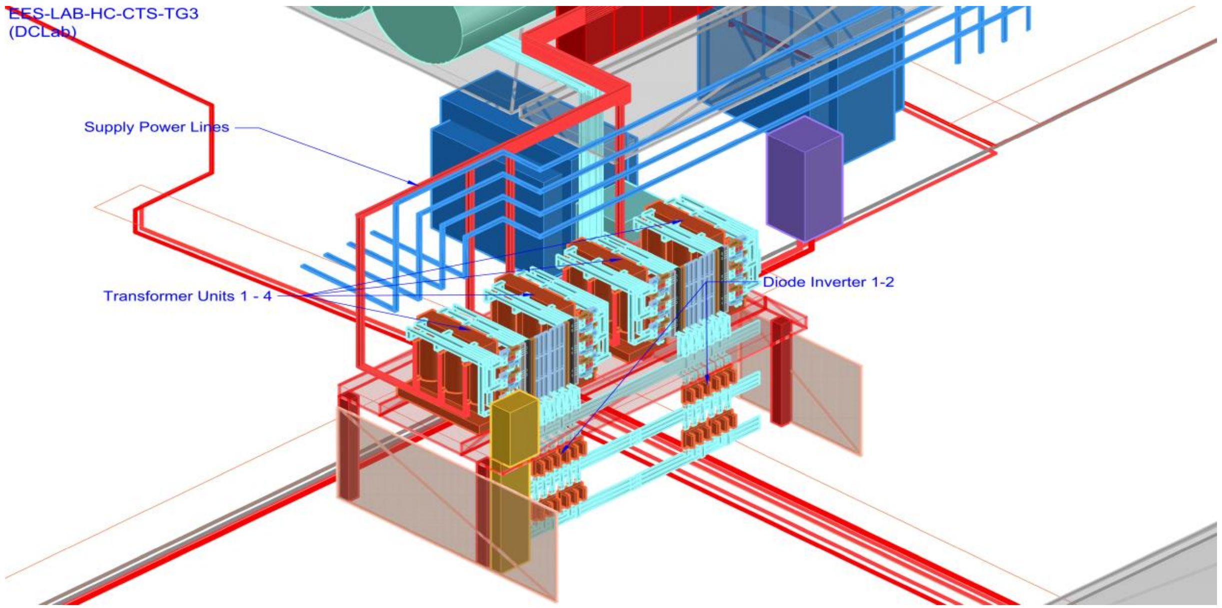


Next steps for DC-Laboratories

- MVDC-Laboratory extension @ AIT
  - High Current DC today → tomorrow (2020)
  - Up to 1.5 kV → 3 kV
  - Up to 30 MW
  - max. 30 kA → 120 kA

- SmartEST/High-current Lablink for P-HIL in MV
  - Physical connection of Power Amplifiers

  - Status: Construction in 2020



Thank you for your attention, please feel free to ask related questions.

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