

Outcomes and Results

Smart beats Copper

TA Project

OLO





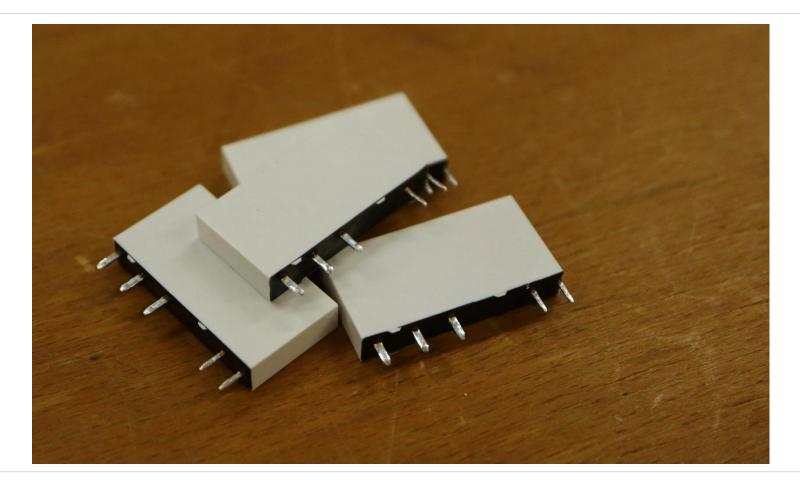
Agenda



- Introduction
- System Setups
- Comparison of System Setups
- Case Study
- Conclusion & Outlook

Digitalisation of the German Energy Sector

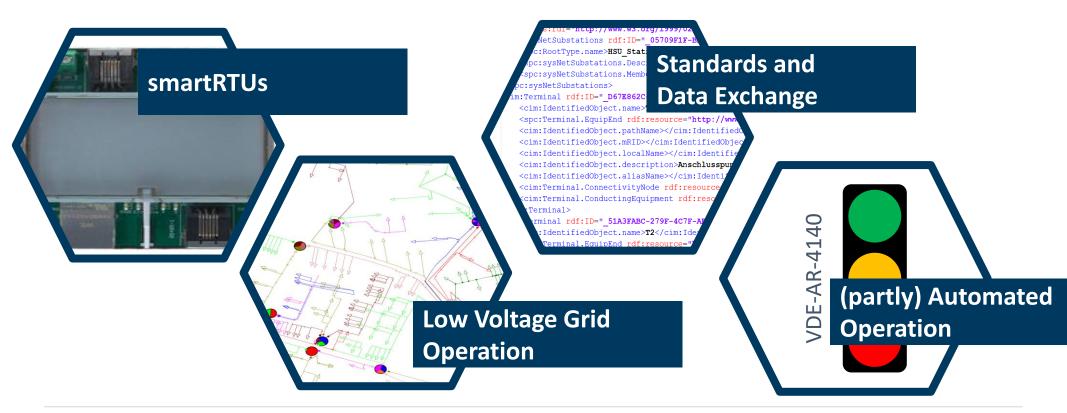




Challenges for DSO



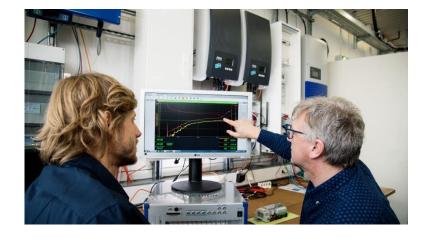
Changes caused by decentralisation and digitalisation:





How can one **test** and **validate** systems which are performing a **smart grid control strategy**?

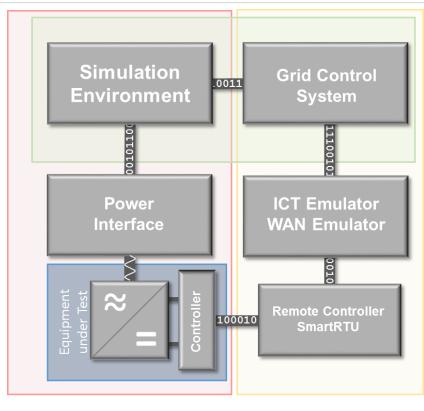
Key Question



July I

X-in-the-Loop for Smart Grid System Testing

- Combination and Usage:
 - Power-Hardware-in-the-Loop (PHIL)
 - Software-in-the-Loop (SIL)
 - Controller-in-the-Loop (CHIL)
 - Communication-in-the-Loop (ICTHIL)





Category	Domain	Requirement	
	Involved Domains	SGAM Domain Distribution, Decentralized Energy Resource or Customer Premise	
Systems Properties	Communication	communication over WAN (e.g., BPL or Mobil 4G)	
	Communication	multiple communication protocols are used and converter	
	Control	central and decentralised control	
	Control	autonomous or partially autonomous control of multiple	
		systems	
	Timing	update and control cycles $> 30s$	
Requirements	Timing	PHIL cycle time $t_{PHIL} \le 1s$	
	Accuracy	only sinusoidal waveform	
	Accuracy	low voltage deviation $\Delta U \leq 1V_{RMS}$	



EriGrid TA: Smart Beats Copper

Key Facts for the TA:

- Host Facility: AIT SmartTest Lab
- User Group: Smart Grid Resarch Group @ Ulm University of Applied Science
- 2 Stays (November 2017 / March 2018)
- 5 Members visited AIT
- 2 Publications
 - 1 Confernce Paper
 - 1 Journal Paper



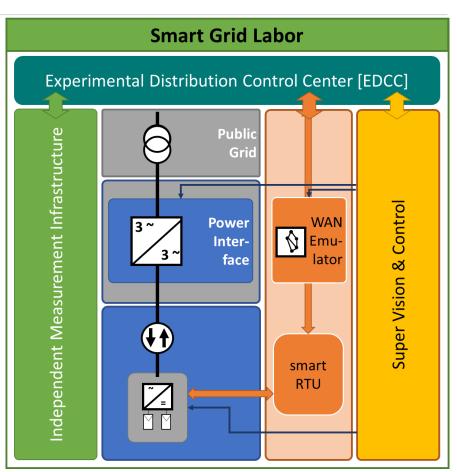
Smart Grid Lab @ HSU



Test of Smart Grid Systems and Components

Key Components:

- Power Interface
 - Regatron Top.Con ACS
- Independent Measurement Device
 - Dewetron Dewe-800
- ICT- Infrastructure
 - IWL KMAX WAN-Emulator
- SmartMeter Infrastructure
 - CLS Management
 - Smart Meter Gateway Admin
- Utility Grade SCADA
 - Siemens Spectrum Power 5



Smart Grid Lab @ HSU

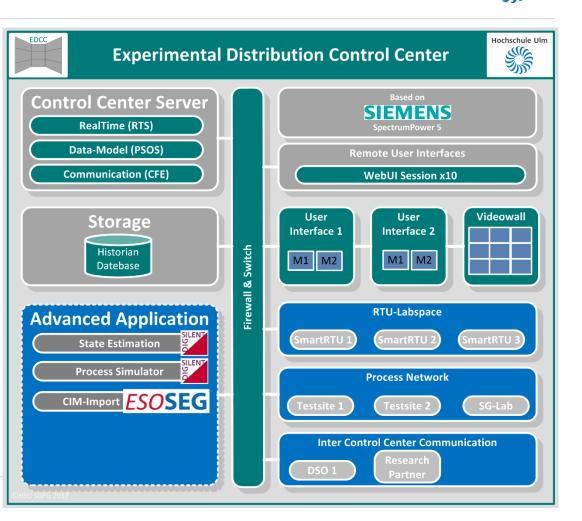




EDCC – Experimental Distribution Control Center

Test of Smart Grid Communication and Strategies

- Siemens SpectrumPower 5
 - IEC104
 - → IEC61850
 - ► TASE.2
- Tele Control Lab
- IEC61850 Test Environment
 - Omicron IEDScout
 - SystemCorp ICDDesginer

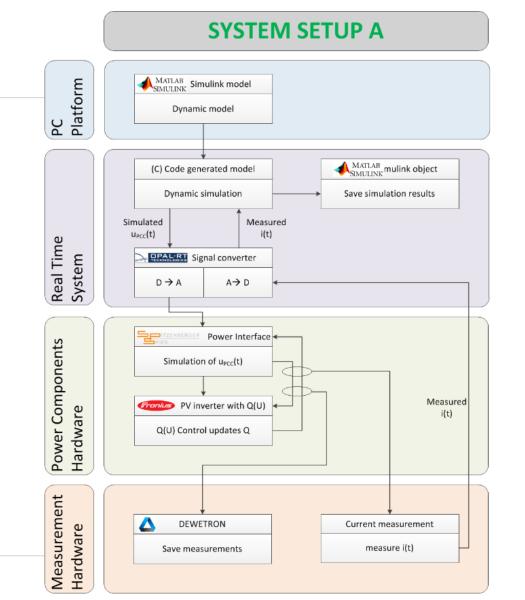


PHIL Setup

Classic Approach

Key Components:

- Power Interface
 - Spitzenberg Spies PAS
 - (Linear Amplifier)
- Simulation System
 - Opal-RT

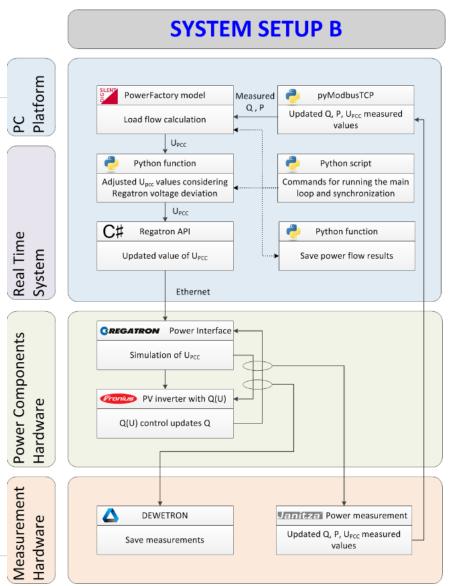


PHIL Setup

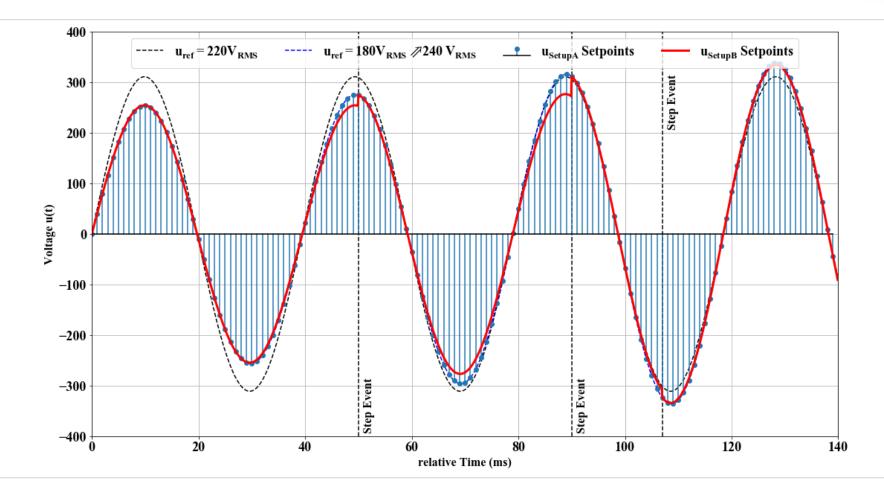
RMS - Approach

Key Components:

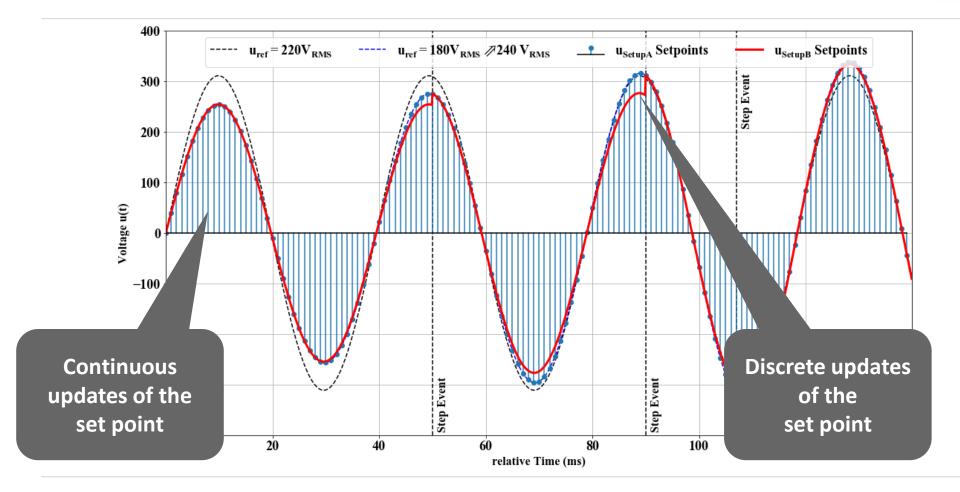
- Power Interface
 - Regatron Top.Con ACS
 - (Switch Mode Amplifier)
- Simulation System
 - Digsilent PowerFactory 2018



PHIL Setup - Comparison

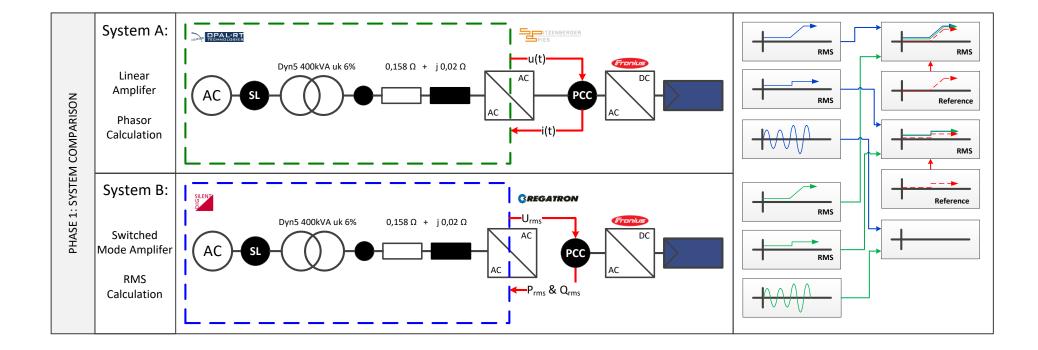


PHIL Setup - Comparison





Test Phase 1 – Comparison of Systems Setups

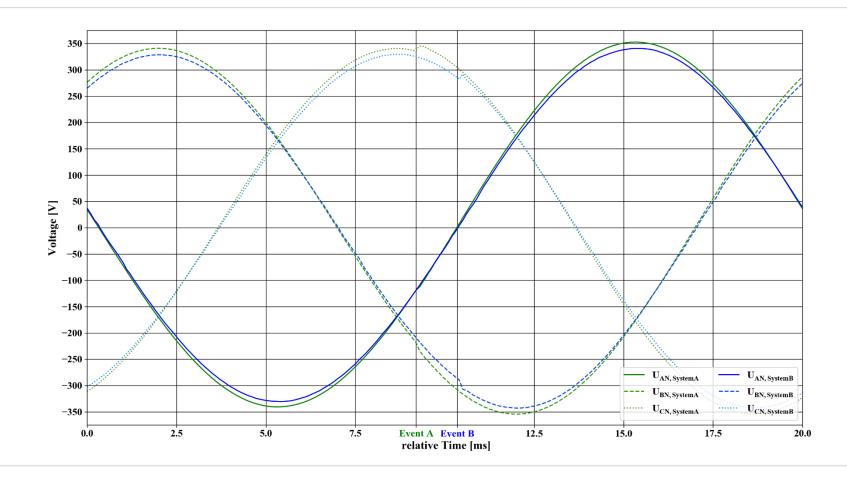


Test Phase 1 - Setup



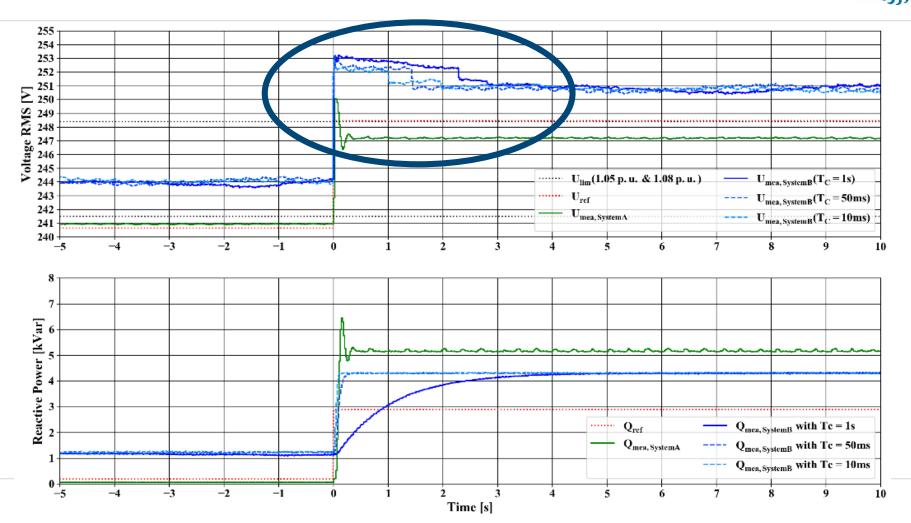


Test Phase 1- Transient Voltage Step



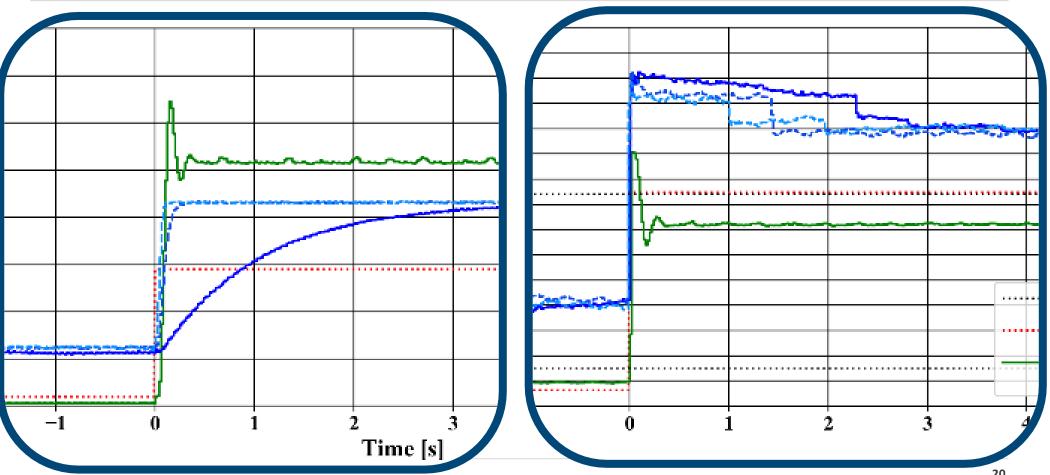
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Test Phase 1 – Voltage Step

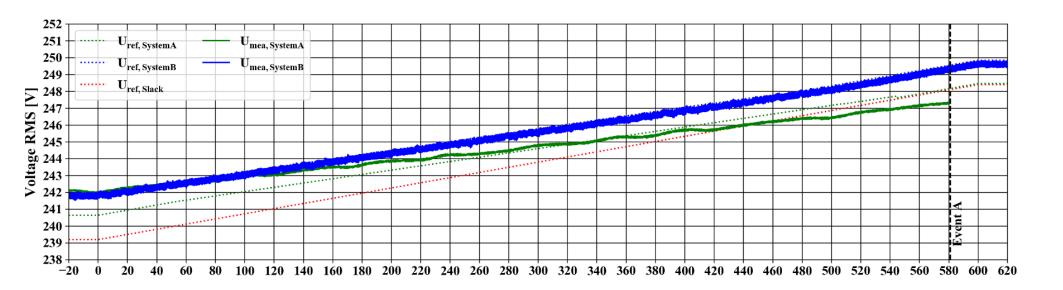


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Test Phase 1 – Voltage Step







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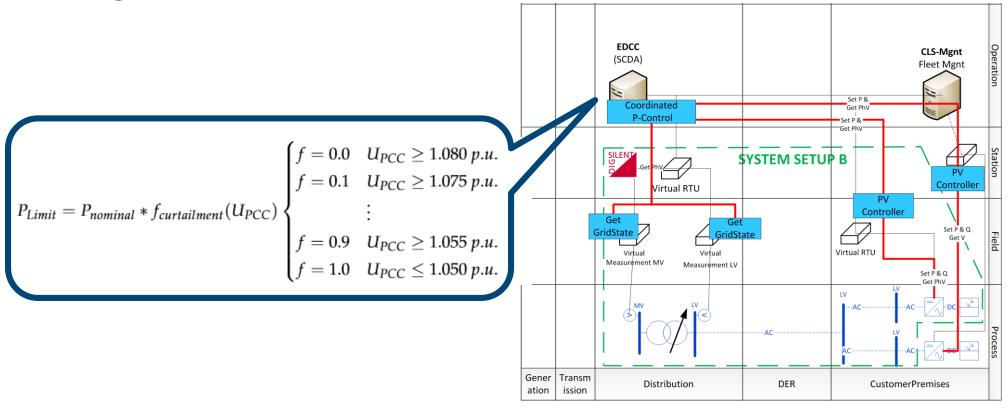
Test Phase 1 – Conclusions

	System Setup A	System Setup B
Pros (+)	small cycle time ($\leq 50\mu s$) multiple calculation methods (phasor simulation, transient simulation) low immanent impedance	regenerates energy during the test
Neutral (#)	specific usage of the simulation tool	sufficient cycle time ($\leq 1s$) variation in cycle time (STD xxx s)
Cons (-)	over heating occurs dissipates energy during test run	one calculation method (steady state) high immanent impedance

Test Phase 2 - Case Study

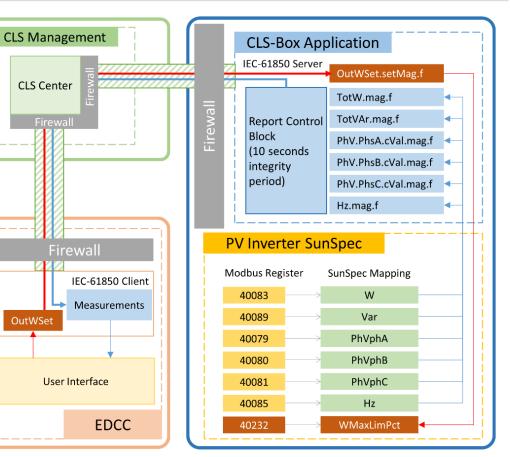


Voltage Control due to Curtailment and decentralised Volt/Var Control



Test Phase 2-Implemented Solution for the PV-Curtailment

- Protocol Conversion from SunSpec to IEC61850 (MMS)
- Utilization of the "FNN Steuerbox" and Smart Meter Gateway Concept
- Direct Control of the Inverter from the EDCC

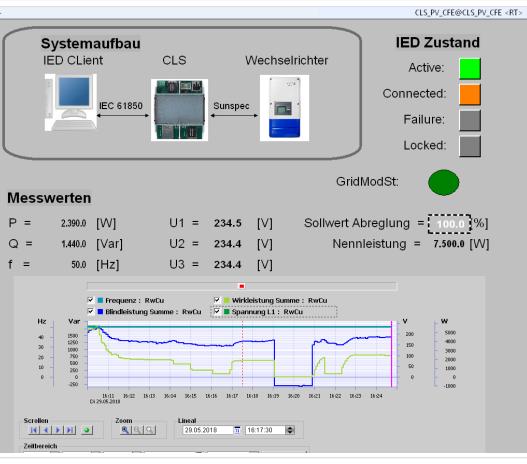




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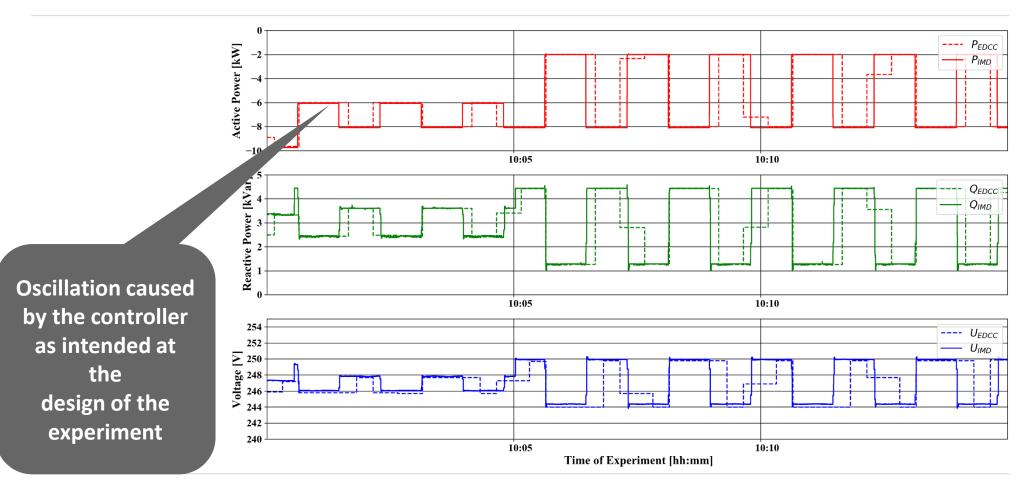
Test Phase 2-Implemented Solution for the PV-Curtailment

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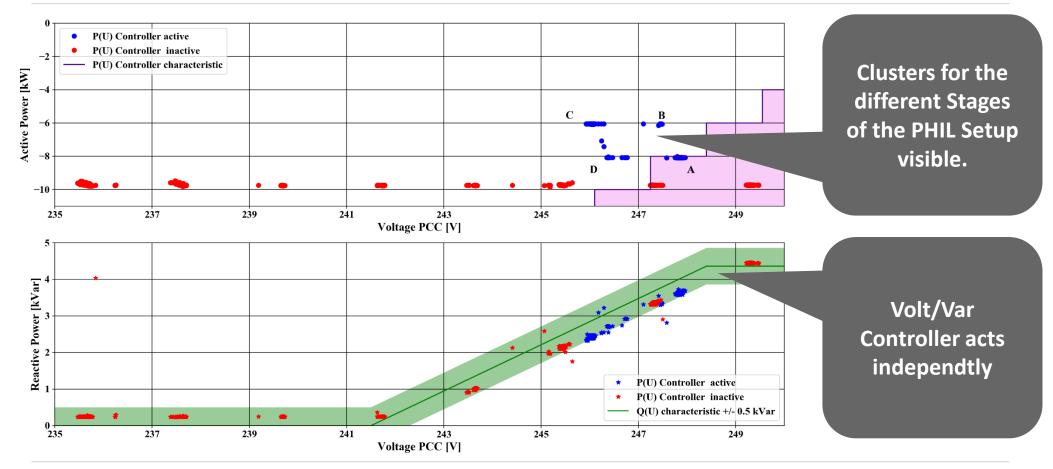




Test Phase 2 – Time Series



Test Phase 2 – P/V & Q/V Plot

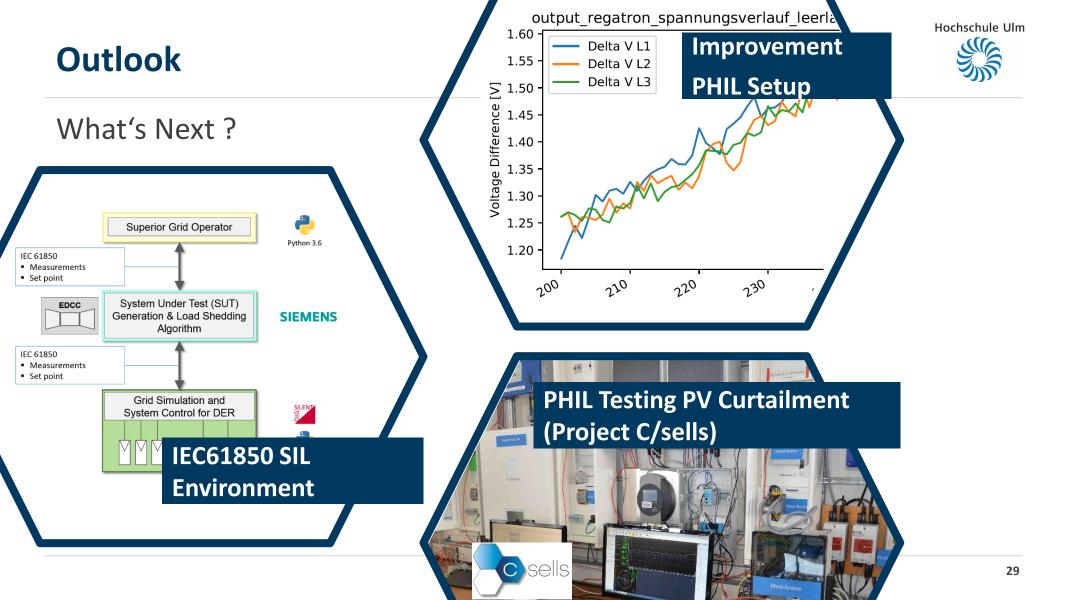


Conclusion



Just a nice trip or ?

- For the planned examinations the System Setup B is suitable.
- The System Setup B is also implemented at the Ulm University of Applied Science
- New ideas who to improve the lab
- Got insight on the usage of a OpalRT system
- Offset of the PI has to be further examined



Outlook - A more detailed Look:



MDPI Energies Journal - Speciel Issue:
"Methods and Concepts for Designing and Validating Smart Grid Systems"
Comparison of Power Hardware-in-the-Loop Approaches for the Testing of Smart Grid Controls (in preparation)

CIRED Workshop 2018 AN APPROACH FOR VALIDATING AND TESTING MICRO GRID AND CELL-BASED CONTROL CONCEPTS

		MDPI		
	Article Comparison of Power Hardware-in- Approaches for the Testing of Smart Talia Tes ¹ , Rosen IdB ¹ , Dovid E. Stakle ¹ , Shee Chen ¹ , Chri Muthias Card ¹ , Card Hichsler ¹ , Christin Schl ² , Baland Rinde ¹ Uite Userwitz of Applied Science, Snat Gala Seeuch Googn U ites, Witt stakle, Institution, and Christen Science, Swart Gala ² All Annual Institute of Robolegi, Blentin Energy System Colum ³ , Caropandrus et edbell and the 2017 IS 2019	Grid Controls toph Kondziałka ¹ , linger ² , Thomas I. Strasser ² in, Germany		
	Academic Editor, name Version October 15, 2018 submitted to Energies	A1050	CIRED Workshop - Ljubijana, 7-8 June 201 Paper 043	
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