2023 EUROPEAN

# RTDS TECHNOLOGIES INC.

# USER'S GROUP MEETING 2023

September 20–22, 2023 | FAU Energie Campus Nürnberg | Nuremberg, Germany

RTDS Technologies

AMETEK

# WELCOME TO THE 2023 EUROPEAN USER'S GROUP MEETING

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## SOCIAL MEDIA

rtds_technologies_inc

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RTDS_Simulator

# WELCOME RTDS SIMULATOR USERS

Hello and welcome to the 2023 RTDS Technologies European User's Group Meeting! We're excited to host this premier event for our European users alongside our colleagues at Friedrich-Alexander-Universität.

We have a packed schedule of presentations and networking opportunities lined up. This year's agenda includes user and RTDS-led presentations focusing on the latest research, trends, and future applications of the RTDS Simulator. We'll also be hosting a special tour of the Siemens Energy HVDC & FACTS Control and Protection Test Facility, as well as an evening of networking at Tucher-Mautkeller.

We urge you to fully participate—engage with your peers and take advantage of all our conference activities. We hope you find this year's European UGM engaging, informative, and enjoyable.

# GENERAL INFO

## Venue

FAU Energie Campus Nürnberg
Fürther Str. 250, 90429
Nürnberg, Germany

## Registration

Wednesday: 8:00 AM
Thursday: 8:00 AM


# NOTES

# AGENDA

| Day 1 | Wednesday, September 20, 2023 |
|---|---|
| 08:00 am – 08:30 am | **REGISTRATION AND COFFEE** |
| 08:30 am – 08:45 am | Welcome address from RTDS Technologies Inc.\| Paul Forsyth |
| 08:45 am – 09:15 am | Keynote Speech: Dr. Matthias Luther · Friedrich-Alexander-Universität |
| 09:15 am - 09:45 am | **User Presentation 1:** The ENSURE Co-Demonstration Platform – Approach, Feasibility and Working Status \| Gert Mehlmann · Friedrich-Alexander-Universität |
| 09:45 am – 10:15 am | **User Presentation 2:** Practical Experience and Techniques from an HVDC Vendor \| Sebastian Harant, Jonas Zucker, Suvansh Srivastava · Siemens Energy |
| 10:15 am – 10:30 am | **COFFEE BREAK** |
| 10:30 am - 11:00 am | **User Presentation 3:** Testing a novel control architecture for isolated microgrids using Gridspertise's Hardware-in-the-Loop setup\| Francesco Renna · Gridspertise |
| 11:00 am – 11:30 am | **User Presentation 4:** AC protection near VSC HVDC converters \| Joachim Vermunicht · KU Leuven and EnergyVille |
| 11:30 am –12:15 pm | **RTDS Technologies Presentation 1:** Corporate Update & Industry Trends Paul Forsyth & Kati Sidwall |
| 12:15 pm – 1:15 pm | **LUNCH PROVIDED BY RTDS TECHNOLOGIES** |
| 1:15 pm – 1:45 pm | **User Presentation 5:** RTDS Simulation and Aquila Interoperability Project \| Dong Chen · The National HVDC Centre |
| 1:45 pm – 2:15 pm | **User Presentation 6:** Hitachi Energy HVDC C & P Factory System Test Saudi Arabia - Egypt Project and RTDS Wind Turbine Model Validation \| Adnan Azmat · Hitachi Energy Sweden |
| 2:15 pm – 2:45 pm | **User Presentation7:** RTDS Model for Offshore Coordinated Fast Active Power Control \| Cees van Vledder · TU Delft |
| 2:45 pm– 3:00 pm | **COFFEE BREAK** |
| 3:15 pm – 3:45 pm | **RTDS Technologies Presentation 2:** RTDS Hardware – New Developments \| Cyprian Peters |
| 3:45 pm– 4:15 pm | **User Presentation 8:** Combined Protection CHIL with Wireless 5G Communication Performance Validation \| Petra Raussi Chauhan · VTT Technical Research Centre of Finland |
| 4:15 pm – 4:45 pm | **User Presentation 9:** Investigation of Model Predictive Control for Grid Forming Converters in MTDC Networks \| Rohan Kamat Tarcar · TU Delft |
| 6:30 pm | EVENING EVENT |

# AGENDA

| Day 2 | Thursday, September 21, 2023 |
|---|---|
| 08:00 am - 08:30 am | **REGISTRATION AND COFFEE** |
| 08:30 am – 09:00 am | **User Presentation 10:** Reduced-hardware PHIL for Real-time Testing of BESS \| Cedric Caruana · University of Malta |
| 09:00 am – 09:30 am | **User Presentation 11:** Co-Simulation of Real-time and Offline Power System Simulators \| Christian Scheibe · Siemens AG |
| 09:30 am – 10:00 am | **User Presentation 12:** A Modular Hardware-in-the-Loop Testbench for the Investigation of Converter Control Interactions and Interoperability \| Julian Richter · Friedrich-Alexander-Universität |
| 10:00 am – 10:15 am | **NETWORKING BREAK & REFRESHMENTS** |
| 10:15 am – 11:00 am | **RTDS Technologies Presentation 3:** All New RSCAD® FX 2.0 \| Arunprasanth Sakthivel |
| 11:00 am –11:30 am | **User Presentation 13:** Functional Testing of HVDC Protection Systems – Towards Multivendor \| Geraint Chaffey · KU Leuven / EnergyVille |
| 11:30 am –12:00 pm | **User Presentation 14 :** Impedance-based Stability Analysis of a Power Hardware-in-the-Loop for Grid-Following Inverter Testing\| Fargah Ashrafidehkordi · Karlsruhe Institute of Technology |
| 12:00 pm – 1:00 pm | **LUNCH PROVIDED BY RTDS TECHNOLOGIES** |
| 1:00 pm –1:30 pm | **User Presentation 15:** HIL and RTDS Assisted De-risking of the Johan Sverdrup Project \| Ming Cai · RTE International |
| 1:30 pm - 2:00 pm | **User Presentation 16:** RTDS Simulation and Network DC – SIF Project \| Suresh Kumar Rangasamy · The National HVDC Centre |
| 2:15 pm | Depart for Siemens Lab |
| 3:00 pm - 4:30 pm | Tour of Siemens Lab |
| 4:30 pm | Return to FAU |

# AGENDA

| Day 3 | Friday, September 22, 2023 |
|---|---|
| 08:00 am - 08:30 am | **COFFEE** |
| 08:30 am – 09:00 am | **User Presentation 17**: Development of a Custom Induction Machine Component for Computationally Efficient Flywheel Energy Storage Simulation \| Damian Vilchis-Rodriguez · The University of Manchester |
| 09:00 am – 09:30 am | **User Presentation 18:** Sub-/supersynchronous Oscillation Analysis in an Offshore Grid Model using RTDS \| Sandro Kellermüller · TU Delft |
| 09:30 am – 10:00 am | **User Presentation 19:** CHIL and PHIL Applications for Protection, Control, and Optimal Operation of Active Distribution Networks and Microgrids \| Alkistis Kontou · ICCS-NTUA |
| 10:00 am – 10:15 am | **NETWORKING BREAK & REFRESHMENTS** |
| 10:15 am – 11:00 am | **RTDS Presentation 4:** New Features, Component Models, and Sample Cases in RSCAD-FX \| Arunprasanth Sakthivel |
| 11:00 am – 11:30 am | **User Presentation 20:** Industrial Research into the Reliable Operation of Digital Substations \| Rick Loenders · KU Leuven and EnergyVille |
| 11:30 am– 12:00 pm | **User Presentation 21:** A Test Framework for an Adaptive Protection Scheme Using a Hardware-in-the-Loop Setup \| Tobias Lorz · Friedrich-Alexander-Universität |
| 12:00 pm – 12:30 pm | **OPEN DISCUSSION & CLOSING REMARKS** |
| 12:30 pm - 1:00 pm | **LUNCH PROVIDED BY RTDS TECHNOLOGIES** |
| 1:00 pm – 1:45 pm | Tour of FAU Simulation Lab |

# PRESENTATIONS

## Wednesday, September 20, 2023

*8:30 AM - 8:45 AM* **Welcome & Opening Remarks**

### Paul Forsyth

*RTDS Technologies Inc.*

Paul Forsyth received his B.Sc. degree in Electrical Engineering from the University of Manitoba, Canada in 1988. After graduating he worked for several years in the area of reactive power compensation and HVDC at ABB Power Systems in Switzerland. He also spent two years at Haefely in both Germany and Switzerland performing system studies and later as part of the network component sales group. Since 1995, Mr. Forsyth has been employed by RTDS Technologies and over the years he has been involved in many facets of the product and company development and

*8:45 AM - 9:15 AM* **Keynote Speech: The Transition of the German Power System: Challenges and Solutions**

The mitigation of climate change and the transformation of energy systems that is primarily necessary for this are among the greatest challenges of the 21st century for politics, business and society. Consequently, the restructuring of the electric power networks is at the center of an ongoing transformation process that must be implemented in a coordinated manner in Germany and Europe.
The presentation gives an overview of the current challenges of grid development and system operation in Germany. In addition, various research examples and technical solutions for the further development of transmission and distribution grids are presented in order to take into account the idea of sustainability.

### Dr. Matthias Luther

*Friedrich-Alexander-Universität*

Professor Dr.-Ing. Matthias Luther studied electrical engineering and received his Ph. D. at the Technical University of Brunswig, Germany in 1992.
From 1993-2013 he held different functions and management positions in the electricity industry at PreussenElektra AG, E.ON Netz GmbH and TenneT TSO GmbH.
Since 2011 Prof. Luther is the Director of the Institute for Electrical Energy Systems at the Friedrich-Alexander-University of Erlangen-Nuremberg, Germany. His main research activities are in the field of electrical networks, integration of renewables and power electronics applications.

# PRESENTATIONS

## Wednesday, September 20, 2023

*9:15 AM - 9:45 AM*

### The ENSURE Co-Demonstration Platform – Approach, Feasibility and Working Status

Within the German research project KOPERNIKUS ENSURE, a distributed real-time platform for Hardware-in-the-Loop simulations is being created. The platform comprises various real-time laboratories linked via VILLASNode to form a distributed laboratory complex across Germany. The platform aims to demonstrate and validate the technologies and solutions developed in the research project. In particular, technologies and their interoperability will be demonstrated on the multi-vendor and multi-domain platform that cannot be implemented directly in the field due to the size of the systems or the type of investigation. The platform is built upon joint real-time power system models, Co-simulation, and the specialized laboratories of various partners. The approach is intended to bundle the competencies of different partners beyond the project.
The presentation's focus is the approach of the platform, different feasibility studies, and the actual working status.

**Gert Mehlmann**
*Friedrich-Alexander-Universität*

Gert Mehlmann received the Diploma in electrical engineering and the Ph.D. degree from Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany, in 2008 and 2013, respectively. From 2013 to 2016, he worked as Power System Consultant for Siemens PTI before moving to university. Since 2016, he is a senior lecturer at the Institute of Electrical Energy Systems, Friedrich-Alexander-Universität Erlangen-Nürnberg. He is responsible for the power system stability group, the affiliated Center for Applied System Simulations and a member of the extended scientific board of the Energie Campus Nürnberg.

# ON-DEMAND RESOURCES

As an RTDS Simulator user you have access to online and on-demand training opportunities at the click of your mouse or swipe of your finger. Navigate to the **Resource Centre** from our homepage menu and click the **Knowledge Base** portal, or scan the **QR code** to unlock dozens of learning resources.

# PRESENTATIONS

## Wednesday, September 20, 2023

### *9:45 AM – 10:15 AM* Practical Experience and Techniques from an HVDC Vendor

The presentation will contain practical experience and techniques acquired through commercial HVDC projects. The presentation will deal with three specific topics. The first is modeling of overhead-transmission lines with AC and DC conductors on one tower. The second relates to reducing the computational burden of complex frequency dependent DC-lines for the RTDS Simulator. The last topic will present an automated Hardware in the Loop (HIL) test setup with the RTDS Simulator. The automated setup is used to test DC protection settings and employs Aurora communication and a National Instruments PXI system connected to the DC protection and measurement cubicles for a commercial HVDC project.

**Sebastian Harant**
*Siemens*

Graduated in 2014 in Erlangen as M. Sc. in Electrical Engineering – Electronics - Information Technology. Started working in the same year for Siemens AG (later Siemens Energy) as a System Engineer for Real Time Simulation for testing in HVDC projects. Since then, experience in several R&D and commercial projects.

**Jonas Zucker**
*Siemens*

He recieved his Bacherlor's and Master's degree in Electrical Engineering and Computational Science from Technical University of Munich (TUM), Germany, in 2017 and 2021, respectively. He is currently working at Siemens Energy Global GmbH & Co. KG as System Engineer for Real-Time Simulation of HVDC Systems.

**Suvansh Srivastava**
*Siemens*

Suvansh Srivastava born in New Delhi, India in 1990. After his bachelor's degree in electrical engineering, he pursued master's in electrical Power Engineering at RWTH Aachen, Germany in 2018. He worked in Aachen for some years as a Software Computational Engineer working with automation of test benches in automotive industry, but as Electrical Power Engineering was always his interest, he switched back to the field. He is currently working as a System Engineer at Siemens Energy Global GmbH & Co. KG for Real-Time Simulation of HVDC Systems since.

# PRESENTATIONS

## Wednesday, September 20, 2023

*10:30 AM - 11:00 AM*

### Testing a novel control architecture for isolated microgrids using Gridspertise's Hardware-in-the-Loop setup

Extreme climate change and global warming have pushed governments towards setting ambitious goals to the ongoing energy transition. These increasing needs requires traditional power systems to shift towards the concept of smart grids, allowing a larger penetration of distributed energy resources (DERs) into electrical grids.
Isolated microgrids would be heavily impacted by the introduction of large percentages of distributed generation in the energy mix, since their intermittent output is not compatible with the low levels of rotational inertia that characterize these networks and would make voltage and frequency more unstable. For these reasons, these networks represent an ideal scenario to test the benefits and the drawbacks of new technologies and optimal management strategies.
In this frame, Gridspertise team in LV Smart Grids Laboratory in Bari developed a hierarchical control architecture that aims at increasing hosting capacity of islanded electrical networks while guaranteeing adequacy and security constraints. In order to validate the effectiveness of such control framework, a Hardware-in-the-Loop (HIL) test platform has been setup. It relies on two Novacor RTDS racks to simulate the isolated grid which has been considered as reference scenario. Moreover, various Intelligent Electronic Devices (IED) and protections, already widespread in Italian electrical distribution networks, have been integrated in the HIL simulation framework. Such devices have been interfaced with RTDS through several communication means such as analog and digital I/O cards, as well as GTNET to emulate different protocols. Even features like UDP acquisitions and scheduler component have been used to facilitate the accomplishment of long-term simulations.

**Francesco Renna**
*Gridspertise*

I have a Master degree in Electrical Engineering achieved at Poitecnico di Bari (Italy) with honors. During my last year at university, I worked as a Matlab student ambassador in the university, where I started approaching the model based simulation world as well as the real-time simulators framework. After a brief experience as a researcher at Politecnico di Bari, I started working in my current position of Smart Grid Engineer at Gridspertise's LV Smart Grid Lab in Bari, Italy.

# PRESENTATIONS

## Wednesday, September 20, 2023

### *11:00 AM - 11:30 AM* AC protection near VSC HVDC converters

Converter-interfaced renewable energy sources and VSC HVDC links are increasingly being used, meanwhile, synchronous generation is gradually being phased out. Consequently, characteristics of the system during short circuit faults is changed and will continue to evolve as more converters are being installed in the future. Unconventional fault current sources challenge the legacy protection that is currently installed in the grid. This presentation will look into converter control impacts on AC protection, and focus on the testing performed by KU Leuven / EnergyVille towards understanding interactions and solutions for the protection of future grids. The studies include impact of converter controls during faults on conventional distance protection and on novel protection concepts such as time-domain protection.

**Joachim Vermunich**
*KU Leuven and EnergyVille*
Joachim Vermunicht is a researcher at Electa/EnergyVille research group from KU Leuven - Department of electrical engineering in Belgium. His research interests include power system protection and voltage-source-converter high-voltage direct-current grids.

### *11:30 AM - 12:15 PM* Corporate Update & Industry Trends

This presentation will include an overview of recent company updates including our integration with Ametek, as well as our bright outlook on the future. It will also dive into industry trends and how these are changing the needs of our users and motivating new developments at RTDS Technologies. Exciting emerging applications for real-time simulation and HIL testing will be identified.

**Paul Forsyth**
*VP Marketing & Sales*
Paul Forsyth received his B.Sc. degree in Electrical Engineering from the University of Manitoba, Canada in 1988. After graduating he worked for several years in the area of reactive power compensation and HVDC at ABB Power Systems in Switzerland. Since 1995, Mr. Forsyth has been employed by RTDS Technologies. He currently holds the title of VP – Marketing & Sales.

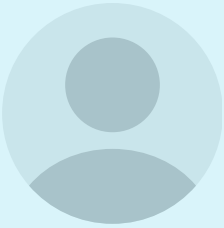
**Kati Sidwall**
*Technical Marketing Manager*
Kati Sidwall holds a B.Eng in Sustainable and Renewable Energy Engineering from Carleton University, Canada. She founded the annual Carleton University Green Energy Symposium in 2010. In 2012, she received the Canadian Solar Industries Association's Emerging Leader Award. She currently serves as the Technical Marketing Manager at RTDS Technologies Inc.

# PRESENTATIONS

## Wednesday, September 20, 2023

*1:15 PM – 1:45 PM* **RTDS Simulation and Aquila Interoperability Project**

Within the "Holistic Network Design" for the Great Britain power system towards 2030, Multi-Terminal High Voltage Direct Current (MT-HVDC) transmission systems have been considered as an effective and economical approach to transmit bulk offshore wind power to the existing onshore power network. Aquila project, which is going to develop a multi-terminal HVDC grid in the east coast between Northern Scotland and England, will be the first of this kind in UK and expected to be energized by 2030. To de-risk the supply chain, the "Aquila Interoperability Project" has been launched to inform the decision-makers on the viability and readiness of Multi-Vendor (MV) interoperability. Real-time simulation platform, i.e. RTDS, is being utilized to develop and test interoperable control scheme for MVMT-HVDC without opening up vendors' IP on internal design of converter control. This presentation will brief the development and outlook of this Aquila Interoperability Project.



**Dong Chen**
*The National HVDC Centre*

Dong Chen received PhD degree in electrical power engineering from the Queen's University Belfast in 2012. He is currently a senior HVDC simulation engineer with the National HVDC Centre UK. As the lead of Aquila Interoperability Project, he is coordinating GB HVDC interoperability expert working group and leading a team on HVDC interoperability. Before joining the HVDC Centre, he was a lecturer in electrical power engineering with Glasgow Caledonian University during 2016-2022. He has been an associate editor of 2 journals in the areas of power electronics and power system, i.e. IEEE Transactions in Power Delivery and IET Power Electronics.

# CALL FOR CASE STUDIES

Your hard work shows—let us promote it! We'd love to feature your latest project with the RTDS Simulator as a case study on our website. Showcase your work in front of a large audience of like-minded pros and expand your network.

*Contact Kati Sidwall (Kati.Sidwall@ametek.com) for more information*

**Kati.Sidwall@ametek.com**

# PRESENTATIONS

## Wednesday, September 20, 2023

*1:45 PM - 2:15 PM*

### Hitachi Energy HVDC C & P Factory System Test Saudi Arabia - Egypt Project and RTDS Wind Turbine Model Validation

HVDC system bearing lower losses, interconnecting energy systems and being cost effective has proven to be the best method for power transmission for long distance. It is essential to have control and protection (C & P) of an HVDC link to ensure power stability and to counter power fluctuations. At Hitachi Energy, Control and protection system for every project is first tested through a method called FST (Factory System Test). FST is done to ensure verification of control and protection functions, testing of equipment to meet design specifications, verifying control and protection system supervision and to reduce interruptions in AC system. The multiterminal HVDC system which is installed between Saudi Arabia-Egypt passes through three terminals. This system with a power rating of 3000 MW, DC voltage of ±500 kV goes through FST and plant simulated on RTDS. Offshore wind power integration into the electrical network has increased rapidly. HVDC is the best solution to transfer the power from wind turbines on an offshore platform to the land. A detailed study is performed using generic wind farm model used for dynamic system studies performed in PSCAD and comparing its results with windfarm model in RSCADFX considering that there is no available project specific model. A generic wind farm model is evaluated when connected to a Thevenin equivalent. Fulfillment of the grid code is presented by performing dynamical disturbances and changes to the connected grid model according to the proposal test plan supplied by the customer. Hitachi Energy's state of the art Factory System Test, Saudi-Egypt HVDC project summary and generic windfarm model performance evaluation will be conferred in this presentation.

**Adnan Azmat**

*Hitachi Energy Sweden*

Adnan Azmat is currently working as a Senior Test Engineer at the department of Control and Protection at Hitachi Energy HVDC Sweden focusing on Global Tenders and Conceptual Design. Adnan received his M.S. degree in Electric Power Engineering from Chalmers University of Technology, Gothenburg, Sweden in 2012. Between 2012 and 2018 Adnan served as a Simulation Engineer and Lead Engineer for HVDC Light® Simulation at the department of Control and Protection mainly using RTDS as simulation tool. Between 2018 and 2021 Adnan worked in the Automotive sector with different capacities performing system design and HIL infrastructure development with leading automotive companies in Sweden viz Volvo Cars and CEVT (China Euro Vehicle Technology).

# PRESENTATIONS

## Wednesday, September 20, 2023

*2:15 PM – 2:45 PM*

### RTDS Model for Offshore Coordinated Fast Active Power Control

Offshore electrical grids are growing rapidly in order to transmit offshore generated wind power to loads onshore. Future offshore electrical systems will become more complex. It will consist out of a mix of HVAC technology and HVDC technologies. In current outlooks, offshore system can also be used to further increase interconnection between coastal regions. In addition, also large scale offshore hydrogen production will be introduced using PEM technology. Many challenges exist in designing these future system. Firstly, the envisioned scale of electrolysis has not been implemented in any electrical system. Although aggregation methods of validated smaller scall models is widely used, validation of larger scale models is essential for the implementation in offshore systems. Secondly, coordinated fast active power flow control system need to be developed. The offshore system should be able to work in a stable manner when it is faced with disturbances. Lots of work has been performed in handling of fault conditions for both HVAC and HVDC offshore systems. In an integrated system, also the active power of all relevant components has to be controlled in coordinated fashion. This will also enable frequency support to the onshore AC grid. However, grid codes require fast response times which require fast response of all component in the offshore system.
This presentation presents a synthetic model built in RSCAD, which is intended as a platform for investigating the above indicated challenges. The model consists of bipolar MMC HVDC links connecting the onshore AC system to an offshore AC system. The offshore system includes 2 GW of wind generation and different sizes of electrolyzer models.

**Cees van Vledder**
*TU Delft*

Cees van Vledder is currently working as a PhD-candidate at Delft University of Technology on coordinated fast active power control in offshore electrical grids. Previously, he has worked on mitigation of sub-synchronous oscillations caused by fully rated wind turbines control interaction. This was part of his thesis for his Master of Science at Delft University of Technology and the Norwegian University of Science and Technology in the European Wind Energy Master-Electrical Power Systems programme.

# PRESENTATIONS

## Wednesday, September 20, 2023

### *3:00 PM – 3:45 PM* RTDS Hardware - New Developments

RTDS Technologies has been hard at work on new hardware to support the industry's growing real time simulation needs. This presentation will outline new hardware developments that RTDS Technologies has released and is working on, including NovaCor 2.0, GTSOC v2, GTDI with improved firing, and more.

**Cyprian Peters**
*Technical Sales Manager*

Cyprian Peters received his B.Sc. Degree in Electrical Engineering from the University of Manitoba, Canada in 2010. Following graduation, he joined RTDS Technologies where he currently holds the title of Technical Sales Manager. Cyprian has full sales & customer relations responsibility for multiple geographic regions and has travelled to over 45 countries to market, sell, and commission real time simulators.

# IN-PERSON TRAINING RETURNS

In-person training returns to the world-class RTDS Technologies simulation lab in Winnipeg, Manitoba. Enroll in both the Introductory Simulator and Advanced Applications Training Courses to further hone your real-time simulation skills.

**Introductory Simulator Training Course**
**Oct 16–20, 2023**
**Winnipeg, Manitoba**

**Advanced Applications Training Course**
**Oct 23–27, 2023**
**Winnipeg, Manitoba**

# PRESENTATIONS

## Wednesday, September 20, 2023

### *3:45 PM - 4:15 PM* Combined Protection CHIL with Wireless 5G Communication Performance Validation

Virtualised protection applications operated on the edge are upcoming and could transition protection systems on an architectural level. Wireless 5G-enabled edge computing allows operating protection and control applications from local datacentres and at far-edge, e.g., base stations. Older wireless technologies such as 4G only support cloud computing, which does not meet the reliability requirements of protection due to longer latency. Future medium voltage grids could consist of sensors and merging units connected to the physical grid to digitalise measurements, and all the intelligence could be concentrated at the edge. Thus, applications could use a wider range of data than a single IED.

In order to validate modern protection and control solutions operating on 5G edge, a realistic experimental setup is required. This presentation will highlight how using RTDS for CHIL simulations combined with QoS performance measurements of the wireless 5G network has enabled this research. Our system under test (SuT) encompasses merging units, protection and control devices, commercial public 5G networks, and a 5G test network. In this presentation, we will provide detailed illustrations of the SuT and further plans through ongoing expansion encompassing commercial telecommunication operator's data centre.

Results from three time-critical use cases of virtual fault passage indicator, line differential, and intertrip protection will also be presented from the perspective of the type of data we can gather via RTDS. For future work, we will continue this research by validating network slicing and other 5G features and studying proposed 6G features and their suitability for power system applications.

**Petra Raussi Chauhan**

*VTT Technical Research Centre of Finland*

Petra Raussi received her M.Sc. in Electrical Engineering from LUT University, Lappeenranta, Finland 2018. Since 2017, she has been first a Research Trainee, a Research Scientist, and currently a Senior Scientist with the VTT Technical Research Centre of Finland, Espoo, Finland. Her research interests include power system communication and automation, 5G and beyond for critical data exchange, distributed control, and real-time systems. She is also currently a doctoral candidate at the Department of Electrical Engineering and Automation, School of Electrical Engineering, Aalto University, Espoo, Finland. Her doctoral research focuses on wireless 5G for protection communication.

# PRESENTATIONS

## Wednesday, September 20, 2023

*4:15 PM - 4:45 PM*

### Investigation of Model Predictive Control for Grid Forming Converters in MTDC Networks

Integrating renewable offshore wind generation into global power grids is a critical issue in the energy industry. Modular Multilevel Converter (MMC)-based High Voltage Direct Current (HVDC) grids are the most effective and promising technical solution for the new offshore wind energy power system connections. Stable and compliant operation of MMCs requires implementing MMC control strategies and controllers. This project investigates the intricacies of HVDC technologies, focusing on MMC control strategies and controllers. The research explores grid-forming converter control strategies, essential for ensuring the stable and compliant operation of MMC-based HVDC grids.

The research elaborates on the Model Predictive Control (MPC), which is a promising control strategy for MMC-based HVDC grids. The MPC controller makes the control strategies respond faster, emphasizing constraints and cost functions. Furthermore, a comparative analysis of Proportional Integral (PI)-based and MPC-based controllers is conducted across various scenarios, highlighting the speed of response of MPC-based controllers over PI-based.

This project illustrates the capabilities of grid-forming control strategy through Model Predictive controllers for FPGA-based MMC-MTDC networks on RSCAD/RTDS®. The FPGA-based converters enable the use of detailed models of the converters without sacrificing the speed of the simulations. For the implementation of MPC, MATLAB /Simulink is used to tune the controller, then a user-defined block in RSCAD software is used to implement it in a real-time environment of RSCAD/RTDS®.

The outcomes of this project possess the capacity to significantly augment the progression of HVDC technologies and control strategies, with implications for enhancing the stability and efficiency of MMC-based HVDC grids.

**Rohan Tarcar**
*TU Delft*

Rohan R. Kamat Tarcar is a promising first-year Ph.D. Candidate who received his MSc. degree in Electrical Power Engineering in 2023 from TU Delft. His master's thesis focused on Control strategies for MTDC networks. His research interests include HVDC Control and Protection and, stability analysis of HVDC networks. His recent publication was presented at the 2023 IEEE PESGM Conference.

# PRESENTATIONS

## Thursday, September 21, 2023

### *8:30 AM - 9:00 AM* Reduced-hardware PHIL for Real-time Testing of BESS

Battery energy storage systems (BESS) are playing a crucial role in the global efforts towards the decarbonisation of power networks. Power-hardware-in-the-loop (PHIL) provides a realistic evaluation method for BESS before the actual commissioning on power networks. Most BESS are integrated on the network through a two-stage power converter topology. Such topology includes an active stage interfacing the system to the network and a dc link in between the power conversion stages. The paper proposes a reduced-hardware PHIL test setup on the assumption that the dynamics of the back-end converter, which interfaces the battery bank to the dc link, are of interest. The objective is to utilise the front-end converter of the hardware under test as the power amplifier, thus relieving the need of a separate power amplifier. The reduced hardware makes the PHIL setup easier and more accessible. The dc link voltage is used as the voltage source for the hardware implementation. The paper will look at the implementation of the proposed reduced-hardware PHIL setup. It will consider its stability and asses its performance against conventional PHIL setups.

**Cedric Caruana**
*University of Malta*

Cedric Caruana is an Associate Professor at the Faculty of Engineering and an associate member of the Institute for Sustainable Energy at the University of Malta, Malta. He is a senior member of the IEEE and a member of the IET. Between 2011-12, he was a visiting scholar at the Petroleum Institute, Abu Dhabi, UAE. His current research relates to the control of electrical drives, control and grid integration of renewable energy, energy storage systems and electrification of transport.

# EVENING NETWORKING EVENT

We'd love to see you at our UGM networking event on Wednesday, September 20 from 6:30 PM - 10:00 PM. We'll be enjoying dinner and house-brewed beer at **Tucher-Mautkeller**, a Franconian brewhouse in an ancient building.

**Turn to page 33 for more information.**

# PRESENTATIONS

## Thursday, September 21, 2023

### *9:00 AM - 9:30 AM* Co-Simulation of Real-time and Offline Power System Simulators

This presentation proposal is based on two papers indicating the interfacing of RTDS real-time simulators with an RMS simulation running in the offline simulation program PSS®E. The former paper (https://doi.org/10.1016/j.epsr.2022.108490) highlights the interface itself with a minimalistic application example. The latter paper (currently under review) uses this interface to couple a 12,000 node RMS network to 3 LCC HVDC stations, providing insights to electro-mechanical transients using a real-time model in its native environment.

In its first part, this contribution proposes a coupling interface between the real-time simulation system RTDS Novacor and the Power System Simulation Software PSS®E for electromagnetic transient (EMT) and phasor (RMS) hybrid simulations to enable a performant connection between the domains. For the coupling interface, an Ethernet (UDP) based connection is utilized. The technical implementation of the interfaces is explained in detail. The functionality of the interfaces is verified based on an EMT-RMS simulation in a small overhead line test system.

Finally, this contribution uses the interface to provide insights into a cosimulation of phasor based and instantaneous value based simulators using a real use case. Coupling multiple high-voltage direct-current (HVDC) stations, modeled in a real-time simulation environment using RTDS simulators, to an offline RMS Simulation in PSS®E allows for producing insights unseen before. The model is tested in the smaller SAVNW system before it is implemented in the East China Transmission System consisting of over 12,000 three-phase nodes. Three HVDC connections are integrated in EMT using an individual real-time simulator each. Finally, a cross-verification is performed comparing the system response to the simulation tool BPA, where the system is modeled in a monolithic way for reference. The results of a disturbance investigation allow a combined investigation of electromagnetic transient as well as transient stability phenomena.

**Christian Scheibe**

*Siemens AG*

Christian finished his Master's degree in 2015 and started with Siemens PTI working on Power System Transients right after that. The work included switching and lightning overvoltage analysis as well as HVDC and converter integration in the grid and their interaction based on electromagnetic transient anaysis. In 2019, he joined the Chair of Electrical Energy Systems at the Friedrich-Alexander-Universität Erlangen-Nürnberg in parallel to his work in Siemens. The topics involved power system co-simulation, especially in the RMS-EMT domain. He took lead of the chair's real-time simulation laboratory in 2020. After finishing his PhD Thesis in early 2023, he is now with Siemens Technology working in the field of power electronics integration and co-simulation of power systems.

# PRESENTATIONS

## Thursday, September 21, 2023

*9:30 AM - 10:00 AM*

### A Modular Hardware-in-the-Loop Testbench for the Investigation of Converter Control Interactions and Interoperability

Various grid-following and grid-forming control concepts are being developed with the increasing integration of converters into the power system. To investigate the system stability and the interactions of such control concepts with bulk integration of renewables, a testbench has been developed including a MVDC/HVDC multi terminal system and various additional converter based sources and control schemes.
In this presentation, the process and challenges faced during the modelling of this testbench shall be discussed. This includes modelling the different equipment in the mainstep and substep, integrating different control concepts, the linkage to a transmission grid section and the resources needed. In addition, the model offers the opportunity to investigate the interactions of the modelled controls with real converters via Power Hardware-in-the-Loop. Finally, the runtime environment of the model with the startup scripts and the application possibilities of this testbench are discussed.

**Julian Richter**
*Friedrich-Alexander-Universität*

Julian is a research associate at the Institute for Electrical Energy Systems of the FAU Erlangen-Nürnberg since February 2021. He is responsible for the power hardware laboratory that includes several storage systems, converters loads and power amplifieres for PHiL couplings. His main research focus is on DC collector grids with battery storages to provide ancillary services with renewable energy systems.

# PRESENTATIONS

## Thursday, September 21, 2023

*10:15 AM - 11:00 AM*

### All New RSCAD® FX 2.0

RSCAD-FX is the enhanced software interface for the RTDS® simulator. Recently, the RSCAD-FX version 2.0 was released with the new and improved HMI module suitable for real-time simulation and hardware in the loop (HIL) testing. This presentation will give an overview of the latest RSCAD-FX software

**Arunprasanth Sakthivel**

*Sr. Simulation Engineer Technical Support*

Sakthivel Arunprasanth (S'10) received the B.Sc. (Eng.) and M.Sc. (Eng.) degrees in electrical and electronic engineering from the University of Peradeniya, Peradeniya, Sri Lanka, in 2010 and 2013, respectively, and is currently pursuing the Ph.D. degree in electrical engineering with a specialization in power and energy systems at the University of Manitoba, Winnipeg, MB, Canada. He is also a Mitacs scholarship intern with RTDS Technologies Inc., Winnipeg, MB, Canada. He was a Researcher and Instructor in the Department of Electrical and Electronic Engineering, University of Peradeniya, Peradeniya, Sri Lanka, from 2010 to 2012. His research interests include transient and small-signal stability studies of HVDC and HVAC systems, and real-time electromagnetic transient simulation of power systems.

*11:00 AM - 11:30 AM*

### Functional Testing of HVDC Protection Systems – Towards Multivendor

Protection of multiterminal HVDC grids continues to be a topic of great interest, with a decade of research now leading to the first industrial systems with DC grid protection. There are still, however, open questions as to the most effective system design, as well as regarding interoperability, functional requirements and specifications. Functional testing of protection systems (e.g. protection relays or IEDs) goes some way towards de-risking the deployment of these still novel technologies. This presentation will look into HVDC protection systems and focus on testing performed by KU Leuven / EnergyVille – including demonstration and validation of functional performance, and looking towards future standardisation of HVDC protection functions, functional requirements/tests, and design/specification of protection systems.

**Geraint Chaffey**

*KU Leuven and EnergyVille*

Dr Geraint Chaffey received his PhD from Imperial College London in 2017, titled 'The impact of fault blocking converters on HVDC protection'. Since 2017 Geraint is at KU Leuven and EnergyVille where he is a research expert looking into the design, validation and demonstration of protection systems for future power systems, with a focus on protection of multiterminal HVDC networks and functional testing of protection systems using hardware-in-the-loop real-time testing. Geraint is the convenor of IEC TC95 WG3 - standardisation requirements for HVDC protection, representing Belgium in CIGRE B4, and an active participant in CIGRE and IEEE working groups.

# PRESENTATIONS

## Thursday, September 21, 2023

*11:30 AM - 12:00 AM* **Impedance-based Stability Analysis of a Power Hardware-in-the-Loop for Grid-Following Inverter Testing**

Power Hardware-in-the-Loop (P-HIL) provides a reliable evaluation of real hardware interactions under realistic grid conditions in the Laboratory environment. A P-HIL setup comprises three main sectors: real-time simulator, hardware under test (HuT), and interfaces. The limitations of interfaces and the delays between the sectors can result in stability issues. Therefore, a precise stability analysis is necessary before conducting laboratory experiments. This paper proposes the impedance-based approach to asses the stability constraints for a P-HIL using a grid-following inverter as HuT. The stability criterion
is determined based on the impedances seen by the grid and the inverter at the PCC. The impact of interface dynamics, delays, and controller bandwidth is carefully regarded. All P-HIL components are implemented in Simulink first, then the actual setup with RTDS and linear amplifier has been configured to provide a more realistic reference for impedance verifications. The calculated impedances are verified with both simulations and experiments through frequency response. The comparison between the time domain response and the Nyquist criterion confirms the validity of the given stability criterion.

**Fargah Ashrafidehkordi**
*Karlsruhe Institute of Technology*

Fargah Ashrafidehkordi (Student Member, IEEE) received his B.Sc. and M.Sc. degrees in electrical engineering in 2016 and 2019 from Babol Noshirvani University of Technology, Iran, and Amirkabir University of Technology, Iran, respectively. Currently, he is working towards his Ph.D. in stability and accuracy analysis of the Power Hardware-in-the-Loop setups in the "Real Time System Integration" group at "EnergyLab 2.0" at the Karlsruhe Institute of Technology. His research interests include power electronics integration in power systems, grid-tied converters control, stability analysis, real-time simulations, and power hardware in the loop.

# DOZENS OF VIDEO MODULES

Expand your usage of the RTDS Simulator through our video resource library. We offer a series of video resources for RTDS Simulator users looking to improve their usage.

**Our expansive resource library includes:**

- Hardware setups
- Software (RSCAD FX) tutorials
- Application Exploration

# PRESENTATIONS

## Thursday, September 21, 2023

*1:00 PM - 1:30 PM*

### HIL and RTDS Assisted De-risking of the Johan Sverdrup Project

Located approximately 155 km west of Stavanger, the Johan Sverdrup (JS) O&G field is among the largest ever discovered on the Norwegian continental shelf. The power feeding the JS field, together with its satellite platforms, is supplied by two symmetric monopole HVDC links from two vendors in parallel connection both on shore and offshore. These two links were developed in two consecutive phases, in which Phase-1 is a two-level VSC-HVDC of 100 MW from Hitachi Energy (in operation since 2019), and Phase-2 is a 200 MW MMC-HVDC from Siemens commissioned in July 2022. The JS project is Europe's first multi-vendor parallel connected HVDC systems in grid-forming operation.

HIL simulation using the C&P replicas from both vendors and the RTDS simulator was opted as an indispensable approach to de-risking the parallel operation of the JS HVDC systems due to:

- Accurate representation of the C&P functions implemented by both vendors is compulsory to investigate potential interaction phenomena and improve multi-vendor interoperability.
- Intellectual properties of each vendor must be protected, making the use of a detailed open offline model impossible in system testing and problem-solving.
- A global controller, namely the Power Management System (PMS), whose functions are not available in the offline model, was used to coordinate power sharing between both HVDC links.
- This approach has been proven extremely helpful to prepare for and perform on-site commissioning tests while ensuring stable and continuous production.

The aforementioned aspects shall be further developed during the presentation.


**Ming Cai**

*RTE International*

Ming Cai received his B. A. Sc, and M. A. Sc degrees in electrical engineering at the University of British Columbia in 2008 and 2011, respectively. In 2019, he received his Ph.D degree in electrical engineering at Polytechnique Montréal, Canada. He joined RTE international in the same year and is currently involved in projects of electromagnetic transient studies as a technical expert.

# PRESENTATIONS

## Thursday, May 18, 2023

*1:30 PM - 2:00 PM*

### RTDS Simulation and Network DC – SIF Project

The UK government has set targets to increase offshore wind to 50GW by 2030, Multi-Terminal High Voltage Direct Current (MT-HVDC) transmission systems have been considered an effective and economical approach to transmit bulk offshore wind power to the existing onshore power network. “Network-DC” Project will investigate and demonstrate the use of DCCB on a DC switching station (DCSS) proposed at Peterhead, that could support HVDC links connecting electricity transmission in NE Scotland to locations in England and international interconnectors. To de-risk the engineering challenges the “Network-DC” project will use Hardware Testing in the Loop (HIL) and Software Testing in the Loop (SIL) to establish performance standards for DCCBs. Testing and consultation with key stakeholders will establish and demonstrate DCCB performance, resulting in approved specifications that can be used for procurement. This presentation will brief the development and outlook of the “Network -DC” project.

**Suresh Kumar Rangasamy**

*The National HVDC Centre*

Suresh Kumar Rangasamy is an HVDC simulation engineer with the National HVDC Centre, UK, responsible for power system studies using real-time simulators. He received a bachelor’s degree in electrical & electronics engineering from Anna University, India in 2013. After graduation, he joined the Central Power Research Institute (CPRI), in India, where he is responsible for the dynamic testing of AC Protection systems, then he joined Hitachi Energy where he is responsible for Factory system Testing of HVDC Control and Protection systems. He is also a member of IET(UK) and IEI(India).

# SIEMENS LAB TOUR

Join us for an exciting tour of the Siemens Energy HVDC & FACTS control and protection test facility on Thursday, September 21. A bus will pick us up at the FAU campus at 2:15 PM, and depart the Siemens facility at 4:30 PM to return to FAU.

Note that photography is not permitted and unfortunately direct competitors of Siemens Energy cannot attend the tour due to compliance considerations.

**Turn to page 34 for more information.**

# PRESENTATIONS

## Friday, September 22, 2023

*08:30 AM -09:00 AM*

### Development of a Custom Induction Machine Component for Computationally Efficient Flywheel Energy Storage Simulation

In addition to the classical, dq-based, induction machine (IM) model, RSCAD-RTDS includes the _rtds_INDM, which is a phase-domain (PD) based formulation. The PD model equations are embedded within the network solution by incorporating its differential equations. This approach has been shown to have superior numerical performance compared to the indirect interfacing used with the dq model, allowing the use of a larger simulation time-step. However, in the PD model, the IM inductances vary with changes in rotor position. This characteristic has a negative impact on simulation times. To avoid the time-step limitation of the dq model, while improving on the efficiency of the PD formulation, an IM model is implemented as a custom component in RSCAD.

The custom IM model combines PD and dq quantities to produce a very efficient formulation, which has similar numerical accuracy to the PD model at large time steps. Furthermore, when magnetic core saturation and zero sequence components are neglected, the custom model exhibits a constant, diagonal conductance matrix, which is very convenient for the efficient solution of the EMTP nodal network.

The custom IM model is subsequently combined with the average UCM to produce an efficient formulation of a flywheel energy storage system (FESS). The main goal on combining the average UCM and the custom IM model is to develop a computationally efficient FESS representation. Such a model is suitable to be used with a hardware-constrained RTDS environment, while enabling the analysis of a central controller when several FESS are present in the network.

**Damian Vilchis-Rodriguez**
*The University of Manchester*

Damian Vilchis-Rodriguez received the Ph.D. degree in electrical engineering from the University of Glasgow, Glasgow, U.K., in 2010. He was a Computer Programmer and a Power Quality Consultant in Mexico, from 1993 to 2004. He is currently a Senior Research Associate with the Power and Energy Division, The University of Manchester, Manchester, U.K. His current research interests include electrical machines modelling, condition monitoring of rotating ac machinery, power systems simulation, high-voltage dc protection, reliability analysis of HVDC systems.

# PRESENTATIONS

## Friday, September 22, 2023

*09:00 AM - 09:30 AM*

### Sub-/supersynchronous Oscillation Analysis in an Offshore Grid Model using RTDS

To reach the ambitious goals related to the decarbonization of the power generation it is inevitable to use the full potential of renewable energy sources, which includes also the massive deployment of offshore wind energy. Furthermore, there exists the possibility connecting hydrogen production equipment to the offshore platforms building so called offshore energy hubs. However, several challenges related to dynamic stability need to be solved for the proper large scale integration of this offshore energy hubs. One of the stability issues is related to sub-/supersynchronous oscillations and to assess this phenomena, suitable EMT models are required. The multi-GW offshore energy system model to be discussed in this presentation, will illustrate an example with 2GW size, including wind turbines aggregated in different smaller portions of powers, different sizes of electrolysers and a bipolar HVDC link to connect the offshore hub to the power system on the main land. The dynamic stability of sub-/supersynchronous oscillations depends on many factors such as for example the parameters of the control loops, the operating conditions, length of the transmission cables and thus it is important to explore different conditions and topologies to get a holistic understanding of the capabilities and limits of the model. In addition, the individual size of the aggregated electrolysers and wind turbines might affect the properties of sub-/supersynchronous oscillations and thus need to be taken into account.

**Sandro Kellermüller**
*TU Delft*

Sandro Kellermüller received the BSc and MSc degrees in Energy and Environment Engineering from the Zurich University of Applied Sciences (ZHAW), Winterthur, Switzerland, in 2019 and 2022, respectively. During 2019-2023, he worked as a research assistant at ZHAW in the Electric Power Systems and Smart Grid group. Since May 2023, he is a PhD student at TU Delft, the Netherlands, in the Intelligent Electrical Power Grids group, working on the dynamic stability of offshore energy systems.

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# PRESENTATIONS

## Friday, September 22, 2023

*09:30 AM -10:00 AM*

### CHIL and PHIL Applications for Protection, Control, and Optimal Operation of Active Distribution Networks and Microgrids.

New CHIL and PHIL experimental setups, applications and considerations implemented in the Electric Energy Systems Laboratory (EESL) of ICCS-NTUA will be presented and discussed. The presentation will commence by showcasing the interaction between a hardware inverter controller and a hardware protection relay implementing an islanding detection scheme, in a CHIL setup. Next, the design and testing of an adaptive protection scheme, adjusting setting groups of three feeder relays using industrial communication protocols (IEC 61850, DNP3) in a CHIL setup, will be presented. Moreover, the CHIL testing of an industrial controller for Grid Code Requirements compliance, facilitating the integration of renewable energy sources and advanced technologies into the grid, will be highlighted. In the realm of microgrids, the HIL testing of a developed in-house energy management system will demonstrate cutting-edge performance in simulating and refining real-world microgrid operation using a digital twin, optimizing renewable energy utilization. Emphasis will be placed on the combined CHIL and PHIL setup, investigating the interaction between a controller for seamless microgrid transition and a hardware PV inverter. A critical factor for the successful PHIL implementation is to have a stable but at the same time accurate setup, thus our recent work in the frame of ERIGrid 2.0 project, published at IEEE Transactions on Industrial Electronics on extended range of high-fidelity setups for PHIL testing will be presented. Lastly, the presentation will highlight the benefits of Geographically Distributed Real-Time Simulations and the work carried out within ERIGrid 2.0, enabling comprehensive power system analysis and optimization over larger areas.

**Alkistis Kontou**
*ICCS-NTUA*

Alkistis C. Kontou (Student member, IEEE) received the Diploma degree in Electrical and Computer Engineering from the National Technical University of Athens, Greece, in 2019. During 2019 she was also an intern with BayWa r.e. Since 2019, she has been a PhD Candidate within the Department of Electrical and Computer Engineering in National Technical University of Athens, Greece, and working as a researcher for the SmartRUE founded by Prof. Hatziargyiou. Her research interests lie in control of power inverters, converter-driven stability, microgrids and laboratory validation methods.

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# PRESENTATIONS

## Friday, September 22, 2023

*10:15 AM - 11:00 AM*

### New Features, Component Models, and Sample Cases in RSCAD-FX

Computer simulation of present power systems consisting of renewables requires accurate models, smaller integration timestep, and faster simulation of relatively large power networks. The RSCAD-FX software comes with new features and component models to support the simulation needs of the growing power industry. This presentation will highlight the attractive features, new components models, and latest sample cases in RSCAD-FX.

**Arunprasanth Sakthivel**
*RTDS Technologies Inc.*

*11:00 AM - 11:30 AM*

### Industrial Research into the Reliable Operation of Digital Substations

Digitalisation plays a crucial role in the EU energy transition. Digital substations form the data nodes of a smart grid. It is therefore crucial to ensure their reliable operation. The Protection, Automation, and Control System (PACS) is a core component in safeguarding the substations' reliability. As digital substations heavily rely on communication buses to carry out their essential functions, it becomes imperative to conduct thorough testing to identify and mitigate potential failures. Exploiting vulnerabilities across a broader system necessitates the use of in-the-loop simulation. Such simulations provide a flexible means to accurately depict the real-life conditions within and around the substation. Within a loop, substation cubicles equipped with intelligent monitoring and control systems interact, while mitigation scenarios encompass human-in-the-loop elements. This presentation will look into the challenges of digital substations and focus on emulation testing performed by KU Leuven (EnergyVille), garnering laboratory requirements for conduction industrial research for digital substations.

**Rick Loenders**
*KU Leuven and EnergyVille*

Rick Loenders received his master of science in Energy engineering at KU Leuven (Belgium) in 2017, and has since joined the department of electrical energy & computer architectures of KU Leuven. He is currently working there as project coordinator for the digital grid emulation lab in EnergyVille. His research interests include high-voltage AC/DC protection and smart grid communication applications.

# PRESENTATIONS

## Friday, September 22, 2023

### *11:30 AM - 12:00 PM* A Test Framework for an Adaptive Protection Scheme Using a Hardware-in-the-Loop Setup

The increase in distributed generation leads to phenomena like intermediate infeed and inversed power flow on a previously unseen scale. Additionally, variable infeed of renewable energy sources necessitates frequent topology changes, which protection schemes need to compensate for. This poses a challenge for distance and overcurrent protection schemes. Therefore, an increased flexibility of protection schemes is necessary, which is enabled by an adaptive protection concept that dynamically adapts parameters depending on infeed and topology status of the grid.

In order to test and guarantee the functionality of an adaptive protection system, a test framework is implemented in a real-time laboratory. The framework consist of a grid model containing the challenging topologies, which is running in real-time on an RTDS real-time simulator. The analog measurement values produced by the RTDS simulator are amplified by four Omicron CMS devices and serve as inputs for four Siprotec 5 Protection Devices. The interaction of the protection devices with the breakers in the real-time simulation is enabled by the digital front panel inputs of the RTDS Simulator.

The topology of the simulated grid is monitored via TCP/IP using a virtual control center implemented in Python. By using a previously developed IEC61850 client, the protection parameters of the Siprotec devices can be dynamically adapted depending on the state of the real-time environment. The protection configurations for different scenarios were pre-calculated and saved in a database. The test framework delivers a successful proof of concept to verify the adaptability of protection settings.

**Tobias Lorz**

*Friedrich-Alexander-Unversität Erlangen-Nürnberg*

Tobias Lorz is a Research Assistant at the Institute of Electrical Energy Systems at the Friedrich-Alexander-Universität Erlangen Nürnberg since Novermber 2020. His focues in research is the development of adaptive protection systems and the challenges contained therein.

# SPECIAL EVENTS

## Networking Dinner

### Tucher-Mautkeller
*Hallpl. 2, 90402 Nürnberg*

**Wednesday, September 20** **6:30 - 10:00 pm**

Please join us at this year's networking dinner at Tucher-Mautkeller! This Franconian brewhouse serves house-brewed beers and local cuisine, and it's a great opportunity to connect with fellow RTDS Simulator users and the RTDS team.

Transportation to dinner is not provided. The restaurant is in Nürnberg city centre, about a 10 minute drive from FAU campus.

# SPECIAL EVENTS

## Tour of Siemens Energy HVDC & FACTS Control and Protection Test Facility

### Thursday, September 21
### 2:15 - 4:30 PM

**Bus pick-up at FAU campus at 2:15 PM**
**Bus will leave Siemens at 4:30 PM and return to FAU**

Siemens Energy is one of the top suppliers of HVDC and FACTS schemes worldwide as well as one of RTDS Technologies' largest customers. Siemens Energy uses the RTDS Simulator for the Dynamic Performance and Factory Witness testing of the Control and Protection (C&P) equipment for all HVDC and FACTS schemes. They typically run several projects in parallel and operates therefore several test facilities around the world, one of these state of the art test facilities is located in the Nuremberg / Erlangen region. As part of the tour, Siemens Energy will make a presentation outlining their business and the role played by the RTDS Simulator. After the presentation, attendees will be walked through the test area to see where the tests are conducted and there will be an opportunity for questions to be asked.

Note that it will not be permitted to take any photographs inside the facility. Additionally, due to compliance considerations, competitors of Siemens Energy will not be permitted to take part in the tour.

# NOTES

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