DFG SPP 1984

Technische Universität München

Spring School Agenda

Location: TUM, Lichtenbergstraße 4a, 85748 Garching bei München, Germany

Date: 12-14 April 2023

Day 1 – Wednesday, April 12

[13:30] — [15:00]	Prof. Thomas Hamacher – Welcome note and the lecture "Sector Coupling – Potentials, Opportunities and Challenges"
[15:00] — [16:30]	Prof. Kai Strunz, – "Enabling 100 % Renewable Power Systems Through Power Electronic Grid-Forming Converter and Control: System Integration and Application to Europe"
[16:30] — [17:45]	CoSES Lab Tour/Workshop Introduction

Day 2 – Thursday, April 13

[09:30] — [12:00]	Visit to research neutron source Heinz Maier-Leibnitz
[12:00] — [13:00]	Lunch Break
[13:00] — [14:00]	Industrial Keynote, Dr. Micheal Metzger, Siemens AG Title: Towards autonomous grids - How to address the challenges in power distribution
[14:15] — [15:45]	Career Paths in Academia, TUM ForTe

[15:45] — [16:45]	Industrial Keynote, Dr.-Ing. Nam Truong, CEO, STABL Energy, Title: Aging of second-life batteries – an industry view on approaches in the market
[17:00] — [18:30]	Dr. Sante Pugliese – "Accuracy and Stability of P-HIL Simulation in Power Electronics Testing"
[19:30] —	Dinner

Day 3 – Friday, April 14

[9:00] — [10:00]	Workshop – Group discussion and presentations
[10:00] — [10:45]	Industrial Keynote, Mr. Eugenio Scionti, E.ON Future Lab, Title: Smarter energy systems with emerging digital technologies: insights, examples, risks
[11:00] — [12:30]	Prof. Zhao Yuan – "Real-Time Control of Battery Energy Storage Systems"
[12:30] — [13:00]	Lunch – Adjourn

Online Participation

Join Zoom Meeting:
https://tum-conf.zoom.us/j/64891057272?pwd=eGFBVDF3bjFKWTFWdVp0dHFWUCtjQT09

Meeting ID: 648 9105 7272
Passcode: 782700

Access to Heinz Maier-Leibnitz Laboratory

Meeting point is the gate of the FRM II, Lichtenbergstraße 1, 85748 Garching.
Thursday, April 13th at 9:30am.
Please be there on time as the entrance clearance might be lengthy.

Important instructions:
• Access to our research facility is not possible without presenting a valid ID card (ID card or passport only, non-EU citizens need a passport, "residence permit" or driver's license cannot be accepted)

• Only people registered for the Spring School will be able to enter the nuclear reactor as the list of visitors is required in advance.
• Minimum age: 18 years
• Duration with access formalities depending on group size: about 2-2.5 hours
• Before entering the controlled areas, a personal search takes place
• Mobile phones and cameras must be left in lockers
• Please bring as little luggage as possible
• Access with walking aids is not possible for safety reasons

Directions: http://www.frm2.tum.de/ueber-uns/kontakt/anfahrt/

Virtual tour of the FRM II: http://mlz-garching.de/panorama/full/de/index.html

Keynote Speakers

Speaker: Dr.-Ing. Michael Metzger
Title: Towards autonomous grids - How to address the challenges in power distribution

Abstract:
Today's distributions grids, especially low voltage grids, are lacking control and even measuring technologies. The increasing demand through electric heating and electric vehicles combined with volatile in-feed from Renewables leads to more and more critical situations in the lower end of the grid. The vision of autonomously operated grids helps to master the increasing complexity and to achieve optimized operation.

Biography:
Michael Metzger received a PhD degree in process control at the University of Erlangen-Nuremberg and a master's degree in mathematics at the Technical University Munich, Germany. He has acquired a strong experience in process and energy automation at the Fraunhofer Institute for Integrated Systems and Device Technology and Siemens AG for more than twenty years in several positions. He is mainly in charge of R&D activities and pilot projects dealing with model-based system design and digitalization of energy supply. He started his career at Siemens in the business of steel works, mining, and gas networks. Currently Dr. Metzgeris the principal key expert for sustainable energy and infrastructure at the Siemens Technology, located in Munich.
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Speaker: Dr.-Ing. Nam Truong
Title: Towards autonomous grids - How to address the challenges in power distribution

Abstract:
Further use of batteries after their first life in electric vehicles is increasingly discussed and experimented with. While the idea of a second life for batteries is very appealing, the complexity of battery degradation prohibits the mass adoption of this approach today. An overview of the approaches in the industry is presented and evaluated.

Biography:
Dr.-Ing. Nam Truong has received his diploma in electrical and computer engineering in 2013 from Technical University of Munich. He has finished his PhD at the same university in 2018 at the Chair of Electrical Energy Storage Technology. After graduation, together with the partners, he has founded STABL Energy GmbH, which is a provider of novel, modular power inverters for battery systems that makes commercial and utility scale energy storage systems more efficient, reliable, safe, and affordable. He currently serves as a CEO of the STABL Energy GmbH.
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Speaker: Eugenio Scionti,
Title: Smarter energy systems with emerging digital technologies: insights, examples, risks

Abstract:
Emerging digital technologies have the potential to fundamentally transform the way we conceive of the energy system today. The necessity for new technologies to support a broader digital transformation in the sector stems from the need to create energy systems that are more intelligent, efficient, and sustainable. During the keynote speech, the speaker will delve into specific examples of how digital technologies, such as those in the areas of robotics, Internet of Things (IoT), and Artificial Intelligence (AI), can provide advantages in terms of better system management, improved performance, and greater resilience. These examples will be accompanied by a showcase of strategic initiatives and pilot projects that have been undertaken at E.ON.
Finally, the speech will address the risks and barriers that come with adopting these technologies, with the aim of leaving the audience with an opportunity to consider how these challenges can be addressed in their own work or by the wider research community.

Biography:
Eugenio is an Engineer and Technical Product Owner at Future Lab, the digital R&D arm of E.ON Digital Technology. After graduating as an Energy Engineer from the University of Calabria, he joined the E.ON Graduate Trainee Program in 2017, where he acquired broad industry knowledge and product management experience. Since 2019 he has been working as engineer with focus on applications of robotics and AI/ML, both driving technical projects and promoting academia-industry collaborations.
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Lecturers

Speaker: Prof. Dr. Thomas Hamacher
Title: Sector Coupling – Potentials, Opportunities and Challenges

Abstract:
Sector coupling and integration of different energy sectors such as electricity, heat, gas, and transport has a great potential to increase efficiency and reliability of energy system. In this talk, the potentials, opportunities, and challenges of sector coupling are discussed with the reference to regional differences and specific challenges. The technical, regulatory, and economic challenges that need to be addressed to fully realize the benefits of sector coupling. Finally, the need for collaboration and innovation across different regions is emphasized to address the challenges and opportunities of this emerging field.

Biography:
Thomas Hamacher studied physics at Bonn University, at RWTH Aachen and at Columbia University, New York. He received his Doctorate in Natural Sciences from the University of Hamburg in 1994 for his work on baryonic beta decay. Between 1996 and 2010, he was with the Max Planck Institute of Plasma Physics in Garching bei München and was head of the Energy and System Studies Group. Since 2010, he has been a professor at the Department of Electrical Engineering and Computer Science at the Technical University of Munich. In 2013, he was appointed Full Professor for the Chair of Renewable and Sustainable Energy Systems.
Thomas Hamacher takes part frequently in public debates about the German Energy transition in Germany, nuclear power and fusion power. His main research focus lies on the modeling, analysis, and design of energy systems in the context of disruptive technologies such as nuclear fusion, renewable energy, smart cities, or electromobility.
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Speaker: Prof. Dr. Kai Strunz
Title: Enabling 100 % Renewable Power Systems Through Power Electronic Grid-Forming Converter and Control: System Integration and Application to Europe

Abstract:
In this presentation, a control scheme for power electronic grid-forming conversion is developed as an enabler for a system-wide integration of 100 % renewable energy sources (RESs) in power systems. The scheme culminates in the concept of the grid-forming resource (GFR) that brings together both the control technologies of the renewable power resource and the grid-forming converter. As part of GFRs, a grid-forming converter controller is presented to ensure operation under diverse transient conditions as needed for overall system security. The controller is shown to be practical in offering inertial response emulation and frequency control based on droop characteristics to maintain power balances rapidly and to control voltages. The integration with the control of wind energy conversion systems (WECSs) creates a grid-forming wind park as the prototype of the GFR. Feedforward signals exchanged between grid and resource-side controls enhance fast overall controllability. The principal claims are substantiated for a European scenario example with the Irish power transmission system in the focus. The model comprises more than 2000 individual WECSs grouped into wind parks, where ten wind parks function as GFRs. The transient behavior of this scenario comprising 100 % converter-interfaced generation is shown to be superior compared with a counterpart case comprising synchronous machinery. The results validate the fact that GFRs with their proposed controls are expected to be key elements in creating a renewable and secure electric power system.

Biography:
Kai Strunz received the Dr.-Ing. degree (summa cum laude) from Saarland University, Saarbrücken, Germany, in 2001. He was with Brunel University, Uxbridge, U.K., from 1995 to 1997. From 1997 to 2002, he was with the Division Recherche et Dévelopment of Electricité de France in Paris. From 2002 to 2007, he was an Assistant Professor of electrical engineering with the University of Washington, Seattle, WA, USA. Since 2007, he has been a Professor for Sustainable Electric Networks and Sources of Energy with Technische Universität Berlin, Berlin, Germany. He has been a Guest Professor of the Chinese Academy of Sciences, Beijing, China, since 2017. He was the General Chair of the Conference IEEE PES Innovative Smart Grid Technologies Europe in 2012. He is the Chair of the IEEE PES Subcommittee Distributed

Energy Resources and the Co-Chair of the IEEE Working Group Dynamic Performance and Modeling of HVDC Systems and Power Electronics for Transmission Systems. He was the recipient of the IEEE PES Prize Paper Award in 2015, the IEEE Journal of Emerging and Selected Topics in Power Electronics First Prize Paper Award 2015, and the 2020 Best Paper Award in the field of electric machines and drives by IEEE Transactions on Energy Conversion. On behalf of the Intergovernmental Panel on Climate Change, he acted as the Review Editor for the Special Report on Renewable Energy Sources and Climate Change Mitigation.

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Speaker: Dr.-Ing. Sante Pugliese
Title: Accuracy and Stability of P-HIL Simulation in Power Electronics Testing

Abstract:
Modern energy systems are characterized by a wide adoption of power electronics interfaced generation and loads. Hardware performance validation is a fundamental step before its commercialization and installation into the grid. Power hardware in the loop (P-HIL) is a powerful tool for effective testing of power converters in real-time simulated grid. P-HIL simulation should be accurate to truly reflect the behavior of the systems under test, however it may result in errors or even instability. A systematic definition of the accuracy based on the emulated real-time impedance is given as concept for comparing and selecting the proper P-HIL design in power system real-time simulations. Furthermore, a frequency domain approach, based on the concept of singular values in Multi-Input Multi-Output systems, is presented to study the P-HIL accuracy and stability in grid connected converter testing under asymmetrical fault conditions.

Biography:
Sante Pugliese received the M.Sc. degree in Automation Engineering and the Ph.D. degree in Electrical and Information Engineering from the Politecnico di Bari, Italy, in 2013 and 2018 respectively. In 2017, ha was a visit scholar with the Chair of Power Electronics, Kiel, Germany where he is currently a Post-Doctoral Researcher. His research interests include power converters and control techniques for distributed power generation systems based on renewable energies.

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Speaker: Prof. Dr. Zhao Yuan
Title: Real-Time Control of Battery Energy Storage Systems

Abstract:
Frequency response and voltage support are vital ancillary services for power grids. In this paper, we design and experimentally validate a real-time control framework for battery energy storage systems (BESSs) to provide ancillary services to power grids. The objective of the control system is to utilize the full capability of the BESSs to provide ancillary services. We take the voltage-dependent capability curve of the DC-AC converter and the security requirements of BESSs as constraints of the control system. The initial power set-points are obtained based on the droop control approach. To guarantee the feasibility of the power set-points with respect to both the converter capability and BESS security constraints, the final power set-points calculation is formulated as a nonconvex optimization problem. A convex and computationally efficient reformulation of the original control problem is then proposed. We prove that

the proposed convex optimization gives the global optimal solution to the original nonconvex problem. We improve the computational performance of this algorithm by discretizing the feasible region of the optimization model. We achieve a 100 ms update time of the controller setpoint computation in the experimental validation of the utility-scale 720 kVA/560 kWh BESS.

Biography:
Dr. Zhao Yuan is an Assistant Professor and the Head of the Electrical Power Systems Laboratory (EPSLab) at the University of Iceland. He worked as a Scientist at the Swiss Federal Institute of Technology Lausanne (EPFL) from 2019 to 2021. Zhao received the joint PhD degree from KTH Royal Institute of Technology (KTH), Comillas Pontifical University (COMILLAS) and Delft University of Technology (TU Delft) in 2018.

Additional Information

Arrival:

1) From Munich Airport
   Public transpiration: There are multiple options to arrive to Garching Forschungszentrum. Please consult google maps, or https://www.mvv-muenchen.de/ for details. The ticket price from 7.40 € (single ticket) or day ticket 11.00 €. Trip lasts around 40 minutes
   Taxi: 45-50 €
2) By train from Munich Central Station
   There are multiple options to arrive to Garching Forschungszentrum. Please consult google maps, or https://www.mvv-muenchen.de/ for details. The ticket price 7.40 € (single ticket) or day ticket 11.00 €. Trip lasts around 35 minutes.
3) By car
   Parking is free of charge at the Garching Forschungszentrum (Parkplatz Zufahrt Nord TUM)
   https://goo.gl/maps/w568mVamVEVbt9Lv7

Hotels recommendations:

1) Courtyard By Marriott Munich Garching
   The hotel in campus. Walking distance from the Spring School venue.
   https://www.booking.com/hotel/de/courtyard-by-marriott-munich-garching.html
2) Hotel König Ludwig II, Garching
   Nearby hotel. 1 stop by U-Bahn
   https://www.booking.com/hotel/de/konig-ludwig-ii.en-gb.html

3) Hotel Hoyacker Hof, Garching
   Nearby hotel. 1 stop by U-Bahn
   https://www.booking.com/hotel/de/hoyacker-hof.en-gb.html

4) Hotels in Munich city center along the U-bahn U6 line (the commute lasts around 30 minutes).

Social Dinner (Wednesday, April 13th):
Garchinger Augustiner,
Freisinger Landstraße 4, 85748 Garching b. München
http://www.garchinger-augustiner.com/about.php

GARCHINGER AUGUSTINER
IM ALTEN GESINDEHAUS

One stop by U bahn from Garching Forschungszentrum Campus.