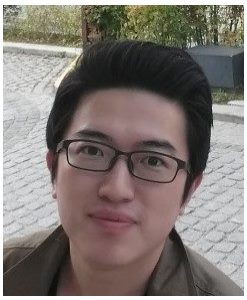
Prof. Antonello Monti RWTH Aachen University 	Before joining RWTH in Aachen, **Prof. Monti** was Professor of Electrical Engineering at the University of South Carolina (USA). During his tenure at USC he has been Associate Director of the Virtual Test Bed (VTB) project, which focuses on computational simulation and visualisation of modern power distribution systems that fully integrate power electronics into the network design. He has developed the real-time extension of VTB for Hardware in the Loop applications and has designed innovative tools supporting the automatic generation of VTB native models. He worked on expanding the limits of real-time simulation thanks to the application of PC clusters and FPGA technology. He was the director of the Real Time and Electromechanics Laboratory (REM Lab). He started his academic career at Politecnico di Milano after 4 years of industrial experience in Ansaldo Industria. **Scope of the presentation** The power grid is going through significant transformations and it is hard at this time to predict how the system will look like in the future. This presentation will summarize a set of options and technologies that are candidate to play a role in the future. Main idea is to discuss in a fair way how different solutions may help solving the challenges we can envision for the future. The experience built in a set of international projects will be the main ingredient to substantiate the conclusions
Prof. Rik de Doncker RWTH Aachen University 	**Rik W. De Doncker** received the Ph.D. degree in electrical engineering from Katholieke Universiteit Leuven, Leuven, Belgium, in 1986, and the Honorary Doctor Degree from Riga Technical University (RTU), Riga, Latvia, in 2010, for significant contribution to the perfection of the study process at RTU and the development and promotion of international scientific cooperation in the field of electrical engineering.,In 1987, he was a Visiting Associate Professor with the University of Wisconsin, Madison, WI, USA. He was an Adjunct Researcher with the Interuniversity Microelectronics Centre, Leuven. In 1989, he joined the Corporate Research and Development Center, General Electric Company, Schenectady, NY, USA. In 1994, he joined Silicon Power Corporation, Malvern, PA, USA, a former division of General Electric Inc., as the Vice President of Technology. In 1996, he became a Professor with RWTH Aachen University, Aachen, Germany, where he currently leads the Institute for Power Electronics and Electrical Drives. Since 2006, he has been the Director of the E.ON Energy Research Center, RWTH Aachen University.,Dr. De Doncker was the President of the IEEE Power Electronics Society in 2005 and 2006. He was the Founding Chairman of the German IEEE Industry Applications Society PELS Joint Chapter. He was a recipient of the IEEE IAS Outstanding Achievement Award in 2002, the IEEE Power and Energy Society Nari Hingorani Custom Power Award in 2008, and the IEEE William E. Newell Power Electronics Award. **Scope of the presentation** The increasing portion renewable energy in the energy mix leads to challenges for the energy infrastructure. In the scenario with 100% of energy comes from renewables, the power in the electrical network will mostly flow within the distribution network leading to a congestion in the medium voltage grids. Furthermore, with the increasing usage of electric vehicles (EV) to decarbonize the transportation sector, the required power from distribution grids for EV charging is also immense. Therefore, the electrical grids in the future need a high-degree of flexibility in shifting the energy on the distribution level (underlay) which can be effectively accomplished by direct current (DC)

	technology. The key enabling technology for the success of DC underlay grid is the efficient, cost effective and reliable power electronics. The development of semiconductor materials and power electronic systems over the past decades not only improves the efficiency but also reduce the material consumption for passive components which makes power electronics very attractive from the economic and ecological perspective.
Dr. Lucian Toma University POLITEHNICA of Bucharest 	**Lucian Toma** received the B.Sc. and Ph.D degree in electrical power engineering from the University "Politehnica" of Bucharest in 2002 and 2010, respectively. Currently he is an associate professor at the same university, at the Department of Electrical Power Systems. His fields of interest include power system analysis and control, computer modeling of power system components (including FACTS devices and HVDC), network design, smart grids and electricity markets. Since 2015 he is the representative of Romania in the CIGRE B4 Study Committee on "HVDC and power electronics". Dr. Toma is coauthor of the books "Power System dynamics: modeling, stability, and control" and "Advanced Solutions in Power System: HVDC, FACTS, and Artificial Intelligence", published by IEEE Press and Wiley within the Power Engineering Series, as well as over 70 papers published in journals and conference proceedings. He was engaged in 9 international and 11 national research grants, as well as in 10 consultancy projects for industry. In 2009 Dr. Toma has co-organized the IEEE PowerTech Conference in Bucharest. Since 2018 he is the Vice-Chair of the IEEE Romania Section **Scope of the presentation** The lecture addresses the technical and economic aspects related to the frequency control procedures in power systems. At the power system level, the three control levels (frequency containment, automatic restoration, and manual restoration) are described focusing on both time frames and automatic control scheme. The importance of inertia is particularly addressed. Performances of the various types of generation sources (hydro, gas, coal, wind, nuclear, convertor-based storage) are discussed in order to emphasize their contribution to the frequency control. Additionally, the behavior of real power systems using PMU measurements, for various perturbations, are explained.
Dr. David Raisz RWTH Aachen University 	**David Raisz** received his M.Sc degree and his PhD in Electrical Engineering from Budapest University of Technology and Economics (BUTE), Budapest, Hungary, in 2000 and 2011 respectively. From 1999 to 2001 he joined Graz University of Technology, Austria, as a guest researcher. From 2012 until 2016 he led the Power Systems and Environment Group at the Dept. of Electric Power Engineering at BUTE, as Associate Professor. In 2017 he joined the Institute for Automation of Complex Power Systems within the E.ON Energy Research Center at RWTH Aachen University. He has been working on or leading more than 40 industrial and research projects. He is member if CIGRÉ, VDE, MEE and senior member of IEEE. **Scope of presentation** The share of power converter based renewable generation is steadily increasing at the expense of rotating inertia. Virtual Synchronous Machines are deemed to ensure system stability, however, there are no widely accepted criteria for the design of their controllers. In converter-dominated power systems, one of the main challenges will be to analyze power angle stability, because of the large number (and possibly divergent design) of converters. Converters, however, also offer the possibility to shape system dynamics in a way that was impossible with synchronous machines. This talk will elaborate

	on the new concept of Linearized and Uniform Swing Dynamics. This allows the linearization of the nonlinear swing behavior over almost the entire power range, thereby extending the validity of the small-signal stability analysis techniques for larger disturbances. By properly choosing the controller parameters, the dynamics of the large number of converters expected in the system can be made unified and predictable.
Marco Pau RWTH Aachen University 	**Marco Pau** received the M.S. degree (cum laude) in electrical engineering and the Ph.D. degree in electronic engineering and computer science from the University of Cagliari, in Italy, in 2011 and 2015, respectively. Since 2015, he is a Research Associate with the Institute for Automation of Complex Power Systems, at the E.ON Energy Research Center of RWTH Aachen University, where he is leading the team for Power System Automation. He took part to the European H2020 projects Flexmeter and In2Rail, and he is currently involved in the H2020 project SOGNO. His research interests include the design of measurement systems for the monitoring and management of active distribution systems and the development of solutions for distribution grid automation. **Scope of the presentation** This session will present the main techniques adopted for the real-time monitoring of electrical grids and will show challenges and innovative solutions devised for the monitoring of tomorrow's smart grids. The session will provide first an introduction on the basis of the power system estimation theory. The most common approaches adopted as state-of-the-art solutions for the monitoring of power systems will be presented. In the second part, the challenges associated to the monitoring of future distribution grids will be discussed. Innovative techniques and methodologies developed to face the challenges posed by the distribution system scenario will be finally presented to give the students an overview of the solutions at the forefront of this research field.
	Abhinav Sadu (GS'14), received his degree of Bachelor of Technology in Electrical Engineering from Malaviya National Institute of Technology, Jaipur India and his M.S degree in Electrical Engineering and Information Technology from RWTH Aachen University, Aachen, Germany in 2014. He is currently pursuing the PhD degree with the Institute for Automation of Complex Power Systems at the E.ON Energy Research Center, RWTH Aachen University, Aachen, Germany. His current research is in the design of monitoring & automation systems of distribution grids for operational resiliency. His research interests include PMUs, state estimation algorithms, real-time simulation, substation automation with IEC 61850 and application of complex theory for resilient design of smart grids.
Sriram Gurumurthy RWTH Aachen University	**Bio:** Sriram Karthik Gurumurthy received the M.Sc. degree in electrical power engineering from RWTH Aachen University, Aachen, Germany in 2017. He is currently a Research Associate and pursues his P.hD degree with the Institute for Automation of Complex Power Systems, E.ON Energy Research Center, RWTH Aachen University. His research interests include modelling, control, stability analysis and automation of power electronics driven power systems. **Course Description:**

	Futuristic distribution systems will witness large installations of distributed energy resources (DERs) which interfaced to the distribution feeder though power electronics. Large number of power electronic inverters operating in parallel may lead to parallel resonance and harmonic instabilities. These new voltage instability phenomenon are attributed to the impedance of the converter and the grid at the point-of-common-coupling. RESERVE proposes a decentralized framework which rely on ICT to supervise, monitor and loop-shape the impedance of inverter to maintain and enhance the stability of its interconnection. Additionally, RESERVE proposes a ICT driven decentralized method to generate operational active and reactive power set points for Renewable Energy Sources (RES) inverter for optimal power flow in the grid and minimize voltage unbalances in the grid. The proposed two-fold solution for futuristic distribution grids for monitoring and managing voltage leads to new forms of ancillary services and network codes. This course will enable one to understand the challenges in distribution grids in terms of voltage stability and further understand the solutions in order to tackle the problems.
Shenghui Cui RWTH Aachen University 	**Shenghui Cui** received the B.S. degree in electrical engineering from Tsinghua University, Beijing, China, and the M.S. degree in electrical engineering from Seoul National University, Seoul, South Korea, with distinctions in 2012 and 2014, respectively. Since 2015, he has been with the Institute for Power Generation and Storage Systems, E.ON Energy Research Center, RWTH Aachen University, Aachen, Germany as a Research Associate. His current research interests include wide band gap power-semiconductor devices, high-power converters for medium- and high-voltage applications, and interactions of power-electronics converters and power systems. He has authored or co-authored over 25 IEEE journal and international conference papers, and holds one U.S. patent. **Sscope of presentation** The increasing portion renewable energy in the energy mix leads to challenges for the energy infrastructure. In the scenario with 100% of energy comes from renewables, the power in the electrical network will mostly flow within the distribution network leading to a congestion in the medium voltage grids. Furthermore, with the increasing usage of electric vehicles (EV) to decarbonize the transportation sector, the required power from distribution grids for EV charging is also immense. Therefore, the electrical grids in the future need a high-degree of flexibility in shifting the energy on the distribution level (underlay) which can be effectively accomplished by direct current (DC) technology. The key enabling technology for the success of DC underlay grid is the efficient, cost effective and reliable power electronics. The development of semiconductor materials and power electronic systems over the past decades not only improves the efficiency but also reduce the material consumption for passive components which makes power electronics very attractive from the economic and ecological perspective.
Dr. Fiona Williams Ericsson GmbH	**Dr. Fiona Williams** is a Research Director of Ericsson, based in Aachen, Germany, driving innovations in 5G based ICT solutions and their use in sectors such as energy. As initiator and leader of large-scale collaborative programmes and projects in the national and European context she has built up research, innovation and IPR activities for Ericsson, bringing results through to business innovation as solutions, products and as spin-off companies. As coordinator of the H2020 projects SUCCESS and RE-SERVE, she is bringing 5G-based ICT to bear on the challenges of implementing Secure and resilient Smart Energy infrastructures.

	She holds board positions in industrial and academic organizations. She built up the research and innovation unit in Ericsson Eurolab, after moving to Germany in 1991 from Ireland, where she set up and managed an Ericsson-Eircom joint venture company. She studied for her B.Sc. (Hons.) and Ph.D. degrees at the National University of Ireland and as a visiting fellow at Imperial College, **Scope of the presentation** 5G will come on the market towards the end of this year. It is the next generation mobile communications solution specifically designed to support both industrial automation, in sectors such as energy, as well as private customer requirements. Field and laboratory trials of smart energy solutions enabled by 5G are ongoing. In this presentation, the new capabilities of 5G and their applicability to the challenges of Smart Energy requirements described.
Steffen Bretzke Ericsson GmbH 	**Steffen Bretzke** holds a M. Sc. degree in Computer Science from the University of Erlangen (Germany). Mr. Bretzke worked at Ericsson since 1991 as engineer and project manager in R&D projects in multiple domains, including training, SW design, billing systems, and technology projects. **Scope of the presentation** This module of the course will address the key functionality and characteristics of 5G mobile networks, with special focus on their relevance for distribution and transmission system operators. It will also discuss how future mobile networks lead to highly reliable, secure and flexible smart grids based on up to 100% renewable energy sources.
Mihai Paun Romanian Energy Center 	**Dr. Mihai PAUN** is Vice-President & co-founder of the Professional Association – Romanian Energy Center (CRE) acting in Brussels. He has experience of more than 30 years in the electricity industry, at managerial and executive level in electricity Transmission, Distribution and Generation, in both national and international environment. This includes: Senior Project Manager at Mediterranean Transmission System Operators for Electricity - Med-TSO and Network and System Development adviser at the European Networks of Transmission System Operators for Electricity - ENTSO-E, responsible for the preparation of the non binding European-wide Ten-Year Networks Development Plan - TYNDP, HV electricity infrastructure, Smart Grids, Electricity Highways. Energy Policy and Networks adviser at EURELECTRIC – Union of the Electricity Industry in Brussels. Member of the Board of the Electricity Distribution System Operator ELECTRICA - Electricity Distribution Subsidiary ”Electrica Distribuție Muntenia Nord” SA (EDMN). Head of R&D&I Section and EU Programmes and Projects Manager at CRE. Rapporteur – WG Regulation in BRIDGE Initiative - Cooperation group of Smart Grids and Energy Storage H2020 projects. Independent Expert evaluator for the EC FP6, FP7 H2020 Energy and ICT Projects. PhD degree in Power Engineering and a Master degree in Financial Management and Banks. **Scope of the presentation** Key topics to be addressed include: • What is a Network Code? • How are Network Codes Developed?

	• OVERVIEW Current and Future Network Codes • THE PROCESS of Network Codes Developement • The puzzle of Network Codes • Grid Connection related Network Codes • Network Codes & Ancillary Services Updating Needs • New Network Code for Storage • New Structure of Ancillary Services, CSR impact & Business Models • Network Codes Updates • Stakeholders Consultations & Feed-back • Objectives, Achievements and Next steps
Dr. Holger Kettenis RWTH Aachen University 	**Holger Ketteniß**, born in Stolberg in 1975, studied business administration at RWTH Aachen University from 1995 to 2000. Since 2000, he is working in the field of financial and managerial accounting at the School of Business and Economics. Holger Ketteniß received a doctor's degree in 2008 from RWTH Aachen University. Since 2010 he is working as a senior lecturer at the School of Business and Economics where he is mainly responsible for the following courses: - Bookkeeping and Managerial Accounting (Accounting I) - Financial Accounting (Accounting II) - Consolidation of Financial Statements - Cost Management Systems - Production- and Sustainability Controlling His research interests are mainly focused on: - Managerial Accounting - Financial Accounting - Empirical Research in the Capital Market - Business Model Controlling - Supply Chain Controlling **Scope of the presentation** The presentation focuses on different aspects of business modeling and corporate social responsibility. The first part deals with the conceptual basis of these two topics. We address relevant definitions as well as the basic assumptions and underlying ideas. Furthermore, we connect the theoretical basics with the application in the future energy market as it is considered in RESERVE. In the second part of our lecture we bring together the basics with the experience and knowledge of the participants. In an interactive format, the participants use examples to work out which opportunities and risks come up in the context of the transition towards 100% RES.
Prof. Alan Mantooth University of Arkansas 	**H. Alan Mantooth** (S'83 - M'90 - SM'97 – F'09) received the B.S. and M.S. degrees in electrical engineering from the University of Arkansas in 1985 and 1986, respectively, and the Ph.D. degree from the Georgia Institute of Technology in 1990. He then joined Analogy, a startup company in Oregon, where he focused on semiconductor device modeling and the research and development of modeling tools and techniques. In 1998, he joined the faculty of the Department of Electrical Engineering at the University of Arkansas, Fayetteville, where he currently holds the rank of Distinguished Professor. His research interests now include analog and mixed-signal IC design & CAD, semiconductor device modeling, power electronics, and power electronic packaging. Dr. Mantooth helped establish the National Center for Reliable Electric Power Transmission (NCREPT) at the UA in 2005. Professor Mantooth serves as the Executive Director for NCREPT as well as two of its centers of

	excellence: the NSF Industry/University Cooperative Research Center on GRid-connected Advanced Power Electronic Systems (GRAPES) and the Cybersecurity Center on Secure, Evolvable Energy Delivery Systems (SEEDS) funded by the U.S. Department of Energy. In 2015, he also helped to establish the UA's first NSF Engineering Research Center entitled Power Optimization for Electro-Thermal Systems (POETS) that focuses on high power density systems for transportation applications. Dr. Mantooth holds the 21st Century Research Leadership Chair in Engineering. He served as President for the IEEE Power Electronics Society in 2017-18. Dr. Mantooth is a Fellow of IEEE, a member of Tau Beta Pi and Eta Kappa Nu, and registered professional engineer in Arkansas. **Scope of the presentation** A future electronic grid will be highly dependent of software and will mostly be cyber-physical system. While this kind of systems offer incredible opportunities of flexibility for future power systems, there is also a clear potential threat related to cyber-crime. Prof. Mantooth will present relevant considerations in this field thanks to his unique experience in cybersecurity for power electronic systems. The discussion will be enriched by the experience developed in a unique infrastructure at the University of Arkansas.
Dr. Andrea Mazza Politecnico di Torino 	**Andrea Mazza** received the master degree in electrical engineering in 2011 and the Ph.D. in Electrical Engineering in 2015 from Politecnico di Torino, Torino, Italy, where he is currently Assistant Professor. His research activities include distribution system optimization, distribution system reliability, decision-making methods applied to electricity system and integration of Distributed Energy Systems in the electricity grid. Furthermore, he is currently working on studying the integration of large power-to-methane plants in electricity systems. Beyond these activities, he is also active in the analysis of the optimal integration of different "distribution" networks (heat, gas and electricity) for increasing the share of renewable-based dispersed generation in the distribution electricity network. He is member of AEIT, IEEE Power and Energy Society and he is both member and Scientific Coordinator at Politecnico di Torino of CIGRE. He co-authored more than 30 publications, published in international conferences proceedings and in international journals. **Scope of the presentation and workshop**
Dr. Aysar Musa RWTH Aachen University 	**Aysar Musa** obtained his B.Sc. and M.Sc. degree in electrical engineering from University of Mosul (Iraq) and University of Eastern Mediterranean University (Cyprus) in 2004 and 2013, respectively. In 2019, he obtained his PhD degree from RWTH Aachen University. Since 2005, he worked as Operation and Maintenance Engineer in the Norther Transmission Networks, Ministry of Electricity in Iraq. In 2013, he became a Senior Power System Engineer. From 2013, he is working as a Research Associate at the Institute for Automation of Complex Power Systems, RWTH Aachen University. His research interests include renewable energy integration, frequency control and stability in low (zero) inertia power systems, control and stability of HVDC and hybrid ac/dc networks. **Scope of the presentation and workshop**

	Future power systems will experience radical transition from classical synchronous generation to converter-based renewable energy systems (RES). Some countries, like Germany, are expected to reach 100% converter-based generation, resulting in a very low (zero) inertia grid operation that will significantly affect the fundamental health indecator of ac power systems, i.e. grid frequency. In this regard, innovative concepts and new frequency control techniques are developed within RESERVE framework, by exploiting the smartness and controlability of deployed power electronics to define new system dynamic behavior, provide virtual inertia and participate in frequency stabilization. This will result eventually in defining new a new form of ancillary services and network codes, e.g. for RES integration and HVDC connection.
Dr. Gianluca Lipari RWTH Aachen University 	**Gianluca Lipari** received his M.Sc. and Ph.D. degrees in electronic engineering from the University of Reggio Calabria, Italy, in 2012 and 2016. In 2015, he joined the Institute for Automation of Complex Power Systems, E.ON Energy Research Center, RWTH Aachen University, Germany, where he is currently postdoctoral research associate and team leader of the Cyber-Physical Energy Systems Management Team. His current research interests include cloud applications for cyber-physical systems monitoring and automation, with special focus on cybersecurity and communications, and measurement systems for electric distribution grids. **Scope of the presentation and workshop** Nowadays, cyber and physical security are of key importance to the integrity of the grid and attacks on field devices monitoring and controlling the grid can have severe consequences for this critical infrastructure. Therefore, high levels of security are required. This workshop will focus on the results of research activities, carried out as part of H2020 SUCCESS project, presenting an overarching approach to threat and countermeasure analysis, with special focus on the vulnerabilities that could be introduced through Smart Meters, to detecting security threats to the distribution system operator's management and communication systems and to executing countermeasures which mitigate these threats. Additionally, resilience and survivability aspects for critical infrastructures will be addressed, presenting the practical solutions envisioned for enhancing resilience in future power networks, especially in scenarios with 100% renewables penetration, and the provision of survivability capabilities, in case of blackouts, based on exploitation of local distributed energy resources and islanded microgrids.
Steffen Vogel RWTH Aachen University 	**Steffen Vogel** received his M.Sc. degree in Electrical Engineering and Computer Engineering from RWTH Aachen University, Germany in 2017 after completing an internship at OPAL-RT Technologies. Since 2017 he is research associate and Ph.D. student at the Institute for Automation of Complex Power Systems, E.ON Energy Research Center, RWTH Aachen University. His current research interests are real-time power system simulators, distributed co-simulation and FPGA-accelerated real-time simulation. **Scope of the presentation and workshop** This 1,5h session introduces the state of the art real-time simulation tools and their application within the RESERVE project. The course starts with an introduction of general concepts of real-time simulation and hardware-in-the-loop testing. Existing categories of HIL testing such as CHIL, SIL and PHIL will be summarized. A short overview over commercial products and open source

	projects is given and demonstrated with a system from OPAL-RT using Simulink. Within the RESERVE project, real-time simulation tools are used in a pan-European simulation infrastructure to interconnect laboratories in Ireland, Italy and Germany. We will cover some examples of past distributed simulations. Finally we will present the application of real-time simulation tools for rapid control prototyping with an example of a live 5G network-in-the-loop.