Sandia National Laboratories

THE POWER ELECTRONICS AND ENERGY CONVERSION WORKSHOP

JULY 15-16, 2025

2025 Power Electronics and Energy Conversion Workshop

ALBUQUERQUE MUSEUM | 2000 MOUNTAIN ROAD NW ALBUQUERQUE, NM 87104
JULY 15-16, 2025

The Sandia Power Electronics and Energy Conversion (PEEC) Workshop, held annually, focuses on the latest technical advancements in power electronics and energy conversion technologies. The workshop features technical sessions and panels that delve into topics across applications, converter topologies, and components. By bringing together experts from academia, industry, and government, the event aims to foster collaboration and accelerate the development of innovative solutions.

The PEEC 2025 themes are *Integration of Power Electronics and Power Systems* and *Security and Resilience*

Tuesday, July 15, 2025

Breakfast

8:00 am – 9:00 am

Opening Remarks

9:00 am – 9:45 am

9:00 – 9:10 **Welcome:** Valerio De Angelis *(Sandia National Laboratories)*

Dr. De Angelis joined Sandia in 2020 to work on battery modeling, system integration, and power systems. He is a Distinguished Member of the Technical Staff and Manager of the Power Electronics and Energy Conversion Group. He is a co-founder of batteryarchive.org, the first public repository for easy visualization and comparison of lithium-ion battery degradation data across institutions. Before joining Sandia National Laboratories, Dr. De Angelis was the Executive Director of the City University of New York (CUNY) Energy Institute. At the Institute, he expanded the scope of the battery research from the lab to large-scale energy storage systems. Several initiatives have spun off from the research, notably the Grid-Modernization Center and Urban Electric Power, of which Dr. De Angels was co-founder, interim CEO, and VP of Product. Regarding his previous career, De Angelis was the CEO and CTO of Mindflash Technologies, a leading provider of online training platforms that he founded when he was a Ph.D. student at UC Santa Barbara. Mindflash was acquired by Applied Training Systems.

9:10 – 9:20 **Welcome:** Erik Webb *(Sandia National Laboratories)*

Erik K. Webb is the Director of the Nuclear Fuel Cycle and Grid Modernization Center at Sandia National Laboratories, leading R&D programs focused on the safety and resilience of nuclear power and the electric grid, as well as radioactive waste management. Previously, Erik was the Senior Manager of Sandia's Geoscience Research & Applications Group, overseeing efforts in fossil energy and carbon management. He has held leadership roles in the Global Security Strategic

Futures organization, engaging with NNSA's Defense Nonproliferation Programs and international partners. Erik has extensive experience addressing earth science challenges with U.S. government agencies and foreign organizations, including a fellowship with the Japanese Atomic Energy Agency. He holds a BS in Engineering Geology from Brigham Young University and an MS and PhD in Hydrogeology from the University of Wisconsin, and has served as adjunct faculty at the University of New Mexico.

9:20 – 9:30 **Virtual Welcome:** Department of Energy

9:30 – 9:45 **Overview of MERIT:** Madhu Chinthavali (*Oak Ridge National Laboratory)*

The Grid Modernization Lab Consortium (GMLC) Medium Voltage Resource Integration Technologies (MERIT) is a multi-lab effort focused on development, demonstration, and evaluation of medium voltage (MV) power electronics. The project team, which includes Oak Ridge National Lab, National Renewable Energy Lab, Sandia National Labs, and Pacific Northwest National Lab, is analyzing the quantitative impact potential of power electronics in MV utility applications. This comprehensive assessment cuts across device, circuit, and system domains to identify—and ultimately overcome—obstacles to at-scale deployment of transformative power conversion and control technologies.

Madhu Chinthavali, Electrical Systems Integration Program Manager, was instrumental in founding the Grid Research Innovation and Development Center, (GRID-C) at Oak Ridge National Laboratory (ORNL) and has served in a series of leadership roles during more than two decades at the Laboratory. Dr. Chinthavali grew the lab's power electronics and grid systems research expertise from a team to large group before taking the helm of the Electric Energy Systems Integration and Controls Section. Dr. Chinthavali has managed ORNL's energy portfolio at ORNL as program lead across multiple DOE offices and provided national leadership in helping DOE's Office of Electricity establish the Power Electronics Accelerator Consortium for Electrification. Dr. Chinthavali provides broad experience in developing many facets of power electronics technologies and innovative solutions for applications including vehicle charging, building energy integration, grid-tied energy storage and photovoltaic systems, and power flow control grid devices. He earned his master's and doctorate degrees in Electrical Engineering from the University of Tennessee, Knoxville while working at ORNL. Dr. Chinthavali has been recognized with multiple honors for leadership, technology innovations and collaboration projects.

Break

9:45 am – 10:15 am

Session 1: Grid Security & Resilience

10:15 am – 12:00 pm **Co-Chairs:** Steve Glover *(Sandia National Laboratories)* & Mike Ropp *(Sandia National Laboratories)*

10:15 – 10:20 **Introduction:** Session Chairs

10:20 – 10:35 **Building a Smarter Energy Future: Duke Energy's Path to a Secure & Resilient Grid:** Jason Handley *(Duke Energy)*

As threats to the electric grid continue to evolve, securing and fortifying our energy infrastructure has never been more critical. This presentation will document Duke Energy's comprehensive approach to grid security and resilience—exploring the strategies, technologies, and innovations deployed to safeguard power systems against cyber and physical threats. From integrating advanced monitoring solutions to enhancing system redundancy and response capabilities, Duke Energy's proactive measures ensure reliability and stability in an increasingly dynamic energy landscape. By sharing key

insights and lessons learned, this discussion will highlight the importance of resilience in modern grid operations and the path forward for securing America's energy future.

Jason Handley, P.E., is the General Manager of the Distributed Energy Group at Duke Energy in Charlotte, NC, with over 28 years of utility experience. He leads a team focused on engineering, deploying, operating, and maintaining regulated distributed energy resources and microgrids. Jason has held leadership roles, including past Chairman of EPRI's IntelligGrid Program Advisory Committee and service on the Smart Grid Interoperability Panel and the National Institute of Standards Technology's Smart Grid Advisory Committee. He currently serves on the IEEE Industry Technical Support Leadership Council and is Co-Chair of the SEPA Microgrids Working Group. A holder of five patents and recipient of Duke Energy's James B. Duke Award, Jason earned his electrical engineering degree from Auburn University and an MBA from Wake Forest University. He has been a registered professional engineer since 2002 and obtained his electrical contractor's unlimited license in 2009.

10:35 – 10:50 **Grid Resiliency and the DoD:** Matt Haupt *(Former Navy)*

With over three decades of distinguished C-suite leadership, Matt Haupt brings an unparalleled ability to bridge technology, execution, and policy into transformative, holistic solutions. Renowned for his strategic vision, Matt excels at building dynamic ecosystems—connecting needs with resources, addressing the root causes of complex challenges, and driving meaningful cultural change. Matt's expertise lies in seamlessly integrating data, advanced analytics, legacy and emerging technologies, and interdisciplinary collaboration to deliver exceptional value and elevate the experience for clients, consumers, and stakeholders alike. As the former Energy Director within the Public Works Directorate at Naval Facilities Engineering Systems Command (NAVFAC) Headquarters in Washington, DC, Matt was entrusted with leading energy security initiatives and deployment strategies for the entire Department of the Navy. In this pivotal role, he developed and executed innovative solutions to enhance energy resilience and operational dominance across Navy and Marine Corps installations worldwide. His leadership in forging global partnerships—spanning academia, private industry, and government—has been instrumental in sustaining superior mission support for the warfighter through both public/public and public/private collaborations. A retired U.S. Navy Civil Engineer Corps Officer with over 25 years of service, Matt's technical and operational acumen is matched by his academic credentials: a Bachelor of Science in Ocean Engineering from Florida Atlantic University, a Master of Science in Environmental Engineering from the University of South Florida, and completion of the prestigious NAVFAC Senior Leadership curriculum. Matt is a licensed Professional Engineer (PE) in Civil Engineering in multiple states and holds the Certified Energy Manager (CEM) and Certified Protection Professional (CPP) credentials. His proven track record, visionary leadership, and commitment to innovation make him a trusted partner for organizations seeking to achieve mission-critical objectives and lasting impact.

10:50 – 11:05 **Ground Induced Current Drivers and Mitigation:** Joseph Blankenburg (*Department of Energy*)

Ground Induced currents are driven by natural processes and can be caused by manmade

phenomena, causing reduced power quality, losses and potentially causing misoperations and damage. This talk will discuss the drivers of these phenomena and the potential for future investigations in power electronics and energy conversion to assist in making transmission systems more efficient, reliable and resilient.

Mr. Blankenburg is a physicist working for DOE's Office of Cybersecurity, Energy Security, and Emergency Response. He

manages the program that performs new research, development and demonstrations to mitigate high energy electromagnetic pulses to energy infrastructure.

11:05 – 11:20 **Resilient Energy Systems Development at Sandia National Laboratories:** Lee Rashkin *(Sandia National Laboratories)*

Sandia National Laboratories has been working on the development of power electronics and controls to improve grid resiliency and stability for many years. Since 2020, this work has been gathered as part of a Mission Campaign in Resilient Energy Systems since 2020. This presentation will cover the development of solid state transformer (SST) technology to improve resiliency, analysis of the vulnerabilities of SST systems, and the development of packaging and materials to enable and protect SST devices.

Lee Rashkin received his Bachelor's Degree in Electrical Engineering from the University of Illinois at Urbana-Champaign in 2006. He then went on to get his Master's Degree and Ph.D. from Purdue University in 2008 and 2014 respectively. His Ph.D. thesis, titled "Large Displacement Stability of AC Microgrids," examined stability in power electronics controlled systems under large swings in power demand. He started at Sandia in June 2014 as a Postdoctoral Appointee before transitioning to a staff position in 2018. During his tenure at Sandia, he has worked on electric vehicle drivetrain optimization, power electronics and controls design for the Navy all-electric warships, energy storage sizing for grid applications, and many other power electronics and controls projects. His research interests include power electronics, power systems, controls, and optimization.

11:20 – 12:00 **Panel Discussion**

Lunch

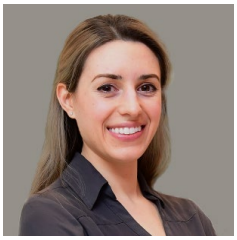
12:00 pm – 1:00 pm

Session 2: Overview of Power Electronics

1:00 pm - 2:30 pm **Co-Chairs:** Stan Atcitty *(Sandia National Laboratories)* & Jake Mueller *(Sandia National Laboratories)*

1:00 – 1:05 **Introduction:** Session Chairs

1:05 – 1:20 **Electrical Insulation Investigation for Medium-Voltage SiC Power Modules:** Christina DiMarino *(Virginia Tech)*



Christina DiMarino is an assistant professor at Virginia Tech in the Center for Power Electronics Systems (CPES). She earned her M.S. and Ph.D. degrees in electrical engineering from Virginia Tech in 2014 and 2018, respectively. Her research focuses on power electronics packaging, high-density integration of wide- and ultra-wide bandgap power semiconductors, and medium-voltage power modules. Dr. DiMarino serves as a Member-at-Large for the IEEE Power Electronics Society (PELS), Chair of the PELS Technical Committee on Power Components, Integration, and Power ICs, and Associate Editor for the IEEE Transactions on Power Electronics. She is also a member of the PCIM Europe Advisory Board. Her accolades include five best paper and presentation awards at international conferences, the Outstanding New Assistant Professor Award at Virginia Tech in 2022, and the IEEE PELS Richard M. Bass Outstanding Young Power Electronics Engineer Award in 2024.

1:20 – 1:35 **Power Electronics and the Energy Transition:** Joseph Benzaquen *(Georgia Institute of Technology)*

Power electronics is at the heart of the 21st-century energy transition, serving as the key enabler and accelerator for the integration of exponential technologies, such as solar, storage, transportation, and AI. With more than twice the US electrical energy generation capacity waiting to be connected to the grid through power electronics converters in under a decade, the future inverter-based resource (IBR)-based grid will present unique challenges associated with the shift from a synchronous generator-based system to an IBR-based grid. In this presentation, we will delve into the Center for Distributed Energy's power electronics research, development, and deployment initiatives, which focus on holistically addressing the energy transition challenges, including grid-interactive and industrial power converters, control, and grid-enhancing technologies. Lastly, we will pay special attention to energy access technologies in collaboration with Sandia National Laboratories.

Joseph Benzaquen received the B.Sc. and M.Sc. degrees in electrical engineering from Universidad Simón Bolívar, Caracas, Venezuela, in 2011 and 2015, respectively, and the Ph.D. degree in electrical engineering from Kansas State University in 2020 with the Smart Power Electronics & Control Systems (SPECS) research group. He is currently a Chief Research Engineer with the Center for Distributed Energy at the Georgia Institute of Technology, where he joined in the Fall of 2020 as a Postdoctoral Fellow; his research interests lie at the intersection of power electronics and the grid, focusing on the control of grid-interactive power converters, grid-enhancing technologies for augmentation and dynamic support, and energy access technologies.

1:35 – 1:50 **Evaluation of Power Electronics for Optimal Performance and Offsite Implementation:** Christopher Recio *(Mainstream Engineering)*

Power electronics play a pivotal role in modern military and electrical systems. The evaluation of power electronics for military and commercial applications is essential to ensure performance, reliability, and ruggedness across diverse operational environments. Advanced power electronic devices, conversion topologies, control strategies and optimization, thermal management, and packaging are considered to improve system performance. This presentation will cover the approach that Mainstream Engineering has taken from demanding military applications to cost-optimized commercial products and further development in the area high-voltage grid-tied applications.

Mr. Christopher Recio has over twenty years of experience in the design and development of power electronic converters for commercial and military applications and currently serves as Mainstream's Power Electronics Technology Leader. He received his master's degree in Electrical Engineering from the University of Illinois at Urbana-Champaign. Prior to joining Mainstream Engineering, Mr. Recio worked at General Electric where he was a lead design engineer and worked in the R&D group for power electronics. More recently, he worked on the development and commercialization of energy products for a start-up company that has reached an annual volume of 100k units, including AC motor controllers for the Oil & Gas Industry and voltage stabilizers for single, split, and three-phase commercial, industrial, and residential systems. At Mainstream Engineering, his research is focused on the use of wide-bandgap semiconductors for power electronics operating in extreme environments and where SWAP is critical. Mr. Recio holds patents in the areas of power electronics, grid stabilization, power factor correction, and reactive power support.

1:50 – 2:05 **Powering Data Centers with DC: Opportunities and Design Insights:** Amin Zamani *(Quanta Technology)*

As data centers continue to expand in both scale and energy consumption, direct current (DC) power architectures are gaining renewed attention for their potential to improve efficiency, reliability, and integration with renewable energy and storage systems. This presentation examines the evolving landscape of DC-powered data centers, focusing on key configurations such as centralized, distributed, and hybrid DC systems. It will address technical and operational challenges while exploring emerging solutions and design strategies. Real-world examples will demonstrate how DC architectures can create new opportunities for energy optimization, resilience, and sustainability in next-generation data centers.

Amin Zamani is the Senior Director of Advanced Technology Integration at Quanta Technology, with over 15 years of global experience in the utility and energy sectors. His expertise spans power system protection and control, emerging technology deployment, integration of inverter-based solutions, and advanced real-time testing. Previously, he was Director of Global Grid Modernization Services at GE Grid Solutions. Amin has led numerous utility and industrial projects involving microgrids, distribution automation, large load interconnections, and advanced protection systems. He is a Senior Member of IEEE, actively involved in the IEEE PSRC, and a licensed professional engineer in Ontario.

2:05 – 2:30 **Panel Discussion**

Break

2:30 pm – 3:00 pm

Session 3: Power Electronics Integration with Power Systems

3:00 pm - 4:30 pm **Co-Chairs:** Brian Pierre *(Sandia National Laboratories)* & Matthew Reno *(Sandia National Laboratories)*

3:00 – 3:05 **Introduction:** Session Chairs

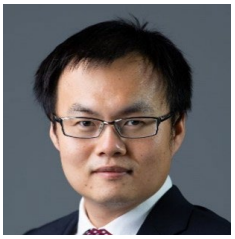
3:05 – 3:25 **Inverter-dominated Transmission Systems – Protection and Stability:** Matthew Reno *(Sandia National Laboratories)*

This presentation discusses how power electronics will impact future power system operation in an inverter-dominated grid. Due the hardware limitations of inverter-based resources (IBRs), they provide significantly smaller currents during fault events than synchronous generators in traditional power systems. These challenges demand a new approach to power system protection and stability analysis, as conventional methods may no longer be effective. This presentation discusses some of the potential tradeoffs for improving grid-forming inverter (GFM) controls compared to different protection techniques. This includes the comparison of four different fault-ride through (FRT) functions for GFM IBRs, including current limiting, virtual impedance, and virtual resistance. We compare traditional transmission protection methods including distance, differential protection, and Permissive Over-Reaching Transfer Trip (POTT) protection.

Matthew Reno is a Distinguished Member of Technical Staff in the Electric Power Systems Research Department at Sandia National Laboratories. His research focuses on distribution system modeling and analysis with Big Data and high penetrations of PV by applying cutting edge machine learning algorithms to power system problems. Matthew is also involved with the IEEE Power System Relaying Committee for developing guides and standards for protection of microgrids and systems with high penetrations of inverter-based resources. He received his Ph.D. in electrical engineering from Georgia Institute of Technology.

3:25 – 3:45 **Advanced Models and Simulation Tools for Studying Power Electronics in Power Systems:** Wei Du *(Pacific Northwest National Laboratory)*

This presentation will introduce PNNL's work on advanced models and simulation tools for integrating power electronics in power systems. It will first cover the standard library grid-forming inverter models developed in collaboration with leading inverter manufacturers and transmission planners, which have been adopted by the Western Electricity Coordinating Council (WECC) and integrated into commercial power system stability simulation tools. Simulation studies conducted by industry collaborators using these models will be presented. Additionally, the presentation will introduce an open-source distribution simulation platform for modeling transient and dynamic behaviors of unbalanced distribution systems with high penetration of distributed energy resources, highlighting studies performed on a real-world distribution feeder model.



Dr. Wei Du is the solar subsector manager and a staff research engineer at Pacific Northwest National Laboratory (PNNL), with a joint appointment as a Research Associate Professor at Washington State University (WSU), where he is responsible for PNNL's power electronics strategy and serves as the interim co-director of the PNNL-WSU Advanced Grid Institute (AGI); his research focuses on control design, modeling, and simulation of power systems with high penetration of power electronics, and he is the Principal Investigator of multiple DOE projects investigating the impacts of inverter-based resources on power system stability. Dr. Du co-leads the Modeling and Simulation Area of the Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium and is the lead developer of the US WECC standard library grid-forming inverter models, REGFM_A1 and REGFM_B1, which have been integrated into leading commercial power system stability simulation tools, and he also serves as an Associate Editor of IEEE Transactions on Smart Grid.

3:45 – 4:05 **Frequency-Constrained Real-Time Co-Optimization of Energy and Regulation Reserve with Inverter-based Battery Energy Storage Systems:** Masood Parvania *(University of Utah)*

This talk will present a two-state stochastic optimization model for real-time operation of energy and frequency regulation markets, where thermal generating units as well as inverter-based battery energy storage (IBES) systems provide the energy and regulation services. The proposed model accurately represents the dynamic behavior of thermal generation units and IBES systems, enabling the precise and cost-efficient allocation of up- and down-regulation reserves in the real-time market.

Masood Parvania is the Roger P. Webb Endowed Professor of Electrical and Computer Engineering and the Director of Utah Smart Energy Laboratory and the Utah Energy and Power Innovation Center (U-EPIC) at the University of Utah. Dr. Parvania is also the Principal Investigator and Director of the U.S.-Canada Center on Climate-Resilient Western Interconnected Grid (NSF WIRED Global Center) that is co-funded by U.S. National Science Foundation (NSF) and Natural Sciences and Engineering Research Council of Canada (NSERC), to develop solutions for safeguarding the Western Interconnection against natural disasters such as wildfire, heatwave and droughts.

4:05 – 4:30 **Panel Discussion**

Closing Remarks

4:30 pm – 5:00 pm

Evening Reception / Software Showcase

5:00 pm – 6:30 pm

- COMSOL / TCAD *(Mihai Negoita, Sandia National Laboratories)*
- LTSPICE *(Felipe Palacios II, Sandia National Laboratories)*
- PLECS *(Jake Mueller, Sandia National Laboratories)*
- PSCAD *(Miguel Jimenez Aparicio & Michael Ropp, Sandia National Laboratories)*

Wednesday, July 16, 2025

Breakfast

8:00 am – 9:00 am

Opening Remarks

8:30 am – 9:05 am

8:30 – 8:35 **Welcome:** Charles Hanley *(Sandia National Laboratories)*

Mr. Hanley is Senior Manager of the Electric Grid Security Group at Sandia National Laboratories. His group conducts research on enhancing the resilience of our critical energy infrastructures, including grid-scale optimization, controls, and microgrids; energy storage technologies; renewable energy integration; power electronics; cyber security; and advanced analytics for complex systems. He joined Sandia in 1988 and has been working in Sandia's renewable energy and electric grid programs since 1994. From 2005 through 2014, Charlie managed Sandia's Photovoltaics and Distributed Systems Integration Program. Prior to that, he managed Sandia's international renewable energy programs, through which he oversaw the implementation of more than 400 photovoltaic and wind energy systems in Latin America. He received his B.S. in Engineering Science from Trinity University in San Antonio, Texas, and his M.S. in Electrical Engineering from Rensselaer Polytechnic Institute, in Troy, New York.

8:35 – 9:05 **Keynote Presentation | Unit of Compute:** Peter Panfil (*Vertiv)*

Data centers are undergoing a paradigm shift, transitioning from traditional facility-centric infrastructure to becoming the next logical unit of compute. This represents a natural progression from chips to servers to entire data centers functioning as integrated computational units. This architectural evolution represents a fundamental change in how we conceptualize and design data center infrastructure, moving away from the traditional building-centric approach toward a more holistic, compute-centric model.

Peter Panfil is the Vice President of Global Power at Vertiv, leading strategic customer development for the Vertiv power business. He is skilled at solving customer challenges with the latest power and control technologies delivering availability, scalability, and efficiency levels to meet diverse customer and sustainability needs. Peter has deep knowledge in power solutions to support the unique needs of AI applications, and he is an advocate of the "Bring Your Own Power" approach to solving utility dependence issues. With more than 30 years in the critical infrastructure space, he has held executive positions including VP Engineering and VP/GM AC Power prior to his current responsibilities. He is a frequent presenter and spokesperson for industry trade shows, conferences and media outlets serving the IT, facilities and engineering industry, and a published author via his contribution to the 2024 book "Greener Data Vol. 2".

Session 4: Semiconductor Materials

9:05 am – 10:20 am **Co-Chairs:** Andrew Binder *(Sandia National Laboratories)* & Lee Gill *(Sandia National Laboratories)*

9:05 – 9:10 **Introduction:** Session Chairs

9:10 – 9:25 **The Challenges and Opportunities for Integration of GaN Transistors in Modern Power Systems:** Eric Persson *(Infineon Technologies)*

Wide-BandGap power transistors (WBG) are capable of extraordinary switching performance, which enables ultra-high efficiency power conversion systems. As with any high-performance device, a complete understanding of the transistor's capabilities and limitations is necessary to successfully design power systems with WBG and realize the full benefits of the technology. This presentation focuses on GaN power transistors key device parameters, packaging considerations, gate-drive requirements and the importance of PCB layout, and concludes with the future of integration with GaN devices.

Eric Persson is a power electronic industry veteran, with 19 years of hands-on experience designing power converters and inverters, followed by 24 years of applications engineering at Infineon Technologies (formerly International Rectifier). He is a Senior Principal Engineer specializing in wide-bandgap semiconductor circuits and applications. Eric has presented more than 100 tutorials and papers on topics related to applications and practical design aspects of power electronic circuits. He is a regular lecturer for power electronic short courses at UW Madison where he has been adjunct faculty for 24 years. Mr. Persson holds 19 patents and is a recipient of the IEEE Third Millennium Medal. He has a BSEE degree from the University of Minnesota.

9:25 – 9:40 **Silicon carbide devices for demanding power conversion applications:** Akin Akturk *(CoolCAD Electronics)*

To address the need for high power and high voltage protection devices for more reliable and high SWAP systems, we design and fabricate niche silicon carbide devices. These silicon carbide components are used in high reliability terrestrial and extra-terrestrial systems, operating under low and high temperature and power conditions. The device solutions are based on low on-resistance power devices in the case of next generation power electronics, and on high voltage and on-resistance devices in the case of circuit protection. In this talk, we will discuss our perspective on state-of-the-art and next generation SiC power devices. We will also briefly discuss silicon carbide device development and manufacturing by CoolCAD. Additionally, we will give a summary of high efficiency and high power resonant bidirectional DC-DC circuit design and fabrication work at CoolCAD.

Dr. Akin Akturk is the co-founder and CTO of CoolCAD Electronics. Dr. Akturk earned his Ph.D. and M.S. degrees from the University of Maryland, College Park. He is an expert in testing and modeling of electronics for extreme environment applications that target high and/or low temperature, as well as radiation-rich ambients. Dr. Akturk is an accomplished expert in Electrical Engineering specializing in silicon carbide (SiC) and silicon (Si) electrical and thermal design, modeling, fabrication and testing. Currently, he is leading the design and fabrication effort of silicon carbide power devices at CoolCAD. This effort includes streamlining silicon carbide device design and fabrication. Dr. Akturk additionally works on silicon carbide business and market development for CoolCAD SiC devices. Besides the power device development, he is involved in thermally hardened silicon carbide CMOS based integrated circuit research. He has developed process technology for SiC fabrication, especially related to mesa structure avalanche photodetectors. He has published more than

hundred journal and conference papers, mostly on silicon carbide electronics, radiation effects and low temperature CMOS operation.

9:40 – 9:55 **Progress in β-Ga2O3 Materials for High Voltage Vertical Devices:** James S. Speck *(University of California, Santa Barbara)*

β-Ga2O3 is the one of the very few wide bandgap or ultrawide bandgap semiconductors that can be grown directly from the melt (something not offered by SiC, GaN, AlN, or diamond). The system offers easy of doping via group IV donors on the Ga sites. Acceptor doping for semi-insulating behavior can be realized via Mg, Fe, or N doping. Epitaxial growth can be realized by molecular beam epitaxy (MBE), metalorganic chemical vapor deposition (MOCVD) and hydride vapor phase epitaxy (HVPE). In the highest quality MOCVD growth, controlled donor doping in the low to mid 1015 cm-3 has been demonstrated by several groups with compensating acceptor concentration as low as ~1014 cm-3. Outstanding Schottky and ohmic contacts have been demonstrated. The system offers wet etching via hot phosphoric acid. In this talk we survey the materials progress for vertical diodes and transistors with 10 kV blocking voltage. The primary support for this work has been the AFOSR GAME MURI.

James S. Speck is a Distinguished Professor in the Materials Department at the University of California Santa Barbara. He received a Bachelor of Science and Metallurgical Engineering in 1983 and his S.M. and Sc.D. from the Massachusetts Institute of Technology in 1985 and 1989, respectively. He joined UCSB in 1990 as an Asst. Professor. Speck's early work focused on epitaxial oxide films on semiconductors, ferroelectric thin films, and strain relaxation in highly misfitting epitaxial systems. Major aspects of his work on nitrides include elucidating basic growth modes and defect generation, the development of MBE growth of GaN, and the development of nonpolar and semipolar GaN, revealing the nonradiative processes in GaN LEDs, and a large body of early work on β-Ga2O3. He was the recipient of the Quantum Device Award from the International Symposium on Compound Semiconductors, the IEEE Photonics Society – Aron Kressel Award, and the North American MBE Conference James S. Harris award. Recently he was a recipient of a Vannevar Bush Faculty Fellow from the U.S. Department of Defense. He is an inaugural Fellow of the Materials Research Society, a Fellow of the American Physical Society, and a Fellow of the National Academy of Inventors.

9:55 – 10:20 **Panel Discussion**

Break

10:20 am – 11:00 am

Session 5: Passives & Packaging

11:00 am – 12:30 pm **Co-Chairs:** Luciano Garcia Rodriquez *(Sandia National Laboratories)* & Rick Floyd *(Sandia National Laboratories)*

11:00 – 11:05 **Introduction:** Session Chairs

11:05 – 11:20 **Capacitors and Aircraft Power System Considerations for Higher Temperature Operation and Wide Bandgap Enablement:** Roger Brewer *(Lockheed Martin)*

The evolving and challenging demands placed on electronics when installed on a modern military Aircraft, driven largely by environment (high ambient heating, vibration, etc.) could not be any timelier for focused attention. To serve as an introduction on this topic, an overview of a modern aircraft (very generalized) power system that might leverage a high-power density Wide Bandgap-based supply and the associated electrical usage needs that, in turn, drive thermal management challenges on electronics will set the opening stage. Following the introduction there will be more in-depth discussion regarding what limits upper temperature operating range for many existing capacitor technologies

(ultracapacitors, film capacitors and ceramic capacitors) which are a key bottleneck in expanded temperature range for many power electronics and avionics systems within an aircraft. Mechanical fatiguing effects and material limitations within capacitor cells will be illustrated and shown to contribute to these component limitations. The equation for capacitance will be utilized to draw attention into how capacitor cell structure (distance "d" between plates and area "A" of plates) attributes impact attainable capacity and power (irrespective of temperature considerations) prior to turning attention to next generation technologies to address some of these challenges and, finally, a conclusion. Note: This talk has been provided at other conferences and is approved for Public Release (ref: LM PIRA# AER2024070658). Further discussions can be held for added details subject to Non-Disclosure Agreements and Export Control.

With 36 years of experience at Lockheed Martin, Roger started his career in Electrical Engineering at the Missiles and Space Systems Business Unit in Sunnyvale California supporting power component reliability assessments and investigations for a major Missile program. Since 1993, he has been with the Lockheed Martin Aeronautics Business Unit at both the Marietta Georgia and Ft. Worth Texas sites supporting aircraft power systems and related technology development for a variety of Aircraft, Advanced Development Programs and support to the LM Corporate Engineering and Enterprise strategy teams. He has provided several presentations and given talks, both at internal Lockheed Martin conferences and business engagements and industry energy and power conferences (SAE, IEEE, High Temperature Electronics, APEC and AIAA) outlining research being performed to improve aircraft power system performance in both existing and future platforms with a recent, specific emphasis on the wide-ranging benefits of high temperature enabled electronics for Military and Aerospace industries. He is an AIAA Associate Fellow inducted in 2022 and a Technical Fellow (serving his third three-year term) as his primary position at Lockheed Martin in the Electrical Power Systems and High Temperature Electronics domains. He holds a Bachelor of Science Degree in Electrical Engineering from the University of Illinois and a Master of Science Degree in Electrical Engineering from North Carolina State University.

11:20 – 11:35 **High-Power Medium Frequency Transformers in Medium Voltage Power Electronics:** Zhicheng Guo *(Arizona State University)*

This presentation will review the high-power medium frequency transformers in medium voltage power electronics: state of the art, challenges, and solutions. The discussion will focus on challenges and solutions in MFTs insulation design and test. Topics that will be covered include complex voltage stress and electric field distribution, partial discharge under high frequency high dv/dt waveform, what are the MFTs insulation test standards. The efforts to achieve partial discharge free MFT design will also be discussed.

Dr. Zhicheng Guo is an assistant professor at Arizona State University, director of Power Electronics and Energy Conversion (PEEC) Lab. Zhicheng Guo received his Ph.D. degree in power electronics and power systems from the University of Texas at Austin in 2023. His research interests include high-frequency magnetic, WBG intelligent power modules, solid-state transformers, 60 Hz/HF partial discharge, and insulation design of modern power electronics systems. Dr. Zhicheng Guo is the recipient of U.S. Department of Energy (DOE) 2023 Electricity / Large Power Transformers Bonus Prize Winner, the 2022 Transformer Association (TTA) Award, Cockrell School of Engineering fellowship. He serves as founding chair of IEEE Power Electronics Society Phoenix chapter and member of the IEEE standard committee P3105 working group for solid-state transformers.

11:35 – 11:50 **Advancing High Voltage Power Module Packaging: Strategies for Partial Discharge Mitigation:** Xiaoqing Song *(University of Arkansas)*

High-voltage (>10 kV) power conversion is a cornerstone of modern energy systems, driving efficient power transmission, industrial automation, renewable energy integration, and transportation electrification. However, its widespread adoption is limited by constraints of high-voltage power semiconductor devices, including low voltage and current ratings, reliability concerns, restricted commercial availability, and challenges in high-voltage power module packaging. This talk will explore the state-of-the-art in high-voltage power module packaging and the key challenges in their development. It will highlight strategies to overcome these limitations offering valuable insights into enhancing efficiency, reliability, and compactness in next-generation high-power applications.

Dr. Xiaoqing Song received the B.S. and M.S. degrees with Beijing Institute of Technology, China, in 2009 and 2012, respectively, and the Ph.D. degree with North Carolina State University in 2017, all in electrical engineering. Since 2022, he has been with the University of Arkansas as an Assistant Professor in the Department of Electrical Engineering and Computer Science. From 2017 to 2022, he was working with ABB U.S. Corporate Research Center as a principal research scientist and led multi-discipline research and R&D projects in the field of solid state and hybrid circuit breakers in low voltage and medium voltage DC distribution system protection. Dr. Song's current research interests include wide bandgap power semiconductor devices, power electronics packaging and solid-state device-based power system protection. Dr. Song has published more than 70 peer reviewed journal and conference papers, two book chapters and 14 U.S. patents granted. He is the recipient of 2016 Outstanding Young European Power Electronics (EPE) Association Member Award, 2020 ABB Inventor of the Year Award, 2021 ABB Publisher of the Year Award, and ITEC 2022 Best Paper Award. He is IEEE senior member, Vice Chair of 11th IEEE Workshop on Wide Bandgap Power Devices and Applications (WiPDA 2024), Associate Editor of Open Journal of Power Electronics, and Secretary of IEEE IAS Power Electronic Devices and Components Committee (PEDCC).

11:50 – 12:05 **Advanced Packaging and Optimization for High Power/High Density WBG Modules:** Fang Luo *(Stony Brook University)*

This presentation will cover the latest research from the author's group on high-power, high-voltage SiC module packages and GaN module packages using double-sided cooled structures. The speaker will discuss challenges in these module designs, such as interconnection issues, EMI mitigation, and fabrication processes, and propose potential solutions. The presentation will specifically cover the 3D GaN module design using fuzz button instead of soldering and sintering technologies.

Dr. Fang Luo (S'06- M'10- SM'13) is SUNY Empire Innovation Associate Professor in the ECE Department and Spellman High Voltage Power Electronics Lab director at Stony Brook University, Stony Brook, New York. His research interests include advanced grid-tied converters, HVDC systems and its economic-technical modeling, high-voltage/high power-density converter design, EMI, and advanced power module packaging/integration for wide band-gap devices. Dr. Luo is a senior member of IEEE. He holds three US patents and has authored/co-authored more than 50 journal papers and 150 peer-reviewed conference papers, and one book. He is an Associate Editor of IEEE Transactions on Power Electronics. He is a recipient of the NSF CAREER Award. He was an Assistant Professor in the Electrical Engineering Department at the University of Arkansas (17'-20') and a research assistant professor at the Ohio State University (14'-17').

12:05 – 12:30 **Panel Discussion**

Lunch

12:30 pm – 1:30 pm

Session 6: Demonstrations

1:30 pm – 3:00 pm **Co-Chairs:** Jack Flicker *(Sandia National Laboratories)* & Yuliya Preger *(Sandia National Laboratories)*

1:30 – 1:35 **Introduction:** Session Chairs

1:35 – 1:50 **Demonstrations & Value Propositions for Utility Integrated Power Electronics:** Mack W. Knobbe *(Southern California Edison)*

The rapid electrification of buildings and transportation is driving unprecedented load growth, surpassing the traditional capacity of utilities and equipment suppliers. This surge in demand, combined with the evolving nature of two-way power flow, presents new challenges for grid architecture that must be addressed with innovative technology and planning approaches. Power electronics are being integrated into nearly every device on the load side and should become a key enabling technology on the supply side. To facilitate the adoption of power electronics into the utility grid, our valuation methods need to expand to recognize the unique contributions that power electronics bring to the grid. Southern California Edison is advancing medium voltage, multi-megawatt projects in multiple grid domains to demonstrate the value of solid state power electronics for meeting the challenges of rapid electrification.

Mack W. Knobbe is multi-domain cross functional technical leader with over 24 years of experience working with state-of-the-art materials and power systems. Mack joined SCE in 2020 leading the Grid Edge Analytics and Control team with a focus on integration of microgrids and remote grids into SCE's power system. Currently, Mack has focused on Grid Architecture Innovation with a particular focus on non-wires technologies for rapid electrification, including integration of power electronics and DER from Sub-transmission down to the Grid Edge and even off the grid edge. His previous work with fuel cells and hydrogen generation technologies led to the successful commercialization of eleven fuel cell system products and chemical manufacturing processes. He has previously held executive and technical leadership positions at Knobbe Consulting, Origin Fuel Cell, SiGNa Chemistry, Intelligent Energy, Jadoo Power System, and TVN Systems. Mack holds an MBA and both M.Sc., and B.Sc in Chemical Engineering.

1:50 – 2:05 **Tesla Megapack Grid-Forming:** Mohammed Nassar *(Tesla)*

This presentation reviews Tesla's Megapack grid-forming model, highlighting active/reactive power dispatch and the role of the virtual synchronous machine in grid stability. Real-world projects, technology comparisons, and case studies are also presented.

Mohammed Nassar holds a BSc, MSc, and PhD in Electrical and Computer Engineering, specializing in power systems. He has served as a Lecturer and Adjunct Assistant Professor at the University of Waterloo from 2017 to 2023 and has been a Sessional Instructor at McMaster University during the same period. His professional experience includes roles as a Power System Studies Engineer at SNC-Lavalin (Atkins Realis) and as a Power System Consultant III at Power System Consultants PSC. In addition to his consulting work, Mohammed has contributed to the University of Waterloo's Hyperloop and Waterloo Formula electric design teams as a consultant from 2020 to 2023. He also held the position of IEEE-KW Chair of the Educational Activities Committee in 2022-2023. Currently, he is a Staff Power System Engineer at Tesla. Throughout his career, Mohammed has been recognized for his

teaching excellence, receiving multiple awards, including the Amit and Meena Chakma Exceptional Teaching by a Student Award in 2017, the Engineering Society Teaching Excellence Award in 2020 and 2023, and the Ontario Undergraduate Student Alliance Teaching Excellence Award in 2019 and 2021.

2:05 – 2:20 **Operationalizing Industrial Sensor Data for Scalable Asset Management of PV Inverters:** Murat Yildirim *(Wayne State University)*

This talk introduces predictive and decision-making frameworks for sensor-driven asset management of PV inverter fleets. Predictive modeling component of the framework introduces a method that integrates autonomous data preprocessing, environmental de-confounding using neural networks, and ensemble-based anomaly detection to flag early signs of degradation in inverters. It constructs a dynamic baseline from early-life data and identifies deviations indicative of failure risk. Unlike traditional fault detection or prognostics, the framework does not rely on labeled failure data or asset-specific models. In decision making modeling component, we demonstrate how the improved predictions on inverter health can be used to derive optimal maintenance, crew routing and spare part provisioning decisions for a fleet of assets. Real-world case studies derived from industrial data demonstrates the effectiveness of the framework in reducing downtime and improving maintenance outcomes.

Murat Yildirim is an Associate Professor in the Department of Industrial and Systems Engineering at Wayne State University. Prior to joining Wayne State, he worked as a postdoctoral fellow at the Georgia Institute of Technology (2016-2018). He obtained a PhD degree in Industrial Engineering, MS degree in Operations Research, and BS degrees in Electrical Engineering and Industrial Engineering from Georgia Institute of Technology. Dr. Yildirim's research interest lies in advancing the integration of mathematical programming and data analytics in various application domains. Specifically, he focuses on the modeling and the computational challenges arising from the integration of real-time inferences generated by advanced data analytics into large-scale decision optimization models used for optimizing and controlling networked systems. To date, Dr. Yildirim's research has been supported through funding from NSF, DoE, Michigan Translational Research and Commercialization, and Ford Motor Company.

2:20 – 2:35 **The Importance of BESS AC Containers for Grid Forming:** Andreas Fornwald (*StarCharge)*

Blackouts and grid instability are becoming more frequent in modern electric grid to the various intermittent power supplies and the advent of Data centers. Battery backed solutions can easily mitigate these risks. Andreas Fornwald brings 30 years of leadership and project development experience from prominent companies such as Siemens and ABB. He has held several CEO positions in energy and electrical manufacturing, where he successfully implemented restructuring programs, revitalized management teams, and significantly increased revenue.

As CEO of Doosan GridTech, Andreas established a state-of-the-art EPC in Seattle, deploying over 1 GWh of battery energy storage system (BESS) projects in the U.S. and Australia from 2021 to 2024, with a 2 GWh pipeline in progress. He recently joined Star Charge as Chief Development Officer, overseeing a global pipeline of BESS projects focused on grid-forming technologies and next-generation BESS AC containers. An award-winning executive fluent in multiple languages, Andreas has lived and worked across four continents, gaining recognition for saving companies from bankruptcy, driving over 40% annual revenue growth, and championing diversity and inclusion. He has received national awards for innovation and employee retention and

was selected by the German Parliament for its Advisory Board on Energy Policies. Andreas holds a Master of Science from Stanford University, where he was a Sloan Fellow, and a master's in electrical engineering, along with a European Union patent. He has a vast network of C-level executives across Europe, China, India, Southeast Asia, the Middle East, and Latin America.

2:35 – 3:00 **Panel Discussion**

Closing Session

3:00 pm – 5:00 pm

- Student Project Demonstrations with Explora
- Free Entrance to Albuquerque Museum (Tour Guides Available)

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