UILU-ENG-2026-2601

FORTY-SEVENTH ANNUAL REPORT
OF THE
POWER AFFILIATES PROGRAM

University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering
306 N. Wright St.
Urbana, IL 61801

PAP-TR- 26-01

May 2026

TABLE OF CONTENTS

FOREWORD

This report provides a summary of Power Affiliates Program (PAP) activities in the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign for the calendar year 2025. Information listed below is intended to be a progress report for the affiliate companies. The PAP is the foundation of the industrial liaison effort in the power and energy systems area. We would also like to express our sincere thanks and gratitude to S&C Electric Company, our longest-standing supporting member of the Power Affiliates Program. Their continued engagement and support over the years have played an important role in sustaining the strong connection between industry, students, and faculty within the Illinois power community.

2025 was an active year for the PAP and the highlights are covered in this report. We acknowledge the valuable interaction of the Affiliates and are most thankful to these companies for their continued support.

Arijit Banerjee, Director
Alejandro Domínguez-García, Co-director
Ulas Coskun
George Gross
Kiruba S. Haran
Philip Krein
Olga Mironenko
Jonathon Schuh
Andrew Stillwell
Kevin Toomey
Jeremy Sykes

1. INTRODUCTION AND SUMMARY

The Power Affiliates Program was initiated in January 1979 as part of a major effort to strengthen the power and energy systems area. The original objectives were to:

- Maintain stimulating, meaningful and high quality undergraduate and graduate programs in electric power engineering.
- Increase university-industrial interaction at all levels of education and research in electric power engineering.

These objectives are as valid today as they were in 1979. The multi-faceted activities in 2026 under the PAP umbrella clearly were in support of these objectives.

Throughout the past 47 years, the PAP has maintained a stable financial base during times of rapid change in the power industry and provided seed money for research. This led to additional funding by other sources and has made it possible for students to be exposed to industrial problems and participate in technical and professional meetings.

This annual report is organized as follows. The financial statement for the 2025 calendar year is given in Section 2. Section 3 describes how the Power Program fits into the departmental structure. There is no official degree or option associated with the Power Program, but there is a significant level of specialization, which is possible through a set of courses developed and offered by the faculty group who constitute the Power and Energy Systems Area. Section 4 gives a brief description of the courses for specializing in electric power and tabulates the enrollment figures for the most recent offerings. Included in this section is a historical record of the number of graduates who have taken three or more of these courses. Section 5 lists the activities of both the students and the faculty members during the 2024 calendar year. Section 6 gives information about the graduate students in the power area. In addition to personal data and interests, each student has written a brief abstract of his or her research work. Laboratories and other facilities of the power area are discussed in Section 7. The report concludes with directories in Sections 8 and 9 and with the 2025 publications listed in Section 10.

2. FINANCIAL STATEMENT

The following tabulation of income and expenditures for the calendar year 2025 was prepared from a detailed University statement as of December 31, 2025.

Income carried over from the 2024 calendar year	$ 138,891.21
Total income during Calendar Year 2025 *	$ 16,300.00
Total available income during calendar year 2024	$ 153,476.71

Expenditure	**Expenditure Amount**
Miscellaneous	$ 3,000.00
Personnel	$ 4,000.90
Supplies	$ 16,274.99
Services	$ 7,160.38
Transportation/Travel/Event	$ 4,161.00
Total expenditures	$ 34,747.27

Summary

Amount of funds available during calendar year 2024	$ 153,476.71
Amount of expenses during calendar year 2024	$ 34,747.27
Balance as of December 31, 2024	$ 118,729.44

* This does not include funds that were received in 2025 but not posted on the university accounting system until 2025. The 36th International Conference on Automated Planning and Scheduling
Dublin, Ireland, June 27 - July 2, 2026

3. THE POWER PROGRAM WITHIN THE DEPARTMENT

Electrical engineering undergraduate students are required to complete 128 hours of course work for a BSEE degree. Detailed descriptions of the undergraduate program and suggested curriculum in Power are on the Department web site. The MEng is a technical degree requiring a minimum of 32 credit hours and includes a professional development requirement. MSEE students are required to complete a minimum of 32 credit hours including a graduate thesis. All PhD students must qualify through a research paper and presentation and complete course and thesis requirements. A detailed description of the graduate programs is given on the Department web site.

The Electrical and Computer Engineering Department is subdivided into eight distinct technical areas as follows:

Biological Imaging, Bioengineering, and Acoustics
Circuits
Communications and Control
Computer Engineering
Electromagnetics, Optics and Remote Sensing
Microelectronics and Nanotechnology
Power and Energy Systems
Signal Processing and Data Science

While the Department does not have official degree-granting options in these areas, in practice, the eight areas serve as the appropriate grouping of faculty activities and interest. In terms of size, the Power and Energy Systems area represents about 7% of the total active faculty and about 14% of the total student enrollment. The faculty committee in each group has the responsibility for administering courses and research in that group within the Department. The Power and Energy Systems Area Committee and associated faculty for the 2024 – 2025 year together with their fields of interest are:

A. Banerjee	Electromechanical energy conversion systems, power electronics, electrical machines and drives, electric propulsion systems, renewable energy, robotic actuators
A. Domínguez-García	Power and energy systems, microgrids, grid data analytics, reliability analysis, cyberinfrastructures, decision science
G. Gross (Emeritus)	Large-scale system analysis and computing, energy economics, effective bio-fuel applications for electricity, electricity planning and analysis
K. Haran	Autonomous vehicular technology, UAVs, electric transportation, electrical machines and drive systems, power and energy systems
P. T. Krein (Emeritus)	Electric machinery and electromechanics, power and energy systems, power electronics, energy efficient buildings, transportation electrification

A. Stillwell	Power electronics, alternative and renewable energy systems, transportation electrification, wide bandgap power devices, design optimization

In addition to this committee, the area has two teaching professors that provide enormous value and student support with instruction and consulting on research projects. These are:

J. Schuh	Came to us with a PhD in Theoretical and Applied Mechanics (at UIUC) and is a Teaching Assistant Professor in the ECE department. He teaches courses in power engineering and senior design. His goal as an educator is to instill knowledge of fundamental behavior to allow his students to solve a range of problems outside those covered in class.
O. Mironenko	Came to us with a PhD in ECE from the University of Delaware and is a Teaching Assistant Professor in the ECE department. She teaches courses in power engineering, including renewables and electric vehicles. Her goal as an educator includes demonstrating to students the applicability of gained knowledge to address real-world challenges, as well as to benefit the student's future career goals.

Two of the primary responsibilities of the Power and Energy Systems Area Committee are to improve, keep current, and staff the courses assigned to the Power and Energy Systems Area. In 2024 those courses were:

ECE 217	Solar Car
ECE 330	Power Circuits and Electromechanics
ECE 333	Green Electric Energy
ECE 431	Electric Machinery
ECE 432	Advanced Electric Machinery
ECE 464	Power Electronics
ECE 469	Power Electronics Laboratory
ECE 476	Power System Analysis
ECE 530	Analysis Techniques for Large-Scale Electrical Systems
ECE 554	Dynamic System Reliability
ECE 568	Modeling and Control of Electromechanical Systems
ECE 573	Power Systems Operations and Control
ECE 576	Power System Dynamics and Stability
ECE 590 I	Seminar: Power Systems
ECE 598 AB	Power-Electronic Converter and Control for Electric Machines: Theory and Practice
ECE 598 KSH	Electrical Machine Design

The four-hundred level courses are advanced undergraduate or beginning graduate courses, while the five-hundred level courses are graduate. The Power and Energy Systems Area Committee periodically evaluates each course outline for possible revision for future offerings. A brief description of each of these courses, together with the enrollment of the past year, is included in the next section. In addition, the Power Faculty supervises numerous student projects performed in ECE 445. This is the capstone design course for our seniors.

4. COURSES AND ENROLLMENT

As one of seven major areas in Electrical and Computer Engineering, the Power and Energy Systems Area is responsible for the development and offering of a considerable number of courses. Current courses assigned to the power area are described briefly below. Total enrollment for courses offered in the 2025 – 2026 academic year is also given for each course.

ECE 217: Solar Car

The course objective is to show students that a multidisciplinary understanding is essential to create a complex system. UIUC's own Solar Car "Argo" will be the example. The course will cover high-level aspects of the design, construction, analysis, and economics of solar-powered electric vehicles. Topics will bridge a variety of engineering disciplines integrated with business to present a cohesive overview highlighting complexities of solar-powered vehicles. Students are expected to gain hands-on experience working with the Solar Car Team to build the next solar car. In-class presentations will provide a platform to individuals to convey ideas and contributions to a broad set of multidisciplinary audience. In place of a text are Instructor Notes and the *Solar Car Wiki*. References are *Solar Car Primer*, by E. F. Thacher and *The Leading Edge: Aerodynamic Design of Ultra-streamlined Land Vehicles*, by G. Tamai, 1999. The total enrollment for the academic year 2025 – 2026 was 37.

ECE 330: Power Circuits and Electromechanics

The goal of this three-hour course is to provide an introduction to three-phase circuits, transformers, and electromechanical systems with an emphasis on analysis and some design insight. The course starts with a review of phasors followed by three-phase power circuits, mutual inductance, magnetic circuits and transformers. Electromechanical systems are analyzed using energy-balance concepts. Introduction to synchronous, induction, dc and small machines is given. The required text is *Power Circuits and Electromechanics*, by M. A. Pai. The total enrollment for the academic year 2025 – 2026 was 439.

ECE 333: Green Electric Energy

A course on the challenges of meeting future energy needs using renewable resources; this is a three-hour technical elective for engineering introductory-level undergraduate students with a background in electric circuits. The course explores the technical, economic, environmental and policy aspects of renewable and alternative energy systems to provide a comprehensive picture of their role in meeting society's electricity needs. The upsurge in the worldwide demand for oil-based resources, the restructuring of the electricity industry, advances in engineering technology and the increasing interest in environmental protection are presenting unparalleled challenges to the electric power industry. The role of new energy-resource technologies, the application of power electronics, the use of demand-side management, and the effects of market forces in addressing these challenges are discussed. The course covers the basics of energy production from renewable sources, the relevant thermodynamics background, the structure and nature of the interconnected electric power system and the critical need for environmentally sensitive solutions. In addition, the economic and regulatory policy aspects of electricity and electricity markets are treated. The course has the following texts: *Renewable and Efficient Electric Power Systems*, 2nd Edition, by G. M. Masters, 2013. The total enrollment for academic year 2025 – 2026 was 110.

ECE 398GG: Electric Vehicles (EVs)

Electric vehicles (EVs) have the potential to drastically reduce the global CO2 footprint to effectively address climate change issues. Massive EV adoption requires the establishment of an EV charging infrastructure (EVCI) to supply the energy needs of EV owners/users. This three-hour course examines technical, economic, environmental and policy aspects of EVs and the required EVCI. A basic physics discussion of rolling vehicles serves to determine the power and energy requirements and their implications for energy storage and transfer. The course covers EV architectures and configurations, as well as the detailed description of the deployment of motors and generators, drives for traction applications, batteries and their management and the EV-grid nexus. The description of the various technologies and approaches deployed in EV design and operations is augmented by a detailed examination of the energy efficiency and environmental benefits of EVs. The application of power electronics to EV charging is accompanied by a detailed examination of the EVCI and its interactions with existing infrastructures. Throughout the course, there is a strong focus on the efficient utilization of energy in an environmentally sensitive manner to emphasize the significant role of EVs and EVCI in the energy transition. Copies of the slides used in the lectures will be downloadable from the course website. This class was not offered in the 2025 – 2026 academic year.

ECE 431: Electric Machinery

This four-hour course contains a laboratory one-credit hour component, which is an elective in a list of fourteen from which students select two. The fifteen experiments typically include power measurement, power-factor correction, transformer characteristics, three-phase transformer connections, induction motor tests, induction motor torque-speed characteristics, synchronous machine tests, synchronous-machine power characteristics, digital simulation of machine dynamics, motor control, and a written, plus oral project presentation on power and energy system topics. This class includes an offsite trip to a corporate manufacturing facility to see the use of electric machinery in large scale industrial design. The required text is *Electric Machinery,* by Fitzgerald, Kingsley, and Umans, 2013. The total enrollment for academic year 2025 – 2026 was 52.

ECE 432: Advanced Electric Machinery

This three-hour course contains advanced theory and analysis of rotating and linear machines and drives. It includes power electronic drives for dc and ac motors. The analysis uses *d-q* transformations and related techniques. Emphasis is placed on time-scale modeling of electromechanical devices and on their function in drives. The required text was *Analysis of Electric Machinery and Drive Systems*, by P. C. Krause, O. Wasynczuk, S. D. Sudhoff, and S. D. Pekarek, IEEE Press, 2025. This class was not offered in the 2024 – 2025 academic year.

ECE 464: Power Electronics

This three-hour course is a comprehensive treatment of switching power-conversion systems and the devices used to build them. Concepts of switch control are developed from general switching functions. Phase control, pulse-width modulation, and phase modulation are studied for applications in all types of converters. Converter topologies are introduced along with design concepts for power filters and interfaces. Devices such as diodes, thyristors, bipolar transistors, field effect transistors, capacitors, and magnetic components are examined in the context of high-power switching applications. The required text is *Elements of Power Electronics*, 2nd Edition, 2014, by P. T. Krein. The total enrollment for academic year 2025 – 2026 was 122.

ECE 469: Power Electronics Laboratory

This two-hour course, designed to accompany ECE 464, is a laboratory study of circuits and devices used for switching power converters, solid-state motor drives, and power controllers, including dc-dc, ac-dc, and dc-ac converters and applications. It includes high-power measurements for silicon-controlled rectifiers, diodes, capacitors, power transistors and magnetic components. The total enrollment for the academic year 2025 – 2026 was 68.

ECE 476: Power System Analysis

This three-hour course is the first of two courses on power system analysis. Topics included are transmission-line parameter calculations, equivalent circuits, network analysis, load flow, fault analysis, symmetrical components, unsymmetrical fault analysis, and introduction to economic dispatch. The course is designed to be a stand-alone introduction to the fundamentals of power system analysis and provide the basis for all subsequent courses in the power system analysis. The required text is *Power System Analysis & Design*, 7th Edition, 2022, by J. D. Glover, T. J. Overbye, M. S. Sarma and A. B. Birchfield. The total enrollment for the academic year 2025 – 2026 was 60.

ECE 498AS: Electric Mobility Systems

Transportation electrification is foundational to global decarbonization. This course covers electric mobility from foundational physics to system-of-systems energy interactions. We introduce the common system-level components of electric vehicles -- electric propulsion, energy storage, power conversion, drive cycles -- and how they operate together to meet mobility needs. The course focuses on energy linkages, and on modeling and design of system components. Application examples from electric aircraft, passenger cars, trucks, and drones will motivate each topic. In place of a text are Instructor Notes and current papers. The total enrollment for the academic year 2025 – 2026 was 22.

GRADUATE COURSES:

ECE 530: Analysis Techniques for Large-Scale Electrical Systems

This is a four-hour course in modeling power systems in steady-state and dynamic regimes. It includes analysis and simulation techniques for power and power electronics systems as well as computational issues in power systems and power electronics. Topics covered are advanced power flow, sparsity techniques, power-flow control, least-squares and estimation-applications averaging techniques for power electronics systems, numerical integration of differential equations and Krylov subspace applications. This class was not offered in the 2025 – 2026 academic year.

ECE 554: Dynamic System Reliability

This four-hour course offers subjects in new and developing areas of knowledge in electrical and computer engineering intended to augment the existing curriculum. Topics include basic reliability concepts, uncertainty modeling, reliability analysis, system design, fault detection, diagnosis, and applications. Text is *Large Scale System Analysis Under Uncertainty* by Alejandro D. Dominguez-Garcia, 2022. This class was not offered in the 2025 – 2026 academic year.

ECE 568: Modeling and Control of Electromechanical Systems

This four-hour course addresses issues of electrical drives in a modern control and circuit framework. Dynamic models of electric machines are presented. There is special emphasis on field-oriented control methods for ac motors. Power electronics systems for high-performance drives are studied. Nonlinear system methods such as periodic transformations, averaging, geometric control, and feedback linearization are presented. Special topics covered include electrostatic micromachines and permanent magnet machines. The recommended texts are *Control of Electrical Drives*, 3rd edition, 2001, by W. Leonard and *Analysis of Electric Machines*, 2025 by P. Krause, O. Wasynczuk, S. D. Sudhoff, and S. D. Pekarek. This class was not offered in the 2025 – 2026 academic year.

ECE 573: Power Systems Operations and Control

This four-hour course provides an overview of power system operations and control with major emphasis on security and economics. The role of EMS (energy management system) and principal EMS functions are discussed in depth. Major topics include optimal power flows; economic dispatch problems; role of reactive power; resource scheduling and commitment; state estimation; observability; bad data identification/detection, analysis and processing; electricity restructuring; competitive electricity markets; market design; congestion management; and ancillary services. The two suggested texts are *Power Generation, Operation and Control*, 2nd edition, by Wood and Wollenberg, and *State Estimation* *in Electric Power Systems: A Generalized Approach* by A. Monticelli, Kluwer Academic Publishers, Boston, 1999. This class was not offered in the 2025 – 2026 academic year.

ECE 576: Power Systems Dynamics and Stability

This four-hour course includes the dynamic representation of interconnected power systems—electrical plus mechanical, linearized dynamic models of multi-machine systems, methods of coherency identification, order reduction by singular perturbation, time-scale decomposition and aggregation techniques, dynamic equivalents, direct methods of stability analysis and power system stabilizer design. The required text is *Power Systems Dynamics and Stability* by P. W. Sauer and M. A. Pai, 1997. This class was not offered in the 2025 – 2026 academic year.

ECE 590 I Seminar: Power Systems

This course is a graduate seminar on advanced topics of current interest. Both faculty and students participate by presenting either current research results or topics of interest in journal publications. Guest speakers from industry and other universities are also scheduled periodically throughout the semester. Approximately 130 students participated in this course for both semesters.

ECE 598 KSH: Electrical Machine Design

Technologies like advanced materials, manufacturing processes and power electronics can open up the design space for new electrical machine solutions aimed at emerging applications in the transportation, energy, and industrial sectors. To take full advantage of these developments, engineers need to be well versed in the multidisciplinary design process for electrical machines, with a good understanding of complex trade-offs that span multiple disciplines. They must also be comfortable with both analytical and numerical tools and know when to apply these to obtain the best results. The course attempts to prepare electrical and mechanical engineers for this opportunity by focusing on practical design considerations. It builds on fundamentals covered in ECE 330 and 431 and takes students through the design of a variety of electromechanical devices. Fundamental principles of energy conversion applicable to all types of electric machinery are first reviewed. Basic design rules, analytical formulae and the use of numerical design tools are then introduced, and experience is gained through a hands-on design project. This class was not offered in the 2025 – 2026 academic year.

ECE 598 AB: Power-Electronic Converter and Control for Electric Machines: Theory and Practice

This course introduces modeling, analysis, and design of electromechanical energy-conversion systems from a simultaneous perspective of power electronics, electromechanics, and control. We will take a hands-on approach. Theories are discussed in lectures and implemented in real-world laboratory setups. Three-phase power-electronic converters specifically designed for machine drives are introduced.

Dynamic models of different types of electrical machines are developed using generalized machine theory. Finally, different control architectures and their impact on the dynamic performance of the drive are discussed. “Real-world” examples from many existing and emerging applications including electric vehicles, renewable energy systems, and high-power and high-performance industrial drives are used to show the need for interdisciplinary understanding from a system perspective. The required text is *Control of Electrical Drives*, 3rd edition, 2001 by W. Leonhard. References include *Vector Control and Dynamics of AC Drives* by D. W. Novotny and T. A. Lipo, *High-Power Converters and AC Drives,* by B. Wu and M. Narimani, 1996. *Control of Electric Machine Drive Systems* by S. Sul, *Power Electronics and Motor Drives: Advances and Trends* by B. K. Bose, 2011 and various IEEE papers. Prerequisites: ECE 464 (Power Electronics) and ECE 431 (Electric Machinery). ECE 486 is preferred. The total enrollment for the academic year 2025 – 2026 was 19.

NUMBER OF ELECTRIC POWER AND ENERGY SYSTEM AREA GRADUATES IN RECENT YEARS

Annual Average of Power Area Graduates

1950-1970

B.S.E.E.	-	25
M.S.E.E.	-	3

1970-1980

B.S.E.E.	-	44
M.S.E.E.	-	7

1980-1990

B.S.E.E.	-	32
M.S.E.E.	-	5
Ph.D.	-	2

1990-1995

B.S.E.E.	-	40
M.S.E.E	-	6
Ph.D.	-	2

1995-2000

B.S.E.E.	-	35
M.S.E.E.	-	9
Ph.D.	-	3

2000-2005

B.S.E.E.	-	40
M.S.E.E.	-	8
Ph.D.	-	3

2005-2010

B.S.E.E.	-	50
M.S.E.E.	-	10
Ph.D.	-	5

2010-2015

B.S.E.E.	-	60
M.S.E.E.	-	12
Ph.D.	-	6

2015-2020

B.S.E.E.	-	50
M.S.E.E.	-	10
Ph.D.	-	5

2020-2023

B.S.E.E.	-	75
M.S.E.E.	-	25
Ph.D.	-	11

2024-2026

B.S.E.E.	-	73
M.S.E.E	-	10
Ph.D.	-	6

5. ACTIVITIES

Faculty and students in the Power and Energy Systems Area participated in a considerable number of special activities during the academic year 2025 – 2026. The major events are listed below:

JUNE 2025

- Philip Krein attended the IEEE Foundation and IEEE Technical Activities Board Meeting, Chicago, IL.
- Philip Krein presented a paper and attended the Electrification Council's AdCom meeting at IEEE's Transportation Electrification Conference and Expo (ITEC) in Anaheim, CA.
- Kiruba Haran attended and gave a keynote to the 2025 International Conference on Superconductivity and Magnetism in Dalaman, Turkey.
- Kiruba Haran attended as Chair of the IEEE-TEC Technical Committee on Electrified Aircraft, Anaheim, CA
- Graduate student, Mudith Withmaralage attended and was honored with a certificate of achievement for the student design competition at the IEEE Transportation and Electrification Conference in Anaheim, CA.
- Announced the operation of the University of Illinois's first Windmill for Arijit Banerjee.
- George Gross directed and presented lectures at the 2026 edition of the *Transmission Business School* in Chicago, IL.
- Andrew Stillwell attended the IEEE Workshop on Control and Modeling of Power Electronics (COMPEL) in Knoxville, TN. He attended meetings, met with vendors and chaired a session.

JULY 2025

- Alejandro Domínguez-García attended and presented research at the European Control Conference in Thessaloniki, Greece.
- Olga Mironenko attended a Keen Entrepreneurial Engineering Network workshop in Minneapolis, MN.
- Philip Krein attended and served as a judge at the IEEE Future Energy Challenge in Taiwan.
- Philip Krein was invited to do a talk at Cirrus Logic, in Austin, TX.
- Graduate student, Joshua Feldman was a Young Scientist Plenary Speaker at the International Conference on Magnet Technology in Boston, MA where he presented research. He also attended the CHEETA Review Board meeting in Cleveland, OH.
- Graduate student Iven Guzel presented research at the 8^{th} International Conference on Continuous Optimization, held at USC, in Los Angeles, CA.
- Graduate student Yijin Wang attended the Institute for Operations Research and the Management Sciences, (INFORMS) Conference in Atlanta, GA.

- Graduate students T.G. Roberts and Grant McKechnie attended and presented at the Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium in Madison, WI.

- George Gross organized, and participated in the instruction at, the University of Salerno Summer School on Smart Grids in Fisciano, Italy.

AUGUST 2025

- Graduate student Furkan Karakaya defended his dissertation on campus.

SEPTEMBER 2025

- Graduate student Anjana Samarakoon attended and represented his research at the Doble Client Committee Meetings and Conference in Coral Gables, FL.

- Kiruba Haran met with representatives of Ford Motor Company and other groups, on behalf of the Center for Power Optimization of Electro-Thermal Systems.

- Kiruba Haran was invited to give a talk at Columbia University for the 2025 CCAE Symposium (Columbia Center for Advanced Electrification, in New York City.

- Philip Krein attended the IEEE Foundation Board Meeting as a Director of the IEEE Foundation, attended the IEEE International Symposium on Technology, in Santa Clara, CA.

OCTOBER 2025

- Olga Mironenko attended and recruited at the Society of Women in Engineering's (SWE) Annual Conference in New Orleans, LA.

- Kiruba Haran and Philip Krein attended and were a part of various committee meetings at the National Academy of Engineering (NAE) meeting in Washington D.C.

- Kiruba Haran attended the IEEE's Energy Conversion Conference and Expo (ECCE) in Philadelphia, PA and presented a paper. He also gave a talk at Villanova University.

- Philip Krein attended the IEEE's Energy Conversion Conference and Expo (ECCE), and attended meetings of the Power Electronics Society meetings, in Philadelphia, PA and presented a paper. He also presided over a Center for Electric Machinery and Electromechanics (CEME) meeting held with people attending ECCE.

- Philip Krein attended the IEEE International Telecommunications Energy Conference (INTELEC) in Houston, TX. He was invited to present the keynote speech and to chair discussion session section.

- Philip Krein served at ZJUI and at Zhejiang University related to faculty partnership appointments. Talks at Beijing Jiaotong University and also at Tsinghua University in China.

- Graduate students Yijin Wang and Iven Guzel attended and presented at the Institute for Operations Research and the Management Sciences, (INFORMS) Conference in Atlanta, GA.

- Graduate student Grant McKechnie attended and presented his paper at the North American Power Symposium (NAPS 2025) conference, in Hartford, CT

NOVEMBER 2025

- Jonathon Schuh attended the American Physical Society, Division of Fluid Dynamics, meeting in Houston, TX.

- Olga Mironenko attended and presented at the Frontiers in Education Conference (FIE 2025) in Nashville, TN.

DECEMBER 2025

- George Gross attended the Power Systems Engineering Research Center (PSERC) meeting in Washington, DC. Gross represented Illinois PSERC leadership in lieu of Alejandro Domínguez-García who was unable to attend.

- Philip Krein, Andrew Stillwell, and graduate student Aria Delmar attended the NSF Workshop on the Compute-Energy Nexus in Chicago, IL.

JANUARY 2026

- Kiruba S. Haran was invited to give a talk at the American Institute of Aeronautics and Astronautics (AIAA) SciTech Forum 2026 in Orlando, FL.

- Graduate student Muhammad Talal Khalid defended his dissertation.

FEBRUARY 2026

- Graduate students T.G. Roberts and Grant McKechnie attended and presented a paper at the Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium Annual Meeting in Raleigh, N.C.

- Olga Mironenko did a talk at Tennessee Tech University, Cookeville, TN.

- Philip Krein attended the IEEE Foundation meeting, served on the IEEE Technical Activities Board Meeting, in Austin, TX.

MARCH 2026

- Philip Krein attended and presented three papers at the IEEE Applied Power Electronics Conference (APEC) in San Antonio, Texas.

- Andrew Stillwell also attended and presented at the IEEE Applied Power Electronics Conference (APEC) in San Antonio, Texas.

- Graduate students Aria Delmar, and Shivam Kumar attended and presented on different topics at the 2026 Applied Power Electronics Conference (APEC) in San Antonio, Texas.

- Graduate student Hong-Ming Chiu presented his research and attended the INFORMS Optimization Society Conference in Atlanta, GA.

APRIL 2026

- Graduate student’s Sebastian Armstrong and Ryan Horvath attended the ARPA-E Energy Innovation Summit in San Diego, CA, representing their and Prof. Banerjee’s research at a booth. The event was attended by industry and government researchers and contractors.

- Post-doctoral student, Kunal Layek attended and presented research at the IEEE International Conference on Intelligent Design and Control of Automation and Drive Systems. The conference was held virtually.

- Graduate students organized the annual Power and Energy Conference of Illinois (PECI). Dennis Butts and Ryan Billings were co-directors of the conference, PECI 2026. Academics from prestigious research institutions were invited to speak. Likewise graduate students from other universities came to town to participate. Graduate students Nina Ayar and Anjana Samarakoon also presented their research at the event.

- Graduate student Anuj Maheshwari defended his dissertation.

GUEST SPEAKERS

During the 2025–26 year, the power area group hosted the following people, from academia and industry:

- Cameron Lowe, Field Application Engineer at Tektronix, 590I Seminar at ECE Building, Champaign-Urbana, September 2025.
- Ruchir Puri, Chief Scientists of IBM Research, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Prashant Shenoy, Professor & Assoc. Dean in the College of Information and Computer Sciences at the University of Massachusetts Amherst, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Howard Gugel, SVP of Regulatory Oversight at NERC (North American Electric Reliability Corporation) NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Andrew Chien, William Eckhardt Professor of Computer Science at the University of Chicago and a Senior Scientist at Argonne National Laboratory, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Alaa Youssef, Sr. Manager and Master Inventor at IBM T.J. Watson Research Center, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Dr. Jian Huang, Assoc. Professor and Y. T. Lo Faculty Fellow in the ECE department at the University of Illinois at Urbana-Champaign, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Nathan Rice, Supervisor of Electric Transmission Strategic Initiatives at Dominion Energy, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Brian Zahnstecher, Sr. Member of the IEEE, Chair (Emeritus) of the IEEE SFBAC Power Electronics Society (PELS), IEEE PELS North America Regional (R1-3) Chair, Chair PELS Sustainability "GREENS" Ad-hoc Committee, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Dr. Kashif Nawaz, Section Head for Building Technologies Research at Oak Ridge National Laboratory, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Davide Ziviani, Assoc. Professor of Mechanical Engineering at Purdue and the Co-Director of the Center for High Performance Buildings, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Praveen Kumar is the Executive Director for Prairie Research Institute, Urbana-Champaign, and the Colonel Harry F. and Frankie M. Lovell Endowed Professor in Civil and Environmental Engineering, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.
- Karu Sankaralingam, Principal Research Scientist at NVIDIA Research and Professor at UW-Madison. Founder SimpleMachines, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Srdjan Lukic, Deputy Director of the National Science Foundation Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Engineering Research Center, headquartered at North Carolina State University, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Rajesh Gopinath, PE is Data Center Architect at Oracle Cloud, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- William Schaumann, PE of the Global Mission Critical Electrical Engineering Practice at Burns & McDonnell, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- T. Bruce Tsuchida, Principal at The Brattle Group, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Mohammad Hajiesmaili, Assoc. Professor in the Manning College of Information and Computer Sciences at the University of Massachusetts Amherst, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Abdeltawab Hendawi, Assoc. Professor in Computer Science and Data Science at the University of Rhode Island, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Sushma Honnavara-Prasad, Engineer at Google DeepMind, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Tanya Das, Formerly, Bipartisan Policy Center, Director of AI and Energy Technology Policy, NSF Compute-Energy Nexus Workshop in Chicago, December 2025.

- Matt Woongkul Lee, Purdue University, 590I Seminar at ECE Building, Champaign-Urbana, March 2026.

- Yong-June Shin, Professor, School of Electrical and Electronic Engineering, Yonsei University, Republic of Korea, visited campus discuss partnerships and collaborations with Kiruba Haran in March 2026.

- Minjie Chen, Assoc. Professor at Andlinger Center for Energy and the Environment, Princeton University, speaker at the Power and Energy Conference of Illinois, April 2026.

- Sreekant Narumanchi, Group Manager - Advanced Power Electronics and Electric Machines, Center for Energy Conversion and Storage Systems, National Laboratory of the Rockies, speaker at the Power and Energy Conference of Illinois, April 2026

- Bulent Sarlioglu, Professor at University of Wisconsin-Madison, speaker at the Power and Energy Conference of Illinois, April 2026.

- Dr. Nathan Miles Ellis, Assist. Professor at the Baskin School of Engineering, University of California, Santa Cruz, speaker at the Power and Energy Conference of Illinois, April 2026.

- Khurram Khan Afridi. Professor at the Cornell Duffield Engineering, Cornell University, speaker at the Power and Energy Conference of Illinois, April 2026.

- Alex J. Hanson, Assoc. Professor and Chevron Centennial Fellowship in Engineering No. 1 in Computer Engineering in the Chandra Family Department of Electrical and Computer

Engineering at The University of Texas at Austin, speaker at the Power and Energy Conference of Illinois, April 2026.

- Cameron Lowe, Field Application Engineer at Tektronix, speaker at the Power and Energy Conference of Illinois, April 2026.

- Maryam Saeedifard, Professor; Director of Faculty Evaluation and Recognition, Georgia Tech, speaker at the Power and Energy Conference of Illinois, April 2026.

- Hang Dai, Assist. Professor, Utah State University, speaker at the Power and Energy Conference of Illinois, April 2026.

- Kathleen O' Brien, CTO of Siemens Energy, 590I Seminar at ECE Building, Champaign-Urbana, March 2026.

LOCAL LECTURES

During the academic year 2024 – 2025, the power faculty and students presented the following seminars to our local audiences:

- Kiruba Haran, Illinois ECE Saturday Engineering for Everyone, "Ultra Efficient Machines", April 2026.

- Kiruba Haran gave a talk to the Kent Seminar Series at the Illinois Center for Transportation, April 2026.

- Graduate student Yaokun Shi ran a project for students from the University Laboratory High School on campus. The students participated in activities ranging from simulation work (electric field and circuit modeling) to hardware development in order to learn more about Magnetic Muscle Stimulation (MMS). This project aimed to introduce high school students to the full research pipeline: design, simulate, build, and test.

6. STUDENT PROJECTS

This section of the report contains information on the graduate students whose major research efforts were supervised by faculty in the Power and Energy Systems Area. While not all of these students received financial aid from the Power Affiliates Program in terms of Research Assistantships, they were all associated with the program through the active involvement of their respective advisors. Those students supported by the Power Affiliates Program received maximum one-half time Research Assistantships for 11 months. The results of each student's work will be made available to all affiliate companies in the form of technical reports upon request. The following students were associated with the Power and Energy Systems Area, and their work is described in the following pages:

Appiah, Listowell (Ph.D.)
Amuda, Temitope Victor (Ph.D.)
Armstrong, Sebastian
Bajaj, Parag (M.S.)
Bali, Arjit (Ph.D.)
Billings, Ryan (Ph.D.)
Bose, Anubhav (Ph.D.)
Butts, Dennis Chen
Chiu, Hong-Ming (Ph.D.)
Crandall, Patrick (Ph.D.)
Delmar, Aria (Ph.D.)
Feldman, Joshua Michael (Ph.D.)
Freeman, Andrew (M.S.)
Guclu, Arda (Ph.D.)
Guzel, Iven (Ph.D.)
Hallitsche, Robin (Ph.D.)
Horvath, Ryan Matthew (Ph.D.)
Karakaya, Furkan (Ph.D.)
Khalid, Muhammad Talal (Ph.D.)
Layek, Kunal (Post Ph.D.)
Maheshwari, Anuj (Ph.D.)
McKechnie, Grant (Ph.D.)
Roberts, T.G. (Ph.D.)
Rodgers, Aidan Finn (M.S.)
Samarakoon, Anjana Jayasanka (Ph.D.)
Shi, Yaokun (M.S.)
Silk, Eric (Ph.D.)
Stokowski, Nicole M. (M.S.)
Andrew Vithoulkas (M.S.)
Wang, Yijin (Ph.D.)
Witharamalage, Mudith (Ph.D.)
Wolhaupter, Brian Andrew (M.S.)

Listowell Appiah

B.S.:	November 2019, Kwame Nkrumah University of Science & Technology, Ghana
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Energy Markets, Energy Equity, Context in Engineering

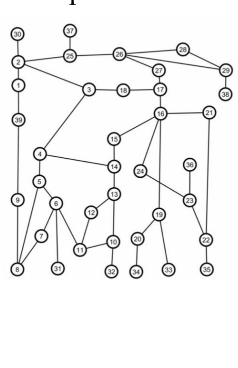
Distributed Economic Dispatch Algorithm for Smart Grids Using ADMM and Dynamic Average Consensus

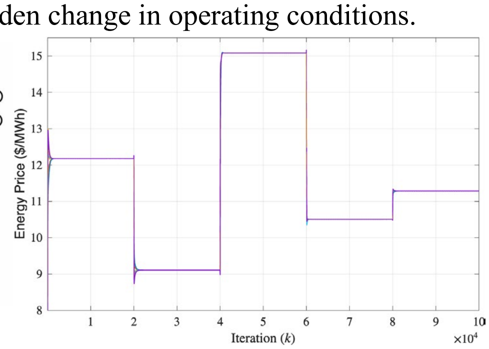
Listowell Appiah with Advisor Prof. Kiruba Haran

Supported by Grainger CEME

ABSTRACT

Modern power systems face significant challenges from the integration of distributed energy resources, necessitating a shift from centralized control towards distributed energy management frameworks. This work addresses this by developing a distributed economic dispatch algorithm grounded in Alternating Direction Method of Multipliers and dynamic average consensus algorithm. To achieve this, the optimization problem is decomposed into optimizations at local agents, where each agent iteratively estimates the solution of the optimization problem by communicating only with its immediate neighbors. The algorithm's primary advantage is preserving data confidentiality; local agents are not required to share private information, such as generator incremental costs. As a corollary, computational and communication costs are reduced which facilitates the plug-and-play property required by smart grids. Compared with centralized solutions, the distributed algorithm not only achieves comparable solutions but can also respond timely when the system experiences sudden change in operating conditions. Results of a case study based on the IEEE 39-bus test system illustrate the feasibility of the proposed approach.





Temitope Victor Amuda

B.S.: November 2017, University of Lagos, Nigeria

Status: Working towards Ph.D. at University of Illinois Urbana-Champaign

Professional Interests: Microgrid Control and Operations, Numerical Analysis

A Data-Driven Voltage Regulation
Framework for Power Distribution Systems

Temitope Amuda with Advisor Prof. Alejandro Domínguez-García

Supported by the Department of Energy

ABSTRACT

We consider the problem of voltage regulation in power distribution networks with inverter-based resources (IBRs) whose reactive power output can be controlled. The problem is formulated as a stochastic optimization program, which is solved online using a modified version of the projected stochastic gradient descent (PSGD) algorithm. The proposed PSGD-based algorithm leverages the sensitivities of changes in bus voltage magnitudes to changes in the reactive power setpoints of the IBRs. We propose a method for learning such sensitivities online using a recursive least squares estimator. To ensure the proper operation of the estimator, the sequence of incremental changes in IBR reactive power setpoints must remain persistently exciting. This requirement is guaranteed by design through a mechanism that is built into the voltage regulator. We demonstrate that the estimator and the regulator are amenable to a distributed implementation.

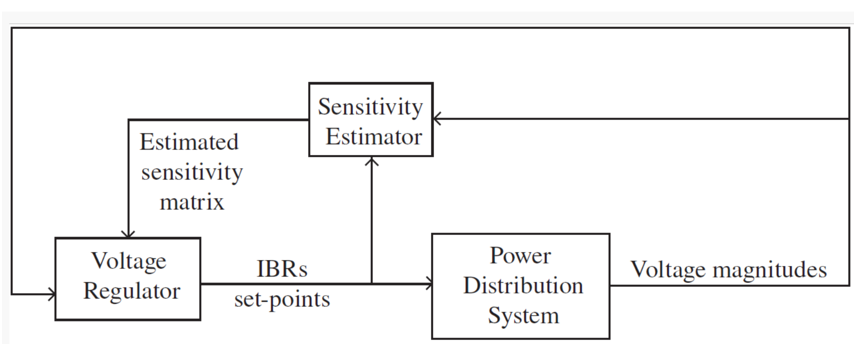


Figure 1 Online voltage regulation framework

Sebastian Armstrong

B.S.:	May 2024, University of Massachusetts Amherst
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Wind energy conversion, electrical drives, co-design, sustainable development

Control framework for the integrated generator-rectifier in offshore wind turbines

Sebastian Armstrong with Ryan Horvath,
Advising Prof. Arijit Banerjee

Supported by Grainger CEME

ABSTRACT

Offshore wind has an immense resource potential but brings challenges for the design of a multi-MW drivetrain, which must be highly reliable, efficient, and compact to reduce the levelized cost of energy. Modern turbines are trending towards the direct-drive permanent magnet synchronous generator (PMSG), due to its high efficiency and elimination of the gearbox. However, these designs typically require a fully rated power electronic converter, which suffers from a high failure rate. In this seminar talk for ECE 590I, the drivetrain concept known as the integrated generator-rectifier will be discussed. Using a co-design framework for the generator and power electronics, the integrated generator-rectifier gains the advantages of the PMSG in addition to a partially rated active switching converter. In addition, the control strategy for the drive system is discussed, with an emphasis on torque ripple reduction.

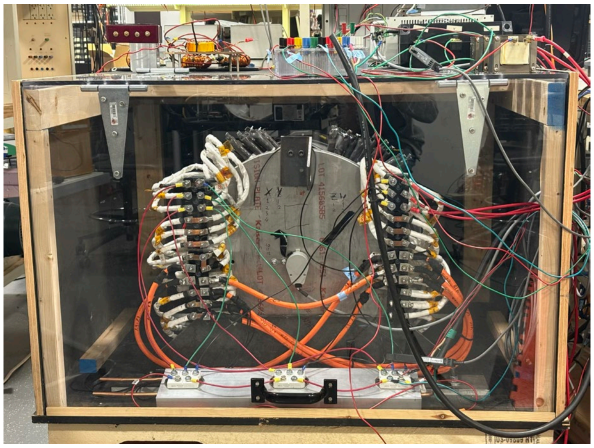


Figure 2 Experimental 4-port Integrated Generator-Rectifier

Parag Bajai

B.S.:	May 2021, University of Illinois at Urbana-Champaign
Status:	Working towards M.S. at University of Illinois at Urbana Champaign
Professional Interests:	Electrical Machines, Electrical Transportation

A Slot-Based Winding-Function Model for Toroidally Wound Variable-Pole Induction Machines

Parag Bajaj Advising Prof. Arijit Banerjee

Supported by Grainger CEME

ABSTRACT

Variable-pole induction machines (VPIMs) extend the torque-speed envelope of conventional fixed-pole induction machines by dynamically reconfiguring their effective pole-phase combination. Their design is, however, complicated by the pole dependence of the equivalent-circuit parameters (ECPs) and by the changing phase count of the per-phase model itself, which precludes a direct comparison of pole-induced parameter variation on a common basis. This work develops a per-slot model (PSM) of the toroidally wound VPIM, built from magnetic equivalent circuit (MEC) theory and a slot-based winding function. By indexing the model at the stator-slot level rather than at the per-phase level, the PSM expresses the ECPs as explicit functions of the pole-pair count and accommodates both integer and fractional effective phase counts within a single framework. The PSM is used to construct a variable-pole fixed-phase (VPFP) equivalent circuit in which the magnetizing inductance, the referred rotor resistance, and the referred rotor leakage inductance carry the pole dependence, while the stator-side parameters remain pole-invariant. The framework is validated on a 36-slot, 28-bar toroidally wound VPIM operated as a 9-phase/2-pole, 4.5-phase/4-pole, and 3-phase/6-pole machine under 18-leg excitation, and as a three-phase 2-, 4-, and 6-pole machine under 6-leg excitation, with both finite-element and experimental verification. The PSM provides the modelling foundation on which a backward design procedure for VPIMs, one that targets the full torque-speed envelope rather than a single base-pole configuration.

Arjit Bali

B.S.:	May 2018, Rose-Hulman Institute of Technology, Terre Haute IN
M.S.:	December 2023, University of Illinois Urbana-Champaign
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests	Electric Machines and Drives, Power Electronics, Control, Electric Vehicles

Active-Filter Inverter Architecture for Electric Aviation Applications

Arjit Bali with Advisers, Prof. Kiruba Haran and Andrew Stillwell*

Supported by POETS (Power Optimization of Electro-Thermal Systems)

Abstract

Electric aviation demands lightweight, high-efficiency electromechanical energy conversion systems, but bulky passive filtering components can limit motor-drive power density. Slotless permanent magnet synchronous machines, particularly when cryogenically cooled with liquid nitrogen, offer high power density through reduced iron losses and improved thermal performance; however, their extremely low per-phase inductance makes them highly susceptible to current ripple and harmonic distortion. This research proposes an active-filter motor-drive architecture in which a low-frequency two-level voltage-source inverter supplies the fundamental current, while a high-speed flying-capacitor multilevel auxiliary inverter injects compensating ripple current to suppress switching harmonics at the machine terminals. By separating bulk power delivery from high-frequency waveform shaping, the architecture reduces passive-filter requirements, improves current quality, and enables modular integration for electric aviation propulsion. The system is validated through PLECS simulation, and a field-oriented control scheme is developed to regulate machine current while suppressing circulating current between inverter branches.

Ryan Billings

B.S.:	May 2024, Rutgers University
M.S.:	May 2026, University of Illinois Urbana-Champaign
Status:	Working towards a Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Power Electronics, Power Electronics Control, Renewable Energy

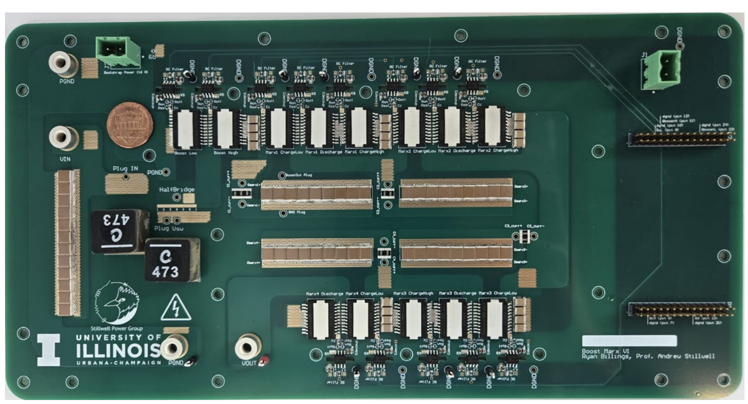
Soft-charging of a Marx Generator for Efficient and Compact Pulsed Power Converters

Ryan Billings with Advisor Prof. Andrew Stillwell

Supported by the UIUC ECE Department and Grainger Foundation

ABSTRACT

The Marx generator is a common topology used in repetitive pulsed power generation due to its modular construction and flexibility. Conventional Marx generators are constructed with a voltage-source input and are referred to here as hard-charged Marx generators (HCM). The charging phase of a HCM poses a design challenge since improving charging performance often creates a tradeoff with system performance, such as maximum pulse repetition rate or power density. By treating the Marx generator as a switched-capacitor converter (SCC) and implementing soft-charging operation, it is shown that charging losses can be reduced, leading to a new class of Marx generators, referred to as the soft-charged Marx generator (SCM). Simulation and experimental results compare a HCM and SCM with equivalent parameters and demonstrate that a magnitude reduction in switch resistance leads to a near-equivalent reduction in power loss at the same switching frequency for the SCM.



Anubhav Bose

B.S.:	May 2021, University of Mumbai, Mumbai, India
M.S.:	May 2023, University of Illinois Urbana-Champaign
Status:	Working towards a Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Aerospace Propulsion Electrification, High Power Density Electric Machines & Drive Systems, Renewable Energy Systems

Slotless Permanent Magnet Multi-Port Generator Design for Integrated Generator-Rectifier Systems for Wind Turbine Applications

Anubhav Bose with Advisor Prof. Kiruba Haran

Supported by the Advanced Research Projects Agency - Energy (ARPA-E)

ABSTRACT

Integrated Generator-Rectifier Systems have been shown to improve reliability and operating efficiency of offshore wind turbine generation systems, as well as reduce the overall Levelized Cost of Energy (LCoE) and Annual Energy Production (AEP) from these systems. These advantages have been shown in design studies at the 10 MW scale, as well as in laboratory testing at the 200-kW scale. For long term system level demonstration of this architecture, a 20-kW scale wind turbine system is being deployed near the University of Illinois Urbana-Champaign campus. This research focuses on the design & development of the slotless permanent magnet multi-port generator that enables this architecture.

This update details the assessment and verification of the thermal management system for the generator prototype. The generator is cooled using ambient air ducted into the turbine nacelle. This cooling mechanism creates a direct link between the shaft power generated by the turbine blades and the maximum power that can be converted by the generator under a certain thermal limit. Thus, the thermal management system and generator temperatures must be evaluated for the entire power-windspeed characteristic of the turbine. This is accomplished using a conjugate heat transfer and nonisothermal computational fluid dynamics model of the generator. To verify the accuracy of this model, a pole-pair motorette (composed of a 1/18th section of the generator stator) and a controllable airflow test fixture were fabricated. Testing of the motorette prototype under different loss and flow regimes will enable characterization of the temperature profile under different power and wind speed conditions.

The 20kW generator is currently being manufactured in partnership with McCleer Power Inc and Applinetics Engineering LLC in Michigan. For system validation, a new drive testbed is being commissioned in the UIUC Electrical & Computer Engineering Building. This bespoke testbed is specified to meet the unique challenges of system-level testing of a low-speed direct drive high torque generator. Some of the specific capabilities enabled here include a HIL prime mover emulation using a Typhoon-HIL real-time target, variable DC bus operation through power recirculation across 480V and 208V AC buses, and a bespoke high-bandwidth, high-channel count EMI-immune data acquisition system.

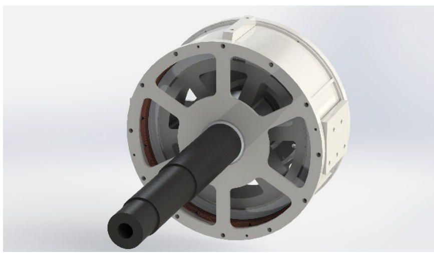


Figure 3: CAD Rendering of the generator

Once the system operation has been validated, the system will replace the baseline generator and power electronics on the wind turbine system on campus and run for over a year to verify the LCoE and AEP improvements. In addition, exploratory research is being conducted to assess the benefits of this integrated architecture for applications in transportation electrification and datacenter applications.

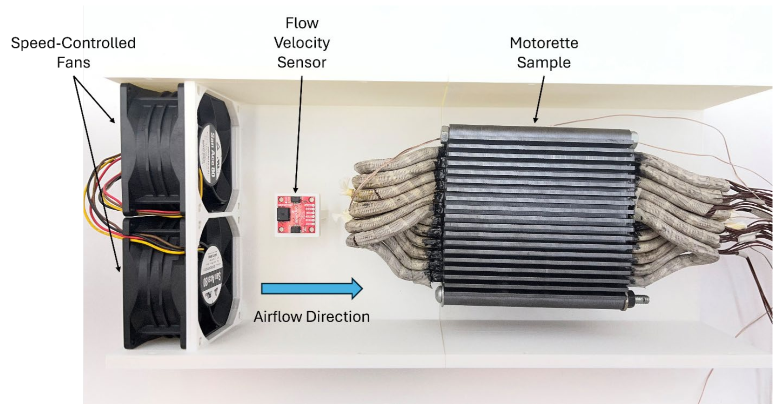


Figure 4: Generator pole-pair motorette placed in the flow-controlled thermal test chamber.

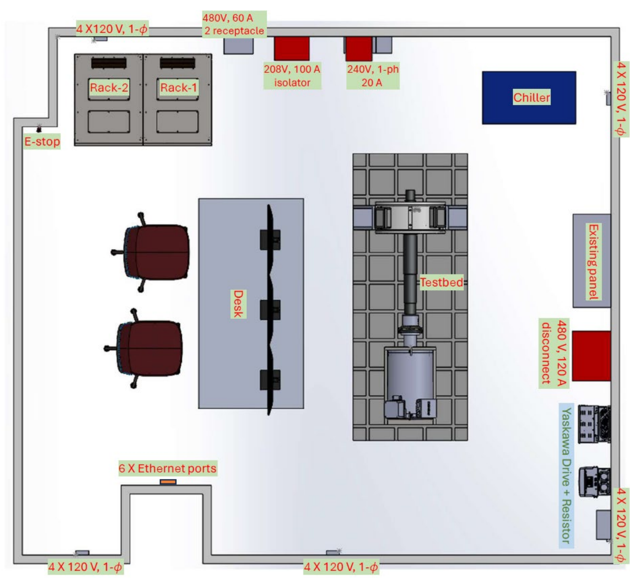


Figure 5: Layout Plan of the testbed laboratory being commissioned for the generator-rectifier system.

Dennis C. Butts

B.S.: May 2020, National Yang Ming Chiao Tung University

M.S. August 2026, University of Illinois Urbana-Champaign

Professional Interests: Electric Machines

Applications of an Electromechanical Actuation System to a Snake Robot

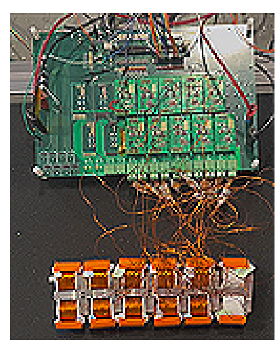
with Advisor Prof. Arijit Banerjee

Supported by NSF Career and ONR Award

ABSTRACT

Inspired by the flexible movements of animals, the robotic spine aims to solve some of the issues with rigidity in robots. This project uses a distributed electromechanical actuation system that can be stacked to form a robotic spine. This electromechanical actuator exchanges torque for total angular flexibility – the total rotational range each joint can achieve – which contrasts with the torque and speed relationship of a motor. When the rotational angle of the distributed actuation system is small, the torque density of the actuator is much larger than that of brushless DC motors. Because animal spines are usually limited in rotational capability, the actuation system is well-suited for robotic spine applications. Additionally, the current through a motor is often limited to avoid nonlinearities between torque and current. However, limiting the electromechanical actuation system's current is not necessary since the relationship between current and torque is already nonlinear.

Research focuses on the successful implementation of an agile snake robot using the proposed distributed electromechanical actuation system. Any new actuator setup requires careful consideration of the material and mass properties to optimize mechanical efficiency in locomotion. Additionally, the actuator's highly nonlinear torque-current relationship makes traditional control approaches difficult. The small airgap further complicates the control since the controller needs to be extremely precise. This research attempts to integrate modeling, hardware, and control design to successfully implement an agile snake robot using the distributed electromechanical actuation system.



Hong-Ming Chiu

B.S.: May 2020, National Yang Ming Chiao Tung University

Status: Working towards Ph.D. at University of Illinois Urbana-Champaign

Professional Interests: Machine Learning and Optimization

On the Complexity of Second-Order Methods for Semidefinite Least-Squares Problems with Chordal Sparsity

with Advisor Prof. Richard Zhang

Supported by NSF Career and ONR Award

ABSTRACT

High-accuracy solutions to sparse semidefinite least-squares problems (SDLS) are critical in many real-world applications. First-order methods offer linear per-iteration cost but suffer from sublinear convergence, requiring an excessive number of iterations to reach high accuracy. In contrast, second-order methods achieve linear to quadratic convergence but are typically limited to medium-scale problems due to the cubic cost of Hessian inversion. In this paper, we establish the first sufficient conditions under which second-order methods achieve linear per-iteration cost for solving both SDLS and its Burer--Monteiro reformulation. Specifically, we prove that when the extended sparsity pattern is chordally sparse, interior-point methods achieve linear per-iteration complexity for solving SDLS. Moreover, when the solution is low-rank, we show that trust-region and adaptive cubic regularization methods achieve a further reduced per-iteration cost for solving the Burer--Monteiro reformulated SDLS. The chordal sparsity and low-rank structure commonly arise in many practical SDLS problems, including matrix completion, sensor network localization, and power system state estimation.

Patrick Crandall

B.S.: July 2025, California Polytechnic State University

Status: Working towards M.S. at University of Illinois Urbana-Champaign

Professional Interests: Power Electronics, Controls

Assessing Slow Electric Vehicle Chargers' Ability to Meet User Demand

Patrick Crandall with Advisor Prof. Philip Krein

Supported by the iSEE

ABSTRACT

In recent years, the adoption of consumer electric vehicles has rapidly increased, adding to electricity demand on the power grid. This work examines the feasibility of Level 1 chargers in meeting the daily charging needs of electric vehicle users. Level 2 and Level 3 chargers are significantly faster but come at the cost of increased infrastructure demands. Increased infrastructure requirements include higher installation costs and potential grid impacts due to high-power ratings. On the other hand, Level 1 chargers are more easily implemented in the form of a standard 120V outlet. For reference, charging levels are generally broken down as follows: Level 1 is 1.4-2.4 kW, Level 2 is 3.8-20 kW, and Level 3 is 50-350 kW.

Figure 1. Smart Metering Prototype

To determine the effectiveness of Level 1 chargers, a custom power monitoring PCB, as shown in Figure 1, has been created and installed at various locations on the University of Illinois at Urbana-Champaign campus. The PCB measures metrics such as voltage, current, time, and power factor, then remotely transmits the data to a server. From the raw data files, roughly 600 Level 1 charging sessions have been identified and extracted. Figure 2 shows the percent of

charging sessions that fall into specified energy bins, and Figure 3 shows the percent of charging sessions that fall into specified duration bins. This information gives insight into how much energy users can recharge in an at-work setting. By comparing against survey data, Level 1 supported daily needs can be quantified. The goal is to find the optimal number of Level 1, Level 2, and Level 3 chargers to service a given community.

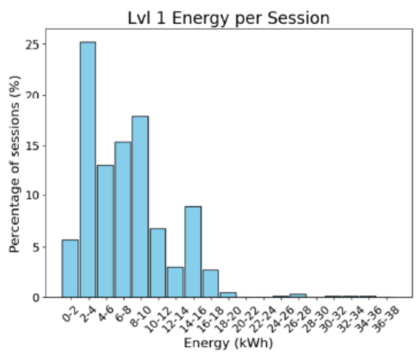


Figure 2. Level 1 Charging Sessions vs Energy Bar Graph

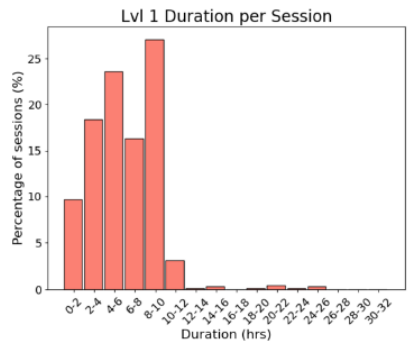


Figure 3. Level 1 Charging Sessions vs Duration Bar Graph

Aria Delmar

B.S.:	May 2021, Florida State University
M.S.:	August 2023, University of Illinois Urbana-Champaign
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Power Electronics, Power Electronics Control, Renewable Energy

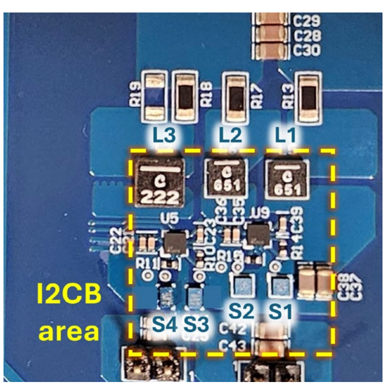
Input-Inductor Cascaded Buck (I2CB) Converter for 48 V IBC Applications

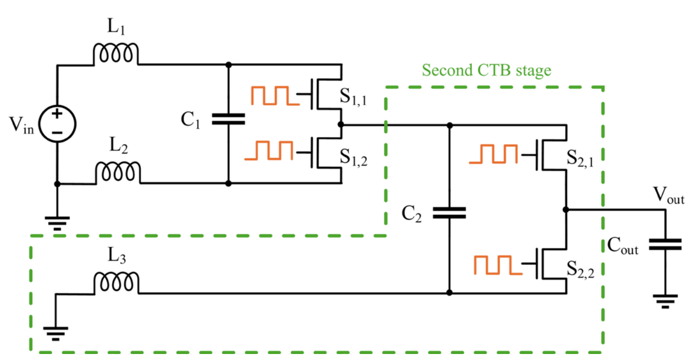
Aria Delmar with Advisor Prof. Andrew Stillwell*

Supported by the UIUC ECE Department and Grainger Foundation

ABSTRACT

The AI accelerators of the future necessitate thousands of amps of current, resulting in large resistive losses in the PDN. Vertical power delivery (VPD) and/or 48 V IBCs built entirely on the SOC package can address this issue but demands extreme power density of the power delivery solution. The size of the magnetics is still the biggest bottleneck, dictating the overall converter size and optimization. We present an input-inductor cascaded buck (I2CB) topology that minimizes inductor footprints by (i) keeping them on the input side (HV side) facilitating VPD and on-package integration with minimal EMI concerns, (ii) employing a switching scheme that can lower the inductor footprint by 3x, and (iii) enabling soft switching to maximize switching frequency (>2 MHz) while improving efficiency by >5%. Results from both the theoretical study as well as measurements from an 80~W hardware prototype are presented.





Joshua Michael Feldman

B.S.: May 2019, University of Illinois Urbana-Champaign

M.S.: December 2021, University of Illinois Urbana-Champaign

Ph.D. March 2026, University of Illinois Urbana-Champaign

Professional Interests: Electric Aviation, Cryogenics, Superconductivity, Heat Transfer

Design and analysis of a cryogenic, liquid hydrogen based cooling system for a fully-superconducting aircraft propulsion motor

Joshua Feldman with Advisor Prof. Kiruba Haran

Supported by NASA

ABSTRACT

The aviation sector's greenhouse gas emissions could be reduced by replacing jet engines with electric motor-driven propellers. However, the high power required of these motors is possible only by increasing the motor size and/or the current it carries. Larger size means more mass, which would reduce the plane's range and payload capability. Higher current means more heat generated by resistive losses. This heat cannot exceed the system's cooling capability, so the current must be limited accordingly.

Cryogenic cooling could enable higher currents by reducing the electrical resistivity of the motors' magnetic coils. At cryogenic temperatures, the motor coils could employ superconductors (SC) or non-SC materials, like aluminum, whose resistivity drops significantly with temperature. In either case, the reduced heat generation would allow higher currents, and hence higher power, without increasing motor mass or size. This could help make electric motors suitable for aircraft propulsion.

Feldman's dissertation presents a proposed cryogenic motor for aircraft propulsion. Ongoing research projects are discussed, and key research needs are identified.

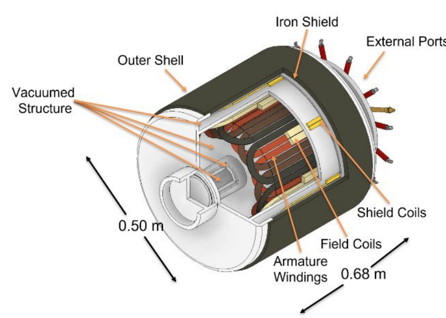


Figure 1.1: Proposed CHEETA Motor

Andrew Freeman

B.S.:	May 2023, Purdue University
M.S.:	August 2025, University of Illinois Urbana-Champaign
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Power Electronics, Electrification, Renewable Energy

A flying capacitor multilevel dual-active bridge converter for interfacing high voltage in more-electric aircraft

Andrew Freeman with Advisor Prof. Andrew Stillwell

Supported ARPA-E Department of Energy

ABSTRACT

The term more-electric aircraft refers to the reduction or replacement of mechanical, hydraulic, electrical, and pneumatic subsystems with their electrically powered counterparts. This consolidation substantially lowers system weight and complexity, while improving efficiency, versatility, and serviceability. An increased electrical power demand necessitates a higher transmission bus voltage to prevent ohmic losses. However, existing power converter switches are limited in their maximum voltage capabilities; as a workaround, multilevel converters enable the use of lower-voltage switches with improved performance. Therefore, this project demonstrates a proof-of-concept flying-capacitor multilevel dual-active bridge (FCML-DAB), demonstrating how low-voltage GaN devices can be successfully integrated into a high-voltage power-conversion application. An 800:28 V prototype achieves a peak efficiency of 93.75% at 88 W in preliminary testing. The design incorporates a high-frequency planar transformer and leverages both the inherent frequency multiplication and the natural DC-blocking of the FCML half-bridge architecture.

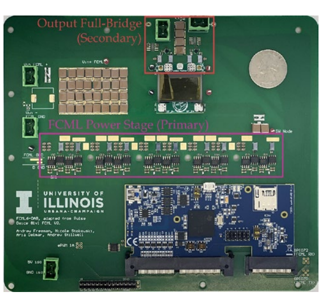


Figure 1: The pink box is the FCML Power Stage (Primary) and the red box is around the Output Full-Bridge (Secondary)

Arda Güçlü

B.S.:	May 2021, Bilkent University, Ankara, Turkey
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Electricity Markets, Control Theory

Tangential Randomization in Linear Bandits (TRAiL): Guaranteed Inference and Regret Bounds

Arda Güçlü with Advisor Prof. Subhonmesh Bose

Supported by National Science Foundation

ABSTRACT

Adaptive control tackles the question of control in an unknown environment. While a number of algorithms already exist in this space, our work deals with an under-explored algorithmic framework called forced exploration. We provide theoretical guarantees for the performance of our proposed algorithm called TRAiL (Tangential Randomization in Linear Bandits). The project sheds light into how inference about the environment interplays with control performance of an algorithm in adaptive control problems.

Iven Guzel

B.S.:	June 2019, Middle East Technical University, Ankara, Turkey
M.S.:	July 2022, Middle East Technical University, Ankara, Turkey
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Optimization Methods Applied to Power Systems and the Smart Grid

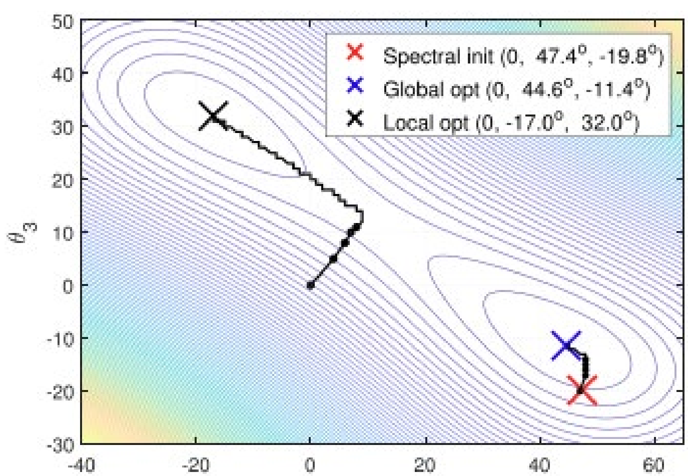
Power System State Estimation by Phase Synchronization and Eigenvectors

Iven Guzel with Advisor Prof. Richard Y. Zhang

Supported by the National Science Foundation and C3.ai

ABSTRACT

To estimate accurate voltage phasors from inaccurate voltage magnitude and complex power measurements, the standard approach is to iteratively refine a good initial guess using the Gauss–Newton method. But the nonconvexity of the estimation makes the Gauss–Newton method sensitive to its initial guess, so human intervention is needed to detect convergence to plausible but ultimately spurious estimates. This paper makes a novel connection between the angle estimation subproblem and phase synchronization to yield two key benefits: (1) an exceptionally high quality initial guess over the angles, known as a *spectral initialization*; (2) a correctness guarantee for the estimated angles, known as a *global optimality certificate*. These are formulated as sparse eigenvalue-eigenvector problems, which we efficiently compute in time comparable to a few Gauss—Newton iterations. Our experiments on the complete set of



Polish, PEGASE, and RTE models show, where voltage magnitudes are already reasonably accurate, that spectral initialization provides an almost-perfect single-shot estimation of n angles from $2n$ moderately noisy bus power measurements (i.e. n pairs of PQ measurements), whose correctness becomes guaranteed after a single Gauss–Newton iteration. For less accurate voltage magnitudes, the performance of the method degrades gracefully; even with moderate voltage magnitude errors, the estimated voltage angles remain surprisingly accurate.

Robin Hallitschke

B.E.: May 2024, Baden-Wuerttemberg Cooperative State University

Ph.D.: Working towards M.S. at University of Illinois Urbana-Champaign

Professional Interests: Power Electronics and Renewable Energy

1 MW Electric Propulsion Testbed for Future Aircraft Systems

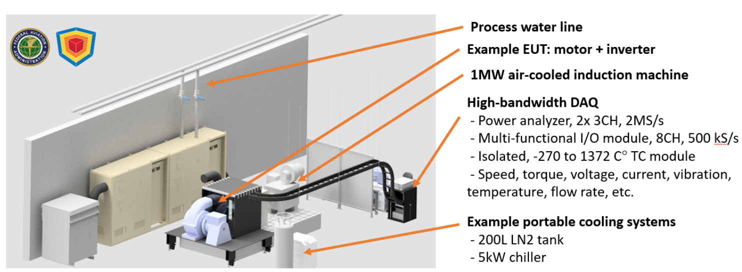
Robin Hallitschke with Advisor Prof. Kiruba Haran

Supported by the Office of Naval Research MVDC Risk Reduction Program

ABSTRACT

As aviation moves toward lower-emission propulsion, one of the major barriers is not only developing high-power electric machines and drives but also having the infrastructure to test them at realistic operating conditions. Future aircraft propulsion systems are expected to operate at much higher power and voltage levels than today's automotive platforms, making megawatt-class validation essential for translating laboratory concepts into practical systems. This need is especially important for evaluating integrated propulsion hardware, mission-relevant operation, and reliability under the demanding conditions expected in next-generation electrified aircraft.

To address this gap, the University of Illinois Urbana-Champaign is developing a 1 MW testbed for electric aircraft propulsion research. The facility will support full-scale demonstrations of motor-drive systems and simulated flight missions, while also enabling hardware-in-the-loop studies for rapid and safe system development. Building on the existing POETS infrastructure, the expanded platform is intended to provide scalable power capability, high-fidelity instrumentation, and flexibility for future configurations. The project includes megawatt-class motor-drive testing, environmental and reliability evaluation. Additionally, to be able to test cryogenic systems the testbed will be connected to a cryogenic test setup, which is part of the overall project funded by the Federal Aviation Administration's Fueling Aviation's Sustainable Transition (FAST) program. Together, these capabilities will position the testbed as a key research asset for advancing high-power, low-emission aviation technologies.



Ryan Horvath

B.S.:	May 2024, University of Maryland
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Wind energy conversion, electrical drives, co-design, sustainable development

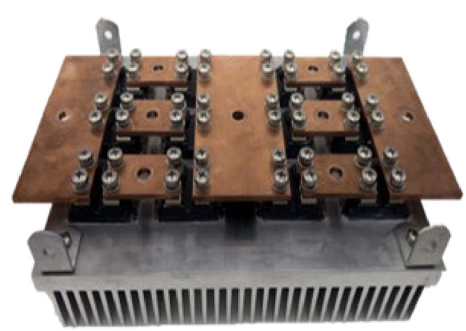
Power Electronics for Future Drivetrains in Wind Turbines

Ryan Horvath with Sebastian Armstrong
Advising Prof. Arijit Banerjee

Supported by Grainger CEME

ABSTRACT

Offshore wind is an attractive energy source for future needs. Unfortunately, it has a large levelized cost of electricity compared to other energy sources. Direct-drive permanent magnet synchronous generators are a leading technology due to high torque density and efficiency while eliminating the problematic gearbox, but they require fully rated rectifiers with active switching. This talk will discuss a novel drivetrain to improve the efficiency and reliability of offshore wind drive trains to bring down costs. This is done by rectifying the voltage through both active rectifiers with transistors and passive rectifiers with diodes. This reduces the power processed by the active rectifier, which is lossy and less reliable. The design of the power electronics, including the number of active and passive rectifiers, and device selection will be discussed.



Furkan Karakaya

B.S.: 2017, ECE – Middle East Technical University, Ankara, Turkey

M.S.: 2021, ECE – Middle East Technical University, Ankara, Turkey

Ph.D.: 2026, March at University of Illinois Urbana-Champaign

Professional Interests: Power Electronics and Renewable Energy

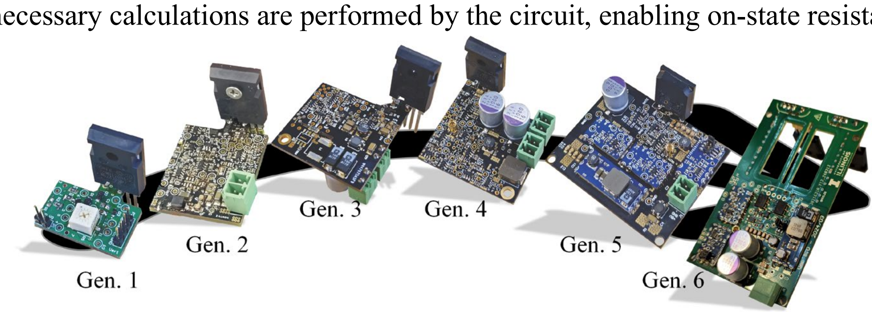
Furkan Karakaya with Advisor Assoc. Prof. Arijit Banerjee

Supported by the Office of Naval Research MVDC Risk Reduction Program

ABSTRACT

Silicon Carbide (SiC) MOSFETs are being widely adopted in the industry as a viable substitute for conventional power transistors, due to their superior figure-of-merit and compact, efficient power conversion. However, the relatively novel manufacturing technology of these devices raises further questions regarding long-term reliability, as SiC devices have been known to suffer from degradation over time, manifesting in an increased on-state impedance or a spike in gate leakage current. In order to identify the remaining useful lifetime of a SiC MOSFET, measuring the on-state impedance periodically is essential, though the operating voltage and current levels in kilovolts and kiloamperes presents a challenge, due to the impedance values typically falling in the range of several dozen milliohms.

Our recent design successfully addresses this challenge and enables reliable on-state impedance characterization, even during an active converter operation, with an estimated error of less than 5%. The key idea behind the proposed design involves injecting a sinusoidal current in the MHz range, with the resultant voltage being filtered out by custom-engineered analog circuitry. Then, necessary calculations are performed by the circuit, enabling on-state resistance and package inductance to be accurately estimated in the milliohm and nanohenry ranges, respectively.



Muhammad Talal Khalid

B.S.:	N.E.D. University of Engineering and Technology, Pakistan
M.S.:	University of Technology Sydney, Australia
Status:	Working towards M.S. at University of Illinois Urbana-Champaign
Professional Interests:	Electric Vehicle Charging Infrastructure, Electricity Rates, Electric Transportation Planning and Policy

An Introduction to "Alternative Fuel Grades" for Electric Vehicle Fast Charging

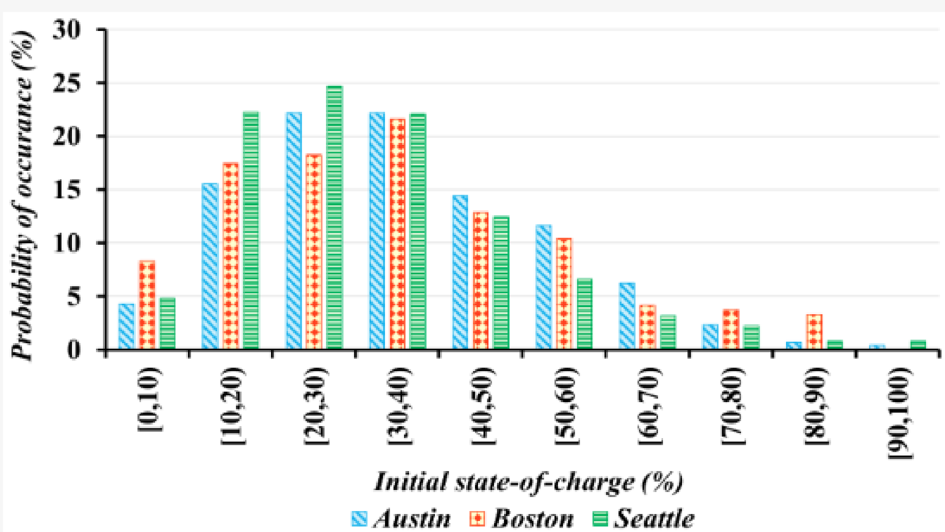
Talal Khalid with Advisor Prof. Ann-Perry Witmer

Supported by ECE ICR

ABSTRACT

The maximum demand payment component (MDPC) of the electricity bill, which reflects the highest level of power demand during a billing period, is a well-recognized barrier to the feasibility of electric vehicle fast-charging facilities (EVFCFs). While several studies have explored control strategies to mitigate demand peaks, they primarily focus on slow-charging facilities and fail to account for maximum demand prices. On the other hand, the few existing

Figure 4. Initial state of charge of *EVs* visiting the three *EVFCFs* between 06:00 and 07:00 p.m.



EVFCF-particular strategies overlook the diminished user-desired quality of service caused by the additional charging time needed for demand management. Moreover, their implementations under real-world conditions also remain unexplored. To address these issues, this work proposes a managed charging solution that explicitly considers the impact of maximum demand prices while maintaining user-desired quality of service and implements it under real-world conditions in three different metropolitan areas in the United States. Simulation results indicate that the proposed solution can increase an EVFCF's operational profits by 5–26% compared with conventional charging methods. The findings also highlight that the outcomes of the proposed solution are significantly influenced by the EVFCF utilization rate, the time between consecutive EV arrivals, the incumbent electric utility-specified maximum demand prices, and the user preferences of selecting the various "alternative fuel-grade options" offered at an EVFCF. These findings could pave the way for a more informed deployment of managed charging solutions at EVFCFs, thereby accelerating equitable transition to transportation electrification.

Kunal Layek

B.Tech.	May 2013, Asansol Engineering College, Asansol, India,
Ph.D.:	March 2025, IIT Madras, Chennai, India
Status:	Post-Doctoral Researcher
Professional Interests:	Wind energy conversion, electrical drives, co-design, sustainable development

Effects of Winding Asymmetry on Power Quality in Multiport Integrated Generator Rectifiers

Kunal Layek with Advisor Prof. Arijit Banerjee

Supported by Department of Energy

ABSTRACT

Permanent magnet-based multiport integrated generator-rectifiers are well-suited for high-power generator applications due to their reliability, efficiency, and power density. However, the winding pattern of these generators introduces an imbalance in the mutual inductances between phases, resulting in second-order harmonics in the dc output current of the rectifier. This paper presents a dynamic model to explain the effects of these imbalances on the harmonic performance of the output dc power. Sequence component networks are derived to quantify the dc current ripple in terms of the unequal mutual inductances of the active port winding. A feedforward-based control strategy is proposed to reduce the current ripple, thereby compensating for asymmetry in the active port control system, and improving the quality of dc power delivered to the grid. The proposed concepts are validated through simulations of a 4-port, 120 kW prototype generator-rectifier system, with experimental validation performed on the same machine at a scaled-down power level.

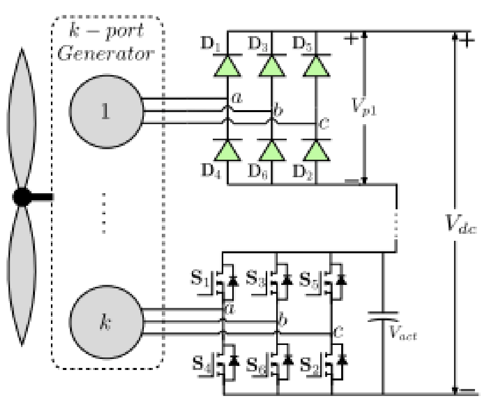


Fig. 1. Integrated generator rectifier architecture with k ports.

Anuj Maheshwari

B.S.: May 2019, Indian Institute of Technology (IIT), Kharagpur, India

M.S.: December 2022, University of Illinois Urbana-Champaign

Ph.D. May 2026 at University of Illinois Urbana-Champaign

Professional Interests: Design and Control of Power Electronics, DC-DC Converters

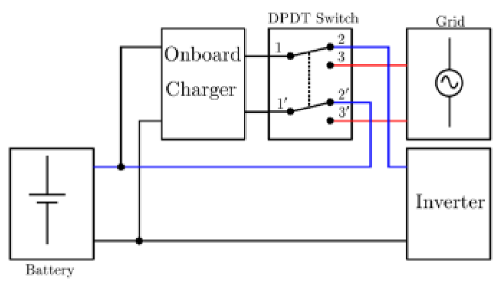
Dual-Use of Onboard Chargers to Achieve Controllable DC Bus Voltage for Variable Pole Induction Motors in Traction Applications

Anuj Maheshwari with Advisor Prof. Arijit Banerjee

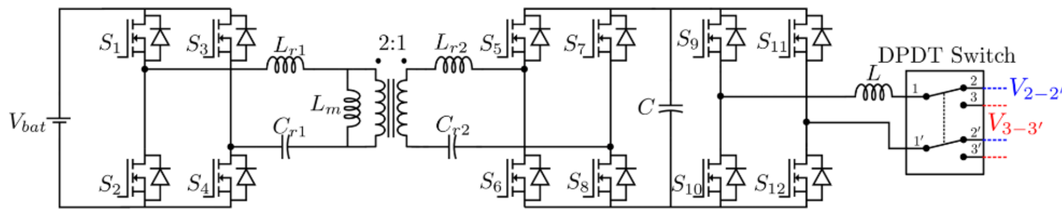
Supported by Grainger CEME

ABSTRACT

In electric vehicles, the power flow architecture must prioritize high efficiency and power density while consistently delivering the rated torque-speed envelope. In conventional systems, where the battery is directly connected to the traction inverter's dc-link, this envelope degrades as the battery discharges. A common solution involves inserting a dc-dc converter between the battery and the inverter to stabilize the dc-link voltage. Such converters must be rated for full traction power, leading to increased system weight and reduced efficiency. Alternatively, the onboard charger (OBC) can be utilized to regulate the dc-link voltage during motoring operation. A double-pole double-throw (DPDT) switch—implemented using antiparallel thyristors—enables transition between charging and motoring modes. The analysis shows that the system maintains the full torque-speed envelope down to a 20% battery state of charge (SOC) with an OBC rated at only 15% of the traction motor's power. Figure 2 shows the control architecture for the proposed system. The drivetrain is regulated using a field-oriented control (FOC) strategy. The CLLC converter operates at its resonant frequency, with power transfer controlled through phase shift. The buck converter is used to control the inverter dc-link voltage and uses the motor current, CLLC dc-link voltage, battery voltage and inverter reference voltage to generate feedforward terms for current and duty ratio, improving bandwidth and overall dynamic performance.



Compared to conventional architecture using a fully rated boost dc-dc converter, the proposed system also demonstrates a 1.5% improvement in efficiency across the torque-speed envelope. To validate this, 60V, 700W GaN-based hardware prototypes were developed for both architectures. Experimental results validate the analytical predictions, demonstrating improved drivetrain efficiency while maintaining dynamic performance with the proposed configuration. Overall, this architecture eliminates the need for a separate high-power dc-dc converter, thereby increasing power density and enhancing system efficiency.



Grant McKechnie

B.S.: December 2023, University of Illinois Urbana-Champaign

M.S.: December 2025, University of Illinois Urbana-Champaign

Status: Working towards Ph.D. at University of Illinois Urbana-Champaign

Professional Interests: Power electronics and power systems

Phase Control of Delta-Connected Grid-Forming Inverters for Auxiliary Signal Injection

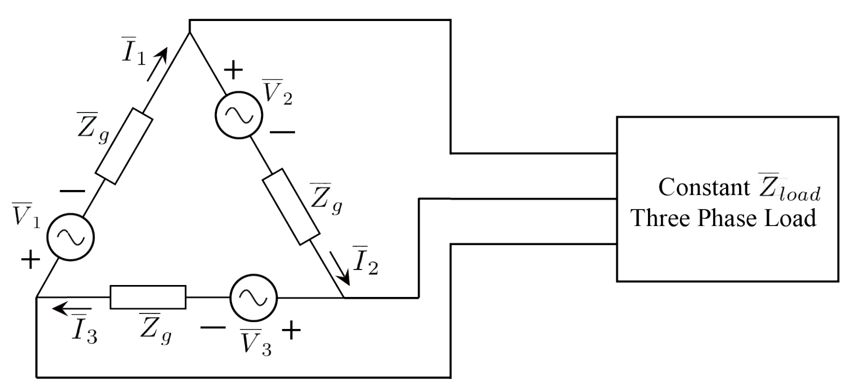
Grant McKechnie with Advisor Prof. Alejandro Domínguez-García

Supported by Department of Energy

ABSTRACT

With the rapid shift toward distributed inverter-based resource (IBR) power generation, ensuring the reliability and stability of the electrical grid is becoming increasingly critical. Historically, the grid relied on the rotational inertia of centralized synchronous generators for stability. However, modern grid-following (GFL) inverters offer little inertial support and often go offline if the grid itself fails. To address this, research is focusing on grid-forming (GFM) inverters, which can emulate synchronous generator dynamics and support the grid even during islanded operation.
A major challenge in integrating GFM inverters is their compatibility with legacy grid protection schemes. Traditional devices like circuit breakers are designed for the high fault currents produced by synchronous generators, whereas IBRs have sensitive electronics that strictly limit fault currents. Because IBR fault currents are so low, they often fail to trigger protective devices, risking equipment damage and delayed fault isolation. To overcome this, new control strategies are required that can alter inverter behavior specifically for fault detection and injection.

This work investigates a novel control framework that explicitly manages the phase differences between single-phase units in a delta-connected



system through analysis of phase balancing dynamics. Using a high-fidelity model (Typhoon HIL), we develop and compare a Linear Quadratic Integral (LQI) controller and a Proportional-Integral {Pl) controller for phase angle reference tracking. We evaluate the system's ability to operate as a balanced three-phase source under nominal conditions while allowing for intentional unbalancing to inject auxiliary signals for fault detection. This flexibility is essential for adapting modern inverter-based resources to meet strict grid protection requirements.

T.G. Roberts

B.S.: May 2020, University of California, Berkeley

M.S.: May 2022, University of Illinois Urbana Champaign

Ph.D.: August 2026, at University of Illinois Urbana-Champaign

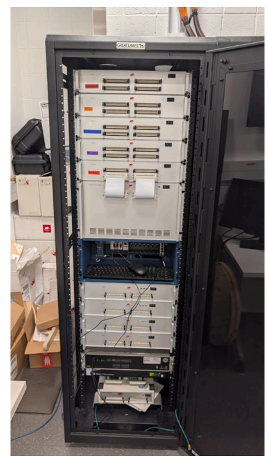
Professional Interests: Microgrids, Grid Forming Inverters, Power Systems, Control

Design, Analysis, and Controller Hardware-in-the Loop (C-HIL) Testing of Hybrid Control Systems for Networked Microgrids

T.G. Roberts with Advisor Prof. Alejandro Domínguez-García

Supported by Department of Energy

ABSTRACT



This research has previously developed a suite of system level controls for the Banshee microgrid and tested them in a high-fidelity real-time controller hardware in the loop (C-HIL) setting. Now, we aim to analyze the closed-loop stability of an abridged version of the Banshee microgrid (Figure 1) with two feeders and their associated controllers. Controls include regulation of frequency, active power, islanding of grid connected feeders, and the synchronization of islanded feeders to the grid/one another. With the two-feeder model we have a total of 7 modes that depend on the position of the 4 circuit breakers in the simplified model. The modes are depicted in Figure 2, and they include grid connected mode, fully islanded mode, networked mode, partially islanded mode(s), and back fed mode(s). Each arrow in the mode diagram represents a control action that can move the system from one mode to another by seamlessly opening/closing desired circuit breakers. We use a linearized state-space model of the two-feeder system to tune controller gains and determine how the gains affect stability of both the linearized and full-order systems. The results of this tuning for point of interconnection (POI) power control in grid connected (GC) mode are shown in Figure 3. Using the linearized two feeder model we identified that the POI control gain should be below 52.55 to ensure stability. We then compared this to the full-order C-HIL model and determined that the full order model becomes unstable at 58 but has an undesirable oscillatory response past 52.55. Therefore, we have shown that gain tuning of the linearized system can be helpful in informing the gain tuning of the full order model. This research is funded by the U.S. Department of Energy.

Aidan F. Rodgers

B.S.: May 2024

M.S.: May 2026, University of Illinois Urbana-Champaign

Status: Working towards Ph.D. at University of Illinois Urbana-Champaign

Professional Interests: Power electronics, hybrid switched-capacitor converters

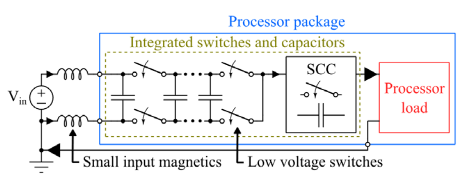
A Multilevel Current-Sourced Converter for Integrated Data Center Point-of-Load Conversion

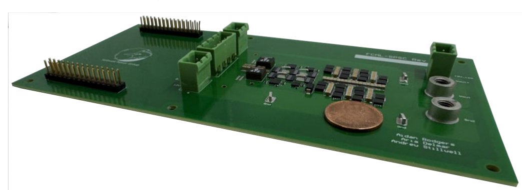
Aidan F. Rogers with Advisor Andrew Stillwell

Supported by Grainger CEME

ABSTRACT

Data centers require power delivery at a low voltage and a very high current, necessitating high power density and high efficiency point-of-load (PoL) conversion. As the power demand of data centers increases, processors must include more pins for power delivery. In-package integration of the point-of-load converter directly with the processor could reduce the current that must be delivered to the processor package, simplifying the power delivery network. Current-sourced hybrid switched-capacitor converters (SCCs) have recently been proposed for integrated PoL conversion. This design approach could allow for magnetic components to be connected externally at the input, while the rest of the converter can be more feasibly integrated in-package. This research proposes a current-sourced hybrid SCC with an input inductor flying capacitor multilevel (FCML) converter as an input stage, shown in Figure 1. By implementing a multilevel input stage, the input inductors experience a low current ripple, allowing for small input inductors. A 48 V to 3 V, 100 W prototype with a 4-level input inductor FCML input stage and a 4:1 series-parallel SCC output stage is demonstrated in hardware, shown in Figure 2, using discrete components. The hardware implementation exhibits a peak efficiency of 93.9% and a power density of 134 W/in3.





Anjana Jayasanka Samarakoon

B.S.:	December 2018, University of Moratuwa, Sri Lanka
M.S.:	May 2022, University of Illinois Urbana-Champaign
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Electric Machine Design, Insulation System Design and Dielectrics

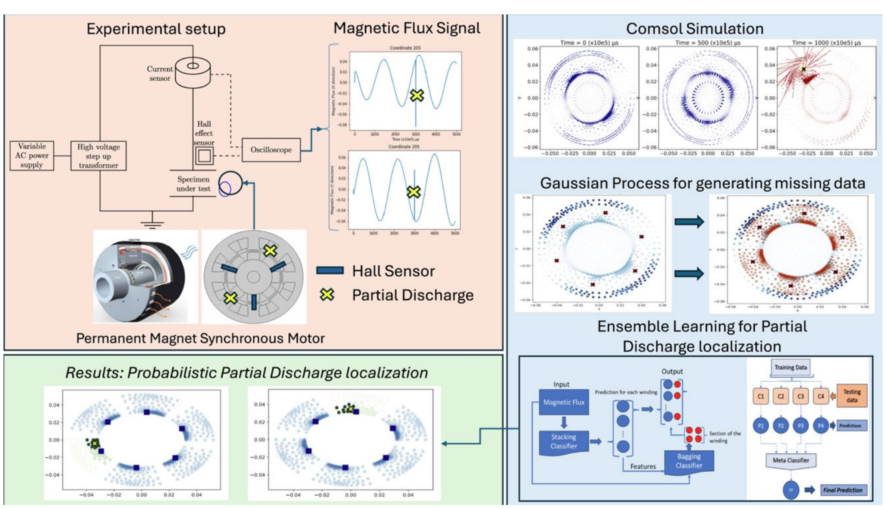
Investigation of Partial Discharge and Thermo-Mechanical Aging in Electric Aircraft Motor Insulation Systems

Anjana J. Samarakoon with Advisor Kiruba S. Haran

Supported by NSF and POETS

ABSTRACT

This work experimentally investigates insulation reliability challenges in high-power-density electric aircraft propulsion motors under representative thermal and environmental operating conditions. The study focuses on partial discharge inception voltage (PDIV) behavior, thermo-mechanical insulation aging, and electromagnetic interference (EMI) characteristics in inverter-fed motor systems. Impregnated random-wound motorette and twisted-pair specimens were subjected to thermal cycling up to 4000 cycles while periodically measuring PDIV under atmospheric and reduced-pressure conditions. The results demonstrate that proper vacuum pressure impregnation can increase the PD-free operating voltage by more than five times compared to unimpregnated windings, while thermo-mechanical stresses generated during thermal cycling gradually reduce PDIV due to material expansion mismatch between copper, enamel, and epoxy insulation systems. In parallel, a high-altitude test chamber capable of reproducing pressures corresponding to altitudes up to 35,000 ft was commissioned to investigate partial discharge and EMI behavior in a 300 kW



slotless permanent magnet aircraft propulsion motor. Baseline PD measurements confirmed PD-free operation below 1 kV under sinusoidal excitation, while additional experiments investigated the interaction between inverter-generated high dv/dt excitation, conducted EMI, and PD activity under reduced-pressure conditions. The experimental findings contribute toward improved insulation lifetime modeling and reliability assessment methods for future electric aircraft propulsion systems.

Yaokun Shi

B.S.: May 2022, University of Illinois at Urbana-Champaign

Status: Working towards M.S. at University of Illinois Urbana-Champaign

Professional Interests: Magnetic Resonance Imaging, Machine Learning

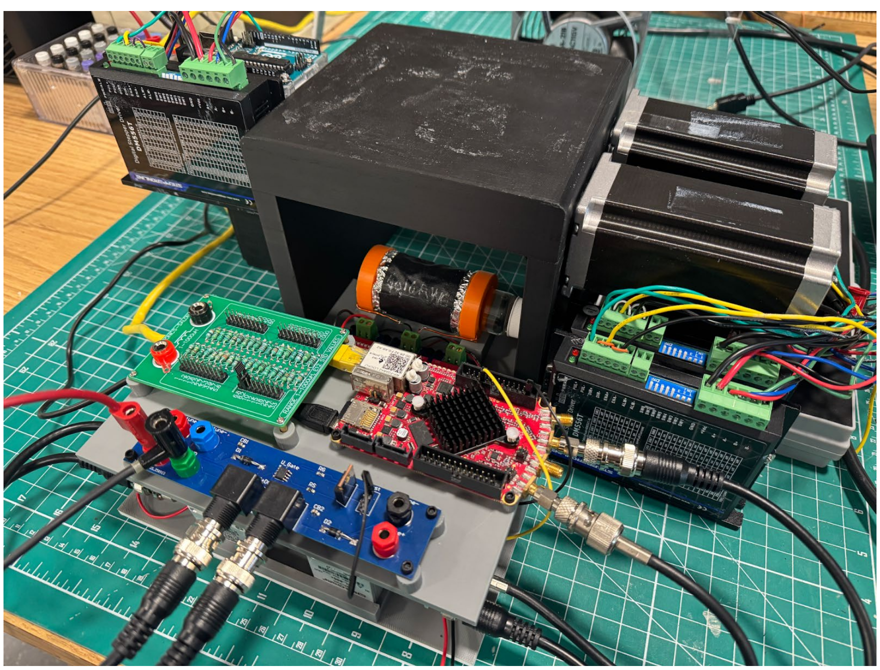
Towards Miniaturization of MRI Devices: Roadmap, Challenges, and Progress

Yaokun Shi with Advisor Prof. Kiruba S. Haran

Supported by Grainger CEME

ABSTRACT

Portable low-field MRI systems have advanced significantly in recent years, driven by their lower cost, greater accessibility, and increasing image quality enabled by machine learning-based reconstruction and post-processing methods. Recent research has further demonstrated that spatial encoding can be achieved without conventional gradient coils by intentionally exploiting magnetic field inhomogeneity. Building on this concept, this work investigates a more unconventional encoding strategy based on rotating permanent magnet arrays. Rather than viewing field inhomogeneity as a drawback, the proposed approach leverages it for spatial encoding while enabling a semi-open, single-sided imaging geometry suitable for a broader



range of applications. A dedicated machine learning pipeline is then used to generate denoised and super-resolved images, improving image quality toward clinically meaningful performance.

The rotating magnet arrays, combined with RF excitation at multiple center frequencies, produce volumetric signals that can be back-projected to reconstruct the final image. Magnetic field maps are obtained through finite element analysis (FEA), and a prototype system incorporating a custom-built RF coil was designed, constructed, and experimentally evaluated. Both simulation and experimental results validate the feasibility of the proposed imaging approach, while ongoing efforts focus on optimizing signal acquisition and reconstruction quality. In addition, two machine learning methods targeting denoising and super-resolution were developed and validated, demonstrating substantial improvements in image fidelity compared with existing state-of-the-art techniques. Although in early development, this portable MRI prototype demonstrates the promise of compact, low-cost MRI systems for rapid point-of-care imaging applications.

Eric Silk

B.S.:	Electrical Engineering, University of Idaho, Dec. 2016
M.S.:	Applied Mathematics, University of Washington, Dec. 2021
Status:	Working towards Ph.D. at University of Illinois Urbana-Champaign
Professional Interests:	Protection, Control, and Security of Power and Industrial Automation Systems; Machine Learning and Optimization; Software Engineering

Secure Distributed Control Algorithms for Microgrids

Eric Silk with Advisor Prof. Alejandro Domínguez-García

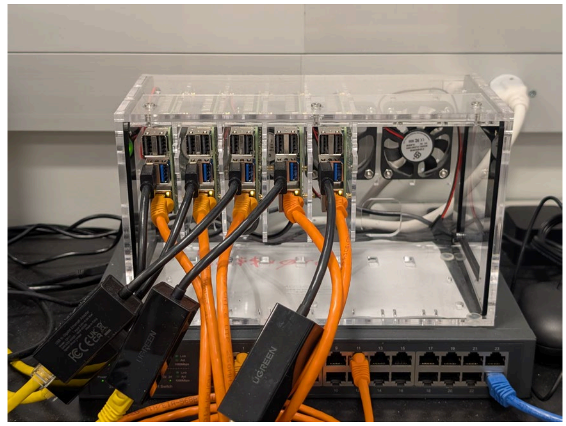
Supported by Department of Energy's CyDERMS project

ABSTRACT

As distributed energy resources (DERs) continue to see increased utilization in the modern grid, the use of distributed controls becomes increasingly necessary for their operation. A promising family of algorithms are known as consensus algorithms – in particular, we rely heavily on Ratio Consensus (RC) and Min-Max Consensus (MMC), including a new variant known as Shadowbanning Ratio-Consensus.

The goal of this project is to enable decentralized control of generation resources in microgrids, improving resiliency by removing the single point of failure in centralized controller. Key controls implemented include secondary voltage control, secondary frequency control, active and reactive power over intertie regulation, Regulation D following, islanding, and resynchronization for reconnection to the bulk grid. The use of shadowbanning ratio-consensus has enabled runtime verification of the calculations using a mathematical invariant. This in turn enables participants to identify malicious or mis-operating participants, improving the security and resiliency of the controls. We have demonstrated all controls except

resynchronization and islanding using a realtime, controller hardware-in-the-loop (CHIL) system provided by Typhoon HIL.



The software to enable this has been developed in Python, chosen because of its ease of implementation without undue performance loss. Architecturally, we have relied heavily on composition and inheritance to enable easy code re-use and extension. Long term plans are to implement most of the algorithmic consensus primitives in Rust, while providing Python bindings for end users if desired.

Nicole M. Stokowski

B.S.:	May 2022, University of Berkeley
M.S.:	May 2024, University of Illinois at Urbana-Champaign
Status:	Working towards Ph.D. at University of Illinois at Urbana-Champaign
Professional Interests:	Power Electronics, Electrification, and Renewable Energy

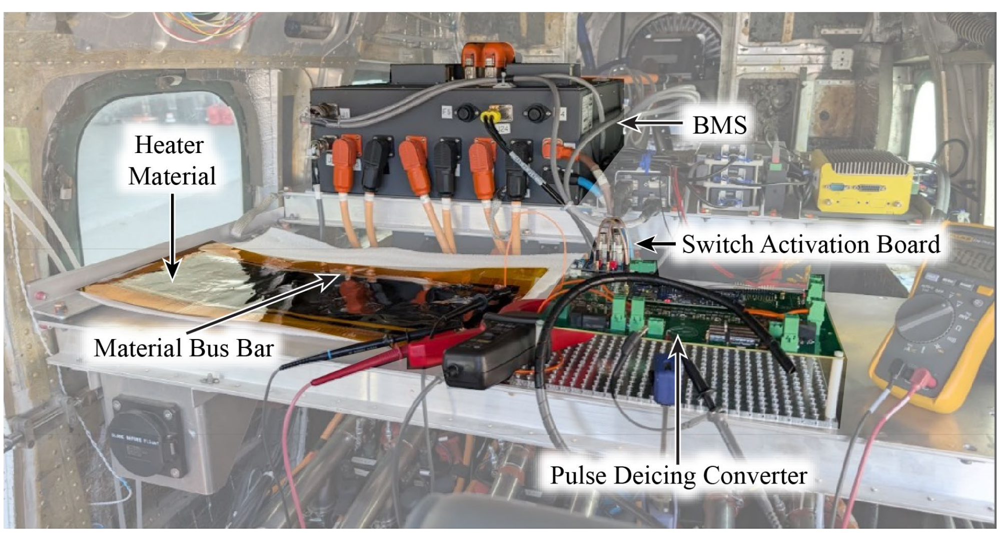
DC-DC Converter for Electric Aircraft Wing Deicing

Nicole Stokowski with Advisor Asst. Prof. Andrew Stillwell*

Supported by ARPA-E, Department of Energy

ABSTRACT

Ice formation and accumulation on aircraft is a major problem for the aviation industry. Icing is directly responsible for fatal aircraft incidents, negatively impacting the safety of air travel and requiring expensive, inefficient, and sometimes ineffective de-icing strategies to be employed both pre-flight and during flight. Current research at the university is being conducted to develop a method of electro-thermal pulse deicing capable of efficiently and rapidly removing ice from the exterior of an aircraft during on-ground, takeoff, and in-flight operation. This research focuses on the design and implementation of a high-power dc dc converter stage on-board the aircraft that is responsible for directing power from the on-board batteries to sections of the



aircraft wings for deicing. Special design considerations are made regarding converter power density and weight, in addition to efficiency. The converter design adheres to the operating range limits of the on-board battery and clearance and creepage constraints for aerospace, as well as heater-material power requirements (based on heater material properties, geometry, and layout).

The pulse deicing converter shown has been thoroughly bench tested, to prove baseline operation (startup, pulsing, and shutdown), as well as fault operation (ability to shutdown safely in the event of a fault). Further testing of the prototype in elevated ambient temperatures, and in the presence of mechanical shocks and vibrations, was performed to ensure operability under stressful environmental conditions. Finally, startup, pulsed operation, and shutdown were executed in a successful ground test. The pulse deicing converter was attached between the on-board battery system of an airframe (for input power) and the heater material load.

Andrew Vithoulkas

B.S.: May 2025, University of Virginia

Status: Working towards M.S. at University of Illinois Urbana-Champaign

Professional Interests: Electric Transportation, Machines, Renewable Energy Applications

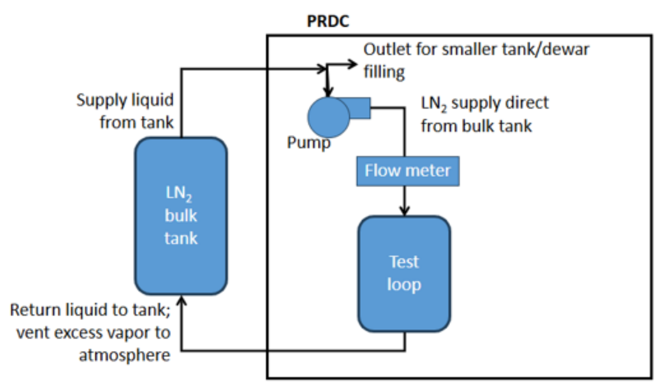
Design and Selection of a Bulk LN_2 Tank System for Superconducting Machine Testing

Andrew Vithoulkas with Advisor Prof. Kiruba Haran

Supported by Grainger CEME

ABSTRACT

The aviation industry faces distinct challenges to electrify single-aisle commercial aircraft. NASA has established targets for the power density of electric machines in order to compete with conventional propulsion sources. Most already available permanent magnet machines today do not meet these targets, which is why research into cryogenically cooled superconducting machines with a focus on aircraft propulsion has become popular. Superconducting machines require specialized equipment to be able to test and operate. Previously, smaller liquid nitrogen (LN2) tanks were rented to perform testing of such machines, but as research grows and the CHEETA motor is to undergo testing, a larger and more versatile LN2 system must be built. This work will choose a suitable bulk LN2 tank for the POETS lab to function as a proper superconducting machine test center.



Yijin Wang

B.S.: May 2019, University of California, Berkeley

M.S.: December 2023, University of Illinois Urbana-Champaign

Status: Working towards Ph.D. at University of Illinois Urbana-Champaign

Professional Interests: Control, Game Theory, Optimization, Data Science

Pricing Problems in Adoption of New Technologies

Yijin Wang with Advisor Prof. Subhonmesh Bose

Supported by Grainger Foundation and National Science Foundation

ABSTRACT

We propose a generalization of the Bass diffusion model in discrete-time that explicitly models the effect of price in adoption. Our model is different from earlier price-incorporated models and fits well to adoption data for various products. We then utilize this model to study two decision-making problems. First, we provide a series of structural results on optimal pricing strategies to maximize profits from product sales by a monopolist over a finite horizon. We fully characterize the optimal pricing strategy in the single-period problem, and establish several structural properties of the same for the multi-period counterpart. Second, we study a Stackelberg game between a policy-maker and a monopolist, where the former seeks to maximize adoption through rebates, while the latter focuses on profits. For this problem, we analytically characterize crucial properties of the equilibrium path of the single-period game, and demonstrate how they carry over to the multi-period variant.

Table 1: Model Fit Performance Results

	NRMSE	R^2
Air Conditioners	0.0661	0.9956
Television	0.0650	0.9958
Dryers	0.1243	0.9845
California Solar Data	0.1727	0.9702

Mudith Withmaralage

B.S.: May 2023, University of Moratuwa, Sri Lanka

Status: Working towards Ph.D. University of Illinois Urbana-Champaign

Professional Interests: High Power Density Electric Machines, Power Electronics,

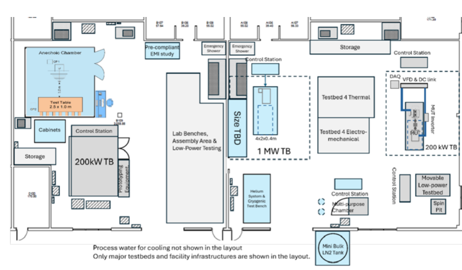
Electromagnetic Interference of WBG Motor Drive Systems and Motor Development Impacts on EMI

Mudith Withmaralage with Advisor Prof. Kiruba S. Haran

Supported by Grainger CEME

ABSTRACT

Wide-bandgap (WBG) power semiconductor devices such as SiC and GaN enable higher switching frequencies, faster voltage transitions, and higher power density in modern motor drive systems. However, the steep dv/dtdv/dtdv/dt and di/dtdi/dtdi/dt associated with WBG switching significantly increase electromagnetic interference (EMI), creating new challenges for electric propulsion systems and high-power electrified platforms. Fast switching events excite high-frequency currents through parasitic capacitances and inductances in the inverter, cables, and motor, altering EMI propagation mechanisms within the motor-drive system. These effects are particularly important in emerging high-specific-power machines with reduced inductance and increased parasitic coupling. This project investigates the electromagnetic interference behavior of WBG motor drive systems and examines how electric machine design influences EMI generation and propagation. In addition to modelling and analysis. It also focuses on the development of experimental measurement infrastructure for EMI and electromagnetic compatibility (EMC) of motor-drive systems. This includes the design and implementation of a pre-compliance EMI/EMC testing environment with specialized measurement equipment such as semi-anechoic chamber, line impedance stabilization networks (LISNs), EMI test receivers, current probes, antennas, and controlled measurement setups. These facilities enable systematic investigation of conducted and radiated emissions in high-power WBG motor drives and support the development of EMI-aware motor design methodologies for next-generation electric propulsion systems.



Brian Wolhaupter

B.S.:	May 2022 University of Illinois Urbana-Champaign
M.S.:	December 2024, University of Illinois Urbana-Champaign
Status:	Working towards Ph.D. University of Illinois Urbana-Champaign
Professional Interests:	High Power Density Electric Machines, Power Electronics, and Thermal Management

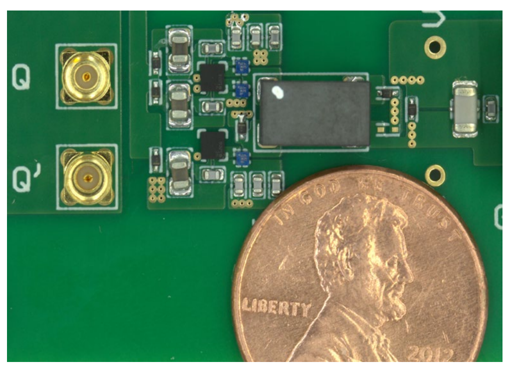
Cryogenically cooled inverters for superconducting electric machines

Brian Wolhaupter with Advisor Prof. Kiruba S. Haran

Supported by Grainger CEME

ABSTRACT

Silicon carbide FETs are commonly used for multi-kilowatt to low megawatt scale inverters, but they do not operate efficiently at the cryogenic temperatures required by fully superconducting electric machines. Therefore, they must be physically separated from the machine, limiting the power density and efficiency of the overall powertrain. Additionally, the cryogenic temperatures cause some integrated circuits to stop working. This project is developing an inverter designed to be integrated with superconducting machines. Over the past year, work has been focused on powering the gate drivers for switches that are not ground referenced, and now the project is moving on to producing a small scale prototype.



7. LABORATORY FACILITIES

The Power Area has assembled some of the nation's finest facilities for experimental and computer-based research and teaching. Both undergraduate and graduate students can take advantage of these facilities.

The **Grainger Power Engineering Software Laboratory** Located in rooms 4038 (workstations 1 – 5) & 4068 (workstations 1 – 5) Electrical and Computer Engineering Building. The Software Laboratory has nine advanced personal computers. All stations are connected to the campus network and Internet.

A major objective of the laboratory is to develop an extensive library of commercial software and large-scale databases for power area applications. Some of the commercial software packages currently in use include:

- **Mathematica / Wolfram** (advanced symbolic mathematics, fully integrated technical computing) Mathcad / PTC (Industry standard for engineering calculations)
- **MATLAB / MathWorks** (MATrix LAB, technical computing)
- **Simulink** (Matlab package, graphical simulation, model-based design, dynamic and embedded)
- **SimElectronics** (Simulink Toolbox, Model and simulate electronic and electromechanical systems)
- **SimPowerSystems** (Simulink Toolbox, Modeling and simulating electric power systems)
- **xPC Target** (Simulink, Rapid control prototyping and hardware-in-the-loop)
- **PLECS** (Simulink, fast simulation of electrical and power electronic circuits)
- **acslX(treme) / Aegis** (general-purpose simulation environment)
- **LabVIEW** (Visual programming language, lab bench dynamometer control program)
- **PSS/E / Siemens PTI** (Power System Simulator for Engineering, electrical transmission)
- **RISKSYM / Henwood** (package for energy market analysis)
- **PowerWorld** (Power systems analysis, power market analysis, locational marginal price analysis)
- **Power System Tool Box** (PST Version 2.0)
- **ANSYS / Ansoft** (FEA finite element analysis modeling)
- **Maxwell** (ANSYS, EM Field Simulation for High-Performance Electromechanical Design)
- **RMxprt** (ANSYS, Design Software for Electric Machines)
- **Simplorer** (ANSYS, simulation of electrical, electromechanical, electromagnetic, power, thermal)
- **Flux / Magsoft** (Electromagnetic and Thermal Physics Simulation)
- **Eagle / CadSoft** (Schematic capture and PCB design)

- **SAM / NREL** (System Advisor Model, PV Photovoltaic system cost estimation)
- **Altera Quartus & DSP Builder** (FPGA software & Digital Signal Processing tool)
- **SPEED / STAR-CCM+ / CD-adapco / Siemens** (design and analysis of electric machines)

The **Grainger Electrical Machinery Laboratory** is located in 4024 ECEB. This facility is primarily for undergraduate teaching and is used for ECE 431 (Electric Machinery), ECE 469 (Power Electronics), many ECE 445 (Senior Design) groups, and student groups and projects, including Engineering Open House (EOH), Future Energy Challenge (FEC), Solar Decathlon (Solar House), Wide Impact Developmental Engineering (WIDE), Society of Women Engineers (SWE), Formula Electric Car, and Fuel Cell Electric Car. With many power and energy teaching labs cutting back on hardware and machines, or going totally software and virtual because of fiscal restraints, the Grainger lab has been able to maintain and increase our large inventory of test machines and equipment. Ten self-contained machinery workstations are available. Each has an integral horsepower machine set with a servo-based dynamometer. The lab benches are equipped with digital watt meters, oscilloscopes, signal generators, power supplies, and speed / torque displays. The equipment is suitable for the study of induction, synchronous, and DC machines. Small portable machine sets are used to introduce stepper motors and brushless DC machines. Transformers, resistor boxes, capacitor boxes, SCR, and power FET units are provided to support a full range of experiments in all aspects of power and power electronics. The facility has a dedicated three-phase supply 120/208 Vac (225 kVA) and 240 Vdc (+/- 120 Vdc) 80 A supply.

The **Advanced Power Applications Labs** is located in 4020 and 4026 ECEB. These research labs have motor test benches with precision dynamometers. The benches can access 208 Vac 3-phase, 480 Vac 3-phase, and 240 Vdc. These labs serve as a research facility for all hardware aspects of power electronics, machines, and power systems. Additional equipment is available for the study of harmonic effects, high-performance switching converters, and digitally controlled converters/drives. Computers are available throughout the laboratory for automation of experiments using LabVIEW and Matlab/ Simulink/Real-Time Toolbox. This fourth-floor lab has direct access to the roof to allow for solar panel and weather station placement.

The **Power and Energy Computer Research Lab** Located in 4076 ECEB. This laboratory provides the user with a controller hardware-in-the-loop (C-HIL) testbed. The C-HIL testbed is used to achieve: (1) high-fidelity modeling and real-time simulation of an electric power grid, (2) the synthesis of coordination and control algorithms on several controller hardware platforms, and (3) the testing and validation of the resulting coordination and control technologies. The electric power grid is modeled using the Typhoon HIL Platform, and the Arduino Due, Raspberry Pi, and National Instruments cRIO controller hardware platforms are employed in the testbed. The hardware used in this testbed includes:

A set of Arduino Due microcontrollers, each coupled with a W5100 Ethernet shield and an XBee module.

- Eight Typhoon HIL 402 unit
- Four Typhoon HIL 603 units
- A National Instruments cRIO 9068 with NI PS-15 power supply
- Two 24 Port Gigabit Switches

This comes with a set of software packages installed on two advanced personal computers as listed below:

- Arduino IDE Software
- LabVIEW
- Typhoon HIL testing software
- MATLAB

8. DIRECTORY

THE UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
Grainger College of Engineering

Rashid Bashir, Dean
(217) 333-2150
rbashir@illinois.edu

Philippe Geubelle, Executive Associate Dean
(217) 244-7648
geubelle@illinois.edu

Laura Child, Associate Dean for Advancement
(217) 244-6566
llchild@illinois.edu

Michael J. Devocelle, Associate Dean for Finance and Administration
(217) 333-2151
mdevocel@illinois.edu

Jonathan Makela, Associate Dean for Undergraduate Programs
(217) 265-9470
jmakela@illinois.edu

Daniel J. Bodony, Associate Dean for Graduate, Professional and Online Programs
217) 244-3844
bodony@illinois.edu

Address: University of Illinois College of Engineering
306 Engineering Hall
1308 W. Green St
Urbana, IL 61801
Fax: (217) 244-7705
www.engr.illinois.edu

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Administration

Jennifer T. Bernhard, Department Head
(217) 333-0293
jbernhar@illinois.edu

Kent D. Choquette, Associate Head for Graduate Student Affairs
(217) 265-0563
choquett@illinois.edu

Jonathon K. Schuh, Associate Head for M. Eng Programs
(217) 300-7091
schuh4@illinois.edu

Wenjuan Zhu, Associate Head for Graduate Programs
(217) 244-9456
wjzhu@illinois.edu

Nicole E. Johnson, Assistant Head for Administration
nejohn@illinois.edu

Heather Finneran Vazquez, Senior Director of Advancement
(217) 333-2517
hfv@illinois.edu

Nikki Slack, Alumni and Donor Relations Coordinator
(217) 265-4317
nslack@illinois.edu

Todd Sweet
Director of Constituent Engagement
(217) 333-5943
tmsweet@illinois.edu

POWER AND ENERGY SYSTEMS AREA

Jeremy A. Sykes, Office Manager
(217) 333-5491
jeremys@illinois.edu

Kevin Toomey, Coordinator
Grainger Center for Electric Machinery
and Electromechanics
(217) 333-6034
ktoomey2@illinois.edu

Prof. Arijit Banerjee
(217) 300-5319
arijit@illinois.edu

Prof. Alejandro Domínguez-García
(217) 333-3953
aledan@illinois.edu

Emeritus Prof. George Gross
(217) 244-6346
gross@illinois.edu

Prof. Kiruba Haran
(217) 244-1838
kharan@illinois.edu

Emeritus Prof. Philip Krein
(217) 333-4732
krein@illinois.edu

Prof. Olga Mironenko
(217) 244-5404
olgamiro@illinois.edu

Prof. Jonathan Schuh
(217) 300-7091
schuh4@illinois.edu

Prof. Andrew Stillwell
(217) 300-7400
andrews@illinois.edu

Ulas Coskun, Research Engineer
ucoskun@illinois.edu

Address:
University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering
Electrical and Computer Engineering Building
306 N. Wright Street, MC-702
Urbana, IL 61801
www.energy.ece.illinois.edu

9. CURRENT AFFILIATE CONTACT INFORMATION

S&C ELECTRIC COMPANY

Dr. Michael G. Ennis
S&C Electric Company
6601 North Ridge Boulevard
Chicago, IL 60626-3997
(773) 338-1000
mennis@sandc.com

PREVIOUS AFFILIATES INFORMATION

CONTINENTAL AUTOMOTIVE

Mr. Dennis Stephens
21440 Lake Cook Road
Deer Park, IL 60010
(847) 862-2757
dennis.stephens@continental-corporation.com

EXELON

Ms. Jennifer Sterling
Exelon
Two Lincoln Centre
Oakbrook Terrace, IL 60181
(630) 437-2764
jennifer.sterling@exeloncorp.com

G&W ELECTRIC

Mr. John T. Pederson
G&W Electric Company
305 W. Crossroads Pkwy
Bolingbrook, IL 60440
jpederson@gwelec.com

Mr. James Parejko
G&W Electric Company
305 W. Crossroads Pkwy
Bolingbrook, IL 60440
parejko@gwelec.com

SARGENT & LUNDY ENGINEERS

Ms. Carol Talaronek
Sargent & Lundy Engineers
55 East Monroe Street
Chicago, IL 60603
(312) 269-3578
caroltalaronek@sargentlundy.com
Or contact
Linda Kelnosky
linda.e.kelnosky@sargentlundy.com

Mr. Robert M. Dahlgren
Sargent & Lundy Engineers
55 East Monroe Street
Chicago, IL 60603
robert.m.dahlgren@sargentlundy.com

CITY WATER, LIGHT AND POWER, SPRINGFIELD, IL

Mr. Shaun Anders
City Water, Light and Power
1008 E. Miller Street
Springfield, IL 62702
(217) 789-2120
Shaun.Anders@cwlp.com

10. SELECTED PUBLICATIONS (CHRONOLOGICAL ORDER)

[1] Mironenko, O., Alvarez, J., & Shao, Y. V. (2025, June). "Work In Progress: Promoting Undergraduate Student Success through Faculty Mentoring." *ASEE Annual Conference & Exposition*, June 2025. doi: 10.18260/1-2—57438.

[2] P. T. Krein, R. Mahony and R. E. Liem, "Expectations and Performance of Ubiquitous Electric Vehicle Charging Alternatives," *2025 IEEE/AIAA Transportation Electrification Conference and Electric Aircraft Technologies Symposium* (ITEC+EATS), Anaheim, CA, 2025, pp. 1-7, doi: 10.1109/ITEC63604.2025.11098005.

[3] Shao, V. V., Alvarez, J., & Mironenko, O. (2025, June). "Work In Progress: Gamification as an Engagement Tool in ECE Courses." *ASEE Annual Conference & Exposition*, June 2025, doi: 10.18260/1-2—57415.

[4] U. Bong and K. S. Haran, "Assessment on PMSC Machines (Permanent Magnet Rotor and Superconducting Stator) to Ship Propulsion Application," 2025 *IEEE/AIAA Transportation Electrification Conference and Electric Aircraft Technologies Symposium (ITEC+EATS),* Anaheim, CA, June 2025, pp. 1-6, doi: 10.1109/ITEC63604.2025.11097990.

[5] C. N. Hadjicostis and A. D. Domínguez-García, "Shadow Banning in Directed Graphs for Fault-Tolerant Averaging," *2025 European Control Conference (ECC)*, Thessaloniki, Greece, June 2025, pp. 1055-1061, doi: 10.23919/ECC65951.2025.11187028.

[6] J.A. Taylor and A.D. Domínguez-García, "Active Fault Detection in Static Systems," in IEEE Transactions on Automatic Control, vol. 70, no. 8, pp. 5523-5529, Aug. 2025, doi: 10.1109/TAC.2025.3547848.

[7] I. Guzel, R. Zhang, "Power System State Estimation by Phase Synchronization and Eigenvectors," *IEEE Transactions on Control of Network Systems*, vol. 12, no. 3, Sept. 2025.

[8] N. Miljkovic, T. Foulkes, P. Birbarah, T. Gebrael, A. Stillwell, R. Pilawa-Podgurski, "Immersion cooling with water-based fluid using nano-structured coating," U.S. Patent Office, Patent 12426206, Sept. 23, 2025.

[9] U. Bong, T. Balachandran, N. Salk, S. Huq, P. Bauer and K.S. Haran, "A Study on Scalability of Superconducting Rotating Machines with Passive Quench Protection Approach," *2025 IEEE Energy Conversion Conference Congress and Exposition (ECCE)*, Philadelphia, PA, Oct. 2025, pp. 1-8, doi: 10.1109/ECCE58356.2025.11260090.

[10] G. T. McKechnie, A. Domínguez-García, "Phase Difference Control of Single-Phase Grid Forming Inverters for Fault Detection," North American Power Symposium, Oct. 2025, doi: 10.1109/NAPS66256.2025.11272435

[11] S. Raju, B. Johnson, A. D. Domínguez-García and S. Dhople, "On Balancing Phase Angles with Droop Control," in *IEEE Transactions on Power Systems*, Oct. 2025. doi: 10.1109/TPWRS.2025.3618915.

[12] M.T. Khalid, A. Witmer, "Prompt Engineering for Large Language Model-Assisted Inductive Thematic Analysis," *Social Science Computer Review*, Oct. 2025. doi: /10.1177/0894439325138809

[13] Y. Wang, S. Bose, "Pricing Problems in Adoption of New Technologies," *arXiv.org,* Oct. 2025.doi: /10.48550/arXiv.2510.21951

[14] J. Feldman, V. Ganesan, S. Uan-Zo-Li, A. Shah, S. Robieson, W. Stautner, K.S. Haran, N. Miljkovic, "Cryogenic flow boiling heat transfer in subcooled, near saturated, and high vapor content flow," *International Journal of Heat and Mass Transfer*, Vol. 256, Part 2, Nov. 2025, 128060, doi: /10.1016/j.ijheatmasstransfer.2025.128060.

[15] A. Maheshwari, S. Chaubal, D. Mazumdar, P. Bajaj, A. Banerjee, P.T. Krein, "Modulation Depth Maximization for High Phase Count Drives with Emphasis on Variable Pole Operation" in *IEEE Transactions on Industry Applications*, vol. 61, no. 6, pp. 9295-9306, Nov.-Dec. 2025, doi: 10.1109/TIA.2025.3571361.

[16] A. Bali, X. Zhang, A. Bose, K.S. Haran and A. Stillwell, "Analysis and Design of a Multilevel Interleaved Hybrid Active Neutral Point Clamped Inverter for Electric Aircraft Propulsion," in *IEEE Open Journal of Power Electronics*, vol. 7, pp. 209-225, Dec. 2025, doi: 10.1109/OJPEL.2025.3644673.

[17] A. Banerjee, "IEEE PELS University Lab Kits Democratize Hands-On Power Electronics Education [Expert View]," in *IEEE Power Electronics Magazine*, vol. 12, no. 4, pp. 119-124, Dec. 2025, doi: 10.1109/MPEL.2025.3620519.

[18] M.T. Khalid, M.V. Benito, A. Rzonca, and A. Witmer. 2025. "An Introduction to "Alternative Fuel Grades" for Electric Vehicle Fast Charging" *Electricity* 6, no. 4: 62. doi: /10.3390/electricity6040062

[19] S. Kohtz, A. Renteria, A. Rodriguez, A. Lalwani, A. Samarakoon, K.S. Haran, D. Senesky, P. Wang, "Partial discharge diagnosis in electric motor with digital twin model-enhanced ensemble learning," *Reliability Engineering & System Safety*, Vol. 264, Part B, Dec. 2025, 111370, doi: /10.1016/j.ress.2025.111370.

[20] M. Breschi, K.S. Haran et al. "A strategic roadmap for implementing superconductivity towards zero-emission transport," *Supercond. Sci. Technol.* Vol. 39 011001, Jan. 2026. doi: 10.1088/1361-6668/ae34ec.

[21] E. Pontika, P. Laskaridis, P.J. Ansell, K.S. Haran, R. Navaratne, T. Kipouros, "Technology exploration of zero-emission regional aircraft: Why, what, when and how?" Progress in Aerospace Sciences, Vol. 160, Jan. 2026, 101171, doi: /10.1016/j.paerosci.2025.101171.

[22] K.S. Haran, T. Balachandran, N.J. Salk et al. "Aircraft Propulsion Motors with Cryogen-Free Superconducting Rotor" AIAA 2026-0999, *AIAA SCITECH 2026 Forum*, Jan. 2026. doi: 10.2514/6.2026-0999.

[23] S. Link, O. Mironenko, A. Banerjee, J. Schuh et al., "WIP: Teaching Students to Synthesize Knowledge by Recognition of Connections," *2025 IEEE Frontiers in Education Conference (FIE)*, Nashville, TN, Jan. 2025, pp. 1-5, doi: 10.1109/FIE63693.2025.11328297.

[24] K. Layek, S. Armstrong, A. Banerjee, "Effects of Winding Asymmetry on Power Quality in Multiport Integrated Generator Rectifiers," in the *IEEE Journal of Emerging and Selected Topics in Power Electronics*, Feb. 2026. doi: 10.1109/JESTPE.2026.3663113

[25] D. Chatterjee, S. Kapat, P.T. Krein, et al. "Discrete-Time Multivariable PID Design in

Voltage-Mode Boost Converters for Enhanced Performance and Stability," *2026 IEEE Applied Power Electronics Conference and Exposition (APEC)*, San Antonio, TX, Mar. 2026.

[26] A.K. Delmar, M. Khatua, H. Krishnamurthy, and A. Stillwell, "Input-Inductor Cascaded Buck (I2CB) Converter for 48 V IBC Applications," *2026 IEEE Applied Power Electronics Conference and Exposition (APEC)*, San Antonio, TX, Mar. 2026.

[27] S. Kapat, T. Golla, P.T. Krein, "EMI Reduction and Performance Assessment in a Multiphase Buck Converter Using Digital Current Control Techniques Under Periodic Frequency Modulation," *2026 IEEE Applied Power Electronics Conference and Exposition (APEC),* San Antonio, TX, Mar. 2026.

[28] S. Kapat, C. Paul, A. Maulik, P.T. Krein, "A Parametric Discrete-Time Solver for Analysis, Control, and Fast Hardware-in-the-Loop Simulation of Flying Capacitor Multilevel DC–DC Converters" *2026 IEEE Applied Power Electronics Conference and Exposition (APEC)*, San Antonio, TX, Mar. 2026.

[29] S. Sirimanna, M. Vermilyea, B. Roland, T. Balachandran, K.S Haran, "Superconducting Motor with Rotating Multilayer Insulation," U.S. Patent Office, 19320540, Mar. 2026.

[30] S. Sirimanna, B. Roland, K.S Haran, "Superconducting Motor with Truss-Supported Multilayer Insulation," US Patent Office, 19320624, Mar. 2026.

[31] J.S. Aflatounian, S. Subramaniyan, K. Luo, S. Dewanjee, V. Ganesan, O.R. Gittus, E.A. Müller, G. Prentice, M.J. Payne, A. Stillwell, P.V. Braun, N. Miljkovic, "Comparative evaluation of dielectric liquids for single-phase immersion cooling of electronics," *International Journal of Heat and Mass Transfer,* Vol. 265, Apr. 2026, 128765, doi: 10.1016/j.ijheatmasstransfer.2026.128765.

[32] K. Luo, S. Aflatounian, S. Sirimanna, D.H. Parker, T. Balachandran, S. Subramaniyan, K.S. Haran, N. Miljkovic, "Mitigation strategies to reduce the impact of compression on multi-layer insulation performance for cryogenic applications," Applied Thermal Engineering, Vol. 298, Part 2, 130886, Apr. 2026, doi: /10.1016/j.applthermaleng.2026.130886.

[33] S. Aflatounian, K. Luo, S. Sirimanna, Y. Gurumukhi, S. Joshi, D.H. Parker, T. Balachandran, H. Rautela, J. Xiao, K.S. Haran, N. Miljkovic, "Design and development of an apparatus for evaluating multi-layer insulation effectiveness," *Cryogenics*, Vol. 149, July 2025, 104080, doi: 10.1016/j.cryogenics.2025.104080.

[34] U. Bong, T. Balachandran, S. Huq, P. Bauer, J. Xiao and K.S. Haran, "Tests and Analyses on Quench Behavior of Conduction-Cooled No-Insulation Racetrack Coils," in *IEEE Transactions on Applied Superconductivity*, vol. 36, no. 3, pp. 1-5, May 2026, Art no. 4600305, doi: 10.1109/TASC.2025.3620782.

[35] T. Balachandran, K.S. Haran et al., "Superconducting Rotor with Closed-Loop Rotor-Mounted-Cryocooler: Design, Analysis, Assembly Procedure, and Experimental Results," in *IEEE Transactions on Applied Superconductivity*, vol. 36, no. 3, pp. 1-5, May 2026, Art no. 5200505, doi: 10.1109/TASC.2025.3620773.