Centre for Power Electronics Annual Conference held at the University of Sheffield on 8 - 9 July 2025

The Centre for Power Electronics and IMAPS-UK organised the Annual Conference serving the Power Electronics, Machines and Drives (PEMD) Research and Development community, with over 160 people attending over the two days of the in-person event. The Conference featured state of the art presentations from academic and industrial speakers, 1 Sponsors, 12 Exhibitors and 40 poster presentations from Early Career Researchers.

The Conference Chair, Antonio Griffo (University of Sheffield) welcomed participants to the event with an overview of the CPE and an outline of the activities scheduled over the two days of the Conference.

Day 1: Tuesday 8th July 2025

Keynote Presentation 1: Methods for Condition Monitoring and Reliability Testing of SiC and GaN Semiconductor Devices - Status and Prospects - Professor Francesco Iannuzzo, Politecnico di Torino

This keynote addressed primarily modern condition monitoring methods, including new concepts and techniques, useful for the safe operation of modern power semiconductor devices, especially the wide-bandgap ones. Modern testing techniques for reliability, particularly accelerated testing, with a focus on recent packaging for both traditional silicon switches and wide-bandgap devices were reviewed.

The current global scenario was examined, highlighting recent technological advancements, significant developments, and market trends. Then, a more technical section followed, starting from the basic semiconductor equations and exploring selected approaches for power cycling to assess expected time to failure. A presentation of promising condition monitoring approaches specifically for wide-bandgap semiconductor switches was made.

Lecture 1: A 99.79% efficient 11 kVA 400 V cryogenic inverter - Dr Dan Rogers, University of Oxford

The aviation sector is exploring liquid hydrogen as a fuel for carbon-neutral aircraft, with demonstration aircraft expected to fly in the middle of the next decade. Liquid hydrogen is a very effective cryogenic coolant, perhaps enabling operation of key powertrain components at -50 to -200°C and to a 3-8x reduction in the resistivity of copper and the on-state resistance of GaN HEMTs. In principle, this should lead to engineers being able to build drivetrains with efficiencies approaching 99%. This talk presented the results of recent research on the design, construction, and testing of a 400V 11kVA GaN-based inverter that achieves over 99.5% efficiency. It covered design tips for building cryogenic power electronics, discussed a calorimetric approach for measuring efficiency of cryogenic systems, and showcased the final design.

Lecture 2: 80kW SiC dual inverter and contactless power transfer for an open-rotor engine pitch control actuator – Milijana Odavic, University of Sheffield

The more electric aircraft concept drives the shift towards advanced electromechanical actuation solutions. For the highest efficiency an open rotor engine will have the ability to control the pitch of the blades through an electric drive. The two critical power electronics aspects of the proposed powertrain architecture include the contactless power transfer and electric drive for precise actuation capability. The research includes design optimisation of a rotary transformer and associated power electronics based on SiC MOSFET considering high ambient temperature of 120 °C, rotation-induced loading and space and weight constraints.

Lecture 3: X in 1 –the Future of Converter Integration – Pete James, Drive System Design

As power electronics evolve toward greater efficiency, compactness, and functionality, the concept of "x-in-1" integration - combining multiple power converters into a single enclosure is gaining momentum. This talk explored the design, benefits, and challenges of multi-functional converter architectures, such as

integrating onboard chargers, DC-DC converters, inverters, and auxiliary systems into a single module for applications in electric vehicles, renewable energy, and industrial systems.

Shared thermal management, common control architectures, and co-packaging strategies were examined that can reduce system volume, cost, and interconnect complexity, while enhancing overall reliability and power density. A case study from automotive application illustrated real-world performance gains and trade-offs. Attention was given to the role of wide-bandgap semiconductors (SiC, GaN), digital control, and advanced materials in enabling such integration.

A holistic understanding of x-in-1 integration was provided, including electrical, mechanical, and thermal considerations, and how this approach can accelerate system-level innovation. Whether you're designing next-generation EV platforms or modular energy storage solutions, x-in-1 integration presents a compelling path forward in power converter architecture.

Lecture 4: Advancements in Aircraft Hybrid Electric Propulsion System - Nouman Sadiq, Collins Aerospace

Collins Aerospace is at the forefront of developing cutting edge technology to support more electric aircrafts. There have been some interesting and exciting developments in the hybrid electric propulsion system to optimise fuel burn. Collins Aerospace is closely collaborating with AIRBUS to develop next generation single-aisle (NGSA) aircraft. This include moving towards much higher voltage levels, improving power density by using permanent magnet synchronous machines (PMSM) and developing advanced motor control techniques to support different stages of mission profile. These new developments pose some interesting engineering challenges at functional and safety level. This presentation provided an overview of hybrid electric propulsion architecture and new technology being developed to support it.

Lecture 5: GaN Smart Power IC Technology Development - Petar Igic, Coventry University

Similarly to Silicon power technology development (from discrete devices to smart power integrated circuits), the arrival of GaN-based integrated circuits, GaN power transistors monolithically integrated with Hall-effect and temperature sensors, GaN gate drivers and ASICs, will facilitate widespread use of gallium nitride technology for high-volume applications. The GaN Smart Power Integrated Circuit Technology developed by the Universities of Coventry and Glasgow incorporating a normally-off power GaN HEMT with advanced galvanic Hall-effect and temperature sensors was presented. HEMT is a voltage controlled device and on-chip monitoring of its output current is critical for safe and long operation of an electronic system. The galvanic sensor is a GaN Hall-effect device accompanied by signal conditioning circuitry to minimise drift in sensor characteristics at elevated temperatures. This increases functionality, enables a reduction of system volume, reduces cost of assembly, and as chip temperature can be actively compensated, improve reliability and efficiency of the power device. These are fundamental requirements for complex power electronics systems, in particular when installed in limited volume, hostile (high temperature/vibration) environments, such as battery electric and hybrid vehicles for example.

Day 2: Wednesday 9th July 2025

Professor Antonio Griffo introduced the Day 2 agenda. This was followed by an update from the CPE 25 Conference Sponsor – Rohde and Schwarz Ltd

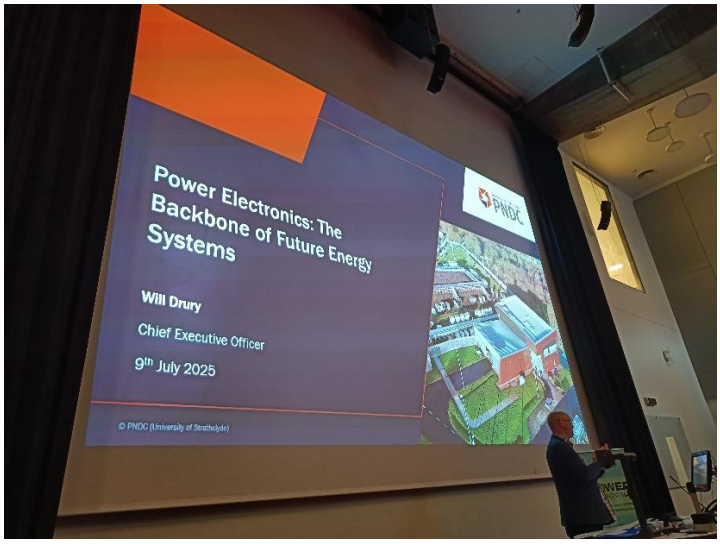
Keynote Presentation 2: The Role of HVDC in Reducing Carbon Emissions – Colin Davidson, GE Vernova

High-Voltage Direct Current (HVDC) is the most high-power application of power electronics. HVDC has been commercially available as a niche technology in power grids for 70 years, first using Line-Commutated Converters and, in the last 25 years, using Voltage-Sourced Converters. However, in the last five years the growth of HVDC has been spectacular, much of it associated with the large-scale integration of renewable energy sources. HVDC has been used for decades to connect remote hydro generating stations to load centres. More recently, HVDC allows offshore wind farms to be built far from shore, where the wind is

stronger and steadier, beyond the maximum distance over which the power can be efficiently transmitted using AC cables. HVDC is now starting to be used for connecting large-scale solar parks to the grid. HVDC also allows long-distance interconnectors to be built between neighbouring power grids so that local fluctuations of renewable energy output can be smoothed out by aggregating power generation over a wider geographical area.

With this growth comes new challenges. The first concerns the transition from point-to-point HVDC links (the established practice)) to multi-terminal HVDC networks. The second concerns how the HVDC converters are controlled, especially in view of the fact that the growth of renewable energy sources means that power grids now contain far less rotating inertia in the form of synchronous machines than was the case 20 years ago. The first challenge involves new protection methods and new types of HVDC equipment, while the second involves new control algorithms for the HVDC converters. Both challenges make HVDC a fascinating and important topic for the industry.

Lecture 6: Power Electronics -- The Backbone of Future Energy Systems - Will Drury, PNDC, University of Strathclyde



Power electronics is rapidly emerging as the cornerstone of modern and future energy systems. As the world shifts toward renewable energy, electric mobility, and smart grids, the ability to efficiently convert, control, and manage electrical power becomes critical. This talk explored how power electronics is enabling this transformation—through innovations in semiconductor materials, converter topologies, and digital control. Attendees gained a clear understanding of the field's growing impact, current research frontiers, and the vital role engineers will play in building resilient, low-carbon energy infrastructures. The session aimed to inform, inspire, and empower the next generation of innovators.

Oral Presentations from PhD Students

The following 6 presentations were made by PhD students:

- Optimising MOSFET Selection for EMC-C Automotive Applications by Sasha Cazzitti, University of Manchester
- Magnetic-Field-Based Switching Pattern Optimization for Active Gate Driving in SiC Power by Yuxiao Bai, University of Edinburgh
- A 2kV/2kA Capable Continuous Circulating Current Testing Facility for DC-AC Power Converters by Max Watson, University of Edinburgh
- Performance Evaluation of a 1200 V Si Trench Clustered IGBT and SiC MOSFET Hybrid Power Switch by Alireza Sheikhan, University of Sheffield

- A Fast Short Circuit Detection Method for SiC MOSFETs based on Drain Voltage Swing by Zekun Li, University of Leicester
- Real-time Condition Monitoring Technique for SiC MOSFET Gate Oxide Degradation Based on Turn-Off Delay Time by Mojtaba Jazayeri, Queen Mary University of London

Prizes awarded to PhD Students for Oral Presentations donated by the Centre for Doctoral Training in Sustainable Electric Propulsion

- 1st prize – Zekun Li, University of Leicester
- 2nd prize – Yuxiao Bai, University of Edinburgh
- 3rd prize – Alireza Sheikhan, University of Sheffield

CPE 2025 Conference 1st Prize Oral Presentation awarded to Zekun Li of University of Leicester presented by Professor Xibo Yuan (Director of CPE) and Professor Antonio Griffo (University of Sheffield)

Lecture 7: Advanced Embedded Packaging for WBG - Jonathan Jones, RAM Innovations

Wide bandgap (WBG) semiconductors like silicon carbide (SiC) and gallium nitride (GaN) offer superior electrical, thermal, and frequency performance compared to silicon, enabling higher voltages, greater efficiency, and faster switching for power electronics in electric vehicles and renewable energy. To fully leverage these benefits, embedding technologies that integrate semiconductor devices directly into printed circuit boards or substrates are essential.

Embedding reduces parasitic inductance, improves heat dissipation, and enhances reliability while enabling more compact, high-power-density modules. This supports the ongoing demand for miniaturisation and efficiency in power electronics. RAM Innovations, originally a skunkworks for Infineon (2011–2017), now focuses on advanced packaging techniques for WBG semiconductors in power applications. With three years of development in embedded die packaging, die handling, and low-cost sintering, RAM has achieved highly automated, low-cost manufacturing of heterogeneous 3D packages. This approach is ideal for companies seeking in-country packaging or licensing RAM's intellectual property.

As WBG devices operate at higher voltages and frequencies, embedding technologies like those developed by RAM are vital to unlocking their full potential. Continued research aims to optimise materials, processes, and packaging to meet the rigorous demands of next-generation electronic systems.

Lecture 8: VHF Power Electronics at Imperial: Technology and Commercialisation in Wireless Power - Dr Paul Mitcheson, Imperial College

This presentation discussed the value proposition of wireless power transfer (WPT) and its potential applications. It highlighted the benefits of WPT, such as powering or charging mobile devices in hard-to-reach places, like micro mobility solutions and medical implants, where traditional charging methods are impractical. WPT can also improve reliability and safety by eliminating issues like corroded or improperly connected contacts and sparks in hazardous environments. Additionally, it offers convenience by enabling automatic power connections and removing the need for human intervention, which can lead to direct cost savings. While WPT is not yet as ubiquitous as wireless communications, it is gaining traction in some common applications, such as wireless charging, and is essential in high-value applications like medical implants. The killer application for near-field WPT may not be in the consumer area but could be in industrial robotics. It was also mentioned that MHz inductive power transfer (IPT) is much lighter and more capable than kHz, making it suitable for various applications.

Lecture 9: Exploiting University Innovation – Stuart Calverley, Magnomatics

Innovation is widely regarded as essential for company survival, it is the basis for thwarting competition and creating value. In its full form innovation extends beyond the development of new technologies, it is a process, or the results of a process where new products and technologies are brought to market. By creating a pipeline of novel and inspiring technologies, Universities play an essential role in this process, but taking a technology to market is not a given, and many outstanding ideas do not fulfil their potential.

Innovation, new ideas and products do not simply expand some global portfolio, they tend to replace something with a framework of “creative destruction”. To do this it must be better than the existing alternative, but this is not easy to achieve or demonstrate, and beyond the initial invention this is the second challenge of innovation.

This presentation covered the process of innovation that lies after the initial invention. While no single recipe for success for this second phase can ever be conceived, this presentation covered the experiences gained in the formation of a spin out company and the journey taken to demonstrate technology and ultimately become the manufacturer.

Lecture 10: Power Electronics Challenges for Marine Wave Energy Generation – Judith Apsley, University of Manchester

As competition for wind farm sites increases, marine wave energy offers a possible solution. Global resources of 2 TW are similar to wind, and complementary, with peak wave power lagging peak wind. Despite many prototypes, there are few commercial devices, with only 400 kW deployed in Europe in 2022. However, sharing infrastructure with floating offshore wind turbines improves viability.

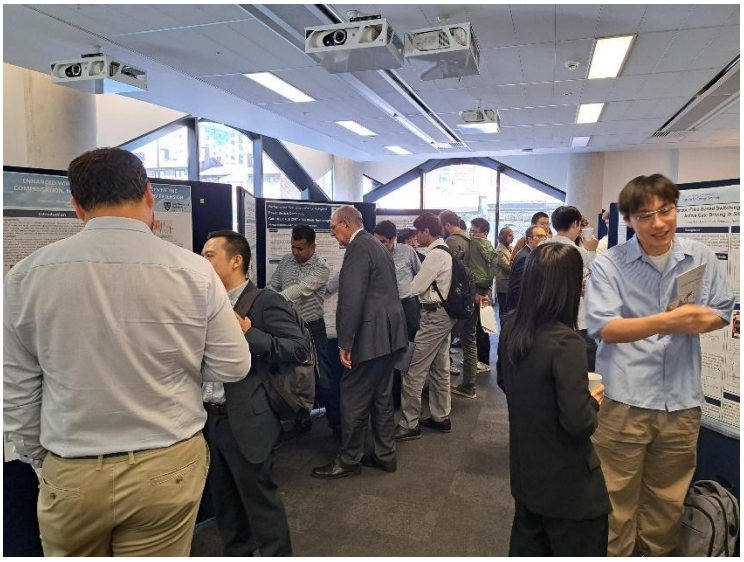
Waves are stochastic, with a mean period of a few seconds. Peak power can be ten times average power within a single sea state, and wider across sea states. For maximum power extraction, the power converters need to be sized and costed for peak power resulting in low capacity factor. Converter challenges include: minimising losses; maximising power recovery; limiting voltage and current in high sea states; protection in extreme sea states; wave-period thermal cycling of devices; high vibration; corrosive environment. Challenges were illustrated from laboratory tests in Manchester and sea trials in Australia for the raft-type ‘M4’ wave energy platform. The M4 has an electro-mechanical power take-off, comprising active rectifiers for the generator control, a DC/DC converter interfacing to supercapacitor energy storage for DC bus regulation. Initial aquaculture applications would be standalone, scaling up to a DC/AC grid interface connection.

Lecture 11: Integrating Renewable Energy and Energy Storage into Railway Systems – Zhongbei Tian, University of Birmingham

Static frequency converters (SFC) have been recently implemented into the British railway traction power networks to accelerate the electrification and decarbonisation of railways. The Global Centre of Rail Excellence (GCRE) is being constructed in South Wales and will be powered by a grid-connected SFC. This research tackles the integration of renewable energy and energy storage into AC-powered railway systems with an SFC.

The interactions among electrical power grid, renewable energy, energy storage and trains through a system-level model were analysed. Various train operations, energy demand and generation scenarios were introduced. The topology to integrate the renewables and energy storage into the DC bus within the SFC back-to-back converter were simulated and analysed. To collect the fluctuating and peaky regenerative braking power, the supercapacitors will act as an energy storage form in this case. A lab-based hardware-in-the-loop platform to emulate the railway power network with renewables and energy storage has been developed. Optimising energy flow according to the train operation characteristics is critical to enhancing overall system efficiency. The feasibility and performance of the integrated renewable railway power network was demonstrated.

Early Career Researcher Poster Competition



Poster Prizes awarded to Early Career Researchers

- 1st prize: Three Phase Dual Active Bridge for Wireless Charging for EVs by Yichong Zhang, University of Sheffield
- 2nd prize: High Bandwidth Current Sensing for Wide Bandgap Power Electronics by Jiaqi Yan, University of Bristol
- 3rd prize: Static and Dynamic Performance of the 3.3kV Semi-superjunction MOSFET with Deep Trench Side-Wall Implantation by Kyrylo Melnyk, University of Warwick

Design Competition for Undergraduates

- 1st Prize: The Design and Development of a Controllable, Modular, Three Phase Inverter for MsC Power Engineering Laboratories by Marc Taljard, University of Edinburgh
- 2nd Prize: Electromagnetic Interference (EMI) in DC-DC Boost Converters using Wide Bandgap Devices by Dhruv Bhatt, University of Warwick
- 3rd Prize: Parameter Analyser PCB for Power Semiconductor Devices by Gabriel Pamintuan, University of Warwick

Professor Xibo Yuan thanked attendees at the Conference, Professor Mark Johnson at the University of Nottingham for support from the CPE Discretionary Fund, the other members of the CPE 2025 organising team (Martin Foster, Layi Alatise, Paul Evans, Joe Gillett, Steve Riches, Martin Wickham and Andy Bonner) in putting the Conference together over the past year. The support of the Sponsors and Exhibitors was acknowledged, along with the contributions from the Session Chairs and Judges for the Awards.

Professor Volker Pickert (Newcastle University) encouraged delegates to attend the ECCE Europe Conference to be held at the International Convention Centre, Birmingham from 31 August to 4 September 2025.

Sebastian Neira announced that the CPE Conference 2026 will be held in the University of Edinburgh on 7-8th July 2026. Further details about the Conference will be provided in due course.

CPE 2025 Sponsors

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Exhibitors at CPE 2025

The following organisations exhibited at the CPE 2025 Conference:

Charcroft Electronics - Specialist manufacturer and distributor of passives, interconnect, power, magnetics, opto-electronics and electro-mechanical components

ETPS Ltd - Specialise in programmable power supplies and test systems, catering for almost any DC or AC power, voltage or current requirement

Indium Corporation - Premier materials refiner, smelter, manufacturer and supplier to the global electronics, semiconductor, thin-film and thermal management markets

IPP Group Ltd - Innovative inspection, production and test solutions

ipTEST Ltd - Designs, builds and supports parametric test equipment for all aspects of power semiconductor test, encompassing laboratory, characterisation and full production test for the world's leading global power semiconductor manufacturers

Matrix TSL - Leading provider of innovative and hands-on educational solutions and learning resources for engineering classrooms and laboratories worldwide

PPM Power - Power electronics, power supplies, test and systems

PMK IWATSU UK Ltd - A joint venture between PMK Mess und Kommunikationstechnik GmbH and IWATSU Electric Co Ltd, specialise in high-precision electrical measurement equipment for power electronics applications, including oscilloscopes, advanced probing solutions, curve tracers, B-H analysers and related accessories

REWIRE - Is an £11m Innovation and Knowledge Centre (IKC), funded by UKRI, dedicated to transforming Net Zero by delivering the next-generation of wide-band gap semiconductor technologies and power electronic devices through academic and industry collaboration and co-creation

Tektronix - We are the measurement insight company committed to performance, and compelled by possibilities. Tektronix designs and manufactures test and measurement solutions to break through the walls of complexity, and accelerate global innovation

Teledyne LeCroy - Is a leading provider of oscilloscopes, protocol analysers and related test and measurement solutions that enable companies across a wide range of industries to design and test electronic devices of all types.

The N-ZEEE Network - is building a community of academia, industry, policy makers and wider stakeholders to ensure cross-sector technology transfer in addition to renewables-specific developments that will enable the next generation of wind, marine, photovoltaic and novel future energy generation and allow the UK to deliver on its energy and climate priorities and lead the way in underpinning PEMD research.

CPE 2025 Workshop on High Frequency Power Electronics and Drives

The CPE 2025 Conference was rounded off on Thursday 10 July 2025 with a workshop at Mappin Hall, University of Sheffield attended by 30 people on Power Electronics from High Frequency Power Electronics and Drives.

The workshop covered the following topics:

- Voltage Stress in Inverter-Fed Electrical Machines by Antonio Griffo, University of Sheffield
- High Frequency Modelling of Wide Bandgap Power Semiconductor Devices, Modules and Circuits by Ke Li, University of Nottingham
- Mitigation of Motor Overvoltage in SiC-Based Drives using Active Waveform Shaping Techniques by Wenzhi Zhou, Coventry University
- Sensing for Silicon Carbide MOSFET Modules by Paul Judge, University of Edinburgh and Jiaqi Yan, University of Bristol
- Framework for Designing Piezoelectric Transformer Power Supplies by Martin Foster, University of Sheffield