



Driving the
Electric Revolution
Industrialisation Centres

**Growing UK
Manufacturing in
Power Electronics,
Machines and Drives**
Powering Net Zero



Innovate
UK

The funding is provided through the UKRI's Driving the Electric Revolution Challenge, delivered by Innovate UK.

Driving the Electric Revolution Industrialisation Centres

Growing UK Manufacturing in Power Electronics, Machines and Drives Powering Net Zero

Contact

info@der-ic.org.uk
www.der-ic.org.uk

Driving the Electric Revolution Industrialisation Centres (DER-IC) are a UK-wide network of over 30 Universities and Research and Technology Organisations (RTO).

DER-IC's mission is to work with industry to grow UK Power Electronics, Machines and Drives (PEMD) manufacturing capability, capacity, and competitiveness.

PEMD forms the foundation of critical control and motion technologies across all sectors. From aerospace to automotive, bulk electrical power transfer, consumer electronics, heating and lighting, marine, off-highway, rail, renewable energy and robotics, PEMD technologies play a vital enabling role.

Powering Towards Net Zero

The UK has embarked upon a 30-year journey to Net Zero. However, significant work is required to increase adoption of renewable energy through electrification, and transition away from reliance on fossil fuels.

PEMD technologies underpin:

Industrial decarbonisation: increased energy efficiency, industrial electrification and clean energy transition (wind, solar, nuclear, hydrogen)

Green transport: mainly battery electric and hydrogen

Domestic emissions reduction: heat pumps, local solar

PEMD technologies are fundamental enablers for achieving a sustainable, zero emission future.

Power electronics are needed to control generation, transmission, storage and deployment of electrical energy. Electrical machines take this energy and convert it into motion.

As a significant global manufacturer, the UK must build its own solutions for these critical emerging technologies rather than relying on overseas supply chains.

The UKRI's Driving the Electric Revolution (DER) Challenge, delivered by Innovate UK, supports the advancement of PEMD technologies to aid this transition. The DER Industrialisation Centres offer development and scale-up facilities for UK manufacturers to accelerate and de-risk their electrification journeys.



Funded by DER Challenge

The DER-ICs have received funding from UKRI's Driving the Electric Revolution (DER) Challenge, delivered by Innovate UK. Part of this investment established the UK-wide DER-IC network, led by Newcastle University and operating from regional centres in the North East, the Midlands, the South West and Wales, and Scotland.

How DER-IC Can Help

How to Engage

The DER-IC network

- > engages in collaborative research and development projects (CR&D) funded through UKRI, Innovate UK, regional initiatives and other funding schemes
- > can deliver projects and access to equipment and capability through commercial contracts
- > provides SME advice and regional support programmes

Benefits of Engagement

DER-IC can facilitate targeted introductions to expedite access to the UK academic and RTO community, engineers and capabilities across the partner network.

By using DER-IC equipment and capability, supply chain partners can:

- > develop and verify manufacturing process and product performance ahead of committing to capital investment
- > reduce cost and risk of new product introduction
- > develop prototypes
- > achieve a faster time to market
- > protect their company IP through all engagement routes

Working with DER-IC

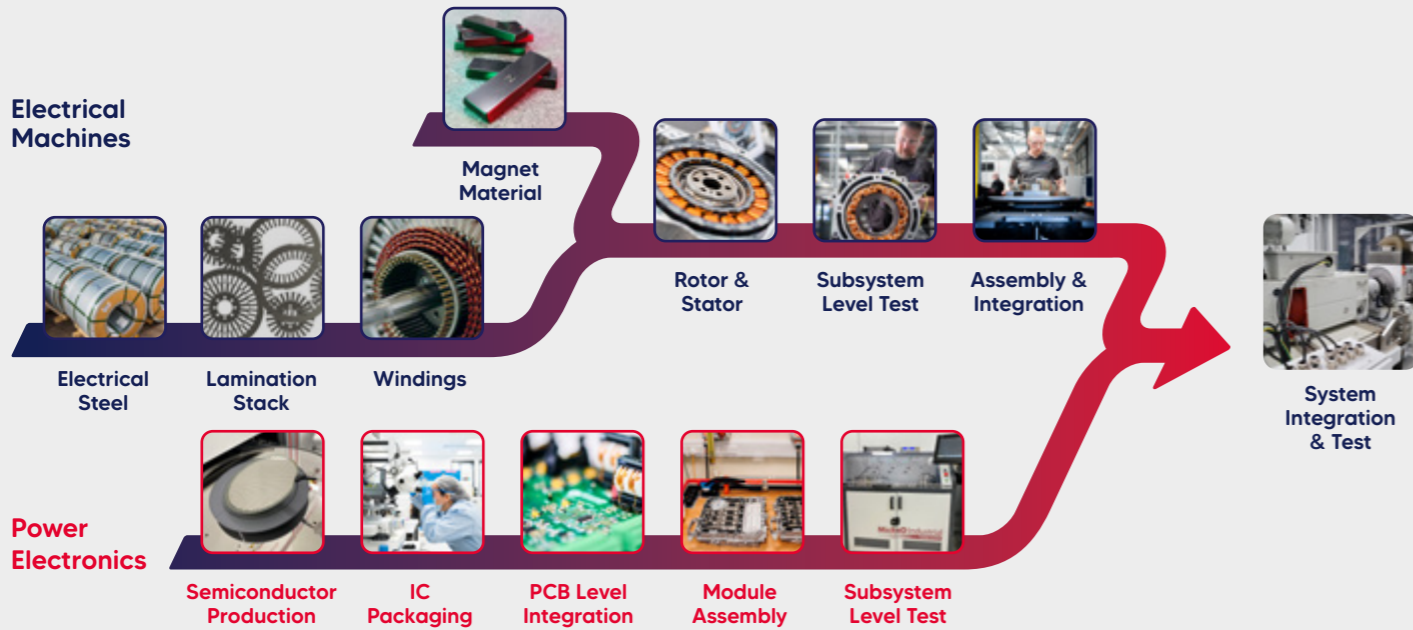
The entire DER-IC network can be accessed through any of the regional centres.

Contact us info@der-ic.org.uk



PEMD Value Chain

The PEMD value chain is complex and varies across sectors. DER-IC capabilities encompass and support all value chain elements except Electrical Steels supply and other raw materials that have to be imported. Key cross-cutting technologies, including sustainability, rare earth elements, lightweight materials and thermal management, must also be considered at the relevant development stage.



Cross-cutting strategies are considered at all relevant stages:

- > Sustainability
- > Rare earth elements
- > Lightweight materials
- > Thermal management

Our Capabilities

The DER-IC network draws upon a broad range of capabilities to support industry partners in developing products and manufacturing processes.



Product and Manufacturing Process Equipment Design

Design support for both product and manufacturing process equipment to develop effective solutions for specific requirements.



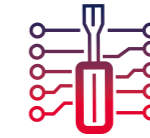
In-Process and End-of-Line Test and Validation

Assuring the reliability and performance of products and systems, covering functional testing, performance evaluation and environmental testing at all stages of the production process with a 'no fault forward' approach.



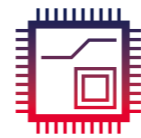
Manufacturing Process Development and Optimisation

Streamlining production workflows, improving quality control processes, and enhancing productivity - much of the DER-IC processes are representative of volume manufacturing process to accelerate and de-risk project delivery.



Materials and Component Characterisation

The DER-IC network can draw on extensive facilities to characterise materials and components used in PEMD. DER-IC equipment can help analyse and evaluate the properties and performance of materials, components and joining technologies, enabling informed decision-making in material selection, quality control and design optimisation.



Prototype Manufacture and Scale-up Support

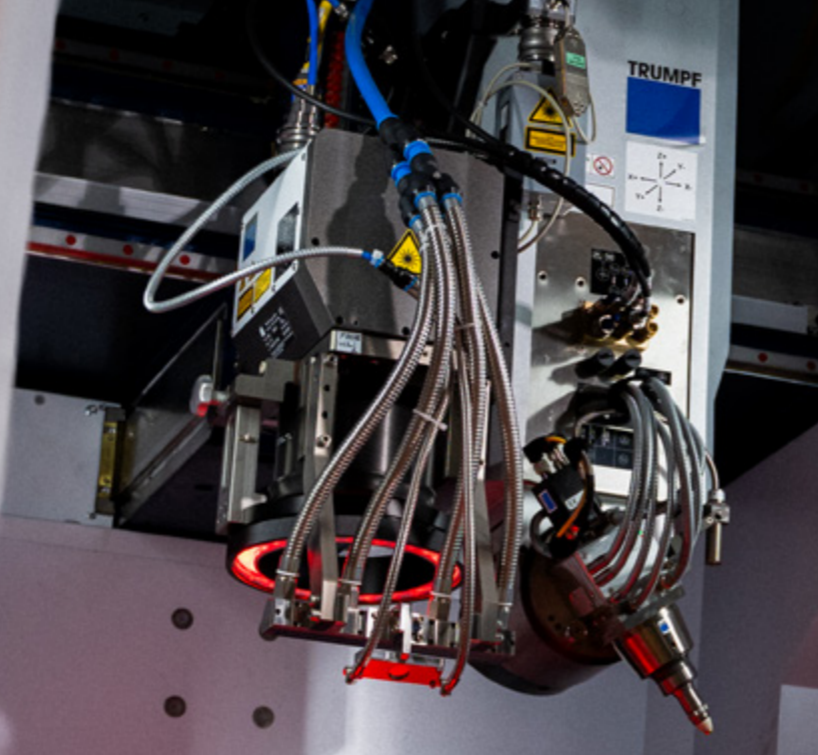
Smoothing the transition from prototypes to full-scale production, optimising manufacturing parameters, and integrating new technologies or designs into production.



Electrification Skills Learning and Development

The DER-IC network provides a comprehensive package of electrification skills learning and development, working with various skills and training bodies to enhance the knowledge and skills of professionals in the PEMD industry. This covers technical areas across all skill levels, including bespoke short courses for industry. DER-IC additionally offers open access equipment for hire to facilitate training.

DER Funded Equipment



DER-IC North East

DER Funded Equipment

DER-IC North East



8

Driving the Electric Revolution Industrialisation Centres offer a range of equipment designed to meet the needs of the UK manufacturing industry.

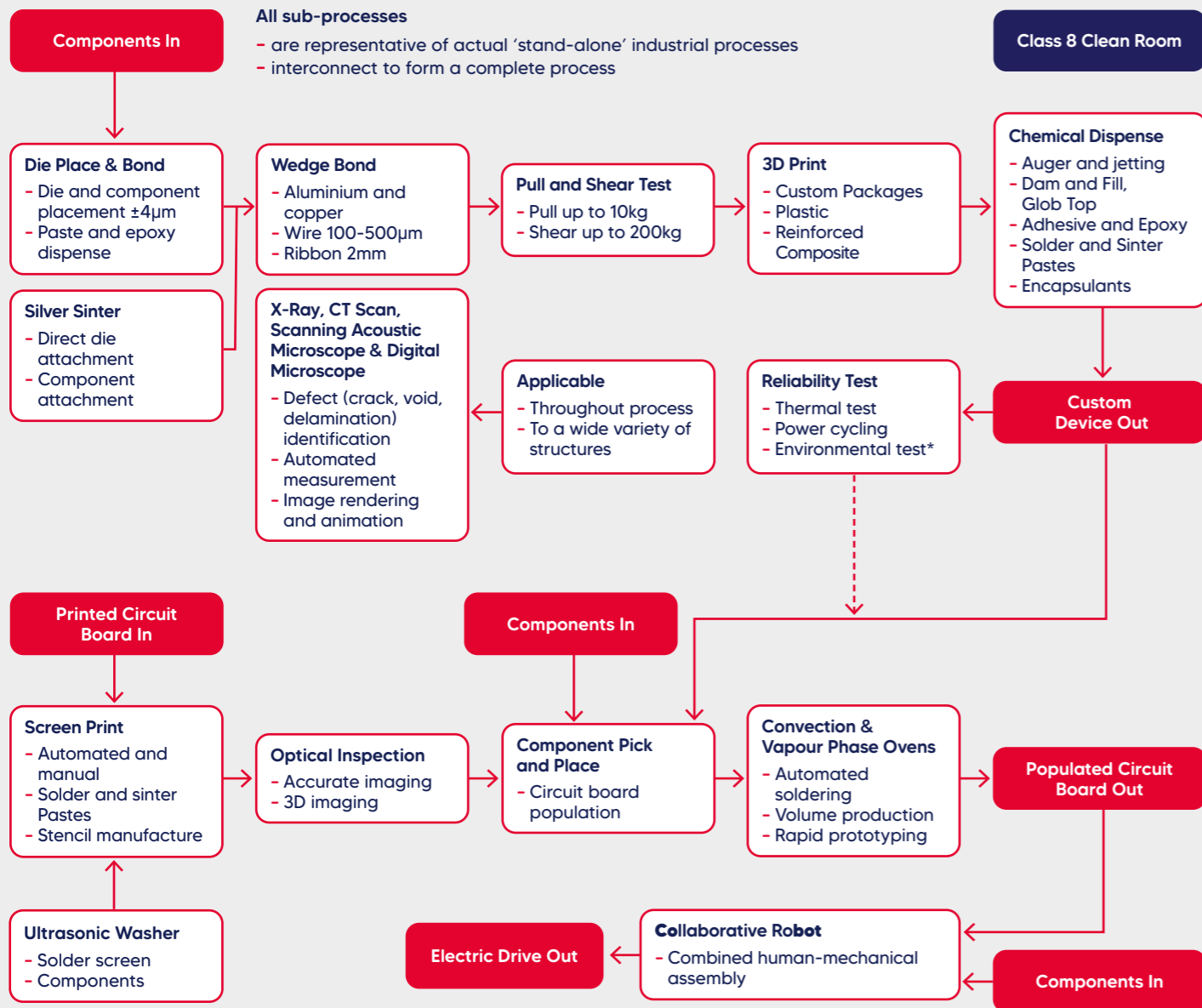
In collaboration with industry professionals, the DER equipment is designed to support the industry in addressing manufacturing and scale-up challenges to achieve Net Zero goals by 2050. The DER funded equipment supports growth, accelerates technical advancement, and enables scale-up in Power Electronics, Machines, and Drives (PEMD).

Located across the UK, these open-access facilities offer essential resources to support innovation in PEMD manufacturing. DER-IC prioritises quality and accessibility, ensuring the equipment meets the practical needs of the PEMD sector.

DER-IC North East is part of Newcastle University and is located near the International Advanced Manufacturing Park, Sunderland, the heart of the region's advanced manufacturing base. The Centre is equipped with DER funded equipment that enables packaging of power electronic semiconductor devices, SMT PCB manufacture to support prototype and scale-up manufacturing of power converters and electric drives, and prototype and scale-up manufacture of electrical machines. Individual processes are representative of mid to high volume manufacturing, are highly reconfigurable, and incorporate in-process inspection to enable process development, optimisation, and verification. Assembly is supported by dynamometer, X-ray and CT scan, and environmental test equipment.

Power Electronics Advanced Packaging and Electric Drive Assembly and Scale-Up

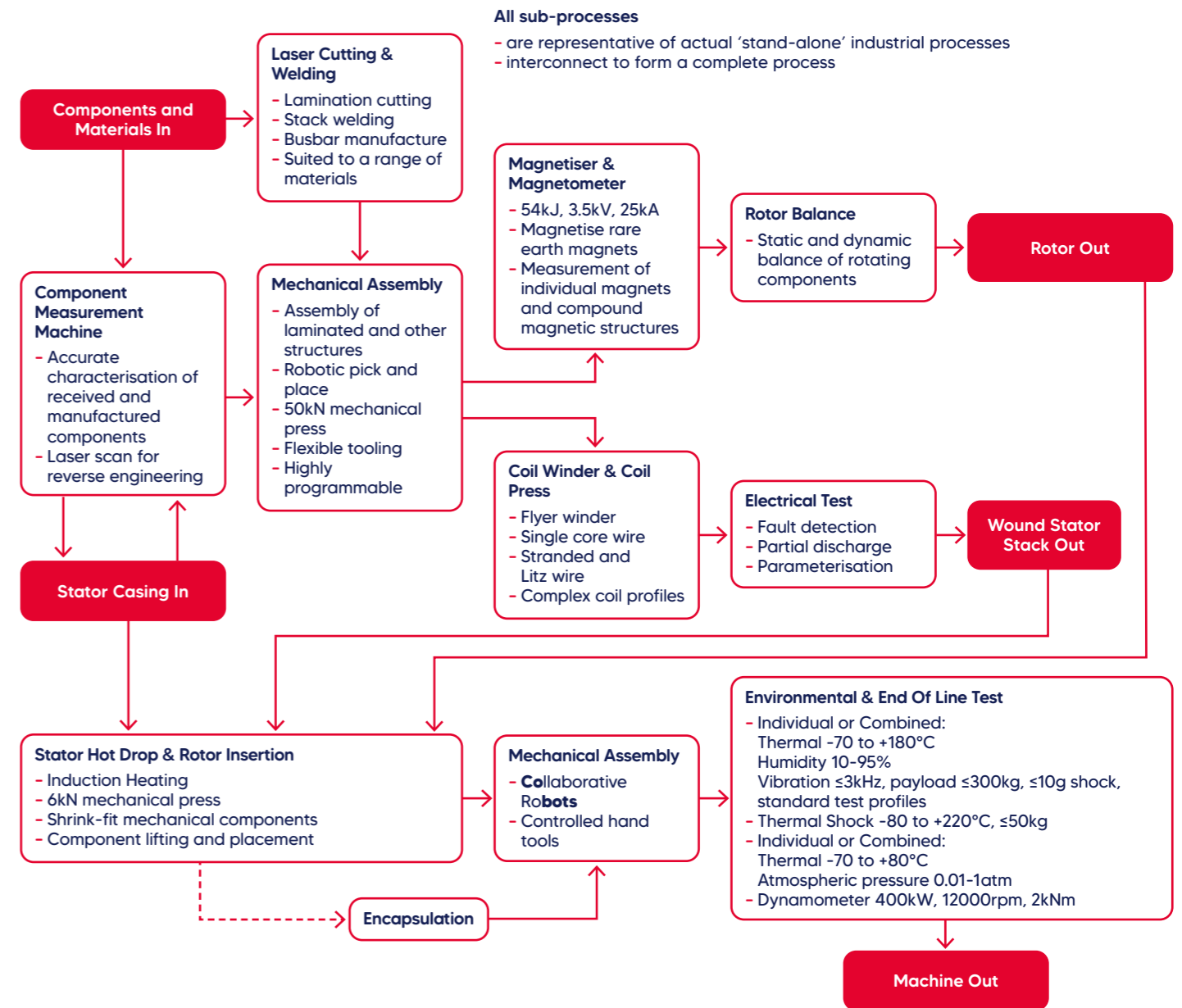
Located within a cleanroom environment, state-of-the-art, flexible, industry-representative equipment enables custom packaging of semiconductor die, devices and integrated circuitry, and surface mount circuit board manufacture and inspection, providing a platform for the development and scale-up of advanced manufacturing processes for highly integrated power electronic systems. Specialist inspection and diagnostic equipment enable verification of manufacturing process quality.



*See Electrical Machines flow diagram for full details

Electrical Machines Assembly and Scale-Up

The Electrical Machines assembly line includes a range of flexible, automated assembly and test and measurement equipment, providing an end-to-end platform for electrical machine manufacturing process development.



University of Sheffield - Advanced Manufacturing Research Centre (AMRC)

26

The University of Sheffield (AMRC) has established a rotor spin tester which provides the UK with a unique open-access facility for testing electrical machine rotors and other components for rotating machinery. Together with manufacturing capability at AMRC, this enables the rapid iterative design, prototyping and testing that will support UK manufacturers develop the next generation of high-performance machines.

Rotor Spin Test Facility

High-speed and destructive testing of rotating components: spin balancing; measurement of radial growth; high- and low-cycle fatigue testing; and burst testing with a high-speed camera (up to 160,000 frames per second).

Max. Speed	63,000rpm
Max. Rotor weight	800kg
Max. Rotor diameter	1,000mm
Max. Rotor length	820mm

The University of Nottingham

21

The University of Nottingham houses their DER equipment at the Power Electronics and Machines Centre (PEMC). The PEMC includes purpose-built laboratories designed for the Power Electronics, Machines and Control Research Group. This facility plays a crucial role in the university's commitment to position Nottingham and the East Midlands as a hub for the translation of net zero technologies from research bench to real world solutions.

High Frequency Coil Manufacturing and Magnetic Test and Characterisation

DER has enabled funding for developing a "Future Factory for High Performance Electrical Machines" - a facility for developing manufacturing processes for high performance electrical machines through a number of winding machines including:

Litz wire winding process

Advanced hairpin solutions for high frequency drives

Fully customisable vacuum pressure impregnation (VPI) and a range of magnetic and insulation test equipment

The University of Warwick

34

The University of Warwick's DER-funded equipment is located within the School of Engineering and comprises a power electronics module assembly, reliability and failure analysis facility. The equipment is focused on enhancing the reliability of wide band gap power electronics modules and allows the technology for reducing size, weight and cost across all sectors to be better understood for volume production.

Power Electronics Reliability and Failure Analysis Facility

Power cycling facility

Industrial data logging equipment / HIL

Environmental chamber for reliability testing

Thermal camera

Fiber Bragg grating system

Scanning acoustic microscope and oscilloscope

De-capsulation facility

WMG

35

WMG is an academic department at The University of Warwick known for its strong collaboration between academia and the public and private sectors. The Winding Centre of Excellence has been established to provide enhanced capabilities for UK-based OEMs and SMEs developing eMachine solutions. Additionally, WMG provides a PEMD Reliable Manufacturing In-process Testing mobile facility.

Winding Centre of Excellence

Equipped to manufacture all types of windings at production quality, specialising in hairpin stators:

Discrete hairpin winding and continuous hairpin winding

Distributed winding and winding of synchronous wound rotors

Concentrated windings for radial and axial flux machines

Laser welding for busbars and connections

Insertion robot for magnetised and unmagnetised magnets for rotor assembly

Magnetiser, rotor assembly to hub, trickle impregnation, stator loading into housing and curing ovens

In-process testing of electrical, thermal and mechanical effects

WMG's PEMD Reliable Manufacturing In-process Testing - PERMIT provides assembly insights, manufacturing data and produce prototype power electronics assemblies to de-risk industry partner investments.

PEMD Reliable Manufacturing In-process Testing - PERMIT

The equipment consists of a flexible production line, in-process testing and end-of-line test for production process research, validation and optimisation for typical assembly operations:

Press-fit (force and deflection) to validate correct power module fit

Fasteners (torque and angle) to ensure correct fastener conditions

Leak tests (pressure decay curves, helium seeker etc)

Connector tests (push-fit force and deflection) to ensure engagement of connector clasps

Temperatures - powered first-time operation, ramp-up and down for electrical connections and component operation

Vibration, noise and order track for power module check

Electrical (voltage, current, resistance, inductances etc) for communications system operation

Alignment and presence detection for geometrical errors, missing components

University of Birmingham

University of Birmingham has constructed a production line for recycled sintered magnets with an 'end-to-end' supply chain to enable a UK supply of recycled rare earth magnets from processed oxides. This equipment provides a platform to secure a strategic supply of NdFeB alloy powder which can be fed into any part of the value chain from chemical processing to alloy production, or directly into magnet manufacture.

Recycled Sintered Magnets Production Line

Large scale recycling and production facility for Rare Earth Permanent Magnets (REPM)

A range of advanced and highly unique equipment to enable the sensing, sorting, separation, purification and re-processing of rare earth permanent magnets. This includes pre-processing equipment (cropping machines), a 2,000 litre capacity hydrogen reactor, a powder processing unit including sieves, jet mill and blending system, uniaxial and transverse magnetic aligning presses, a pellet press and a sintering furnace. The equipment can also be used to process primary rare earth cast alloys.

Machining and finishing

A range of machining and finishing equipment for REPMs including electrical discharge machining (EDM) and grinding equipment.

Characterisation facilities for magnetic materials

This includes 2 permeameters running up to 200°C, 2 vibrating sample magnetometers (VSM) to measure the hysteresis loops of solid and powdered magnetic samples, particle size analysis, 3D magnetic scanning, Kerr effect microscopy and inductive coupled plasma (ICP) chemical analysis equipment.

Bench scale magnet processing equipment

This includes high velocity ball mills, glove boxes, a pulse magnetiser, isostatic presses and sintering furnaces for sample sizes between 10-50 grams.

CSA Catapult

5

The **Catapult** in Newport, South Wales, focuses on materials and on power electronics packaging components. The DER funded equipment addresses supply chain challenges with high power density and high temperature device packaging.

Compound Semiconductor Applications (CSA) Catapult Advanced Packaging Prototype Facility

Ceramic 3D printing for device packaging:

Ceramic 3D printer

Thermal optimisation

Ceramic debinder furnace - ceramic post process

Ceramic oxide oven - post process

Ceramic sintering furnace - high temperature ceramics

Cleaning station

Metal 3D printing:

Metal 3D printer (e.g. Copper)

Printing materials supply

Metal debinding oven - debinding process for package

Metal sintering oven - sintering process

Metrology and processing tools:

Tensile testing equipment - device quality check

Fully automated Vickers micro hardness tester - device quality check

Laser cutting / drilling machine - device processing for novel package design

Lapping and polishing machine - device polish / lapping for preparation

Density / volume measurement for 3D objects

Swansea University

30

Swansea University's **Centre for Integrative Semiconductor Materials (CISM)**, has created a wide band gap power electronics component industrial pilot line. The pilot line is also part of CScnected, the world's first compound semiconductor cluster based in South Wales working closely with companies such as KLA SPTS, Vishay Intertechnology, IQE and Microchip. The equipment is housed in CISM at Swansea University's Bay Campus in bespoke ISO 5 and 6 Cleanrooms.

Wide Bandgap Power Electronics Component Industrial Pilot Line

The pilot line includes:

Advanced lithography - photo and nano-imprint

Advanced etch - SYNAPSE deep dry etch for SiC

Advanced deposition - dielectrics and metals including conformal Molecular Vapour Deposition

Backend - rapid thermal and laser anneal, wafer dice and grind

Wafer and die-level high temperature and voltage test

PNDC



24

The DER-IC Scotland equipment is primarily housed at **PNDC (University of Strathclyde)**. PNDC specialises in de-risking and accelerating the commercialisation of innovative MW-scale technologies and architectures through testing and validation using real-world hardware and simulation capabilities. It has a proven track record in innovation and supporting the advancement of novel technologies through design, manufacture, and verification at system, sub-system and component levels. PNDC works with a broad range of stakeholders across industry, academia and policy-making.

High-Power Propulsion and Powertrain Systems Validation Capability

MW-scale innovation and testing capability, comprising:

MW-rated dynamometers - 2 units of 1 MW power rating each, switchable torque/speed ranges, comprehensive data acquisition capability to enable testing of powertrains for Aviation, Maritime, Rail and HGV applications

2 x MW-scale AC & DC power supplies - 1 MVA 4-quadrant power supply capable of operating in AC and DC modes; 3-phase and single-phase AC power supply capability; can be combined to offer up to 2MW 3kV DC capability

Complements existing multi-MW PNDC whole systems capability for power, heat and transport

Gaseous hydrogen supply for testing power, heat and transport applications

MW-scale test bed for machines and drives

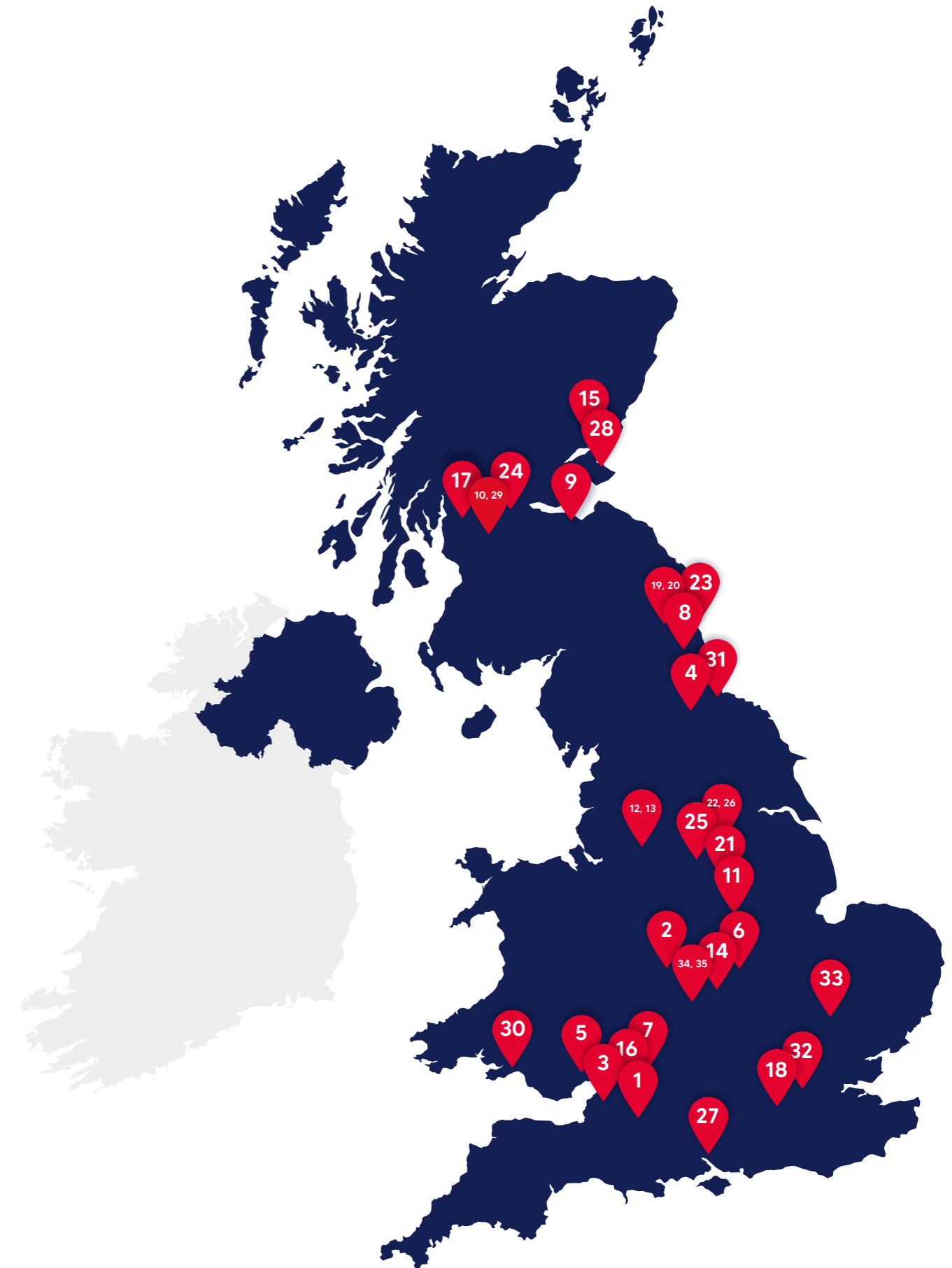
Complemented by partner capabilities at the University of St Andrews (hydrogen platforms), University of Edinburgh (semiconductor device and converter capability), University of Glasgow James Watt Nanofabrication Centre, NMIS (semiconductor device research and manufacture) and Michelin Scotland Innovation Parc (MSIP)

Environmental chamber test capability, which can be used in combination with significant power hardware in the loop capability to test Power Electronics, Machines and Drives under controlled temperature and humidity environmental conditions. Relevant for maritime, rail, heavy duty vehicle, aerospace and energy sector applications



The National Network

- | | | |
|--|--|--|
| 1 The University of Bath | 14 MTC | 25 The University of Sheffield |
| 2 University of Birmingham | 15 Michelin Scotland Innovation Parc (MSIP) | 26 The University of Sheffield Advanced Manufacturing Research Centre (AMRC) |
| 3 University of Bristol | 16 National Composites Centre (NCC) | 27 University of Southampton |
| 4 CPI | 17 National Manufacturing Institute Scotland (NMIS) | 28 University of St Andrews |
| 5 Compound Semiconductor Applications Catapult | 18 National Physical Laboratory (NPL) | 29 University of Strathclyde |
| 6 Coventry University | 19 Newcastle University | 30 Swansea University |
| 7 CSconnected | 20 Northumbria University | 31 Teesside University |
| 8 DER-IC North East | 21 University of Nottingham | 32 University College London (UCL) |
| 9 University of Edinburgh | 22 Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) | 33 The Welding Institute (TWI) |
| 10 University of Glasgow | 23 Offshore Renewable Energy (ORE) Catapult | 34 The University of Warwick |
| 11 Loughborough University | 24 PNDC | 35 WMG at The University of Warwick |
| 12 University of Manchester | | |
| 13 Manchester Innovation Activities Hub (MIAH) | | |



Network Partners

For details of our network partners, their capabilities and contact details, visit our website www.der-ic.org.uk



1 University of Bath

University of Bath is a leading research university in low carbon emission transportation technology. University of Bath has extensive close collaboration with aviation and automotive industry in powertrain, hydrogen, and cryogenics. IAAPS is the University of Bath's new state-of-the-art facility which develops clean, sustainable, and affordable technologies to support the transport industry in the transition to net zero. IAAPS is a strategic investment of over £70m by the University of Bath, government, and industry funding, which has 11,300sqm at the Bristol & Bath Science Park.

- > Power Electronics Laboratory
- > Control and Machine Drives Laboratory
- > Applied Superconductivity and Cryogenic Propulsion Laboratory



2 University of Birmingham

The Magnetic Materials Group (MMG) at the University of Birmingham is the only UK research group focused on processing and recycling permanent rare earth magnetic materials. The MMG is internationally recognised for its work on hydrogen processing of rare earth alloys and magnets which are used worldwide in the production and recycling of Neodymium-Iron-Boron (NdFeB) magnets. The Group has been in existence for over 45 years under the leadership of Professor Rex Harris, Dr Andy Williams and now Professor Allan Walton.

- > Large scale recycling and production facility for rare earth permanent magnets
- > Machining and finishing equipment
- > Characterisation facilities for magnetic materials
- > Bench scale magnet processing equipment



3 University of Bristol

University of Bristol's Electrical Energy Management Group has an excellent track record of long-term strategic partnership with industry, encompassing both TRL 1-5 support of research and development and skills training, with a strong power electronics and machine drives focus. Furthermore, it also has a history of supporting SME aided funding schemes such as KTPs, UKRI grants, and Impact Acceleration Awards. Capabilities in this area include:

- > Design studies into electrical machine and power electronic converters customised to bespoke energy conversion applications
- > Detailed forensic experimental and model based examination of electrical machine and power conversion to understand where performance falls short of expectations and sources of parasitic loss or premature failure



4 CPI

CPI connects the dots in the innovation ecosystem to bring ideas to life. CPI is an innovation catalyst that accelerates the development, scale-up and commercialisation of deep tech and sustainable manufacturing solutions. CPI partners with industry, academia, government, entrepreneurs and investors to deliver incredible innovations through a range of technologies, including:

- > High throughput formulation and automation equipment
- > Advanced characterisation facilities
- > Batch and roll to roll coating capabilities
- > In slot die and screen printing
- > Materials synthesis capability, including raw materials and ability to develop recycling processes
- > Modelling, informatics and data science
- > Process optimisation and scale-up, including process engineering design



5 Compound Semiconductor Applications Catapult

(CSA) Catapult's purpose is to deliver long-term benefit to the UK economy and accelerate UK economic growth in industries where applying compound semiconductors creates a competitive advantage and enables new products or end markets. Its vision is for the UK to become a global leader in developing and commercialising new applications for compound semiconductors.

- > Power electronics lab - design and characterisation of high performance devices and modules
- > RF and microwave lab - supports development of leading edge products in multiple sectors
- > Photonics lab - supporting customer breakthroughs in optical sensitivity and beam control
- > Advanced packaging line - leading - edge package design and development including thermal optimisation



6 Coventry University

With a proud tradition, Coventry University's research and innovation aims to address real-world challenges. Its research into future transport solutions takes place in the birthplace of the British motor industry. Coventry University supports DER-IC through its Centre for Advanced Low-Carbon Propulsion Systems (C-ALPS) and Institute of Advanced Manufacturing Engineering (AME). C-ALPS combines academic expertise and state-of-the-art facilities in battery and supercapacitor cells, hydrogen fuel cells, e-motors and drives. AME blends research and training activities in a unique 'Faculty on the Factory Floor' initiative with expertise in metrology, digital processes and laser joining.

- > Hydrogen and electric propulsion system test cells
- > Pre-compliance EMC test chamber
- > Power-semiconductor device characterisation
- > Advanced manufacturing and materials



7 CScnnected

CScnnected is the collective brand for a growing number of advanced semiconductor related activities in Wales, home to a unique community of academic institutions, prototyping facilities and global, high-volume manufacturing capabilities that collaborate across a range of research and innovation programs. Capabilities available across the CScnnected cluster include:

- > Power semiconductor R&D - a range of materials expertise in Si, SiC, GaN and other advanced semiconductor technologies at TRLs 1 - 3
- > Power semiconductor design and test - high voltage power lab for design, test and prototyping of power electronic applications at TRLs 4 - 6
- > Manufacturing processes - equipment and processes for manufacture of power semiconductor devices



8 DER-IC North East

As one of the four regional centres, DER-IC North East combines unique open-access hardware with Newcastle University Electrical and Electronic Engineering (EEE) and partner institution capability, and is staffed by academics and engineers from industry. The Centre supports low TRL (1-3) research and mid-high TRL (4-8) applied research and development across all sectors.

It houses two new facilities representing £10.5M of equipment investment, supported by an extensive suite of end-of-line test and measurement, and in-process inspection equipment:

- > Power Electronics Advanced Packaging and Electric Drive Assembly and Scale-Up
- > Electrical Machines Assembly and Scale-Up



9 University of Edinburgh

University of Edinburgh's School of Engineering addresses diverse complex challenges across the entire field of engineering. Its Electrical Power Conversion Group has a long track record in electrical power technologies for renewable energy applications. This includes designing, modelling and testing electrical machine and power converters for some of the leading companies in offshore renewable energy.

- > Electrical machines lab
- > Power electronics lab
- > High temperature superconducting lab



10 University of Glasgow

The James Watt Nanofabrication Centre (JWNC) is a 1200m² cleanroom at the University of Glasgow which houses over £35M of state-of-the-art fabrication and metrology equipment. It is one of the leading centres of research and international collaboration in micro and nanofabrication technologies undertaking fundamental, applied and commercial research, and small industrial prototyping and production runs.

- > James Watt Nanofabrication Centre
- > B1505 power semiconductor analyser
- > Characterisation equipment for power semiconductor devices together with a high temperature on-wafer probe station



11 Loughborough University

Loughborough University is an international leader in High Value Manufacturing (HVM) research, with a leading-edge PEMD and related research portfolio in the areas of control systems, energy systems and advanced materials, electronics packaging and manufacturing. It works closely with industry through funded research, consultancy and exploitation of cutting-edge technologies across aerospace, energy, marine and land transport industrial sectors.

- > Ultrasonic assisted bonding systems
- > Precision electronics assembly and packaging
- > Advanced thin films and coatings for interconnects
- > Multiphysics modelling and cyber validation
- > Electron and Optical Microscopy and Surface Analysis
- > X-Ray Diffraction and Thermal Analysis



12 University of Manchester

The eTransport research area at the University of Manchester focuses on the electrification of land, air, and sea transport. It aims to develop solutions that lead to more efficient, higher power density and lower emission systems achieved through the use of advanced materials, improved manufacturing processes and the development of new analytical methods. All technologies will make a strong contribution towards achieving the 2050 zero carbon target.

- > MEA aerospace laboratory - IEPNEF
- > National grid high voltage laboratories
- > Cryogenics test facilities



13 Manchester Innovation Activities Hub (MIAH)

MIAH is a net zero industrialisation and electrification skills training facility in the heart of Manchester Science Park, offering access to industrial grade equipment and capability to de-risk and accelerate the commercialisation of product design, prototyping, testing and systems integration of power electronics for renewable energy applications, transport, construction and manufacturing.

A centre of excellence for inclusive innovation, it offers state-of-the-art facilities in battery, hydrogen generation, fuel cells, e-motors and drives.

- > Additive Manufacturing Workshop - 3D rapid prototyping, metals, polymers
- > Automation and robotics adoption
- > Digital Twinning - process simulation development for optimisation
- > Makerspaces - including mechanical and electronics labs and test equipment, advanced machining and fabrication machines,
- > Emerging Skills Academy - supply chain and workforce development including skills, training and equipment



14 MTC

MTC transforms how products are designed, made and built so that they can be produced on a commercial scale - more sustainably, effectively and safely. Since 2010, their independent research and technology organisation has delivered pioneering solutions to help overhaul industries spanning Aerospace, Defence & Security, Power & Energy, Built Environments, Space, Agriculture, and Food & Drink.

MTC are proud to be part of the High Manufacturing Catapult, supported by Innovate UK.

- > The National Centre for Additive Manufacturing - metals, polymers, ceramics
- > Laser cutting, joining, cleaning, and surface texturing - including red, green and blue sources
- > Automation and robotics adoption and implementation
- > Digital Twin and process simulation development
- > Supply chain assessments and development
- > Product development - Design for Manufacture / Assembly
- > Advanced Manufacturing Training Centre



17 National Manufacturing Institute Scotland (NMIS)

The National Manufacturing Institute Scotland (NMIS) is a group of industry-led manufacturing R&D, innovation and skills facilities operated by the University of Strathclyde and supported by a network of partners across Scotland. The group has a national mandate to create and deliver inspiring, sustainable and translational research and skills for all by accelerating innovation in the manufacturing community.

- > Industrial-scale superconducting windings machine
- > Incremental near net shape forming and forging
- > Materials science and residual stress characterisation
- > Lightweight Manufacturing Centre



18 National Physical Laboratory (NPL)

NPL is the UK's National Metrology Institute, providing the measurement capability that underpins the UK's prosperity and quality of life.

- > Future factory for high performance electrical machines
- > Suite of traceable measurement capabilities
- > Bespoke reliability tests on materials, devices and interconnects
- > Custom semiconductor imaging equipment



15 Michelin Scotland Innovation Parc (MSIP)

MSIP is a dynamic and creative home for innovators, manufacturers and skills leaders who are actively working towards reducing carbon emissions and fostering a cleaner, more sustainable future. MSIP offers space to manufacture and scale-up; business, skills and innovation support; and access to green energy from sustainable sources.

- > Innovation Labs - workshops starting at 73m², designed for short-term, flexible project use, each includes standard power, with some offering 3-phase power and water
- > Makerspace - including mechanical and electronics labs, equipped with a 3D printer, laser cutter, pillar drill and various tools
- > The Skills Academy - offering access to resources including skills, training and equipment



19 Newcastle University

The Newcastle University Electrical Power Research Group has an established record of academic excellence and innovative, multidisciplinary, industrially collaborative electrification research, focusing on developing high-efficiency, power-dense electrical machines, drives and power converters. Research areas include semiconductor devices, switch control, converter topologies, thermal management, electric drives, electrical machine design, and energy storage. Specialist capabilities include:

- > Electrical Power Research Laboratory - extensive state-of-the-art test facilities
- > Battery, Power Systems, and Smart Grid Laboratories
- > Cleanrooms - class 100 for fabrication of custom (SiC) power devices and modules
- > Future Electrical Machines Manufacturing Workshop
- > Design Unit - electrical and mechanical manufacturing and test equipment, specialising in gear technology



16 National Composites Centre (NCC)

The National Composites Centre (NCC) is the UK's centre of excellence for the development and application of composite materials. The NCC specialises in identifying and solving challenging problems through the application of advanced design and simulation tools, expert knowledge of all kinds of composite materials and world-leading manufacturing facilities.

- > Open access technology testbed for advanced composites
- > Vast array of automated manufacturing processes
- > Tensioned fibre winding
- > In-process manufacturing control and inspection
- > Multidisciplinary design and simulation
- > High temperature materials (ceramic and polymer)
- > Broad range of integrity & verification technology
- > Life cycle analysis



20 Northumbria University

Northumbria University is a well-regarded research institution specialising in electrical power and control systems. Its Electrical Power and Control Systems Research Group researches various topics, including renewable energy, power electronics, electric vehicles, and related areas.

- > 3D rapid prototyping service - printing solutions with Computer Numerical Control (CNC) and conventional machining capabilities
- > Structural integrity testing - testing of prototype structures to explore failure modes, acceptance testing, and define design rules
- > Environment testing (Portable X-Ray Fluorescence (XRF) testing) - determining the chemical composition of materials, mobile air quality measurement and monitoring systems
- > Surveying, scanning and construction capability-LIDAR, photogrammetry and infra-red scanning



21 University of Nottingham

The Power Electronics and Electrical Machines Centre (PEMC) at the University of Nottingham is one of the largest groups of its kind worldwide, with over 170 researchers and 5,000m² of dedicated research and development space. The Centre hosts the UKEAPF (UK Electrification of Aerospace Propulsion Facility) and the Future Factory for High Performance Electrical Machines. PEMC research ranges from basic technology investigation to fully engineered advanced concept demonstrators, carried out in experimental facilities that allow realistic practical validation of novel components and systems.

- > Future Factory for Advanced Electrical Machines
- > Power electronics integration facilities
- > Power electronics characterisation facilities
- > UK Electrification of Aerospace Propulsion Facility



22 Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC)

The Nuclear AMRC helps companies in low-carbon industries to improve their manufacturing quality and performance. Core technology areas include digital engineering, controls and instrumentation, joining, machining and metrology. Based at the University of Sheffield, with additional facilities in Derby and Warrington, the Nuclear AMRC is part of the High Value Manufacturing Catapult.

- > Control and instrumentation laboratory, including equipment qualification through shaker tables
- > Production-scale workshop with advanced machining, joining and fabrication technologies
- > Additive manufacturing laboratory with capabilities for a variety of metals and polymers and 3D-printed electronics
- > Metrology laboratory, including large-volume gantry CMM and non-contact measurement
- > Digital engineering workshop, including industrial digital technologies testbed, and tracked mixed-reality cells



23 Offshore Renewable Energy (ORE) Catapult

ORE Catapult is the UK's leading technology innovation and research centre for offshore renewable energy. ORE Catapult's National Renewable Energy Centre in Blyth, Northumberland, is home to the world's most comprehensive open access research, test, innovation and validation services to accelerate the deployment of new and innovative offshore renewable energy technology.

- > 1MW Drivetrain test facility
- > 3MW Drivetrain test facility
- > 15MW Drivetrain test facility
- > 'e-Grid' grid emulation



24 PNDC

PNDC is an established whole systems (power, heat and transport) innovation facility with a significant track record in delivering accelerated development, testing and demonstration projects in a controlled, real-world environment for the energy sector and high-power/high-integrity transport applications, including aviation, marine, HGV, off-highway, and rail.

- > DER-funded high-power propulsion and powertrain systems validation capability
- > Power hardware-in-the-loop simulation and testing capability up to 1MW
- > Configurable 11kV and LV distribution network
- > MW-scale on-site generation
- > Real-time digital simulator (RTDS) for power system modelling
- > Gaseous hydrogen supply for testing power, heat and transport applications
- > EV charging test capability including 90kVA rated EV emulator, which offers bi-directional AC/DC (power supply or load)
- > Environmental chamber



25 University of Sheffield

The Electrical Machines and Drives (EMD) group at the University of Sheffield is renowned for its pioneering research on permanent magnet electrical machines. It hosts six industrially-funded research centres, including the Rolls-Royce University Technology Centre in Advanced Electrical Machines, the Siemens Gamesa Renewable Energy Research Centre, and the EPSRC Future Electrical Machines Manufacturing (FEMM) Hub.

- > Dynamometers – 15kW at 51,000rpm; 120kW at 18,000rpm; 250kW at 14,000rpm
- > Electrical test equipment including high-accuracy microhmmer; surge tester up to 6kV; 50MHz impedance analyser; and partial discharge measurement
- > Thermal test equipment including environmental chambers with 10kW load capability down to -55°C



26 The University of Sheffield Advanced Manufacturing Research Centre (AMRC)

The University of Sheffield Advanced Manufacturing Research Centre (AMRC) is a leading research centre specialising in advanced manufacturing technologies for aerospace, automotive, medical and other high-value industries. Alongside the wider PEMD activities at the University of Sheffield, the AMRC supports PEMD development, testing, and industrialisation. The AMRC has expertise in creating lightweight components for PEMD through machining (including shafts, hubs, gears), casting, additive manufacturing, and composites, plus specific capabilities including:

- > Rotor spin test facility including burst testing
- > Remote laser high-speed processing of electrical steels
- > Coil winding, shaping and pressing
- > High tension filament winding of rotor containment sleeves



27 University of Southampton

The Faculty of Engineering and Physical Sciences (FEPS) at the University of Southampton undertakes internationally leading research in energy storage, electronics, high-speed electric machine design, cryogenic and superconducting magnetic systems, and system integration in the fields of electric vehicles, rail, aerospace, maritime, and autonomous systems.

- > Testbed for 100kW superconducting electric machines at 60-77K
- > Electrochemical engineering laboratory
- > Towing tank
- > National wind tunnel test facility for aerospace and UAV testing



28 University of St Andrews

The University of St Andrews is renowned for its fundamental research in energy topics such as energy storage, sustainability and energy and ethics. The University has particular research strengths in low carbon technologies. Within its 'energy, environmental and sustainable chemistry' theme are topics such as materials for energy storage and synthetic fuels, solar energy, critical raw materials and pollution, which provide real solutions for today's world problems.

- > Electron microscope facility
- > Fabrication and prototyping facility
- > Dry room laboratory



29 University of Strathclyde

The University of Strathclyde's Institute for Energy and Environment (InstEE) is recognised as a leading academic research centre for electrical power systems, and energy and electrification technologies. InstEE is well resourced with cutting edge experimental infrastructure, supporting academic research, extensive industry engagement, and international cooperation. This sees the team advance the design, prototyping, testing and systems integration of power electronics for smart grids, microgrids, aerospace, marine and other heavy-duty transport applications. Alongside simulation suites and PNDC, the facilities available for industrial collaboration include:

- > Dynamic Power Systems Lab
- > Aero-Electrical Protection Lab
- > Power Electronics, Drives and Energy Conversion Lab
- > Applied Superconductivity Lab



30 Swansea University

The Centre for Integrative Semiconductor Materials (CISM) at Swansea University combines semiconductor and advanced materials platforms and processes to deliver technologies and products via an Open Access Fab Pilot model. CISM includes a facility for wafer-level processing of Silicon Carbide Power Electronic Components – the UK's national industrial pilot line for SiC power electronic components. R&I services include:

- > Advanced electron microscopy (TEM, SEM, FIB)
- > Surface chemical analysis and multi-functional scanning probe
- > Multi-wafer batch wet etch stations and comprehensive dry etch capability
- > Advanced atomic layer, physical vapour, chemical vapour, and molecular vapour deposition
- > Component modelling and design suite
- > Component stress and failure testing
- > Thin film analysis (ellipsometry, spectrophotometry)



31 Teesside University

Teesside University School of Computing, Engineering & Digital Technologies has two key research centres – the Centre for Sustainable Engineering and the Centre for Digital Innovation. Some of the research activities are focused on the decarbonisation of industry and society, using engineering approaches spanning the disciplines of electrical and electronic engineering, instrumentation and control engineering, chemical and materials engineering, civil engineering, computational mechanics, robotics, virtual reality, artificial intelligence, and biomechanics.

- > Simultaneous thermal analyser
- > Digitalisation of Power Electronics, Machines, and Drives
- > Circular economy and non-mechanical recycling
- > Materials for electrical machines in extreme environments
- > Electrical insulation materials



32 University College London (UCL)

Advanced Propulsion Lab (APL) is a cutting-edge electrical system engineering centre focused on developing and characterising high-power and energy, zero-carbon propulsion systems. The centre brings together experts in batteries, hydrogen generation and utilisation, electric motors, and power electronics to deliver research and teaching capabilities at scales directly relevant to industrial partners. The centre is designed to facilitate the creation, construction, characterisation, and validation of cutting-edge industrial-scale propulsion systems, leveraging this capability to support the UK's commitment to achieving zero-carbon targets.

- > Unique facility to develop, test and characterise batteries, fuel cells, power electronics drives and electric motors
- > Complete facilities for full electric system testing
- > Advanced packaging capabilities for system-on-chip



33 The Welding Institute (TWI)

TWI is a membership-based organisation helping individuals and companies to design, create and operate the best products possible. Descending from the British Welding Research Association (BWRA), TWI has grown into one of the foremost independent research and technology organisations, spanning innovation, knowledge transfer and problem resolution across all aspects of welding, joining, surface engineering, inspection and whole-life integrity management.

- > EB welding
- > LASER welding
- > Friction welding
- > NDT capability (PAUT, UT, XRAY)



34 The University of Warwick

The University's School of Engineering is home to the PEATER (Power Electronics Applications and Technology in Energy Research) Group, founded in 2005 to establish a world class centre for research into power electronics, power semiconductor devices and applications in power systems and power conversion. The focus is on electrical energy conversion and semiconductor switching devices. Developments in MOSFET and IGBT technologies are delivering new applications for electrification of vehicles, aircraft, ship propulsion, wind turbines and the revolution in mobile phone and computing devices.

- > Power electronics reliability suite
- > Clean rooms for manufacture and packaging of semiconductor devices
- > ISO class-8 packaging cleanroom
- > Power and control systems research laboratories
- > Chemical vapour deposition reactor
- > Doctoral training centre, industry learning and development courses



35 WMG at The University of Warwick

WMG is an academic department at The University of Warwick and the leading international role model for successful collaboration between academia and the public and private sectors, working with over 1,000 companies cross-sector. WMG is also a High Value Manufacturing Catapult (HVMC) Centre, driving growth and productivity by accelerating and de-risking innovation to deliver powerful solutions for industry. The WMG Centre leads for HVMC on net zero mobility, with major roles in energy / electrification, intelligent vehicles and digital technologies.

- > Winding Centre of Excellence
- > PEMD Manufacturing In-process Testing facility
- > Wireless charging
- > Advanced Propulsion Research Laboratory
- > Advanced Steel Research Centre
- > Energy Innovation Centre – battery materials scale-up line (mixing, coating and cell building, characterisation, and in-use / abuse testing)
- > Industry learning and development provision through the WMG Skills Centre



Industry Engagement

Inverter Testing Facility at The University of Warwick



Innovative inverter testing equipment has been developed by Professor Phil Mawby and his team at The University of Warwick's School of Engineering following almost £900k of funding from the Driving the Electric Revolution Challenge. The University's WMG Centre High-Value Manufacturing Catapult (HVMC) also contributed £300k of funding.

The equipment has been designed to help speed up the development of electric vehicles (EVs) and reduce testing costs for British manufacturers. The facility was used for the first time by the premium car manufacturer BMW to test a new power inverter.

Previously, car manufacturers tested inverters with motors at high-cost dynamometer facilities with concrete bunkers that contained high-speed equipment failures. This newly designed equipment is smaller, less costly, more accessible and allows manufacturers to test components in isolation - i.e. the inverter - without the motor. This technology is also applicable to other sectors.

BMW is one of the businesses behind @FutureBev, a project group made up of six partners, including The University of Warwick and CSA Catapult, who have come together to develop a UK supply chain that can support the transition of BMW to SiC-based power electronics in their future generations of BEV (Battery Electric Vehicle). This will ensure competitive powertrains in function and costs and enable UK technology transformation to zero-emission mobility.

Low Carbon Transport Applications Centre (LOCATE)

As part of DER-IC Scotland, the Hydrogen Accelerator has attracted £4M of investment from Transport Scotland to fund the new LOCATE facility (Low Carbon Transport Applications Centre). The project is being led by the Hydrogen Accelerator (University of St Andrews and University of Strathclyde). This is part of a pipeline of support preceded by the DER funded equipment at PNDC (University of Strathclyde) which provides sub-systems and powertrain testing and de-risking prior to platform-level testing at LOCATE.

DER-IC has helped to facilitate this partnership through its connections with partners the University of St Andrews, which specialises in batteries, fuel cells and hydrogen, and the University of Strathclyde, which has expertise in energy systems, power electronics, machines and drives. LOCATE provides a first-of-a-kind, platform-level, route-to-market Power Train Test Bed (PTTB) for hydrogen fuel cell and battery electric drive trains.

LOCATE will form part of a Low Carbon Transport Programme being jointly developed between Scottish Enterprise and Transport Scotland. The LOCATE test facility will provide an 'emulated' representation of real-world duty cycles for various heavy-duty road/niche vehicles. This replaces and brings forward what would traditionally have been on-road testing. It is aimed at platform-level testing at TRL levels 5-7 and will reduce the cost and time spent marketing for the users.



UK-Alumotor



The Ricardo UK-Alumotor project received two phases of funding from the UKRI Driving the Electric Revolution Challenge fund. A consortium of key industry partners were formed to develop the UK's electric motor supply chain by leveraging its manufacturing expertise to deliver the next generation of sustainable electric motors. DER-IC network partner Warwick Manufacturing Group (WVG) was part of the consortium along with Ricardo, Aspire Engineering, Brandauer, Phoenix Scientific Industries and Global Technologies Racing.

Throughout the project, the partners identified and developed preferred manufacturing processes which are suitable for volume production of the patented motor design from a UK supply chain, whilst refining the design to meet the future requirements of their UK and international stakeholders. The project supported the UK's net zero ambitions by developing a more affordable, environmentally sustainable design which displaces the need for scarce material resources, resulting in a greener and more affordable solution to support the mass adoption of electrification. Training the next generation was also a focus and UK-Alumotor was committed to growing the UK's PEMD manufacturing capability and training the next generation of skilled engineers and technicians, positioning the country at the forefront of the global electric revolution.



H2GEAR

The **H2GEAR** programme involves leading academics at Newcastle University's School of Engineering, led by GKN Aerospace will be at the heart of the technological developments needed for the future of more sustainable aviation.

The programme has access to equipment at the DER-IC North East in Sunderland, including a power electronics assembly line and a flexible electric machines assembly line. The Newcastle University team will use their understanding of electronic materials, power electronics and electrical power networks to develop an ultra-high efficiency power and propulsion system that will provide the backbone of this advanced technology.

The programme will develop a cryogenically enhanced propulsion system for short-distance aircraft that could be scaled to larger aircraft. Liquid hydrogen is converted to electricity within a fuel cell system, which efficiently powers the aircraft and eliminates all harmful CO₂ emissions. H2GEAR will create a new generation of clean air travel and reinforce the UK's position at the forefront of aerospace technology research and development. Newcastle University's collaboration with GKN Aerospace, Intelligent Energy, Aeristech, University of Manchester and University of Birmingham are expected to create more than 3,000 jobs in the next decade.

The programme is supported by £27M from Aerospace Technology Institute funding, matched by GKN Aerospace and its industrial partners to make a total investment of £54M.



Key features and benefits:

Rare-earth magnet-free synchronous-reluctance traction e-motor concept with aluminium stator windings

Designed with supply chain security and environmental sustainability in mind

Low cost

Oil cooled within rotor and stator plus spray jets

Voltage: nominal 800 VDC

Scalable to a variety of applications

Robust design

Power density: 2.4 kW/kg

Efficiency: 93%

Testimonials



@FutureBEV with Warwick University is demonstrating the ability of industry and academic partners coming together to deliver accelerated technologies to market. The access to a strong academic base with matched development and test hardware enables rapid implementation of ideas from drawing board to real hardware. The investment from DER-IC is one of the enablers for this ensuring the facility is tooled with the latest test equipment, meaning the university is ready and able to support business. The @FutureBEV team directly benefit from quick access to the BEV specific test equipment enabling risk reduction as well as improving the change of emerging technologies to be implemented in new designs. The net benefit is through this collaboration we can bring these CO₂ reducing technologies to the road quicker whilst keeping the business case and enabling a next generation of engineers."

David Bock,
Project and Technical Lead
for @FutureBEV,
BMW Group



Rolls-Royce believes the DER Industrialisation Centres play an important role helping the supply chain to access both manufacturing process development and scale-up and test capabilities, and that they will ultimately support us as we develop our electrification capability and solutions."

Eddie Orr,
Head of Research Partnerships,
Rolls-Royce Electrical



It is essential that the UK reacts quickly to the growing market demand for electric motors and power electronics systems, scaling up capacity at every level within the supply chain. AEM is already working closely with the DER Industrialisation Centres to deliver a truly sustainable end-to-end supply chain for our unique, rare earth free, high performance motor technologies."

Mike Woodcock,
Chief Commercial Officer,
Advanced Electric Machines

Driving Innovation in PEMD

Power Electronics, Machines, and Drives (PEMD) are essential for critical control and motion technologies in various sectors.

DER-IC comprises a UK-wide network of over 30 universities and Research and Technology Organisations (RTOs). Each partner contributes unique expertise, specialist knowledge, and advanced capabilities to drive innovation in PEMD technologies.

Contact your regional DER-IC Centre:

North East
northeast@der-ic.org.uk

South West and Wales
southwestandwales@der-ic.org.uk

Scotland
scotland@der-ic.org.uk

Midlands
midlands@der-ic.org.uk





Driving the
Electric Revolution
Industrialisation Centres

Visit our
website



www.der-ic.org.uk
info@der-ic.org.uk

 [DER_IC_UK](#)
 [DER Industrialisation Centres](#)



Innovate
UK

The funding is provided through the UKRI's Driving the Electric Revolution Challenge, delivered by Innovate UK.