

Driving the  
Electric Revolution  
Industrialisation Centres

## Industrial Engagement and Challenge Proposal – Power Electronics and Integrated Motor Drives

CPE Conference 6<sup>th</sup> July 2022

Accelerating Power Electronics, Machines and Drives  
Supply Chain Capability and Growth



# Driving the Electric Revolution is a UKRI funded cross-sector challenge in transport, energy and industry



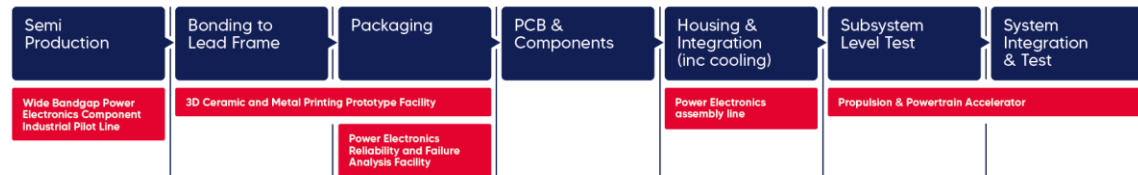
*Power Electronics, Machines & Drives (PEMD) are essential to next generation technologies:*

- All UK cars to be zero carbon by 2035 (no 100% internal combustion engine from 2030)
- New aircraft to be electric/hybrid to meet next phase emissions and noise legislation by 2040
- Renewables (Wind, Wave, Tidal) to form an increasing % of energy generation (80% CO<sub>2</sub> reduction by 2050)
- High speed rail network to grow, no new diesels after 2040
- Marine transport's target to be 50% CO<sub>2</sub> reduction by 2050
- PEMD supports the realisation of the industrial digital technology (IDT) revolution – Industry 4.0

# Driving the Electric Revolution – Industrialisation Centres, £33m

- A UK-wide network of PEMD capability, led by Newcastle University
- Four regional centres – Scotland, North-East, Midlands and South-West & Wales
- Nine gap-filling suites of PEMD development and testing equipment

## Power Electronics




## Electrical Machines





- Enhancing and providing open access to £300m+ of existing capability across more than 30 RTO and academic partner organisations



# DER-IC New Equipment Locations


 **University of Strathclyde Glasgow**  
Propulsion and powertrain systems validation capability at MW scale with hardware in the loop.


 **UNIVERSITY OF BIRMINGHAM**  
A production line to for recycled sintered magnets with 'end to end' supply chain to enable UK supply of recycled rare earth magnets from processed oxides for more secure UK supply.


 **CATAPULT**  
Compound Semiconductor Applications  
A facility to prototype ceramic and copper elements and sub-assemblies within highly integrated PE modules..


 **Swansea University Pritysgul Abertawe**  
A Wide Bandgap Power Electronics Component Industrial Pilot Line.



 **Newcastle University**  
Reconfigurable **Power Electronics assembly line** for semi or fully integrated high-power density drives.  
**Flexible electric machines assembly line** which includes stator, rotor assembly, chemical dispensing, automated machine assembly line end of line testing.

 **University of Nottingham**  
UK | CHINA | MALAYSIA  
A High Frequency Coil Manufacturing and Magnetic Test Characterisation capability to develop and manufacture electrical Machines to operate at higher frequencies.

 **WARWICK**  
THE UNIVERSITY  
A Power Electronics reliability and failure analysis facility.

 **WVG**  
WINDING CENTRE OF EXCELLENCE  
A Winding Centre of Excellence facility to manufacture all types of windings at production quality; specialising in hairpin stators.

# DER-IC network partners

## National reach through regional centres

- Enhancing and providing open access to £300m+ of existing capability across more than 30 partner organisations
- Regional centres facilitate access to industry clusters and support from SME to large OEM
- To deploy recognised PEMD industrialisation expertise
- To leverage regional and devolved funding for industry
- A strong collaborative approach

## Network partners

### North East:

AMRC  
CPI  
Newcastle  
Northumbria  
OREC  
Sheffield  
Teesside  
TWI

### Scotland:

AFRC  
Edinburgh  
Glasgow  
MSIP  
NMIS  
PNDC  
Strathclyde  
St Andrews

### Midlands:

Coventry  
Loughborough  
Manchester  
MTC  
NAMRC  
NCC  
Nottingham  
NPL  
Southampton  
Surrey  
UCL  
Warwick  
WMG

### SW & Wales:

Swansea  
Birmingham  
CSAC

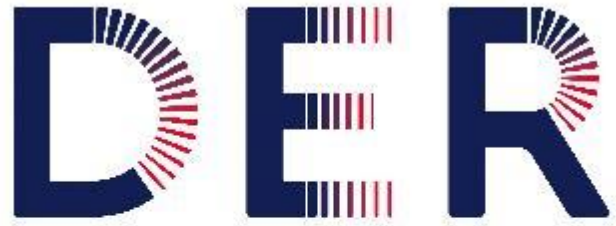


## How we deliver benefits for UK plc

- **Investing in state-of-the-art equipment** for industrial partners to accelerate capability, capacity and competitiveness in PEMD technologies
- Identifying **industry challenges** and **engaging with academia** to accelerate research and development activities to address these
- Building on UK **academic excellence**
- Developing a **UK PEMD supply chain** essential to achieving **2050 climate commitments** and the Government **Net Zero** agenda
- Growing PEMD **engineering talent** to meet industry needs

## How we work

- In **collaborative partnerships** in CR&D projects – UKRI and EU funded
- In **direct commercial projects** with industrial partners



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# APC Roadmaps and Industry Challenges



# Products vs technology roadmaps

## Product Roadmaps



Light Duty  
Vehicle <3.5t



Heavy Goods >3.5t &  
Off-highway Vehicle



Bus & Coach

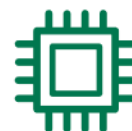
## Technology Roadmaps



Electrical  
Energy  
Storage



Lightweight  
Vehicle &  
Powertrain  
Structures



Power  
Electronics



Fuel Cell



Electric  
Machines



Thermal  
Propulsion  
Systems





This roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology forecast for mass market adoption. Specific application-tailored technologies will vary from region to region.



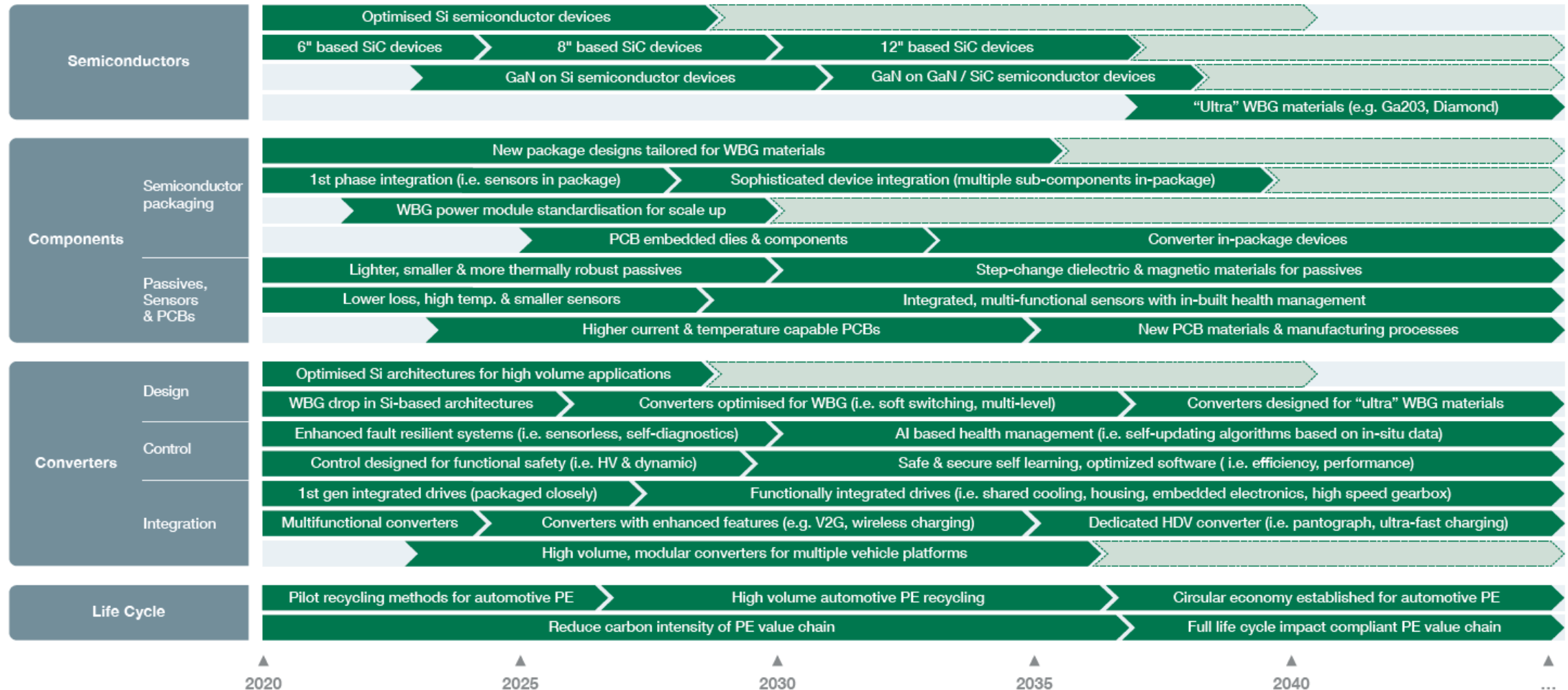
**Dark bar:**  
Technology is in a mass market application. Significant innovation is expected in this time frame



**Transition:**  
Transitions do not mean a phase out from market but a change of R&D emphasis



**Dotted line bar:**  
Market Mature – technology has reached maturity. Likely to remain in mass market until it fades out where it's superseded



# A Focus on Manufacturing Process Challenges

- The Driving the Electric Revolution challenge has a focus on building supply chain capability, capacity and competitiveness
- From the APC Roadmaps, we have distilled some key manufacturing related challenges to join up industry challenges with academic capability
- Our challenge for CPE conference delegates:
  - Are any of these in your areas of research or development interest?
  - Are you already engaged in work that can be linked better with industry?





# Power Electronics Challenges

- Scaling up wide-bandgap manufacturing
  - Identifying commonality in Si and wide-bandgap device manufacturing and adjusting processes to create reduced cost manufacturing capability for wide-bandgap devices
  - Improve GaN-on-Si epitaxy processes to increase yield rates and enable GaN based semiconductors to be used for automotive
  - Manufacturing methods that enable diamond and Gallium Oxide based power semiconductor materials to become viable

# Power Electronics Challenges

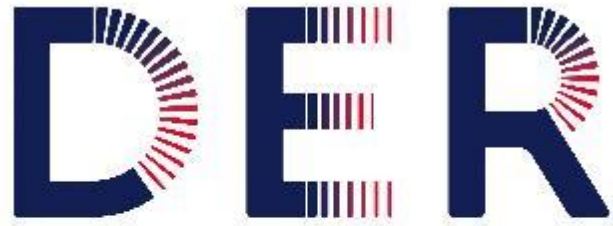
- Improved inverter performance
  - Enhanced thermal management for inverters (e.g., immersion cooling or advanced liquid cooling plates) to reduce stress during peak acceleration / regeneration events
- Reduce the life cycle impact of power electronics, from production to end-of-life
  - Liquid cooling plates to reduce stress during peak acceleration / regeneration events
- Accelerated, high-fidelity testing and validation capability
  - Improved accelerated test methods and non-destructive evaluation/validation for PE components and packaging
  - Development of co-design tools for WBG devices



# Drives Challenges

- Lightweight, high performance integrated EDUs
  - Multi-material casing and housing solutions to reduce weight and maintain structural integrity (i.e., metal matrix composites in rotors, composite housings)
- Managing noise, vibration and harshness
  - Electrical isolation of power electronics and windings to reduce electrical interference and harmonics
- Assembly and disassembly solutions for integrated drives, serviceability and fault avoidance
  - Additive layer manufacturing of high performance, functionally integrated drives that achieve a step change in power density





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## An Industry View

Dr David Moule  
Technical Specialist – Electric Drives  
ZF Group





# Coffee break challenge

## Purpose

- To identify high priority industry challenges and engage academia to accelerate research and development activities to address these

## Coffee break challenge questions:

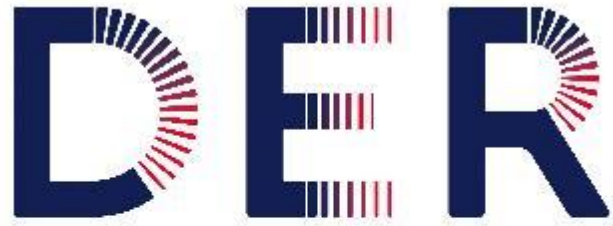
- Integration or modularisation in PEMD technologies?
- How do we accelerate cross-sector knowledge development?
- Are you working on something that is ready for industry partners?
- Have you any other questions/comments you would like to pose?

# Next Steps – Thank you!!

- We will gather all of the discussion and inputs
- Workshop to capture multiple sector challenges and gain consensus on priorities
- Promote the opportunities to industry through the IET and DER-IC websites and other media – articles, thought leadership, etc
- Propose the priority opportunities to funding bodies to achieve focus and speed
- Establish an ongoing process to review progress and add new opportunities for collaboration between industry and academia







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