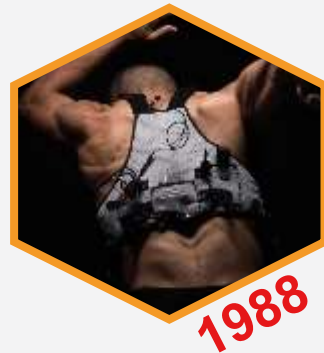




ESCAPE - End-to-end Supply Chain development for Automotive Power Electronics

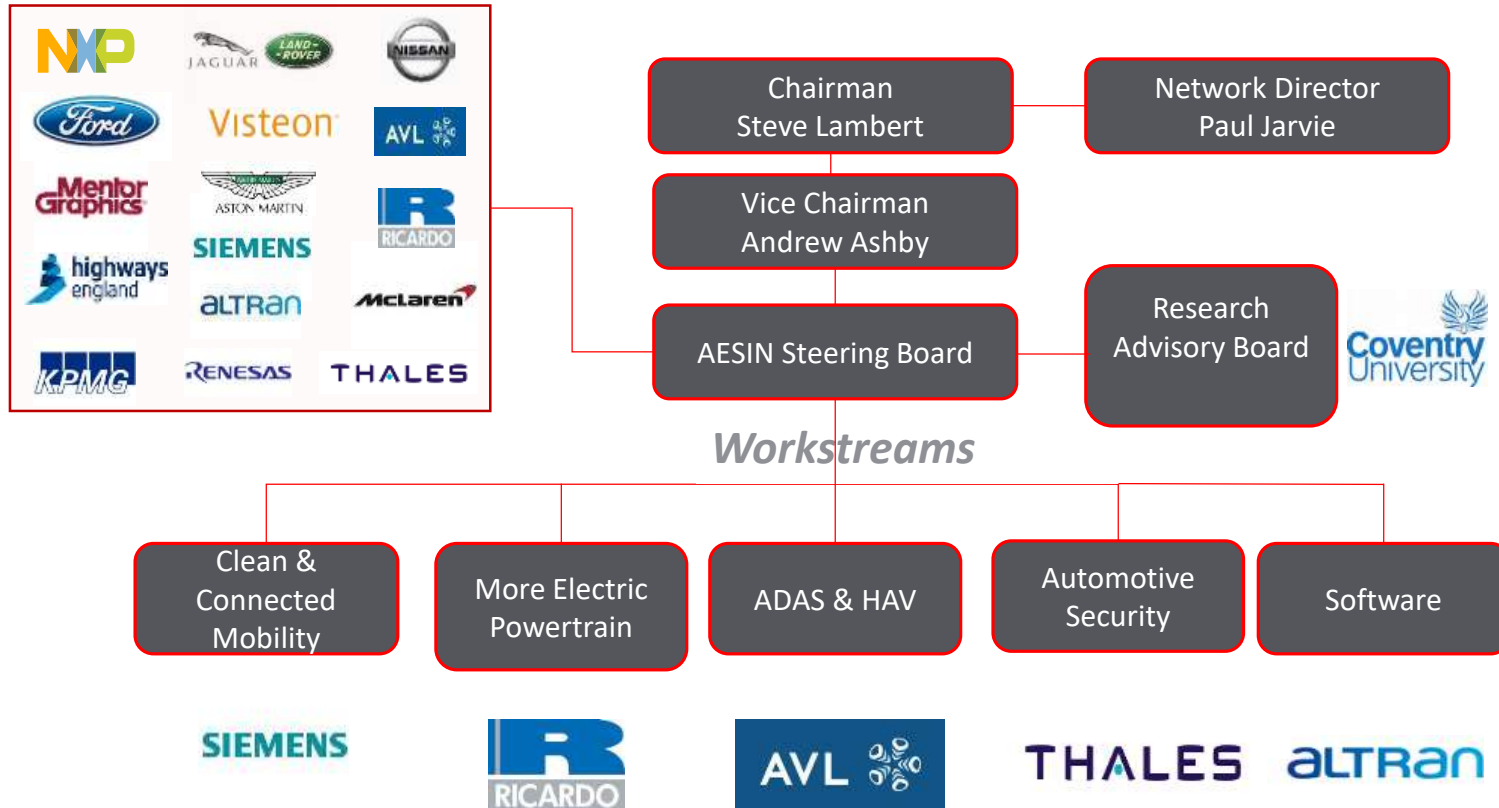
5th September 2019







AESIN Organisation & Work Streams





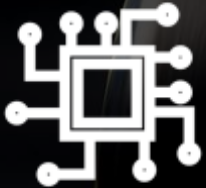
ESCAPE Introduction



ESCAPE is a multi-million pound project, incorporating 12 partners, part funded by the Advanced Propulsion Centre



ESCAPE will build a secure UK end-to-end supply chain capable of competing globally



ESCAPE will produce game changing technology supporting the drive for electrification UK and worldwide



Successful exploitation of **ESCAPE** will Result in further UK investment in SiC R&D and capital expenditure



The Opportunity



Supply Chain Reliability

- Lead time/availability/obsolescence
- Cost/Quality
- Packaging disparity
- Automotive qualification

UK Opportunity

- Materials to finished products
- Large export market (not limited to automotive)

Non UK Competition

- Japan, Germany, US and China are investing to create domestic supply chains
- Opportunity for UK differentiated supply chain aligned to high value industry requirements



Why Silicon Carbide (SiC)?

60% Reduction in Total Inverter Losses
Typically 95% - 98% incremental improvement over IGBT
>5% increase in EV range



Reduced aerodynamic requirements



Easier to package and reduced radiator size required for cooling

Reduced overall vehicle mass



Lighter inverter
Lighter motor
Reduced cooling

TRL/MRL levels are at the right level for exploitation



Unlike other competing technologies, such as GaN

Extended EV range/smaller battery



Reduces EV barriers to entry



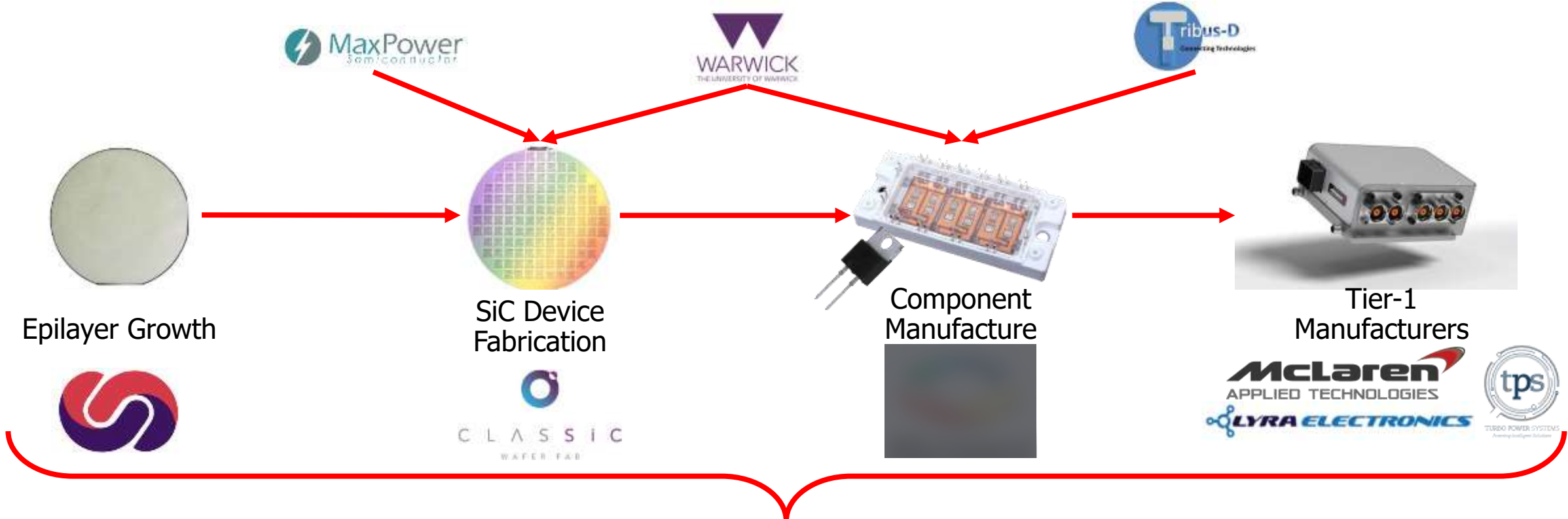
Project Aim, Objectives and Scope

To establish a globally unique and cohesive end-to-end supply chain capability for innovative SiC power electronics designed to service UK and global end user demand

- Drive capability through embedding the CSA Catapult as the enabler for UK SiC power electronics integration and innovation
- Alignment of the UK SiC supply chain to be capable of the end-to-end supply of materials and parts to support UK power electronics manufacturing
- Development of tier-1 products, based on a robust, secure and integrated supply chain, to production-ready solutions
- Alignment of OEM requirements to ensure UK supply chain sustainability and aid the disruption of the market through SiC technology sooner
- Scale-up investment in UK SiC fabrication will be covered through other funding routes



ESCAPE PROJECT PARTNERS



CATAPULT
Compound Semiconductor Applications

AESIN
ULTRAPOWER ELECTRONICS MANUFACTURING

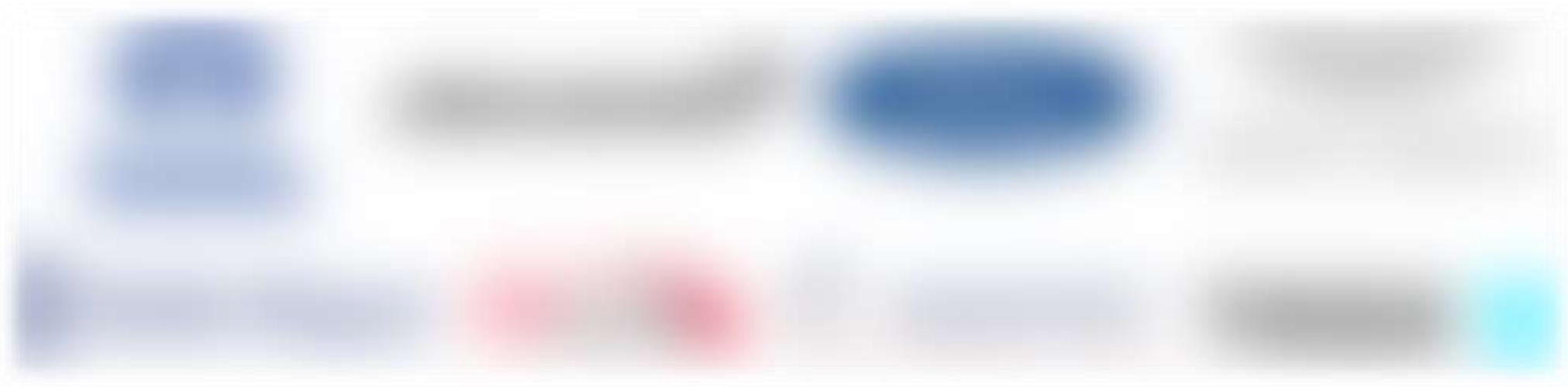
Zelenergy



ESCAPE Steering Group

High Level of Multi-Sector Market Pull and Interest

If you are interested in joining the steering group, please get in contact





Significant Project Innovations



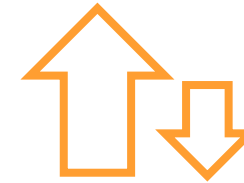
Supply Chain Innovation

- Co-design of innovative solutions through the supply chain
- Embedding the capability for future UK innovation and access



Device Innovation

- Development and implementation of new vertical trench MOSFET with reduced die size
- Transfer of process to 6" wafers, increasing die count and reducing cost



Packaging Innovation

- Development and implementation of novel embedded and miniaturised packaging techniques
- Improved thermal management, leading to higher power densities



Inverter Innovation

- Optimised SiC inverter design for automotive applications



DC/DC Converter Innovation

- High power DC/DC converter enabling novel vehicle



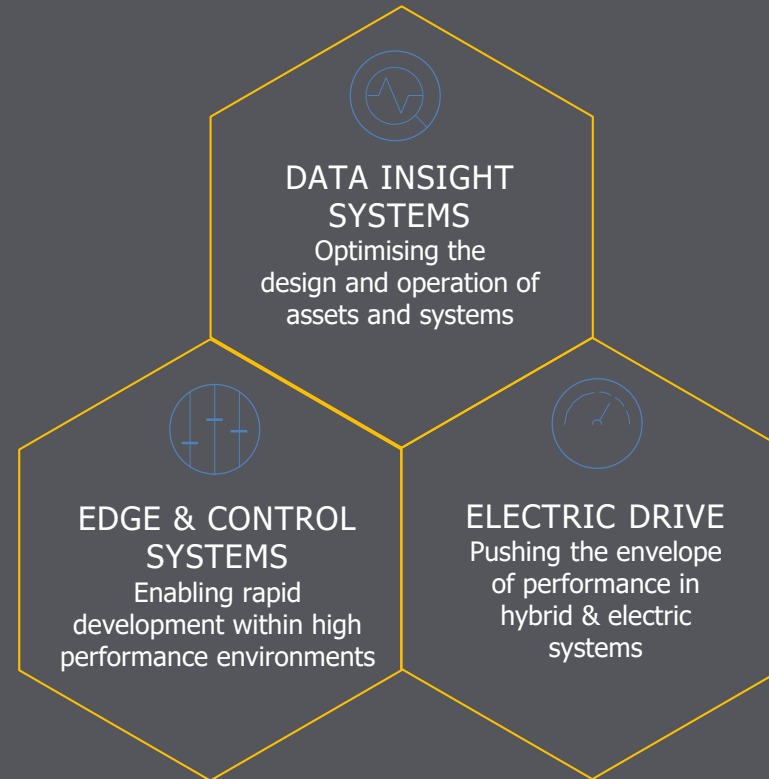
Charger Innovation

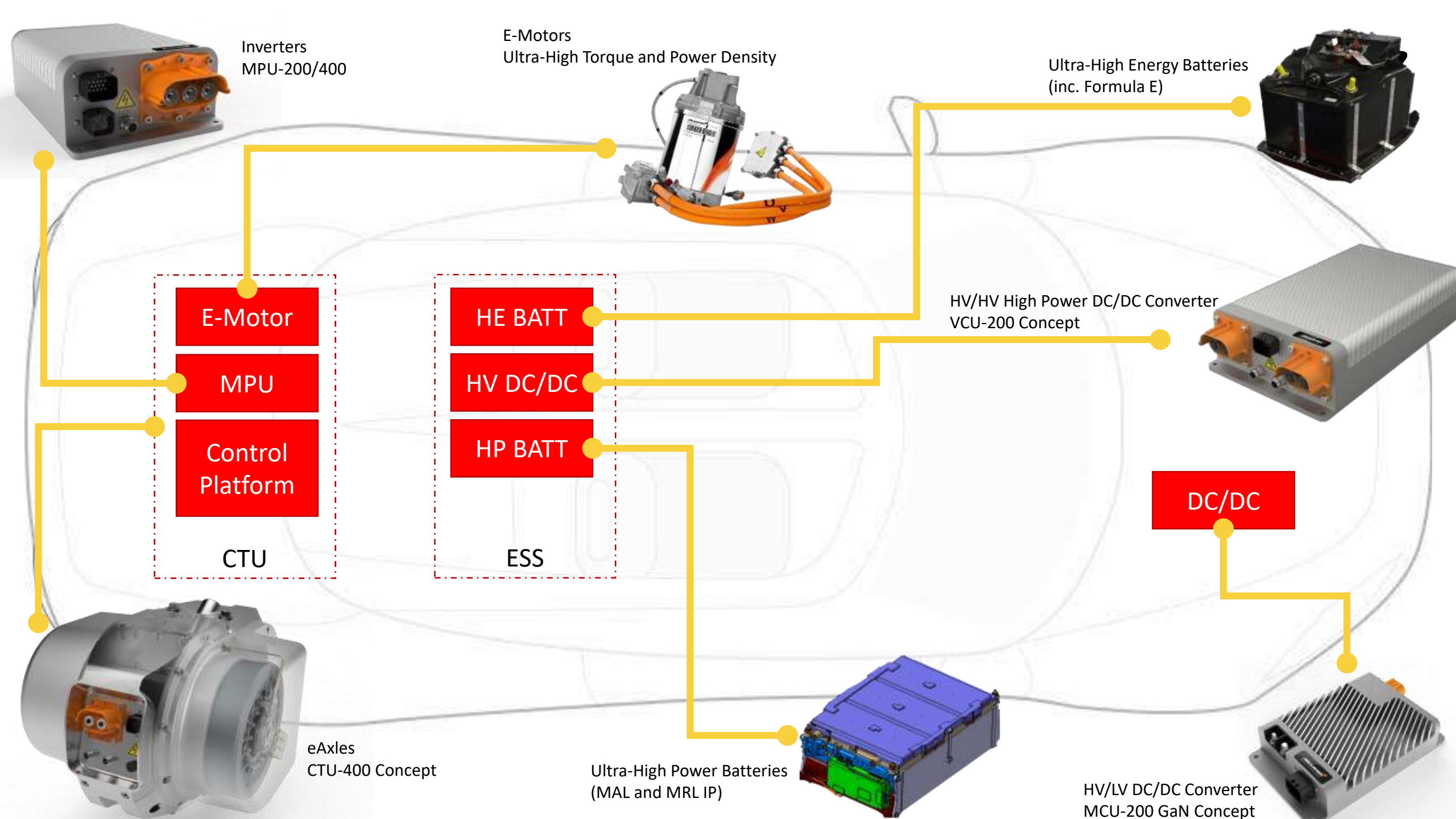
- Electric vehicle charger, connected to the medium-voltage grid



McLaren Applied Technologies

Automotive Technologies

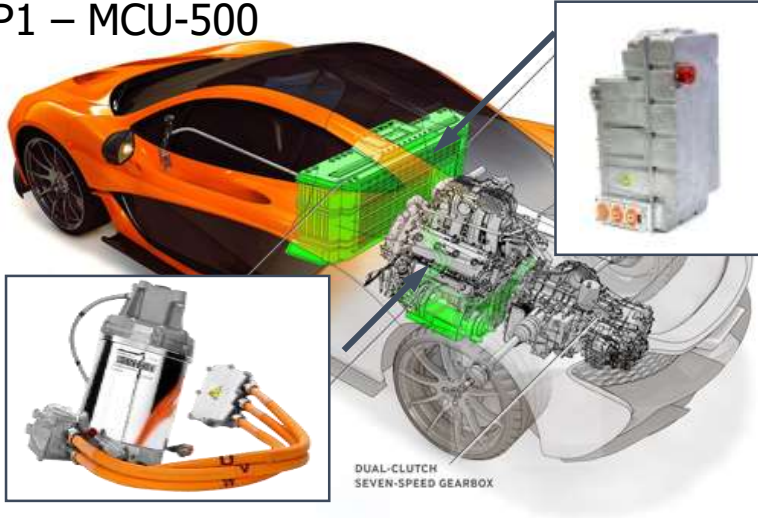






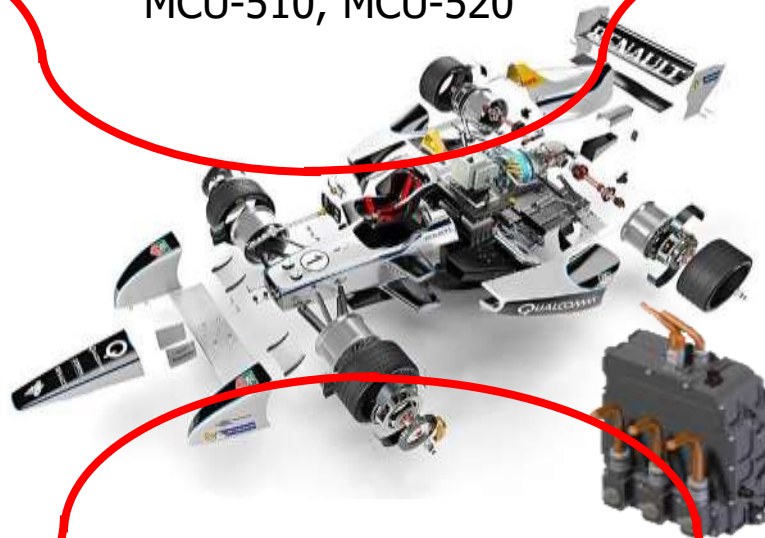
MAT Inverter Journey

P1 – MCU-500



Formula E

MCU-510, MCU-520



Formula 1 - MPU-320, MPU-324, MPU-325



MPU-600, MPU-360

Next Generation MPU





Inverter Innovations

MPU-200 Specifications

- **500-900V Operating range**
- **<5kg**
- **3.2 litres**
- **>400A_{rms} Capable**

Safety Features

- **Functional Safety to ASIL D**
 - (Assumed direct drive, TV etc)
- **Active short circuit**
- **IEC60664, ISO64469 etc**

Software Control

- **MAT Automotive GDE or AUTOSAR**
- **MAT GDE for Motorsport**
- **Domain controller for torque arbitration**

Interfaces

- **TBC (CAN, Flexray, Broad-R Reach etc)**

2x3Ph Version also Possible

- **<9kg, 6.3 litres**





Conclusions

- UK has almost lost its Si manufacturing capability
 - This project is an opportunity to support and grow long-term UK SiC supply chain and associated capabilities
- SiC technology underpins the electrification revolution
 - This project will place the UK as a global leader in SiC powertrain innovation
 - Supports the transition from ICE to EV for UK OEMs
- McLaren Applied Technologies is developing a game changing inverter solution
 - With power density greater than the APC target for 2035

McLaren