Collaborating to build the UK's Power Electronics Supply Chain

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McLaren Applied

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Overview

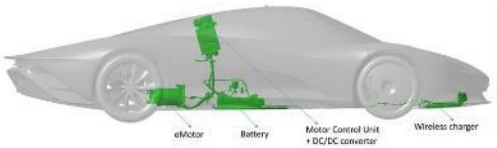
McLaren Applied is a Tier 1 supplier developing and manufacturing future-focussed, sustainable products

McLaren Applied's Power Electronics Journey

Inverter History

Gen 1.0
120kW
IGBT
2013 SOP

Gen 1.3
230kW
IGBT
2019 SOP



Gen 1.1
170kW
IGBT

Gen 1.2
200kW
IGBT

FORMULA·E

Gen 3.1
200kW
SiC

Gen 3.2
200kW
SiC

Gen 4.5
250kW
SiC

Gen 2.0
SiC

Gen 3.0
SiC

Gen 4.0
SiC

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

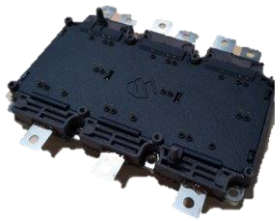
Technical Consultation & Hardware Testing

VISHAY · WARWICK THE UNIVERSITY OF WARWICK · Tribus-D Connecting Technologies

Hardware Development & Manufacture

Epilayer Growth

Device Fabrication



Component Manufacture

Tier-1 Manufacturers

Clas-SiC WAFER FAB · MICROCHIP · McLaren APPLIED · tps TURBO POWER SYSTEMS · LYRA ELECTRONICS

Technical Acceleration & Market Engagement

AESIN AUTOMOTIVE ELECTRONICS INNOVATION · CATAPULT Compound Semiconductor Applications · exawatt

UKRI Innovate UK · ADVANCED PROPULSION CENTRE UK www.apcuk.co.uk

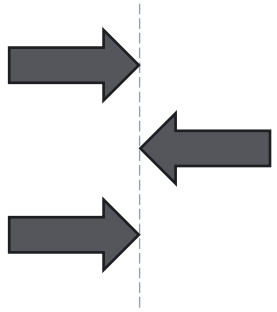
AESIN · CATAPULT Compound Semiconductor Applications · Clas-SiC WAFER FAB · exawatt · LYRA ELECTRONICS · VISHAY · McLaren APPLIED · MICROCHIP · Tribus-D · tps · WARWICK THE UNIVERSITY OF WARWICK

Project Objectives & 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

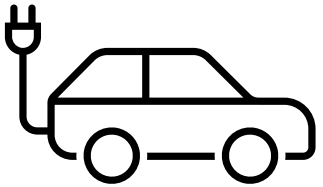
Drive power electronics innovation capability

UK supply chain alignment



Tier-1 product development

Alignment to OEM requirements



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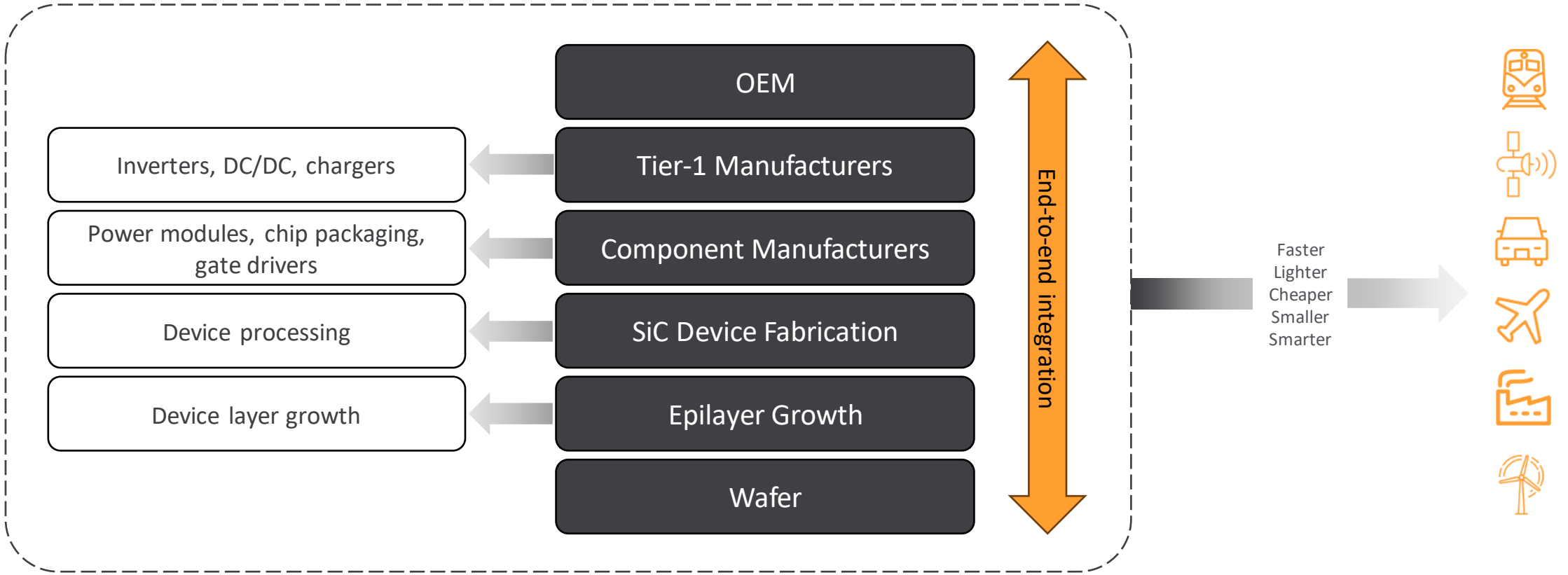
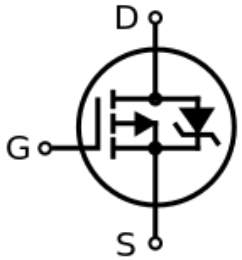


Technical Objectives

Supply Chain Innovation

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



Vishay & ClasSiC

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

Microchip & Tribus-D

- Development and implementation of novel embedded and miniaturised packaging techniques
- Improved thermal management design

McLaren Applied

- Optimised SiC inverter design for electrified applications

Lyra

- High power DC/DC converter enabling novel vehicle topologies

Turbo Power Systems

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

Partners & Responsibilities

Work Package 1
Epilayer Manufacturing & Development

Work Package 2
SiC Fab Preparation

Photo Illuminescence

Next-gen MOSFET

Work Package 3
Device Packaging

Innovative Packaging

Bacchus Packaging

Aurora Packaging

Work Package 5
DCDC Converter Development

Work Package 7
Charger Development

Work Package 6
Inverter Development

Work Package 8
Market Analysis

Work Package 9
Dissemination & OEM Engagement

Work Package 11
SiC Power Electronics Integration

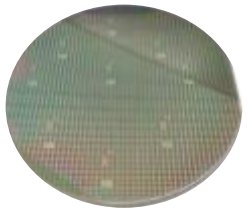
Key Outcomes

Work Package 2
SiC Fab Preparation

- **Next-gen MOSFET**
- **Photo Illuminescence**

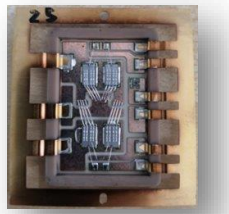
Work Package 3
Device Packaging

- **Bacchus Packaging**
- **Aurora Packaging**



Next-gen vertical trench MOSFET

Novel technology for device inspection

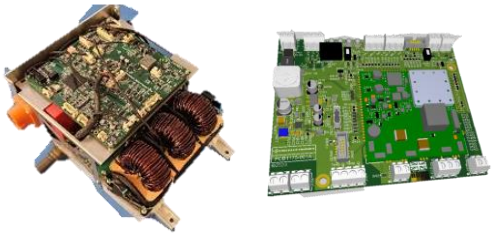


80A half-bridge package

450A 3-phase package

Key Outcomes

Work Package 5
DCDC Converter Development



High-power DCDC Converter
CCS communications device

Work Package 6
Inverter Development

IPG5 800V SiC Inverter

Work Package 7
Charger Development

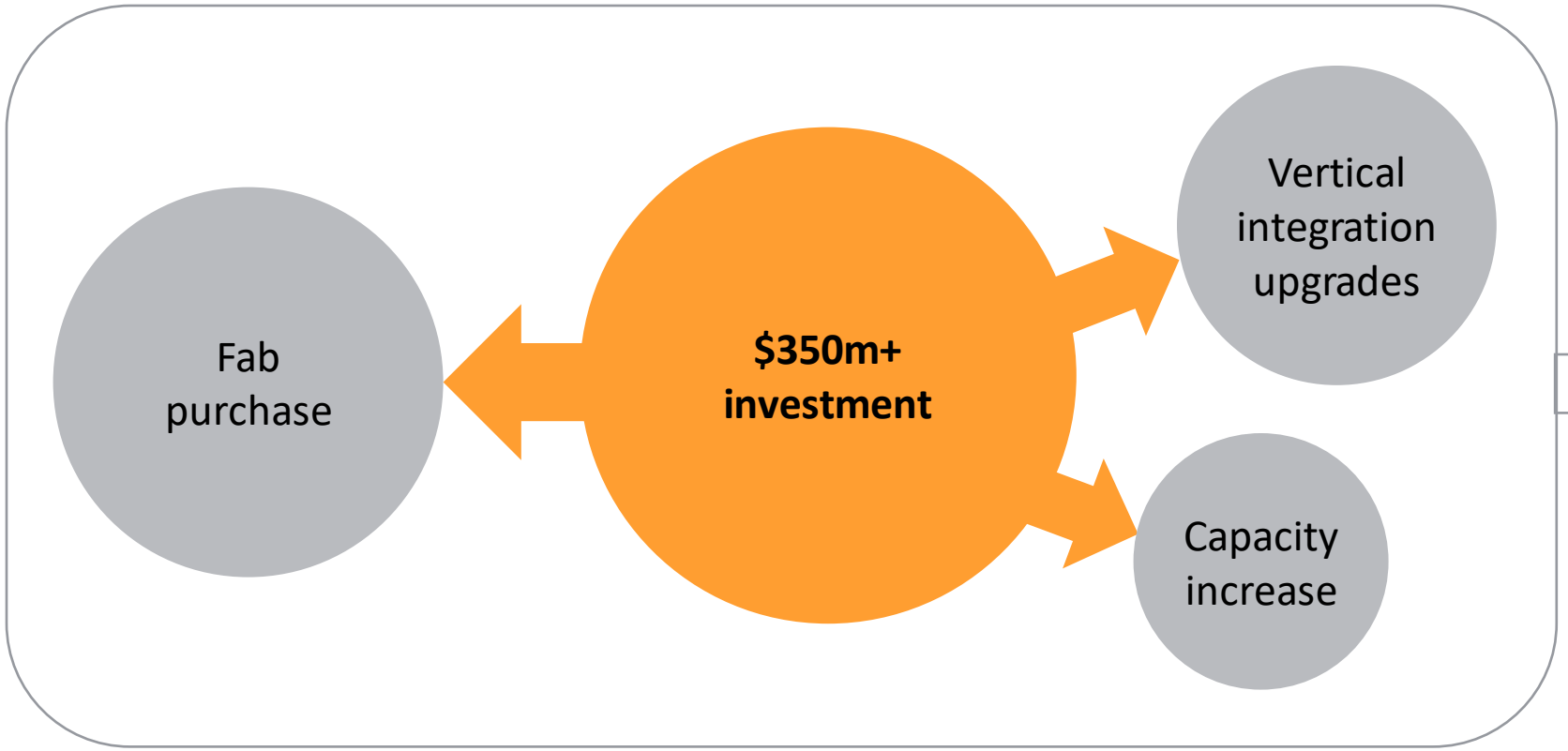
Velox Fleet EV Charging point
MV/LV Module (Bacchus 2)

Vishay acquisition of & investment into Newport Wafer Fab

VISHAY NEWPORT WAFER FAB

"With the acquisition of the Newport Wafer fab, Vishay will be able to provide the quality and scale required for its SiC portfolio... This effort is aligned with Vishay's goal to be prepared to meet the supply demands in the e-mobility, sustainability, and connectivity marketplaces."

Amr Darwish
Senior Director, Product Marketing & Market Development, Vishay



- 150mm wafer prod. starting **H2 2026**
- Pilot line for 200mm wafers in parallel
- **Full transition to 200mm by 2028**

- Initial capacity of **500k units per month**
- Increasing up to **20x by 2028**

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CO_2 Saving

Average UK ICE vehicle
25 miles per gallon
7,500 miles per year
15-year lifespan for vehicle

Average ICE vehicle emissions
8.89kg of CO_2 per gallon burnt
2,667kg of CO_2 per year
40 tonnes of CO_2 over lifetime

McLaren APPLIED	Pipeline ramps to 10k inverters/avg. **5k vehicles per year**
VISHAY	500k traction devices/month = 100k inverters/**50k vehicles per year**
tps LYRA ELECTRONICS	Several streams of commercial opportunities

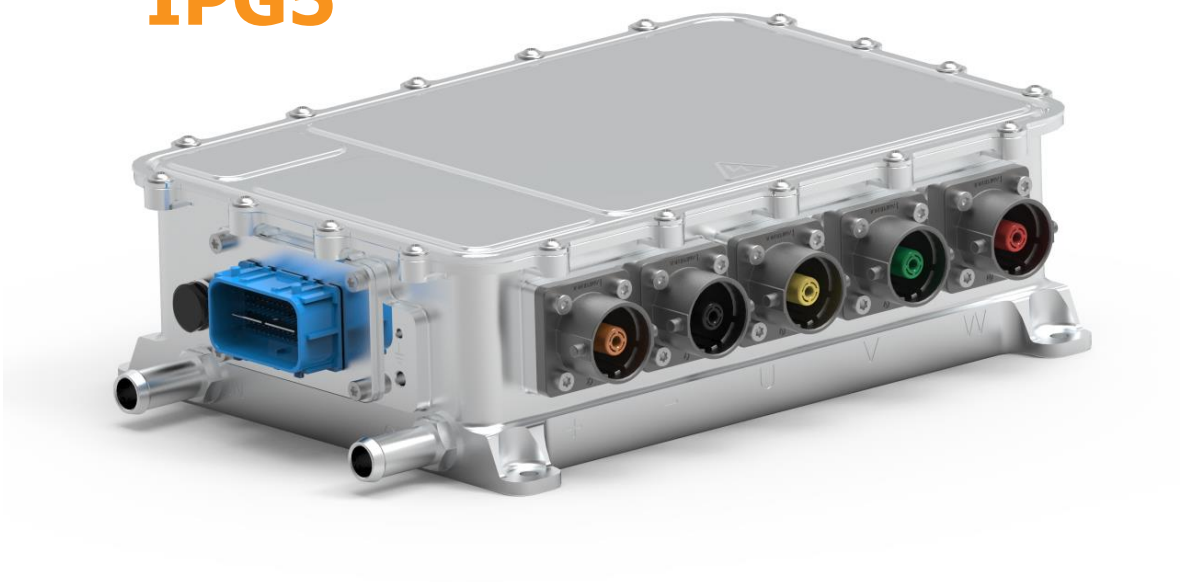
Contribution to **100,000s** of electrified vehicles over next **5 to 10 years**

ESCAPE contributes to a reduction of on-road CO_2 emissions of **several million tonnes of CO_2**

McLaren Applied – Project Responsibilities

Development of **5th generation** inverter, using **800V Silicon Carbide** architecture

IPG5



Supports ultra-fast charging
450-900V HV Input

Lightweight & compact
5.5kg & 3.88L

Class-leading power density
>85kVA/kg >125kVA/L

High Efficiency
97% typical, 99% peak

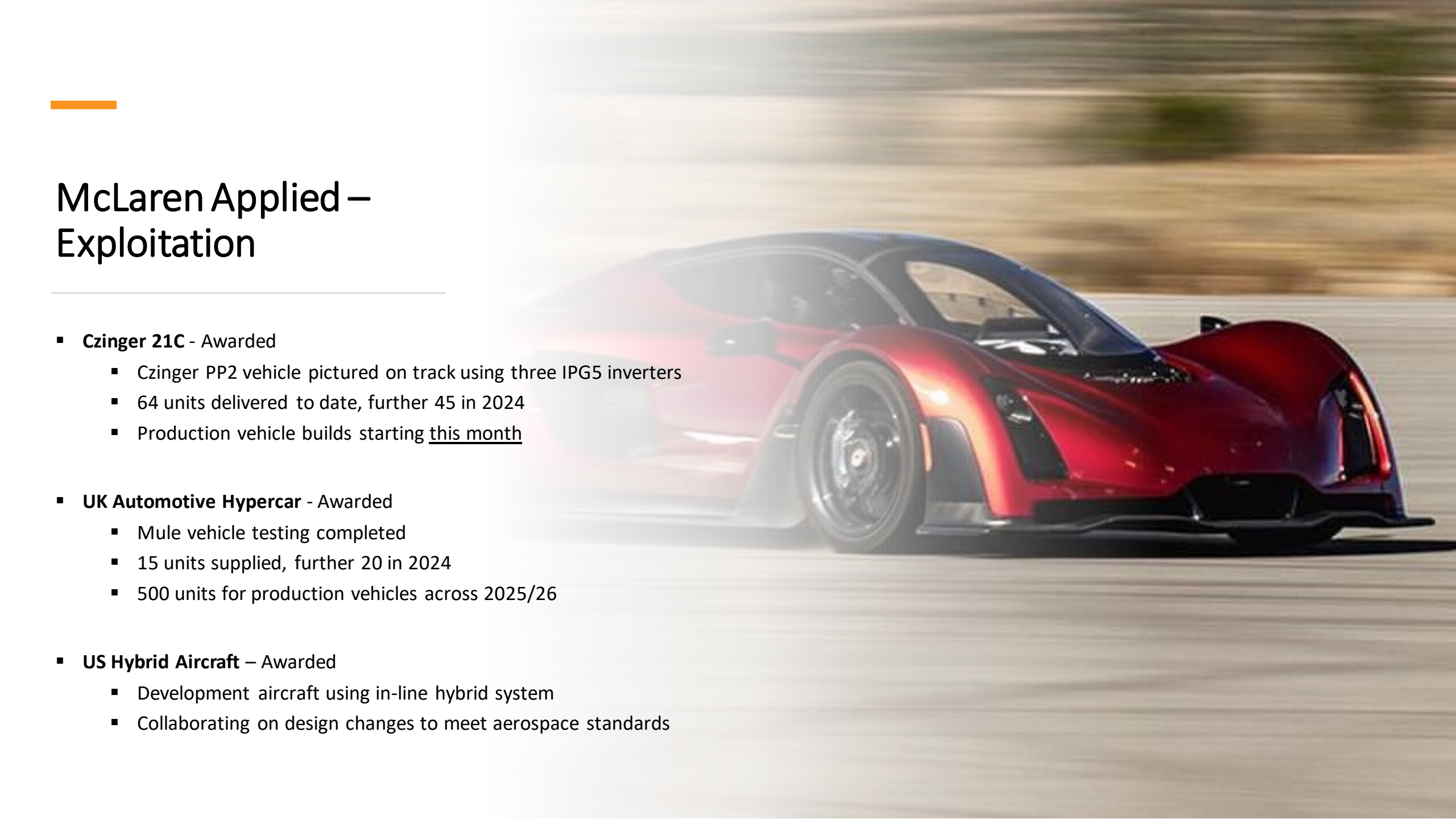
High Current Capability
$540A_{rms}$ Peak & $320A_{rms}$ Continuous

Advanced SW control
Variable Switching Frequency 1 – 32kHz

Safety features
ISO26262 to ASIL D
Integrated HVIL
Active Short Circuit
AUTOSAR 4.3 Compliant

UK Supply Chain

McLaren Applied – Exploitation



- **Czinger 21C** - Awarded
  - Czinger PP2 vehicle pictured on track using three IPG5 inverters
  - 64 units delivered to date, further 45 in 2024
  - Production vehicle builds starting this month

- **UK Automotive Hypercar** - Awarded
  - Mule vehicle testing completed
  - 15 units supplied, further 20 in 2024
  - 500 units for production vehicles across 2025/26

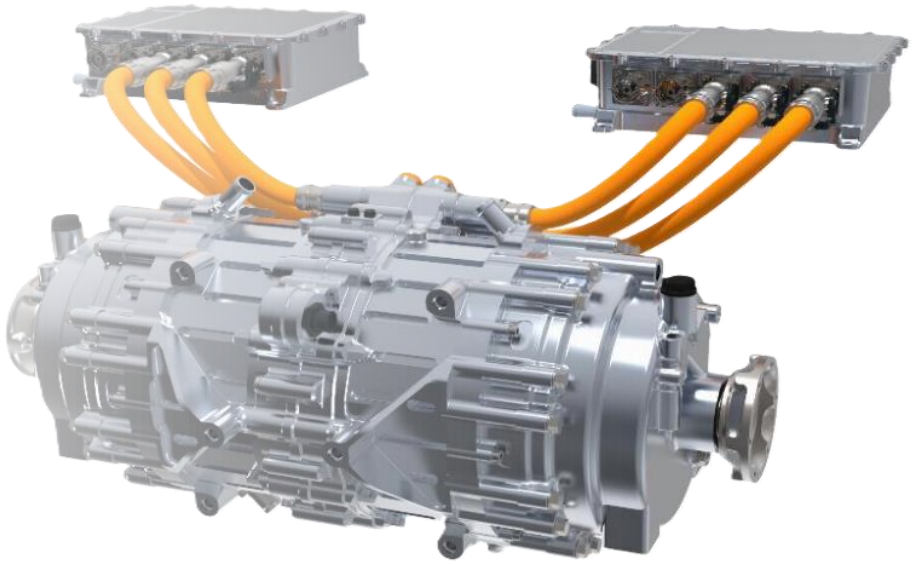
- **US Hybrid Aircraft** – Awarded
  - Development aircraft using in-line hybrid system
  - Collaborating on design changes to meet aerospace standards

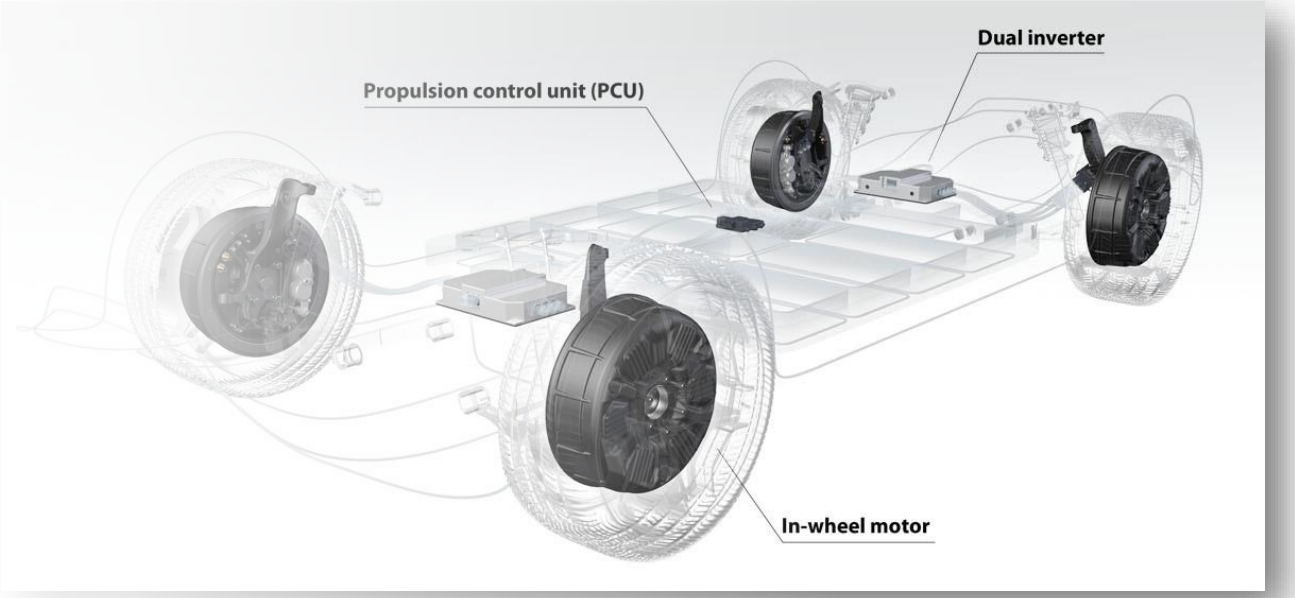
McLaren Applied – Collaborations

- **Tremec** – Strategic Partner (EDUs)
  - Development of **Electric Drive Unit** systems
  - Several opportunities, including supply for performance variant for US OEM EV
  - 4 units for demo vehicle supplied
  - 1400hp Mule vehicle in 2024
  - Production series requires >10,000 IPG5 units over 18 months from 2025

- **Elaphe** – Strategic Partner (Motors)
  - Supplier of in-wheel motors, 'Corner Control Unit' available using IPG5
  - Several key customer programmes in pipeline

- **Undisclosed Partnerships**
  - Several partnerships with motor & transmission Tier 1s





McLaren Applied – Future Investments

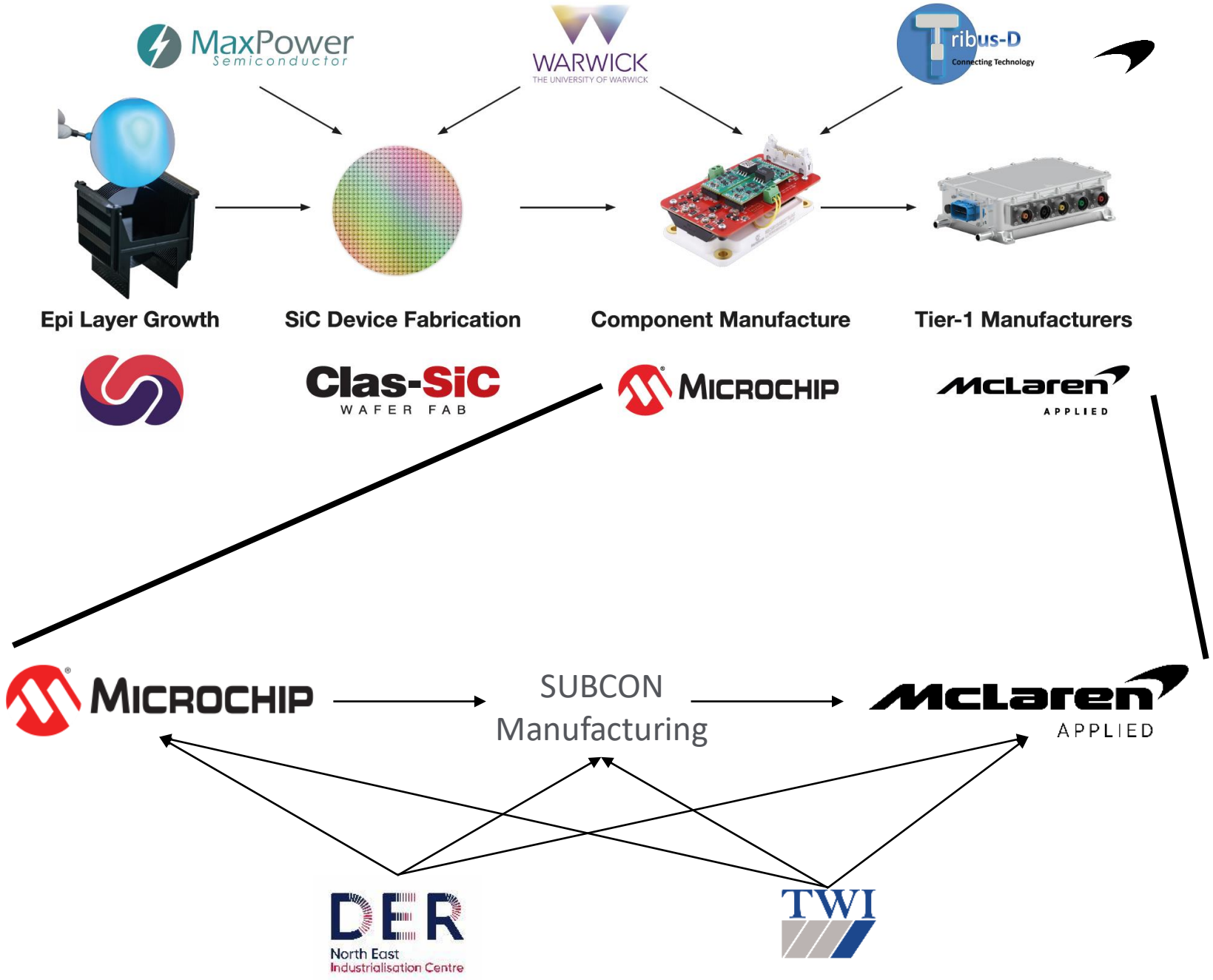
IPG5-x

- Inverter platform designed for **direct integration** into Electric Drive Unit housings
- Increased peak current to **600Arms**
- Housing removal, integration of busbars/cooling and integrated connections **reduces overall system weight and LCA impact**
- Design work happening in parallel, production release **~18 months behind IPG5**

Product Manufacturing Supply Chain Development

The SCIENZE Project

Supply Chain Innovation Engineering for Net ZEro



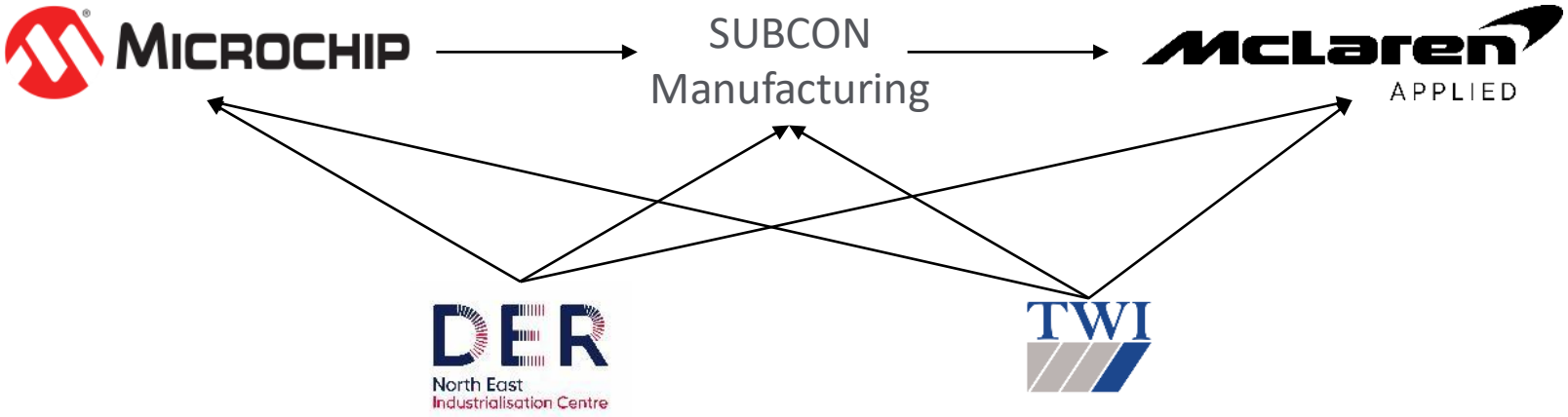
Product Manufacturing
Supply Chain Development

The SCIENZE Project

Supply Chain Innovation
Engineering for Net ZEro

SCIENZE

To establish a sustainable and secure UK based supply chain capability for the manufacture of complex automotive power electronics products at volume and be able to compete globally



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Contact us to find out how we can help you

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