UK HDV supply chain opportunities to 2035

Insight report

July 2024

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Accelerating Progress

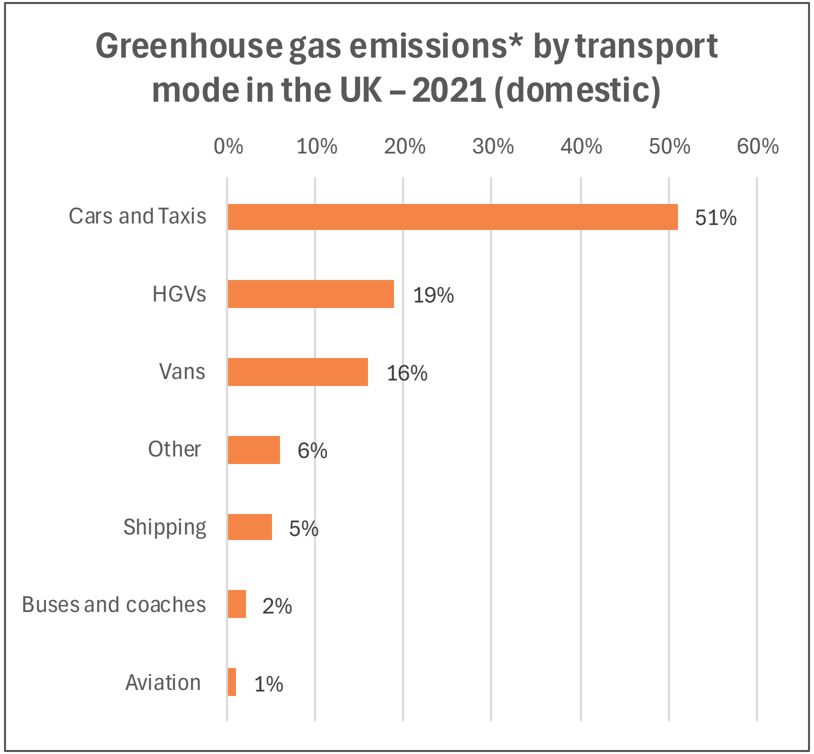
£2.4 billion opportunity for the UK in HDV sector battery and fuel cell electric supply chains by 2035

- The Heavy Duty Vehicles (HDV) sector, which includes Heavy Goods Vehicles (HGV) and buses, contributes to 21% of overall greenhouse emissions in the UK for transport, with the HGV sector taking 19% of the share.

- In 2021, UK Government announced an end of sale date for new, non-zero emission HGVs weighing less than or equal to 26 tonnes from 2035, and from 2040, all new HGVs must be fully zero-emission at the exhaust*. In spring 2022, UK Government ran a consultation to help determine the exact date for ending the sale of new non-zero emission buses, and a call for evidence on the decarbonisation of coaches was also held.

- This report outlines a £2.4 billion revenue opportunity in the HDV sector** for UK organisations and their supply chains to innovate and industrialise zero-emission technologies, including:
    - Battery packs
    - Electric drive units (EDUs)
    - Fuel cell system components
    - Hydrogen storage tanks

- £2.4 billion revenue opportunity includes nearly £1 billion worth of export potential in battery electric value chain and fuel cell technology systems for the UK. This becomes more prominent with the recent emissions mandate of the EU for the HDV sector by 2040.



*Source: Gov.uk

**APC analysis of supply chain opportunity, using base production data from LMC – Global Data Q3 2023 forecasts.

HDV net zero emission commitments in key regions: UK, EU, and USA

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	2025	2030	2035	2040	2045	2050
	New HDV CO_2 15% reduced from 2019* baseline	New HDV CO_2 30% reduced from 2019* baseline	All new <26T HGVs zero emission	All new HGVs zero emission		Net Zero target
		90% of vehicle sales of city buses must be zero emission				
	New HDV CO_2 15% reduced from 2019* baseline	New HDV CO_2 43% reduced from 2019 baseline	New HDV CO_2 64% reduced from 2019 baseline	New HDV CO_2 90% reduced from 2019 baseline		Net Zero target
		New medium HDV 40% CO_2 reduction New heavy HDV 30% CO_2 reduction (2032)	All drayage trucks will be zero emission (California)	Ends the sale of new combustion engine trucks by 2036 (California)	100% truck fleet zero emission (California)	Net Zero target

*Currently regulated trucks >16t with 4X2 and 6X4 axle configurations are covered with 2019 baseline for all years and newly added vehicles are covered with 2021 baseline.US EPA CO_2 reductions are based on phase 2 standards.

Source: ICCT, California Air Resources Board, EPA

The opportunity in decarbonising HDVs is through battery, fuel cell electric vehicles, and enabling non-fossil fuels ICE technologies

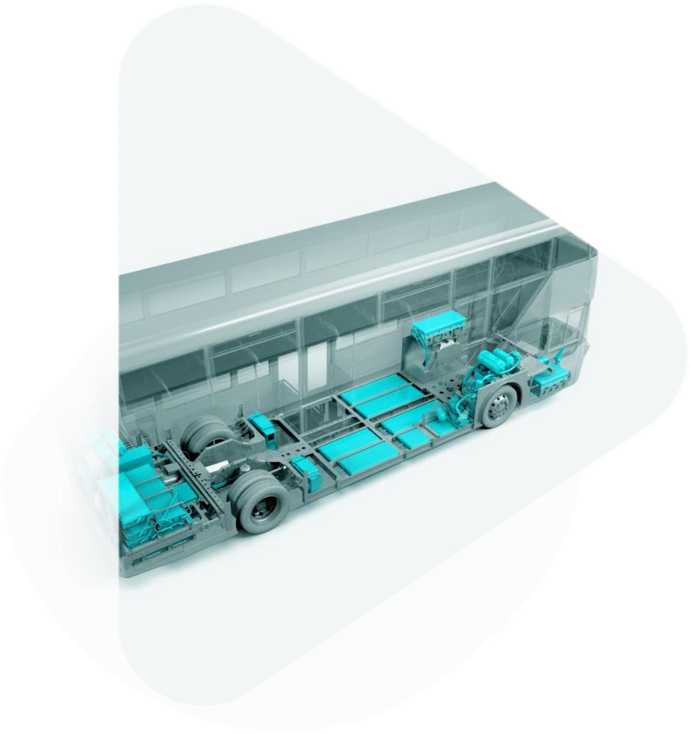
To address the challenge ahead for heavier vehicles, there are primarily two zero-emission and other net-zero propulsion technologies for road transport:

1. Battery Electric Vehicles (BEV)

2. Fuel Cell Electric Vehicles (FCEV)

Non-fossil fuels Internal Combustion Engines (ICE) comes under net-zero propulsion technologies powered by combustible fuels, such as hydrogen, e-fuels and biofuels. Whilst non-fossil fuels ICE is a promising technology, there are significantly established supply chains in the UK for ICE systems that can be adapted.

This report focuses on the supply chain opportunities for BEV and FCEV, and their key components.



APC analysis projects there will be 35,000 HGVs and buses produced by 2035, with at least 75% from zero-emission vehicles at the tailpipe

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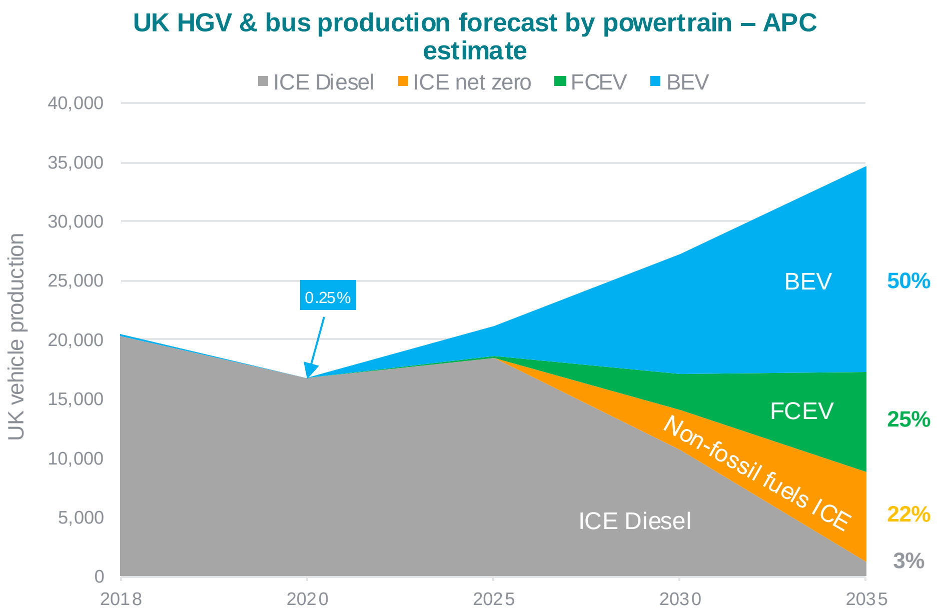

BEV

The trend shown for BEV HGVs and buses, is a small percentage from 2018-2020, which increases slightly between 2020-2025, but is projected to own a share of 50% by 2035 due to technology and commercial attractiveness of battery packs.

FCEV

There is minimal to no movement, up until 2025, however the forecast expands, and it reaches a projected powertrain share of 25% by 2035 due to the expected maturity of Proton Exchange Membrane (PEM) fuel cells.

Non-fossil fuels ICE

There is a significant opportunity in production volume from 2025 onwards for non-fossil fuel ICE technologies, which is projected to capture 22% of powertrain share by 2035.

ICE diesel

ICE diesel HGVs and buses experienced a decline from 2018 during the pandemic, however between 2020-2025 are projected to rise slightly, before falling again by 2035, at just 3% as the HGV zero-emission regulation nears 2040.

Based on LMC – Global Data Q3 2023 forecast, supplemented with APC / Automotive Council analysis.

UK supply chain opportunities for HGVs and buses in the high-value components of battery and fuel cell technologies

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Zero-emission HGVs and buses manufactured in the UK offer significant opportunity for local EV supply chains

High-value components include:

- Battery packs
- Electric drive units
- Fuel cell systems
- Hydrogen tanks
- High-power converters

Image credit: Adobe

Battery packs (BEV and FCEV)

A key component for the operation of both battery and fuel cell propulsion technologies, battery packs will provide significant investment and growth opportunity, to cater for specific requirements of HDV operations.

Image credit: Leyland DAF

Electric Drive Units (BEV and FCEV)

The Electric Drive Unit (EDU), is a necessary component for both BEV and FCEV technologies, with the focus for HDVs remaining in the integration and packaging of power electronics, motors, and transmission units.

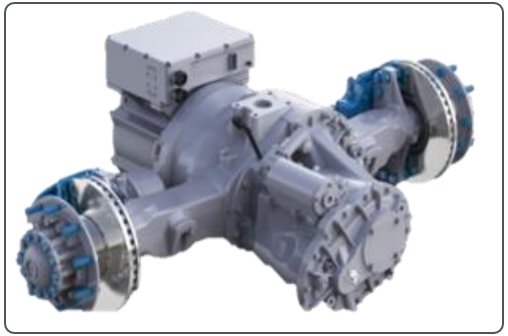

Image credit: Meritor

UK supply chain opportunities for HGVs and buses in the high-value components of battery and fuel cell technologies

Fuel cell systems (FCEV)

The Proton Exchange Membrane (PEM) fuel cell technology is expected to mature and help the fuel cell powertrain market share for HDVs grow by 2035. APC analysis identifies key investment opportunities in PEM fuel cell components for the UK manufacturing industry.

Image credit: Intelligent Energy

Hydrogen Tanks (FCEV)

As a supporting technology to the fuel cell system, hydrogen tanks are incredibly important. High-pressure carbon fibre tanks are needed to meet the FCEV vehicle production demands by 2035.

Image credit: Hyzon motors

High-power converters (FCEV)

To ensure the vehicle receives the correct and appropriate power levels, the DC-DC, high-power converters form another investment opportunity within the UK.

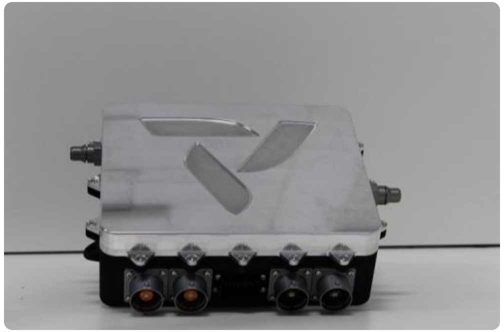

Image credit: Viritech

£2.4 billion UK HDV supply chain opportunity* is the combination of local vehicle production and export potential for UK-based supply chain players of high-value components

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£1.39bn
UK HDV production-led opportunity

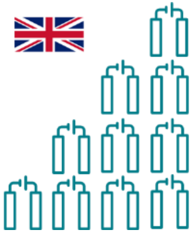
+

£967m
UK Tier 1 production-led export potential

=

£2.4bn
UK HDV supply chain opportunity

Opportunity exists across five high-value components, for UK HGVs and buses manufactured in the UK.



There are multiple avenues for export opportunity for the UK supply chain. This report focuses on two key component categories where there is potential for export (EDUs, e-axles, fuel cell systems and Catalyst Coated Membranes (CCMs)

£

This represents the total UK HGV supply chain opportunity, combining both local and exported opportunity and potential across all key high-value components.

*APC analysis of supply chain opportunity, using base production data from LMC – Global Data Q3 2023 forecasts.

£2.4 billion opportunity in electrified HGV and bus supply chains by high-value components split

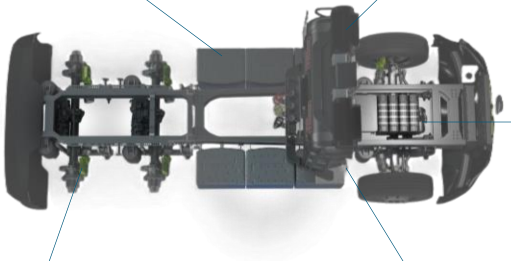
Total £2.4bn

£790m
Batteries

BEV and FCEV batteries
Cells and packs

£130m
Hydrogen tanks

Type III & type IV tanks
Carbon fibre materials



£870m
Fuel cell systems

Fuel cell stacks
Balance of plant

£570m
Electric Drive Units
(EDUs)

EDUs (e-motors and inverters)
E-axles

£10m
DC-DC converters

FCEV high-power converters

Image credits: Equipmake (HTM-3500 motor), Luxfer (hydrogen tank), Intelligent Energy (fuel cell stack) & Viritech (DC-DC converter)

Total UK market opportunity for zero-emission HDVs to 2035, across high-value components totals £1.39 billion, increasing by 10 times the current value

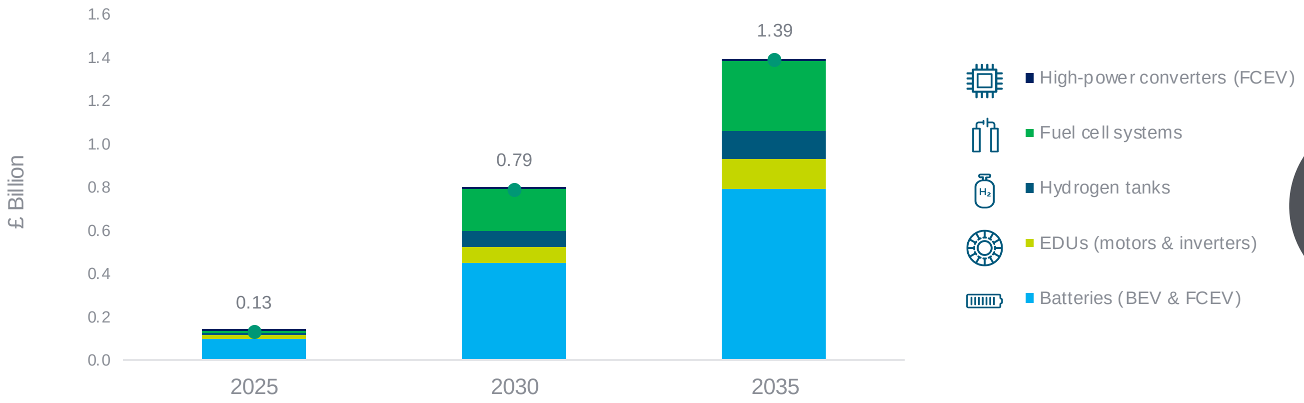
UK market HDV opportunity (ZEV)

UK-produced HGVs & buses

7.5t to 44t trucks

Buses & coaches

Refuse trucks



UK HGV production-led opportunity

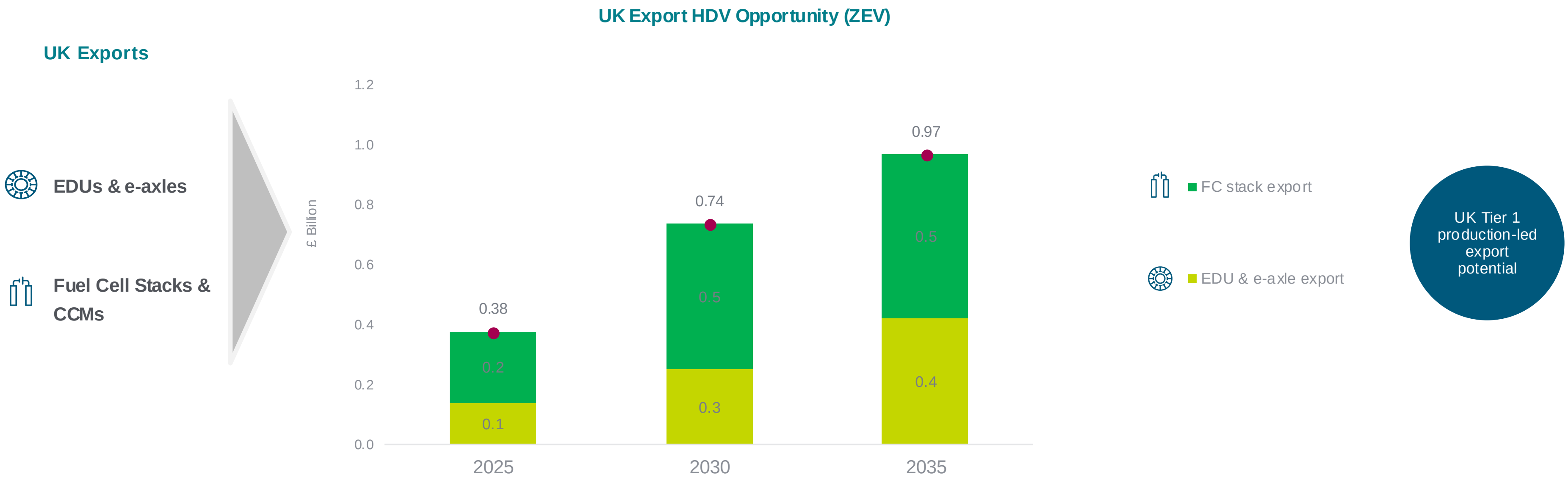
2025 Within the UK, the **2025** opportunity is projected at £100m across all listed technologies above, with the majority of share going to Batteries, followed closely by EDUs.

2030 The forecast shows an ~6 times increase within the UK market opportunity by **2030** up to £790m, with the majority share going to batteries and fuel cell systems. Fuel cell systems are projected to significantly increase in market opportunity contribution to nearly £200m. As the technologies for battery cell and fuel cell matures, the opportunity for EDU integration and hydrogen storage tanks becomes prominent.

2035 Projection for UK production-led HDVs, show an increase to £1.39 billion, with respective high-value component share increasing its opportunity size by **2035**. The batteries and fuel cell market export potential will in total reach over £1 billion, providing a substantial opportunity for supply chain investment in the UK within the next decade.

APC analysis of exports opportunity, using base production data from LMC – Global Data Q3 2023 forecasts.

Total UK export opportunity for zero emission HDVs, across key components of EDUs and fuel cell stack components totals £970 million by 2035



- The overall export opportunity represents a steady growing market in fuel cell stack manufacturing and EDUs for the UK
- The fuel cell supply chain is still in early maturity stage in the UK, with strong presence of hydrogen supply chain actors (more than 250) representing future potential for scaling up fuel cell systems for heavy-duty automotive applications.

CCM = Catalyst coated membrane

APC analysis of exports opportunity, using base production data from LMC – Global Data Q3 2023 forecasts.

We have identified the following 10 opportunities* for major high-value components in battery and fuel cell electric value chain, in focus with HDVs

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Battery packs

- Battery chemistries suitable to the requirements of HDVs
- Thermal and safety management for battery packs

Electric drive units

- Dedicated transmission and powertrain design for HDVs
- Optimisation of noise, vibration, and harshness through AI design and simulation techniques
- System integration and packaging of power electronics and battery management systems

Fuel cell systems

- Investment in high temperature PEM systems
- Increasing durability of fuel cell stack and its operational components
- Integration of DC-DC converters to FCEV system

Hydrogen storage tanks

- Reducing carbon fibre cost and improving circularity of materials
- Investing in Type 4 storage tanks for high-pressure hydrogen applications (700 bar)

*APC analysis of supply chain opportunity

Battery packs - £790 million opportunity

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1. Battery chemistries for HDVs

- Key opportunities for HDV batteries are around increasing reliability and reducing cost. Increasing reliability is needed dueto the rigorous usage, drive cycles, and reducing costs for widespread adoption. There are opportunities around solid-state, sodium-ion batteries for improving performance, and reliability of the battery electric HDVs.

- Solid-state batteries present an opportunity to be an alternative for the current generation of liquid-based electrolyte. Solid-state batteries could pack more energy into a smaller space and provide enhanced safety and faster charging for HDVs.

- Sodium-ion batteries could be a cost-effective alternative for off-highway heavy-duty applications. Na-ion could operate with a safer temperature range and exhibit better stability than Li-ion batteries for stationary off-highway applications.

2. Safety considerations in HDVs

- Niobium-based oxides have the potential to be a safe alternative to commercial graphite anode materials thanks to its high operating voltage potential. Niobium-based oxides have the potential to inhibit lithium dendrites and deposits to ensure safety and could help reduce the risk of short circuits and fires in batteries, improving the overall safety of electric HDVs.

- Active thermal management and investment in advanced cooling methods (phase change materials, submerged cooling) are key in improving the efficiency of battery systems. Detection and prevention of abnormal usage and charging is vital in preventing thermal runaway in heavy-duty electric vehicles. There are opportunities around active management and monitoring of battery health systems of heavy-duty battery packs.

Electric Drive Units - £570 million opportunity

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3. Transmission and powertrain design

- HDVs have unique torque and power-weight ratio requirements. There are opportunities in designing drive system options (central and distributed) and to invest in multi-speed gearbox to optimise the torque requirements for heavy-load applications. Battery electric trucks may need the emergence of multi-speed gearboxes that provide benefits of efficiency, better acceleration, and traction at low speeds.

4. Noise, Vibration, and Harshness (NVH)

- There is opportunity for HDV electric vehicles to optimise and reduce noise and vibration through the deployment of advanced AI design techniques and simulation modelling. Physics-based NVH simulation and modelling can provide optimised designs for reducing noise vibration and maximising ride comfort in the driver cabins.

5. Systems integration

- There is opportunity to optimise the HDV electrical drive train system through the integration of power electronics, DC-DC converter, auxiliary inverter, and battery management system through an efficient systems architecture. The integrated systems architecture provides opportunity for Over-The-Air software updates (OTA), efficient diagnostics, and connectivity digital services.

Fuel Cell Systems - £880 million opportunity

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6. High temperature PEM Fuel Cells

- Proton-Exchange Membrane Fuel Cells (PEMFC) are generally regarded as the fuel cell of choice for automotive applications as they have comparative advantages over others in efficiency and compactness. There is growing interest and intention to enable Higher Temperature (HT) operational capability for a PEMFC system to enable heavy transport applications.

- The HT PEM provides advantages over Low Temperature Proton-Exchange Membrane (LTPEM) in thermal management and cooling systems. The higher operating temperature simplifies the need for complex cooling systems, reducing the need for higher weight in heavy-duty and off-highway vehicles.

7. Increasing durability in fuel cell stack

- The UK has promising capability in fuel cell stack and component development. There is significant opportunity in increasing the durability across all components, such as Gas Diffusion Layers (GDL), Bipolar Plates (BP), and Membrane Electrode Assembly (MEA). Durability in the fuel cell stack is a key enabler of high temperature fuel cells, particularly in the HDV sector, with intensive load and cycle requirements for regular operations.

- Investments into the durability of components brings an improved power density within fuel cell applications and could allow for a reduced thickness of the MEA, creating an efficient path for the gas diffusion. An added benefit is an extended lifespan, as the fuel cell will become more resistant to degradation and can operate at higher temperatures for longer hours.

8. Integrating DC-DC converters in FCEVs

- The DC-DC converter is a crucial component in the fuel cell system, as fuel cells have a lower and more variable output voltage than the battery system and it enables integration across the system with high voltage power distribution. There is opportunity with integrating the DC-DC converters into the FCEV as well as increasing compactness to make the integration more seamless and adaptable to existing electric architectures rather than redeveloping dedicated powertrains.

Hydrogen tanks - £130 million opportunity

9. Carbon fibre cost and recycling focus

- Hydrogen tanks are essential components for both PEMFC and Hydrogen ICE applications. To increase the strength, hydrogen storage vessels are lined with plastic liners and wrapped in carbon-fibre composite materials. However, there are significant costs associated with the carbon fibre wrapping. The carbon fibre cost reduction can directly contribute to a lower total cost of manufacture and ownership of a FCEV or Hydrogen ICE vehicle. Increasing the carbon fibre recycling and reuse at end of life for a hydrogen storage system, can contribute to the overall sustainability and circularity of the hydrogen tanks.

10. Hydrogen storage container types

- Research focus in automotive hydrogen tanks is the move from Type 3, to Type 4 gas storage. Industry trends show a push towards 700 bar pressure from 350 bar, the maximum capability for Type 3 storage. The opportunity revolves around Type 4 tanks, manufactured with filament-wound carbon fibre and thermoplastic liners specifically designed to cope with 700 bar requirement in automotive application. Type 4 tanks can provide lighter weight design and higher energy density compared to Type 3 tanks, making it an attractive component for heavy-duty transport.

- The UK has a well-established composites manufacturing capability and Type 4 provides a significant opportunity for investment and growth. To meet the specific needs of HDVs research in the space of cryo-compressed hydrogen, and solid-state storage, such as nanoporous structures that can store hydrogen at higher densities in a normal atmospheric pressure, will be welcomed.

Glossary

Glossary and definitions

BEV: Battery Electric Vehicles; a type of vehicle powered solely by an electric motor(s) using energy stored in a rechargeable battery pack.

CCM: Catalyst Coated Membrane; a key component of the Hydrogen Fuel Cell, consisting of the membrane, anode, and cathode catalysts.

EDU: Electric Drive Unit; a system that converts electrical energy into mechanical power to drive electric vehicles.

FCEV: Fuel Cell Electric Vehicle; an electric vehicle that uses a fuel cell to generate electricity, through a reaction between hydrogen and oxygen.

HGV: Heavy Goods Vehicle; a large truck or lorry designed for transporting goods, typically between 7.5 and 44 tonnes.

ICE: Internal Combustion Engine; a machine that burns fuel to produce power, traditionally petrol, diesel, and biofuels.

LDV: Light Duty Vehicle; typically, a passenger car, SUV or small truck designed for personal or commercial use.

OEM: Original Equipment Manufacturer; a company that produces components and final products along a supply chain.

R&D: Research and Development; a process to innovate, create, and improve a product or process.

ZEV: Zero Emissions Vehicle; a zero-emissions vehicle is one that produces no tailpipe emissions.

PEM: Proton-Exchange Membrane fuel cells also known as polymer electrolyte membrane can conduct or transfer protons and keep the reactant separate

NVH: Noise, Vibration and Harshness to reduce and control noise and vibration for user comfort.

Contact APC for further information

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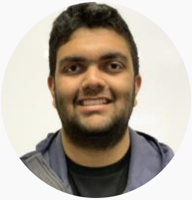
Technology Trends

Technology insights and foresight



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