

Getting ahead of the curve with fuel cell technology in the UK

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CENTRE UK

Accelerating
Progress

Getting ahead of the curve

When can we expect fuel cells to be mainstream in automotive?

- APC forecasts for FCEV volumes globally and in the UK

Why is fuel cell technology a key enabler to an automotive net zero future?

- PEM fuel cell technology will play an increasingly important complementary and supplementary role alongside batteries

How can the UK get ahead of the curve?

- The UK supply chain has key strengths in high-value PEM fuel cell components
- APC ambition is for UK manufacturing to lead in 65% of the entire fuel cell value chain
- Strategy to transition existing UK capabilities into industrial scale capacities
- Call to action: opportunities for international players

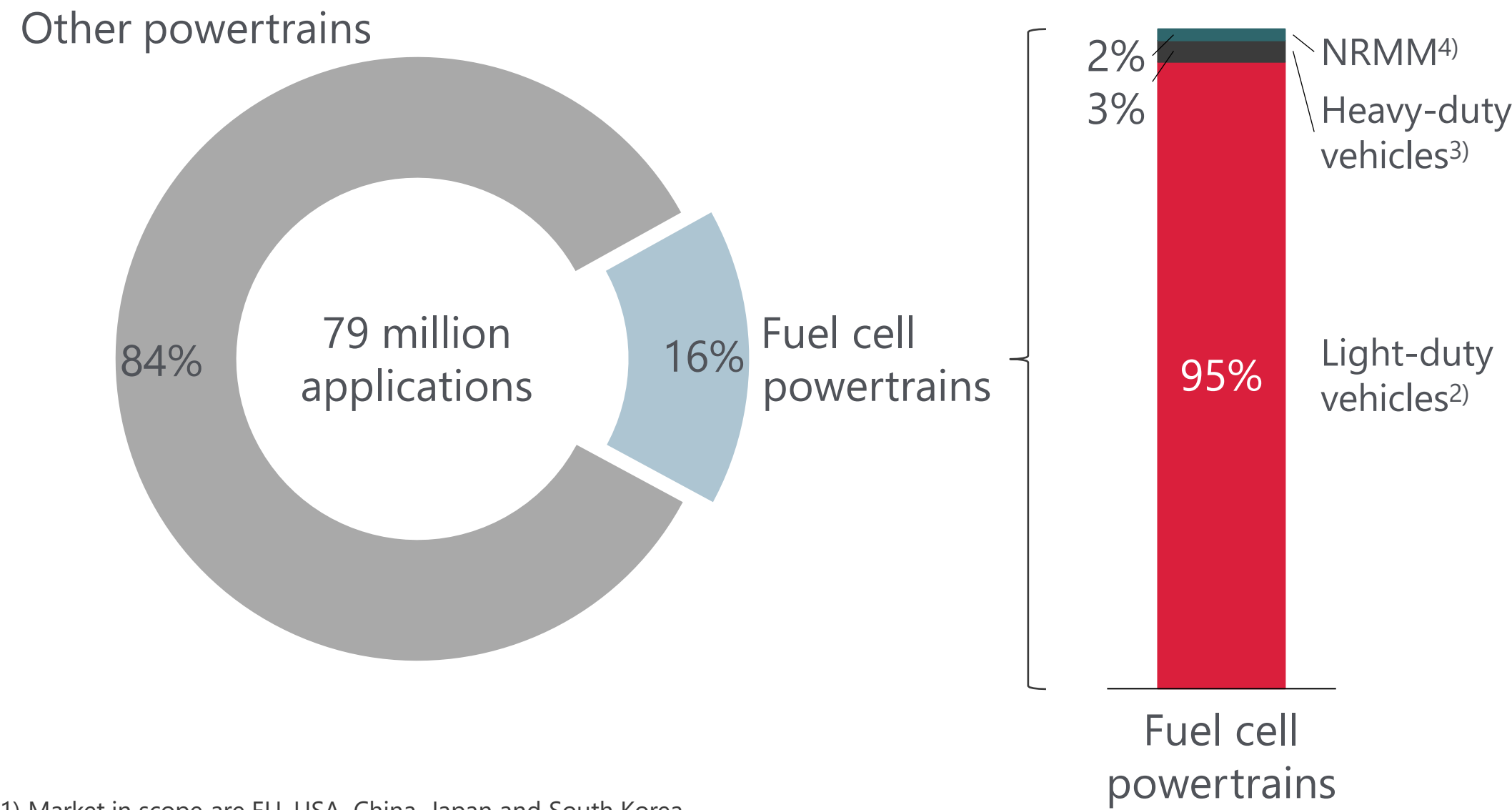


FCEVs are expected to have a global market share of 16% in 2040, with growth initially stronger in the HGV sector but LDV sales dominate in the long-term



2040 FUEL CELL SALES SHARES¹⁾

Total sales in million units



1) Market in scope are EU, USA, China, Japan and South Korea

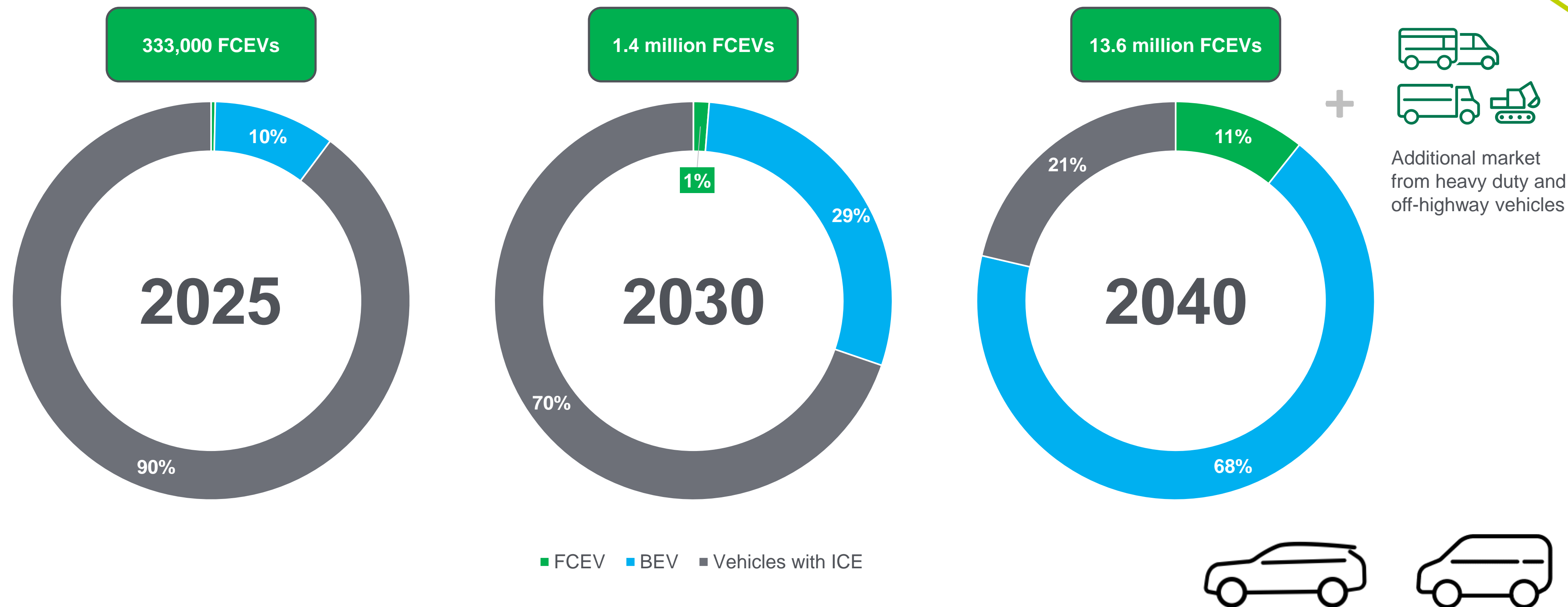
2) Passenger cars and light commercial vehicles

3) Medium and heavy commercial vehicles & bus

4) Agricultural tractors, excavators, forklifts, commercial vessels, pleasure crafts, locomotives and railcars within power segments in scope

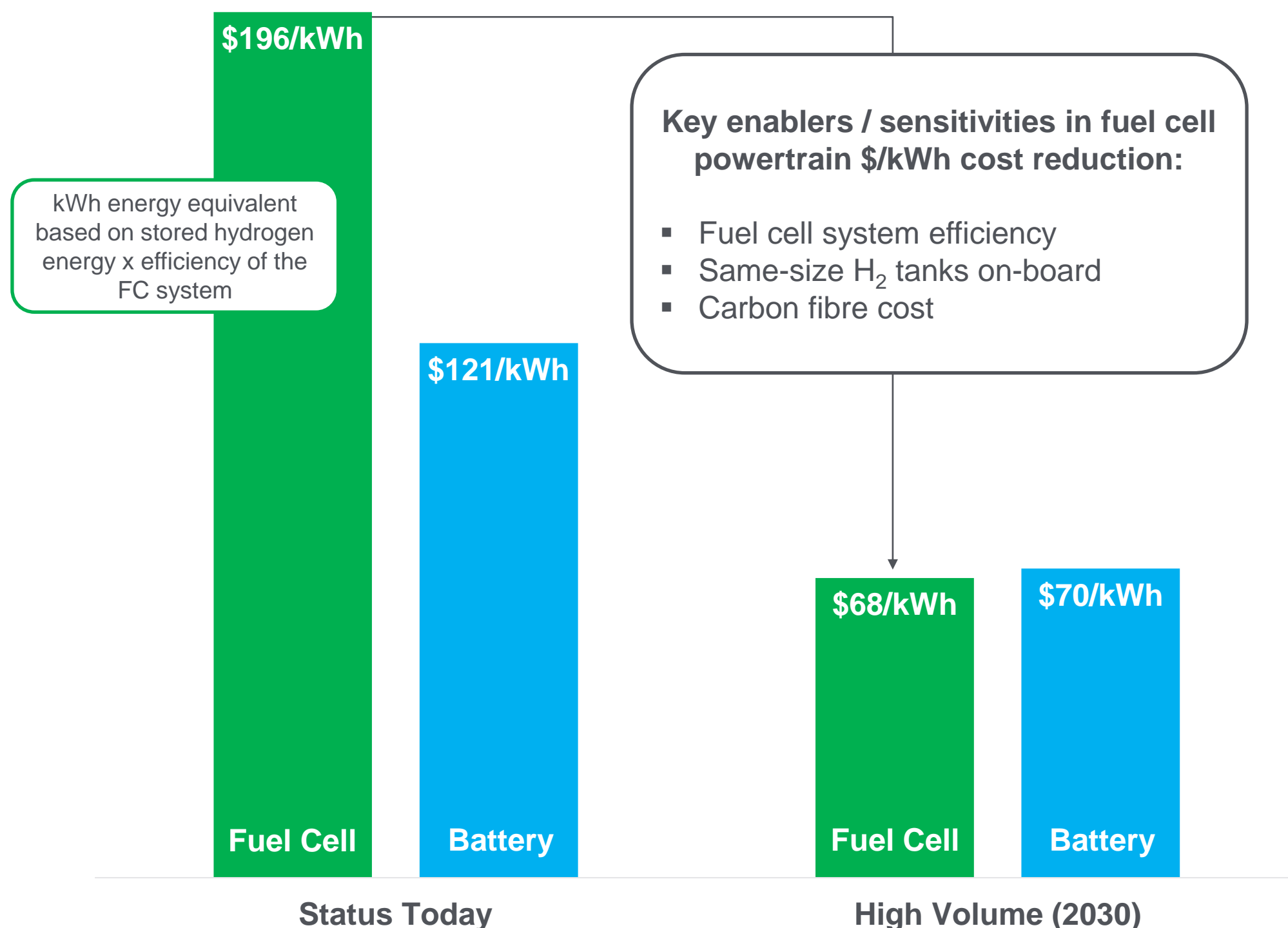
While we expect BEVs to lead the light duty ZEV market, FCEVs will play a complementary role in the market for certain vehicles like SUVs

GLOBAL LIGHT DUTY MARKET – VEHICLE SALES & POWERTRAIN TYPE SHARES



With economies of scale the FCEV powertrain could reach BEV parity, offering an attractive proposition to OEMs in the SUV market for example

SUV FC & BE Powertrain* Fitment Cost Estimation



BMW iX5 FCEV technology specifications:

- 120 kW net fuel cell system (est. based on 125 kW stack)
- 6 kg of useable hydrogen on-board (2 tanks)
- Range estimated ~311 miles (500km)
- 25 kWh HV battery assumed based on PHEV X5



BMW iX xDrive50 BEV technology specifications:

- 105 kWh of useable battery pack capacity
- Range estimated ~314 miles (505km)

Source: APC Technology Trends analysis based on internal analysis, BMW Group website, Electric Vehicle Database

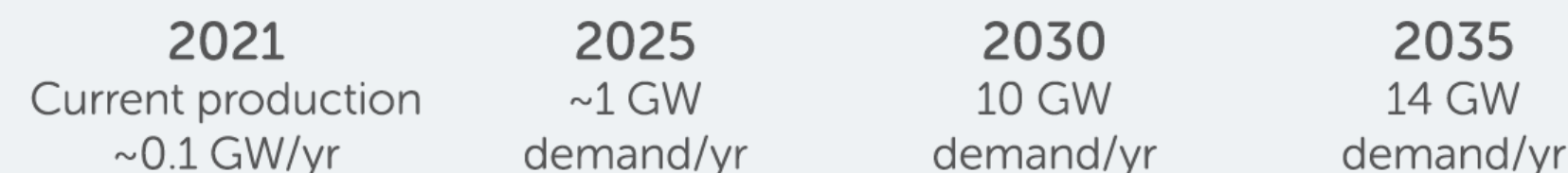
*Powertrain cost excluding Electric Drive Unit and Power Electronics. FC Powertrain here includes the Fuel Cell System, Hydrogen Storage System and a HV Battery

The APC expect UK production of light duty FCEVs to reach 140,000 units by 2035, with additional production of buses and HGVs

Associated demands for automotive fuel cell system components:

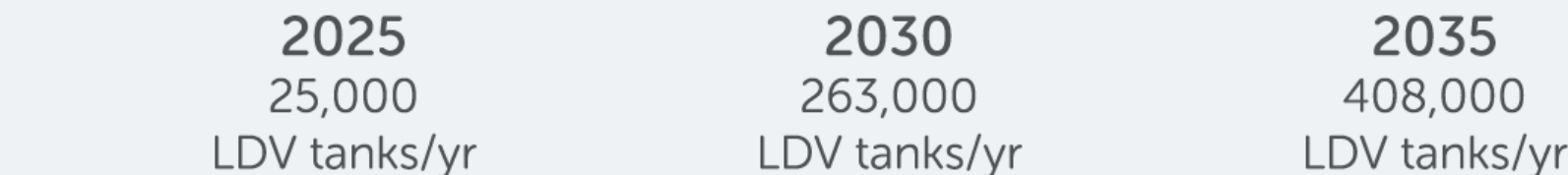
14 GW
of fuel cell stacks

required by UK vehicle manufacturers by 2035 for cars and vans produced in the UK



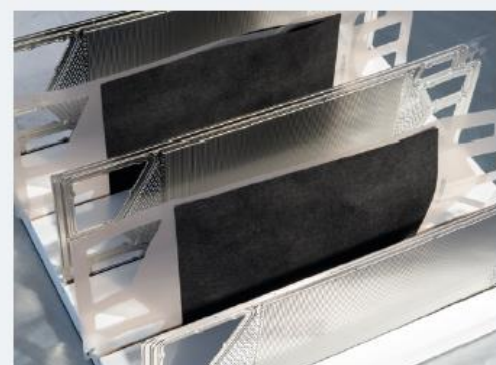
400,000
hydrogen on-board tanks

required by UK vehicle manufacturers by 2035 for cars and vans produced in the UK



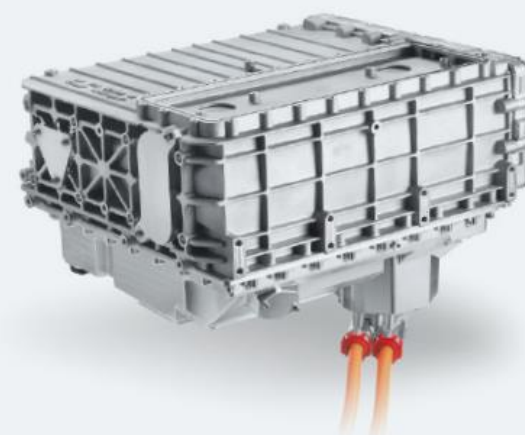
The UK supply chain has a big opportunity to hit the ground running with key investments in MEA, stack and hydrogen tank scale-up

Fuel cell system – key parts



Membrane electrode assembly
including gas diffusion layer, catalyst layer, and proton exchange membrane

32% value-add*



Fuel cell stack

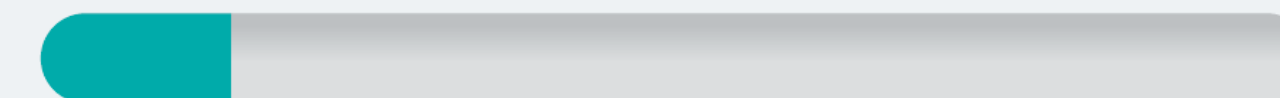
33% value-add*



Hydrogen tanks

Fuel cell system manufacturing in the UK

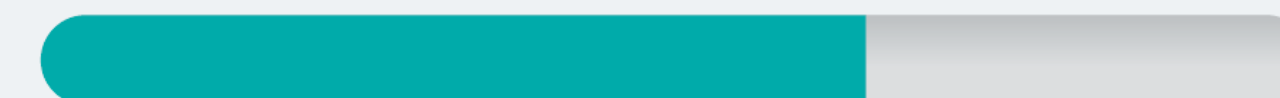
~15%



Currently made in the UK

Estimated fuel cell system value-add generated today in the UK

65%

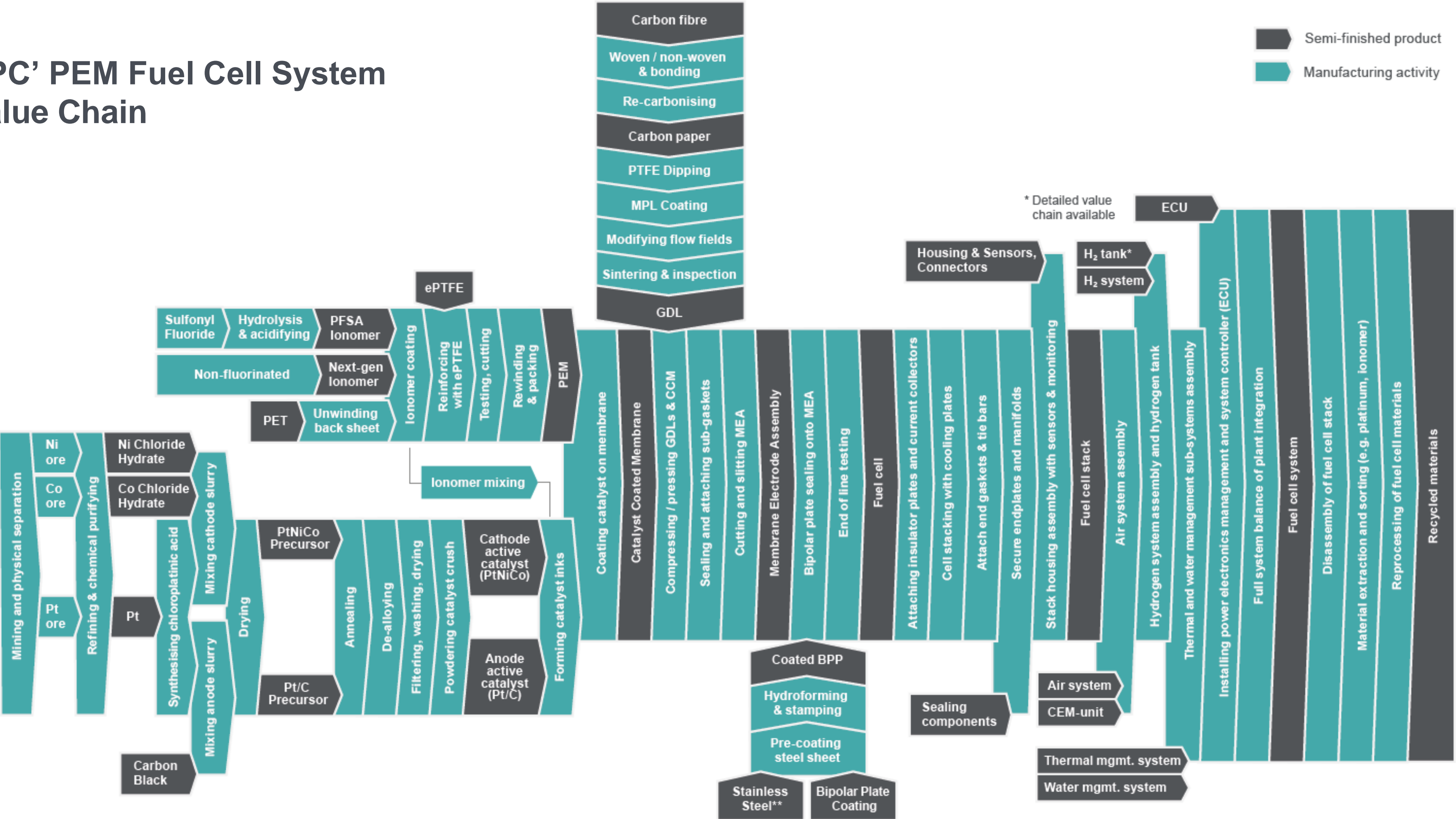


Future ambition

Fuel cell system value-add that the UK is capable of delivering in the future

Based on a 2030 Fuel Cell System

APC' PEM Fuel Cell System Value Chain

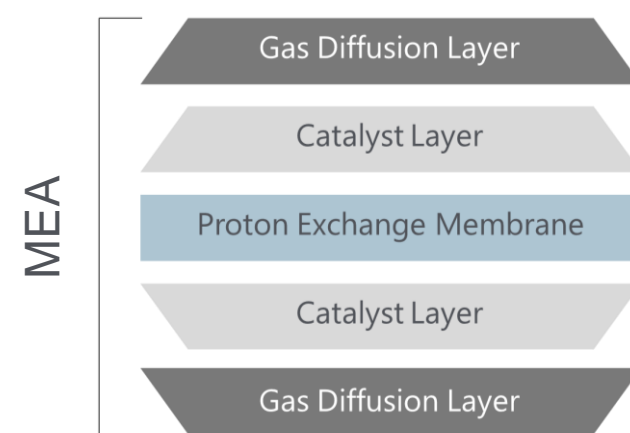


Source: Value chain developed by the APC Technology Trends Team (2021)

** Alternative substrate materials available

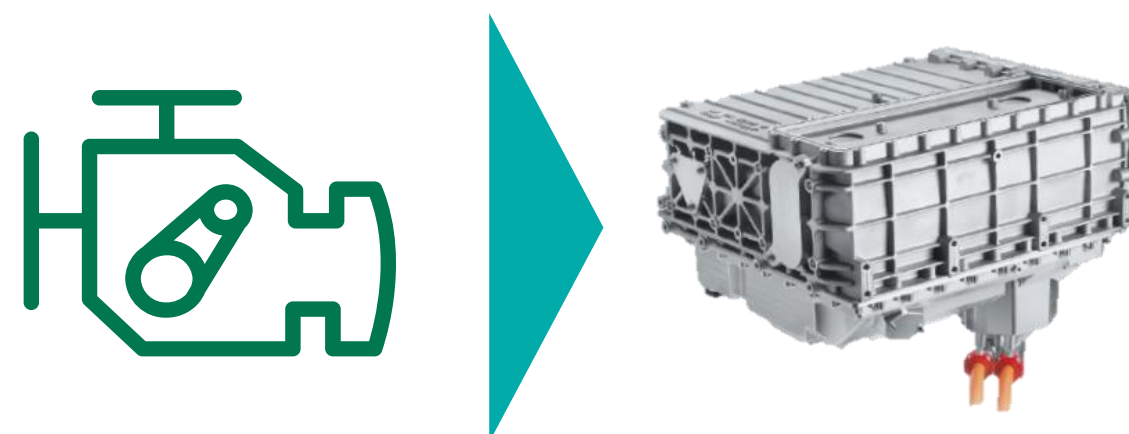
Anchored by strong upstream suppliers, the UK has the right assets to transition into high-volume fuel cell stack and system manufacturing

Anchored Upstream Strengths



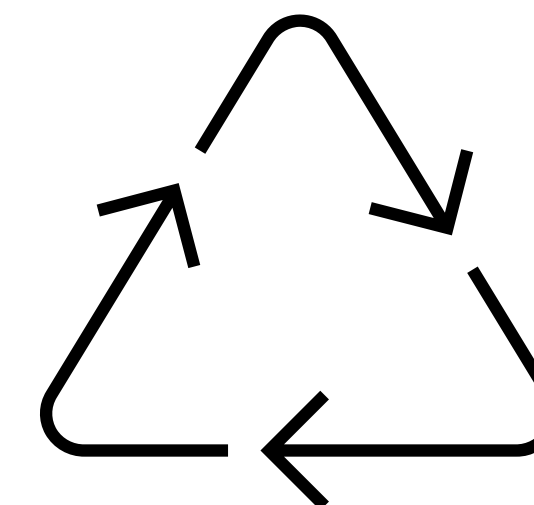
UK players already supply catalyst coated membranes, carbon paper for GDLs, and full MEAs into international markets

From ICE to Stack Manufacturing



Fuel cell stack assembly is one of the main opportunities to transition the UK's existing internal combustion engine plants

Existing Recycling Ecosystem



The UK has world-leading capability in recycling and remanufacture of high-value materials such as platinum group metals

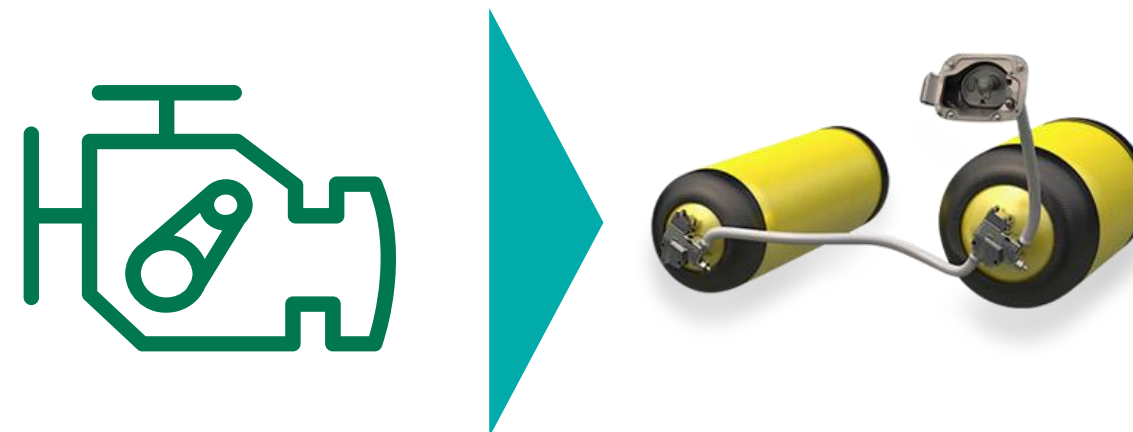
UK OEMs already looking to localise hydrogen tank supply near FCEV production plants. Carbon fibre demand opportunity for tanks is massive

Leading in Carbon Fibre



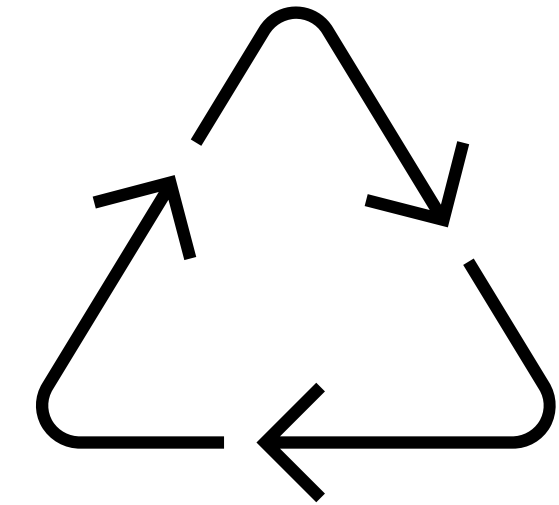
The UK excels in carbon fibre engineering and has world-leading R&D in this area, complemented by local capital equipment suppliers

H₂ Tank Capabilities



Europe's leading hydrogen system supplier is HQ'd in the UK. Existing ICE plants can also be transitioned to hydrogen tank production

Existing Recycling Ecosystem



The UK has strong capability in recycling and reprocessing carbon fibre, a key consideration for future hydrogen storage systems at EoL

Fuel cell projects across the UK gained momentum in 2021, with more to be announced this year

Oct 5, 2021 - 12:16 pm

Tevva receives multi-million £ budget for truck development

ADVANCED PROPULSION CENTRE APC BEV ELECTRIC TRUCKS FCEV FUEL CELL HYDROGEN RANGE EXTENDERS SANGREAL



UK electric truck manufacturer Tevva has secured a £4.2 million (just under €5 million) grant from the Advanced Propulsion Centre (APC) to develop the next generation of medium-duty electric trucks with fuel cell range extenders and gross vehicle weights between 7.5 and 19 tonnes.

Only a few days ago, Tevva unveiled a 7.5-tonne truck as its debut truck, which is supposed to have a range of up to 500 kilometers.



Government funding secured for continued development of Intelligent Energy high power fuel cells for vehicles

Wed 16 October, 2019



APC hydrogen fuel cell project to feature in Land Rover Defender



An Advanced Propulsion Centre (APC) funded project to develop a zero-emission SUV took another major step forward today as Jaguar Land Rover announced the development of a prototype Land Rover Defender using hydrogen fuel cell technology.

News

Wrightbus Awarded £11.2million to Develop Next Generation Hydrogen Buses



Nov 11, 2021



Ballard Power announces acquisition of Arcola Energy to help customers integrate fuel cell engines into heavy-duty mobility

VANCOUVER, CANADA, LONDON, ENGLAND, AND GLASGOW, SCOTLAND – Ballard Power Systems (NASDAQ: BLD; TSX: BDL), a world leader in the design and manufacturing of PEM fuel cell engines for heavy-duty vehicles, today announced the acquisition of Arcola Energy, a UK-based engineering company specializing in hydrogen fuel cell powertrain and vehicle systems. Ballard has acquired 100% of Arcola for total upfront and earn-out cash and share consideration of up to US\$40 million, based on the achievement of certain performance milestones.

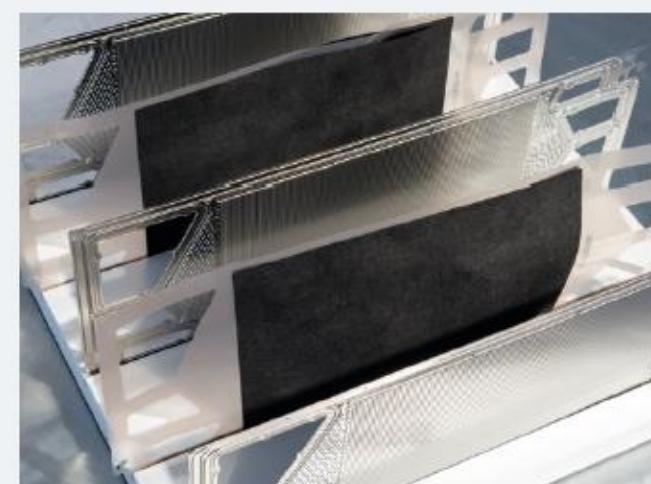
AVL and Ford Develop Fully Operational Transit Fuel-Cell Electric Light Commercial Vehicle Demonstrator in Under 12 Months

AVL and Ford delivered a light commercial Fuel Cell Electric Vehicle (FCEV) as part of the APC Advanced Route to Market Demonstrator Competition.



The APC's value chain ambition puts the UK on the map and offers attractive opportunities to international players considering fuel cell scale up in Europe

Fuel cell system – key parts



Opportunities in **low-energy carbon fibre** manufacturing



Department for
International Trade

The UK supply chain would benefit from having a local **GDL** manufacturer

Membrane electrode assembly
including gas diffusion layer, catalyst layer, and proton exchange membrane

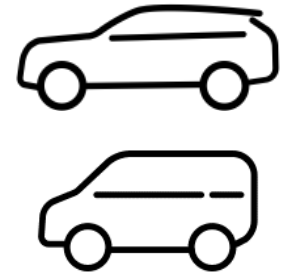
Fuel cell stack

Inward investment from Tier 1s and/or OEMs in **stack** assembly & **bipolar plate** stamping

Hydrogen tanks

Scale up opportunities and collaborative R&D for **improved packaging of H₂ tank systems**

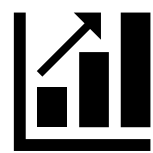
With strategic investments, the UK has an opportunity to lead in Europe and be recognised globally as a centre of excellence in fuel cell system manufacturing



The APC expect global FCEV sales to exceed 1 million units by 2030 and 10 million units by 2040, mainly due to passenger car and van volumes. Growth to 2025 to be led by larger commercial vehicles



The UK has key strengths and assets across the value chain that the APC wants to leverage in an ambition where UK supply chain generates 65% of the fuel cell system and tank value-add



The APC believe that the UK supply chain can support growth in fuel cell markets around the world, especially in high-value materials such as membranes, catalysts and carbon fibre



The APC welcomes international collaboration in fuel cells and tanks, with the value chain ambition hopes to promote the UK higher up the target list of international players considering fuel cell scale up in Europe

Thank you, we look forward to working with you...

Get in touch if you'd like to know more about our roadmaps, supply chain analysis & other trends insight



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