



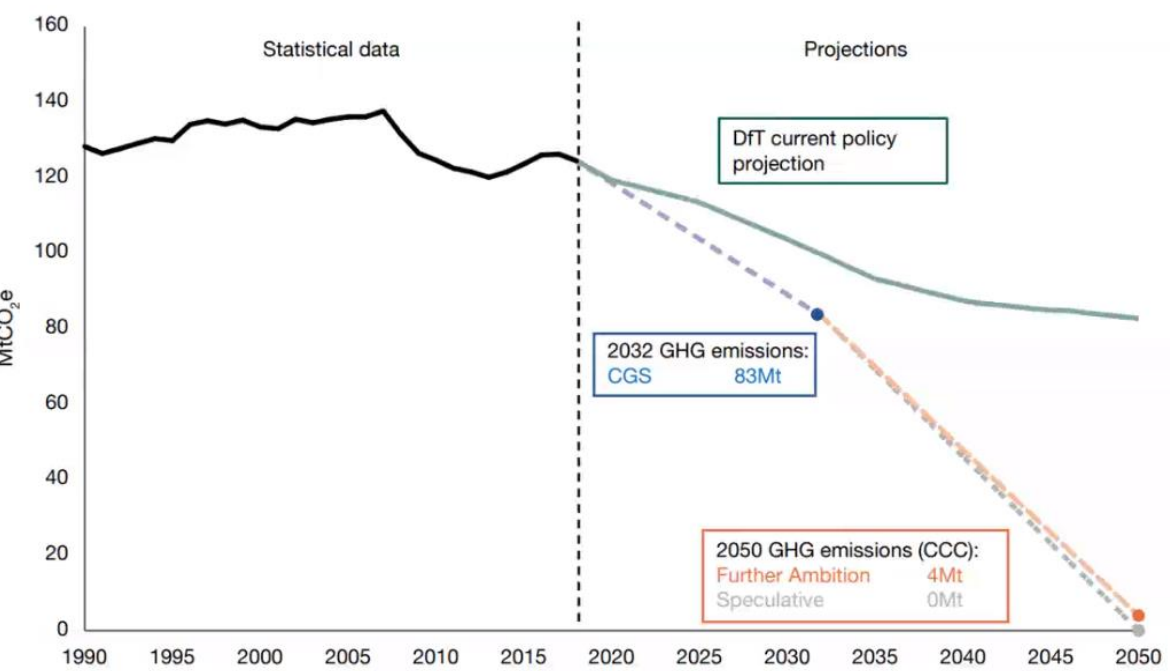
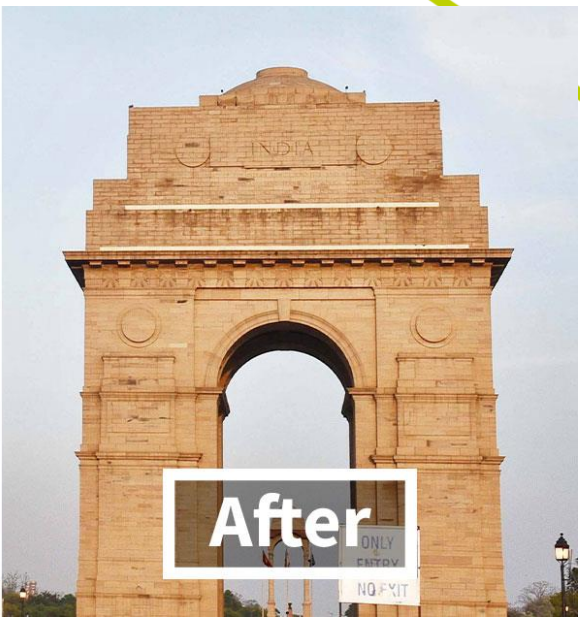
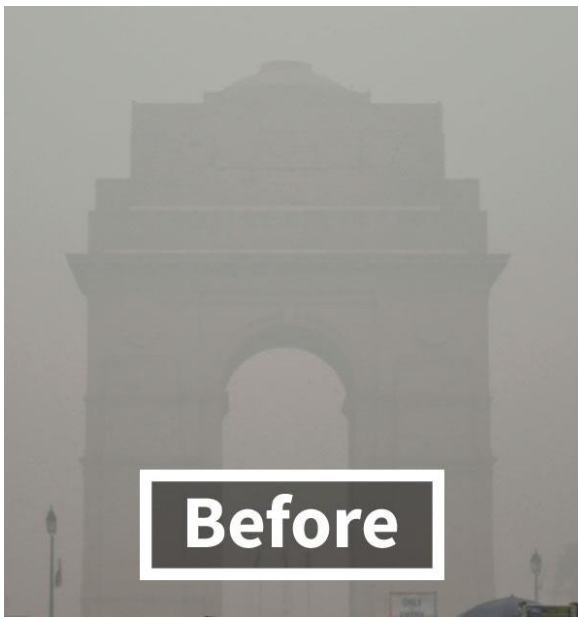
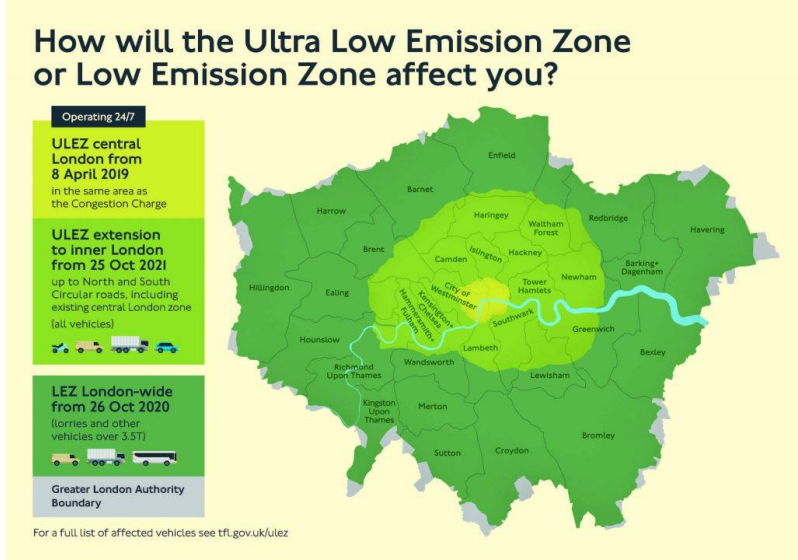
ADVANCED
PROPULSION
CENTRE UK

Accelerating
Progress

Access the future

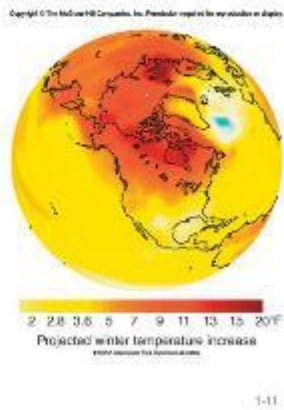
Autolink 26 November 2020

Change is coming

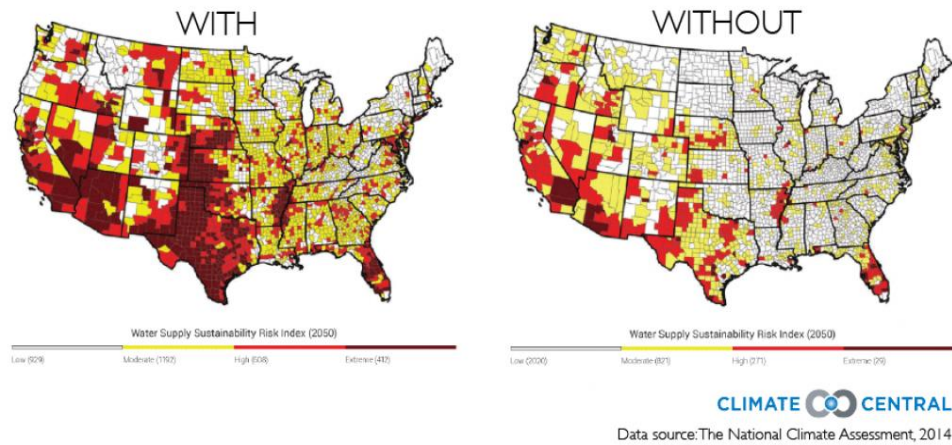


Environmental and Political Challenges: Climate Change

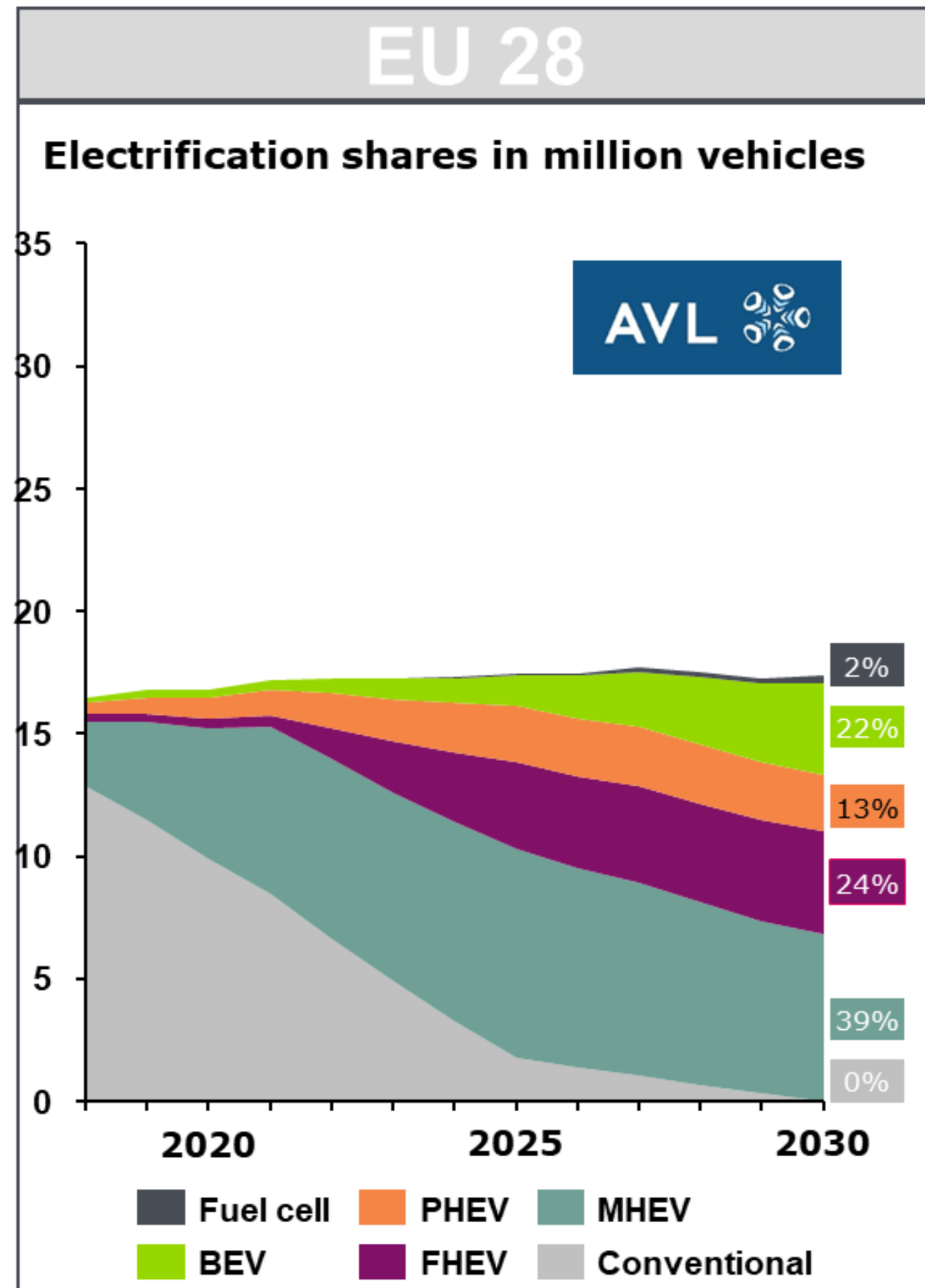
- Human activities have greatly increased concentrations of carbon dioxide and other "greenhouse" gases over the last 200 years.
- Climate models indicate that by 2100, if current trends continue, global mean temperatures will probably warm between about 2 and 6 °C.



Water Stress With vs. Without Climate Change



Rapid growth in electrified vehicles



105GWh of
battery cells

17 million electric
motors & inverters

3.5 million on-board chargers

Jaguar Land Rover to invest £1bn to build
electric cars in Britain

VW invests €900 million for 20% stake in
Northvolt
13 June 2019

Tesla factory outside Berlin to cost €4 billion

BMW Group investing €400M in Plant Dingolfing for
production of BMW iNEXT EV

03 December 2019

The new automotive Council roadmaps are out



Find all the product & technology roadmaps here:
<https://www.apcuk.co.uk/planning-future-automotive/>

Created by:

Jon Regnart

Dave OudeNijeweme

Bhavik Shah

The Advanced Propulsion Centre* conducted a thorough update of the product & technology roadmaps, with a fuel cells as a new addition

Product Roadmaps



Light Duty
Vehicle <3.5t



Heavy Goods >3.5t &
Off-highway Vehicle



Bus & Coach

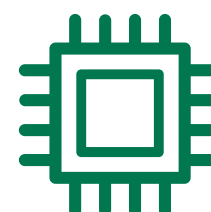
Technology Roadmaps



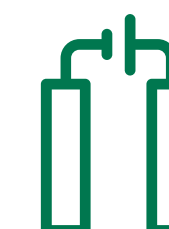
Electrical
Energy Storage



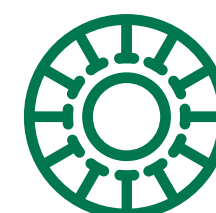
Lightweight
Vehicle &
Powertrain
Structures



Power Electronics



Fuel Cell



Electric
Machines

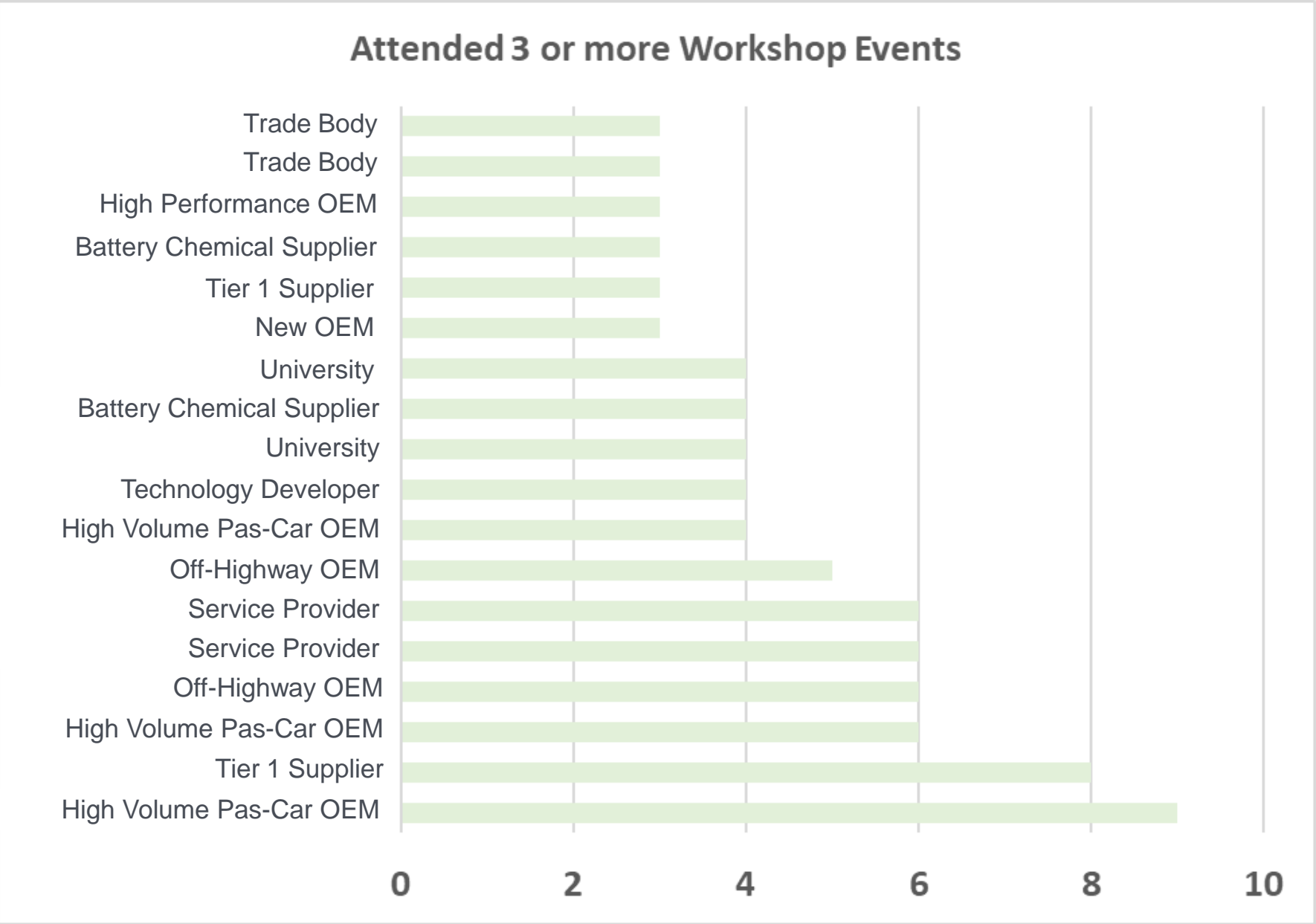


Thermal
Propulsion
Systems

* On behalf of the Automotive Council and with considerable support from BEIS

Virtual workshops and targeted interviews enabled participation of 109 global organisations. These are your roadmaps

Companies that participated in the workshops



109 Industry organisations participated



Number of industry workshops completed

13

Average attendees per workshops

21

Total 1:1 industry interviews completed

19

26
Vehicle
OEM's

51
Tier N's

14
Academic
Institutions

18
Trade body,
Independent,
RTO



Roadmap 2020

Light Duty Vehicles < 3.5t

Drivers and Regulations / Technology Enablers



Policy, environmental, social and economic drivers that exert influence on vehicle design and powertrain choices

Defined driver Predicted driver

| | | | | | | | | | |
|-------------------------|----------------------------|--|---|--|--|------|------|------|-----|
| Drivers and Regulations | CO ₂ e Emission | 95 g/km (NEDC) | -15% (WLTP) | PC -37.5% & Van -31% (WLTP) | Towards net-zero CO ₂ e | | | | |
| | ZEV Uptake Policies | ZEV Credits | Phased introduction of ZEV mandates in certain areas | | Broader adoption of ZEV mandates to achieve net-zero CO ₂ e and local air quality ambitions | | | | |
| | Pollution & Resource | Euro 6d / EPA Tier 3 | Euro 7 / EPA Tier 3 | | Holistic environmental impact legislation (VOC, resource use, land use) | | | | |
| | Zone Regulation | Ultra-low emission zones | Localised zero tailpipe emission zones, and geo-fencing | | Increasing pedestrianisation and vehicle entry restrictions, next gen city designs | | | | |
| | Urban Mobility | Discrete transport services (pay per mile / usage) | | On-demand, integrated transport services that deliver accessible end-to-end mobility | | | | | |
| | EV efficiency | 215Wh/mile | 10-15% | 20-30% | | >30% | | | |
| | | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 | ... |



TAILPIPE EMISSIONS
LEGISLATION



LOCALISED
REGULATION



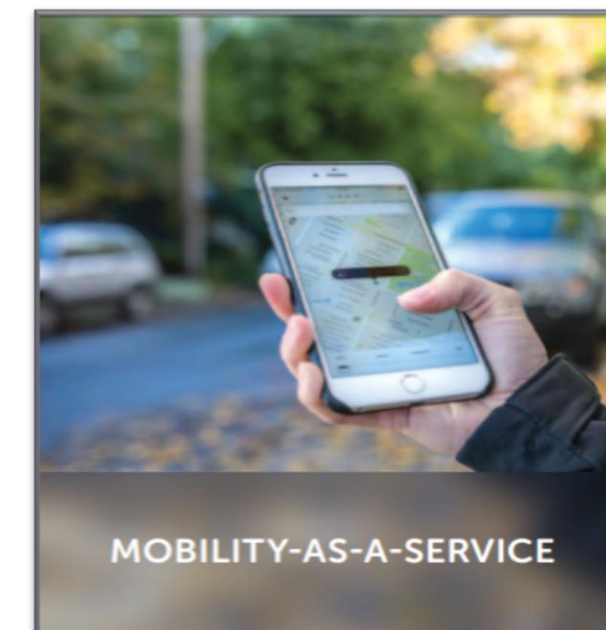
LIFE CYCLE
REGULATION



THE WIDER
ENERGY SYSTEM

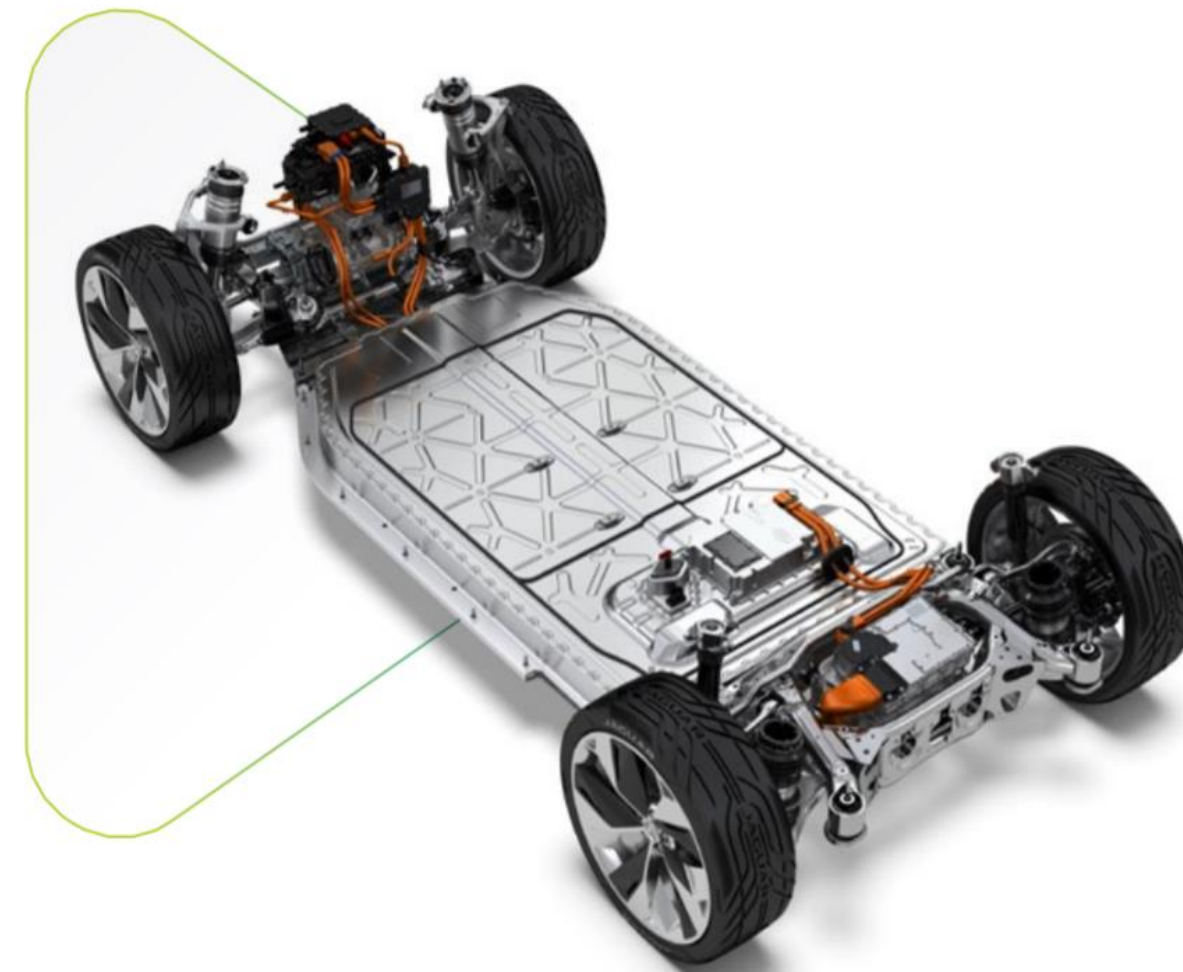
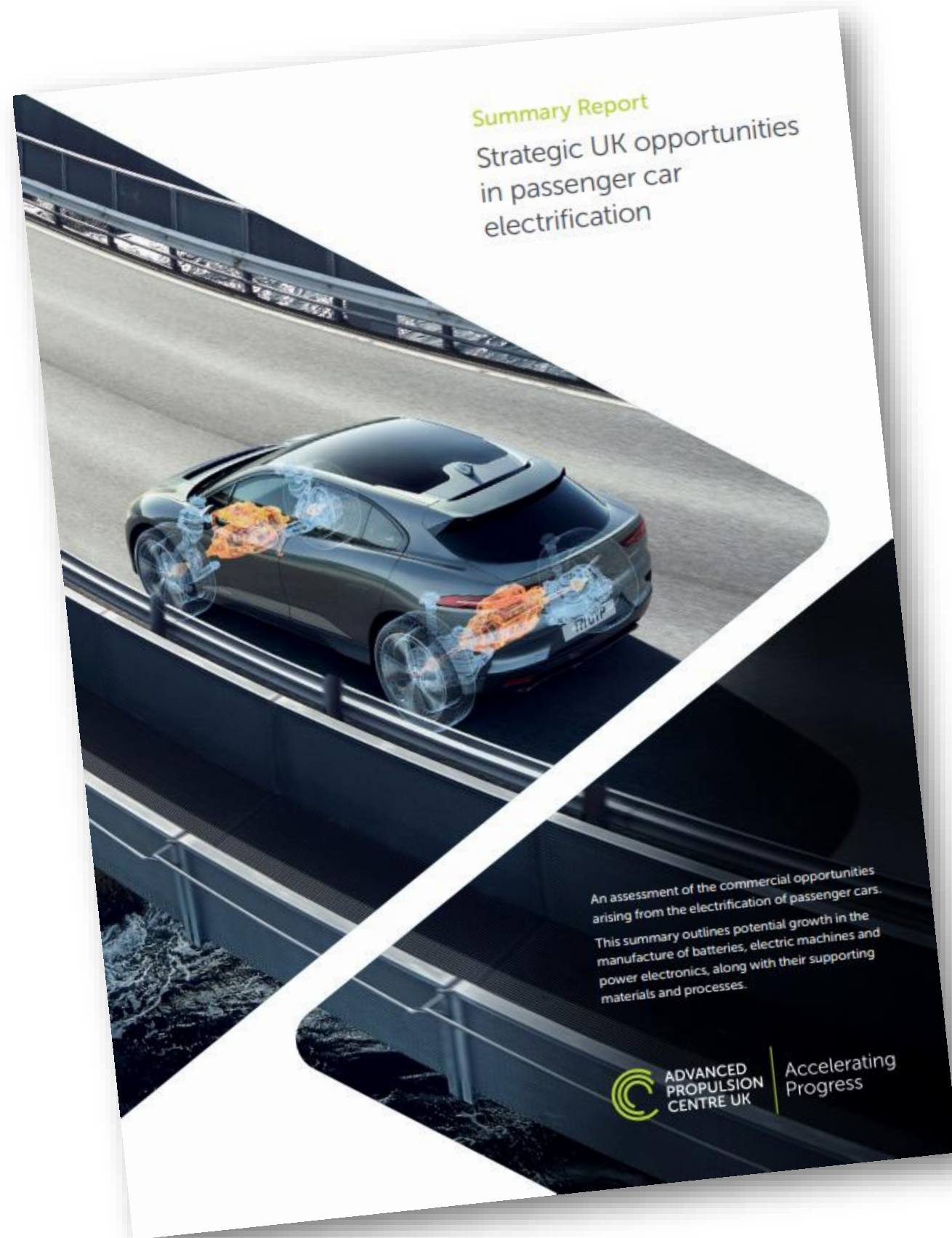


CONNECTED AND
AUTONOMOUS VEHICLES



MOBILITY-AS-A-SERVICE

Passenger car electrification – A £24 billion OPPORTUNITY



Area
of focus

UK opportunity for
the electrification
of passenger cars

Report
timeframe

5 years

Value of
opportunity

£24bn

£24 billion represents the serviceable available market across 12 opportunities considering geographic access for UK-based manufacturers.

<https://www.apcuk.co.uk/opportunities-for-you/strategic-uk-opportunities-in-passenger-car-electrification/>

Opportunities



£2bn

Electric machines

- Magnet manufacturing
- Electrical steel
- Electrical machine assembly and testing



£12bn

Batteries

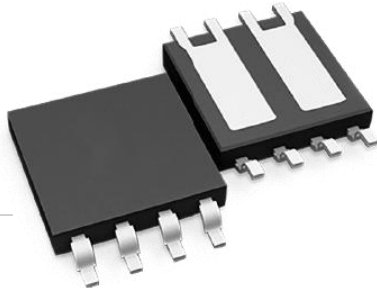


- Cathode materials refining
- Cathode manufacturing
- Anode manufacturing
- Electrolyte manufacturing
- Cell assembly
- Battery pack components

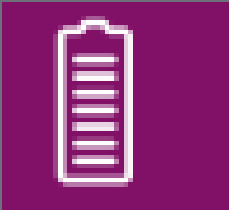




£10bn

Power electronics



12 specific opportunities were highlighted across the battery, Electrical machines and power electronics supply chains

| | |
|---|-------------------|
|  | Batteries - £12bn |
| Cathode materials refining | |
| Cathode active materials manufacturing | |
| Anode materials (synthetic and natural graphite) | |
| Electrolyte mixing | |
| Cell manufacturing and assembly | |
| Battery pack components (BMS, busbars, cooling plates) | |

| | |
|---|----------------------------|
|  | Electrical Machines - £2bn |
| Magnet manufacturing | |
| Electrical steel | |
| Electrical machine assembly (inc. stator winding) | |
|  | Power Electronics - £10bn |
| Wide band gap semiconductors | |
| Sensors | |
| High performance passive components | |

New language, existing capabilities

Today = Foundation

Quality
Cost
Delivery
Development
Management

Tomorrow = **Change Programme**

Supply chain success: Busbars for battery packs

Busbars for automotive battery applications can be both copper and aluminium. Battery pack manufacturers require **complex shapes, good conductivity and high volume manufacturability** in order to meet OEM requirements.



TAM for busbar opportunity

~€380-440m
EU-wide
In 2025

TAM of busbar opportunity in different regions



30-40 m €



380-440 m €



450 m €



155-370 m €

Automotive's influence on demand

- A** The main driver of future demand
- B** Future demand will increase but not the main sector
- C** Very little influence on overall future demand

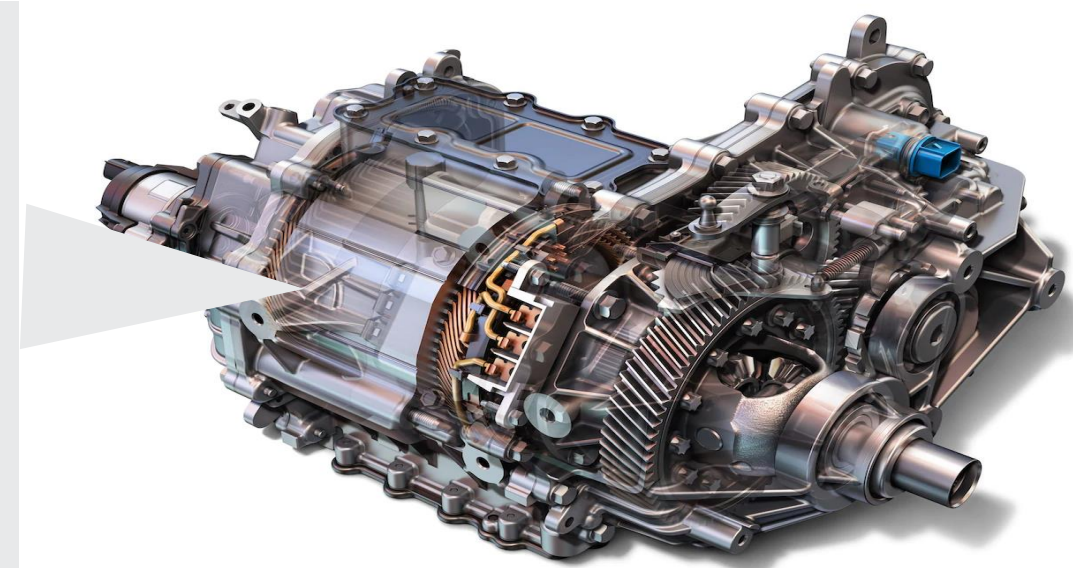
Potential of opportunity

- A** Possible worldwide reach
- B** Regional reach - EU
- C** Supporting local UK companies



Supply chain success: Motor housings for e-machines

Motor housings are a good opportunity for existing Tier 1 / 2 suppliers who supply components for engines and transmissions to take advantage of electrification



TAM for this motor housing opportunity

~€35-40m
UK-wide
In 2025

TAM of motor housing opportunity across regions



35-40 m €



350-440 m €



515 m €



130-380 m €

Automotive's influence on demand

- A** The main driver of future demand
- B Future demand will increase but not the main sector
- C Very little influence on overall future demand

Potential of opportunity

- A Possible worldwide reach
- B Regional reach - EU
- C** Supporting local UK companies

AVL 

Networks



-  **Electric Machines**
Newcastle University
-  **Power Electronics**
University of Nottingham
-  **Electrical Energy Storage**
WMG, University of Warwick
-  **Digital Engineering and Test**
Loughborough University (London)
-  **TPS System Efficiency**
University of Bath
-  **TPS Thermal Efficiency**
University of Brighton

The Funding Landscape

Research

Proof of concept

Application readiness

Industrialisation at scale

Automotive R&D eco system



IDP

APC CR&D

Automotive
Transformation Fund



Cross sector technology

Batteries

Motors
and drives

Enabling digital
technology

Faraday Battery
Challenge

Driving the Electric Revolution

Made Smarter / Brunel

THE ADVANCED PROPULSION CENTRE – PORTFOLIO

Advanced Combustion
Turbocharged Inline
Variable Valvetrain



Ford + Partners

Hydraulic Transmission
for Earthmoving
Equipment



JCB + Partners

GYRODRIVE
Original Equipment
Development



GKN + Partners

FIRS3T
Frequent IntegRATED Soft
Stop Start Technology



Cummins + Partners

HVEMS-UK
High Volume E-
Machine Supply from
the UK



Jaguar Land Rover +
Partners

ALIVE 6
New Technologies for
the Ingenium Engine



Jaguar Land Rover +
Partners

Zero Emission Range
Extended Powertrain
for Electric Vehicles



Intelligent Energy +
Partners

Modular Architecture
for Low Emissions
Buses



Wrightbus + Partners

Accelerated Next
Generation Caterpillar
4-7L Engines



Perkins + Partners

Advanced Transmission
and e-Drive fo Hybrid
Drive Vehicles



hofer + Partners

Transmission Supply
chain for Next Gen.
Dual Clutch
Technologies



Jaguar Land Rover +
Partners

CO2 Divided by 2



Morgan + Partners

High Energy Density
Battery



Nissan + Partners

UK Automotive Battery
Supply Chain



AGM Batteries + Partners

UK Supply Chain Co-
Development



London Taxi Co. +
Partners

THE ADVANCED PROPULSION CENTRE – PORTFOLIO

Breathe



Jaguar Land Rover

APWES: Advanced Powertrain with Energy Storage



Turner Powertrain Systems

ACE-DC: Alliance Casting European Development Centre



Nissan Motor Manufacturing

CEMZEP – Cryogenic Engines for Mobile Zero Emission Power



Dearman Engine Company

SPEED V: Super-high Power-dense Engines for Electric-hybrid Vehicles



McLaren Automotive Ltd.

DIET – Disruptive Integrated Electric Transmissions for Industrial Vehicles



Ashwoods Automotive Limited

Superlight Twin



Norton Motorcycles UK LTD

Strategic Drive for Low Emissions Commercial Vehicles



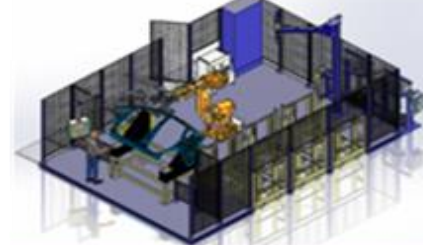
Ford Motor Company Ltd

H₁PERBAT



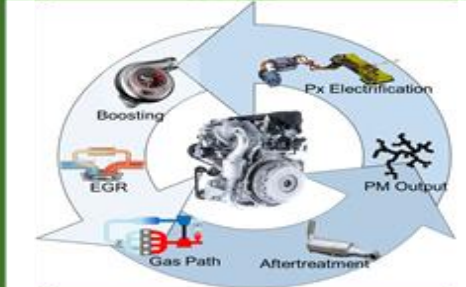
Williams Grand Prix Engineering Ltd

FLAVA: Flexible Lightweight Architecture for Volume Applications



Penso Consulting Ltd

DYNAMO: DYNAMIC Analysis, Modelling and Optimisation of GDI Engines



Ford Motor Company Ltd

Adapt



Westfield Sportscars Ltd

HP-LiSD: High Power Lithium Storage Device



BMW Motorsports Limited

CHAMAELEON



Jaguar Land Rover

LoCT: Low Carbon Tractor



CNH Industrial NV

Competition framework - SCOPE



Support UK's long-term capabilities and supply chain



Significantly reduce CO₂ emissions and improve air quality



Alignment to strategic technology areas:

- Electric Machines & Power Electronics
 - Energy Storage & Energy Management
 - Lightweight vehicle & Powertrain structures
 - Thermal propulsion
-



Develop UK capability and supply chain in this field



First application for automotive – on or off highway vehicles and heavy duty



Collaborative, business led, match funded & UK based.

Competition framework - SCOPE



Contain a vehicle manufacturer / tier 1 supplier



Contain an SME partner



Project duration between 18 – 42 months



Projects total eligible costs £5 - £40 million and be match funded (max 50%)



Clear route to market at the end of the project



Demonstrate how it will increase upskilling and knowledge sharing in the UK

Initial Questions

| | | |
|--------------------|-----------|------------------------------------|
| Project Summary | 400 words | <i>(suitable for funding? Y/N)</i> |
| Public Description | 400 words | <i>(published if successful)</i> |
| Project Scope | 400 words | <i>(within scope? Y/N)</i> |

Part 1

Questions 1-4

The Business Case

Part 2

Questions 5-8

Project Details

Part 3

Questions 9–10

Funding and Added
Value

Part 4

Questions 11-16

Economic
assessment (VfM)

Future competitions

Core Competitions Calendar for 2021

APC18

▶ Opens 4th January 2021

▶ Closes 3rd March 2021

▶ Proposed announcement end of May 2021

APC19

▶ Opens 10th May 2021

▶ Closes 7th July 2021

▶ Proposed announcement end of September 2021

APC20

▶ Opens 9th August 2021

▶ Closes 6th October 2021

▶ Proposed announcement end of December 2021

Automotive Transformation Fund



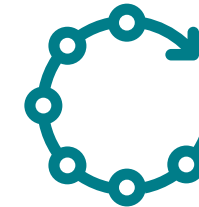
Providing funding and support for R&D and capital investment

in the automotive industry to support electrification transformation at pace



Enabling automakers to develop technology which will meet our 2050 target

by removing the risk and providing support during the transition to electrification



Developing the worlds most comprehensive and compelling electrified vehicle supply chain

through a long-term strategic programme



Ensure that the UK retains its technological leadership position through this transformation

and supporting the sectors strong export performance

Automotive Transformation Fund

Launched in July 2020, ATF aims to:

- ▶ Feasibility studies to assess viability for UK projects
- ▶ Capital investment support for industrialisation at scale
- ▶ R&D leading to product or process scale-up

Technology areas of:

- Batteries
 - Fuel cells
 - Motors
 - Power electronics and drives
- ..and upstream supply chains & recycling



Automotive Transformation Fund

ATF aims to:

- ▶ Secure the transformation to electrification of the UK automotive sector at pace
- ▶ Ensure that the UK retains its technological leadership position through this transformation
- ▶ Support the sector's strong export performance
- ▶ Support the UK's Green Recovery post the COVID-19 crisis

How we can help



Understanding the opportunity



Building partnerships and finding customers



Building your project proposal



Securing facilities & finance



Building the team



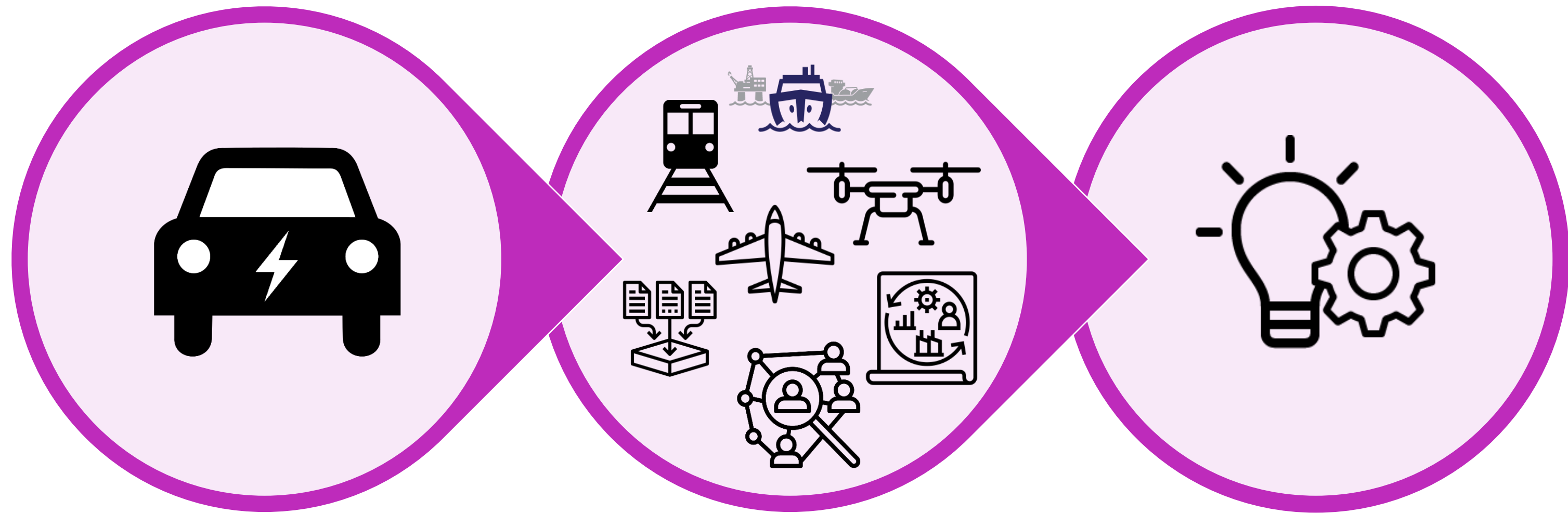
Innovating for the future



Succeeding for the long term



Innovate UK – unlocking value across transport



TDAP Features



Structured early-stage Accelerator Programme



£100k+ Grant support



Independent expert consultancy, mentoring and support



Automotive industry networking

Programme benefits and future



Credibility boost through APC process



57 businesses engaged
27 completed the programme



Businesses feel accelerated route to market by 12 to 36 months



Over £16 million
Investment / debt

- ▶ Next wave announcement coming very soon.
- ▶ Expect to be receiving EOIs and issuing application packs in Q1 2021.
- ▶ Please see www.apcuk.co.uk or contact tdap@apcuk.co.uk to ensure you are on our mailing list.

APC Technology Developer Accelerator Programme

Waves 1 - 4



Thank you for watching. We're here and ready to offer funding, insight and support on your journey to a net-zero future. Please contact us and let's explore how we can help you.

- ▶ Website www.apcuk.co.uk
 - ▶ Email info@apcuk.co.uk
 - ▶ Twitter [@theapcuk](https://twitter.com/theapcuk)
 - ▶ LinkedIn [**Advanced Propulsion Centre UK**](#)
-