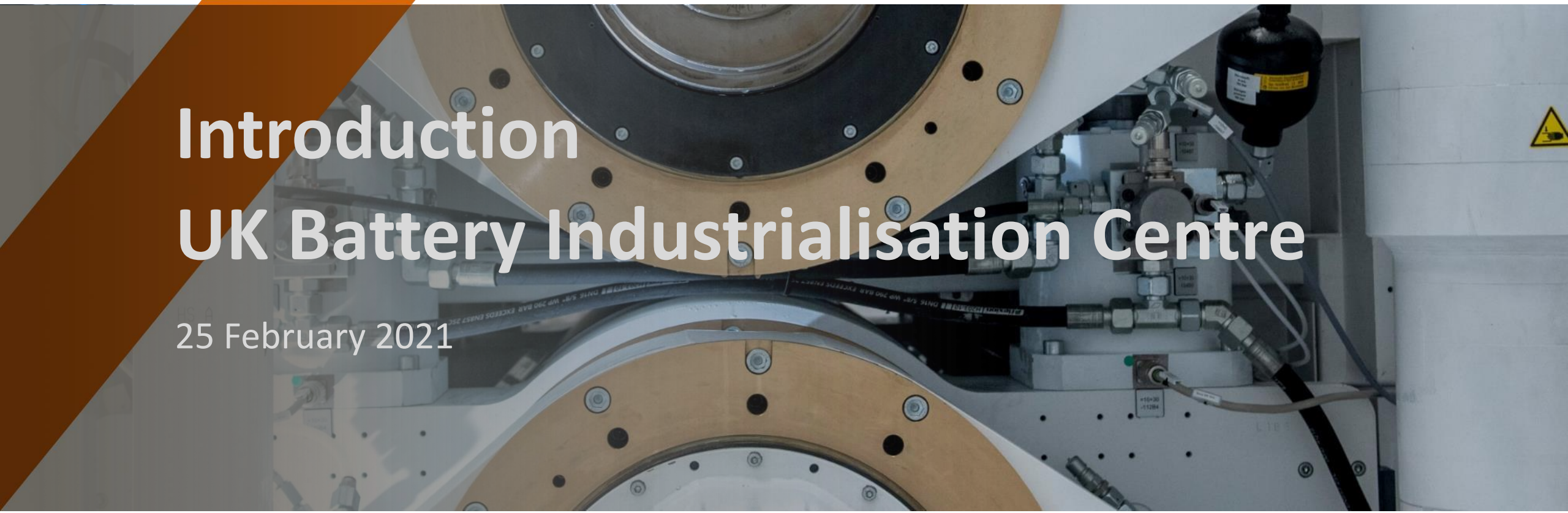
UK BATTERY INDUSTRIALISATION CENTRE



Introduction
UK Battery Industrialisation Centre

25 February 2021

UK Industrial Strategy – Faraday Battery Challenge

ISCF Faraday Battery Challenge

£318 million Government Investment (2017-2022)
'Enabling design, development and manufacture of batteries for EVs'

Research

- Harnessing the strengths of the UK research base
- Creation of the **Faraday Institution** –responsible for coordination of research and training programmes.
- 9 major research programmes across 22 universities and 50 industrial partners addressing battery related scientific challenges at scale:
- Battery Degradation; Multi-scale Modelling; Recycling & Re-use; Electrode Manufacturing; Li-ion cathode materials; Solid State Batteries; Sodium-ion Batteries; Lithium Sulfur batteries.

Innovate

- Creating new solutions and demonstrations
- Backing great UK collaborations to bring cutting-edge solutions to market and build capability across the value chain.
- Over 120 organisations funded across 64 collaborative R&D projects.
- £82m committed in 3 Rounds of funding competitions with £32m additional co-investment provided from industry.

Scale

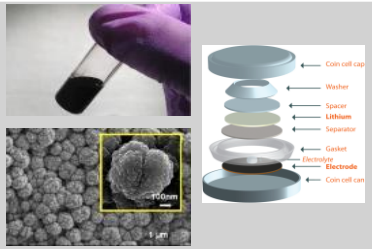
- **£130m for UKBIC funded by Faraday Battery Challenge and West Midlands regional investment.**
- **Scale up programme to allow companies of all sizes to rapidly move new battery technologies to market.**
- **Develop manufacturing tools and processes for mass production and demonstrate production-rate reliability and quality.**
- **Supporting UK skills development for a growing battery industry.**

UK BATTERY INDUSTRIALISATION CENTRE

Bridging the Gap from R&D to Mass Production

UKBIC scope

Volume, TRL, MRL

	Gramme Scale	Kilogramme Scale	Tonne Scale	Giga Scale
				
Characteristic	▪ Typically university scale research labs using small quantities of hand-made materials. ▪ Used for fundamental materials research and initial half-cell experiments at coin cell scale.	▪ Typically corporate R&D pilot line or university / Catapult centre. ▪ Used to demonstrate scalability of materials to full size cell, and to develop electrode mixtures, deposition processes and cell formats.	▪ Typically full-scale manufacturing facilities used at low output rate. ▪ Used to develop and validate materials, cell design, manufacturing processes and parameters at industry rates prior to full plant investment.	▪ Full-scale, high volume manufacturing plant. Typically 6-50GWh/year. ▪ Used to deliver very large volumes of cells with no variation or flexibility to chemistry, format or quality. Cost/kWh and process consistency are critical.

Technology Readiness	TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9
	Principles & Research	Explore Applications	Analytical Experiments	Validation & Requirements	Design & Performance	Model & Prototype	Performance & Testing	Test & Demonstrate	Real World & Launch
	Research & Development						Industrial Engineering		Commercialisation

Manufacturing Readiness	MRL 1	MRL 2	MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
	Implication & Materials	Identify Processes	Proof of Concept	Identify Technology & Test	Prototype Materials, Tools & Skills	Processes & Detailed Costs	Pilot Line & Materials	Process Maturity Demonstration	Manufacturing Processes Proven	Production Ready
	Material Solution Analysis				Technology Development		Engineering & Manufacturing Development		Production & Deployment	Operation & Support

UKBIC Scope

UK BATTERY INDUSTRIALISATION CENTRE

Key Facts

1. 20,000m^2 manufacturing research facility located on the outskirts of Coventry
2. Battery Electrode, Cell, Module and Pack manufacturing capability at industrial rates
3. Modular “Learning Factory”. Used for trialling and short volume manufacture of:
   - New manufacturing processes
   - New materials
   - New cell formats
   - New module structures
   - New pack structures
4. Reducing commercial risk for high volume manufacturing investments
5. Open access and promotes UK industrial collaboration for organisations of all sizes
6. Does not exist to own IP or product but to enable industry user outcomes
7. Delivers skills and training to support the growth of the UK battery industry

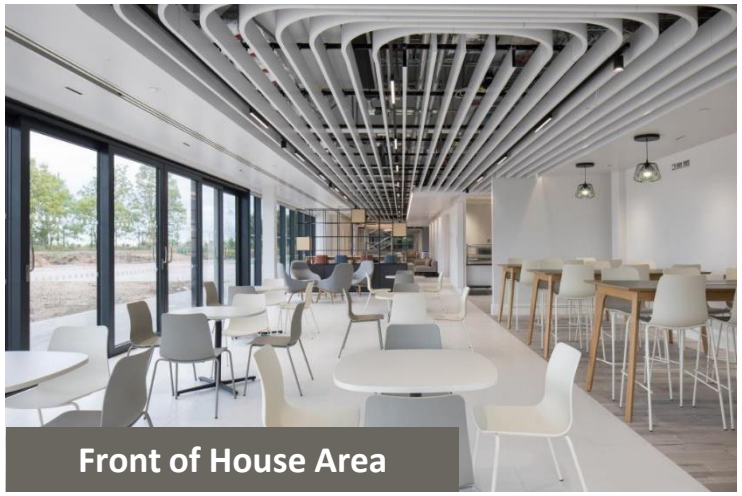
UKBIC Building


Front Entrance


Customer Campaign Room

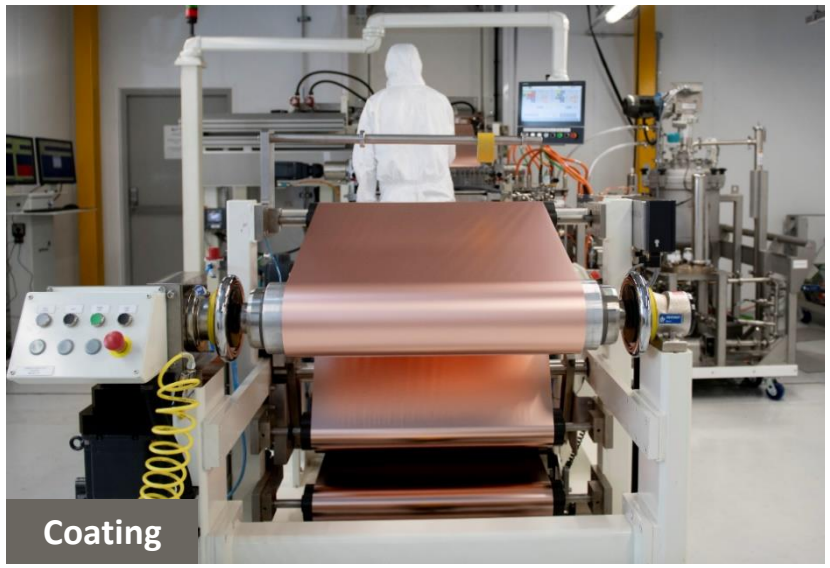

Reception Area


Board Room


Front of House Area

UKBIC Electrode Manufacturing

Mixing

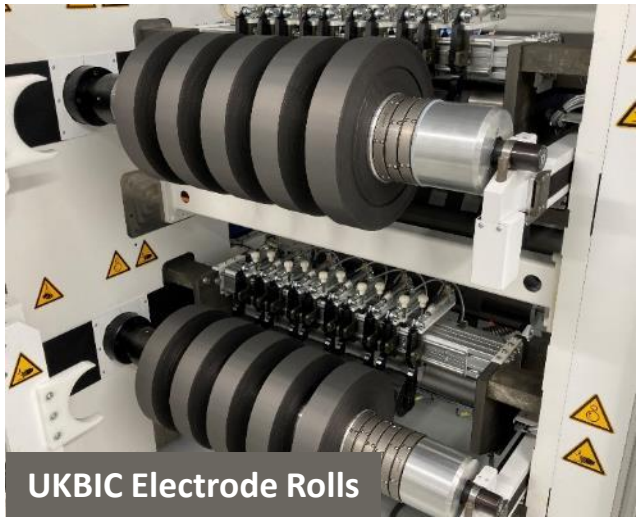

Coating


Drying


Calendering


Slitting

UKBIC Cylindrical Cell (21700) Assembly



UKBIC Electrode Rolls

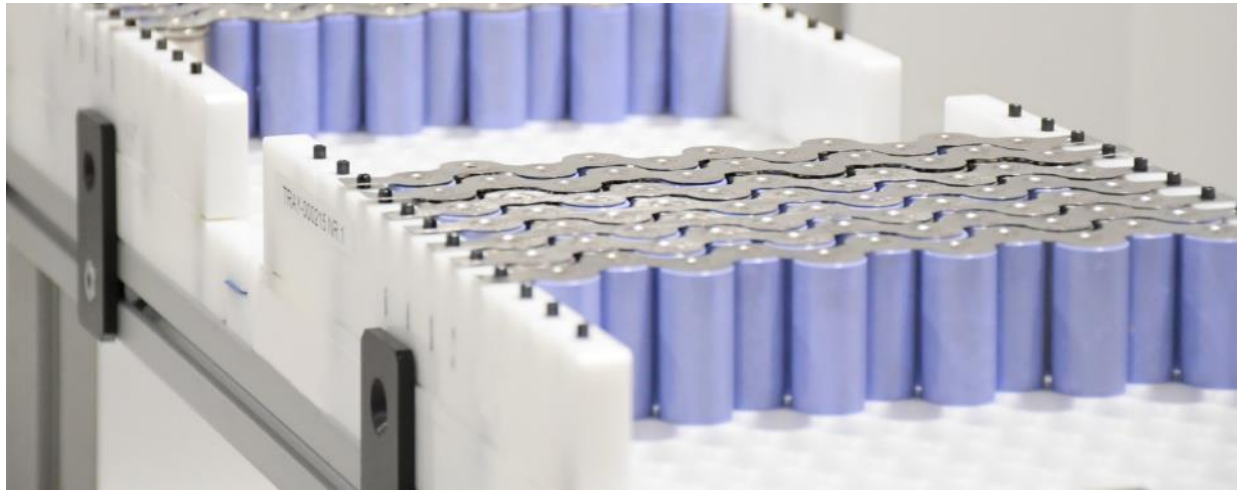
Cylindrical Cell Assembly

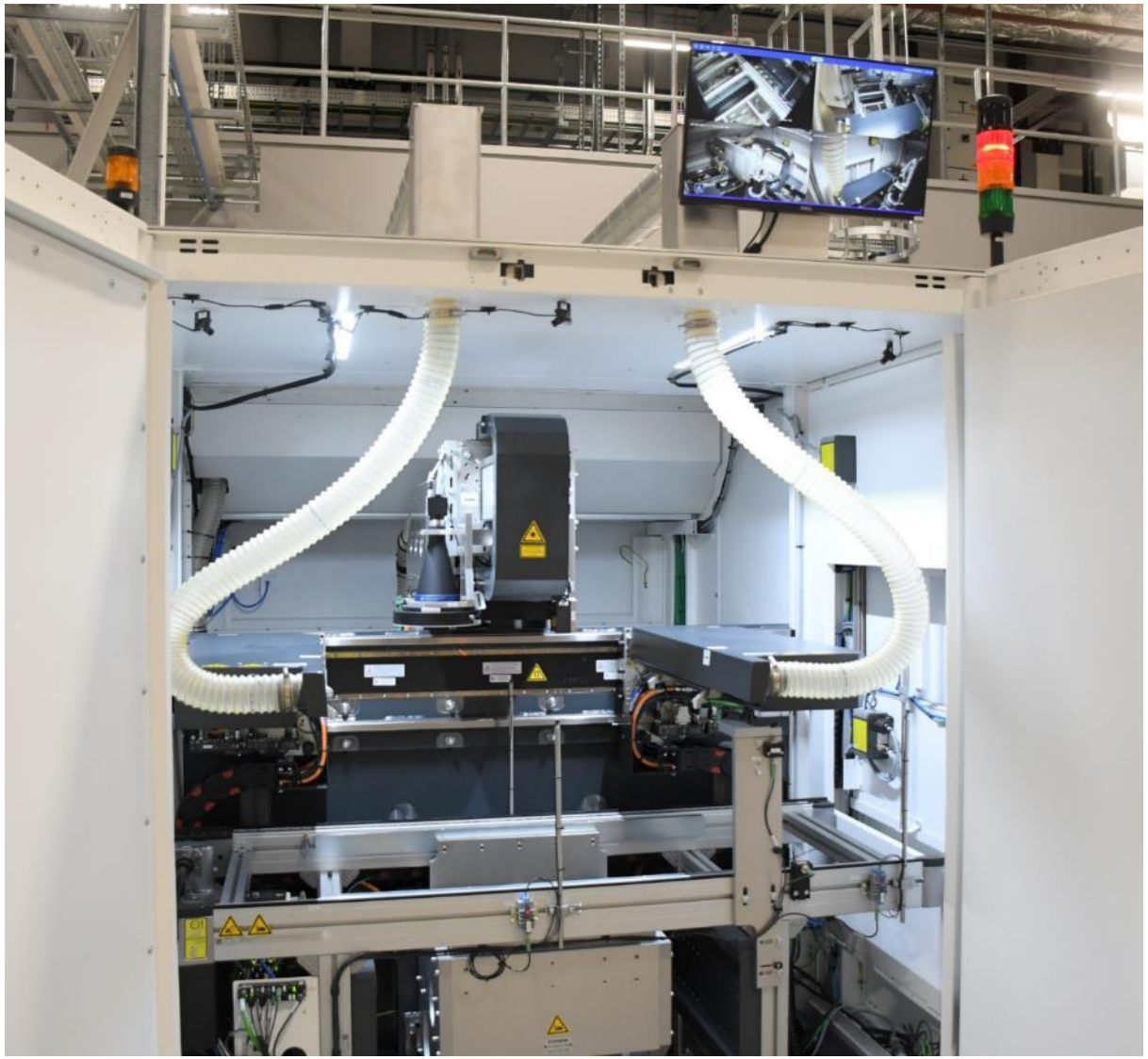
Cylindrical Cell Assembly

Formation, Age and Test (FAT)

FAT Control Room

UKBIC Equipment - Module and Pack Assembly Line





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Thank You

- www.ukbic.co.uk
- Email: info@ukbic.co.uk
- LinkedIn: www.linkedin.com/company/ukbic
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Automotive Transformation

Build your business in the UK

Julian Hetherington
Director, Automotive Transformation

03 March 2021

The current situation…

Meeting the UK's 2050 commitments will require continued effort to reduce the emissions of the UK transport sector

The UK has a significant automotive supply chain which needs to continue to pivot into greener technology if we are to maintain and grow skilled jobs in the UK

ADVANCED PROPULSION CENTRE UK

Today, transport offers the most significant opportunity to reduce UK emissions

transport as a whole accounts for 28% of UK GHG emissions

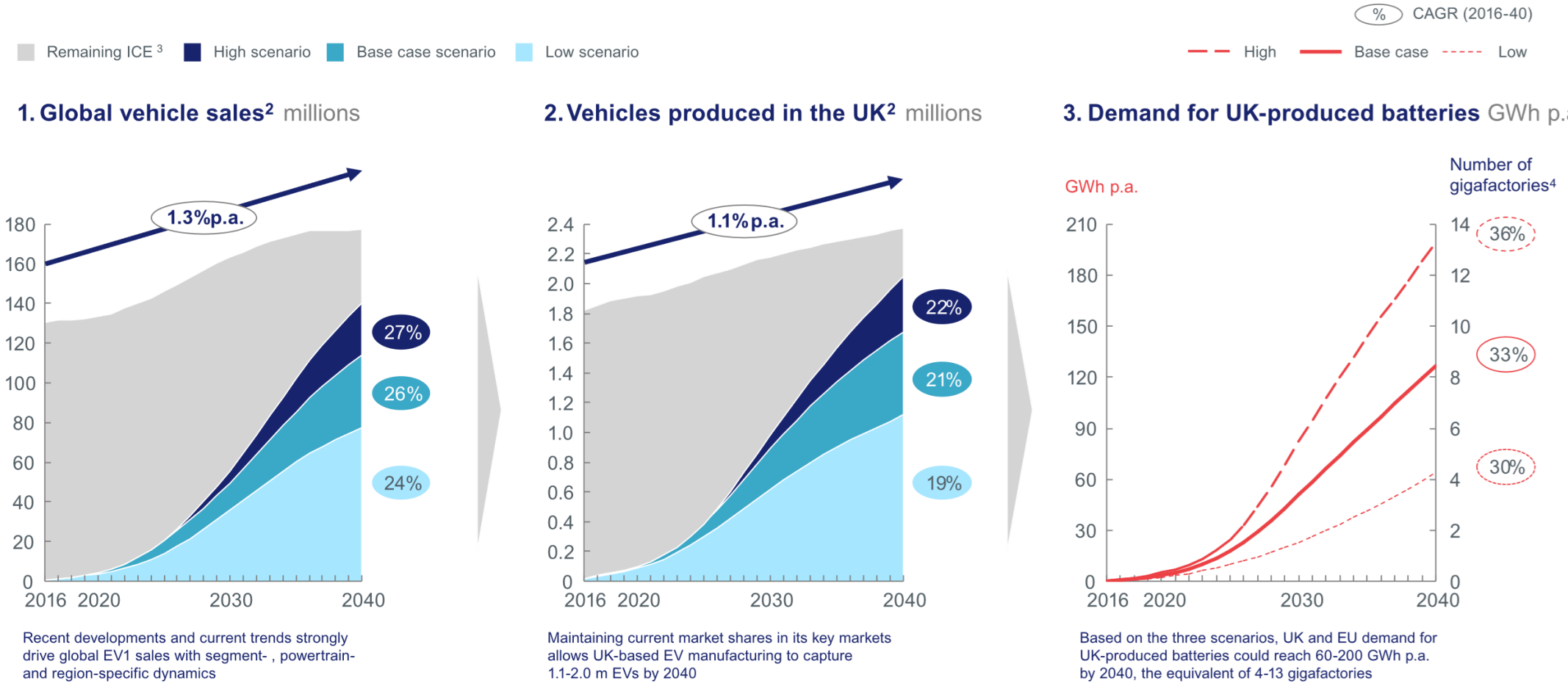
almost double the amount produced by UK homes

2034

The vehicle development cycle in the next 10 years will affect our emissions output for a nearly a quarter of a century

UK demand is coming fast

Even with modest growth, we expect that the UK will need 4+ Gigafactories by 2030



Recent developments and current trends strongly drive global EV1 sales with segment- , powertrain- and region-specific dynamics

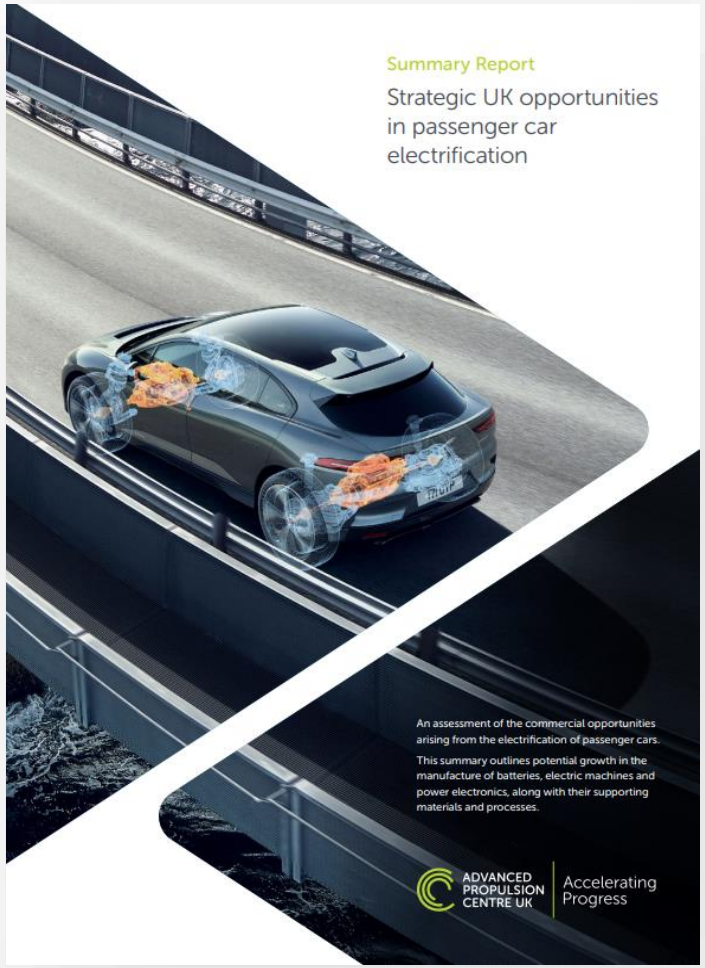
Maintaining current market shares in its key markets allows UK-based EV manufacturing to capture 1.1-2.0 m EVs by 2040

Based on the three scenarios, UK and EU demand for UK-produced batteries could reach 60-200 GWh p.a. by 2040, the equivalent of 4-13 gigafactories

1 EVs include BEV, PHEV, HEV 2 IHS data adjusted for short-term fluctuations 3 ICE vehicles include exported cars (mainly to RoW), domestic and exported trucks and buses 4 One average gigafactory has ~15 GWh p.a. capacity

SOURCE: IHS; McKinsey Energy Insights

Passenger car report



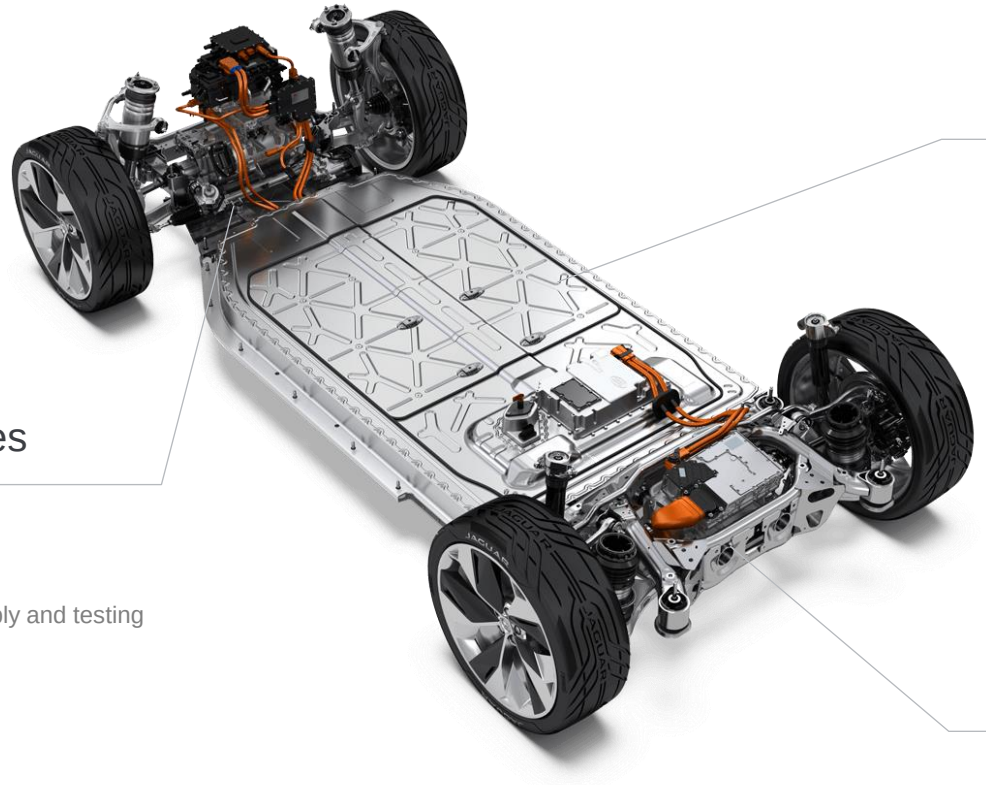
Area of focus	UK opportunity for electrification of passenger cars
Report timeframe	5 years
Value of opportunity	£24bn

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

Split into three key technology areas

£2bn
Electric machines

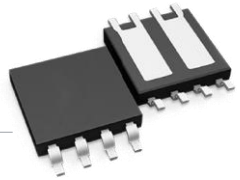
Magnet manufacturing
Electrical steel
Electrical machine assembly and testing



£12bn
Batteries

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

£10bn
Power electronics



Semiconductors
Sensors
High-performance passive components

Automotive is a strategically important industry in the UK

ADVANCED PROPULSION CENTRE UK

People

59,000+
Engineering and manufacturing apprentices

823,000+
People employed in the UK automotive industry

UK exports

1.2m
Vehicles made in the UK

80%
Of cars made in the UK are exported

160
Export destination countries

Manufacturers

£3.75 billion
Spent annually on research and development

8 Major premium and sports car manufacturers
6 Mainstream car manufacturers
4 Commerical vehicle manufacturers
8 Bus and coach manufacturers
60+ Specialist vehicle manufacturers
9 Engine manufacturers

ADVANCED PROPULSION CENTRE UK

Automotive Transformation Fund

Launched in July 2020

- Secure the transformation to electrification of the UK automotive sector at pace
- Capital investment support for factory equipment, land, buildings and set-up costs
- Support for economic & technical compatibility feasibility studies leading to industrial investment
- Complements ongoing R&D project support programmes through regular APC competitions

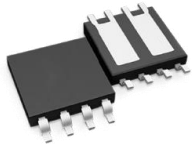
ADVANCED PROPULSION CENTRE UK

Automotive Transformation Fund

Supporting industrialisation and scale-up of:

Batteries

Motors & Drives



Power Electronics

Fuel Cells

Supply Chain

ATF Projects to date

30+

Feasibility Studies

Assess technical or economic viability including:

- Battery materials and upstream raw materials refining
- Battery manufacturing at scale
- Semiconductors for inverters
- Motors
- Fuel cells
- Alternative sources and refining of Nickel, Cobalt and Manganese
- OEM study into adopting large-format cells

20+

Expressions of Interest

Potential UK investment projects of scale, ranging from £20m to over £2bn including:

- Battery manufacturing
- Anode manufacturing and graphitisation
- Active Cathode Materials (CAM)
- Electrolyte
- Separators & HPA for specialist coatings
- Lithium concentrates and precursor battery materials
- Copper materials for batteries
- Fuel cells and coated membranes
- eAxle and motors
- Specialist castings for inverter and motor enclosures
- Wide band-gap semiconductors

ADVANCED PROPULSION CENTRE UK

Accelerating Progress