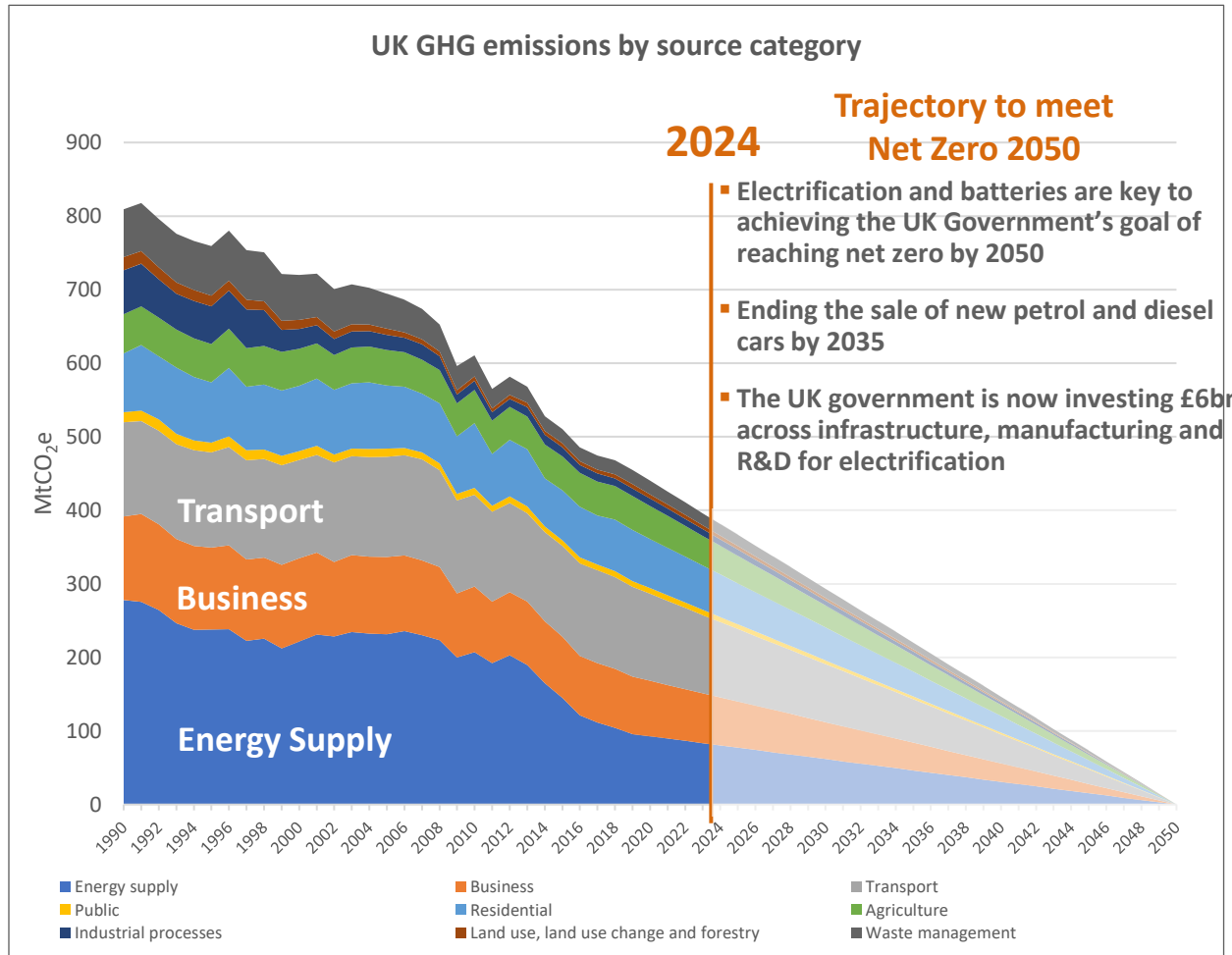




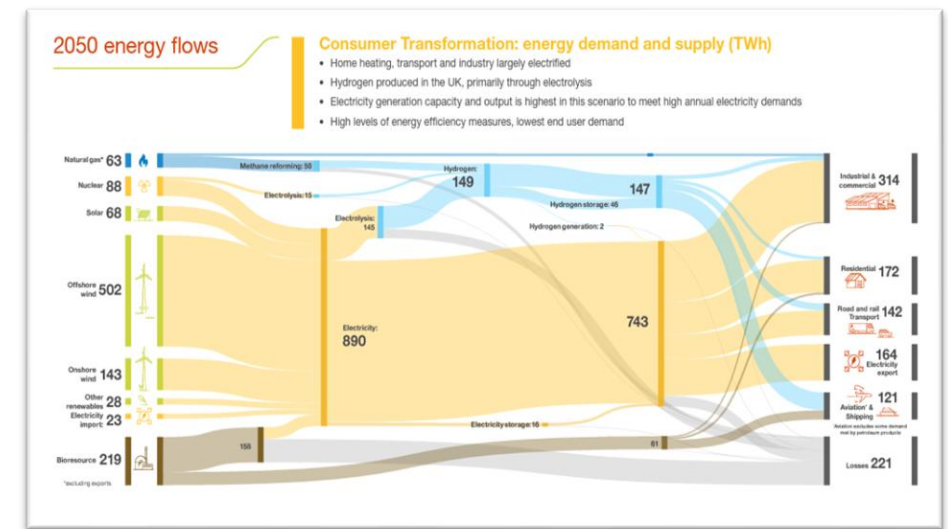
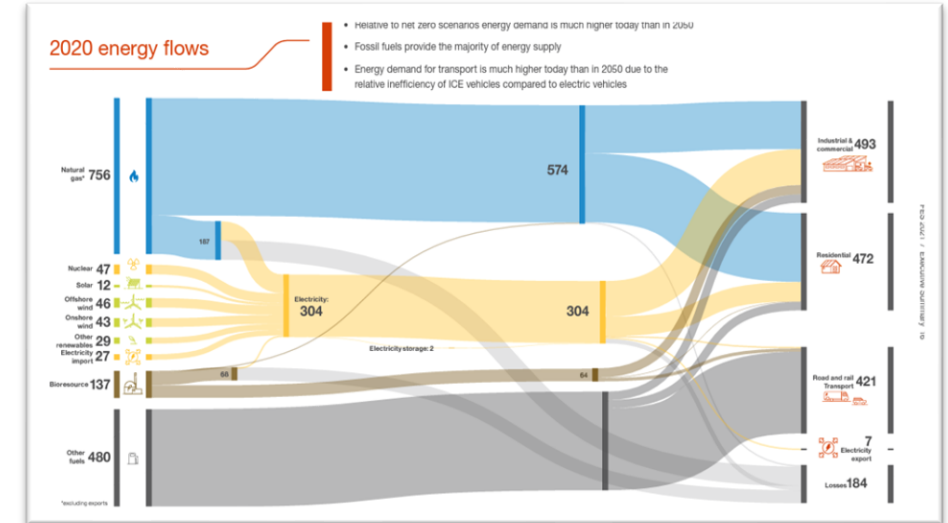
Bridging the gap from R&D to Mass Production: The importance of Battery Manufacturing Scale up

Naseer Ahmed, Commercial Director

The road to Net Zero – It's really happening



Reference: <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2022>



The road to Net Zero

- The UK is strong in vehicle and niche vehicle development and manufacture
- 780,000 people employed across UK automotive
- 182,000 employed directly in manufacturing
- 40,000 new jobs forecast to be created in the sector by 2030

- Key facts:
 - UK automotive manufacturing industry turned over £67 billion
 - Sector accounts for 10% of UK's total exports (£32 billion) in 2021
 - 60+ specialist car manufacturers

905k

Cars built in
the UK in
2023

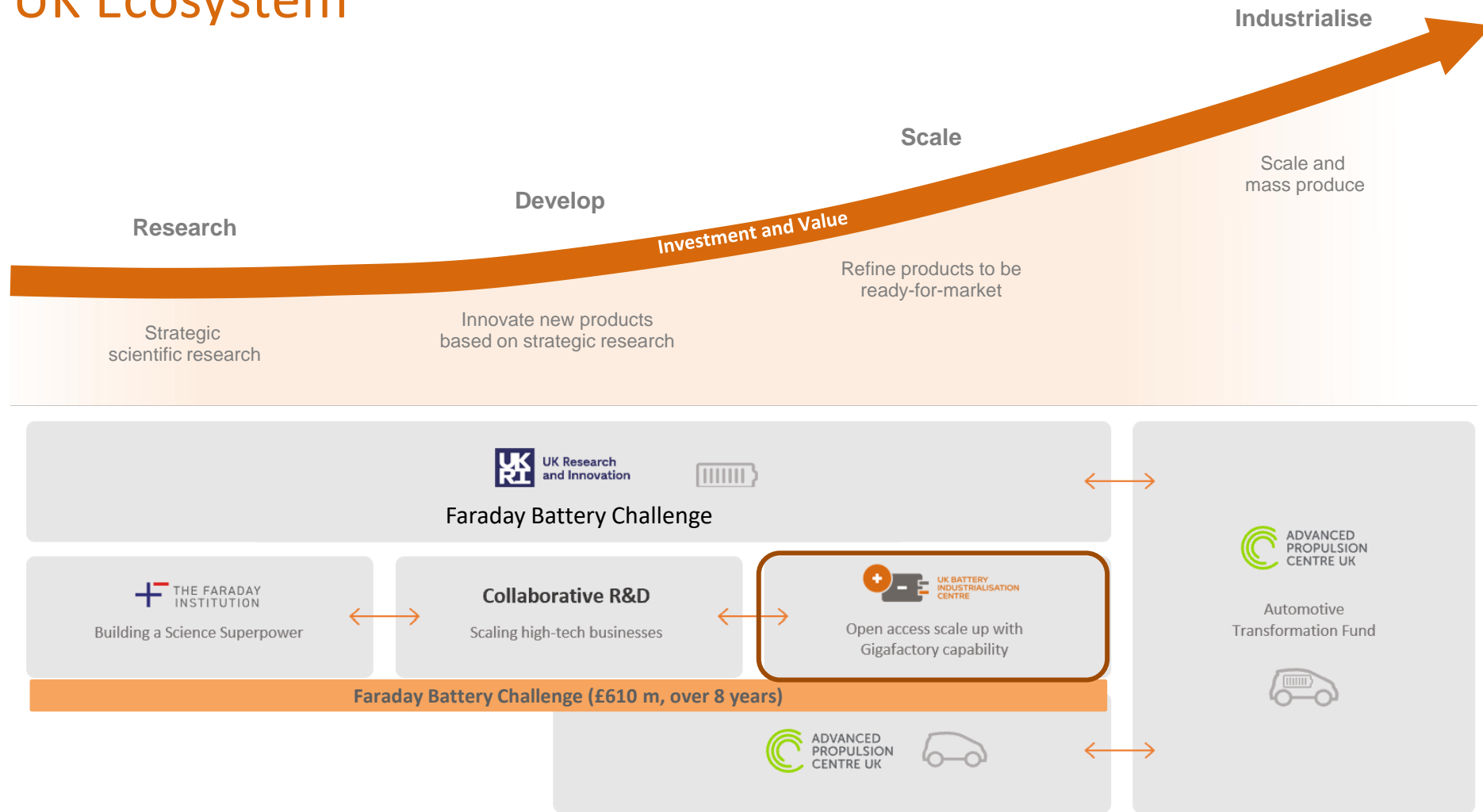
1 million

EVs registered
in the UK
(Jan 2024)

8 in 10

Cars made in
the UK are
exported

The UK Ecosystem



Source: Advanced Propulsion Centre



Based in Coventry



Bridging the Gap from R&D to Mass Production

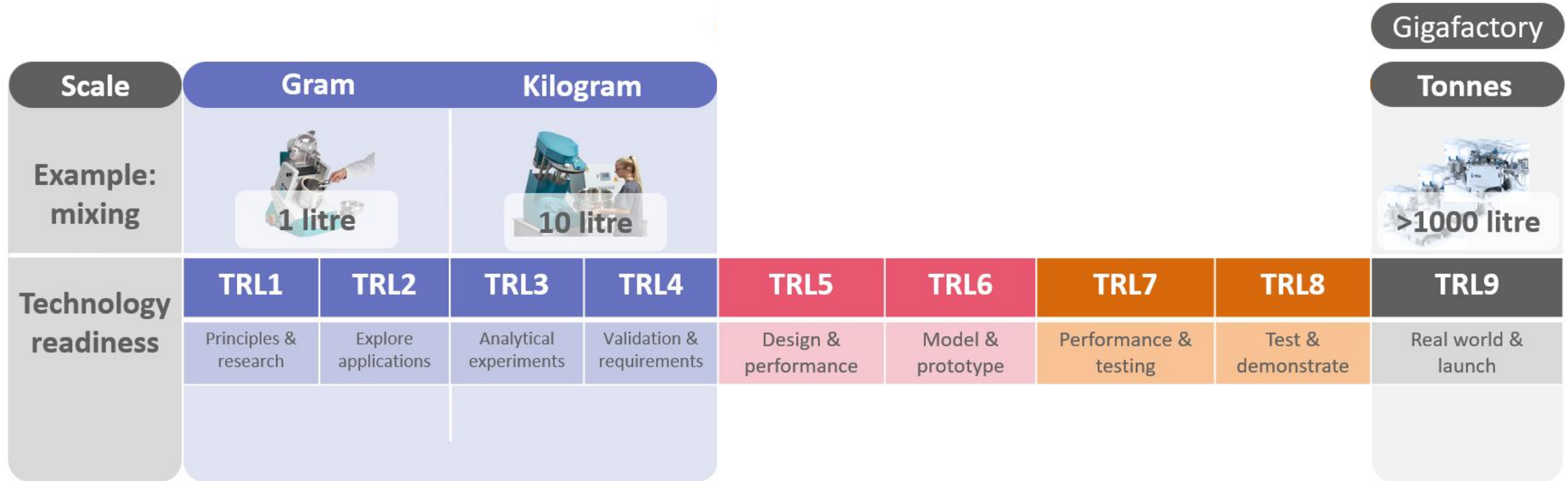
UKBIC scope

Volume, TRL, MRL

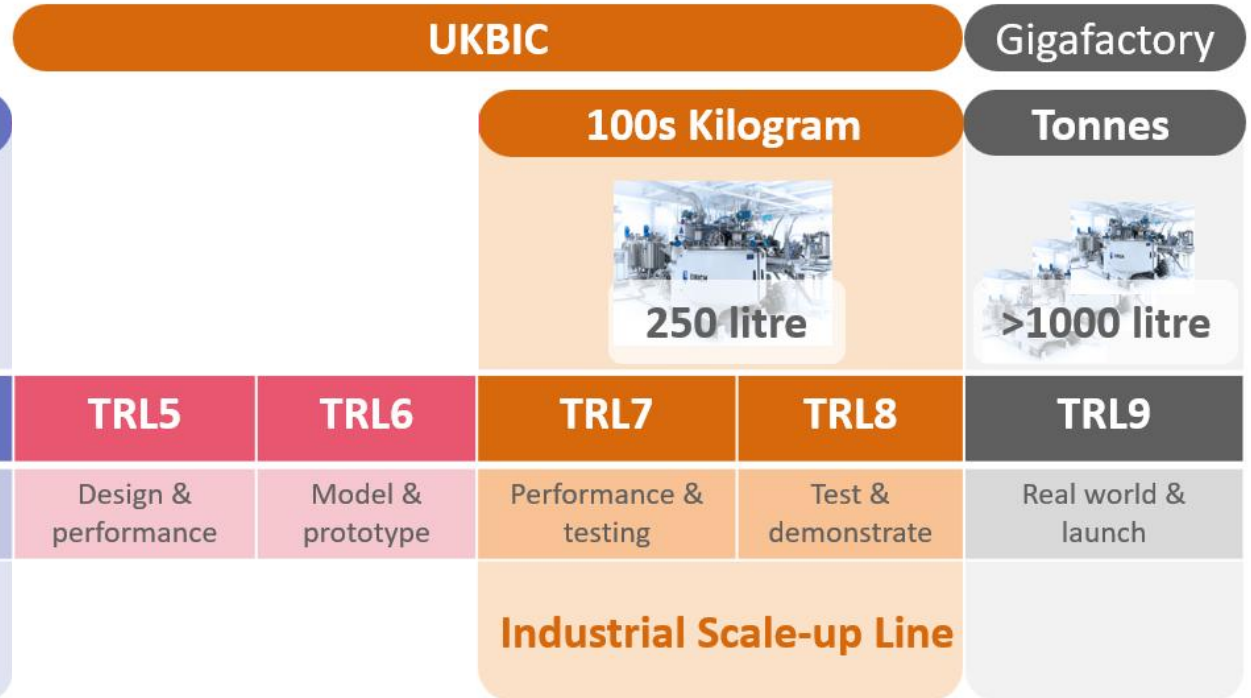
	Gramme Scale			Kilogramme Scale			Tonne Scale			Giga Scale			
Characteristic	<ul style="list-style-type: none"> University scale research labs using small quantities of hand-made materials. Fundamental materials research Initial half-cell experiments at coin cell scale. 			<ul style="list-style-type: none"> Corporate R&D pilot line or university / Catapult centre. Used to demonstrate early scalability of materials to full size cell Develop and demonstrate electrode mixtures, deposition processes and cell formats. 			<ul style="list-style-type: none"> Full-scale GWh/yr 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. 			<ul style="list-style-type: none"> 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				
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	







Bridging the Gap



Bridging the Gap

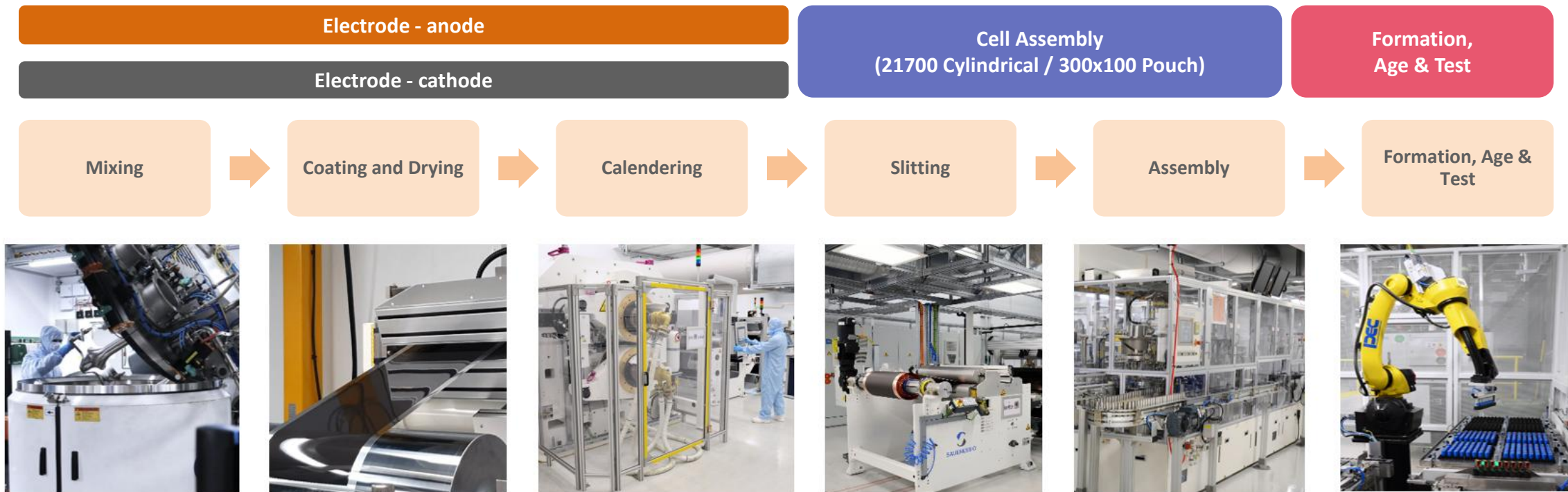


Bridging the Gap

		UKBIC								Gigafactory
Scale	Gram		Kilogram		10s Kilogram		100s Kilogram		Tonnes	
Example: mixing	 1 litre		 10 litre		 70 litre		 250 litre		>1000 litre mixing" data-bbox="828 361 934 501"/> >1000 litre	
Technology readiness	TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9	
	Principles & research	Explore applications	Analytical experiments	Validation & requirements	Design & performance	Model & prototype	Performance & testing	Test & demonstrate	Real world & launch	
					Flexible Pilot Line		Industrial Scale-up Line			

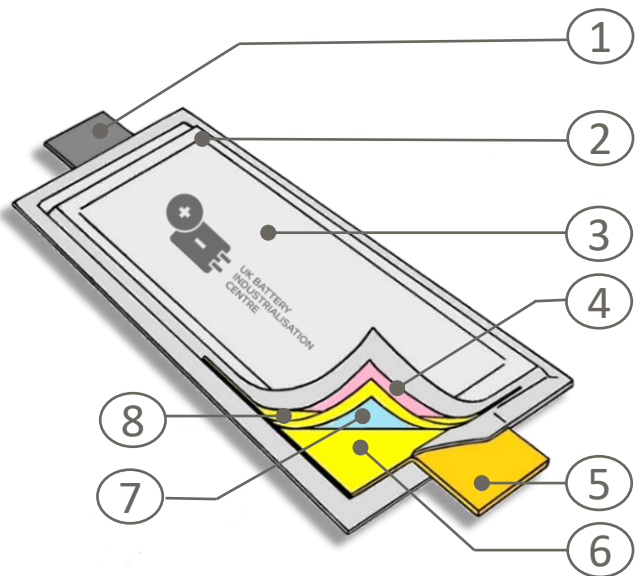
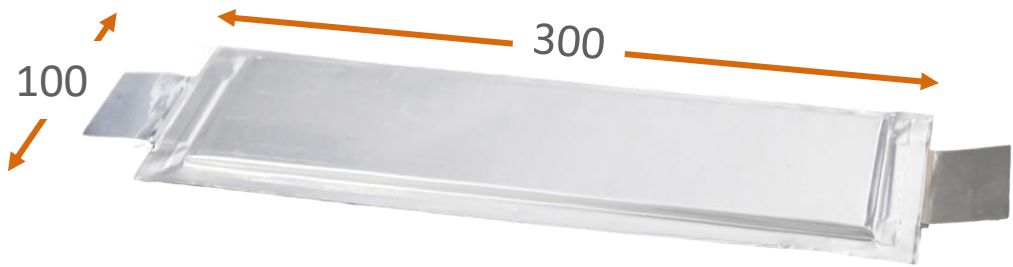


Cell development



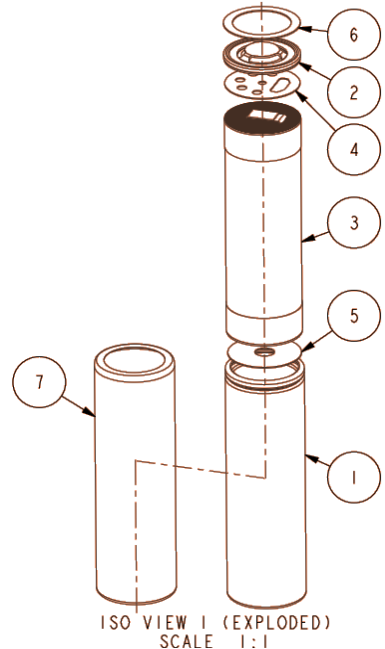
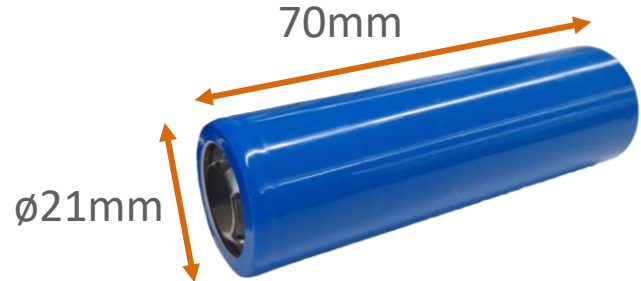
UKBIC current cell formats

Pouch Cell – 300x100



- ① Cathode Tab
- ② Pouch Sleeve
- ③ Label
- ④ Cathode
- ⑤ Anode Tab
- ⑥ Electrolyte
- ⑦ Anode
- ⑧ Separator

Cylindrical Cell - 21700



- ① Can
- ② Cap with CID, vent and Gasket
- ③ Coil Pack (jelly roll)
- ④ Top insulation disc
- ⑤ Bottom Insulation disc
- ⑥ External Insulation Ring
- ⑦ Outer sleeve



What we do



Cell development

- We work with clients across the value chain from mixing to coating to calendaring and on into cell assembly and formation



Module & Pack

- Our agile assembly line transforms cylindrical and pouch cells into modules and packs that are ready for installation or further testing



Battery Development Laboratory

- Analysis and characterisation of raw materials, slurries, coated electrodes, cells and modules



Learning & Development

- Bespoke on-the-line, classroom and virtual battery manufacturing training courses for your organisation



Engineering services

- We provide customers with design, equipment and technical support

Who we support



Cell development



Electric vehicles



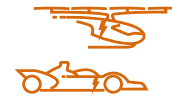
Battery production



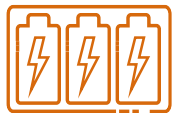
Off-highway vehicles



Battery materials



Niche applications



Module & pack assembly



Energy storage

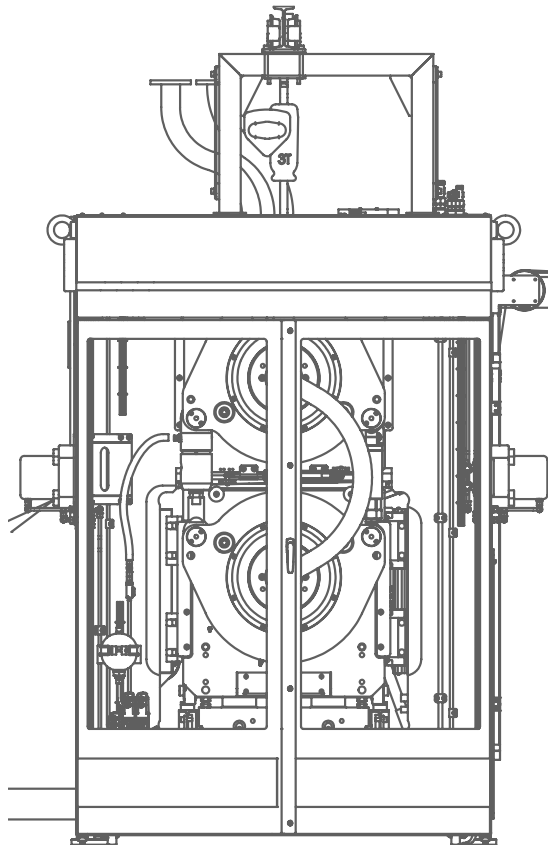


Recycled materials



Process equipment

New developments



Flexible Pilot Line

- Our new FPL allows early-stage optimisation cycles and production trials to demonstrate feasibility
- The FPL is designed to bridge the gap between our existing industrial line and kilogramme scale prototyping

Battery Development Laboratory

- Our bespoke laboratory suite now offers more analytical techniques to support projects, allowing short turnaround times and quicker feedback

Clean and Dry Zone

- Flexible clean and dry rooms providing controlled conditions for equipment testing, temporary installations for manufacturing or other R&D projects

Cell Cyclers

- Designed to perform high accuracy cell cycling in a range of environmental conditions

Flexible Pilot Line (FPL)

- The FPL bridges the gap between our existing Industrial Scale-up Line and kilogramme scale demonstrator lines elsewhere
- Five individually controlled environmental zones
- Process areas from mixing to slitting
- FPL will be jointly operated with WMG, at the University of Warwick

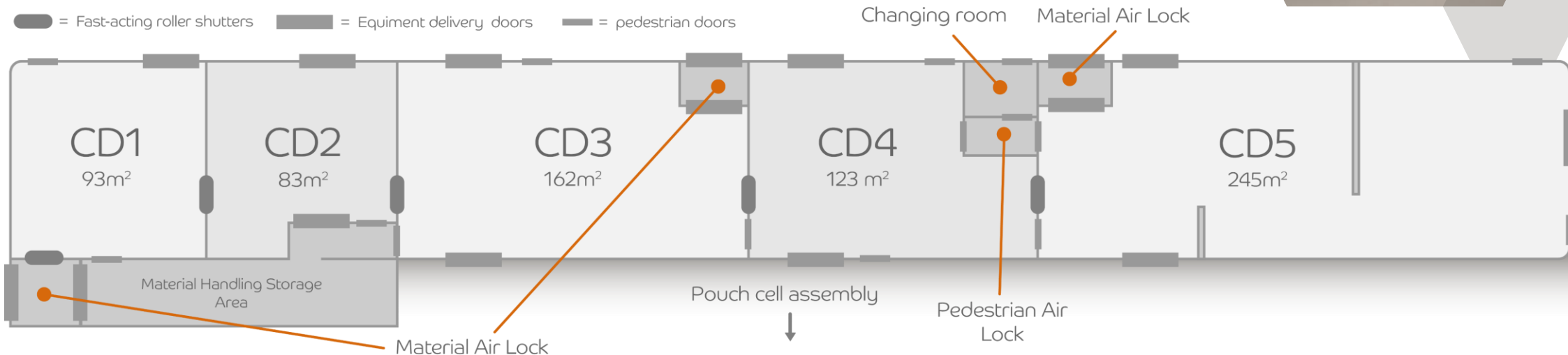
Coming
Early 2025



Clean & Dry Zone (CDZ)

- Flexible clean room space providing controlled conditions
- Ideal for equipment testing, temporary equipment installation, research and development work or manufacturing work
- Rooms range in size from 83m² to 245m² with some expansion available

Coming
early
2025



Battery Development Laboratory

Extensive analytical equipment split into five areas:

- **Characterisation**
Includes: morphology, crystal structure and elemental composition using PSD, XRD, ICP, Raman, NMR & SEM
- **Processing**
Includes: small scale mixing, drawdown and coin cell assembly enabling electrochemistry trials
- **Electrochemistry**
Includes: electrochemical analysis of coin, pouch, and cylindrical cells
- **Forensics**
Specialist glovebox equipped with thermal and optical cameras
- **CT Scanning**
Non-destructive failure analysis

Coming
Autumn
2024



Cell Characterisation

- Bespoke cell cycling housed inside our existing Formation, Ageing, and Testing area
- Extended life-cycle testing
- Environmental control within $\pm 2^{\circ}\text{C}$
- Each cell fitted with its own temperature sensor for comprehensive monitoring

96
Pouch cell
100A test
channels

192
Cylindrical
cell 15A
test
channels



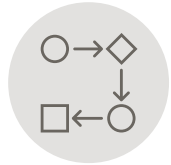
UKBIC's Agile Module and Pack assembly line



Designed to assist companies develop the **optimum manufacturing process** for their product based on size, complexity and quantity.



Equipped for **full scope of module and pack manufacturing** from cell selection and characterisation, laser welding and wire bonding of cell to busbars, BMS assembly and end of line testing.



Low levels of automation with **full traceability** of process steps and measurements (torque etc.)



The facility has capability **for prototype development** and **low volume production manufacturing**

- 50 modules per shift (module end of line test 60V, 770A amp)
- 2.5 EV sized (nominal 60kw/h) packs per shift Pack end of line test 1200V, 800A

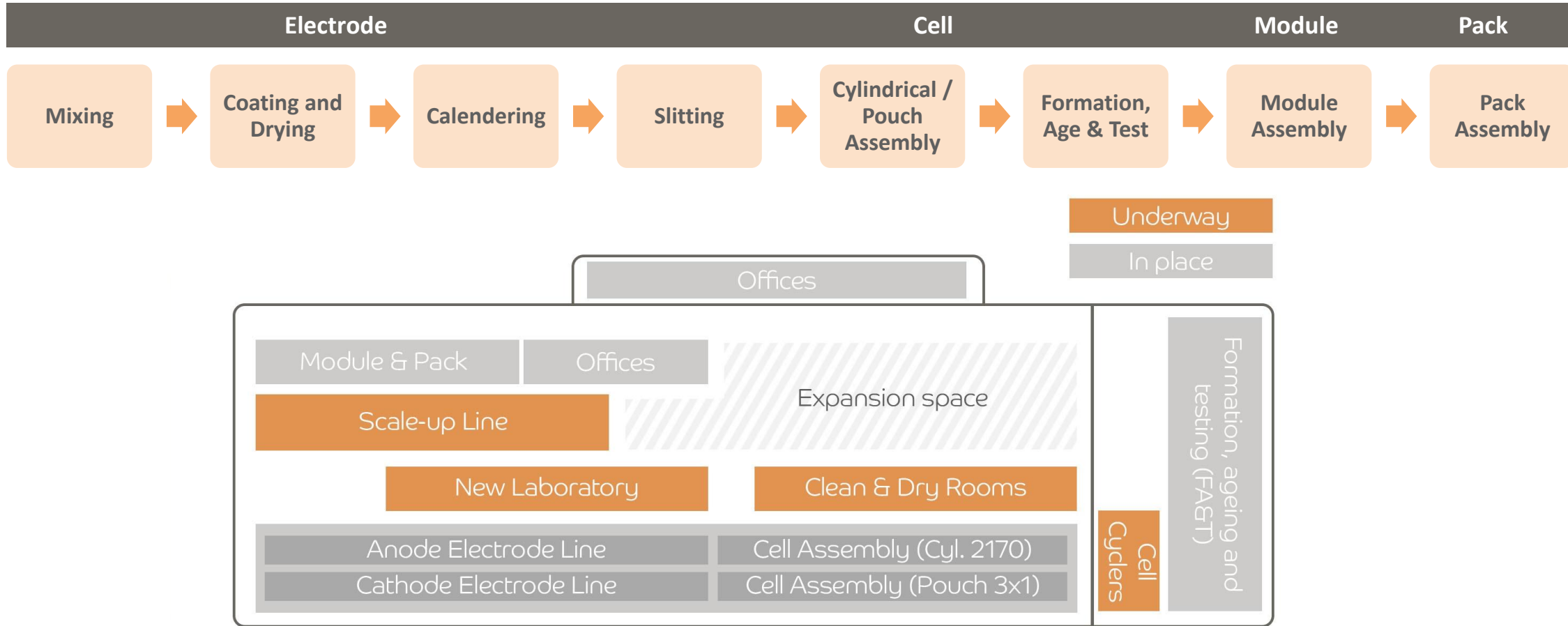


Purpose is to help companies **learn** how to manufacture products so actively encourage clients' employees to work alongside our skilled people.

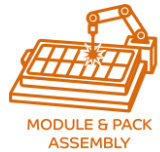
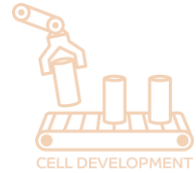


Space protected for higher volume production line installation if required.

Process equipment overview



Bridged the gap: Customer A



Customer A is:

- Large international organisation
- Looking to build battery packs for the first time

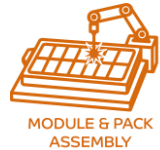
They wanted us to:

- Assemble prototype packs
- Using already designed and developed modules
- Perform end-of-line testing

What they got:

- A very different project...

Bridged the gap: Customer A



Customer A is:

- Large international organisation
- Looking to build battery packs for the first time

They wanted us to:

- Assemble prototype packs
- Using already designed and developed modules
- Perform end-of-line testing

What they got:

- A very different project...

- Initial module design was not scalable
 - ➔ Module redesign support
- Component design not robust and materials sub-optimal
 - ➔ Component modification and quality conformance
- Testing protocol development
- Full packs produced for field trials and further testing
- Company A has the knowledge they need for next steps...

Bridged the gap: Customer B



Customer B is:

- A UK start-up
- Developing battery cells

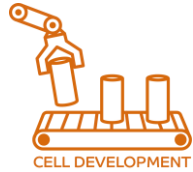
They wanted us to:

- Help scale-up from laboratory prototypes

What they got:

- Access to giga-scale facility
- Understanding of their technology scale-up challenges
- Cells for further application testing

Bridged the gap: Customer B



Customer B is:

- A UK start-up
- Developing battery cells

They wanted us to:

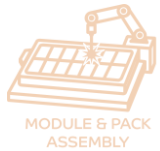
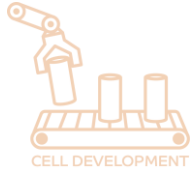
- Help scale-up from laboratory prototypes

What they got:

- Access to giga-scale facility
- Understanding of their technology scale-up challenges
- Cells for further application testing

- Step-by-step scale-up through full cell production process:
 - Mixing
 - Coating
 - Cell assembly
- Overcame mixing / slurry challenges
- Electrolyte benchmarking study
- Cell dimensional study to meet cell target parameters
- Security of IP

Bridged the gap: Customer C



Customer C is:

- A large multinational company
- Battery cell producer

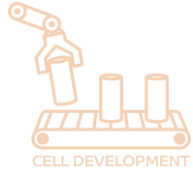
They wanted us to:

- Help train their new people internationally
- Without interrupting their own systems and processes

What they got:

- Tailored training course
- Access to our line

Bridged the gap: Customer C



Customer C is:

- A large multinational company
- Battery cell producer

They wanted us to:

- Help train their new people internationally
- Without interrupting their own systems and processes

What they got:

- Tailored training course
- Access to our line

- Bespoke training – classroom-based and on-the-line
- Language specific
- Customer C could continue operations without disruption
- Follow up courses in planning for other Company C teams
- Reviewing materials production runs for more hands-on training
- Excellent feedback from attendees

UK Battery Industrialisation Centre (UKBIC)

Manufacturing research facility based near Coventry

Open to organisations looking to scale technology in the UK

Access giga-scale equipment to de-risk commercial investment

Trial and validation at industrial scale, speed and quality

Available to any sectors looking to scale battery technologies

Customers retain full ownership of their IP developed at UKBIC

Delivering skills, training and knowledge transfer for the UK



Takeaways



REDUCING RISK

Reducing commercial risk for manufacturing investments



OPEN ACCESS

Open to all sectors, promoting collaboration



DEVELOPING

Modular 'learning factory' for manufacturing scale up



OWN YOUR IP

We don't take a share of customers' IP developed through our facility



UPSKILLING

Delivering skills and training to support the growth of the battery industry



Thank You



UKBIC



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