- AGM Batteries – Brief History
- Introducing AMTE Power
- A Few Short Years - Progress
- A New Industry - Outlook

Who are AGM Batteries

- AGM Batteries Limited has been trading since 1997 and is a recognized brand, having played a vital role in the development of lithium-ion batteries. It subsequently began producing high quality lithium-ion batteries primarily for the defense market
- AGM was acquired in 2013 by AMTE Power and re-commissioned as a portal between development / lab scale and volume production for new battery cell technologies
- AGM is now a flexible manufacturing facility which can accommodate a range of chemistries in both rechargeable (secondary), non-rechargeable (primary) cell types and SuperCaps
- The 4,000 sqm plant is laid out to enable good process flow from incoming materials and storage through material preparation, mixing, coating, calendaring, slitting, cell preparation, cell assembly, cell formation and testing

A brief History

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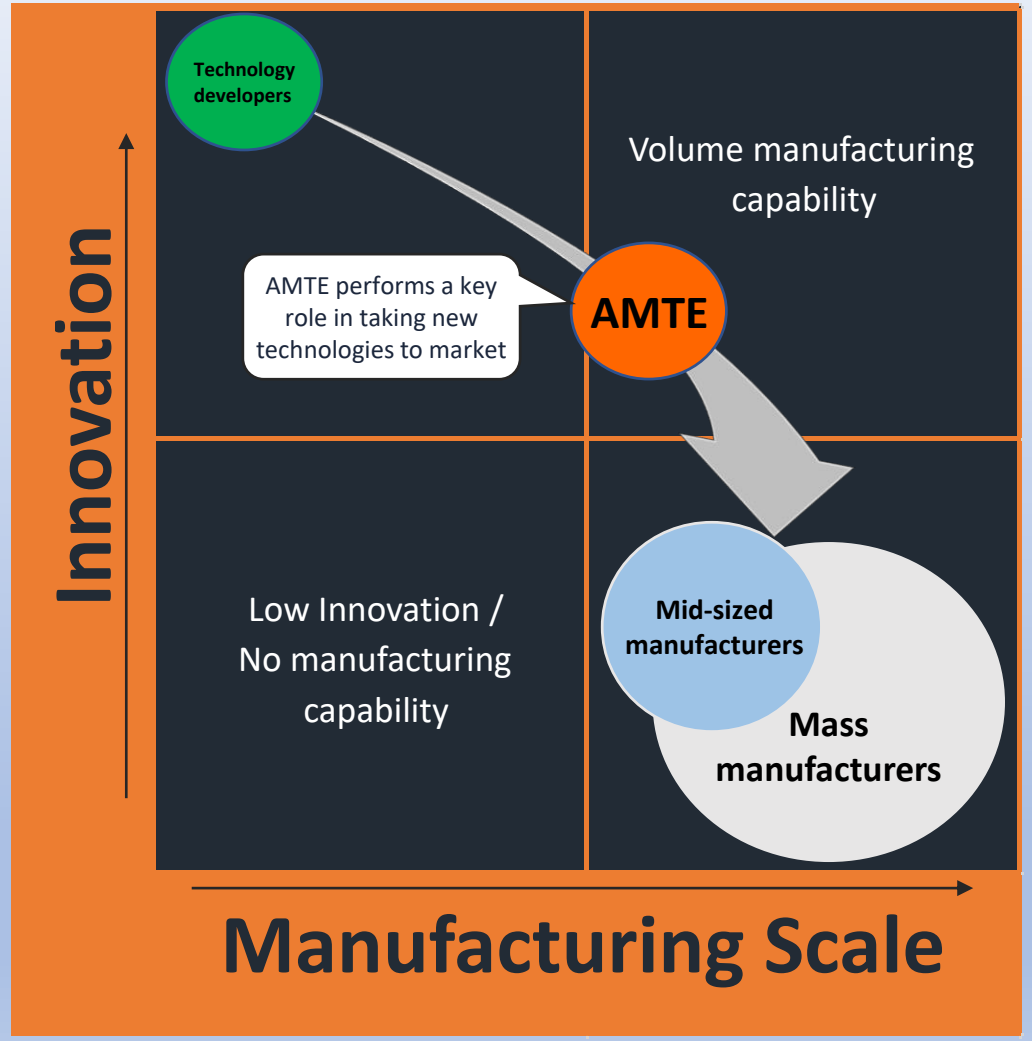
Introducing AMTE Power

Company highlights

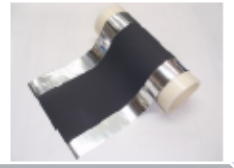
History: AMTE Power was founded in April 2013 by Kevin Brundish, Steve Farmer and Ian Whiting. AMTE secured a production scale manufacturing facility in Thurso, Scotland through the acquisition of AGM Batteries. *"AGM was a key participant in the early commercialisation of li-ion."*

Opportunity: AMTE combines high level skills and access to portfolio of world leading cell chemistry and energy storage IP to develop and commercialise high value technologies into massive growth markets. *"exposure to select portfolio of high potential cell technologies, underpinned by manufacturing of non-off-the-shelf batteries"*

Barrier to entry: scarcity of talented operators with lab-level innovation in electro-chemistry and unique production scale facilities gives AMTE a multi-year lead over the market. *"moat protection against competition"*



Where we sit



Raw Materials

Basic input materials, e.g. metal ores

Mined and typically refined close to source of raw material

Refined materials readily shipped

Materials and Electrochemistry

Materially purified and processed into powders. Ready for transformation into cell components.

Materials' purity greatly influences end cell performance.

Likely to be Li-ion family of chemistry for next 8-10 years. Other options possible beyond that.

Materials readily shipped

williamblythe
Excellence in chemistry
HALDOR TOPSØE
cpi

Electrode, Electrolyte, Separator etc

Coated electrode components; electrolyte; packaging.

Cathode quality especially contributes to cell capacity and overall performance.

Materials can be shipped but shelf life, contamination and environmental constraints apply.

Cell Manufacture

Self contained unit comprises cathode, anode, separator, electrolyte and case.

Highly automated packaging processes. Format standards are an issue.

Shipped as hazardous goods with shelf life and environmental constraints (cost). Pouch cells more fragile than other formats.

Module, Pack and BMS

Cells assembled to modules, modules assembled to packs. Includes, controls (BMS) thermal management, and physical protection.

Proximity to vehicle assembly is highly desirable due to shipping costs and hazardous goods requirements.

MEP Technologies
Battery Systems & Support

Vehicle Application

Pack fully integrated to vehicle design – generally bespoke to each vehicle model and forms part of vehicle brand value. Cooling, crash and package critical.

For high volume, vehicle assembly may follow pack assembly location.

2nd life / Recycling

OEMs retain responsibilities for battery packs at end of life. Significant disposal costs.

2nd life applications technically possible but economics unproved.

Material recovery and recycling technology unproven at scale.

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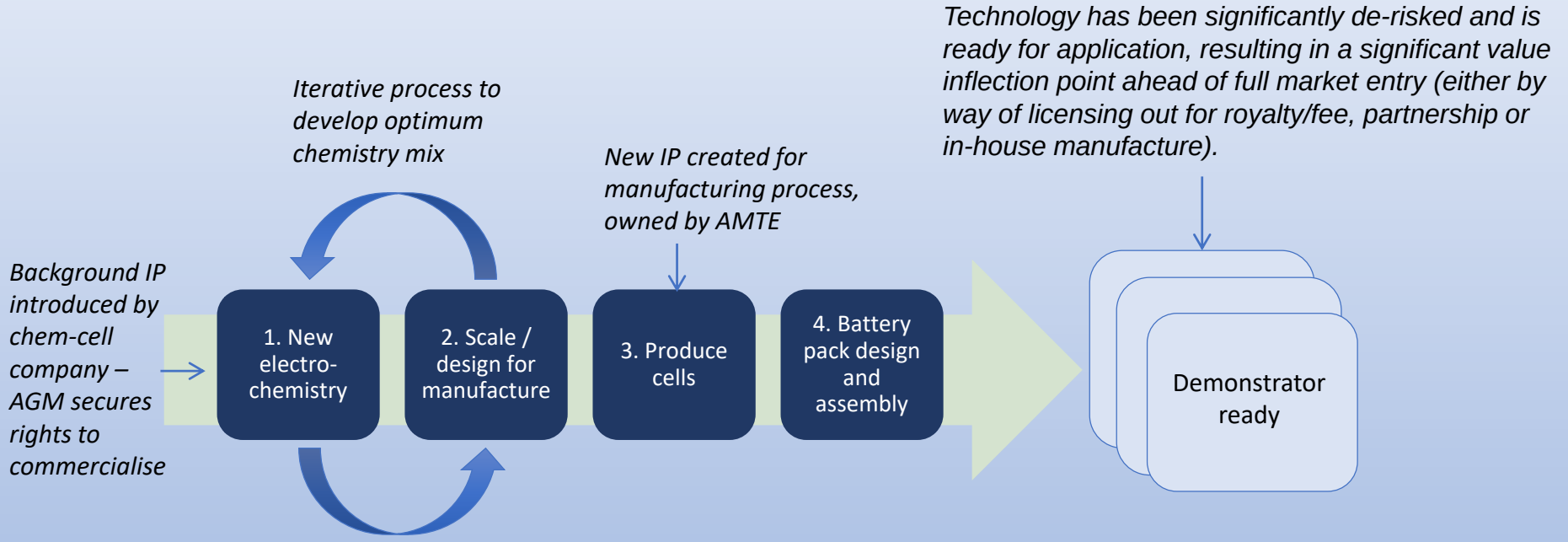
What we do

AGM's internal development process reduces overall development costs and time to market.



AGM is geared to applying this process multiple times over across its portfolio, paving the way for significant value creation

How we do it

Thurso Plant Established & Experienced Team Scaling up of Electro-chemistries

- Flexible Scale-up of multiple Chemistries, Cell sizes & formats
- Fast prototype cell build
- Rapid Scale up– portfolio of 8 Electro-Chemistries in the pipeline
- Development of new technologies eg Smart cells
- Established developer and manufacture of Lithium Cells, SuperCaps and now Sodium-ion cells

Ongoing Investment in State-of-the-Art Cell Production Equipment

- Automated Pouch Cell Assembly Line & Test Equipment
- Cylindrical Cell Assembly Line planned 2019
- Fully equipped Laboratory built
- Battery Assembly &Test Capability built

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Commercial Cells in the UK

- **AGM Batteries to target UK-ABSC LFP (std cell) cell as company's first commercial and saleable cell**
  - **Plan to put our LFP VDA-PHEV 13Ah pouch cell through UN38.3 Certification testing**
    - Target 2020
  - **Massive learning curve for AGM Batteries taking Scale-up right through to Commercialisation**
  - **Arguably UK's 1st Commercial cell (from powder) for many years**
    - Early production in Thurso
      - Higher volumes UK-BIC (& AMTE Power GiGaFactory)
    - Portfolio of 8 more Electro-Chemistries in pipeline to follow up LFP
    - Plan to put Na-ion VDA-PHEV pouch cell through UN38.3

Cylindrical

Cylindrical –larger/custom sizes

Range of Pouch Cells

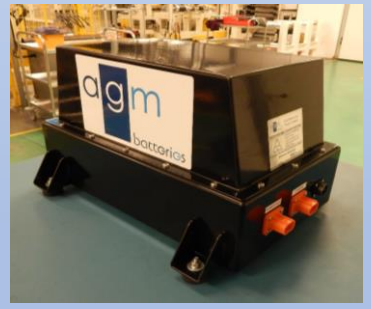
New Generation cells – Smart & NPS

Value Add

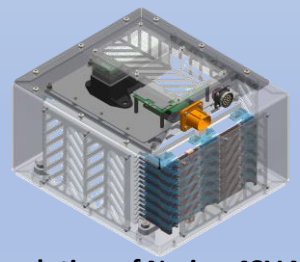
- **We build cell carriers, modules and packs now:**
  - Established skills and facilities to build demonstrator packs to show new technologies
  - Increasing requests to provide Customers with Modules and packs
  - Re-designing cells to improve pack designers and builders
    - Improved joining techniques
    - Improved thermal performance
    - Improved packaging
    - Improved sensing

MEP Technologies
Battery Systems & Support

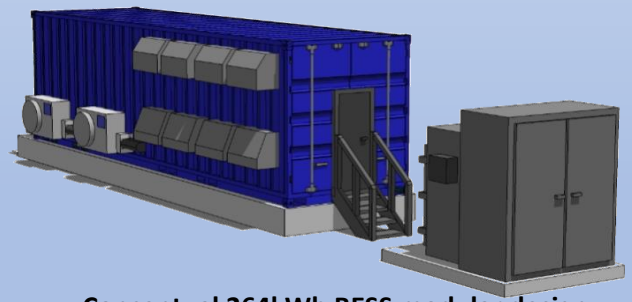
Strong relationship with Dundee based Lithium pack developers and pack builders



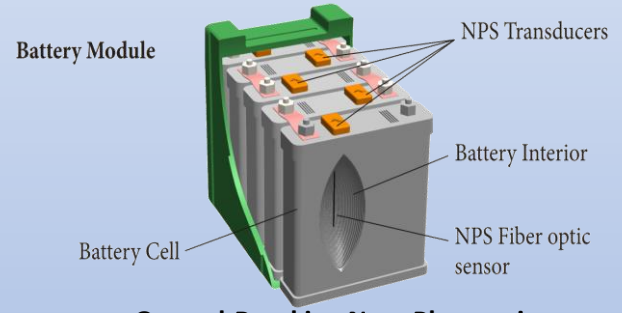
Probably 1st 48V Auto Sodium-ion Pack using 'Production-like' cells



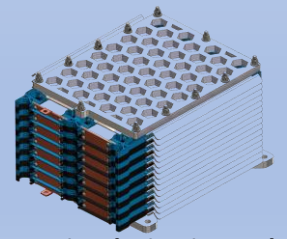
2nd evolution of Na-ion 48V Na-ion Battery pack 50% of weight/volume



Conceptual 264kWh BESS modular design



Ground-Breaking NanoPlasmonic Direct SoC measurement demo pack



Innovative carrier design in modules

Introducing MEP Technologies

MEP Technologies
Battery Systems & Support

A History of Dundee's Battery Industry (1941 – Present)

1941
In April 1941, Royston Industries relocates their battery production to a former jute mill in Dundee following massive damage to their Erith factory after a German incendiary raid during WWII.

1961
Vidor's Dundee factory employs over 100 people and becomes the largest dry battery plant in Europe.

1962
1962, Vidor acquired by Royston Industries, a sheet-metal manufacturer.

1968
Following the collapse of Royston Industries in 1968, the Vidor brand is acquired by Compton Parkinson (a company with a long heritage of battery manufacture.

1989
The Vidor brand is sold to US company Ray-O-Vac in 1989.

1997
TDI Batteries (Europe) Ltd established manufacturing batteries for small appliances. The company dissolved in 2013.

1998
Axeon Group was founded. It's a European leader in the design, development and manufacture of integrated battery modules and systems in the automotive industry.

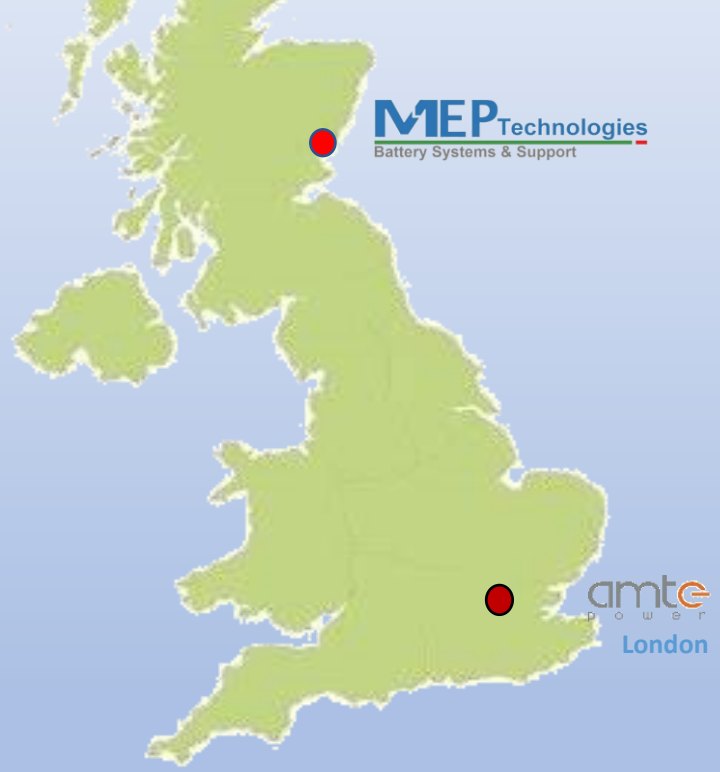
2007
Axeon merged with MPower. MPower's facilities are equipped to handle both high and low volume production.

2012
Axeon was acquired in total by Johnson Matthey. Axeon rebranded as Johnson Matthey Battery Systems and continues to manufacture battery systems (including the traction battery for the McLaren P1 until it is moved to Milton Keynes in 2016.

JM
Johnson Matthey
Battery Systems

2016
MEP Technologies Ltd. Formed. We are an engineering technology company engaged in engineering consultancy and the design and manufacture of battery systems to a range of diverse markets.

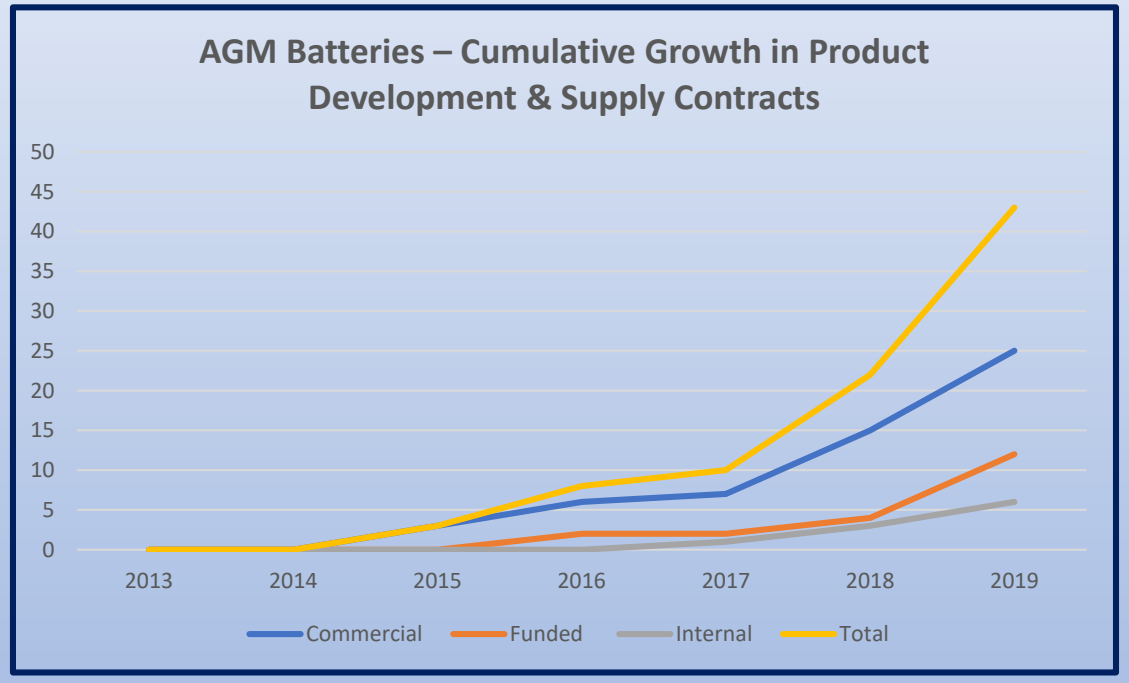
We have extensive experience and background in several industry sectors, but specialise in automotive electronic systems, E-mobility and energy storage technologies.

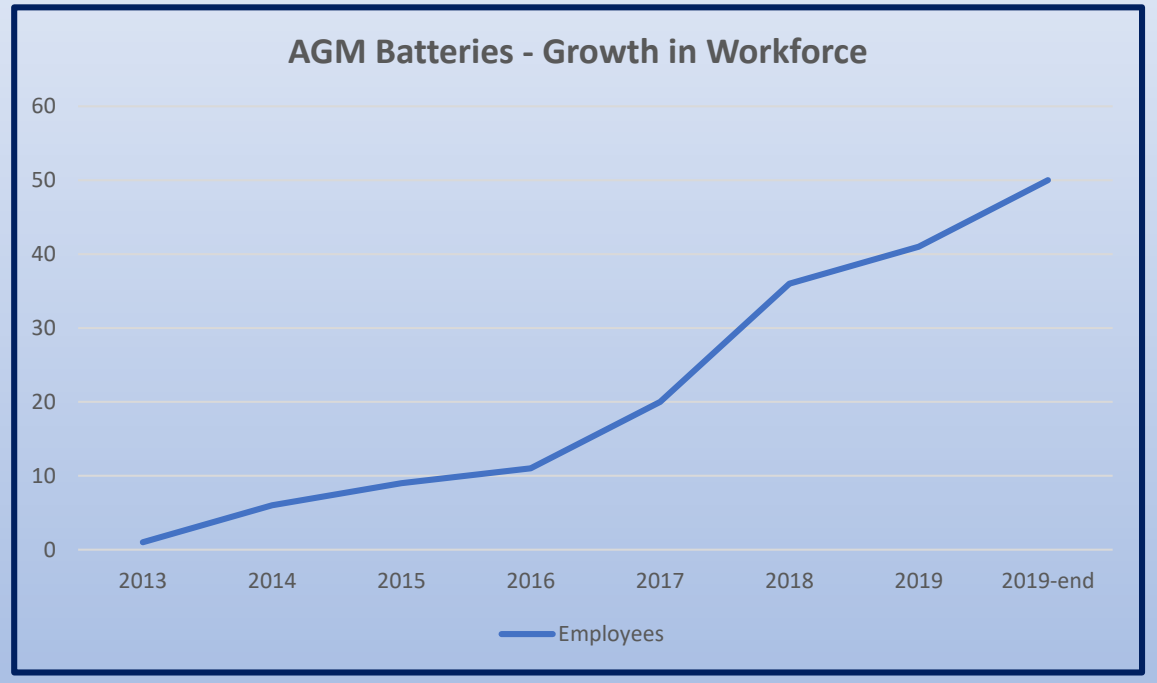


www.meptec.co.uk

Incredible Growth

- Rapid growth in AGM Batteries as reputation and industry grows





- Shows no sign of slowing down!

The way forward

- **We need to:**
  - **Bridge the gap taking UK generated IP to full scale production**
  - **Creating enough UK Manufacturing Capacity to satisfy the explosion in demand**
  - **Establish a robust UK (& European) Supply Chain**
  - **Train a new workforce**
  - **Retain our position as technology leaders**

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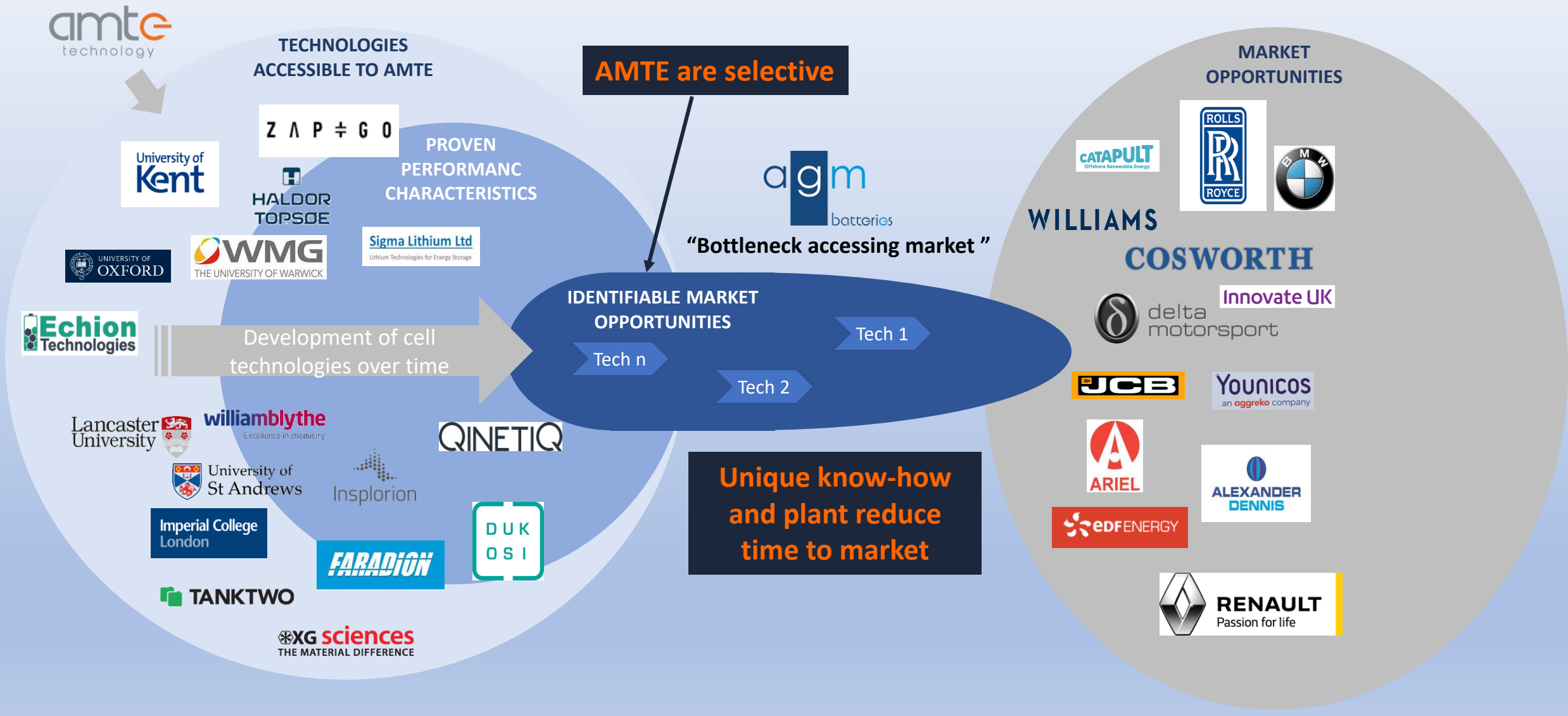
Bridging the gap



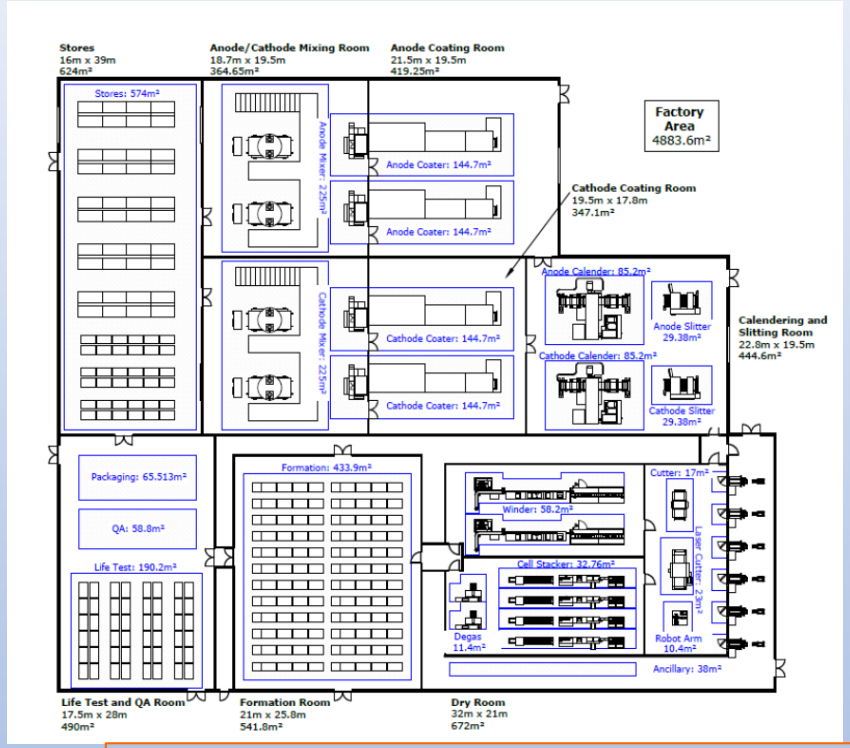
Creating the Manufacturing Capacity

ESSENTIAL to exploit new and existing cell and battery technologies ensuring Manufacture stays in the UK to satisfy home grown demand
There MUST BE sufficient Capacity and Capability to match!

Demand for Lithium Cells and Battery growing exponentially

UK Niche Automotive demand alone is a lucrative market

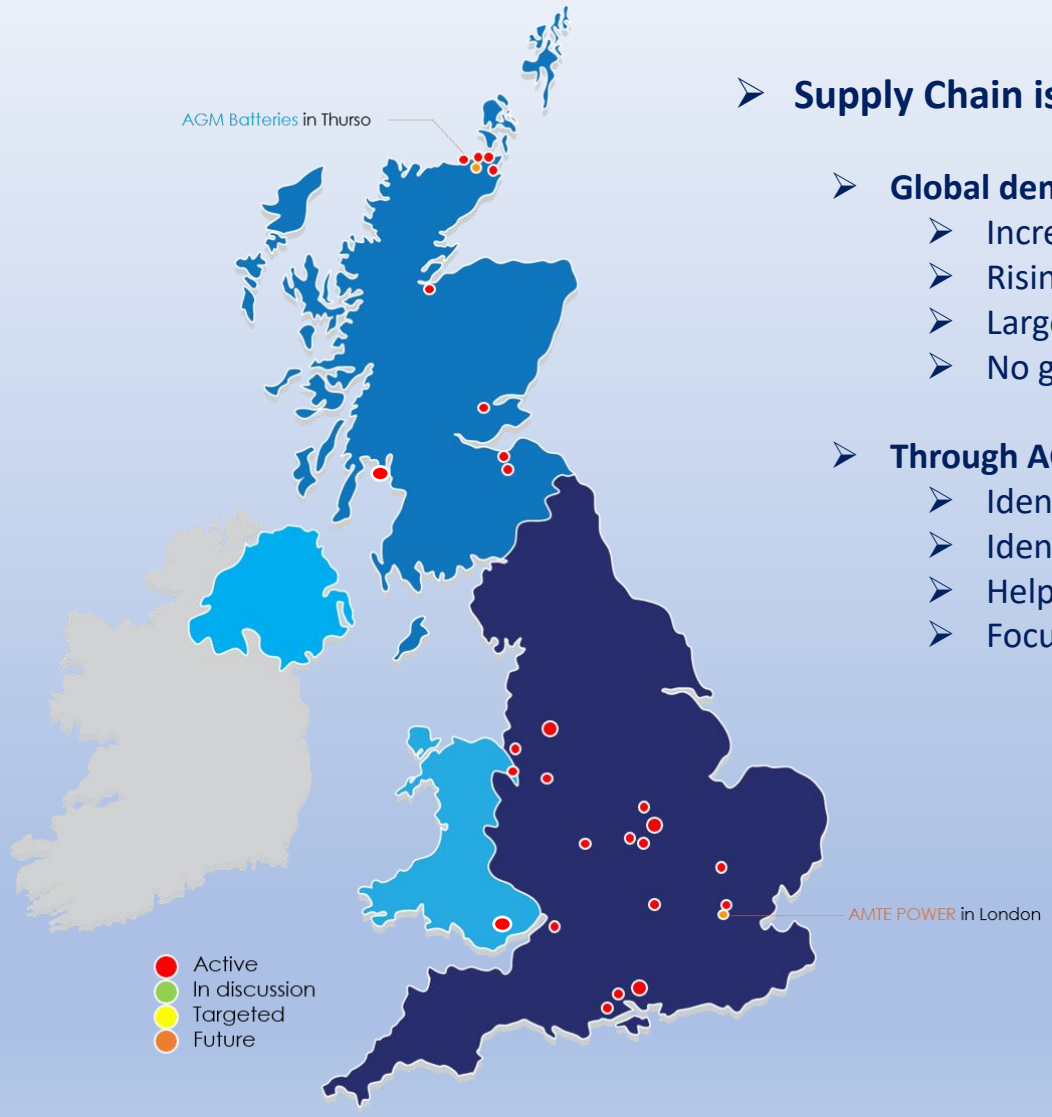
Lithium (& Na-ion) cells for Energy Storage arguably higher



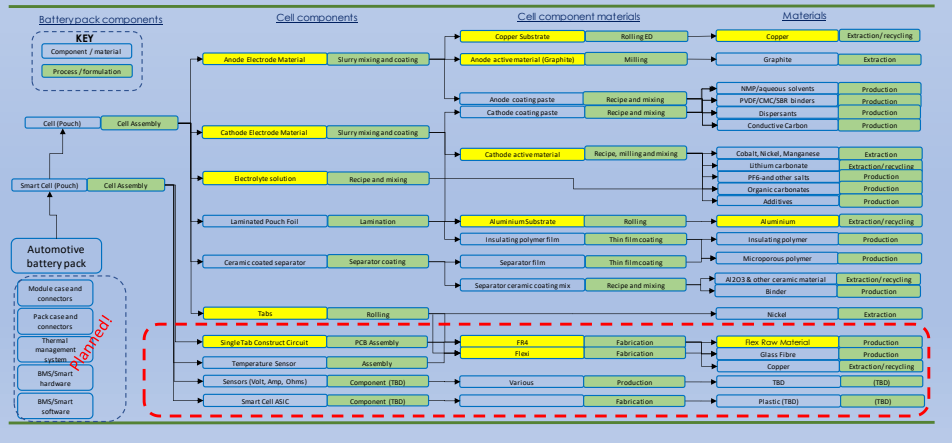
Factory Description: 1 GWh cell manufacturing facility based on 6 off modular lines allowing scale up of existing (30MWh) AGM factory

- **AMTE Power Front and Centre Stage in this Strategy:**
  - AMTE GiGa Factory
  - Discussions with local authorities/regions throughout UK
  - GigaFactory capacity estimate constant re-jigged upwards!
  - AGM capacity already included in UK-BIC forecast
  - Predicted demand for Na-ion especially in Energy Storage adds significantly to capacity needs

Establishing the Supply Chain



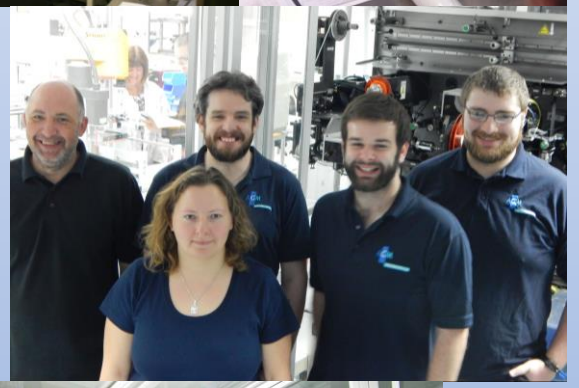
- **Supply Chain is essential to successful UK manufacture of Lithium-ion and Sodium-ion cells**
  - **Global demand of ALL components and materials causing issues for UK now!**
    - Increasing lead-times
    - Rising prices
    - Large OEM's consuming and/or exclusive access to all production
    - No guaranteed longevity of specification/quality/supply
  - **Through AGM's 2 key projects (UK-ABSC & UK-NVBCSC) and in-house activities:**
    - Identify existing suppliers of materials and components
    - Identify new entrants to battery and pack supply from existing UK suppliers
    - Help create and support new suppliers
    - Focus on UK but reach out to European supply base too

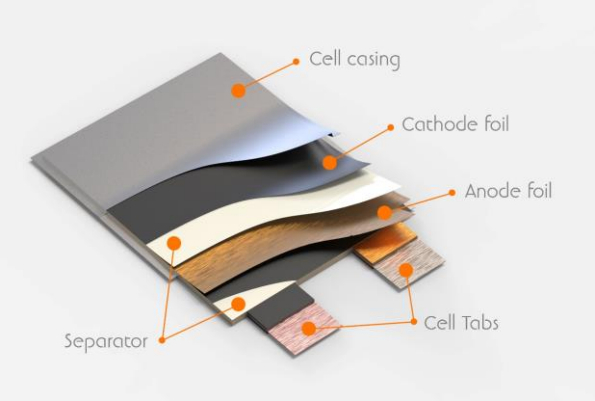


Making progress - Complete Smart cell BOM breakdown – full cell to raw materials

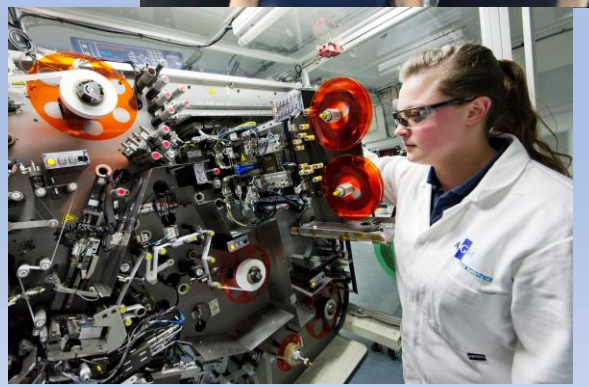
Training the workforce

- **Severe skill shortage in the UK and Europe for this new industry**
  - **URGENT action required as we scale-up capacity and capability in the UK**
    - Focus tends to on lack of Electro Chemists and development grades
    - But it's hurting at every level from operator to technician to engineer
    - No experienced resources to support rapid growth





- **AGM Batteries accepted no option but to train and education ourselves:**
  - Working with partners (HSSMI, QinetiQ, Sheffield Uni, WMG to develop a UK training plan
  - Vocational and practical at multiple sites
  - Ambition to create specific qualifications for this industry
  - Create Lithium-cell apprenticeships (AGM taking on 3 this summer as trial)



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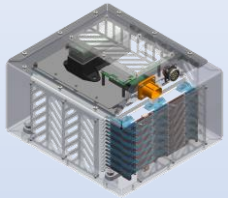
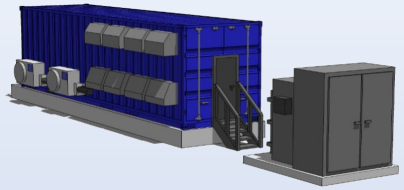
New Technology for 1st Adopters

Exciting New Chemistry Sodium Ion (Na-Ion)

Probably 1st 48V Auto Sodium-ion
Pack using 'Production-like' cells



2nd evolution of Na-ion 48V Sodium-ion
Battery pack 50% of weight/volume



Conceptual Sodium-ion 264kWh
BESS modular design

InnovateUK IDP12 Project

UK-ABSC
UK Automotive Battery Supply Chain

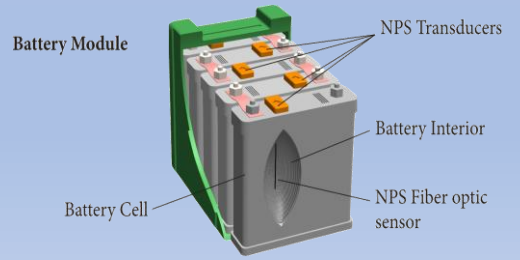
4 Key projects

UK-ABSC
UK Automotive Battery Supply Chain

Smart Cells for Smarter Batteries

- Up 25% lower cost
- Up to 20% weight saving
- Up to 20% less volume

Ground Breaking NanoPlasmonic Sensing (NPS)



Direct SoC measurement

EuroStars Project

New Technology for 1st Adopters

UK Cells for UK Niche Automotive Players

WMG Innovative Solutions

cpi

williamblythe
Excellence in chemistry

WILLIAMS ADVANCED ENGINEERING

Energy Lancaster | Lancaster University

delta motorsport

agm batteries

UK Niche Vehicle Battery Cell Supply Chain

- **Targeting UK Niche Automotive Niche OEM's**
- **1 pouch cell format and at least 1 cylindrical cell format**
- **Guaranteed long term UK manufacture and warranty**
- **UK Cell Supply Chain for entire BoM**

Faraday Challenge Project

UK-ABSC
UK Automotive Battery Supply Chain

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Thank You