

# Introduction to the Faraday Institution

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# Dr Simon Lambert

## Background

- Academic at Electrical Power Group, Newcastle University UK
- >15 years experience R&D in Li-ion battery technology
  - Battery recycling, battery production/QA, BMS technology, chargers
- Member of the Faraday Institution
- Leading academic on Recycling Lithium-ion Batteries FI project
- Consultant to OEM, T1, SME etc.

# THE FARADAY INSTITUTION

## CREATING A UK VEHICLE BATTERY INDUSTRY



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## THE OPPORTUNITY

Why does the UK want to be world-class in automotive battery technology?



**1.7 million**

The UK is the **3rd largest** car producer in Europe, producing **1.7 million** domestic vehicles in 2016

The current  
lithium ion battery  
was invented in  
Oxford in 1980

**-1980 +**



The auto sector employs **163,000 people**



**163,000**



**3000**

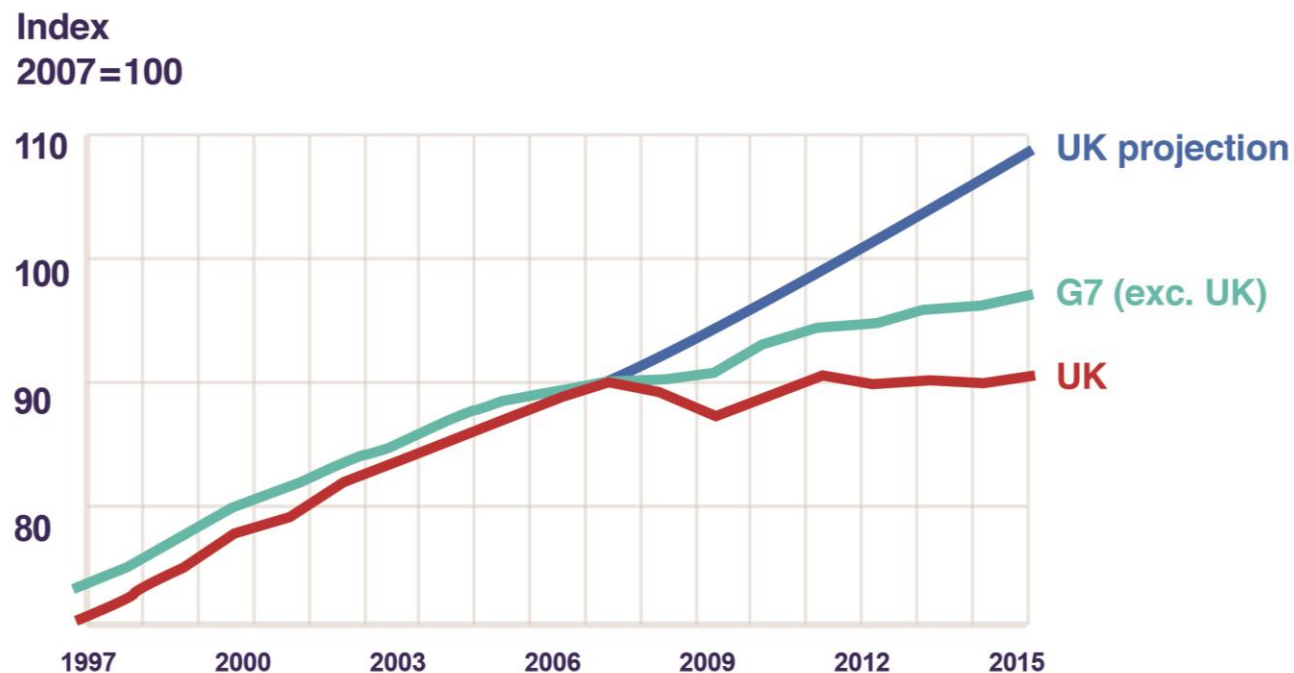
UK companies are  
active in the auto sector

Productivity levels in the  
industry are **£90k per  
person**, 50% higher than  
the UK average and the  
highest amongst major  
car producing nations



## THE PRODUCTIVITY PUZZLE

The UK is generating less value for our efforts than the rest of the G7. We need to find and seize opportunities to work more productively. This requires higher skills, more investment and business sectors that can raise performance.



THE FARADAY INSTITUTION

[www.faraday.ac.uk](http://www.faraday.ac.uk)



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# THE FARADAY MISSION

- Make the UK the go-to place and world leader for energy storage research and technology
- Lead the world in energy storage science and innovation
- Create jobs of the future - at many levels
- Provide policy advice to make best choices
- Secure a cleaner, greener future

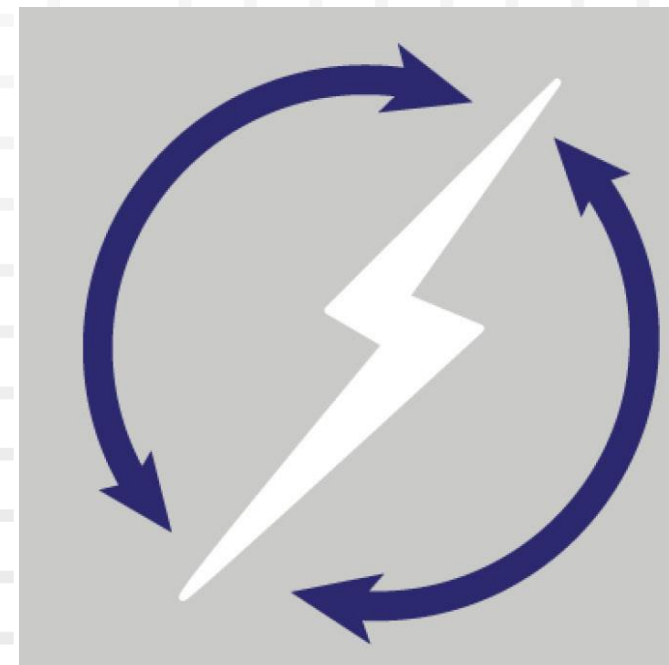




# THE FARADAY BATTERY CHALLENGE

The Faraday Battery Challenge comprises a £246m commitment over the next 4 years to fully exploit the industrial opportunity of vehicle electrification through world-leading batteries developed, designed and manufactured in the UK, by:

- Increasing multi-disciplinary application-led research in battery technologies
- Supporting UK businesses' investment capability in research, development, demonstration and testing of battery technology
- Using R&D to secure additional overseas investment





## EV TECHNICAL CHALLENGES

### Cost



**Now** \$130/kWh (cell)  
\$280/kWh (pack)  
**2035** \$50/kWh (cell)  
\$100/kWh (pack)

### Energy Density



**Now** 700Wh/l,  
250Wh/kg (cell)  
**2035** 1400Wh/l, 500Wh/kg  
(cell)

### Power Density



**Now** 3 kW/kg (pack)  
**2035** 12 kW/kg (pack)

### Safety



**2035** eliminate thermal  
runaway at pack level to  
reduce pack complexity

### 1<sup>st</sup> Life



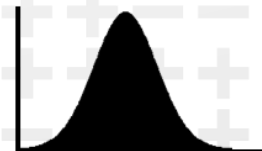
**Now** 8 years (pack)  
**2035** 15 years (pack)

### Temperature



**Now** -20° to +60°C (cell)  
**2035** -40° to +80°C (cell)

### Predictability



**2035** full predictive models  
for performance and aging  
of battery

### Recyclability



**Now** 10-50% (pack)  
**2035** 95% (pack)

# STAGE 1: APPLICATION LED RESEARCH

## Faraday Institution: Virtual Research Institute

Independent, national institute which sponsors and manages mission-driven research on electrical storage.

- Founding consortium of universities brings expertise from academia and industry to set out a **research strategy** for battery technologies
- Funding research projects and training programmes in support of this strategy
- Establishing core research capabilities through Fast Start Projects
  - Battery degradation
  - Metallic anodes & solid electrolytes
  - Multi-scale modelling
  - Recycling and circular economy
- Further projects to be identified and funded through the life of the institute

**Stage 1: Research £78m**

**Stage 2: Innovation £88m**

**Stage 3: Scale-up £80m**

## STAGE 2: INNOVATION- COLLABORATIVE RESEARCH & DEVELOPMENT

### First Collaborative R&D and Feasibility Studies Competition

- £40 million to help make UK businesses world leaders in battery technology.
- 27 projects were funded involving 66 organisations through the Industrial Strategy.
- Projects funded covers wide breadth including thermal management, battery management systems, recycling and second life, emphasis on cell, module and pack development and cell materials.
- Involvement of a wide range of companies across the automotive battery supply chain including SMEs.

**Stage 1: Research £78m**

**Stage 2: Innovation £88m**

**Stage 3: Scale-up £80m**

## STAGE 3: SCALE-UP- MOVING NEW TECHNOLOGIES TO MARKET

£80 Million UK Battery Industrialisation Centre

- Advanced Propulsion Centre competition
- Located in the West Midlands
- Coventry and Warwickshire Local Enterprise Partnership and WMG
- ~ 2 years from commencement
- Developing the processes required to manufacture pioneering battery technology here in the UK at a high-volume production rate appropriate for 'giga' factories

**Stage 1: Research £78m**

**Stage 2: Innovation £88m**

**Stage 3: Scale-up £80m**

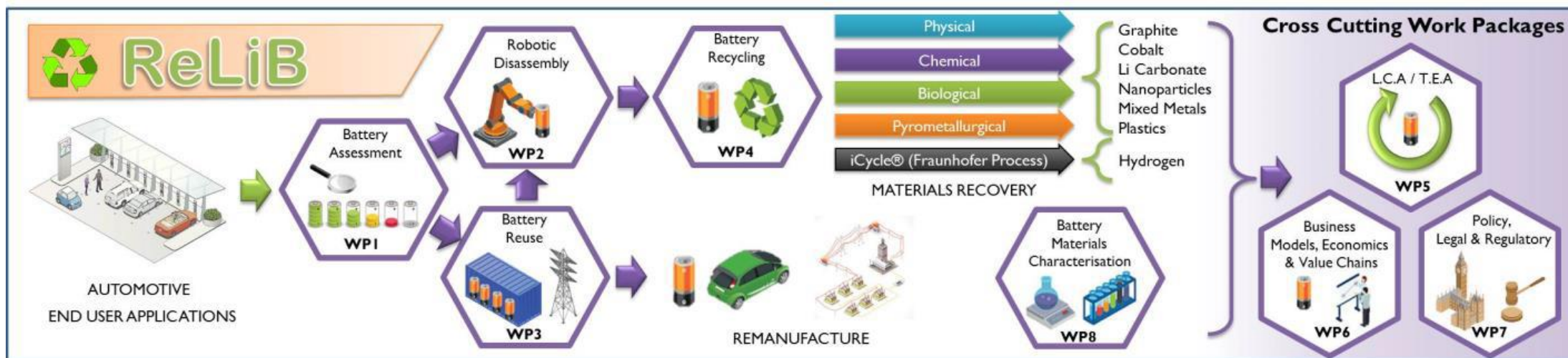
## RE-USE & RECYCLING OF LITHIUM ION BATTERIES

To facilitate a circular economy in lithium-ion batteries, tackling the most demanding technical and socio-economic challenges in sensing, gateway testing, sorting, re-use and recycling 100% of a battery pack.

Partner universities:

Birmingham, Cardiff, Edinburgh, Leicester, Liverpool  
Newcastle, Oxford Brookes, Diamond Light Source

+ 14 industry partners





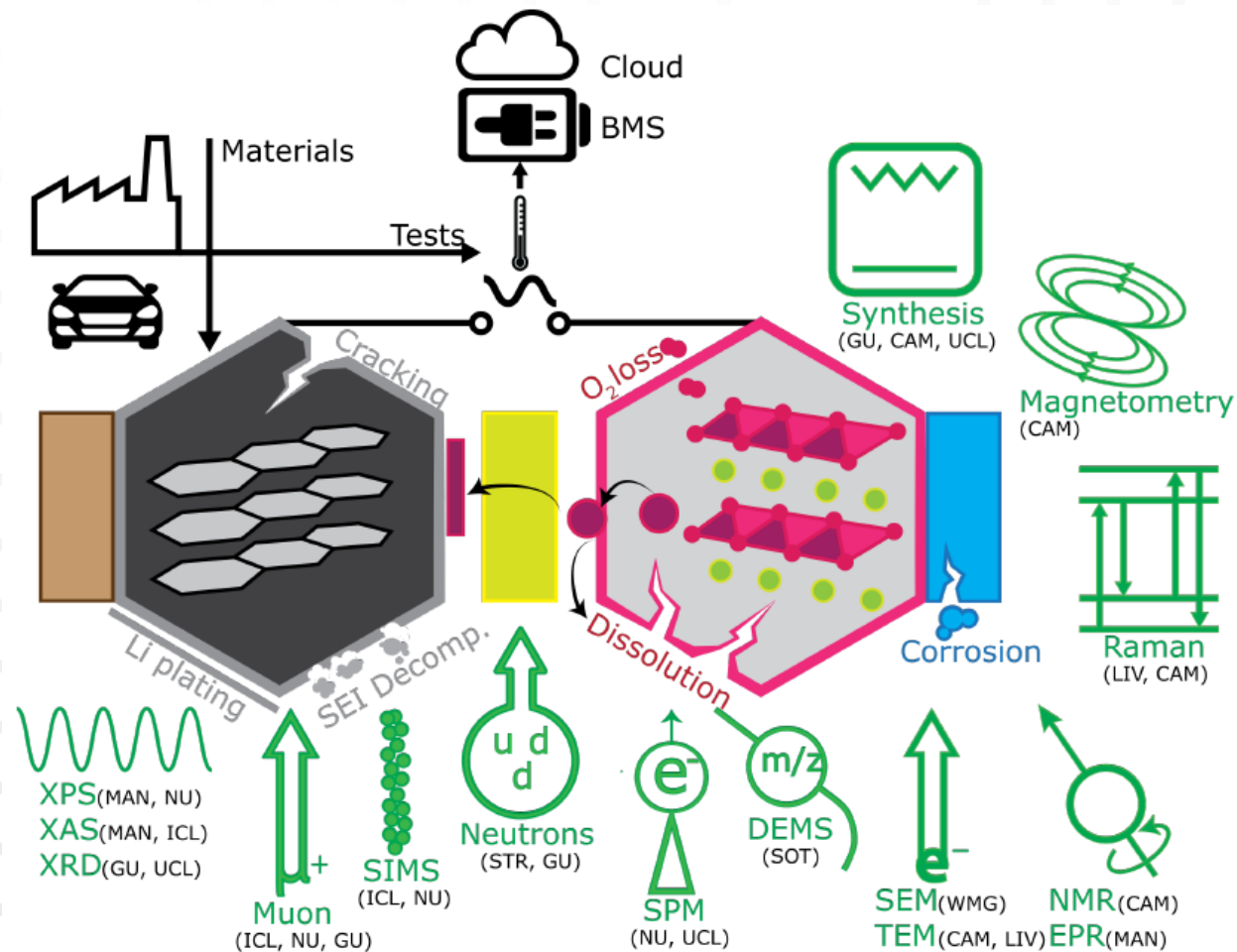
## DEGRADATION

To relate external stimuli and stresses (high temperature, charging rates) to physical and chemical processes that cause degradation of performance inside the battery, and to develop solutions to this through materials and systems design.

### Partner universities:

Cambridge, Glasgow, Imperial College, Liverpool  
 Manchester, Newcastle, Southampton Strathclyde,  
 University College Warwick

+ 10 industry partners



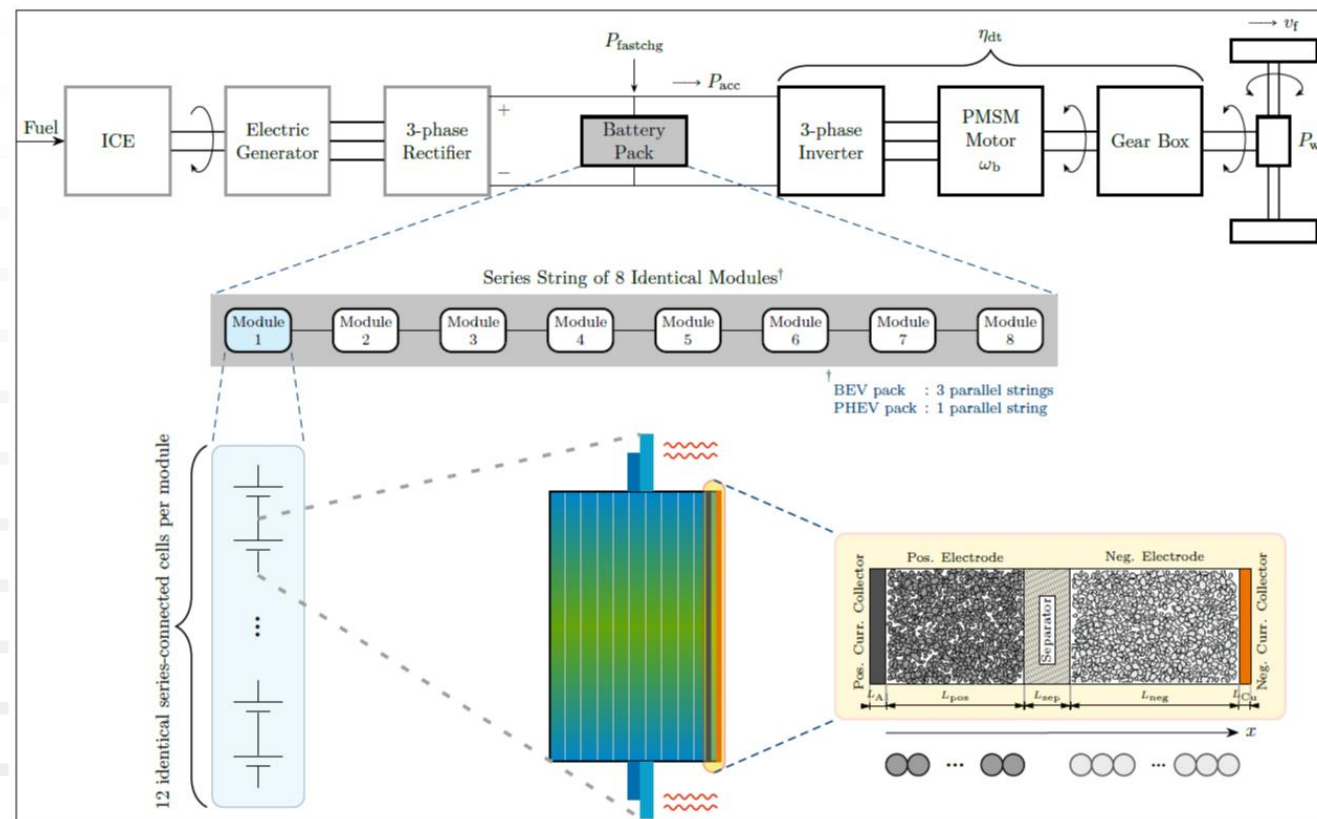
## BATTERY SYSTEMS MODELLING

To predict accurate performance, from materials to packs, for existing and future battery systems, where multiscale modelling can be then used to extend the lifetime and performance of batteries.

Partner universities:

Imperial College, Bath, Lancaster, Oxford, Southampton  
University College, Warwick

+ 17 industry partners





## NEXT GENERATION SOLID STATE BATTERIES

To understand the basic science of solid-electrolyte / solid-electrode interfaces, and demonstrate the viability of a high energy density all solid state battery, with energy and power densities superior to Li-ion technology.

### Partner universities:

Oxford, Cambridge, Glasgow, Liverpool, St. Andrews, Strathclyde, University College

+ 10 industry partners

