Nissan Leaf

Battery research for the energy transition:

Europe and emerging economies

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Faraday Institution
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THE FARADAY INSTITUTION

EUROPE AND EMERGING ECONOMIES

- Introduction to Faraday Institution
- Transforming Energy Access
- STEPS – Storage of Energy in North-West Europe

THE FARADAY INSTITUTION

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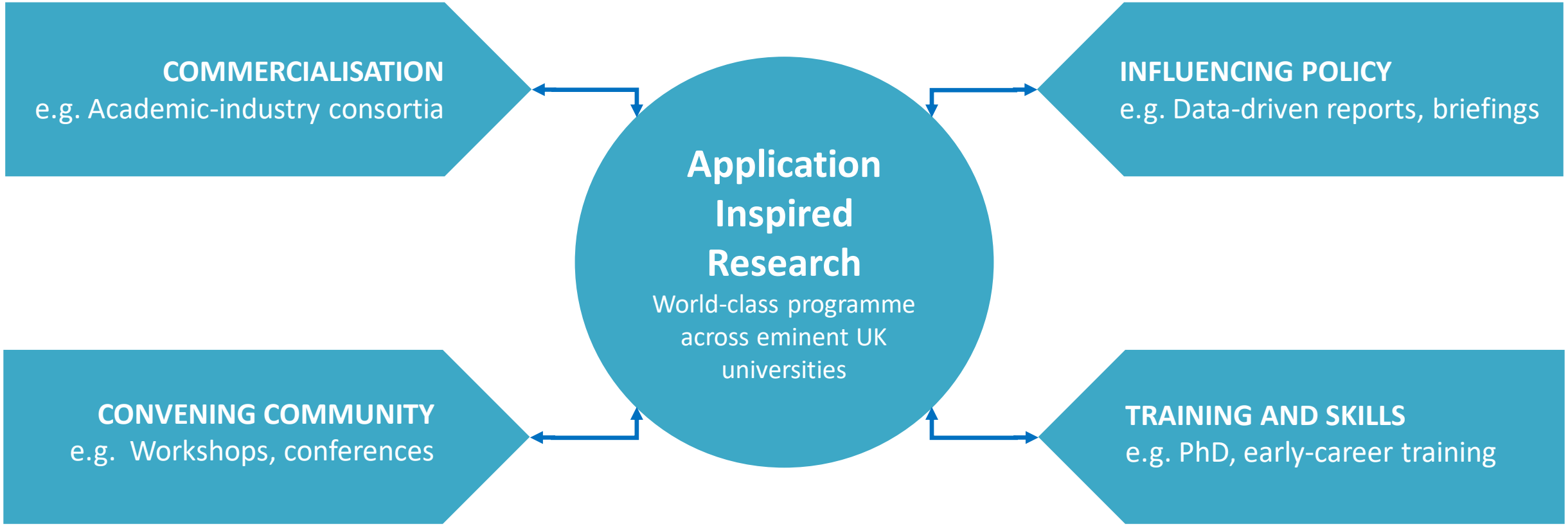
The UK’s flagship programme for electrochemical energy storage research, skills development, market analysis and early-stage commercialisation.

KEY FOCUS AREAS OF THE FARADAY INSTITUTION

The UK's flagship organisation for electrochemical energy storage research, skills development, market analysis, and early-stage commercialisation



Maximising UK Economic Impact of Battery Research

4 YEARS OF HIGH-QUALITY IMPACTS IN ENERGY STORAGE

The Faraday Institution has generated a great return on the UK's investment from a standing start in 2017

Lead 10 major research programmes

across **24 UK universities** and research partners and **50 industrial partners**

United a community of 470 researchers

45% new to field, to solve battery challenges through breakthrough science

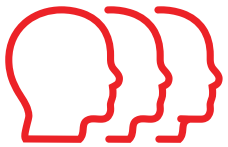
Training and directly funding 55 PhDs

for UK industrial and academic careers, and an additional **82 affiliated** with our projects

Published 410+ scientific papers

63% in top 10% journals
46% in top 10% most cited

50% with international collaborators



Supported 8 entrepreneurial spin-outs

16 industry fellows & **8** industry sprints

Leads a consortium of 7 UK organisations

to develop solid-state battery prototypes

26 inventions identified

3 patents granted and a further **13** in patent process

Shaped policy

through **13 Faraday Insights, 10 major reports, 5 national consultations,** numerous briefings including a House of Commons inquiry and a House of Lords inquiry

Hosted 5 Royal Institution Events

attracting 300**,000 online viewers**

Last updated March 2022

THE FARADAY INSTITUTION RESEARCH PROGRAMME

Application-inspired programme focused on technical targets

RESEARCH STREAM 1

Lithium-ion

Nearer-term market challenges

Projects optimising current generation lithium-ion based batteries where there are still considerable gains to be made and where breakthroughs could start to be realised in commercial settings within 3-4 years.

In addition, our recycling and reuse project is focused on battery end-of-life and the circular economy.

- DEGRADATION
- MULTISCALE MODELLING
- RELIB
- FUTURECAT
- CATMAT
- NEXTRODE
- SAFEBATT

RESEARCH STREAM 2

Beyond Lithium-ion

Longer-term market challenges

Projects that are higher risk, higher reward and could facilitate the long-term commercialisation of next-generation battery technology that still require considerable research in materials discovery and optimisation.

- SOLBAT
- LISTAR
- NEXGENNA

RESEARCH STREAM 3

Batteries for Emerging Economies

Shorter-term projects focused on reducing the cost and improving the performance of battery technologies for use in developing countries and emerging economies. Funded from UK Aid as part of its Transforming Energy Access (TEA) programme

- RELCo-Bat
- Low-Cost Graphite Polysulphide Single Liquid Flow Battery

April 2018 start | Autumn 2019 start | Oct 2020 start | April 2021 start

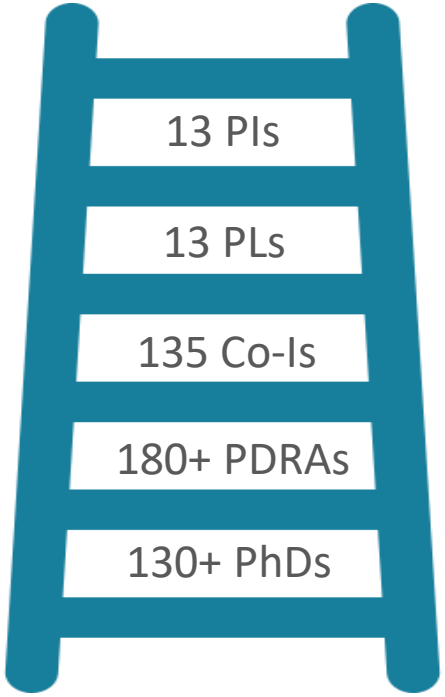
ASSEMBLED A WORLD-CLASS ENERGY STORAGE RESEARCH COMMUNITY

50+

Industry partners

20+

Academic & research partners



450+

Researchers from many disciplines

Grown interest and excitement

- Levelling up across UK
- 30% female
- 74% under 40
- 65% new to battery research

OUR METHODS

Developing a national and international reputation

Increasing collaboration with leading international research groups

Taking a leading role in defining the need for energy storage in emerging economies

Working on international efforts – World Economic Forum's Global Battery Alliance and World Bank's Energy Storage Partnership

SECTOR FINDINGS

Battery systems with solar can increasingly be competitive with diesel gen-sets.

International organisations are developing standards and test protocols

The potential of Sodium ion cells continues to increase with the announcement this year from China based CATL, one of the world's largest battery manufacturers that they will begin commercially producing Na ion in 2023.

UK's Faradion being acquired by Reliance in India.

There are next generation technologies which have potential to increase the pace of competitiveness

There remains significant need for:

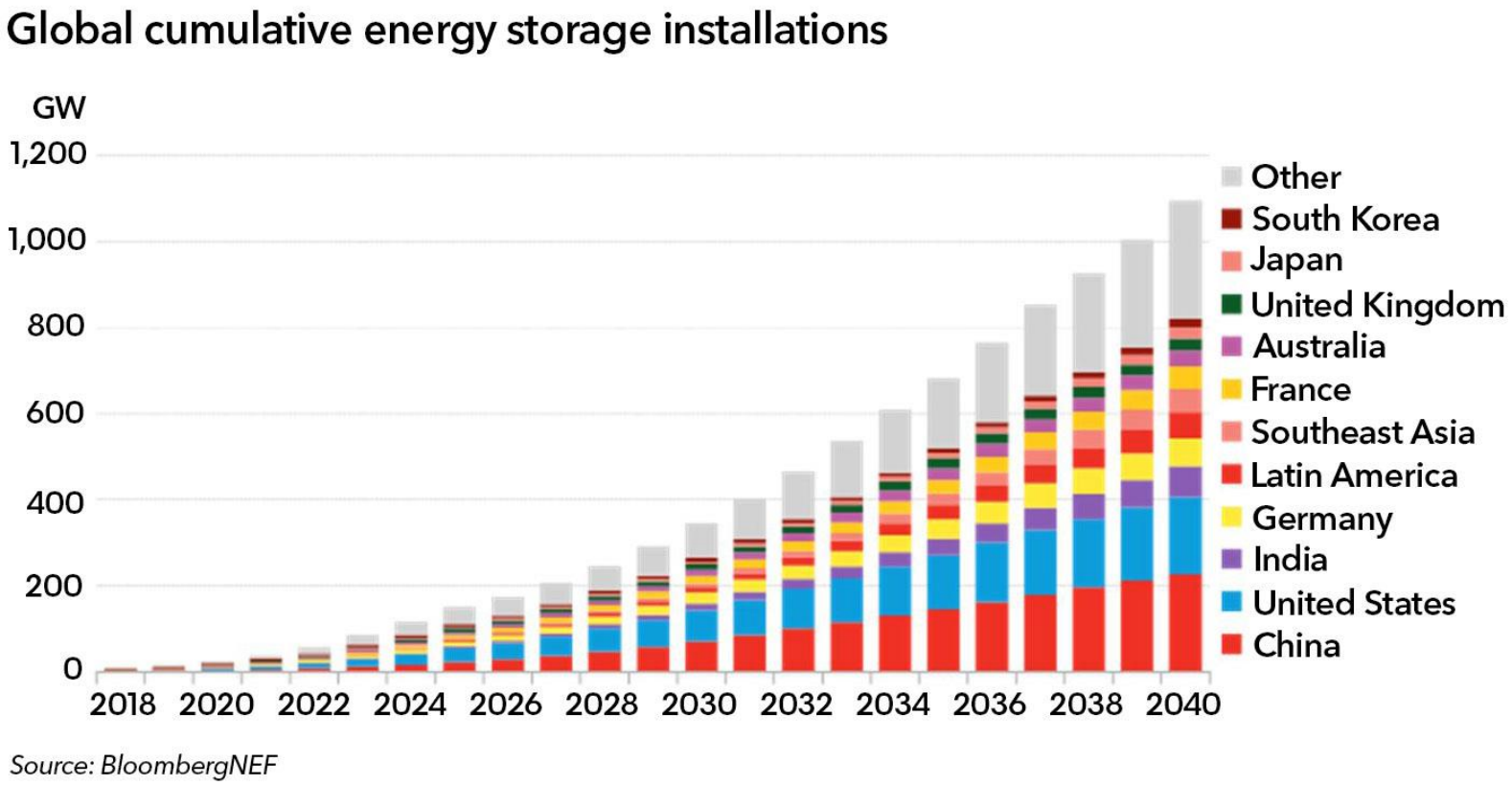
Small and large scale demonstrators to build an evidence base that novel technologies are viable and practical;

Skills and training throughout the supply chain, as there is nowhere near the capacity or capability required to deliver novel solutions;

Legislation and regulation to drive new technologies and challenge and evolve incumbent, established practices;

Standards to drive integration efficiencies and further cost reduction. These challenges will all need to be addressed to accelerate the take up of new energy storage technologies, especially batteries, in SSA markets.

THIS IS A REALLY BIG OPPORTUNITY…



Interreg
EUROPEAN UNION
North-West Europe
STEPS
European Regional Development Fund

Total budget received from Interreg NWE (2020-2023):

€3 million of ERDF

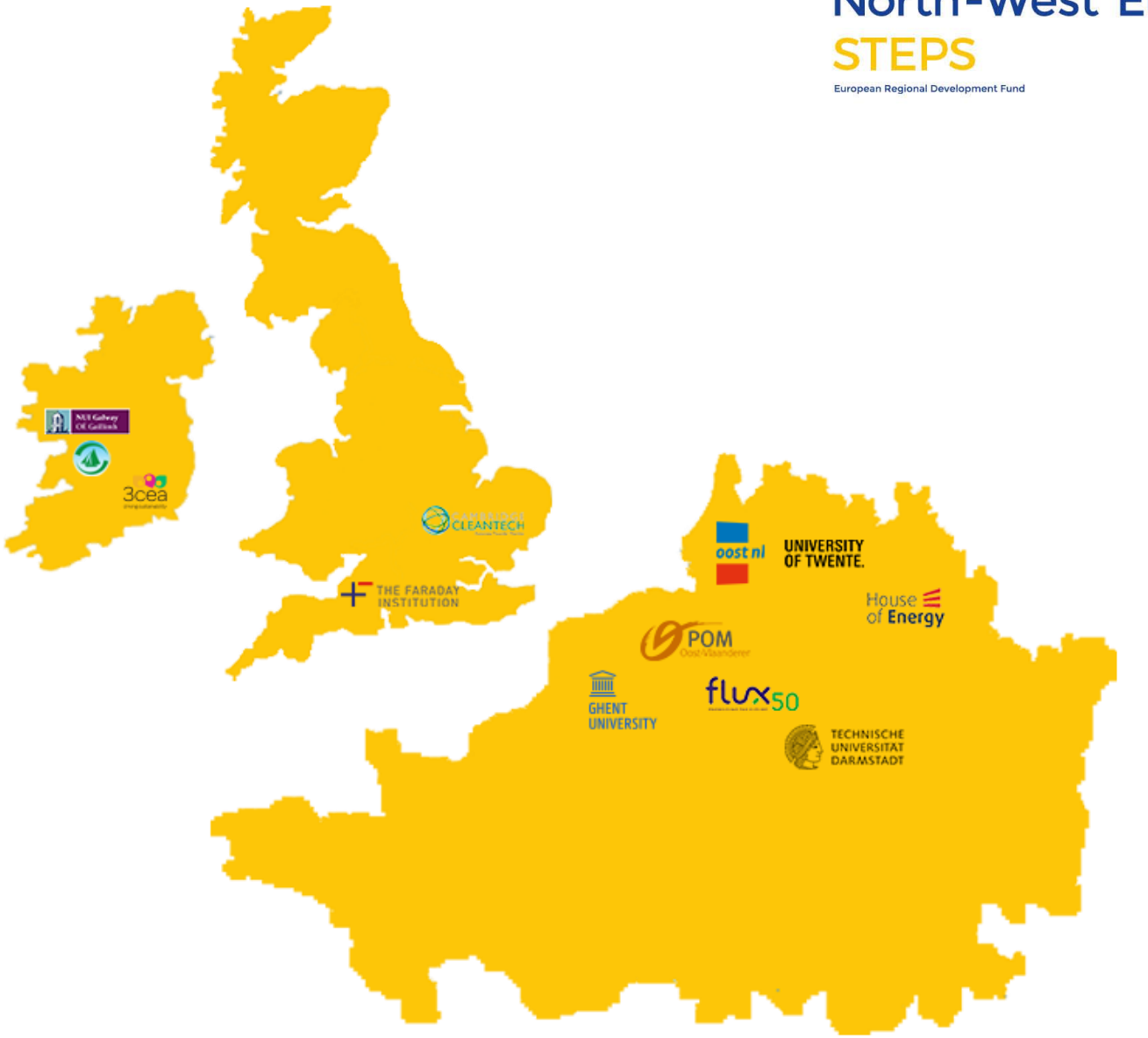
Total project budget:

€5 million

www.nweurope.eu

Partner Introduction

Interreg
EUROPEAN UNION
North-West Europe
STEPS
European Regional Development Fund



TESTBED PROJECT AT HARWELL – FUNDED BY INTERREG EUROPE STEPS

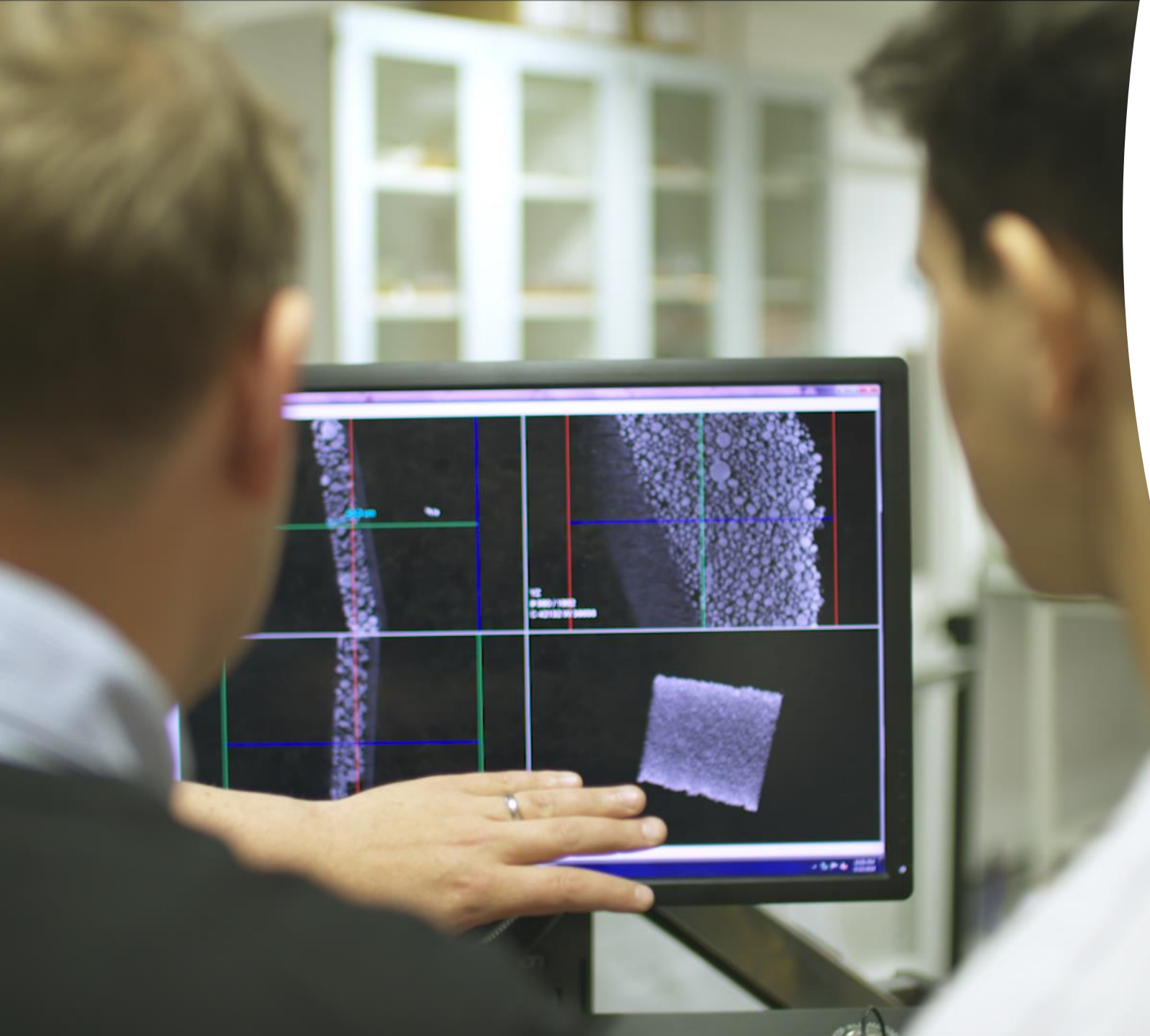
- Demonstrating 3 new, innovative energy storage products for the first time at a commercially relevant scale
  - AMTE Power – sodium-ion battery module
  - Brill Power – battery management system
  - PowerQuad – Mobile Battery Energy Storage
- Integrated to STFC's solar array at Harwell Campus and on-site catering
- Aiding access to project finance for future projects
- Accelerating the uptake of small-scale renewable electricity generation

TECHNICAL AND MARKET REVIEWS SUPPORT THE DEMONSTRATION PROJECTS

IN SUMMARY… IT'S HAPPENING

- The automotive is on the cusp of a revolution
- Emerging markets might reap benefits from the momentum
- The Northern Europe market is large and transformation

Thank you



INDUSTRY FELLOWSHIPS

Fostering relationships between industry & academia

Establishing collaborative research with benefit to UK battery industry

Advancing defined research project with commercial potential

Facilitating university researchers to work in industry settings or vice versa

OUR COMMUNITY – RESEARCH PARTNERS

University of Oxford
UCL
University of Birmingham
University of Cambridge
Lancaster University
University of Portsmouth
Newcastle University
The University Of Sheffield.
Manchester 1824 The University of Manchester
University of Bath
University of Southampton
University of St Andrews
University of Surrey
Warwick
The University of Nottingham
University of Liverpool
The University of Edinburgh
Imperial College London
University of Leicester
NPL National Physical Laboratory
diamond
Science & Technology Facilities Council ISIS Neutron and Muon Source

OUR COMMUNITY – INDUSTRY PARTNERS

Johnson Matthey
Inspiring science, enhancing life
BenevolentAI
Envision AESC
FARADION
talga
cap hpi
AGM
AGM Batteries Ltd
JAGUAR
LAND ROVER
BBOXX
nexeon
arcola energy
Echion Technologies
LMA
williamblythe
Excellence in chemistry
BMW
TOYOTA
KUKA
NPL
National Physical Laboratory
LG Chem
Shell
ilika
accelerated materials innovation
Rolls-Royce
UK BATTERY INDUSTRIALISATION CENTRE
NISSAN
Intellegens
MIRA
QinetiQ
POTENZA
BENCHMARK MINERAL INTELLIGENCE
CLAYTEX
Morgan Advanced Materials
HUNTSMAN
Deregallera
Lianhetech
BMRA
McLaren
SIEMENS
IMERYS
ECOBAT TECHNOLOGIES
cpi
ZEISS
Continental
NVIDIA
Silson
Thatcham Research
PIV3 TECHNOLOGIES
CARTAKEBACK Scrap Car Recycling
ThermoFisher SCIENTIFIC
WILLIAMS ADVANCED ENGINEERING
exawatt
Omicron NanoTechnology
Circular Energy Storage Research and Consulting