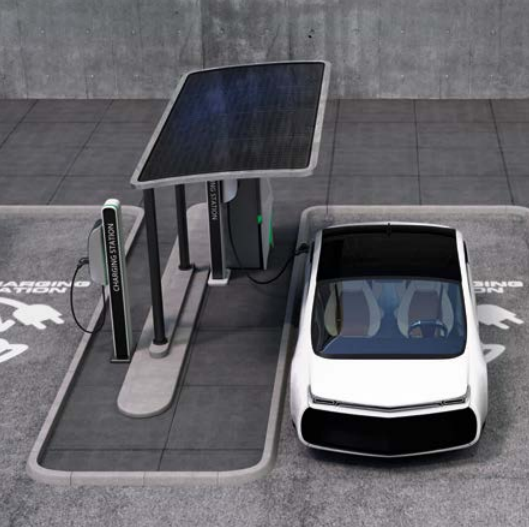


INTO THE NEXT ERA

ACCELERATING INNOVATION TOWARDS NET ZERO

era.ac.uk



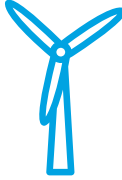


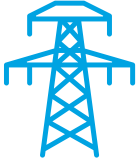
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OUR FOUR CHALLENGES

 <p>Energy Transformation</p> <p>To demonstrate a broad range of renewable and sustainable energy supply technologies that cover electricity, fuels, chemicals and heat.</p>	 <p>End Use Energy Demand</p> <p>To develop innovative technologies, incorporating social and economic considerations and appropriate business models, that will help to reduce UK emissions and lower the amount of energy demanded by both industrial and domestic end users.</p>
 <p>Energy Storage</p> <p>To make major contributions in advancing several different energy storage technologies thus enabling net-zero carbon energy utilisation to become both technically viable and affordable.</p>	 <p>Energy Integration</p> <p>To address technological challenges that enable energy systems to be fully integrated at scale, such that they are smart, flexible, socially acceptable and capable of realising the opportunities afforded to them by future advances.</p>



CONTENTS

OUR FOUR CHALLENGES	02
WELCOME: HELPING TO DELIVER THE CHANGE	04
ERA OVERVIEW AND HISTORY	06
THE ERA INDUSTRIAL ADVISORY BOARD: APPLYING BUSINESS ACUMEN TO ACADEMIC EXPERTISE	10
ERA IN FIGURES	11
EVENTS AND OUTREACH: IMPACT	12
ASTON UNIVERSITY	14
UNIVERSITY OF BIRMINGHAM	15
UNIVERSITY OF LEICESTER	16
LOUGHBOROUGH UNIVERSITY	17
UNIVERSITY OF NOTTINGHAM	18
UNIVERSITY OF WARWICK	19
BRITISH GEOLOGICAL SURVEY	20
CRANFIELD UNIVERSITY	21
KEELE UNIVERSITY	21
POWERED BY PARTNERSHIP: INDUSTRY	22
SKILLS AND DOCTORAL TRAINING: DEVELOPING FUTURE LEADERS IN LOW CARBON ENERGY	28
WORLD-CLASS FACILITIES: PROJECTS FROM THE GROUND UP – 2016 TO 2020	30
COLLABORATE WITH US	32

WELCOME

HELPING TO DELIVER THE CHANGE

Since 2016, the need for radical change has become even clearer. On the back of the COP21 Paris climate change agreement and the aim to limit global warming to less than 2 degrees, the government published its Clean Growth Strategy (CGS). The CGS outlined £2.5 billion of investment made in low carbon innovation and clean growth over the 2015-21 period; this included up to £500 million to drive commercialisation of “clean energy technologies and processes”.

In September 2017, the Midlands Engine published a growth strategy, and clean energy is a key part of its vision. As part of this the Energy Research Accelerator (ERA), with the support of Innovate UK, has the mandate to develop beacons of excellence that demonstrate and show, not only the advantages of clean technology, but also how to develop them economically.

Partnerships between universities and businesses are central to this. The eight Midlands Innovation partners, together with the British Geological Survey have internationally recognised leading research facilities and expertise. Ranging from the technology associated with energy in the built environment, hydrogen and fuel cells, energy storage, power grids, nuclear energy, bioenergy, carbon capture and storage, through to energy policy, economics, regulation and law. These foundations, properly aligned, provide the impetus to work in a collaborative mode and at a scale previously not realised, to deliver real and significant change.

The ultimate aim is to establish a series of pan regional large-scale energy system demonstrators, or Energy Innovation Zones. The size of the challenge nationally and internationally is such that working collaboratively is essential. ERA has recognised this through the present business and academic consortium, but it is clear that even that is insufficient. One of the top priorities is to broaden and deepen the range of collaborative activities through the development of additional relationships with business and academia. The recent expansion of ERA to include the universities of Cranfield and Keele are examples of that widening collaboration.

The Energy Research Accelerator is looking forward to working with you to help shape the future global energy system.



Professor Martin Freer
Director, Energy Research Accelerator



ERA OVERVIEW AND HISTORY

The Energy Research Accelerator (ERA) is part of the Midlands Innovation (MI) research and innovation partnership that combines the collective excellence of leading universities in the heart of the UK. MI, through partnerships like ERA, unites the power of university research with the unique strengths of Midlands industry to drive cutting-edge research, innovation and skills development.

The Midlands is home to a large number of energy businesses as well as some of the newest and most innovative companies that rely on forward looking, ground-breaking R&D to support their own business growth aspirations. There are more than 10,000 companies working in the energy sector supply chain across the Midlands, employing over 56,000 people.

Every year more than £2.5 billion of capital investment is made in energy technologies and infrastructure (excluding buildings and transport) across the Midlands.

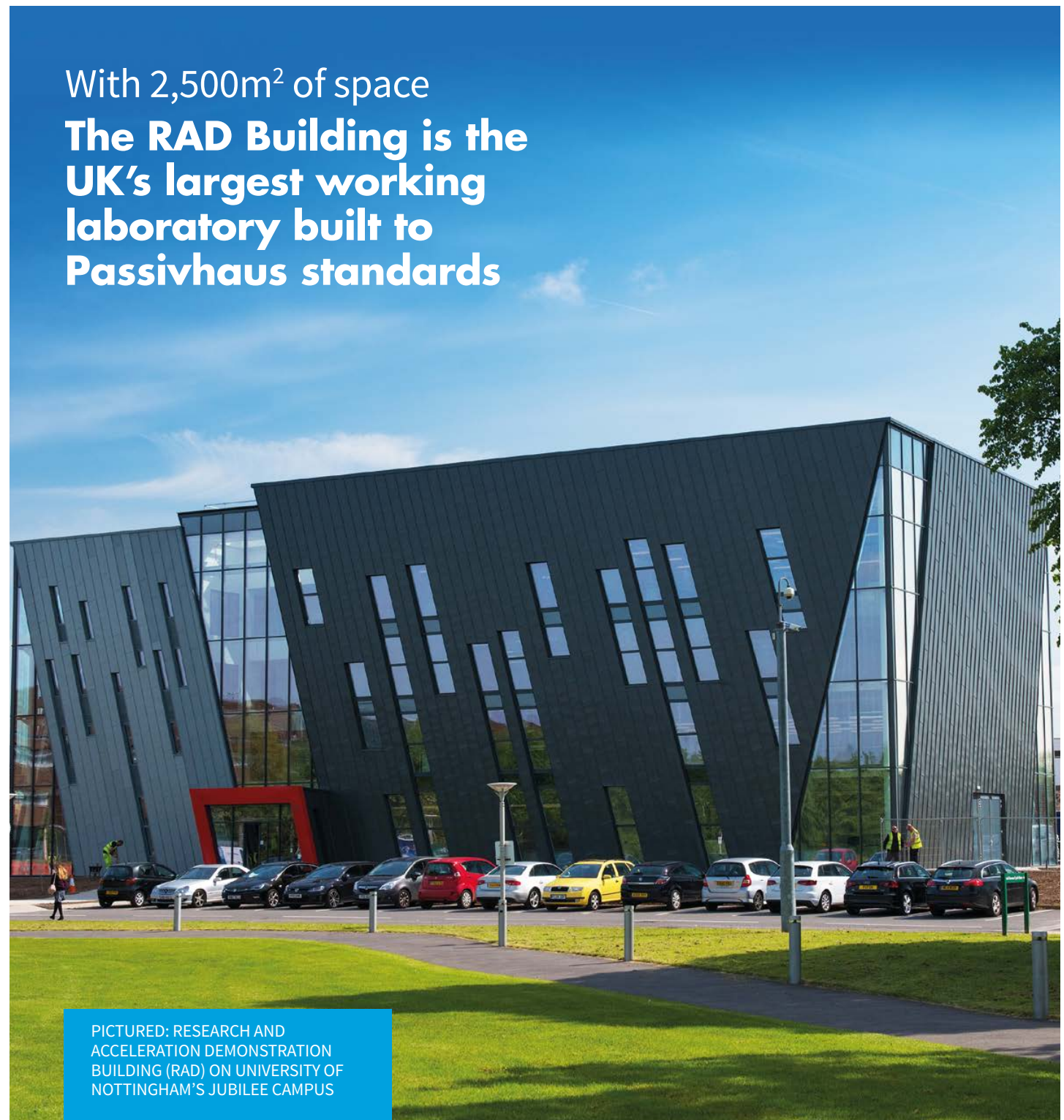
The ERA programme is a capital investment of £60 million from government matched by £120 million of co-investment from the universities and the private sector.

The programme is run by a small team of staff who are funded entirely by the ERA partnership. The funding has helped create 23 new research facilities across the

Midlands, which have, in part, been recognised by the UKRI Infrastructure Roadmap published in 2019 that states that the Midlands has the majority of the national research facilities associated with energy.

There are more than **10,000** companies working in the energy sector supply chain across the Midlands

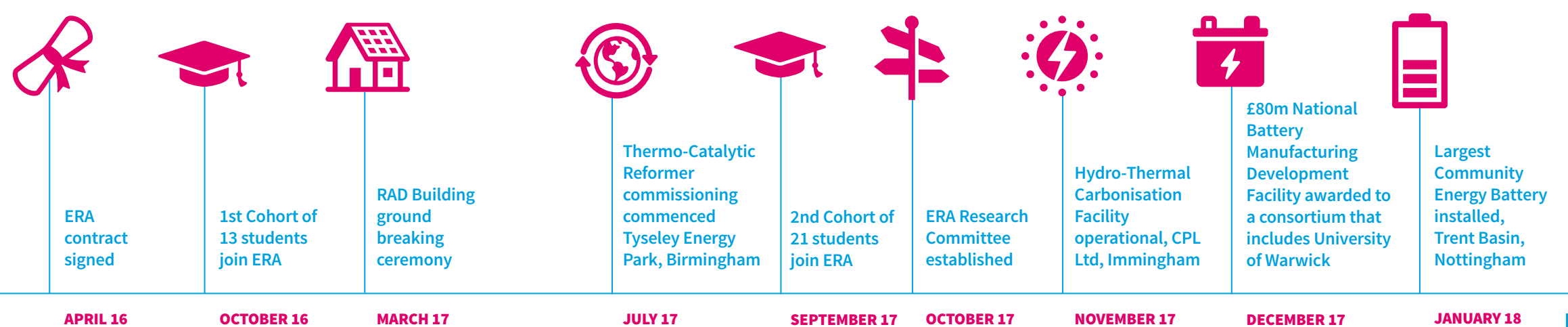
ERA originally involved a consortium of six Midlands based research intensive universities, Aston, Birmingham, Leicester, Loughborough, Nottingham and Warwick, together with the British Geological Survey (BGS), all of whom harness the Midlands' combined research excellence and industry expertise to play a critical role in tackling some of the biggest energy challenges facing the UK. The recent addition of Keele and Cranfield universities to the MI partnership, further strengthens ERA's research capability and clearly demonstrates the value of the ERA partnership.

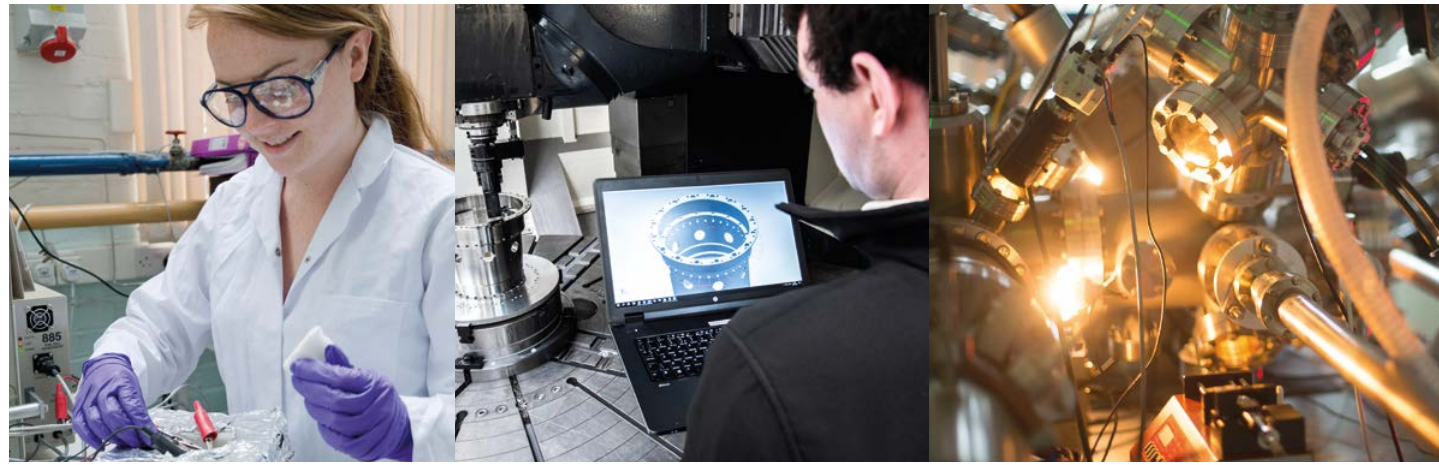


PICTURED: RESEARCH AND ACCELERATION DEMONSTRATION BUILDING (RAD) ON UNIVERSITY OF NOTTINGHAM'S JUBILEE CAMPUS

TIMELINE OF KEY ERA ACTIVITIES

2016-20





ERA mission

- Focus future academic research, industrial collaborations and the creation of a talented skills pipeline into Energy Transformation, Energy Storage, End Use Energy Demand and Energy Integration activities, all considered in the context of the complete, integrated energy system
- Turn the Midlands into a centre of excellence on clean energy research, that through a suite of physical energy demonstrators, can attract further inward investment and delivers technologies that can aid growth relevant to both national and international markets
- Strive to attract the best individuals to learn, develop and grow such that ERA is recognised for its contribution to a vibrant and successful Midlands skills base

The ERA mandate is to:

- develop and enable a broad based, clean energy research strategy that represents the strongest possible combination of technical expertise, demonstration facilities and academic collaborations across the Midlands, in addressing both national and international challenges
- create a co-ordinated skills programme that builds on the existing ERA Doctoral Training Programme and also investigate expansion into masters and undergraduate ERA Skills Academy

The role of Innovate UK

Government oversight of the ERA programme has been via Innovate UK.



Regular meetings over the past three years have ensured that the ERA programme has been maintained, that facilities have been completed and that ERA has grown its relationships with its industrial partners. Through a close working relationship with Innovate UK, the ERA facilities are now operational, an Industrial Advisory Board (IAB) has been created, and ERA is fully focused on maximising its exploitation opportunities. The oversight and support from Innovate UK has ensured that the research being undertaken by all of the ERA institutions is appropriate, relevant and strongly aligned to industrial needs.

ERA Governance

The ERA Management Group (ERA MG) provides the strategic direction and operational support to all aspects of the ERA project. As a sub-committee of the Midlands Innovation Executive Management Group the ERA MG makes recommendations on governance, staffing and budget and is tasked with overseeing and undertaking decisions relating to:

- the strategic aims of ERA
- the annual operational plan with priorities, targets and other measures of success
- ensuring the necessary financial and human resources are in place to deliver the plan
- the monitoring of performance against the plan including budgets and the management of risks

The ERA Research Committee is mandated to devise and manage a collaborative ERA Research Strategy. The Research Committee focuses on defining cross-institutional, collaborative research that builds on and strengthens the energy research, training and enterprise profile of each of the ERA member institutions. It leads the strategy for the delivery of science, innovation and impact from the ERA facilities including research proposals, promotion of research collaborations and defining how ERA facilities will become true national research assets.

The Industrial Advisory Board enables ERA academics to better understand the research and innovation needs of the private sector, in order to secure new industrial partnerships. The Board advises the ERA partner universities and the British Geological Survey on where to focus in securing industrial investment and broader funding for ERA activities.

Governance structure



Regional Energy Policy Commission Launch Event – Energy Innovation Zones in the West Midlands

MARCH 18



RAD building construction complete and building occupied

MAY 18



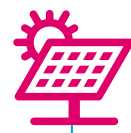
Trent Basin Community Energy Scheme “Switch on Event” by Lord Henley

JUNE 18



Latent Heat Energy Storage Lab commissioned and operational, Loughborough University

JULY 18



Thermal Materials Manufacturing Lab commissioned and operational, University of Birmingham

AUGUST 18



3rd Cohort of 24 students join ERA

SEPTEMBER 18



Energy and Bioproducts Research Institute (EBRI) facilities formally opened, Aston University

OCTOBER 18



ERA Vision Conference held

NOVEMBER 18



Smart Manufacturing Accelerator and Factory In a Box Demonstrator formally opened, MTC

MARCH 19



ERA facilities within Energy Innovation Centre and Sorption Heat Pump Labs formally opened, University of Warwick

JUNE 19



Inaugural meeting of the Industrial Advisory Board held

AUGUST 19



ERA Mission to China

JANUARY 20

THE ERA INDUSTRIAL ADVISORY BOARD

APPLYING BUSINESS ACUMEN TO ACADEMIC EXPERTISE

ERA has brought together leading academic expertise to deliver a range of technological solutions. However, to maximise its potential, ERA needs to be very well connected to industry and closely aligned to its needs. To achieve this, ERA has established an Industrial Advisory Board (IAB).

Comprising 12 senior representatives from across the energy sector, together with myself as chair, the IAB consists of electricity and gas utility companies, equipment manufacturers, engineering companies, technology developers, energy transmission and distribution companies, consultancies, trade associations, institutes and innovation centres, covering a very broad range of energy sources, vectors and utilisation technologies.

The role of the IAB is to offer an industrial perspective to help align ERA's strategy and priorities with commercial, real-world opportunities. The members provide a sounding board, ensuring that ERA plays an important role in the national development of low-carbon solutions, and they also work as advocates and flag-bearers for ERA. The IAB provides an invaluable review and discussion around ERA's work, looking at outputs and deliverables, and ensuring they are fit for industry requirements.

The opportunities for ERA lie with decarbonisation of the energy system – climate change is the driver, providing a focus for reducing costs and addressing the global challenges around energy policy and emerging technologies.

Academia and industry working together is a mutually beneficial process. Industry is naturally focused on those technologies that can be deployed quickly, but sometimes this means that other opportunities are missed. Academics focus on the next generation of solutions on the horizon, and by working with industry, ERA can ensure that it is at the intersection of academia, industry and policy, at the nexus of all these points.

The aim for ERA is to have an established role in this nexus, solving industry needs and bringing academic capability to bear on the challenges. We are already well placed to solve some of these challenges, such as developing energy storage solutions to enable best use of intermittent renewables and many other cutting-edge technologies.

The IAB is helping to ensure that ERA's strategic priorities are aligned to industrial capabilities, and that any ideas emanating from ERA's Research Committee are targeted and tuned to the needs of industry, accelerating the pace at which technologies come to market and keeping the UK at the forefront of energy innovation.



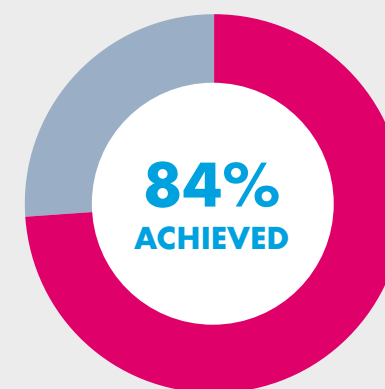
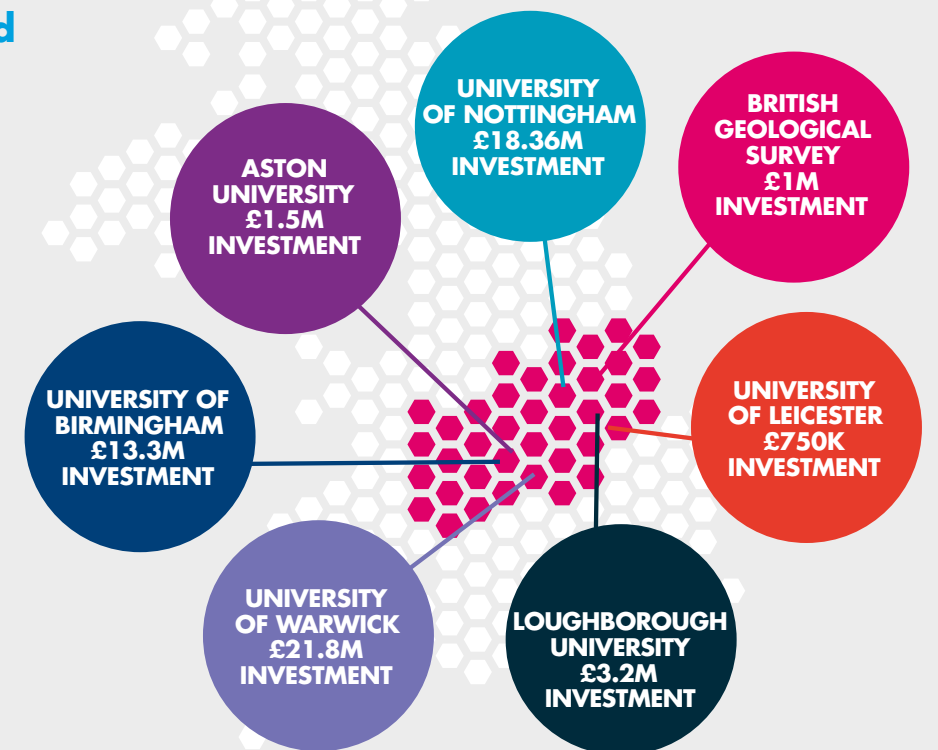
Philip Sharman
Chair, Industrial Advisory Board (ERA)



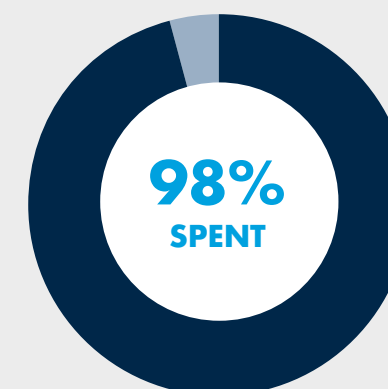
9 MIDLANDS PARTNERS

£60M invested in 23 new R&D facilities

145% investment achieved from universities and the British Geological Survey



ERA Capital project milestones have now been achieved



Capital funding has now been spent



£100.7m of the £110.59m Industrial Co-Investment now contracted

EVENTS AND OUTREACH IMPACT

Outreach allows us to demonstrate to the public, students and the global research community how low carbon technology can help shape the future of the UK's energy landscape.

Outreach is at the heart of ERA, whether it is engaging our doctoral students in outreach opportunities such as Big Bang and Pint of Science events, or sending our Factory-in-a-Box to the Smart Factory Expo in Liverpool, we aim to demonstrate to the general public, students and leading researchers how low carbon technologies can help shape the future of the UK's energy landscape.

Innovate 17, Birmingham

ERA exhibited and presented at Innovate 17, a conference organised by Innovate UK at the NEC in Birmingham. Attended by over 3,000 people, this event represented the public launch of ERA. We presented our aim to keep the UK at the forefront of energy research through its development of state-of-the-art facilities, demonstration facilities, and the mobilisation of a network of over 1,000 researchers and academics.

The Science and Innovation Conference, London

In June 2018, ERA presented to a packed audience at the Science and Innovation Conference at the QE2 Centre in London. The event enabled ERA to engage with company research directors, policy makers and academics with an interest in energy research.

The Big Bang Fair, Derby

ERA PhD students and staff took part in the Big Bang Fair at the Derby Roundhouse in 2018. This event, attended by school children from across the region, provided an opportunity for ERA to inspire children to follow a STEM career path, particularly in the energy industry. Eve Wheeler-Jones, a PhD student from the University of Warwick showed the children how to make fruit batteries!

ERA Vision, Nottingham

ERA Vision, held in October 2018 was ERA's inaugural conference which brought together leading energy experts from across the Midlands, showcasing all aspects of energy, from community energy initiatives to novel battery innovation, thermal energy, hydrogen generation, energy storage technologies, bioenergy and more. Speakers at the event included 'Fully Charged's' Robert Llewellyn, Steve Holliday, Chair of the Energy Institute and other senior figures from funding bodies and industry.

Parliamentary Group for Energy Studies, London

In January 2019, ERA was invited by the Parliamentary Group for Energy Studies to present to members of the Houses of Commons and Lords on the subject of 'disruptive technologies'. The audience consisted of a diverse range of business members and provided an insight into the research being undertaken by ERA on subjects ranging from energy from waste, battery technologies and compressed air energy storage.



All Energy, Glasgow

In the spring of 2019, ERA exhibited at the UK's largest energy conference and expo – All Energy in Glasgow. Over the two days of the conference, ERA obtained over 50 enquiries from businesses, public bodies, academics and other stakeholders. At the event, ERA's link with the Scottish Renewable Engine programme, enabled us to work together to develop a Research Zone where students from ERA and Renewable Engine partner universities presented their research.

Pint of Science, Loughborough and Birmingham

ERA's PhD students brought the worldwide science festival to the Midlands in May 2019, bringing PhD researchers and the public together, in the pub. Pint of Science aims to bring researchers to a local pub to explain their research, their findings, and the importance of this to a public audience. Our researchers covered topics including the joys of catalysis, the wonders of nanoscience, bioethanol from food waste and more.

Resource and Waste Management Show, Birmingham

Energy from Waste is a key theme for ERA, so the Resource and Waste Management Show at the NEC in September provided the perfect platform for ERA to showcase the work that it is doing in this technology area.

The Low Carbon 2020s, London

ERA was one of the sponsors of the CBI's Low Carbon 2020s event held at Schroders in London in the autumn of 2019. Introduced by Kwasi Kwarteng, Minister for Energy and Clean Growth, the event provided a platform for ERA to reach senior business leaders from around the UK.

Smart Factory Show, Liverpool

In November 2019, the ERA funded Factory in a Box (FIAB) was shipped to Liverpool to the Smart Factory Expo, which forms part of Digital Manufacturing Week and showcases manufacturing agility, innovation and thinking. During the event, live demonstrations of the FIAB took place where visitors had the opportunity to speak with engineers to find out more about how the FIAB was developed and how innovative manufacturing system solutions can be deployed to resolve supply chain challenges for businesses.

ERA's China Mission, Beijing, Nanjing, Hangzhou

ERA ran an outbound investment mission to China in early January 2020 to meet with leading Chinese energy companies, research partners and government funding bodies with specialisms in energy aligned with the ERA capability strengths.

The mission was organised by ERA with support from the University of Nottingham's Asia Business Centre and Birmingham University's Energy Institute working closely with the relevant departments at the other ERA institutions as appropriate. It aimed to make use of the participating ERA institutions' UK and China government connections and links with industry to facilitate the visit.

Visits to three centres – Beijing, Nanjing and Hangzhou were selected due to the established links that ERA institutions already hold with local government, industrial company and universities in these three cities, and the publicly declared alignment that these cities have with many of the technology areas in which ERA has strength.

The mission resulted in a number of large and small-scale opportunities that are currently being progressed, including joint technology development and implementation, policy development and knowledge sharing. ERA values these opportunities as potentially being worth in excess of £10 million.





ASTON UNIVERSITY

The Energy and Bioproducts Research Institute (EBRI) at Aston University has been committed to the research and development of sustainable energy technologies and solutions since the 1970s. Its team of internationally-renowned researchers focuses on methods of generating energy, fuels and chemicals from biomass, wastes and residues.

Expertise

EBRI acts as a hub and a focus for worldwide activities and networks of scientific and technological development of biomass production, conversion and utilisation of products for renewable power, heat, transport fuels, hydrogen and chemicals.

EBRI's capabilities cover the breadth of advanced thermal, and catalytic conversion processes. These include gasification, pyrolysis, catalysis and upgrading of biomass, wastes and plastics to high quality products and fuels.

Allied to this is EBRI's expertise in environmental, social and economic impacts of bioenergy systems; smart distributed energy systems; supply chains; logistics; analytics; energy and power systems. This is supported by significant business engagement capabilities.

EBRI and ERA

ERA's investment in EBRI has resulted in new state-of-the-art equipment including a surface imaging machine, a photo-electrical platform and a bioreactor suite. EBRI leads a range of engagement activities which stimulate innovation and knowledge transfer between businesses, scientists and chemical engineers across renewable biomass, biorefining, bioenergy, biofuels and bioproducts.



Over the life of the project, EBRI has generated £29 million in regional impact (Gross Value Added).

EBRI partnership opportunities

EBRI situated on the Aston University campus in central Birmingham is a unique hub of bioenergy research and technology development. It is home to academic and industry facing teams that aim to accelerate the commercial development of emerging energy, bioproducts and supporting technologies. It welcomes collaboration opportunities with academia, government bodies and industry both locally and internationally and actively bids for new research and industrial engagement.

EBRI has generated £29 million in regional impact



UNIVERSITY OF BIRMINGHAM

The Birmingham Energy Institute at the University of Birmingham has over 200 academics engaged in energy-related research and development projects worth more than £200 million. It is driving technology innovation and developing the thinking required to solve the challenges facing the UK as it seeks to develop sustainable energy solutions in transport, electricity and heat supply.

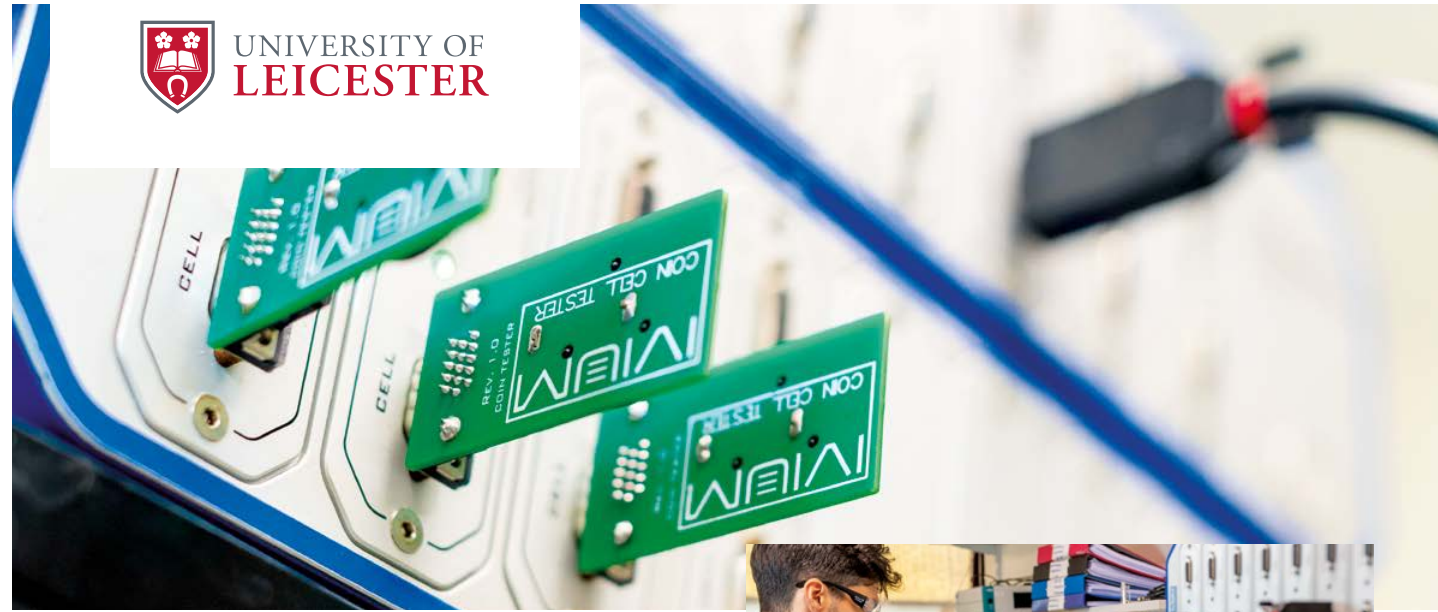
Research at the Birmingham Centre for Energy Storage explores how energy storage, particularly thermal and cryogenic energy-based technologies, coupled with appropriate policy, could play an important role in delivering an integrated energy system.

The Birmingham Centre for Fuel Cell and Hydrogen Research is driving both the technology and thinking required to solve some of the challenges facing the UK, as it seeks to develop sustainable solutions to the designing of future cities, energy and transportation.

ERA has supported a number of developments involving the University of Birmingham, including the revolutionary 'Factory in a Box' initiative at the MTC, which provides a portable, remotely operated smart manufacturing solution. The Thermo-Catalytic Reformer (TCR) at Tyseley Energy Park is transforming waste into energy, and the heat storage and cryogenic labs at the University of Birmingham are enabling world-leading research to be delivered.



Cryogenic energy technologies could help solve integrated energy challenges



UNIVERSITY OF LEICESTER

The University of Leicester has a varied energy research programme coupled to extensive international academic and industrial collaborations that are leading the way in the search for alternative energy sources and greater energy efficiency.

Through ERA's investment, Leicester is playing a leading role in advancing the safety and performance of cell materials and chemistries. These include the development of novel electrolyte technologies to implement the aluminium rechargeable cell. The potential of aluminium to supersede lithium has not yet been realised because of its complex chemistry. The University of Leicester is also developing novel methods for recycling and recovery of critical raw materials from spent cells.

Additionally, investment from ERA has enabled new facilities to study energy storage/ energy supply systems as well as the performance of energy distribution networks and the rapid charging of batteries. In energy generation, optimising hydrocarbon yield accessed by the hydraulic fracturing process is a key research focus for the University of Leicester. This takes place by closely monitoring above and below-ground volatile organic compound gas emissions and more widely their environmental impacts.

Cross-cutting expertise in energy storage, material recovery and cell chemistry



LOUGHBOROUGH UNIVERSITY

Loughborough's energy research priorities include energy transformation, energy storage and energy demand. It is also the home of CREST (Centre for Renewable Energy Systems Technology) and has overseen the research and development of the most progressive renewable energy technologies, collaborating with industry and international academic networks.

Research activities at CREST cover a range of technical applications, including wind power, solar PV, energy in buildings, grid connection and integration, and energy storage (including hydrogen).

CREST is a member of the European Renewable Energy Centres Agency - a prestigious network of over 40 of the top renewable energy research centres. CREST regularly collaborates on projects with many of these organisations. CREST employs academics, scientists and researchers who generate ideas and technologies that have much broader social and economic impact. It is playing a role in helping society to address the global challenges it faces in energy, fuel poverty and environment.

ERA's investment into new laboratory equipment supports Loughborough's leading research and innovation in solar technologies and storage.



Over 20 years experience of R&D in renewable energy technologies



UNIVERSITY OF NOTTINGHAM

The University of Nottingham has several research themes with the common goal of developing sustainable energy solutions. Its mission is to develop the best future talent in energy across the sciences, engineering and social sciences and to create world-class research facilities to support innovation and collaboration.

ERA's involvement with the University of Nottingham includes the development of the Research Acceleration and Demonstration (RAD) building, a £12 million facility which is home to state-of-the-art laboratories for compressed air energy storage, hydrogen, materials analysis and carbon capture. Additional ERA funded facilities run by the University include the Trent Basin community energy programme and the Hydrothermal Carbonisation plant which is operational at Immingham with the company CPL.

Other research at Nottingham includes:

Advanced Materials – This aims to explore the links between the synthesis and processing of materials, the development of their microstructure, and their useful functional properties across a range of energy related applications.

Batteries and fuel cells – As well as conducting research into lifecycle design and monitoring for extended performance, Nottingham is researching advanced



materials to enhance the performance and extend the operating-temperature range of hydrogen fuel cells.

Carbon Capture Utilisation and Storage – Nottingham's main area of research for carbon capture, utilisation and storage (CCUS), is in the capture of carbon before it is released into the atmosphere. This includes using new, high capacity adsorbents which capture CO₂ either pre or post-combustion, and advanced biochemical processes that convert CO₂ to useful chemicals.

Hydrogen – The last few years have seen new generations of electric, hybrid and biofuel vehicles on the road. Hydrogen-powered vehicles offer competitive solutions against these vehicles in terms of range for cars and suitability for heavier vehicles and goods transportation. Hydrogen has a wide range of potential uses; for example, as a replacement for natural gas as a heat source, or to help decarbonise energy-intensive industrial processes.

Thermal energy storage – Nottingham is exploring energy storage before generation, and developing systems with real inertial and compressed air energy storage.

The University also has an active 'Energy for Business' programme, providing product R&D and other support for local businesses.



UNIVERSITY OF WARWICK

The University of Warwick has expertise in a range of energy research areas including electrical power, energy management, storage, low carbon transport and thermal energy. The ERA investment at Warwick contributed to developing expertise and technology both within the university's Energy Innovation Centre and the School of Engineering.

Energy Innovation Centre – The Energy Innovation Centre (EIC) is a world-class facility for battery research and innovation. ERA's investment supports cell materials and characterisation, modelling and simulation, second life battery use, electro-mechanical testing and inductive charging. The EIC works closely with world-class industrial partners and is at the forefront of battery research development and commercialisation. The investment from ERA helped the University of Warwick to secure their bid to be part of the £246 million Faraday Challenge; a national investment into battery research.

The facilities developed by ERA are open for use by academic groups from across the country, and leading industrial partners in the Midlands have committed to use the facilities to undertake research and the development of technologies in energy storage, energy machines, drives and systems.



Thermal Laboratories – The new thermal laboratories in the School of Engineering investigate how real world conditions can influence the performance of new technologies. ERA funding was used to develop a Thermal Analysis Technologies Laboratory – that covered the refurbishment of an existing facility and the introduction of new technologies associated with the development of materials for use in both high and low temperature applications. The funding also enabled the refurbishment of a lab focused on Sorption Heat Pump technologies. Heat driven heat pumps can offer up to 30% emission savings compared to fossil fuel boilers, but it is thought that 65% is achievable in the longer term with lower heat pump costs and improved reliability.

Over 20 companies work with the Energy Innovation Centre at any time



Geoenergy test bed has 11 boreholes drilled to depths of up to 285 metres

BRITISH GEOLOGICAL SURVEY

The British Geological Survey (BGS) is a world-leading geoscience centre. It focuses on public-good science for government, and research to understand earth and environmental processes. It is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge, to help society use its natural resources responsibly, manage environmental change, and be resilient to environmental hazards.

The BGS carries out multidisciplinary research, both collaborative and commissioned work, in areas such as geothermal energy, quarrying and shallow mining, waste management, transport and water service tunnels, groundwater abstractions, resource gas storage, radioactive waste disposal, hydrocarbons, and carbon capture and storage. Their impartial, multidisciplinary survey and research work informs important stakeholders such as the groundwater industry, environmental organisations, the minerals industry, land use planners, academia, and the public.

ERA has funded a GeoEnergy Test Bed, a £2.4 million investment which has involved the drilling of 11 boreholes at the University of Nottingham's Sutton Bonington site. The geology is similar to that of the North Sea and the boreholes include deep and shallow injection wells which can be used to monitor the motion of gases and liquids through natural pathways in the subsurface after injection.

The site is fully instrumented with surface and down-hole sensors and is highly characterised, providing a data archive that can be used to validate future measurements. It has undergone a range of hydrogeological testing, gravimetric surveying, electrical resistivity tomography surveying and a full depth rock core has been extracted for analysis.

The GTB has the infrastructure available to support research and develop monitoring technologies which are applicable to all GeoEnergy sector industries.

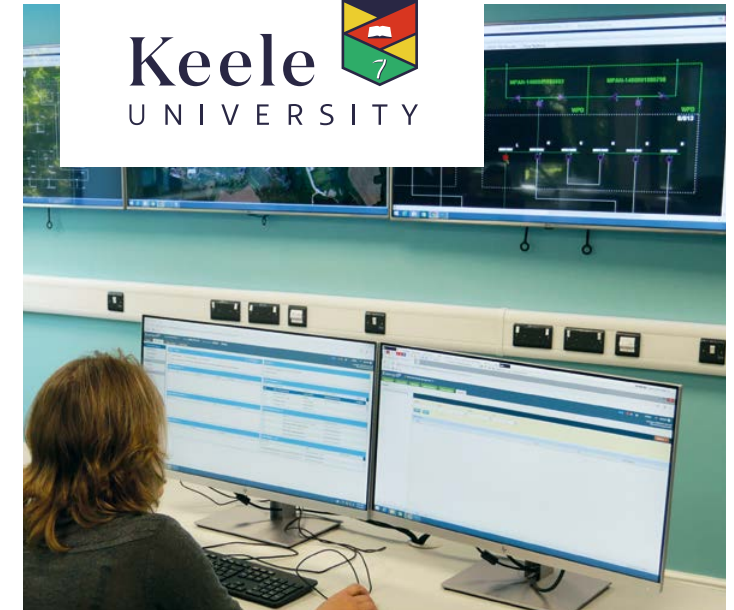


CRANFIELD UNIVERSITY

Cranfield's expertise in energy and power covers a range of the potential energy solutions. The University's expertise is supported by unique industrial scale experimental facilities across many different kinds of energy systems.

These include an ocean systems laboratory, gas turbines, an anaerobic digestion plant, and high temperature coating test facilities. Cranfield's postgraduate community includes around 200 MSc students from around the globe and 150 full-time doctoral students including those on the Renewable Energy Marine Structures (REMS) Centre for Doctoral Training with the University of Oxford. Cranfield graduates are working in engineering and management roles across the energy industry and putting their learning into practice.

Both Cranfield University and Keele University are relatively new additions to the ERA consortium. They have both been attracted to join ERA as a result of the reputation gained through the investment of the Innovate UK funding in world class, cutting edge facilities and research that complemented strongly with the energy research that both were already undertaking. The strength of ERA has been considerably improved with the addition of the universities of Cranfield and Keele. Through cutting-edge energy research and decarbonisation projects such as SEND and HyDeploy at Keele, and innovations in the development of electric aircraft through CAES at Cranfield, these universities are playing an important role in broadening ERA's expertise and industrial offer.



KEELE UNIVERSITY

Keele University is the home of the Smart Energy Network Demonstrator (SEND). A European first, this world-class demonstrator facility for smart energy research and development enables the testing and evaluation of new and evolving energy technologies.

Working collaboratively with Siemens and local partner companies the ERDF funded programme provides the opportunity to assess the efficiency of these new technologies in terms of energy reduction, cost and CO₂ emissions. Transforming the Keele University campus into an 'at scale living laboratory' SEND will provide a unique testing site model due to the diverse range of activities and facilities within it – 3,100 students in halls of residence, 1,000 commercial users on the Science and Innovation Park, and 200 'standard' domestic households.



POWERED BY PARTNERSHIP: INDUSTRY

Partnerships between universities and businesses are central to the UK achieving its ambitious aim of being carbon zero by 2050. The Government has a stated aim to increase R&D spend to 2.4% of GDP to keep the UK at the forefront of innovation. ERA is supporting this by ensuring that its research is aligned to industrial needs and national challenges, and that new technologies are able to be demonstrated at a commercially viable scale. To date ERA has worked with over 40 industrial partners on a wide range of projects, innovations, initiatives and joint facilities. Below are a selection of ERA case studies that demonstrate how successful ERA has been in working alongside industry in order to pull research from the laboratory through to commercial realisation.

**£120M
INDUSTRY
FUNDING:
co-investment
committed to
ERA from over 40
industrial partners**

TYSELEY ENERGY PARK

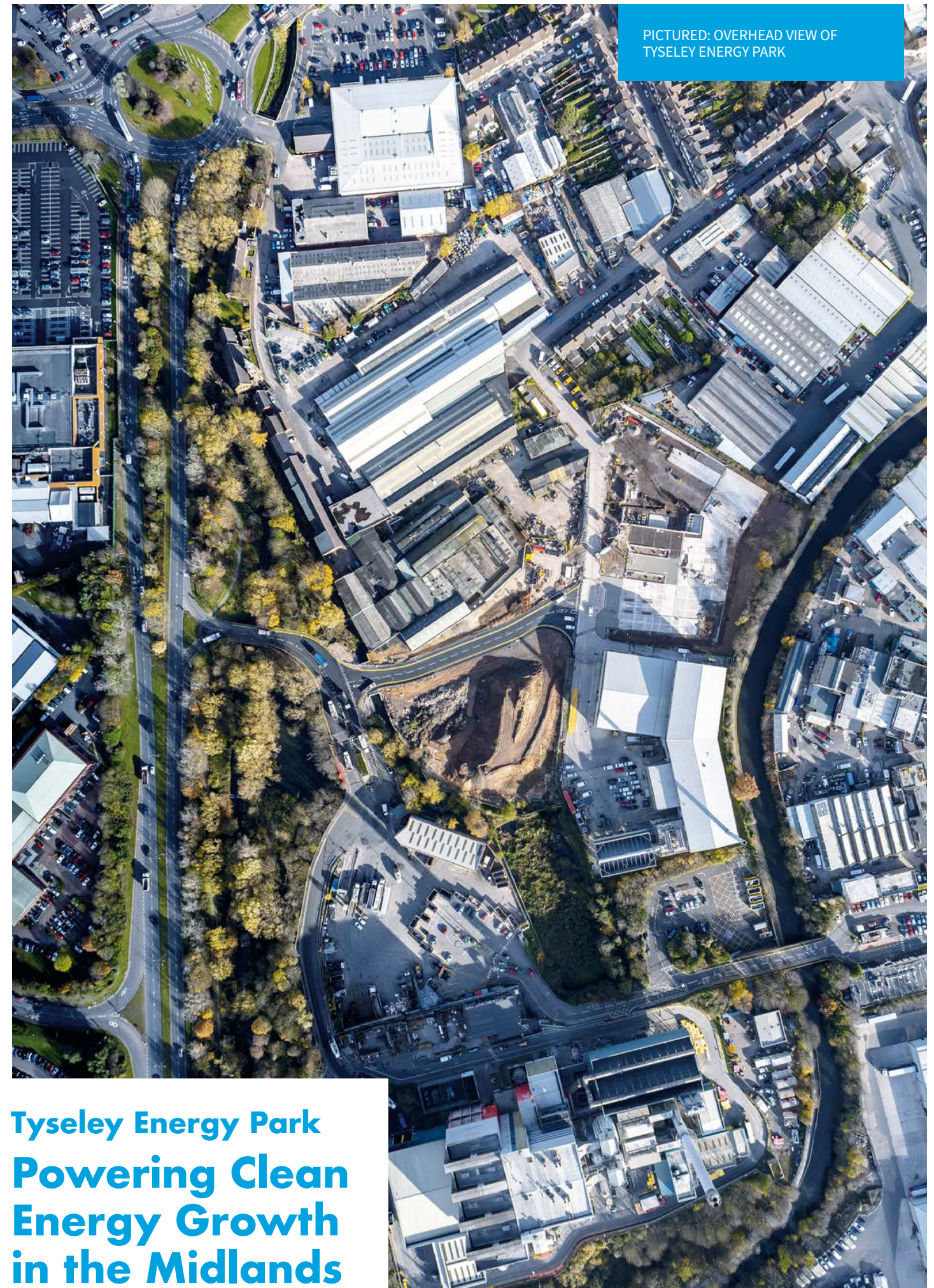
Integrating waste and recycling with energy, fuels and transportation solutions for the City of Birmingham, the Tyseley Energy Park (TEP) is an Energy Innovation Zone being developed in the City of Birmingham to help drive the transformation of the city to meet its plan for decarbonisation and the development of a clean air zone.

Situated on the site of Webster and Horsfall existing manufacturing facility, TEP integrates energy from waste plants with electricity and fuels production. ERA's investment in Tyseley has centred around an innovative Thermo-Catalytic Reformer (TCR), which uses an improved pyrolysis technology to transform various kinds of biomass into synthesis gas, charcoal and diesel quality oil. This effectively uses around 70%

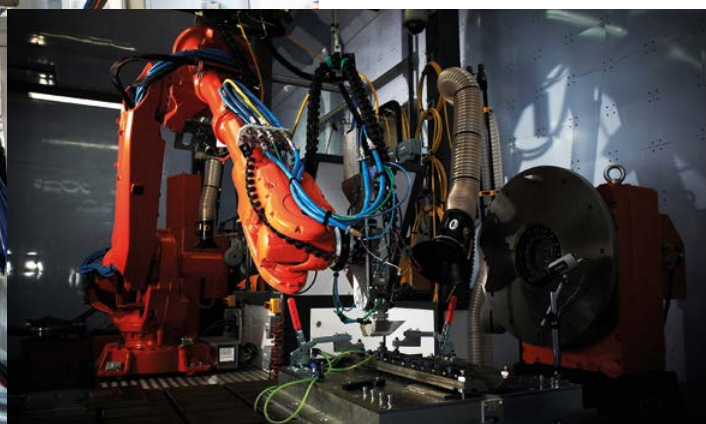
of the energy in the biomass. The TCR process converts the biomass into high quality syngas, bio-oil, biochar and water. TEP has been adopted by Energy Capital, the organisation within the West Midlands Combined Authority, as one of the five trial Energy Innovation Zones within the region, aimed at leading the clean energy and transport transition within the region. Birmingham City Council has set stretching targets to deliver a 60% reduction in CO₂ emissions by 2027.



PICTURED: OVERHEAD VIEW OF TYSELEY ENERGY PARK



**Tyseley Energy Park
Powering Clean
Energy Growth
in the Midlands**



MTC

Smart Manufacturing Accelerator, and Factory in a Box

The Smart Manufacturing Accelerator (SMA) is a framework for delivering integrated manufacturing and supply chain solutions enabled by the application of industrial digital technologies.

Funded by ERA through Innovate UK, the project was delivered by the MTC, in partnership with the University of Birmingham's Birmingham Energy Institute and Loughborough University, as well as a number of technology partners from industry. It aims to support UK-based businesses to catapult their expansion through the adoption of smart manufacturing techniques, Internet 4.0 technology and the very latest remote manufacturing practices.

Developed as part of this project was the Factory in a Box (FIAB) demonstrator; a modular manufacturing supply chain network enabled by industrial digital technologies. The FIAB is contained within a unit the size of a shipping container, and provides a rapidly deployable, remotely managed flexible solution that is fully digital and able to be controlled and monitored from a central control centre. It was officially launched in March 2019 at the MTC in Coventry, to an audience of nearly 300 industry thought-leaders, academia and key stakeholders.

“The Smart Manufacturing Accelerator process helps companies design, develop and operate a remote Factory in a Box and provides tools to adopt advanced manufacturing technology in a traditional manufacturing facility”

In 2019, the project also developed Factory in a Box 2 (FIAB 2); a mixed reality demonstrator for which the factory design, ICT and controls architecture was fully virtually commissioned. Delivered in partnership with Siemens, FIAB 2 can demonstrate a number of manufacturing processes using mixed reality to visualise real time production data.

“The Smart Manufacturing Accelerator process helps companies design, develop and operate a remote Factory in a Box and provides tools to adopt advanced manufacturing technology in a traditional manufacturing facility,” says Dr Hannah Edmonds, technology specialist at the MTC.

The project is currently working alongside the defence and pharmaceutical sectors on further development of the commercial application of the SMA framework.

CPL INDUSTRIES

University of Nottingham partners with CPL industries to make ‘biocoals’

ERA is working with the University of Nottingham and CPL Industries to produce a commercial scale facility capable of converting biomass into next-generation solid fuels having coal-like properties. The technology being used to develop the biocoal is known as Hydrothermal Carbonisation (HTC). This converts high-moisture biomass into solid fuels using moderate temperatures and high pressures. The HTC process effectively mimics the long-term natural process of coal formation, with the process taking a matter of hours rather than millennia! The facility, which is based at CPL's production site in Immingham, is operated by CPL Industries, a major manufacturer and distributor of solid fuels which already has products on the market containing biomass materials. CPL is working with Professor Colin Snape at the University of Nottingham, who is Director of the Centre in Efficient Power from Fossil Energy and Carbon Capture Technologies.

Speaking about the new facility Jason Sutton, Director of CPL, said: “The technology has the potential to revolutionise the treatment of high-moisture organic waste streams, producing value-added products that displace fossil fuels and promoting the circular economy.



TRENT BASIN

Trent Basin is an innovative and contemporary neighbourhood, delivered by award-winning developers Blueprint as part of the 250-acre Waterside Regeneration area in Nottingham, and set to deliver 500 new low energy homes once complete. The £100 million scheme, now starting its third phase of build, is also the site of a transformational energy project that hosts one of Europe's largest community energy batteries.

Project SCENe (Sustainable Community Energy Networks), a pioneering community energy pilot is being supported by £10 million of Innovate UK and ERA investment, match funded and delivered by a formidable consortium of public and private sector partners, including Blueprint and The University of Nottingham. Its aim is to accelerate the adoption of Community Energy Systems by offering a different way of generating and supplying locally generated heat and electricity to homes and commercial buildings.

On the ground, the pilot intends to develop a viable model that can deliver renewable energy generation on new urban developments, which in turn, generates financial returns for the community to offset energy costs. Whilst the model is still in its early stages, the project has drawn both national and international attention and many energy companies are now watching Trent Basin very closely.

Solar photovoltaics are installed on the site, along with the communal battery. A unique community energy company has also been established and residents that have opted to join are provided with Amazon's new Echo Spot, smart thermostats (Honeywell EvoHome) and additional in-home monitoring equipment that will

Trent Basin is a major multi-partner collaboration

Project partners: Innovate UK, the Energy Research Accelerator (ERA), Blueprint, University of Nottingham, Project SCENe (Sustainable Community Energy Networks), AT Kearney, Smartklub, Siemens, URBED, Slam Jam, Sticky World, Loughborough University, Solar Ready and supported by Nottingham City Council.

be accessible from a purpose built app. Blueprint will continue to build on this offer in future phases, eventually offering a full suite of smart technology, from appliances to security features.

The Trent Basin energy system is connected to the grid; utilising sophisticated arbitrage software the system stores energy generated on and off-site distributing power back to the grid at peak times contributing to grid resilience and generating income for the resident members of the community energy company

The project aims to develop a business model that meets government sustainable living targets in a way which is financially stable and future proof.



JAGUAR LAND ROVER

In 2015, Jaguar Land Rover (JLR) pledged to support the creation of unique ERA facilities to serve the automotive, commercial and off road, marine and rail sectors, through creating enabling technologies in energy storage.

The vision was to help enable the effective design, characterisation and manufacture of technically, economically and environmentally sustainable future battery packs and scale up and prepare for exploitation and ongoing research into future battery chemistries.

ERA has delivered on this vision, with the facilities created predicting and underpinning the rapidly accelerating decarbonisation and 'Net Zero' agenda. ERA has been a precursor to the Faraday Battery Challenge and the creation, in Coventry, of the UK Battery Industrialisation Centre, opening in Spring 2020.

The Jaguar I-PACE, which has won three World Car of the Year awards embodies the innovation that has put JLR at the forefront of the electric vehicle revolution. JLR is investing in an electrified industrial footprint, with every new Jaguar and Land Rover model line to be electrified.

Building on the learning from ERA JLR has made an investment in a major Battery Assembly Centre being developed at Hams Hall.

The Jaguar I-PACE, which has won three World Car of the Year awards embodies the innovation that has put JLR at the forefront of the electric vehicle revolution



SKILLS AND DOCTORAL TRAINING

Developing future leaders in low carbon energy

The ERA Skills Academy's vision is to create a holistic energy-related skills provision to help hone and develop the talent of the Energy leaders of tomorrow. Our doctoral students benefit from a wide spectrum of energy research specialisms across six top class academic institutions and work alongside industry world leaders in applied energy research. To help them develop the skills required to be the next generation of energy leaders ERA provides a variety of developmental events looking at impact, energy policy and communication skills, whilst giving them the opportunity to engage with, work in, and tour the exceptional ERA facilities.

The ERA Skills Academy was established in 2016 and now has three cohorts of students. To help build a cohort feel, introduce the PhD students to ERA facilities, and expose them to Energy research outside their direct field of study ERA has arranged tours of its facilities, these prove very popular.

Personal Resilience

ERA strives to provide the training, experiences and skills that the doctoral students need to tackle the ups and downs of life as a researcher so that they can fulfil their potential to become the energy leaders of tomorrow. One of our doctoral students' highlights was welcoming the renowned scientist and education advocate Dr Emily Grossman to provide training in techniques to communicate their work and ideas in a clear and engaging way.

ERA students trade energy

Over 20 of ERA's doctoral researchers gathered at the British Geological Survey (BGS) to take part in an energy trading game. The game involved teams generating and selling electricity to customers, and was designed to help students, businesses and policy makers understand how energy markets work. The winning team made a profit of over £11 million and the event was considered a major success.

A lifelong Journey

As the PhD students start to come to the end of their journey with ERA, it is important for them to have time and space with experts on hand to help them work on their thesis. ERA provides support in this area by arranging writing retreats that offer advice and support to students at this critical time of their PhD work.



PICTURED: ERA's PhD students are provided with a range of opportunities to develop new skills and expertise, and to expand their professional networks.



WORLD-CLASS FACILITIES

Projects from the ground up – 2016 to 2020

Facility Title	Description	Location
Advanced Biomass Processing Facility	Expanded analytical and processing capability in biomass, biofuels, biochemical and bioproducts.	EBRI, Aston University
Advanced Insulation, Glazing and Solar Collector Laboratory	Test facilities to develop high performance insulation materials, façade systems for improved building energy performance.	CREST, Loughborough University
Battery Testing	Bespoke facility for abuse testing of cells beyond their normal operating limits. This enables the stripdown, autopsy and analysis of cells to understand the reasons for failure.	Energy Innovation Centre, University of Warwick
Cell Manufacturing (cylindrical and pouch)	Pilot line for the manufacture of cylindrical and pouch format batteries. Pack scale testing facility for testing of full vehicle battery packs up to 1MW, 900V.	Energy Innovation Centre, University of Warwick
Community Energy Demonstrator	Local integrated energy system supplying power for the local community.	Trent Basin Development, Nottingham
Cryogenic Engineering Research Lab	Support the development of cold engine technology.	Wolfson School, Loughborough University
Geoenergy Test Bed	Comprising of a set of 11 boreholes and data recording infrastructure / office accommodation. The facility will be used to carry out research into new technology sensors and for research related to the geology of the site and into gas injection, including CO ₂ .	Sutton Bonington Campus, University of Nottingham
Hardware in the Loop (HIL) Lab	Bespoke facility for the simulation of drive cycles, incorporating motors/batteries.	Energy Innovation Centre, University of Warwick
High Performance Compression and Expansion Lab (HPCEL)	Facilities at the University of Nottingham and the University of Leicester for research into gas compression, expansion and energy storage.	Jubilee Campus, University of Nottingham
Hot and Cold Thermal Materials Manufacturing Laboratory	Newly refurbished space for the Birmingham Centre for Energy Storage to continue its work into researching and manufacturing cryogenic, sensible heat and high temperature energy storage materials, components and systems.	Metallurgy and Materials Building, University of Birmingham

Facility Title	Description	Location
Hybrid Cryogenic IC Engine Facility	Hot and cold hybrid engine research facility, building on the existing EPSRC 8 Great Technologies funded Liquid Air engine test laboratory. The new facilities allow wider integration with thermal, and in particular, cold chain technologies through the development of the applications of liquid air.	Mechanical and Civil Engineering Building, University of Birmingham
Hydrogen Systems Test Bed	A flexible test facility for the evaluation of hydrogen as an energy source and energy storage medium.	Jubilee Campus, University of Nottingham
Hydro Thermal Carbonisation Rig	Facility for the evaluation of low carbon bio fuels produced from waste materials.	CPL Works, Immingham
IESTV	Research into gas compression, expansion and energy storage.	Department of Mechanical Engineering, University of Leicester
Latent Heat Energy Storage Laboratory	Materials characterisation laboratory and test facilities for photovoltaic energy generation.	CREST, Loughborough University
Materials Lab	For the development of new battery materials and chemistries.	Energy Innovation Centre, University of Warwick
Multidisciplinary Development Lab (MDL)	The MDL is equipped with state of the art facilities for near-ambient pressure photoelectron spectroscopy, nanoscale imaging, gas-storage & separation, thermal analysis, fuel cell testing & accelerated gas cycling.	Jubilee Campus, University of Nottingham
New Cell Chemistries, Electrolytes and Materials	For the development of new battery materials and chemistries.	University of Leicester
Second Life and Wireless Testing Facility	For testing and integrating second life packs/modules into a range of applications including vehicle charging and static storage.	Energy Innovation Centre, University of Warwick
Solid Loop Adsorber	Facility for the evaluation of improved means of scrubbing CO ₂ from combustion products.	Jubilee Campus, University of Nottingham
Thermal Analysis Technologies Laboratory	Development of thermal energy materials.	Faculty of Engineering, University of Warwick
Thermal Belt Demonstrator Facility	Development of novel biomass conversion technologies for the production of biofuels.	Tyseley Energy Park, Birmingham
Thermal Technology Companies Manufacturing Assessment and Support to FIAB Demonstrators	Development of thermal energy manufacturing capability. Create digital/virtual manufacturing environment and two factories in a box to demonstrate Industry 4.0 principles in the thermal energy sector.	Manufacturing Technology Centre



Collaborate with us

ERA welcomes engagement with research, industry and policy-makers across the energy sector.

For more information:

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- 🐦 [@EnergyRA](https://twitter.com/EnergyRA)

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Midlands Innovation has made every effort to ensure that the information in this brochure was accurate when published. Please note, however, that the nature of the content means that it is subject to change from time to time, and you should therefore consider the information to be guiding rather than definitive.

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