

UNIVERSITY OF
BIRMINGHAM



BIRMINGHAM
ENERGY INSTITUTE

BIRMINGHAM ENERGY INSTITUTE



@BHAMENERGY



WWW.BIRMINGHAM.AC.UK/ENERGY

THE BIRMINGHAM ENERGY INSTITUTE



At Birmingham we are 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. Co-ordinated research, education and global partnerships are at the heart of our vision. By creating technology and guiding policy today, we aim to help shape the energy solutions of tomorrow.

The Institute is the focal point for the University and its national and international partners, to create change in the way we deliver, consume and think about energy. It harnesses expertise from the fundamental sciences and engineering through to business and economics to deliver co-ordinated research, education and the development of global partnerships.

OUR EXPERTISE:

- Energy storage
- Nuclear energy
- Economics
- Hydrogen and fuel cells
- Transport
- Electricity and smart grids
- Materials for energy applications
- Sustainability
- Strategic elements & critical materials
- Energy Law and regulation

‘ON BOTH THE NATIONAL AND INTERNATIONAL SCALE THERE EXISTS A COLLECTIVE CHALLENGE FOR GOVERNMENT, SOCIETY AND RESEARCH TO RESHAPE THE WAY WE GENERATE AND USE ENERGY, IMPROVE THE LIVES OF PEOPLE ACROSS THE WORLD, REDUCE THE IMPACTS OF CLIMATE CHANGE AND HELP ECONOMIES TO GROW SUSTAINABLY. THE OPPORTUNITY FOR UNIVERSITIES TO HAVE AN IMPACT IS IMMENSE; BE IT THROUGH FUNDAMENTAL AND APPLIED RESEARCH, ECONOMIC POLICY, OR SOCIAL SCIENCE.’

PROFESSOR MARTIN FREER, DIRECTOR OF THE
BIRMINGHAM ENERGY INSTITUTE

**CUTTING A COUNTRY'S
CARBON EMISSIONS BY
80% IS NOT TRIVIAL;**

IT REQUIRES A REVOLUTION IN THE
WAY WE LIVE OUR LIVES, THE WAY
WE UTILISE AND GENERATE ENERGY,
AND THE ROLE TECHNOLOGY CAN
PLAY IN THIS TRANSFORMATION –
THIS IS OUR FOCUS

£75 MILLION

AWARDED FROM EXTERNAL PROJECT
FUNDING RELATED TO ENERGY

**WE HAVE OVER 140
ACADEMICS ENGAGED
IN ENERGY AND ENERGY
RELATED RESEARCH AND DEVELOPMENT**

ENERGY IN THE REGION

THE CITY OF BIRMINGHAM HAS AMBITIOUS PLANS TO DELIVER EMISSION REDUCTIONS, CREATE A LOW-CARBON INFRASTRUCTURE AND TO MODERNISE HOW IT DEALS WITH WASTE.

These priorities are captured in the Carbon Roadmap, produced by the city's Green Commission, which, in line with the CO2 Emissions Target & Carbon Budgets, sets out to reduce total CO2 emissions by 60% by 2027 from 1990 levels. We are working with city partners to reconsider how Birmingham should be powered and heated in the future, as well as how we travel and create decarbonised local energy generation capacity.

5,000 PEOPLE

ARE EMPLOYED IN TYSELEY.

THE SITE IS CONNECTED TO THE CITY VIA A RAIL, ROAD AND CANAL NETWORK AND HAS BECOME THE FOCUS FOR TRANSFORMING HOW THE CITY OF BIRMINGHAM COULD DO INTEGRATED ENERGY SYSTEMS MORE EFFECTIVELY, LEADING THE UK – AN ENERGY CAPITAL.

**MAKING
BIRMINGHAM
GREENER**

ENERGY CAPITAL

The aim is to work with Birmingham City Council and other stakeholders to transform Birmingham into a beacon of best practice associated with its energy, waste and transport infrastructure. This involves exploiting the expertise within the BEI, coupled with the deployment of new technologies being developed both within the University and in collaboration with our partners to create a large scale demonstrator. This will attract international companies to the region and catalyse the skills development required to underpin the transformation that is required.

Translating our research into action as part of the Energy Research Accelerator (ERA), with the Birmingham City Council and the Energy Systems Catapult, this project sees Tyseley Environmental Enterprise District become the principal location of Birmingham City Council's CO2 emissions reduction plan. The BEI will be establishing in this environment a thermo catalytic reforming (TCR) technology to transform organic waste into biofuels. The aim will be to establish Tyseley as the location for new technology demonstration.

ENERGY SYSTEMS CATAPULT

In Birmingham, the Energy Systems Catapult is right at the heart of a vibrant energy hub that will bring researchers and businesses together – a key component of bringing new and innovative ideas to market. This puts the Energy Systems Catapult in a strong starting position to exploit the commercial opportunities for new technology-based products that address the needs for sustainable, affordable and secure energy – growing the UK energy sector, generating economic growth and creating jobs. The Birmingham Energy Institute is working closely with the Energy Systems Catapult to maximise collaboration and impact.

CATAPULT
Energy Systems



ENERGY RESEARCH ACCELERATOR (ERA)

AS PART OF THE MIDLANDS INNOVATION GROUP OF HIGHER EDUCATION INSTITUTIONS, ERA AIMS TO FOSTER RESEARCH AND DEVELOP NEW TECHNOLOGIES TO SHAPE THE UK'S ENERGY LANDSCAPE OVER THE NEXT 40 YEARS.

The Government has confirmed a £60m capital investment in the Energy Research Accelerator (ERA). Together with private sector and university support, the decision unlocks £180m total investment in the Midlands region. ERA will tackle some of the biggest challenges facing the global economy by transforming research and development in three critical areas of energy: thermal, integrated systems and geo-energy. The core objectives of ERA are to make better use of primary resources, bring about smarter energy systems, reduce our dependence on importing energy, enhance energy security and resilience, and help achieve the UK's carbon reduction targets.

Find out more: www.era.ac.uk

INTERNATIONAL THERMAL ENERGY MANUFACTURING RESEARCH ACCELERATOR (ITEMA)

In partnership with Loughborough University we are working with the Manufacturing Technology Centre (MTC) to develop ITEMA; co-funded by Government, industry and universities. Leveraging Industry 4.0 and other novel manufacturing approaches, ITEMA will scale up and modularise the production of technologies that will improve the efficiency of thermal energy systems. The aim is to revolutionise the manufacturing of energy technologies.

THERMAL ENERGY RESEARCH ACCELERATOR (T-ERA)

The Thermal Energy Research Accelerator (T-ERA) is one of three work streams that form the Energy Research Accelerator (ERA). Led by the University of Birmingham, T-ERA is driving the development and integration of a range of thermal and cryogenic energy technologies and collaborating with industry to convert innovation and emerging technologies into practical solutions with powerful global benefit. It will deliver jobs and apprenticeships, wealth creation and the next generation of scientists and engineers in the energy sector and emerging industries.

The Birmingham Policy Commission 'Doing Cold Smarter' identified the need for a range of more efficient cooling and refrigeration technologies. Our scientists are working on the next generation of materials for energy efficient solid-state cooling.



Innovate UK

FACTORY IN A BOX

Mobile factories, which can be transported in a shipping container, will use next generation Industry 4.0 technology, such as smart sensors, super-fast broadband and big data to measure and control production processes remotely. These are designed to provide manufacturers with missing key components from local suppliers to have a British technology solution delivered to their doorstep, wherever they may be.

INDUSTRY 4.0

Heralded as the 'Fourth Industrial Revolution' Industry 4.0 promises to transform the way we manufacture products; improving productivity and competitive advantage by leveraging digital technologies to create cyber-physical systems and informatics for 'Smart Factories' of the future.

INTERNATIONAL REACH

AT THE BIRMINGHAM ENERGY INSTITUTE WE COLLABORATE WITH LEADING INTERNATIONAL ACADEMIC INSTITUTIONS AND INDUSTRIAL ORGANISATIONS TO PRODUCE GROUND-BREAKING RESEARCH, NEW TECHNOLOGY AND GUIDE POLICY TO HELP SHAPE THE ENERGY SOLUTIONS OF TOMORROW.

To establish closer ties with cutting edge renewable energy technologies in Europe, the University of Birmingham is in the process of developing a 'Joint Research Platform' with Fraunhofer UMSICHT in Germany. Fraunhofer is the largest research organisation in Europe, with over 67 branches worldwide covering a whole range of research and development topics. Phase one of the research platform will focus on delivering new renewable energy systems to the city of Birmingham; one of which is Fraunhofer's new Thermo-Catalytic Reforming technology which converts waste biomass into renewable fuels for transport, heat and power applications. The platform will promote the exchange of research staff and students between the two organisations to encourage knowledge exchange and facilitate with the development of new science. The primary focus is to speed up renewable energy technology routes to market.



**CHINA
INSTITUTE**
中国科学院

THROUGH OUR INVOLVEMENT WITH THE CHINA INSTITUTE AT THE UNIVERSITY, WE HAVE DEVELOPED A SUPPORTIVE NETWORK FOR STUDENTS, ACADEMICS AND COMMERCIAL PARTNERS TO STRENGTHEN STRATEGIC RELATIONSHIPS IN ORDER TO ENHANCE RESEARCH AND KNOWLEDGE TRANSFER.

ENERGY STORAGE RESEARCH LABORATORY

The University of Birmingham and the Global Energy Interconnection Research Institute Europe (GEIRIEU) of State Grid Corporation of China (SGCC) unveiled a new laboratory on Energy Storage Research in 2016. The joint laboratory addresses scientific and technological challenges in thermal and cryogenic energy storage and their integration and application in global energy networks.

EUROPEAN JOINT RESEARCH CENTRE (JRC)

The University signed a collaborative agreement with the European Commission's Joint Research Centre (JRC) in October 2014. The centre acts as a science and knowledge service employing experts to carry out research in order to provide independent scientific advice and support to EU policy.

CENTRE FOR ENERGY AND ENVIRONMENTAL RESEARCH AND EDUCATION (CEERE)

A new joint research centre between Birmingham and the University of Science and Technology Beijing (USTB) launched in October 2016 to drive forward new technologies and train the next generation of engineers. Combining the strengths of the two organisations, we will promote knowledge transfer in the energy and environmental areas and accelerate new technologies out of the laboratory and into market.

For further information about our international collaborations, please contact:

Dr Bing Liu
Head of International Engagement
University of Birmingham
b.liu.2@bham.ac.uk
Find out more: www.birmingham.ac.uk/energy-china

ENERGY RESEARCH AT BIRMINGHAM

OUR RESEARCH IS DRIVEN BY INTERNATIONALLY RECOGNISED DISCIPLINARY CENTRES THAT ARE PUSHING THE BOUNDARIES IN INNOVATION TO ANSWER THE DIFFICULT QUESTIONS.

ENERGY STORAGE

The Birmingham Centre for Energy Storage brings together research expertise from across the University to drive innovation from the laboratory to market. With specialism in materials, thermodynamic processes, application development, smart grid and policy economics the Centre consists of two components: the Birmingham Centre for Cryogenic Energy Storage and the Birmingham Centre for Thermal Energy Storage. We are the first in the UK to have a research facility for energy storage using cryogenic liquids, comprising new laboratories, state of the art equipment, and a major demonstration plant to accelerate research into energy storage technologies.

Find out more: www.birmingham.ac.uk/BCES



STRATEGIC ELEMENTS AND CRITICAL MATERIALS

The Birmingham Centre for Strategic Elements & Critical Materials encompasses expertise from across biosciences, chemical engineering, chemistry, earth and environmental sciences, economics, law, materials science, physics and social sciences.

We are developing new sciences to address the challenges posed by supply constraints on strategic elements and critical materials, developing new recycling processes to enable the recovery of critical materials from end of life products, mining waste and even road dust. We are also pioneering new research into substitutes for scarce materials that are essential to modern energy technologies and electronic devices.

Find out more: www.birmingham.ac.uk/BCSECM

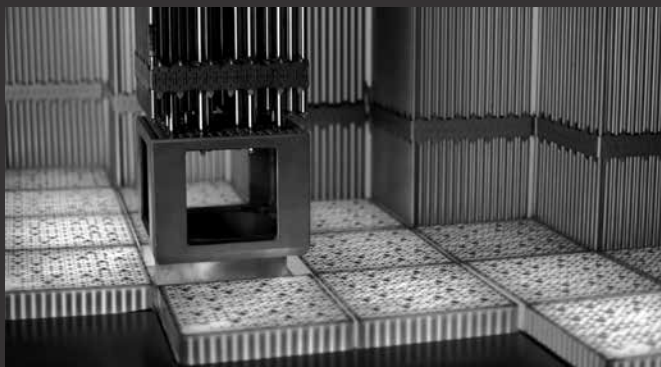


ENVIRONMENTAL AND ENERGY ECONOMICS MANAGEMENT

The Birmingham Centre for Environmental and Energy Economics and Management examines the complex relationship between economic activity and the environment. The Centre complements the University's expertise in energy technologies by providing economic, business and social-science perspective on our global energy challenges.

Key factors in driving change include: innovation; environmental regulation; the global supply chain; international trade and investment; energy efficiency; climate change and natural disasters.

Find out more: www.birmingham.ac.uk/BCEEM



NUCLEAR

The Birmingham Centre for Nuclear Education and Research brings together a multidisciplinary team to tackle fundamental nuclear industry problems.

With significant investment in the area of Nuclear Engineering, Waste Management and Decommissioning we develop solutions for legacy waste, the decommissioning of current power stations and the tremendous challenges in developing the next-generation nuclear facilities. We are well-positioned to support new UK investment in the nuclear power sector and to meet the growing demand for highly skilled graduates. Find out more: www.birmingham.ac.uk/BCNER

ENERGY RESEARCH AT BIRMINGHAM

FUEL CELLS & HYDROGEN

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 DESIGNING FUTURE CITIES, ENERGY SYSTEMS AND TRANSPORTATION.

Our research into Hydrogen as a future energy vector looks at the development of key technologies, from sustainable production and Hydrogen storage to commercial utilisation, as well as the efficient provision of electricity and heat from fuel cells. The Centre opened the UK's first hydrogen vehicle refuelling station on campus in 2008, under the Birmingham Science City Programme; a fleet of hydrogen fuel cell cars is now embedded into University campus operations.

VEHICLE AND ENGINE TECHNOLOGY

The Birmingham Centre for Vehicle and Engine Technology Research has a world-leading research profile in combustion engines and low-carbon vehicle technology. With the number one priority in engine and vehicle development to reduce fuel consumption, we are working closely with UK industry in engine architecture and advanced engine technologies – helping to design the engines and fuels of the future.



RAIL

The Birmingham Centre for Railway Research and Education (BCRRE) is at the forefront of railway science and education; many of the vital requirements contained in the latest UK Rail Technical Strategy are being carried out in our laboratories. Strengths in areas such as conditional monitoring, traffic management, control systems, power and energy, data integration, climate effects, aerodynamics, allow BCRRE to make the vital links between the detail and the big picture. Close relationships with companies in the rail industry mean that research and teaching draws in real-world situations. Find out more: www.birmingham.ac.uk/railways



FURTHER EXPERTISE

SMART GRIDS AND POWER AND ENERGY INTERNET

Smart grid research at the University of Birmingham is focussed on helping deliver the step change in technology required to integrate large and small scale generation, electric vehicles and a variety of energy storage technologies. Our work addresses the fundamental engineering and economic challenges facing electrical power systems, energy systems and future cities.

Birmingham has developed an advanced real-time power grid simulator, which has the powerful capability of 'nano' scale modelling of system components. By investigating the interactions between the simulator, control and protection systems, and products being tested we are able to accelerate new product and system innovation prior to deployment on the grid.

ROBOTICS, VISUALISATION, SENSORS AND CONTROL

Researchers at the Birmingham Centre for Nuclear Education and Research are utilising robotics to manipulate hazardous material, operate robotics in extreme environments, and developing novel low maintenance sensor and analysis systems for extreme environmental monitoring, such as those within a reactor.

The Centre is also leading the largest robotics research project in Europe, aimed at developing the smartest robotic manipulators ever devised for handling dangerous nuclear waste too hazardous for humans. The Robotic Manipulation for Nuclear Sort and Segregation (RoMaNs) project, a €6.4m grant from the European Commission's Horizon2020 programme and an extra €400,000 investment from UK agencies, spans five institutions in three countries, and is coordinated by Birmingham. The project's driver is the vast, challenging job of cleaning up more than half a century of nuclear waste, which in the UK alone – mostly at the Sellafield site – represents the largest environmental remediation problem in the whole of Europe, expected to cost up to £220 billion over the next 100 years.

RESILIENCE AND SUSTAINABILITY

Designing more 'resilient' cities, and trying to tackle the needs of future generations today requires new thinking about energy, water supply, transport, building design and construction at system-level. With engineering solutions comes the challenge of implementation. We are collaborating with the Universities of Newcastle and Leeds to establish the i-build centre, which grow our understanding of new business models to develop our national infrastructure networks, including, energy, water, transport and waste.

ENVIRONMENTAL RESTORATION OF FUKUSHIMA

More than five years after the Fukushima Daiichi nuclear power plant disaster, a massive and assiduous clean-up of the immediate area and wider environment continues. The University of Birmingham is taking the lead in collaborative project Novel restoration materials for clean-up of radionuclides in the environment, funded by the Engineering and Physical Sciences Research Council (EPSRC), to produce novel restoration materials (e.g. magnetic zeolite sorbents, metal phosphate sorbents and fluidised materials) for the clean-up of radioactive contaminated sites.

CYBERSECURITY

Securing future energy networks is of crucial importance to the safety and defence of our strategic national infrastructure. New approaches to energy management, smart buildings, vehicles and grids and demand side management will all result in a greater amount of data about energy usage being exchanged alongside our power networks. Our computer scientists are working on technologies and approaches to ensure that our power systems are robustly secure and energy users' data is held and transferred privately and securely.

BIRMINGHAM HAS A LEADING ROLE IN THE 'LIVEABLE CITIES' PROGRAMME OF RESEARCH

TO DEVELOP A METHOD OF DESIGNING AND ENGINEERING:



**LOW
CARBON**



**RESOURCE
SECURE**



**WELLBEING
MAXIMISED**

LIVEABLE CITIES

INFORMING AND SHAPING POLICY

**THE BIRMINGHAM ENERGY INSTITUTE
DRAWS ON THE BROAD CAPABILITIES
AND EXPERTISE AT THE UNIVERSITY
AND ITS STRONG RELATIONSHIP WITH
COLLABORATORS FROM ACADEMIA AND
INDUSTRY, TO GENERATE NEW THINKING
ON CONTEMPORARY ISSUES OF GLOBAL,
NATIONAL AND CIVIC CONCERN.**

Birmingham Policy Commissions bring together leading figures from the public, private and third sectors, along with Birmingham academics, to generate new thinking on contemporary issues of global, national and civic concern. Among those appointed to the cold commission is Toby Peters, Visiting Professor in Power and Cold Economy at the University of Birmingham.

Summarising the need for the commission, he said: 'As the need for cold across the globe rapidly increases – with rising demand for air conditioning, industrial and medical cooling, refrigerated food storage and transport – a new sustainable approach is required to the way cold is provided. Find out more: www.birmingham.ac.uk/energy-policy



EDUCATION & TRAINING

Technology and policy offer key routes for the delivery of transformational change. However, without the creation of talent and skills the capacity to deliver the change is missing. The Birmingham Energy Institute has developed a range of educational programmes, with a track record of delivering quality graduates to create a talent pipeline. Our programmes are delivered by academics and industrialists to blend theory with practice equipping graduates to transform the energy landscape and create real impact on future societies.

OUR UNDERGRADUATE PROGRAMMES

- BSc / MEng Nuclear Engineering

OUR POSTGRADUATE PROGRAMMES

- MSc Physics and Technology of Nuclear Reactors
- MSc Nuclear Decommissioning and Waste Management
- MSc Railway Systems Engineering and Integration
- MSc Electrical Power Systems (1 year)
Advanced Research (2 years)
- MSc Advanced Mechanical Engineering
- MSc Applied and Petroleum Micropalaeontology
- MSc Energy Technologies and Systems
- LLM Environmental Energy Law

CENTRE OF DOCTORAL TRAINING

- Hydrogen Fuel Cells and their Applications
- Efficient Power from Fossil Energy and
Carbon Capture Technologies
- UK Nuclear Engineering Doctoral Training Centre

THE UNIVERSITY OF BIRMINGHAM HAS MORE THAN
DOCTORAL RESEARCHERS WORKING ALONGSIDE
OUR ACADEMICS. STRONG LINKS WITH ENERGY INDUSTRIES,
OTHER UNIVERSITIES AND DOCTORAL TRAINING CENTRES MEAN
**OUR STUDENTS ARE WELL EQUIPPED FOR
CAREERS IN BOTH ACADEMIA AND INDUSTRY.**

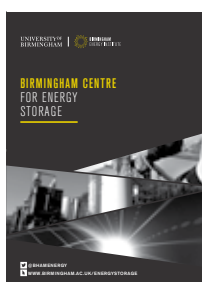
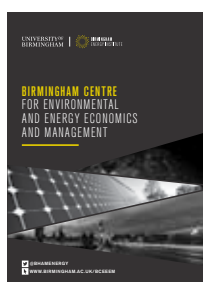
2500

NEARLY 60%

OF MSc PHYSICS AND TECHNOLOGY OF
NUCLEAR REACTOR STUDENTS

**OBTAIN JOBS IN THE
NUCLEAR INDUSTRY
EVEN BEFORE THEY
HAVE COMPLETED
THEIR DEGREE.**

FIND MORE INFORMATION ABOUT OUR RESEARCH CENTRES AND
VIEW ALL OF OUR LATEST LITERATURE AND BROCHURES AT:
WWW.BIRMINGHAM.AC.UK/ENERGY-BROCHURES



JOIN US

We would be delighted to discuss your requirements with you for Research, Consultancy, Education or partnerships through the Birmingham Energy Institute. Our contact details are set out below:

Birmingham Energy Institute
University of Birmingham
Edgbaston B15 2TT
United Kingdom



www.birmingham.ac.uk/energy



energy@contacts.bham.ac.uk



[@bhamenergy](https://twitter.com/bhamenergy)

Read our energy blog:

www.birminghamenergyinstitute.org



UNIVERSITY OF
BIRMINGHAM

Birmingham Energy Institute
Edgbaston, Birmingham,
B15 2TT, United Kingdom
www.birmingham.ac.uk