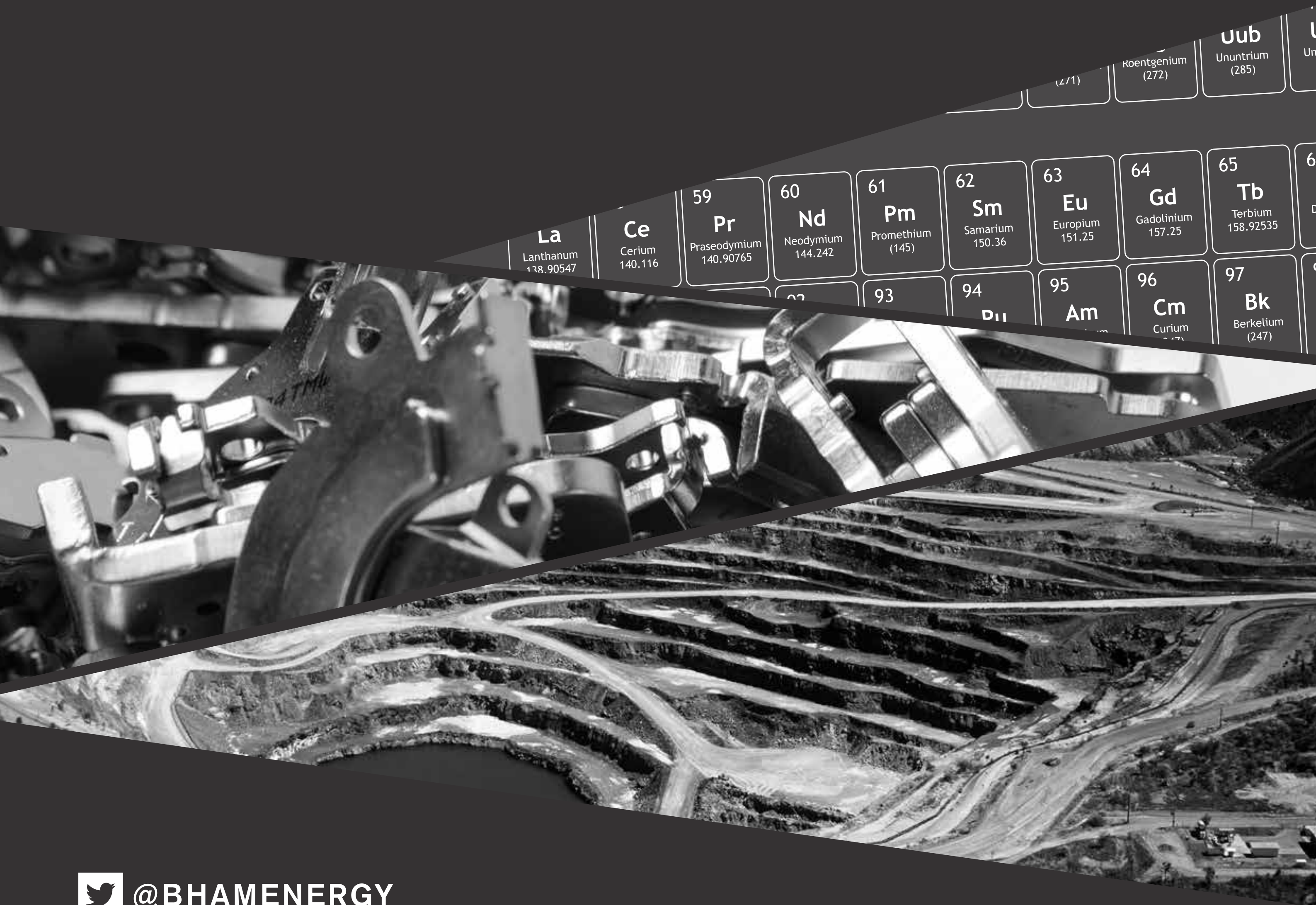
UNIVERSITY OF BIRMINGHAM

BIRMINGHAM ENERGY INSTITUTE

BIRMINGHAM CENTRE FOR STRATEGIC ELEMENTS AND CRITICAL MATERIALS



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BIRMINGHAM CENTRE FOR STRATEGIC ELEMENTS AND CRITICAL MATERIALS

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

The University of Birmingham has significant research activity on strategic elements and critical materials across many science and engineering disciplines.

The supply constraints that cause elements and materials to become critical are often driven by economic or political factors and this naturally draws in other expertise from across campus in Economics, Social Sciences and Law.

'Strategic elements and critical materials play a crucial role in many modern day technologies from electronic components to clean energy applications, such as wind turbines and electric vehicles. The supply of many of these material is often dominated by one or more producers, and some of the elements are scarce, which can put significant pressure on supply. Our scientists are developing sustainable and economically sound solutions to alleviate these supply risks.'

Dr Allan Walton

'Without careful husbandry of these elements in the decades to come, the modern technologies we enjoy and the quality of life they sustain could become impossible to maintain'

Dr Paul Anderson

ABOUT THE BIRMINGHAM ENERGY INSTITUTE

The Birmingham Energy Institute is a focal point for the University and its national and international partners to create change in the way we deliver, consume and think about energy. The Institute 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. More than 140 academics from 4 colleges are engaged in energy and energy related research and development, with over £75 million external research investment. The Birmingham Energy Institute's strength comes not only from the concentration of expertise in specialised centres, but also the breadth of knowledge and facilities that it can draw upon through interdepartmental and interdisciplinary working across the University.

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

£75 MILLION AWARDED FROM EXTERNAL PROJECT FUNDING RELATED TO ENERGY

ENERGY RESEARCH ACCELERATOR (ERA)

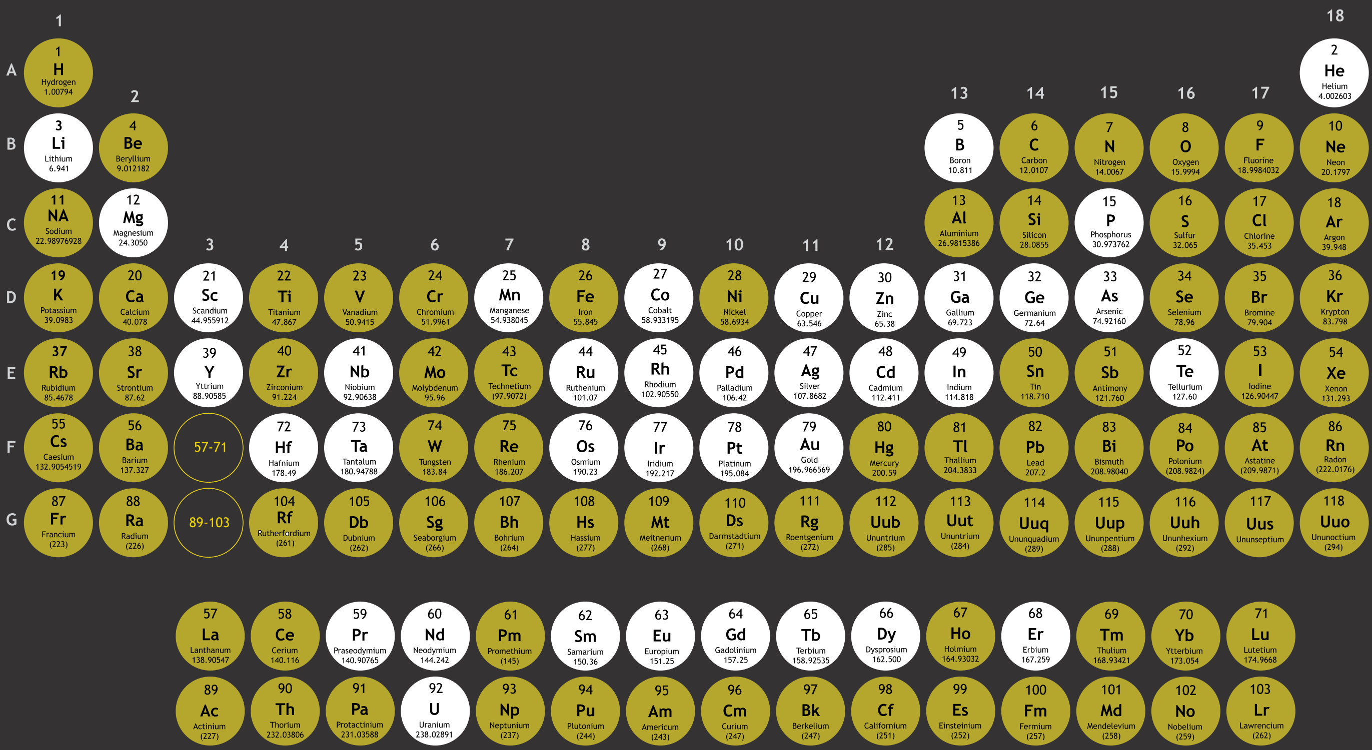
The Government has confirmed a £60 million capital investment in the Energy Research Accelerator (ERA). Together with private sector and university support the decision unlocks £180 million total investment in the Midlands region. The Energy Research Accelerator (ERA) will tackle some of the biggest 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.

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), a capital investment of 60 million by Government to tackle some of the biggest challenges facing the global economy. By transforming research and development in three critical areas: Thermal Energy, Integrated Systems and Geo-Energy, ERA seeks to build on the expertise of six leading Midlands universities*, the British Geological Survey and the regional industrial base to deliver a step-change in energy research and development, securing the UK's leadership position in the sector.

T-ERA is driving the development and integration of a range of thermal and cryo energy technologies, delivering innovation in the sector as well as 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.

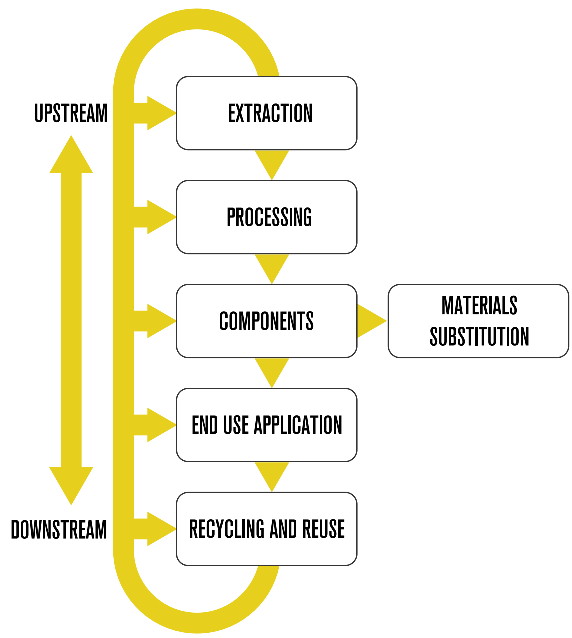
The Birmingham Energy Institute Policy Commission 'Doing Cold Smarter' identified the need for a range of more efficient cooling and refrigeration technologies. Our scientists are working on the next generation of materials for energy efficient solid-state cooling,



OUR SCIENTISTS AT THE UNIVERSITY OF BIRMINGHAM ARE RESEARCHING SUSTAINABLE SOLUTIONS TO THE POTENTIAL RESOURCE CONSTRAINTS THAT MAY BE ENCOUNTERED WITH THESE STRATEGIC ELEMENTS AND CRITICAL MATERIALS.

OVER RECENT YEARS THE WORLD'S SUPPLY OF CERTAIN ELEMENTS (E.G. RARE EARTH AND PLATINUM GROUP METALS) HAS COME UNDER INCREASING PRESSURE FROM SHORT SUPPLY.

These elements are used to create materials that are strategically important for many industrial sectors and have very particular properties that often make them difficult to replace by other less strategic elements. The EU, US and Japan have all created critical materials roadmaps to highlight at-risk elements and materials, which are also of high economic and strategic importance. Supply restrictions for critical elements occur for a number of reasons including: low natural abundance in the earth's crust, deliberate restrictions on supply from one or more dominant producer, low recycling rates, rapid expansion of technologies that use these elements, or the fact that often the processing of materials containing them is environmentally damaging.



Some countries have begun to use their position as a primary producer of strategic elements to dominate the downstream supply chains. Given the huge importance of critical materials to many of the UK's largest industrial sectors, action is urgently required to address these shortages. Strategic and critical elements form an integral part of many high-tech and clean energy technologies. However, critical materials are often only present in relatively small quantities despite playing a huge role in the functionality of the application in which they are embedded. Recycling of these materials is often very challenging due to the small quantities and therefore extremely efficient separation processes are required to remove these materials from the waste streams.

AS THE FIRST UK CENTRE IN STRATEGIC ELEMENTS AND CRITICAL MATERIALS, OUR SCIENTISTS AND RESEARCHERS AT THE BIRMINGHAM ENERGY INSTITUTE, ARE LEADING THE WAY IN WORKING ON THE SOLUTIONS TO THESE CHALLENGES.

MANY TECHNOLOGIES USE MATERIALS WITH SPECIFIC MAGNETIC, CATALYTIC AND LUMINESCENT PROPERTIES. THESE INCLUDE CLEAN ENERGY TECHNOLOGIES, SUCH AS ENERGY-EFFICIENT LIGHTING, ELECTRIC VEHICLES AND SOLAR CELLS, AND BATTERIES FOR CONSUMER ELECTRONICS.

Modern agriculture depends on phosphate fertilizers, whose supply is predicted to become inadequate to meet demand within 30 years. Modern medicine relies on metal catalysts in drug synthesis and pharmaceuticals development, not to mention liquid helium as a coolant for MRI magnets. Modern smartphones and tablets contain over 50 different metals that are essential to their operation. Computer hard drives contain rare earth magnetic materials – we have developed novel methods to recover and recycle this material, hitherto impossible. We are working on the development of new recycling processes to enable the recovery of critical materials from end of life products, mining wastes and even road dust. Simply put, without efficient use, recycling or replacement of these elements, the modern technologies we enjoy, the economic benefits they bring and the quality of life they sustain will be impossible to maintain. Experts within centre are developing new science to allow us to address the global research challenges posed by supply constraints on strategic elements and critical materials.

WE ARE LOOKING AT WAYS TO RE-USE COMPONENTS CONTAINING STRATEGIC AND CRITICAL ELEMENTS, AND DEVELOPING NEW PROCESSING TECHNIQUES TO USE THESE MATERIALS MORE EFFICIENTLY. AN IMPORTANT FOCUS OF THE CENTRE IS ALSO ON THE SUBSTITUTION OF EITHER THE TECHNOLOGY OR THE CRITICAL ELEMENTS CONTAINED WITHIN A WIDE RANGE OF PRODUCTS.

OUR SCIENTISTS ARE WORKING ON DIVERSE CHALLENGES FROM NOVEL METHODS TO RECYCLE THE MAGNETIC MATERIALS IN WIND TURBINES TO EXAMINING HOW TO OVERCOME POTENTIAL PHOSPHORUS SCARCITY IN OUR AGRICULTURAL SYSTEM.

STRATEGIC ELEMENTS AND CRITICAL MATERIALS ARE CRUCIAL TO OUR FUTURE ENERGY SYSTEMS. THEY UNDERPIN MANY OF THE TECHNOLOGIES THAT ARE CRITICAL TO THE FUNCTIONING OF MODERN ENERGY SYSTEMS. AS WE TRANSITION TO CLEANER ALTERNATIVES, THE DEMAND FOR CRITICAL MATERIALS IN ENERGY SYSTEMS WILL ONLY INCREASE.

Direct drive wind turbines eliminate the need for intermediate gearboxes required with induction generators, however, they rely on rare earth magnets in order to generate clean renewable energy efficiently.

66 Dy Dysprosium 162.500

60 Nd Neodymium 144.242

59 Pr Praseodymium 140.90765

Many energy storage technologies such as electric vehicle batteries rely on Lithium which is lightweight and can produce batteries with a high energy storage density.

3 Li Lithium 6.941

Platinum group metals are used in energy conversion devices, such as Fuel Cells, catalytic converters that improve vehicle emissions, and pharmaceuticals manufacture.

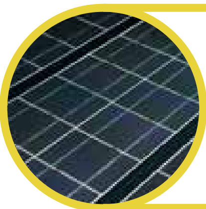
78 Pt Platinum 195.084

77 Ir Iridium 192.217

46 Pd Palladium 106.42

Phosphorus is an essential plant nutrient that underpins our agricultural systems, essential in the production of food and biofuels.

15 P Phosphorus 30.973762



Indium is used in some types of photovoltaic device and also in modern energy efficient display technologies.

49 In Indium 114.818

Efficient LED lighting technologies are reliant on chemicals like Europium, Yttrium and Terbium that are in short supply.

63 Eu Europium 151.25

65 Tb Terbium 158.92535

39 Y Yttrium 88.90585

CONTACT US

To learn more about the detail and impact of our research:

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