



Welcome to the Advanced Resource Efficiency Centre's 2017 Newsletter. The Newsletter contains updates about our new and existing projects, recent publications, and activities.

## AREC'S MISSION

To create a world leading supply chain resource efficiency and sustainability infrastructure addressing critical resource existentiality and challenges using a combination of method, tool, model, technology, process and system.

## RECENT PUBLICATIONS

Structure-integration relationships in Oil and Gas Supply Chains. Ebrahimi, S. et al. *International Journal of Operations & Production Management* (forthcoming 2017).

The environmental impact of fertilizer embodied in a wheat-to-bread supply chain Goucher, L. et al. *Nature Plants* 3 (2017).

Conceptualising A Circular Framework of Supply Chain Resource Sustainability; Koh, S.C.L. et al., *International Journal of Operations & Production Management*, 37, 10, 1520-1540 (2017).

## OVERVIEW

Over the last few years, AREC has contributed to securing >£50 million of grant money from prestigious organisations including but not limited to the Engineering and Physical Sciences Research Council (EPSRC), Leverhulme Trust, Higher Education Funding Council for England (HEFCE), Science and Technology Facilities Council (STFC), European Commission and industry. This Newsletter features a few examples of AREC's current projects. AREC continued to strengthen its strategic partnerships with leaders in industry, academic and government, where highlights of some of these achievements are outlined in this Newsletter. The strategic partnerships and impact range from the World largest tech company Microsoft to the World's leading automotive manufacturer Jaguar Land Rover and the World's well-loved COSTA Coffee, just to name a few.

AREC's releases of its tools building from the SCEnAT suites further advancing the deployment of Cloud platform, big data and business intelligence analytics capability ready for the Internet of Things and Industry 4.0. AREC's academic reputation has enhanced enormously demonstrated through its success in grant capture, and also its collaboration which can be seen from the publications in top ranking and high impact factor journals. AREC's challenge led and cross disciplinary DNA are well embedded into the nature of its research and innovation. AREC has enabled scholars and partners to thrive and has opened door for wider engagement with leading players in the field in the continuous pursuit for excellence and developing new thinkers and transformational leaders of tomorrow.

**Professor Lenny Koh, Director of Advanced Resource Efficiency Centre (AREC)**

### H2020 GOF4R

The University of Sheffield received a grant of 2 million Euros from the European Commission to conduct research as part of GoF4R (Governance



of the interoperability Framework for Rail and Intermodal Mobility) project. The study is funded by the European Commission Horizon 2020 Shift2Rail programme. Prof Toms, Prof Koh and Dr Paragreen are working with colleagues to develop a structure for integrating and sharing data across different transportation operators which serves to enhance seamless – door to door – mobility services. AREC Research fellow for this project is Dr Siemers.

### COSTA/WHITBREAD – PAPER CUPS RECYCLING

**COSTA** COSTA commissioned AREC £100,000 to investigate recyclability and disposal route of paper cups. COSTA decided to launch a pioneering recycling scheme after environmental campaigner and prominent chef Hugh Fearnley-Whittingstall raised awareness about the non-recyclability of paper cups used by coffee chains in his show, Hugh's War on Waste (broadcasted by BBC1). AREC used SCEnAT to map the paper cup recycling chain, undertook a large scale national survey to investigate consumers' attitudes towards recycling; and conducted laboratory testing to conduct fibre breakdown analysis of paper cups. Working with key stakeholders, AREC (Prof Koh, Prof Styring, Dr Solomon, Reed, leaders from COSTA, DS Smith and Anthesis Group), the findings will be announced in public in due course and will contribute towards reducing the waste generated by the 8 million takeaway coffees Britons drink every day.

## LEVERHULME CENTRE FOR CLIMATE CHANGE MITIGATION (LC3M)



The Leverhulme Trust

The University of Sheffield received a prestigious £10 million grant from the Leverhulme Trust to create the Leverhulme Climate Change Mitigation Centre.

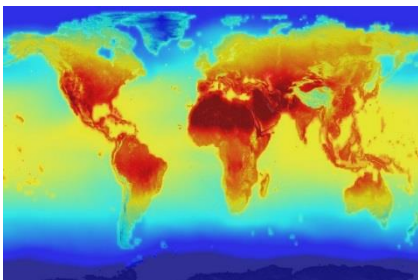
AREC's Director Prof Koh is a Co-Investigator and uses her internationally recognised expertise in supply chain management to contribute to the centre's research theme "Sustainability & Society" (Theme 4) which investigates the sustainability and potential impacts of enhanced rock weathering. Prof Koh and her team use hybrid life cycle assessment which analyses issues related to mining, grinding, transporting and spreading of crushed rocks needed to support enhanced weathering strategies at meaningful scales for carbon capture to enable integrated environmental assessment of the enhanced rock weathering supply chain and uncertainty-perturbation scenario analyses. This helps assess the potential to build a global, sustainable, integrated enhanced rock weathering supply chain framework for analysing and understanding the long-term environmental, social and economic impacts.

*Professor Beerling FRS, Director of the Leverhulme Centre for Climate Change Mitigation at the University of Sheffield, said: "I am delighted that the Leverhulme Trust is providing substantial long-term investment in our pioneering Leverhulme Centre at the University of Sheffield. It couldn't be more timely and represents a huge vote of confidence for the outstanding team of scientists and social scientists involved from Sheffield and elsewhere.*

*"Turning the tide on climate change is a matter of inter-generational justice. Deployable strategies for removing CO<sub>2</sub> from the atmosphere are strongly embedded in climate stabilization policies but don't yet exist. So pinning the future fate of the Earth and 7 billion humans on meaningful emission cuts without fostering research into alternative actions to avert the threat of dangerous climate change is a risky strategy.*

*Professor Koh, a leading expert on low carbon supply chains, said: "Through this Leverhulme Centre for Climate Change Mitigation supply chain sustainability, economics, ethics, risks and social sciences research will be integrated centrally into the earth system science, pure science and applied science on enhanced weathering.*

*"Over the 10 years, it is envisaged that we will identify breakthrough for this 'soft' geo-engineering approach to mitigate climate change sustainably. This will also leave a legacy in social science research which helps addresses human and planet survivability, societal change, global climate change and resource sustainability."*



*Professor Gordon Marshall, Director of the Leverhulme Trust, said: "The new Leverhulme Trust Centres are a major investment in discovery-led research at a time when funding for scholarly inquiry is under great pressure. They are our vote-of-confidence in the quality of the UK's outstanding researchers at every level. Each Centre will embrace multi-disciplinary and international collaborations designed to bring the highest calibre of expertise to bear on these exciting areas of inquiry. We look forward to working with our new award holders over the coming years as they explore these new research agendas."*

## RECENT PUBLICATIONS

Environmental life cycle assessment and techno-economic analysis of triboelectric Nano generators, Ahmed, A.; et al.; *Energy & Environmental Science* 10, 3, 653-671 (2017).

The contemporary landscape of fuel poverty research; Ambrose, A and Marchand, R, *Indoor and Built Environment* (Special Issue), Aug. (2017).

Perovskite solar cells: An integrated hybrid lifecycle assessment and review in comparison with other photovoltaic technologies; Ibn-Mohammed, T. et al. *Renewable and Sustainable Energy Reviews*, 80, 1321-1344 (2017).

Improving retail supply flexibility using buyer-supplier relational capabilities; Obayi, R., et al. *International Journal of Operations & Production Management*; 37, 3, 343-362 (2017).

Sustainable Supply Chain Management and the transition towards a Circular Economy: Evidence and some Applications; Genovese, A.; et al. *Omega*, 66, B, 344-357 (2017).

A hybridised framework combining integrated methods for environmental Life Cycle Assessment and Life Cycle Costing, Miah, J. et al., *Journal of Cleaner Production*, 168, 1, 846-866 (2017).

Integrated hybrid life cycle assessment and supply chain environmental profile evaluations of lead-based (lead zirconate titanate) versus lead-free (potassium sodium niobate) piezoelectric ceramics; Mohammed-Ibn, T. et al. *Energy & Environmental Science*, 9, 11, 3495-3520 (2016).

Integrated resource efficiency: measurement and management", Koh, S.C.L et al. *International Journal of Operations & Production Management*, 36, 11, 1576-160 (2016).

## RECENT PUBLICATIONS

Drivers of U.S. toxicological footprints trajectory 1998–2013; Koh, S.C.L.; et al. *Nature Scientific Reports* 6 (2016).

Retrofitting the Built Environment: An Economic and Environmental Analysis of Energy Systems; Ibn-Mohammed, T. Cambridge Scholars Publishing (2016).

Intelligent Mobility Skills Strategy, *Transport Systems Catapult* (2016).

## PRODUCT NEWS

**Supply Chain Environmental Analysis Tool - Suites**



Customers can now choose among three different Cloud based SCEnAT software products and five service packages to fit their needs. The products are designed with Microsoft technology.



[www.scenat.com](http://www.scenat.com)



## EPSRC SIMULIFE



Through a £1.1 million EPSRC grant as part of the PSi programme, AREC works together with Jaguar Land Rover to investigate the impacts of ageing of materials on performance in the automotive industry. From the Cradle-to-Grave life cycle assessment using SCEnAT, results obtained through each of these steps facilitate understanding of the ageing process and help improve Jaguar Land Rover's performance which contributes to increasing customer satisfaction. This research involves University of Manchester and The University of Sheffield (Prof Soutis, Dr Pinna, Prof Koh, Prof Wagg, Prof Hopkinson, Prof Hodzic, Prof Withers). AREC PDRA for this project is Dr Ebrahimi.

## EPSRC SUBST

Funded by EPSRC (Prof Reaney, Prof Koh, Prof Sinclair, Prof Rainforth, Prof Matthews, Dr Morley, Dr Tennant, Dr Freeman, Dr Dean), this £2.5 million 'Substitution and Sustainability in Functional Materials and Devices' (SubST) grant runs over a five-year period. The research consists of six parallel projects, with more being developed in collaboration with industry partners throughout the course of the funding period. The objective is to identify alternatives to existing Functional Materials and Devices (FMD) which are less harmful to the environment. All projects use multiscale modelling in device design, materials development and understanding physical properties. Supply Chain Environmental Analysis Tool (SCEnAT) is utilized on all projects. SCEnAT is coded based on the state-of-the-art Life Cycle Assessment (LCA) methodology and has been used by leading industry such as TATA, Rolls-Royce and Sheffield Forgemasters International. This research has generated major impact on materials sustainability across Japan, China, Europe and USA. AREC PDRA and PhD researcher for this programme are Dr Ibn-Mohammed and Smith respectively.



A prestigious example worth highlighting: as a result of the LCA research between KNN and PZT (comparing lead-based vs. lead free materials), Georgia Tech collaborated with us on LCA and techno-economic analysis on triboelectric Nano generator. Both of these studies have yielded two high impact outputs published in Energy and Environmental Science (Impact factor 29.518).

## TRAINING FOR ENERGY EFFICIENT OPERATION (TRAINERGY)



With the aim of fostering greater exchange between academia and industry, TrainERGY aims to develop an innovative, evidence-based transnational framework that will markedly improve the knowledge and skills of academic institutions to produce more marked oriented energy efficient operations (EEO) curricula, reducing the barriers in this field. Key academics, small-medium enterprises (SMEs), and industrial association partners from different sectors, work together to identify existing training needs, create a framework for the development of EEO curricular, and produce learning materials for Masters level courses. In addition, led by the University of Sheffield, the team develops an evidence-based Virtual Learning Environment (VLE) based on the SCEnATi where feedback from multiple stakeholders (academics, students, industry) will be evaluated and incorporated into the EEO curriculum in an open innovation and co-creation manner. TrainERGY, which involves Poland, UK, Greece and Italy, is funded by the European Commission ERASMUS+ programme. This team includes Dr Kalinowski, Prof Ketikidis, Dr Solomon, Prof Koh, Dr Genovese, Prof Bruno, Dr Piccolo, and several key representatives from industry and business associations.

## TRANSENERGY - ROAD TO RAIL ENERGY EXCHANGE (R2REE)

**EPSRC**

Engineering and Physical Sciences  
Research Council

Funded by EPSRC, the £1.5 million research project TransEnergy – Road to Rail Energy Exchange (R2REE) focuses on new technology, infrastructure and system to sustainably deliver electrically powered rail transport systems and electric road vehicles (EVs), and extend to the power supply network which supports them. The convergence over coming years of both road and rail transport on electric power with reduced dependence on fossil fuels offers great potential benefits, but also has risks from dependence on a single fuel type and peak demand stress on its underlying supply network. Although fossil fuels have environmental drawbacks they have the advantage of offering inherent energy storage, thereby desynchronising time of energy use from its supply, and smoothing demands on the supply network. This is not the case for electricity use in which there are currently only limited means to smooth and reduce demand.



The proposed research addresses both the technology to store electric energy in a form suited to transport use, and the modelling to understand how to use the technology to reduce overall energy demand. This project focuses on new battery technology for energy exchange between road and rail transport systems, and examines issues surrounding Electric Vehicles (EVs)' composition of the power supply network used to support these systems and the connection to rail and grid, and the associated techno-economic and environment impacts of the technology. Prof Koh leads WP1 in this research to investigate the techno-economic and environmental impact of various battery technology using Life Cycle Assessment (LCA) and Life Cycle Costing methodologies, where SCEnAT+ and SCEnATi are deployed. This project is led by The University of Sheffield in collaboration with Leeds University and Southampton University. The team includes Prof Stone, Prof Foster, Prof Koh, Prof Smith, Prof Harrison, Dr Fletcher, Prof Cruden, Dr Gladwin and Dr Goodwin. AREC PDRA for this project is Dr Miah.

## N8 AGRIFOOD

The N8 AgriFood £16 million research programme funded by HEFCE brings together farmers, the government and leading academics together to tackle the biggest global challenges to provide a sustainable, resilient and healthy food supply for society as a whole. The programme is led by the N8 Research Partnership, which is a collaboration of the eight most research-intensive universities in the north of England: Sheffield, Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle and York. The partnership brings together the greatest concentration of academics engaged in agri-food research in the UK with 370 researchers and £269 million of research funding. AREC is a contributor to this because of its expertise in agri food and supply chain analysis. By integrating understandings of food supply networks from food production and supply through to consumption and nutrition, it is possible to develop practices for the UK's food supply networks that can help address global food security issues. Prof Smith leads this, with a leadership and academic team including Prof Denby, Prof Hartley, Prof Banwart, Prof Firbank, Prof Halford, Prof Reed, Prof Cameron, Prof Jackson, Prof Koh, Prof Oglethorpe, Prof Daniell and a team of research and knowledge exchange fellows (including AREC and Social Sciences N8 Research/KE Fellows Dr Goucher, Dr Reynolds, Dr Langford, Dr Thompson), and supported by Dr Phaff, Research Growth Officer within The University of Sheffield and a team of N8 secretariat and business development team.



## STFC AGRIFOOD NETWORK+



Funded by the Science and Technology Funding Council (STFC) with £363,967, the goal of the STFC Food Network+ (SFN) is to connect various sectors within the area of agri-food to stimulate interdisciplinary research

which is needed in order to develop sustainable, secure supply of safe, nutritious, and affordable high-quality food using less land, with reduced inputs, and in the context of global climate change and declining natural resources. It connects all the leading researchers across disciplines including physics and astronomy, social sciences, plant sciences, data and computer sciences and others to raise awareness about existing challenges and opportunities in agriculture. This STFC funding is led by The University of Manchester, The University of Sheffield, York University, Newcastle University and Liverpool University and led by Prof Bridle, Prof Koh, Prof Flanagan, Prof Reed, Prof Halford, Prof Denby and Prof Grieve. Three champions have recently been appointed by the investigators to coordinate each of the themes: Dr Choudhary (Supply chain), Prof Oliver (Data science) and Dr Reynolds (Consumption).



## EPSRC DARE PROJECT (DESIGNING ALLOYS FOR RESOURCE EFFICIENCY – A MANUFACTURING APPROACH)



The University of Sheffield is directing a large EPSRC-funded research collaboration that investigates resource efficient methods of designing and manufacturing metal alloys. The £3.3 million project is titled Designing Alloys for Resource Efficiency (DARE) and involves AREC member Professor Mark Rainforth, as well as multiple partners from industry and academia.

Society depends on the use of metal alloys in numerous areas of life, including in transport, batteries, orthopaedics, computers, and mobile phones, and many others. However, metal alloys are a finite resource, creating an urgent need for the development of resource efficient alloys. The DARE project works to address this challenge by designing and testing new alloys that are ready for implementation into industry.

The overall aim of the work will be to reduce the reliance on strategic metals and minimise waste in the metals industry. The methods developed within DARE will have a generic applicability to most metal alloys and will therefore impact on a wide range of industrial sectors, including manufacturing, transport, energy, healthcare technologies and defence. Through the design of resource efficient alloys, the DARE project will contribute towards the growth of one of the largest sectors within manufacturing in the UK and Europe, address the transition towards a low carbon society.



Academic partners include Professor Tony Paxton and Professor Mark van Schilfgaarde from Kings College London, Professor Fionn Dunne and Dr David Dye from Imperial College London, and Dr Pedro Eduardo Jose Rivera Diaz del Castillo from the University of Cambridge. Industry partners include Arcelor Mittal Steel, Magnesium Elektron magnesium alloy technology Rolls Royce, SAFRAN, Sheffield Forgemasters, SIEMENS, TATA STEEL and TIMET.

(Left) Louis Brimacombe talked about LCA at a DARE, AREC and SUBST event.

## UK AGRIFOOD VALUE CHAIN RISK ANALYSIS (AVCRA)

Identification and analysis of risks across the value chain is a pre-requisite for developing a resilient and sustainable supply chain of the future. The AVCRA pilot project funded by N8 Agrifood aims to investigate the socio-environmental and geopolitical risk profile of UK agri-food value chains by employing a systems approach. This project is led by Dr Choudhary from Sheffield in partnership with Durham, Newcastle and Leeds, and 6 industrial partners including Co-op Food, Quorn Foods, William Jackson Food Group, WRAP, Anthesis and Barefoot Lighting.



## PROMOTING SUSTAINABLE FREIGHT TRANSPORT IN URBAN CONTEXTS: POLICY AND DECISION-MAKING APPROACHES (PROSFET)



Funded by European Commission H2020 RISE with 283,500 euro, The University of Sheffield coordinates the EU-funded PROSFET which aims to deliver decision support tools to help negotiate conflicting interests that arise in urban logistics management, which includes a large variety of stakeholders. Especially in the area of urban freight transport, it can be difficult to devise strategies that effectively address environmental concerns while reducing freight logistics costs at the same time. In order to better facilitate decisions that address concerns of multiple stakeholders, the project will undertake the following three steps. First, it will conduct a comprehensive review of urban freight transport in Europe, by highlighting best-practices and sharing them across a network of public bodies. Second, it will promote the utilisation of stakeholders' engagement methods in urban freight transport policy formulation and strategic decision making in Europe. Finally, it aims to encourage the use of decision support tools for urban freight transport by public authorities in Europe. It is led by Dr Genovese from the Sheffield based AREC team involving Dr Ballantyne and Dr Sgalambro.



## BLOCKCHAIN AND INTELLIGENT MOBILITY



Funded by Innovate UK Transport Systems Catapult (TSC), AREC is working in partnership with TSC, Computer Science and Transport Innovation Systems Sheffield on Blockchain in Intelligent Mobility. This project is led by Prof Koh, involving Dr Brucker, Dr Le Lerre, Palfreyman, Suresh, Momaya, Carter and Mukherjee, explores the transformational potential of such distributed ledger system (Blockchain) for future enterprises, logistics and supply chains – around the spheres of mobility-as-a-service, autonomous systems, Logistics 4.0 and Industry 4.0. This project builds on the Intelligent Mobility Skills Strategy by TSC, the highlights are summarised below.

- The UK faces a potential skills gap of 742,000 people by 2025.
- ‘Disruptive’ high value digital skills are in short supply.
- Transport industry experts strongly prefer higher degree apprenticeships.
- The potential lost opportunity cost to UK GDP is £50 billion per annum.
- An integrated range of interventions is needed to address the skills shortfall. The industry and research participants agreed that no single intervention will address the shortfall in IM skills.
- Proactive efforts need to be made to attract women to the industry.
- The UK can adopt rapid, novel, low cost international interventions.



## EU-INDIA RESEARCH AND INNOVATION PARTNERSHIP FOR EFFICIENT AND SUSTAINABLE FREIGHT TRANSPORTATION (REINVEST)



Funded by European Commission EuropeAid programme, the REINVEST project aims to foster collaboration between EU and India in the field of freight transportation, working together to make it more efficient, more environmental friendly and financially and socially sustainable. Together with five partners, the University of Sheffield is tasked with the project’s implementation. Objectives include but are not limited to analysing existing freight transport systems in both countries to identify best practices, develop a knowledge framework and a sustainable freight transportation toolkit to assist decision-makers; and increase knowledge sharing through the organisations of seminars and workshops. The Sheffield team includes Dr Ballantyne and Dr Simpson. It involves partners from Loughborough University, IIT Delhi, IIT Bombay, IIT Karagpur, University of Padua and SEERC.

## CIVIL NUCLEAR VALUE CHAIN

The University of Sheffield received a £37.1 million grant from the Regional Growth Fund to support the Nuclear Advanced Manufacturing Research Centre’s large-scale programme of supplier development and manufacturing research in partnership with key industrial members. In this case, the partnership is with Rolls-Royce, which is the lead company for the UK Nuclear Supply Chain. Whilst this programme focuses on the Civil Nuclear new-build industry, but has broad applicability across the nuclear value chain and other industries in the energy sector. In addition, AREC working with Nuclear AMRC analysed the UK civil nuclear supply chain competitiveness and requirement for new nuclear power stations by 2035, and the report has been completed.

Rolls-Royce®



Supported by the  
Regional Growth Fund

## ACTIVITIES

As a world-leading research centre, AREC undertakes a wide range of activities every year, ranging from public engagement to raise awareness about sustainability issues to achieving industry and policy impact. Below are some examples of AREC’s recent engagements.

### AREC WINS AWARD FOR E-WASTE RESEARCH

Prof Koh and colleagues have received the prestigious **Elsevier Atlas Award** for their work on e-waste. The Award recognises scientific research that has an impact on people around the World.

Recycling waste from electrical and electronic equipment (WEEE) more effectively could be worth up to 3.7 billion euros to the European market as well as reducing environmental pollution, an award winning research paper has found. Waste electrical and electronic equipment is currently considered to be one of the fastest growing waste streams in the world, with an estimated growth rate between three and five per cent each year. The project presents a comprehensive framework supporting the decision-making process of multiple electronic recycling centres. The assessment defined the potential revenues coming from the recovery of valuable materials, such as gold and platinum, in 14 electronic waste streams in Europe. It found that recycling electronic waste was equal to 2.15 billion euros in overall potential revenue to the European market in 2014 and could rise to 3.67 billion euros by 2020. As well as providing a significant source of revenue, more effective development of new electronic items and waste set to increase, the research highlights the need for manufacturers and recycling centres to work more closely together in order to recover more material from disposed equipment. It also recommends the development of more flexible recycling plants able to intercept different types of end of life products.



## AREC IN PARTNERSHIP WITH MICROSOFT LAUNCHES SCENAT+ IN MICROSOFT, LONDON



An innovative tool launched by the University of Sheffield in partnership with Microsoft is helping organisations to reduce the environmental impact of their supply chains. In alignment with the United Nations Conference on

Climate Change, the urgent need to reach an international agreement to battle CO2 emissions is unequivocal. Now, public and private sector organisations have the ability to better understand the environmental impact of their supply chain thanks to a new Cloud based tool SCEnAT+ (Supply Chain Environmental Analysis Tool). SCEnAT+ has been implemented in various organisations to help reduce their carbon emissions and pinpoint efficiency improvement opportunities within their supply chains. By running an analysis of a supply chain and presenting a carbon "heat-map", SCEnAT+ provides recommendations for reducing the carbon footprint of the supply chain. The pioneering tool enables companies to perform improved life cycle analysis, better life cycle costing, supply chain benchmarking and evaluation of a plethora of supply chain environmental impact on the ecosystem and wider economy, leading to increased revenues and decreased CO2 emission.



*Professor Lenny Koh, Director of the University of Sheffield's Advanced Resource Efficiency Centre, said: "Microsoft's Futures programme is the ideal platform for us to base the SCEnAT+ on as it will enable its scalability, interoperability and reconfigurability."*

*"We look forward to working with Microsoft on further new developments in the future. Our goal is embedding sustainability conditions in all decision making across supply chains around the world."*

*Mike Davies, Head of Higher Education Business from Microsoft UK, said: "We are pleased to announce this new partnership with the University of Sheffield and its Advanced Resource Efficiency Centre."*

*"The SCEnAT+ has the ability to provide great benefits to organisations in reducing the cost and environmental impact of their supply chains, and it also showcases the abilities of our Cloud services."*

*Dr Kenji Takeda, Solutions Architect and Technical Manager from Microsoft Research, added: "The future of research collaboration will be accelerated via Azure Research and Azure Marketplace which provide a rapid innovation environment supported by Cloud technology. SCEnAT+ technology is based on Azure infrastructure. We are looking forward to our next phase of collaboration with the University of Sheffield."*

## DRIVING FORWARD WITH DBL LOGISTICS, CITY REGION AND PUBLIC-PRIVATE ORGANISATIONS



Some of the world's most well-known companies visited Sheffield to discuss the future of logistics research thanks our partnership with the University of Sheffield.

DBL Logistics have been working closely with the University's Advanced Resource Efficiency Centre (AREC) on the development of an innovative Supply Chain Environmental Analysis Tool (SCEnAT+). The online tool enables companies to map their supply chains and identify CO2 emission reduction opportunities. Following the launch of the tool, DBL Logistics Managing Director David Clarkson, and Professor Lenny Koh of the University of Sheffield's Management School organised an event to discuss the vision of shaping the Sheffield City Region into a world centre for sustainable supply chain logistics research. The event was attended by worldwide organisations such as Microsoft - a strategic partner of the University of Sheffield's Advanced Resource Efficiency Centre - as well as Sheffield City Council, Sheffield City Region Local Enterprise Partnership (LEP), Scarborough Group, Sheffield United, Wurth Research and Shaping Cloud.



*David Clarkson, who is also Sheffield Chamber's Transport Forum representative in the Sheffield City Region Local Enterprise Partnership (LEP) Logistics Group, said: "The event really highlighted the amazing work that is currently being done by the University regarding research and development in the Sheffield City Region."*

*"We're very proud to be a part of this project as we work towards our ambition of becoming a carbon neutral company, which is unheard of in a logistics company."*

*"It's not going to happen overnight, but that's our goal and why we are working with the university. It would be fantastic if our city could lead the way in reducing the supply chain's carbon footprint."*

*Professor Lenny Koh, Director of The University of Sheffield's AREC and also a Co-Chair of the Sheffield City Region Local Enterprise Partnership Sustainability Partnership for Business, Innovation and Skills, said: "Our aim is to play a lead role in creating the sustainable supply chain of the future using the world leading research capability here in both universities in Sheffield in this field."*

*"This is very timely given the recent launch of the Sheffield Green Commitment Report which aims to build a sustainable, smart and competitive future city. I believe productivity and efficiency can be accelerated by exploiting the research and innovation at the universities, working in partnership with industry and government bodies."*

*Martin McKervey, Partner at Nabarro LLP and Private Sector Lead of the Sheffield City Region Local Enterprise Partnership's infrastructure group and the Transport for the North, said: "This ambition is very much aligned with the visions of the Sheffield City Region Local Enterprise Partnership's infrastructure group and the Transport for the North."*

*"Integrating sustainability and its related research and innovation capabilities into our visions will help ascertain that our infrastructure and transport master plan for the UK, in particular the North as part of the Northern Powerhouse project be so much more compelling, especially under the climate from pressure of protecting the natural capital and environment, and of balancing the need to connect and compete in a global stage."*

## AREC TRAVELS TO USA TO FOSTER COLLABORATION



AREC team members (Prof Reaney and Prof Koh) travelled to the United States in order to showcase research and foster international and interdisciplinary collaboration. The team first visited Brown University, an Ivy League institution recognised world-wide for its research excellence; and then continued their

trip to Pennsylvania State University. The team met with various senior Heads of Research Centres and Institutes, and received a very warm welcome, presented their work, and discussed future possibilities for collaboration between the institutions and contributes to raising awareness about excellent work conducted at the University of Sheffield internationally. Dr Ibn-Mohammed (AREC PDRA) was seconded to Pennsylvania State University – Materials Research Institute – to work on life cycle assessment of some novel materials manufacturing processes.

## AREC CALCULATES THE ENVIRONMENTAL IMPACTS OF A LOAF OF BREAD, AND RECEIVES WIDE-SPREAD INTERESTS



AREC researchers calculated the environmental impact of a loaf of bread and quantified which part of its production contributes the most greenhouse gas. Using SCEnAT and its life cycle assessment (LCA) methodology, the group of interdisciplinary researchers from the University's Grantham Centre for Sustainable Futures, including three experts from Sheffield University Management School (SUMS), analysed the complete process from growing and harvesting the wheat; milling the

grain; producing the flour; baking the bread and the production of the final product, ready to be sold by retailers. The study found that ammonium nitrate fertiliser used in wheat cultivation contributes almost half (43%) of the greenhouse gas emissions. With an estimated

12 million loaves sold in the UK every day, these findings have far-reaching implications. The results of the study were published in Nature Plants and were covered by many journalists and broadcasted globally including CNN, BBC, The Conversation, NPR and CNBC, amongst others. The team involves Dr Goucher, Mr Bruce, Prof Cameron, Prof Koh and Prof Horton FRS.



## AREC FORMS PARTNERSHIPS IN CHINA



AREC is establishing an active partnership with leading Chinese research institutions. Team members (Lucy Smith and Mengfeng Gong) presented their research at a conference at Beihang University, one of the top universities in China specialising in aeronautics and astronautics. Lucy won Best paper award from the conference. SCEnAT has been promoted at the conference, and several meetings between Prof Koh and key players in China took place, discussing collaboration and policy & industry impact on resource efficiency and sustainability & life cycle thinking across the supply chain ('Creating the Supply Chain of the Future').



## AREC ON BBC BREAKFAST

AREC Director Prof Koh has made several appearances on BBC Breakfast to share her expertise on reducing negative environmental impacts and securing sustainable energy supply. This actively promotes the impact of our research via public engagement.



## AREC PRESENTS SCENAT SUITES TO EUROPEAN PARLIAMENT



AREC was invited to showcase the Supply Chain Environmental Analysis Tool (SCEnAT) suites to the European Parliament in Brussels. The tool was developed with Microsoft technology and is already used by leading businesses to map their supply chain and identify opportunities to improve environmental sustainability and resource efficiency. SCEnAT suites have created major impact globally.

## MEP JOHN PROCTER VISITS THE UNIVERSITY OF SHEFFIELD

AREC welcomed John Procter, MEP for Yorkshire and the Humber, to the University of Sheffield. As the spokesman for Education and Culture, Mr. Procter has a keen interest in research at the University and was keen to see its facilities and learn more about ongoing projects. The visits included meetings with AREC, AMRC Factory of the Futures, AMRC's Apprenticeship Training Centre and Materials Science and Engineering Department (Prof Hyatt and Prof Reaney).



*Mr Procter said: "I was impressed by the University of Sheffield. It was great to see first-hand the world-leading work produced right here in Yorkshire. The research has great implications for the region, as well as globally. In a world where the global supply chain relies on resources interconnection, it's inspiring to see research which champions an inclusive, integrated approach to resource sustainability and efficiency."*

*Prof Koh continued: "It was my privilege to show Mr Procter leading examples of Sheffield's research. Our cross disciplinary environment, combined with a global outlook, shape our contribution to the region and beyond."*



## PROVIDING THE TOOLS AND TECHNOLOGY TO MOVE THE ECONOMY TOWARDS A SUSTAINABLE, LOW-CARBON FUTURE

OUR DATA ANALYTICS TOOL, BUILT IN PARTNERSHIP WITH ONE OF THE WORLD'S BIGGEST TECHNOLOGY COMPANIES, IS HELPING DECISION MAKERS UNDERSTAND THE FULL ENVIRONMENTAL IMPACT OF THEIR SUPPLY CHAINS AND THE POTENTIAL CONSEQUENCES OF THEIR DECISIONS.



SCEnATi, the improved version of the SCEnAT supply chain environmental analysis tool, now integrates with the Microsoft cloud technology platform, Azure. It outputs on a world map geographic carbon dioxide emissions and environmental impact across global supply chains.

This powerful data visualisation - along with country profiles and sustainability contribution information - helps policy makers, planners, investors and industrialists understand the impact of their supply chains by calculating carbon dioxide emission intensity and environmental impact using life-cycle analysis.

As part of the improvements, SCEnATi has also been enhanced with advanced business intelligence analytics capability from the Microsoft Power BI platform, which works with Shaping Cloud on an Office 365 platform.

*Teresa Hitchcock, Partner at global law firm DLA Piper where SCEnATi was launched, said: "I am delighted to see the evolution of this research capability led by the University of Sheffield, especially the work from Professor Koh and her team. Being an industry member of the AREC committee, we have been involved in the work as part of a co-production process. I believe this tool will*

assist key stakeholders in their transition to a low carbon and sustainable future globally and to support their compliance to environmental regulation and policy."



"This tool will assist key stakeholders in their transition to a low carbon and sustainable future globally and to support their compliance to environmental regulation and policy"

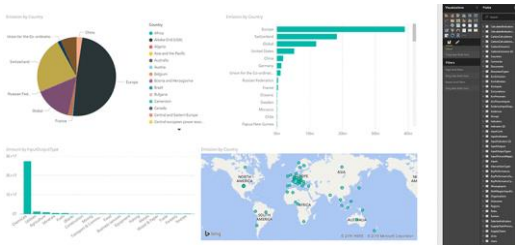
**Teresa Hitchcock, Partner at global law firm DLA Piper"**

Professor Lenny Koh, Chair in Operations Management at Sheffield University Management School and Director of Advanced Resource Efficiency Centre (AREC), said: "The supply chain resource sustainability model demonstrated in SCEnATi is powered by advanced technology and will grow our understanding of global challenges on resources critical in supply chains. The science which underpins SCEnATi has been published in top journals whilst the technology, provided by our strategic partner Microsoft, provides a flexible, secure environment for our users."

Mike Davies, Higher Education Manager from Microsoft, continued: "SCEnATi automates data capture using Microsoft Excel where Office 365 supports complete mobility to enable users to use the tool as part of their routine package."

Steve Beswick, Education Business Development Director from Microsoft, said: "It is compatible with a range of our devices including Surface and Hubs. The built-in touch capability in this tool gives complete flexibility to users to access the tool anytime and anywhere."

Carlos Oliveira, CEO of Shaping Cloud concluded: "The science and technology supporting SCEnATi is world leading. It is a great example of how academic research can be translated into a tangible piece of IP, which we believe can deliver real change and impact worldwide."



(Left) The SCEnATi environmental analysis tool outputs on a world map geographic carbon dioxide emissions and environmental impact across global supply chains

## AREC AND AMRC MEET WITH UNIPART



Unipart visited the University of Sheffield in order to explore opportunities for future collaboration. Unipart is interested in developing its logistics program, with a focus around connected supply chains, and was therefore eager to hear AREC's perspective. Unipart representatives were also keen to learn about the School of Management educational programmes, such as the MSc in Logistics and Supply Chain Management, where students benefit from active partnerships with important industry leaders. Unipart and AREC

then visited the Factory 2050 to observe the cutting edge manufacturing innovation at the AMRC.



Advanced Manufacturing Research Centre



## MCLAREN AUTOMOTIVE TO BUILD NEW MANUFACTURING FACILITY IN SHEFFIELD THANKS TO PARTNERSHIP WITH UNIVERSITY OF SHEFFIELD



A pioneering partnership between the luxury sports car producer McLaren Automotive and the University of Sheffield's Advanced Manufacturing Research Centre (AMRC) has led to the development of a significant new manufacturing

facility – bringing a £100 million boost to the economy. The creation of the Composites Technology Centre is a result of the pioneering partnership between McLaren and the University of Sheffield's AMRC. The new facility is projected to create 200 new jobs and will be based in the UK's first Advanced Manufacturing Innovation District. Its purpose is to develop and manufacture advanced carbon fibre chassis for McLaren Automotive's supercars. As part of the partnership, the University of Sheffield's AMRC Training Centre will also immediately start training McLaren apprentices who will work in the new facility.



## BOEING OPENS FIRST FACILITY IN EUROPE IN SHEFFIELD



Boeing began construction on its first European production facility alongside the University of Sheffield's Factory 2050 at its Advanced Manufacturing Research Centre (AMRC). Boeing selected Sheffield based on its longstanding partnership with the AMRC and because of its partnership opportunities, skilled workforce and investment in research, training and development.

## UNIVERSITY OF SHEFFIELD WELCOMES MICROSOFT

Microsoft senior representatives visited the University of Sheffield. They met with the President & Vice Chancellor Prof Sir Keith Burnett. They were further welcomed by key representatives from the University of Sheffield, which included, among others, AREC Director Prof Koh, Executive Director of the AMRC Group Prof Ridgway, Vice President for Learning and Teaching Prof Morgan, Head of Strategic Projects Ruth Arnold, Dean of Sheffield University Management School (SUMS) Prof Oglethorpe, SUMS Associate Dean of Special Projects Yvonne Beach, and other senior colleagues. As part of their visit, Microsoft toured facilities at the AMRC, including the Factory 2050 and the Apprenticeship Training Centre. The strong partnership with Microsoft has blossomed to strategic institutional level covering research and innovation, learning and teaching, training for future young people, and the role of cutting edge digital technology for enhancing our vision and mission.



## RESEARCH AWAY DAY

Together with the Logistics and Supply Chain Management (LSCM) Research Centre and the Centre for Energy, Environment and Sustainability (CEES), AREC organised a *Research Away Day* in March 2017. The day featured an exploration of themes, sectors, technologies/tools and methodologies in the areas of agrifood, advanced materials and manufacturing, energy and nuclear, water, transport and logistics, climate change, information science, sustainability science and decision science. The day also included informative presentations by The University of Sheffield's Advanced Manufacturing Research Centre (AMRC)'s Chief Technology Officer (CTO) Prof Dawson and Research & Innovation (R&IS)'s cross-disciplinary research manager Dr Knight. The discussions yielded a set of key actions including: 1) the formation of a Task and Finish Group (TFG) to help explore and develop the *hub of excellence idea* with a focus on Life-Cycle-Analysis (LCA) modelling, infrastructure technology and manufacturing supply chain; 2) cross-disciplinary funding applications to involve members of all centres; 3) advancing strategic partnerships and collaboration with key stakeholders; and 4) prioritizing greater connectivity between low and high Technology Readiness Level (TRL) research.



## AREC WORKS WITH UVAID LTD. TO ADDRESS LACK OF ACCESS TO MEDICATIONS IN REMOTE AREAS THROUGH USE OF UNMANNED AIRBORNE VEHICLES (UAVS)

The University of Sheffield and UVAid Ltd have agreed a research collaboration to explore the use of Unmanned Airborne Vehicle (UAV) drone technology to improve humanitarian logistics. With over 1 billion people living in communities without regular access to essential medicines, the human cost of poor infrastructure and inadequate delivery logistics is felt throughout the underdeveloped world. The lack of a reliable delivery mechanism results in limited access to emergency medicines, such as anti-venom, and routine pharmaceuticals such as vaccines. The University of Sheffield, through the Advanced Resource Efficiency Centre (AREC), will assume the lead academic role in the 'Last 100mile Research Group' (LCmRG), which was founded by UVAid co-founder, Daniel Ronen, to drive research in the area of humanitarian logistics. The membership of the group already includes leading academics and experts from across the world in disciplines including logistics, supply chain management, UAV robotics, healthcare and humanitarian action. Together, they aim to utilise the latest advances in UK this technology to solve the supply chain problems caused by poor 'last mile' medical deliveries to remote and difficult to reach areas. In doing so, they hope to improve the health of millions of people and create efficiency savings for governments and aid organisations.



(Left) AREC Drones in humanitarian action meeting in Sheffield.

## AREC TEAM MEMBERS AND MANAGEMENT STRUCTURE

AREC has a well-established management structure that facilitates its continuing growth and success. The centre is led by Professor Lenny Koh from School of Management. In addition, the centre's work is structured around four core research themes which are directed by experts from different departments from the University of Sheffield. This includes:

<b>Academics</b>	
<b>Name</b>	<b>Position</b>
Professor Lenny Koh	Director of AREC
Professor Panos Ketikidis	Co-Director of AREC, Europe
Dr Erica Ballantyne	Lecturer in Operations and Supply Chain Management
Dr Andrew Brint	Lecturer in Operations Management
Richard Bruce	Business Engagement Lead for the Grantham Centre for Sustainable Futures and Lecturer in Supply Chain Accounting & Finance
Dr Chantal C Cantarelli	Lecturer in Operations Management
Dr Sonal Choudhary	Lecturer in Sustainable Management
Professor Federica Cucchiella	University of L'Aquila
Dr Andrea Genovese	Senior Lecturer in Logistics and Supply Chain Management
Professor Jonathan Linton	Operations Management and Decision Sciences
Dr Stuart Maguire	Lecturer in Information Systems Management
Dr Robert Marchand	Lecturer in Operations Management
Professor David Oglethorpe	Dean, Sheffield University Management School
Professor Ian Reaney	Professor in Ceramics
Dr Antonino Sgalambro	Lecturer in Operations Research
Professor Ian Shellard	Rolls-Royce appointed Honorary Visiting Professor
Professor Andrew Simpson	Associate Dean External Business Advancement, Sheffield University Management School
Dr Mike Simpson	Senior Lecturer in Business Management
Professor Elaine Toms	Chair in Information Innovation and Management
<b>Advanced Materials &amp; Manufacturing Leads</b>	
Professor Mark Rainforth	Professor of Materials Science and Engineering, Director of Mercury Centre and Royce Institute Lead
Professor Neil Hopkins/Dr Christophe Pinna	Professor of Mechanical Engineering/Senior Lecturer in Mechanical Engineering
Professor Derek Sinclair	Professor in Materials Science and Engineering
Dr Sam Turner/Dr Stuart Dawson	Chief Technology Officer of AMRC
<b>Energy &amp; Nuclear Leads</b>	
Professor Peter Styring	Director of UK CDU, Dept of Chemistry
Professor Neil Hyatt	Professor of Nuclear Materials
Professor Mike Tynan/Dr Andrew Storer	Chief Executive of Nuclear AMRC



**Water Lead**

Professor Simon Tait	Professor of Water Engineering
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**Agritech & Food Leads**

Professor Jurriaan Ton	Professor & ERC research fellow - Department of Animal & Plant Sciences
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Professor Peter Jackson	Chair of the Food Standards Agency's (FSA) Social Science Research Committee, Geography
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Professor Duncan Cameron	Professor of Plant and Soil Biology, Royal Society University Research Fellow
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**Post-Doctoral Research Associates (PDRAs), Research and KE Fellows and PhD researchers**

Faisal H Abubakar	EPSRC e-futures DTC Doctoral Researcher (AREC researcher – energy, LCA and circular economy – supervised by Prof Lenny Koh and Dr Andrea Genovese)
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Deepak Arunachalam	AREC Doctoral Researcher (AREC researcher – big data – supervised by Prof Elaine Toms)
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Dolores Astudillo	EPSRC Energy Storage Doctoral Researcher (AREC researcher – energy storage and LCA – supervised by Prof Peter Hall and Prof Lenny Koh)
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Andreas Bofinger	SEERC Doctoral Researcher (AREC researcher – green manufacturing – supervised by Prof John Cullen, Prof Lenny Koh and Prof Panos Ketikidis)
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Dr Francesco Ciardiello	Research Associate (AREC PDRA – operational research – supervised by Prof Andrew Simpson)
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Dr Seyed Ebrahimi	EPSRC JLR Simulife Research Associate (AREC PDRA – LCA and resource efficiency – supervised by Prof Lenny Koh, Dr Christophe Pinna, Prof David Wagg, Prof Constantinos Soutis and JLR)
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Mengfeng Gong	Supply Chain Doctoral Researcher (AREC researcher – sustainable supply chain – supervised by Prof Lenny Koh and Prof Andrew Simpson)
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Dr Liam Goucher	N8 KE Fellow (AREC research and KE fellow – agrifood LCA – supervised by Prof Lenny Koh, Prof Peter Horton and Prof Duncan Cameron)
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Besart Hajrizi	SEERC Doctoral Researcher (AREC researcher – innovation model – supervised by Prof Panos Ketikidis and Prof Lenny Koh)
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Dr Taofeeq Ibn-Mohammed	Research Associate - ESPRC - Management School (AREC PDRA – materials LCA – supervised by Prof Lenny Koh, Prof Ian Reaney and Prof Derek Sinclair)
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Benjamin Lowe	Doctoral Researcher (AREC researcher – water sustainability – supervised by Prof David Oglethorpe and Dr Sonal Choudhary)
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Stella Manoli	Mechanical Engineering Doctoral Researcher (AREC researcher – composite materials LCA – supervised by Prof Patrick Fairclough, Dr Chis Holland and Prof Lenny Koh)
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Mauro Cruz Mercado	Food Doctoral Researcher (AREC researcher – food sustainability – supervised by Prof Peter Jackson)
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Dr Jamal Miah	EPSRC R2REE Research Associate (AREC PDRA – road-to-rail energy storage LCA – supervised by Prof Lenny Koh and Prof David Stone)
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Kamal Miah	EPSRC Materials DTC Doctoral Researcher (AREC researcher – manufacturing and sintering materials LCA – supervised by Dr Richard Thackeray and Prof Lenny Koh)
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Ashish Momaya	Doctoral Researcher (AREC researcher – blockchain technology – supervised by Prof Lenny Koh and Prof Jonathan Linton)
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Dr Jonathan Morris	Research Associate (AREC PDRA – water sustainability – supervised by Dr Tina McGuinness)
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Dr Raymond Obayi	AREC Researcher (AREC PDRA – resource efficiency and knowledge management – supervised by Prof Lenny Koh and Prof David Oglethorpe)
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Eunice Oppon	Leverhulme Trust LC3M and Grantham Centre for Sustainable Futures Scholar (AREC researcher – climate change LCA – supervised by Professor Lenny Koh and Prof David Beerling)
Dr Olga Siemers	Research Fellow, EU H2020 GOF4R (AREC research fellow – transport infrastructure policy – supervised by Prof Lenny Koh, Prof Elaine Toms and Dr Jonathan Paragreen)
Dr Victor Shi	AMRC Postdoctoral Researcher (AREC PDRA – servitisation – supervised by Prof Keith Ridgway)
Lucy Smith	Materials Doctoral Researcher (AREC researcher – materials LCA and indicators – supervised by Prof Ian Reaney, Prof Lenny Koh, Dr Taofeeq Ibn-Mohammed and Prof Mark Rainforth)
Karthik Suresh	Research Assistant - Management School (AREC researcher – risk modelling – supervised by Prof Lenny Koh)
Hui Sun (Avril)	ESRC WR CDT Doctoral Researcher (AREC researcher – food supply chain sustainability – supervised by Prof Lenny Koh and Dr Sonal Choudhary)
Andrew Timmis	Post Doctoral Research Assistant (AREC researcher – materials composite LCA – supervised by Prof Lenny Koh and Prof Alma Hodzic)
Dr Abiye Tob-Ogu	Postdoctoral Research Associate (AREC PDRA – sustainable transportation – supervised by Dr Andrea Genovese and Dr Erica Ballantyne)
Dr Adrian Solomon	AREC PDRA – paper cup recycling – supervised by Prof Lenny Koh and Prof Peter Styring)
Richard Bruce	AREC researcher – open book accounting in food supply chain – supervised by Prof John Cullen and Prof Lenny Koh
Dr Rafael Mauricio Eufressio Espinosa	AREC PDRA – Leverhulme Climate Change mitigation LCA – supervised by Prof Lenny Koh and Prof David Beerling
<b>Business Development and Partnership</b>	
Dr Mel Knight	Challenge Driven Support Manager – Research Services
Peter Caven	Challenge Driven Support Officer – Research Services
Jennifer Phaff	Challenge Driven Support Officer – Research Services
Dr Neil Lowrie	Business Development Manager
Dr Richard France	Senior Business Development Manager
Charles Wilby	Business Development Manager
Chris Baker	Partnership Manager
Lee Allman	Research Manager (AMRC/Engineering)
Dr Adrian Solomon	AREC Project Manager
Michaela Bruckmayer	AREC Support Officer


## AREC COLLABORATIVE STEERING GROUP (CSG) BOARD MEMBERS AND PARTNERS

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AREC Thanks All Collaborative Steering Group (CSG) Board Members and Partners for their Support, Contribution, Partnership and Sponsorship

### Civic and regional roles



By the Sheffield Green Commission



Sustainability Partnership

### National roles



By the Cold Commission



**PGES**  
All-Party Parliamentary Group  
for Energy Studies



### European role



### International role

