The University Of Sheffield.

AREC
Creating the Supply Chain of the Future.

Welcome to the Advanced Resource Efficiency Centre's 2018 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.
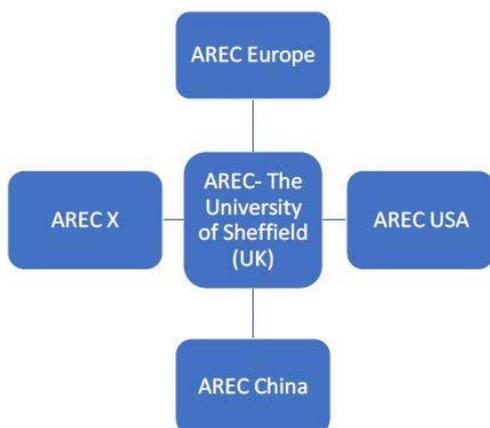
OVERVIEW

Over the last few years, AREC has contributed to securing significant 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 highlights some of the AREC's recent activities. 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.

The AREC 2018 Newsletter 2018 has a specific focus on AREC Global. AREC has expanded its focus globally to address global challenges in resource sustainability. Adding to its existing spoke in Europe, a spoke in China has been established in Beijing and a spoke in the USA through links with Penn State University.

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

AREC GLOBAL

AREC is expanding its operations from its hub in Sheffield UK, to other regions across the globe including Europe, China, and the United States.
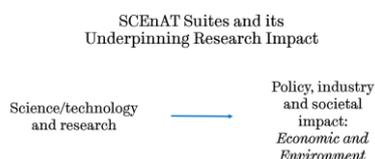
AREC's team includes highly-esteemed academics from a wide variety of disciplines and backgrounds, including but not limited to management studies, engineering, material science, chemistry, energy, environmental science and economics, architecture, geography, and many others. AREC's research agenda is shaped by its Collaborative Steering Group. This group is represented by stakeholders from all sectors, including executives from leading industry, business owners, industry associations and policy makers. AREC also actively fosters engagement with policy-makers on the national and international levels. This approach enables AREC to fully understand the specific challenges each sector and region face in supply chain resource sustainability.

Accordingly, AREC operates a research agenda that is informed by real-world problems.

www.sheffield.ac.uk/arec

Suites and Platforms

One of AREC's key strategic industrial partners is Microsoft. AREC has a strong partnership with Microsoft in the development of the SCEnAT Suites Cloud Platform and the partnership will be advanced further to embrace the most cutting edge digital technologies to transform supply chains and society towards resource efficiency and sustainability.

SCEnAT Suites and its
Underpinning Research Impact

Science/technology
and research

Policy, industry
and societal
impact:
*Economic and
Environment*

SCEnAT*AR*

AREC is gamifying SCEnAT Suites Cloud Platforms. This work is funded by EPSRC SubST and DARE. An alpha version of SCEnAT*AR* is available. The release of the complete version will be done soon. SCEnAT*AR* integrates Augmented Reality (AR) into SCEnAT Suites Cloud platforms making the life cycle educational experience fun, exciting and engaging.

SCEnAT*AR* was launched at the Materials Exchange Conference in London. Feedback from users were used to refine the educational game, and the full alpha version was launched and played at the Beer Festival in Sheffield. AREC is working on further fine tuning and introducing new features into SCEnAT*AR* towards a complete version of the game.

SCEnAT 4.0

Industry 4.0 and Revolution

Industry 4.0 has been presented as the latest industrial revolution. It has a major role in transforming the World's industrial processes within organisations and across the supply chains.

This can be achieved using large-scale Machine to Machine (M2M) and Internet of Things (IoT) deployments to increase efficiency and productivity in supply chains across sectors. Factories will become increasingly autonomous with closer integration between machines and workforce, providing a seamless process with minimal waste. Industry 4.0 will use the IoT and cyber-physical systems such as sensors to collect data. Such advances enable big data analytics and the creation of intelligent supply chains.

In the recent Build 2018 Conference, Microsoft has set their vision and priority in the role of future technology, their advancements, new tools and Cloud services to help developers create a better, safer, more just World. Artificial Intelligence (AI) is at the heart of these advances, which brings together societal need, Intelligent Cloud and Intelligent Edge. In the next 10 years, billions of everyday devices will be connected — smart devices that can see, listen, reason, predict and more.

Policy Implications

The UK 'Made Smarter' review has identified key requirements to support the digitalisation of manufacturing as shown below:
•   the increased pace of adoption of industrial digital technologies,
•   the faster innovation of these technologies,
•   the need for stronger and more ambitious leadership to transform UK industry.

Industrial Digitalisation Technologies (IDTs) are key to both improving prosperity and reducing the environmental impact of industry. IDTs can improve the resource efficiency of industrial processes. IDTs can perform a crucial role in developing a resilient UK industrial base that can ride out disruptions in resource availability, as well as making the UK industrial system more sustainable over the long-term.

www.scenat.com

China have developed a policy known as "Made in China 2025" to boost high value manufacturing in their supply chain. This spans across targeting strategic materials innovation, digitalisation, energy and transport revolution (such as electrification) and so on. Such policy links with major development of science and innovation park across China, driving closer collaboration between knowledge providers such as universities and research centres with industry. AREC China with DRTT (based in the Science Park in Beijing) was established. This provides a strong foundation to enable co-development of new advances that make huge impact in China industry and globally, and Made in China 2025 and Made Smarter policy.

SCEnAT 4.0 for Industry 4.0

By eliminating inefficiencies across the supply chain, supply chain productivity will be improved. To achieve this, intelligent data management will play a critical role. New digital technologies are enabling new levels of increased connectivity and the more effective use of data. Advances in technology are enabling more data to be collected more quickly and this data can be easily accessed from multiple sites, safely shared between different partners in a supply chain, and more effectively analysed.

These technologies allow manufacturers to respond to increasing consumer demands for faster delivery and more personalised products and services. A transition in the way that supply chains operate from the current linear supply chains (with limited use of data and new technologies) to a digitally connected supply chain network supported by these technologies.

UK leaving the EU (Brexit) will open doors to international collaboration and trade deals opportunities. Such an environment requires integrated intelligent supply chain and future network and system capable of seamless transactions and management of flow of assets, goods and services (tangible and intangible).

Based on the policies mentioned above and industrial need, SCEnAT 4.0 for Industry 4.0 which embrace Blockchain, Artificial Intelligence (AI) and Machine Learning (ML) solution will transform future supply chain to a digitally connected system and network. SCEnAT 4.0 Design Thinking workshop in the autumn working with industry leaders and key partners will consider Blockchain, AI and ML integration into SCEnAT 4.0 Azure Cloud Platform. Microsoft Research and AREC are working in partnership on this with input from IBM's Blockchain.

AREC UK

Leverhulme Trust Climate Change Mitigation (LC3M)

The 2018 annual meeting of LC3M will be held in Sheffield in October. Speakers and chairs have been lined up finding ways to solve food security and climate change challenges using enhanced rock weathering. Social Science (Theme 4) leads the sustainability research in LC3M. AREC uses its strong capability in supply chain LCA, GIS and spatial-temporal analyses in this research including the SCEnAT suites cloud platforms.

Sustainable Agri-food Cold Supply Chain International Workshop in India

A workshop entitled "Sustainable Agri-food Cold Supply Chain in India" was held in June, run by Dr Sonal Choudhary. Sheffield University Management School, Hull University Business School and STFC organised the event in Delhi. This was jointly funded by STFC Food Network+ and SheFF (The University of Sheffield Sustainable Food Futures). The event was also run through Facebook and brought together academics, farmers, key industry players and policy makers to identify challenges in the agri-food sector and to formulate future strategies to mitigate them. With the aim of optimising the cold supply chains through use of cryogenics from STFC facilities and other emerging technologies which can help to reduce losses / waste across the supply chain and maximise value for all stakeholders, presentations were given by key players in the supply chain and technology providers.

The workshop concluded with a valedictory talk from Nit Aayog from the Planning Commission of India.

Blockchain disruption in transport

Blockchain could provide the underpinnings for a future integrated transport system, without the need for large and costly centralised control mechanisms, according to a new paper from the University of Sheffield and the Transport Systems Catapult (TSC).

The TSC is calling for government and industry to explore the technology's potential uses in transport to ensure the UK stays ahead of latest developments.

Blockchain is a Distributed Ledger Technology, which is a special type of distributed database. Each computer 'node' or member in a network stores an identical 'ledger' or database. This database takes the form of a chronological chain of unique groups of information called 'blocks' which are securely linked together using cryptography.

The University of Sheffield and TSC report found that, whilst currently the technology is still some years from full maturity, synergies exist in areas like freight and logistics, autonomous vehicles and mobility as a service, where the technology could be applied in the future.

This is because these areas will involve multiple businesses with potentially competing interests, who require trust and transparency to share data and work together seamlessly – which plays to the strengths of Blockchain.

In one example, the report highlights that the decentralised nature of Blockchain could provide an alternative future for mobility as a service business model, where transport is supplied on demand to subscription customers.

Blockchain could help avoid the situation where centralised platforms come to control service provision and data leading to minimal competition. Instead it could facilitate a decentralised network of transport operators by providing built-in trust, consensus and immutability in data and information sharing. Passengers could also have greater control over their personal data.

The report also suggests that Blockchain could also help integrate autonomous drone fleets into the existing transport network, without the need to establish large regulatory organisations to track and monitor use and licensing.

Professor Lenny Koh, Director of Advanced Resource Efficiency Centre (AREC), at the University of Sheffield's Management School, added: "Our transport systems and their wider networks and supply chains are increasingly digitalised. The traditional ways of managing transactions and resources in order to provide frictionless processes, mobility, products and services to users are no longer efficient. In this partnership between the Transport Systems Catapult and the University of Sheffield, we have explored the potential of Blockchain to address these challenges.

"Blockchain as a disruptive technology, to be used in conjunction with Internet of Things and Artificial Intelligence in the Cloud, can add further value and have a transformational impact on transport including the acceleration of the Machine-to-Machine (M2M) economy."

Discussing the report, TSC Chief Technology Officer Mark Westwood added: "The TSC's unique neutral and trusted position allows us to provide a balanced voice against the positive and negative messages around Blockchain through this report. We need to help decision makers understand the potential benefits and limitations of Blockchain technology. It is also important to analyse potential use cases to find out if Blockchain is a good fit, or if other technologies could provide a better solution.

"Blockchain is still a new technology, but it has the potential to disrupt parts of the transport industry in a similar way as it has in finance. Other countries and businesses are exploring its potential right now. The technology's disruptive potential is such that the UK transport industry needs to start paying attention, so we are not caught out later."

The TSC is calling for the government's Industrial Strategy Challenge Fund to support future mobility through the launch of a dedicated R&D programme, collaborating with the transport services industry to build demonstrators of new mobility services. This will enable new service models and technologies such as Blockchain to be tested in-market, creating economic growth for UK based companies through reducing time to market.

More details can be found from the link below including link to download the reports:

https://ts.catapult.org.uk/news-events-gallery/news/blockchain-could-bridge-the-gap-to-integrated-transport/
https://www.sheffield.ac.uk/news/nr/blockchain-integrated-transport-systems-1.784892

H2020 ITN bid "Realising the Transition to the Circular Economy: Models, Methods and Applications"

Dr Andrea Genovese's H2020 ITN bid entitled 'Realising the Transition to the Circular Economy: Models, Methods and Applications' has been successful. This is a 4 years 4 million Euro project with a focus on Circular Economy. Sheffield's share is 600k Euro. Well done and Congratulations to Andrea, to all involved and to all partners. This is fantastic news. There will be PhDs across institutions. ReTraCE will be an important project supported by our strong foundation of AREC capabilities in this area.

AREC UK working with A*STAR Singapore

Supported by the Singapore-UK Commonwealth Innovation Fellowship, Scientist III Hsienhui Khoo from A*STAR Singapore Institute of Chemical and Engineering Science (ICES) collaborate with Prof Koh from Advanced Resource Efficiency Centre (AREC), The University of Sheffield UK on a ground breaking Life Cycle Assessment (LCA) research initiative.

Through this collaboration, bio-derived chemical supply chains, sustainability assessment, and new tool development are amongst the key outcomes. Potential companies of interests such as pharmaceutical and petrochemical industries are testers and users of our research output, building from the historically strong link to this industry in Singapore. During her attachment, Hsienhui Khoo presented a seminar entitled: "Is green chemistry sustainable?" using a life cycle/supply chain approach to investigate the outcomes of some selected green chemistry principles. Her talk has attracted major interest across the University from Science, Engineering and Social Science, as part of a wider interest in our LCA sustainability and energy research portfolio institutionally. Globally, it is becoming increasingly common for pharmaceutical and chemical industries to adopt sustainability practices in their business operations.

Aligned with the aim for more sustainable manufacturing processes or products, the green chemistry concept encourages the application of environmentally benign chemical synthesis, or alternative processes for pollution prevention. In her talk, the true environmental benefits of green chemistry were questioned together with the use of a life cycle or supply chain perspective where issues of mass balances, energy use, and a whole range of environmental impacts have to be addressed. As an example, in place of Green Chemistry Principle 2 (Atom Economy), the concept of "life cycle atom economy' was introduced. The outcome was compared against the conventional method of calculating atom economy of a one-stage synthesis. In other cases, Green Chemistry Principle 7 (Use of Renewable Feedstock), considers replacement of fossil-based chemicals with bio-derived chemicals. By extending the one-step synthesis route to a larger boundary, the production of such bio-derived chemicals starts with biomass growth and generation. This involves the application of energy and fertilizer uses at the farm, leading to further environmental impacts.

AREC working with WRAP

AREC is collaborating with WRAP on a project on household waste simulation. This project is led by Christian Reynolds and Tom Quested. An RA has been appointed to develop the simulation model, based both in Sheffield and WRAP.

AREC EUROPE

AREC Europe is hosted by the South East European Research Centre (SEERC) from Thessaloniki, Greece. This spoke oversees the European expansion of AREC. Its strategic objective is to build leaders and transfer knowledge for enabling the transformation and emergence of innovation and environmentally sustainable enterprises in South East Europe. The branch's core activities include involvement in five EU funded projects related to environmental sustainability and resource efficiency amounting to about 500 000 EUR. It also undertakes several outreach activities often in collaboration with AREC UK, such as the Pathway to Resource Efficiency event at the European Parliament in Brussels in June 2016. AREC-Europa has an active partnership with Olympia Electronics, enabling students to undertake semester long formal assignments with the company as part of their degree. The branch also actively contributes to the research environment by providing guest lectures and organising company visits. Future plans include:

- Acquiring more EU and industry funded projects to build up capacity and leaders in the field of innovation and environmentally sustainable enterprises.
- Engaging and co-creating with industry towards providing tailored training in terms of environmental sustainability.
- Assisting entrepeneurs in ensuring the innovativeness and environmental sustainability of their startups.
- Offering consultancy to businesses in terms of using environmental sustainability assessment and mitigation (SCEnATi).
- Substantial focus shift to Industry 4.0 and blockchain.

AREC CHINA

The Sino-British partnership is going from strength to strength. The focus of AREC China is on the supply chain of the energy, manufacturing and civil nuclear industries (including oil and gas), and is taking on a key role in knowledge exchange with local executives in the newest developments in supply chain environmental sustainability, including opportunities for big data, autonomous and intelligence applications, and the topics of Industry 4.0 and resource efficiency. AREC China is led by Ken Pan from DRTTA.

AREC DRTT WORLD ACADEMY partnership

AREC's partnership with DRTTA (China Development Research Think Tank World Academy) provides the platform for sharing of learning and exchange to advance the impact and collaboration in mutual areas of interest and priorities between the UK and China. DRTTA is located in the Beijing Science park and in partnership with AREC China is making excellent progress and achievement, this has direct links to our research / REF impact (thanks to our strategic partner DRTTA and all team members involved).

Two major achievements include:
• Global Intelligent Supply Chain Big Data Research Centre in China in collaboration with DRTTA, Any Trust, Tsinghua University, Macquarie University and University of Auckland.
• Founding member of the Industrial Blockchain Alliance led by Tsinghua University in collaboration with leading industry such as JD, CIIC and Supoin.

AREC's mission and vision advocate efficient and responsible use of resources throughout the supply chain across sectors, industries and governments. Initially focusing on some of the world biggest resource security such as advanced materials and manufacturing, new energy, water, agri-tech & food and big data applying in industry supply chain efficiency. AREC expands its portfolio to examine those challenges in the automotive, mobility & transport, construction, digitalisation, Industry 4.0, autonomous system, blockchain, intelligence management, waste recycling and circular economy domain. Our key question is with these advances of science and technology, are they resource efficient and sustainable? In the pursuit of our mission and vison, AREC supports the development of resource sustainable supply chains by proposing new ways of reducing risk for stakeholders in overcoming the challenges of resource availability.

FinTech Conference in Beijing

AREC in partnership with DRTTA contributed to a speech at a major industry fintech conference in Beijing in June, promoting AREC research.

Professor Lenny Koh's speech outlined AREC's vision to reengineer future supply chains by integrating efficiency and sustainability into strategic decision making with the aim of improved competitiveness internationally. She went on to explain AREC's mission of creating a world leading supply chain with resource efficiency and sustainability at the heart of its infrastructure.

Professor Lenny Koh explained that AREC's cross-disciplinary research and collaboration with partners in government and industry is resulting in major impacts on policy, industry and society internationally. She said "We are very honoured to have established such a strong partnership in China with the DRTT leading to major policy, industry, economic, environmental and societal impact."

AREC methodologies and tools such as Supply Chain Environmental Analysis Tool (SCEnAT) have been adopted by world industrial leaders as well as innovative SMEs and varying level of government organisations. They have demonstrated major global impact on resource efficiency, regulatory compliance, improved industrial supply chain competitiveness and increased productivity.

Professor Koh visits the Chinese Academy of Sciences (CAS)

Successful meetings with the national CAS ICT research institute in Beijing. These incorporated the exchange of ideas and establishment of the ground for research collaboration in a range of important topics including big data, Artificial Intelligence (AI) and Life Cycle Assessment (LCA).

Professor Koh visits China Centre for International Economic Exchange in Beijing

Highly productive meetings were held in July between AREC China and key stakeholders across governmental organisations in Beijing. These meetings initiated the strong partnership required for major international collaboration in science, technology and innovation relevant to our capabilities.

With DRTT, Professor Koh's visit and meeting with the CCIEE in Beijing provide a very strong partnership basis for AREC China. CCIEE is a premium think thank in Beijing China promoting international economic and policy research exchange. This is aligned with AREC's mission and vision to foster strong partnership with key governmental stackholders for maximum impact in China.

Blockchain Conference at Tsinghua University in Beijing

Professor Koh delivered a keynote speech at the Blockchain Conference at Tsinghua University in Beijing. AREC launched the Chinese edition of their prestigious Blockchain report (thanks to DRTTA, AnyTrust, CIFS, TICS, Transport Systems Cataopult, Tsinghua University, The University of Sheffield and AREC China for their contributions).

During the conference a new Blockchain Research Institute was announced by Tsinghua University and CIFS (thanks to all team members both in the UK and China who were involved).

Professor Lenny Koh also shared her work on blockchain technologies for transport with Transport Systems Catapult, and how this is relevant to the China context. She commented aligning bockchain's potential integration with Internet of Things (IoT) and Artificial Intelligence (AI) on the Cloud will open up enormous opportunities to advance how we design, operate and deliver public and private services globally. This includes:

- For the One Belt One Road Initiative, to adopt blockchain technology for multi-modal travels experience for passengers and freight handling across borders for businesses with seamless transaction.
- For Made in China 2025, to create intelligent supply chains by upgrading to high value manufacturing environments with smart sensors, 5G across supply networks.
- For the economic and environmental resource efficient model for China's NDRC 13th five-year plan, to adopt environmental sustainability reporting and integration with international standards.

The Chinese bilingual version of the report can be downloaded from the link below:

https://s3-eu-west-1.amazonaws.com/media.ts.catapult/wp-content/uploads/2018/07/24101559/00481_Blockchain-Chinese_NEW.pdf

High level policy workshop with NDRC and SCEnAT platform adoption in China

A very successful high level policy workshop with NDRC in Ningbo hosted by the Chief Economist Director Wang. Discussions about the impact of AREC's and Professor Koh's research on policy and industry, and recommendations were presented and also made through a confidential report. This strategic collaboration also involves the adoption of SCEnAT platform in industry working in collaboration with Ningbo International Investment Consultancy Co Ltd and Nottingham University in Ningbo. The policy impacts include Belt and Road, Made in China 2025 and 13th five-year plan. The resulting environmental and economic impacts from these work have been acknowledged.

National Development and Reform Commission (NDRC) People´s Republic of China

Professor Koh visits JD Logistics Park in Shanxi and Taiyuan

Prof Lenny Koh visited JD Logistics Park where research collaboration in areas of mutual interest was discussed. This includes multi-modal transport and logistics, use of blockchain and supply chain resource efficiency. ZDLP is state owned and located in a special development zone. It links up rail, road, port, airports infrastructures together. Partners include Baidu, China Telecom, Bank of China, China Railway Express Co Ltd, JD, Geeley Auto, Taiyuan Heavey Industry Co Ltd and so on.

Professor Koh visits Shanxi AI and Big Data Research Institute

Prof Lenny Koh accompanied by DRTTA (Director of international collaboration Ken Pan, and Associate director of DRTTA Zhenlei Yao) visited Shanxi AI and Big data research institute, they have discussed collaborations related to AI, Big data technologies, next generation tech skills development.

In the afternoon, the Director Runlan Cui of Shanxi AI and Big data research institute demonstrated to AREC and DRTTA about their work related to big data project in various fields, such as industrial applications, urban geography, ecological and environmental monitoring, medical, iNews smart news. The theoretical and outcomes of these project were shared and they also showed Lenny the management model of the centre itself, such as skills development and management process of the centre.

After the demonstration, the Director Runlan Cui from Shanxi AI and Big Data Research Institute introduced the service tenet, work mission, development goals and operation mode of Shanxi Intelligent Big Data Research Institute, as well as the current research and development of big data key technologies, big data academic research, big data industry standard research, and solving big data industry. They provide technical research support for innovation-driven development in the big data sector across the province and the country.

Professor Koh shared how AREC promotes understanding of complex supply chains and proposes solutions using cross-disciplinary research in cross-industry supply chain management and information systems, including the development of digital cloud-based software tools (SCEnAT Suite) to support the transformation of traditional supply chains to high performance and sustainable supply chains. Through the use of the SCEnAT software into the digital supply chain life cycle thinking, it has been widely used in various organisations, technologies and systems.

The partnership of AREC and DRTTA create a positive impact for transformational research on sustainable supply chains and global resource efficiency, specific activities focus on global resource security, advanced materials, new energy, agri-tech, water treatment, waste and circular economy and big data. Key impact activities in the areas of providing high quality research resources, leading policy research model and industrial consulting, Big Data, AI and educational training for comprehensive service solutions for the partners. A very successful visit where all parties have expressed a strong interest for future collaboration in areas that have mutual interests.

Taiyuan University of Technology: Big Data Science

Meeting and visit also took place at the Taiyuan University of Technology, in particular with the College of Big Data Science and Institute of Big Data Research. This is in line with the meeting and tour at the SIBD in Shanxi.

Professor Koh delivers Keynote speech at the Circular Economy Summit in Shanghai

Both Europe and China have committed to working towards a Circular Economy. Both benefit from aligning policies supporting a transition to a low carbon, regenerative circular economy by unlocking new sources of economic growth and innovation in addition to benefits for people and the environment. Professor Lenny Koh delivered a keynote speech at the Circular Economy Summit in Shanghai University promoting the work of AREC. This impressive line-up including the universities of Cambridge, Michigan State, York, Tsinghua, Shanghai Jiao Tong, Southampton, Northampton amongst others. Visit to the Shanghai JiaoTong University Science and Technology Park also took place in particular to a waste recycling company.

AREC USA

The University of Sheffield and Penn State University have a long running relationship through the Penn State Materials Research Institute, which encompasses the national institute and the Centre for Piezoelectrics and Dielectrics (CPD). AREC work closely with the CDP, collaborating on sustainability research. Moving forward these collaborations continue and enable this excellent work to be conducted and disseminated internationally through the AREC USA.

Collaborations with Penn State University and Imerys:

1. To establish a joint LCA research on polymeric materials and bio-materials
2. To establish a joint LCA research to connect agriculture with bio-energy researchers (including sharing of databases)
3. To establish an industrial research partnership with Imerys to investigate LCA of green mining
4. To connect social sciences (urban, transport, supply chain, humanities etc.) researchers in a joint LCA research

A major visit (3rd visit) has been successfully completed with Imerys, a leading global industry partner. This builds from the work between Prof Lenny Koh and Prof Ian Reaney with Penn State University. Imerys have signed the French policy/legislation meaning they need to reduce their C02 footprint, they would like to follow up with discussions regarding SCEnAT and how this tool can help. They are also interested in AREC's capabilities regarding circular economy and in the project diversity we have under various topics. The partnership will enable positive exchange both ways, AREC's global network sharing and Imerys existing projects with Penn State. Sheffield University is coordinating this partnership, thank you to all team members and partners involved.

There are exciting opportunities for AREC USA working with Penn State and Imerys and there are talks happening around establishing a joint research project on plastic, bio-based materials and polymer LCA. There are opportunities to connect agriculture and bio energy researchers (including sharing of database) on joint LCA project. With Imerys as an industry partner, joint LCA collaborative research with a focus on green mining would have mutual interest and benefit. Other projects such as seed funding to pump prime collaborative LCA research are on the horizon. The toxicology footprint Nature paper has been shared with NSF, relevant industry and policy makers and the UK REF impact case study measurement has also been shared. Connecting social sciences (urban, transport, supply chain, humanitarian etc.) researchers in joint LCA projects has exciting opportunities for mutual benefits in resource efficiency and sustainability.

AREC's wider engagement

Thailand and UK

Dr Gate Pichawadee Kittipanya-ngam - Assistant Professor of Operations Management from Thammasat University Business School in Thailand visited Sheffield University Management School where she gave a talk as part of the SCEnATi training. Her talk "Investigating food supply chain sustainability in Thailand: A Comprehensive study of different rice supply chains" was particularly relevant as this collaborative project will incorporate the use of the SCEnATi. The project investigates the environmental impact of various rice supply chains using Life Cycle Assessment (LCA) method.

The SCEnATi on Microsoft Azure Cloud was run on the Microsoft Surface Hub. The SCEnATi training was run by Dr Adrian Solomon and Lucy Smith. They showed the mapping process from data input (e.g. with integration with Office 365 Excel), process mapping of supply chains/selection of similar supply chains through to computation of the environmental impact of supply chains. The environmental impact was shown not just as estimation of carbon emissions but also taking into account a wide range of environmental indicators. Example output was presented:

- A carbon map together with a results dashboard providing an overview of the data.
- Business Intelligence (integrated with Microsoft Power BI) such as customised reporting.

Professor Koh travelled to the Thammasat University Business School in Bangkok where she then gave a talk as part of their research project related to Mekong and N8 Agrifood.

AREC's links with STFC advanced technology

Through the STFC funded Agrifood Network+, AREC has fostered strong relations with STFC group including its advanced technologies and capabilities including RAL, Diamond, etc. This space, satellite and advanced imaging technologies not only can be used for solving big discovery questions in space, physics and astronomy, but also world grand challenges such as food security and climate change. Multiple research projects have already been funded through the STFC agrifood network+, and the second annual meeting at The University of Sheffield has seen the showcases of interesting and exciting projects presented by multiple teams. This is very much in the heart of AREC's cross disciplinary approach in solving resource efficiency and sustainability challenges, and it is a strong demonstration to show how space technology can be used for civil applications.

EXAMPLE OF RECENT PUBLICATIONS

Sustainability Intervention Mechanisms for Managing Road Freight Transport Externalities: A Systematic Literature Review, Tob-Ogu, A; Kumar, N; Cullen, J and Ballantyne, E, Sustainability (2018).

Blockchain disruption in transport: Are you decentralised yet?, Carter, C and Koh, S.C.L. (2018).

Life cycle assessment and environmental profile evaluations of high volumetric efficiency capacitors, Smith, L et al, Applied Energy (2018).

Life cycle assessment and environmental profile evaluation of lead-free piezoelectrics in comparison with lead zirconate titanate, Ibn-Mohammed, T et al, Journal of the European Ceramic Society (2018).

Sustainable resource allocation for power generation: The role of big data in enabling interindustry architectural innovation, Choudhary, S et al, Technological Forecasting and Social Change (2018).

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 six core research themes which are directed by experts from different departments from the University of Sheffield. This includes:

Academics	
Name	**Position**
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
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
Advanced Materials & Manufacturing Leads	
Professor Mark Rainforth	Professor of Materials Science and Engineering, Director of Mercury Centre and Royce Institute Lead
Professor Ian Reaney	Professor in Ceramics, Head of AREC USA
Professor Derek Sinclair	Professor in Materials Science and Engineering
Professor Sam Turner	Chief Technology Officer of HVM (AMRC)
Energy & Nuclear Leads	
Professor Peter Styring	Director of UK CDU, Dept of Chemistry
Professor David Stone	Professor of Energy Storage
Professor Neil Hyatt	Professor of Nuclear Materials
Professor Andrew Storer	Chief Executive of Nuclear AMRC

Water Lead	
Professor Simon Tait	Professor of Water Engineering
Agritech & Food Leads	
Professor Jurriaan Ton	Professor & ERC research fellow - Department of Animal & Plant Sciences
Professor Peter Jackson	Chair of the Food Standards Agency's (FSA) Social Science Research Committee, Geography
Professor Duncan Cameron	Professor of Plant and Soil Biology, Royal Society University Research Fellow
Big data, AI and Industry 4.0 Leads	
Professor Panos Ketikidis	VP of Research and Innovation, International Faculty, Head of AREC Europe
Ken Pan	Vice Dean, Operation Director and International Cooperation Director, DRTT, Beijing. Head of AREC China
Waste recycling and circular economy Lead	
Dr Andrea Genovese	Senior Lecturer in Logistics and Supply Chain Management
Post-Doctoral Research Associates (PDRAs), Research and KE Fellows and PhD researchers	
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