The University Of Sheffield.

AREC

Creating the Supply Chain of the Future.

Advanced Resource Efficiency Centre (AREC)

Creating the Supply Chain of the Future.

高端资源效能研究中心

www.sheffield.ac.uk/arec

The Advanced Resource Efficiency Centre (AREC) is a facility to promote the collaboration between industry and academia. It provides a platform for access to policy makers, in order to address the challenges of resource efficiency and sustainability across supply chains.

Professor Lenny Koh , BEng (Hons), PhD, FRSA

Founder and Director, Advanced Resource Efficiency Centre (AREC)

Head, AREC Global and AREC UK

Cross Cutting Chief, Strategic Futures on Resource Sustainability (SCRS)

AREC in brief

AREC supports the development of resource sustainable supply chains, facilitating collaboration with industrial partners and benefit from cutting edge academic research and skills.

Mission

To create a world leading supply chain resource efficiency and sustainability infrastructure addressing critical resource existentiality and challenges using a combination of methods, tools, models, technologies, processes and systems.

Vision

To reengineer future supply chains by integrating supply chain resource efficiency and sustainability into strategic decision making in government, industry and education for improved competitiveness internationally.

Strategic objectives

- To build partnerships and collaborative approaches addressing the world's biggest challenges of resource existentiality.
- To focus research and innovation on the supply chain of the world's essential resources, particularly in advanced materials/manufacturing, energy and nuclear, water, agritech/food.
- To connect lower and higher TRL activities , accelerating the maximum impact of supply chain resource efficiency and sustainability to users and society.
- To sustain a pipeline of relevant skills, ensuring future supply chain resource efficiency and sustainability.

AREC Global

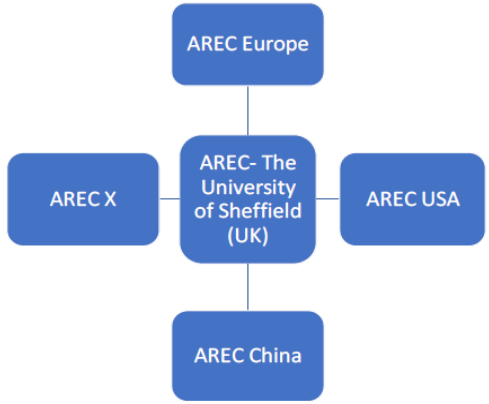
Head of AREC Global and Director of AREC UK – Prof Lenny Koh

Head of AREC China – Ken Pan, DRTT

Head of AREC USA – Prof Ian Reaney

Head of AREC Europe – Prof Panos Ketikidis

AREC Global: UK (Hub and HQ)



AREC UK at The University of Sheffield is the founder of the AREC model, and is the main hub and HQ of AREC overall and AREC Global. AREC has hubs in China (AREC China), Europe (AREC Europe), and USA (AREC USA).

Each of these hubs is structured and run based on the AREC model, and tailored to the local context with respect to partners involved and strategic priority of industry and government policy.

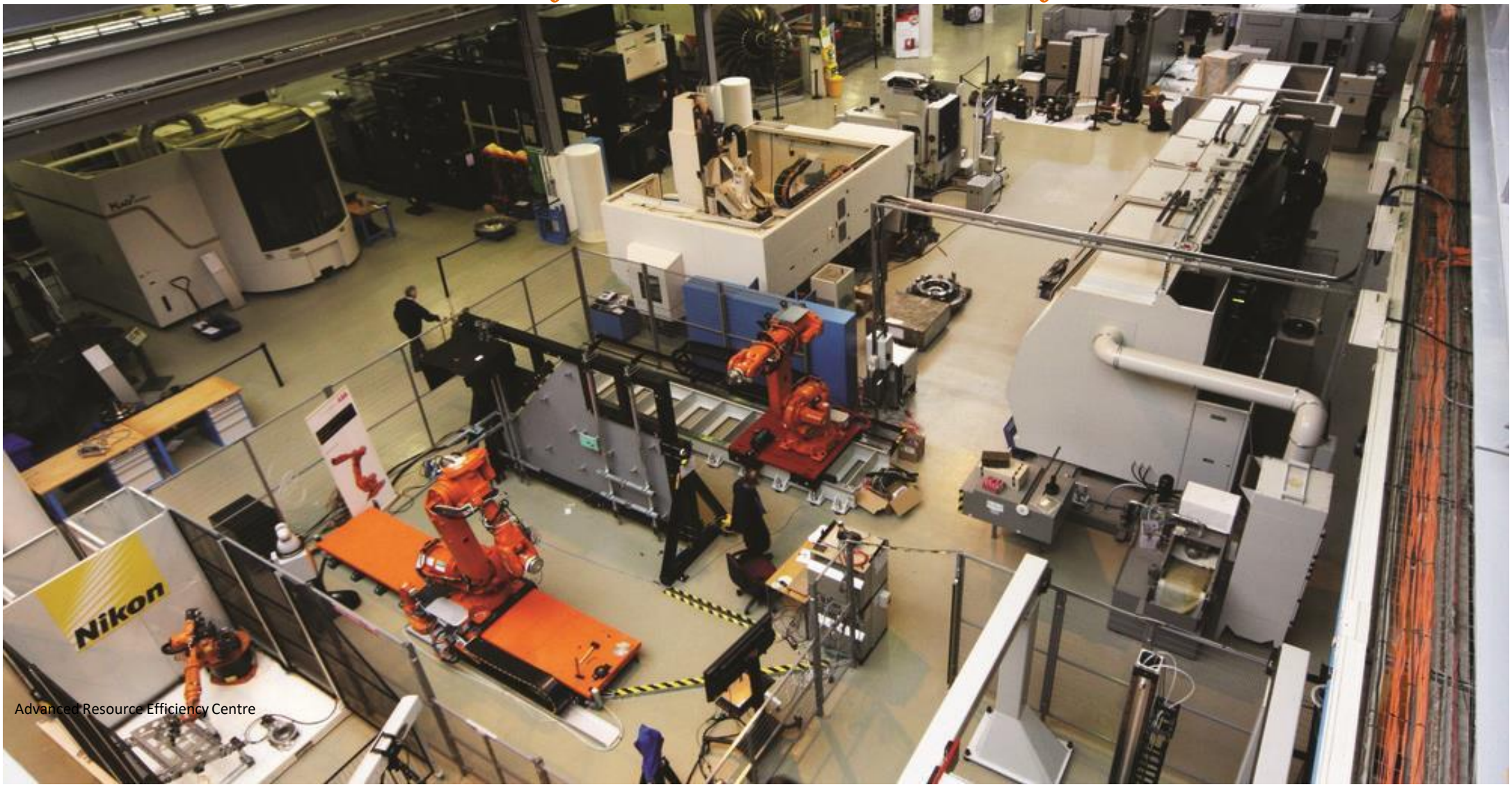
AREC UK's scale:

- 70 people across disciplines
- Projects
  AREC contributed to securing over £50 million in grant money from highly esteemed sources including but not limited to the Engineering and Physical Sciences Research Council (EPSRC), Leverhulme Trust, HEFCE, European Commission, STFC and industry.
- Internationalisation / AREC Global
  AREC UK, AREC Europe, AREC China, AREC USA

AREC Global includes our strategic partnership with Microsoft. This builds from our existing strong partnership with Microsoft on SCEnAT suites cloud platform development and our partnership will be advanced to embrace the most cutting edge digital technologies to transform supply chains and society towards resource efficiency and sustainability, drawing in partnerships with other leaders in specific domain such as Rolls-Royce, IBM, COSTA, Jaguar Land Rover.

Microsoft meeting and visit, Sheffield

Advanced Manufacturing Research Centre (AMRC) with Boeing – A world renowned University of Sheffield and Industry Collaboration.



Advanced Resource Efficiency Centre

Partnership model of the AREC: A feeding facility into AMRC, NAMRC, AMPI and AMPII

Advanced Resource Efficiency Centre

Professor Koen Lamberts
President & Vice Chancellor, The University of Sheffield

Professor Keith Ridgway, CBE, FREng Executive Dean, AMRC and Factory 2050

Andrew Storer
CEO, Nuclear AMRC

Professor Dave Petley
VP Research & Innovation

AREC delivers key policies

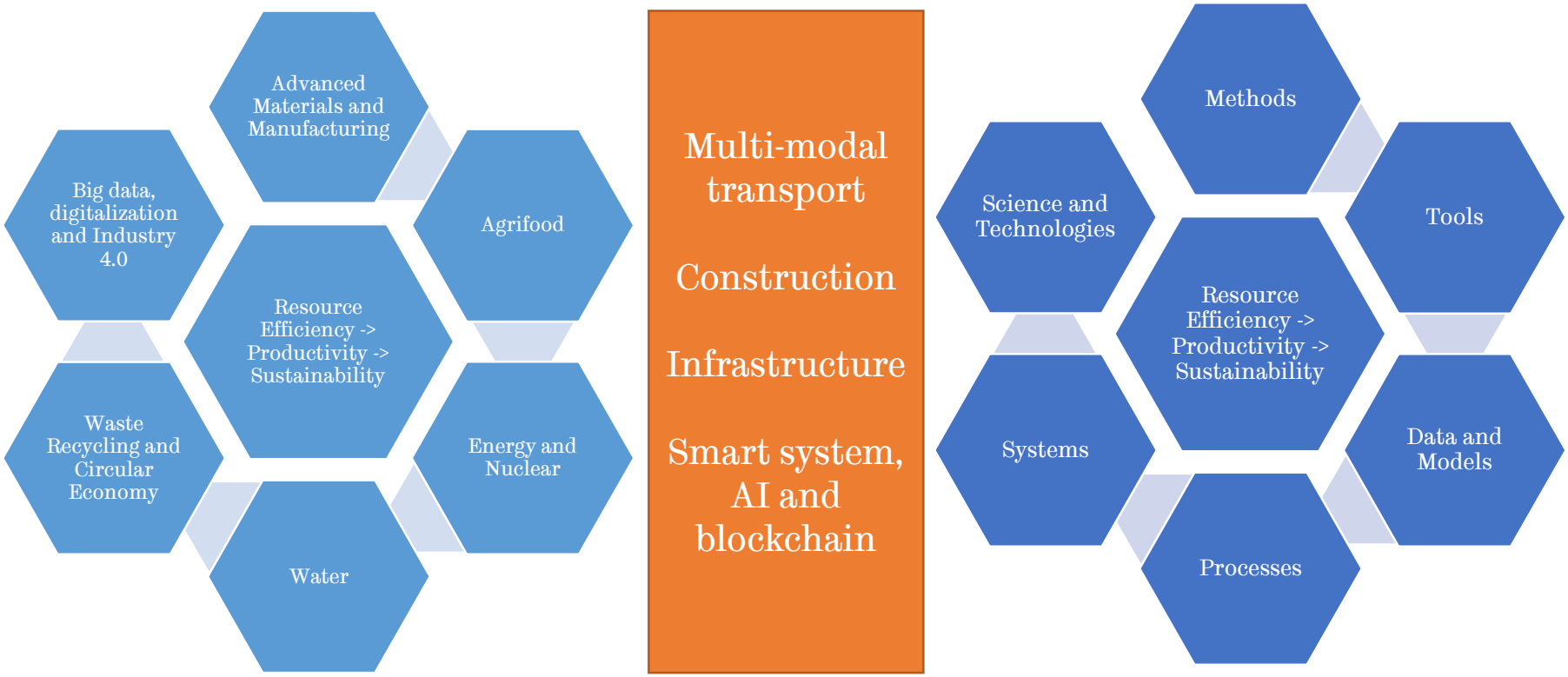
Resource Security Action Plan (BIS, 2012)	**"Resource Security Action Plan"** from the Department for Business, Innovation and Skills (BIS) states: **"Government's objective is to bring better resource use criteria into the mainstream, so they routinely included in the range of minimum and best practice product standards"** The long term vision to achieve this objective is set out, stating: **"The Government is putting innovation and research at the heart of its growth agenda through greater investment and increased collaboration"**
Infrastructure Carbon Review (HM Treasury, 2013)	The UK is committed to driving forward the delivery of strategic new infrastructure alongside the renewal and maintenance of existing infrastructures. These initiatives aim to embed low carbon practices into business activities, leading to reduced energy demand and pressure on resources
Climate Change Act 2008 (HM Government, 2008)	The UK set out legally binding requirements for the UK to reduce CO_2 emissions by 80% against 1990 levels by 2050. The European Union (EU) issued similar directives in 2011, proposing cuts in Greenhouse Gas Emissions of "80 to 95%" by 2050 (Commission of the European Union, 2011).
A Resource Efficient Europe – Flagship Initiative under the Europe 2020 Strategy (Commission of the European Union, 2011)	EU outlined the need for promoting a "resource efficient" Europe, one that is less reliant on scarce fuels and materials, with greater levels of food and energy security, and therefore increase EU member state's resilience against global commodity and energy prices
Eight Great Technologies (Willet, 2013)	The UK Government's vision of future scientific research into the "8 Great Technologies", developing great research with practical industrial application influence the focus of sectors and their supply chains in Supply Chain Resource Sustainability.
Intergovernmental Panel on Climate Change (IPCC)	Established by the United Nations Environment Programme and the World Meteorological Organisation, the IPCC aims to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impact. It is the leading international body on assessing climate change. The IPCC reviews scientific evidence produced around the globe to monitor new and existing findings and to ensure the debate is informed by accurate information.

AREC delivers key policies

UK Industrial Strategy (Department for Business, Energy & Industrial Strategy; Nov. 2017)	Business Secretary launches flagship Industrial Strategy for the UK today with a plan to boost the economy, build on the country's strengths and embrace the opportunities of technological change. Industrial Strategy Challenge Fund will invest £725 million in new Industrial Strategy Challenge Fund programmes to capture the value of innovation. Launch of the Industrial Strategy comes as government announces it has secured a major strategic investment into UK by world leading life sciences company MSD. **First 'Sector Deals'** – to help sectors grow and equip businesses for future opportunities. Life Sciences Construction Sector Deal Artificial Intelligence Sector Deal Automotive Sector Deal **4 'Grand Challenges'** which will take advantage of global trends to put the UK at the forefront of the industries of the future. Artificial Intelligence Clean Growth Mobility Aging Society
Horizon 2020 **The EU Framework Programme for Research and Innovation**	Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). The framework focuses on removing barriers to innovation by fostering collaboration between the public and the private sector. By investing in research, Members of the European Parliament hope to achieve a future of sustainable and inclusive economic growth and jobs.
European Energy Research Alliance **Coordinating Energy for a Low Carbon Europe**	The EERA is a public research alliance between 175 research organisations. The alliance collaborates with industry and research institutions outside the European Union to help align research priorities. It is the research pillar of the European Strategic Energy Technology Plan (SET-Plan) which is Europe's technology response to the pressing challenges of meeting its targets on greenhouse gas emissions, renewable energy and energy efficiency over the coming decades.
United Nations Sustainable Development Goals	As part of the 2030 Agenda for Sustainable Development, governments agreed to pursue 17 Sustainable Development Goals. Over the next 15 years, countries will mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind. These goals call for actions by all countries, irrespective of their development status, with the focus on fostering prosperity while protecting the planet.

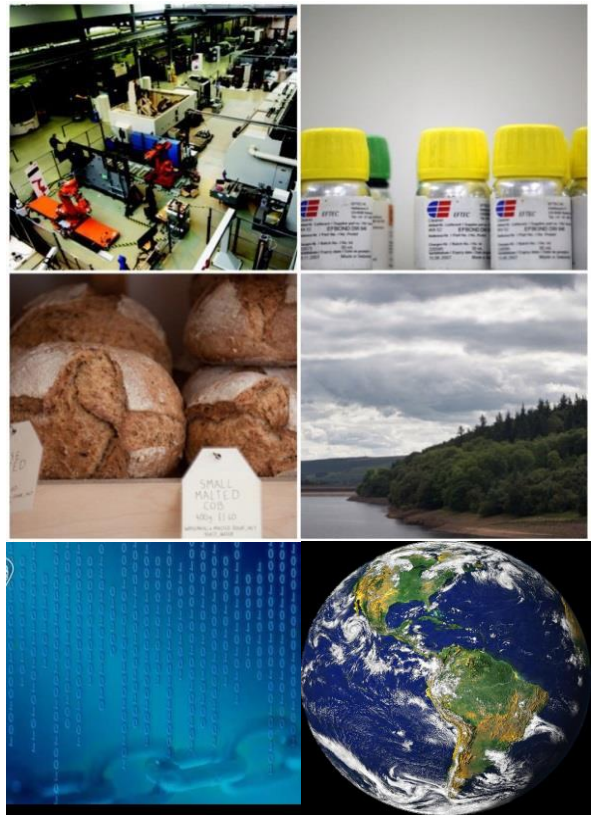
----- Including policies of global significance -----

AREC's Themes and Capabilities

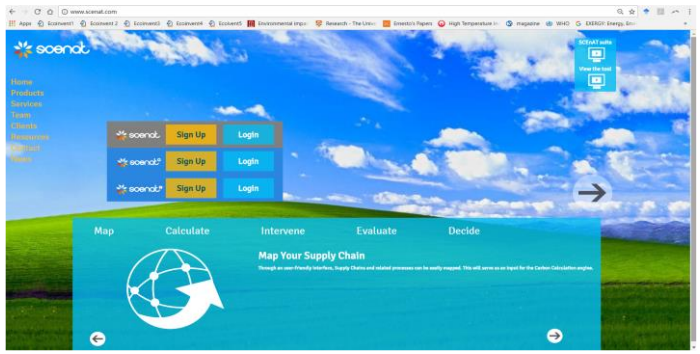


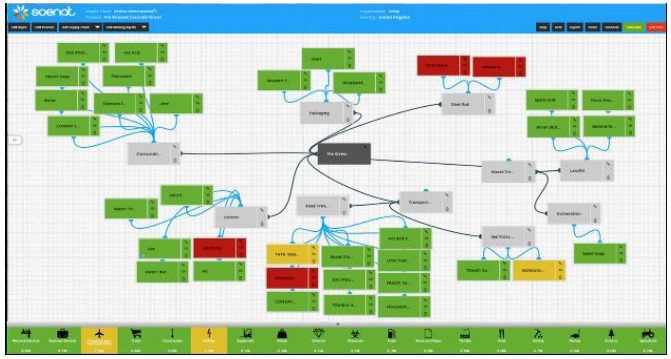
AREC programme focuses on supply chain resource efficiency and sustainability in 6 key themes

Advanced Materials and Manufacturing	• Fragility of global supply chains and resource availability • Cyclic second life of materials • Tools to design future supply chains
Energy & Civil Nuclear	• Help with defining the supply chain • Developing coherent energy policy • Understanding the future energy mix
Water	• Risk and resilience management • Knowledge and transfer of best practice • Understanding the difference between water and manufacturing
Agritech & Food	• Engage with retailers • Provide evidence base and ability to evaluate tradeoffs • Innovation in energy and crop production
Big data, Digitalization and Industry 4.0 (inc. Blockchain, AI and IoT)	• Reducing the environmental impact of industry • Sustainable and resilient industrial system • Improved efficiency through digitally connected supply chains
Waste Recycling and Circular Economy	• Transition to low carbon, regenerative circular economy • Renewable resources • Asset-sharing platforms



SCEnAT Suites Cloud platform in partnership with Microsoft





Supply Chain Environmental Analysis Tool_*intelligence* (SCEnATi)

scenat

AREC

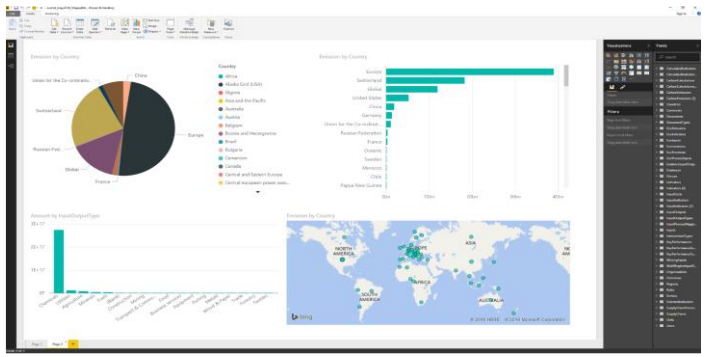
In partnership with Microsoft

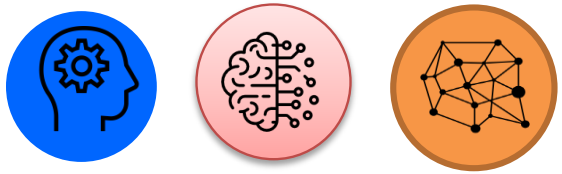
- ✓ Improved resource efficiency
- ✓ Improved supply chain sustainability
- ✓ Improved competitiveness
- ✓ Reduced cost
- ✓ Improved regulatory and ISO compliance
- ✓ Reduced waste
- ✓ Improved and customised reporting and validation
- ✓ Award and contract winning
- ✓ Advanced decision making
- ✓ Hybrid Life Cycle Assessment and Input-Output analysis
- ✓ Resource Efficiency and Sustainability Index

- ✓ Big data analytics
- ✓ Geographic information system visualisation
- ✓ Data security
- ✓ Microsoft Cloud, Azure and Power BI infrastructure, integration and interface
- ✓ Automated data capture
- ✓ Office 365 (e.g. Microsoft Excel) integration link
- ✓ Touch devices compatible

"A powerful sustainability tool that every organisation needs"

www.scenat.com





Advanced Resource Efficiency Centre

Advanced Materials and Manufacturing Leads

Professor W Mark Rainforth

BMet PhD FIMMM CEng FInstP CPhys FRMS

Professor of Materials Science and Engineering

Professor Ian Reaney

Department of Ceramics and Functional Materials

Head, AREC USA

Professor Derek C Sinclair

PhD, BSc, MRSRC

Professor in Materials Chemistry

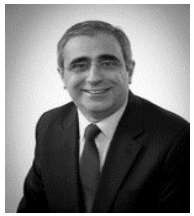
Professor Sam Turner

CTO, High Value Manufacturing Catapult

List of AMM research centres and facilities:

1. Advanced Manufacturing Research Centre (AMRC) with Boeing
2. Royce Institute
3. MAPP – Professor Iain Todd
4. Mercury Centre (Additive Manufacturing / 3D Printing)
5. Composite Systems Innovation Centre
6. Research Centre for Surface Engineering
7. Functional Materials Group
8. Centre for Advanced Additive Manufacturing
9. Leonardo Centre for Tribology and Surface Science
10. Centre for Glass Research
11. Centre for Biomaterials and Tissue Engineering
12. Immobilisation Science Laboratory
13. Polymer Centre – Professor Steve Arms
14. Sheffield Centre for Advanced Magnetic Materials and Devices
15. Centre for Cement and Concrete
16. Sheffield NanoLAB
17. Sorby Centre for Electron Microscopy and Microanalysis
18. X-Ray Diffraction Laboratory (XRD)
19. EPSRC Centre for Doctoral Training in Advanced Metallic Systems
20. Characterisation Small Research Facility (SRF)
21. Logistics and Supply Chain Management (LSCM) Research Centre
22. Centre for Energy, Environment and Sustainability (CEES)

Energy & Nuclear Leads



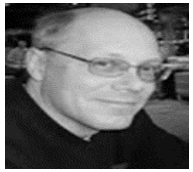
Professor Mohammed Pourkashanian
Head, Energy 2050 and Director of Energy URI

Professor Neil C Hyatt
Professor of Nuclear Materials

Chemistry
Royal Academy of Engineering and Nuclear Decommissioning Authority Research Chair in Radioactive Waste Management
Director, Immobilisation Science Laboratory
Co-Director, Nuclear First & Next Generation Nuclear Doctoral Training Centres

Professor Peter Styring

Professor of Chemical Engineering & Chemistry
Director of UK Centre for Carbon Dioxide Utilisation (UKCDU)



Professorr David Stone
Professor of Energy Storage

Advanced Resource Efficiency Centre

List of E&N research centres and facilities:

1. Energy URI
2. Nuclear Advanced Manufacturing Research Centre (NAMRC)
3. Nuclear Fission DTC
4. Immobilisation Science Laboratory
5. Centre for Energy, Environment and Sustainability (CEES)
6. Centre for Low Carbon Futures (CLCF)
7. UK Centre for Carbon Dioxide Utilisation (UKCDU)
8. EPSRC Energy Storage CDT
9. EPSRC e future CDT
10. ESRC Whiterose CDT
11. Sheffield Solar Farm – Dr Alastair Buckley
12. Siemens Wind Research Centre
13. Sheffield Urban Institute – Professor Simon Marvin
14. Grantham Centre for Sustainable Futures

Water Lead

Professor Simon Tait
Professor of Water Engineering

List of Water research centres and facilities:

1. Pennine Water Group
2. Catchment Science Centre (Ursula)
3. Green Roof Centre
4. Advanced Water Research Centre
5. Centre for Energy, Environment and Sustainability (CEES)

Agritech & Food Leads

Professor Peter Jackson
Head, SheFF

Professor Jurriaan Ton
Co-Director of Plant Production and Protection (P3)

List of Agritech and Food research centres and facilities:

1. Leverhulme Centre for Climate Change (LC3M) – Professor David Beerling
2. Grantham Centre for Sustainable Futures – Professor Tony Ryan
3. Logistics and Supply Chain Management (LSCM) Research Centre – Professor David Oglethorpe
4. Centre for Energy, Environment and Sustainability (CEES)
5. Sheffield Sustainable Food Futures (SheFF)
6. Robert Hill Institute
7. Plant Production and Protection (P3) – Professor Duncan Cameron

Big Data, Digitalization and Industry 4.0 Leads

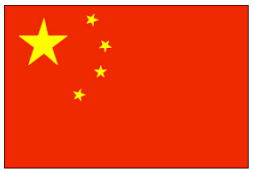
Professor Panos Ketikidis
VP Research and Innovation,
International Faculty, Greece
Head, AREC Europe

Ken Pan
Deputy Dean, Operation Director
and International Cooperation
Director, DRTTA, Beijing
Head, AREC China

Waste Recycling and Circular Economy Leads

Dr Andrea Genovese
Senior Lecturer, Logistics and
Supply Chain Management

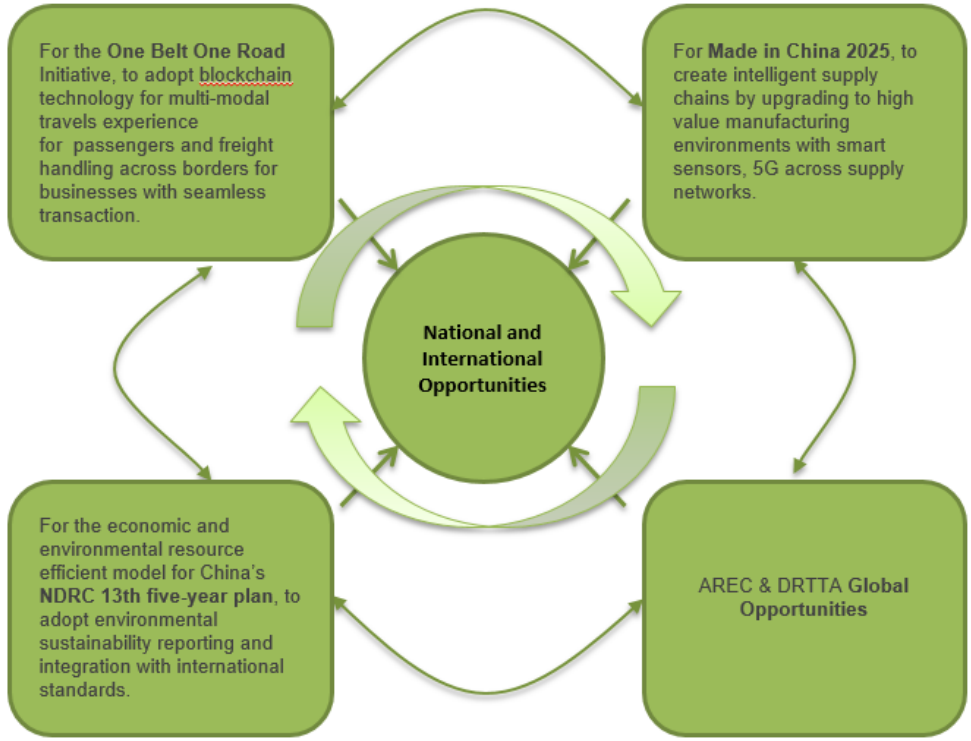
AREC China



国研智库 国际研修院
DRTT WORLD ACADEMY

AREC China – AREC's partnership with DRTT World Academy of China Development Research Think Tank (DRTT) creates positive impact to global resource efficiency and supply chain sustainability. Being a subsidiary of China Development Research Centre of the State Council (DRC), DRTT focuses on providing services covering: high-quality information, top-notch policy research and industry consulting, big data, education and training, conference and industry park. The partnership put it in the unique position to provide comprehensive solutions that benefit all stakeholders, address environmental concerns and issues of resource efficiency. AREC China's HQ with DRTT is located at Beijing Science Park, with spokes across China and Asia.

AREC China focuses on the supply chain of the energy, manufacturing and civil nuclear industries (including oil and gas), food, transport/logistics, fintech/supply chain finance will take 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 AI, blockchain, IoT and resource efficiency.



AREC China

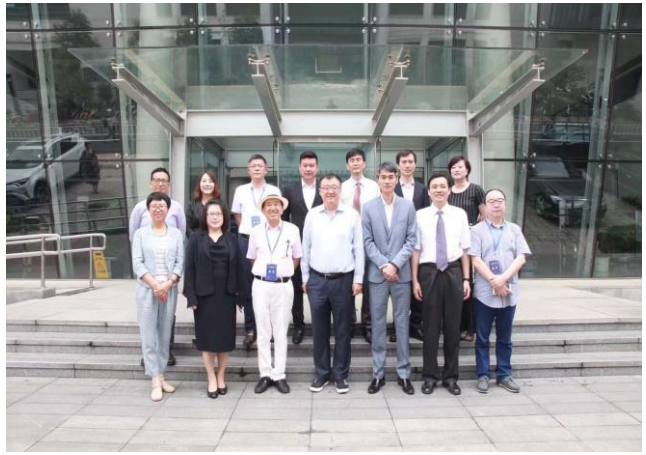
国研智库 国际研修院
DRTT WORLD ACADEMY

AREC China HQ at DRTT, Beijing Science Park

AREC China

AREC China Office at AnyTrust, Haidian District, Beijing

CCIEE meeting and visit, Beijing



Blockchain Conference, Tsinghua University, Beijing (by Tsinghua University and CIFS)

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Chinese Academy of Science ICT Research Institute meeting and visit, Beijing

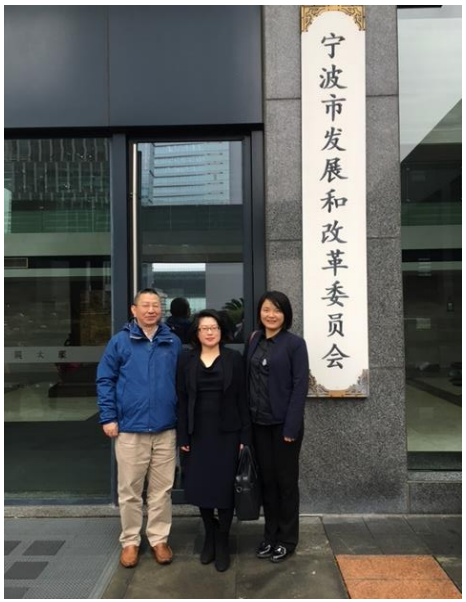
CITTC meeting and visit, Beijing

ZD Logistics Park meeting and visit, Shanxi

Shanxi Big Data Institute meeting and visit

AREC China

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



High level policy workshop at NDRC, Ningbo

AREC Europe

AREC Europe is located in SEERC in Thessaloniki, Greece. The spoke oversees the European expansion of AREC. Its strategic objective is to build leaders and transfer knowledge for enabling the transformation and emergence of innovative 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 Europe 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 innovative and environmentally sustainable enterprises.
- Engaging and co-creating with industry towards providing tailored training in terms of environmental sustainability.
- Assisting entrepreneurs in ensuring the innovativeness and environmental sustainability of their startups.
- Offering consultancy to businesses in using environmental sustainability assessment and mitigation services (SCEnAT suites cloud platform).

Resource efficiency impact workshop at European Parliament, Brussels

AREC USA

AREC USA - AREC UK and Pennsylvania State University have formed a partnership with regard to research related to sustainability. Penn State University is home to the Materials Research Institute, which encompasses the national institute that does world class materials research in the States. Collaboration between the institutions contributes to raising awareness and impact about the excellent work conducted at the University of Sheffield internationally.

AREC USA also includes our strategic partnerships with Imerys and CDP. USA is the home of Microsoft's HQ in Redmond, Washington DC with campus in Seattle.

AREC has also formed collaboration with a number of key partners in the USA including Brown University, Arizona State University and Georgia Tech.

Altair 8800 Computer, Microsoft, how it all began by Bill Gates and Paul Allen

AREC Partners

Advanced Resource Efficiency Centre

AREC Partners

Civic and regional roles

By the Sheffield Green Commission

Sustainability Partnership

National roles

By the Cold Commission

European role

International role

Acknowledgement of Funding Councils and All Partners

AREC's Strategy and Partnership (now and future)

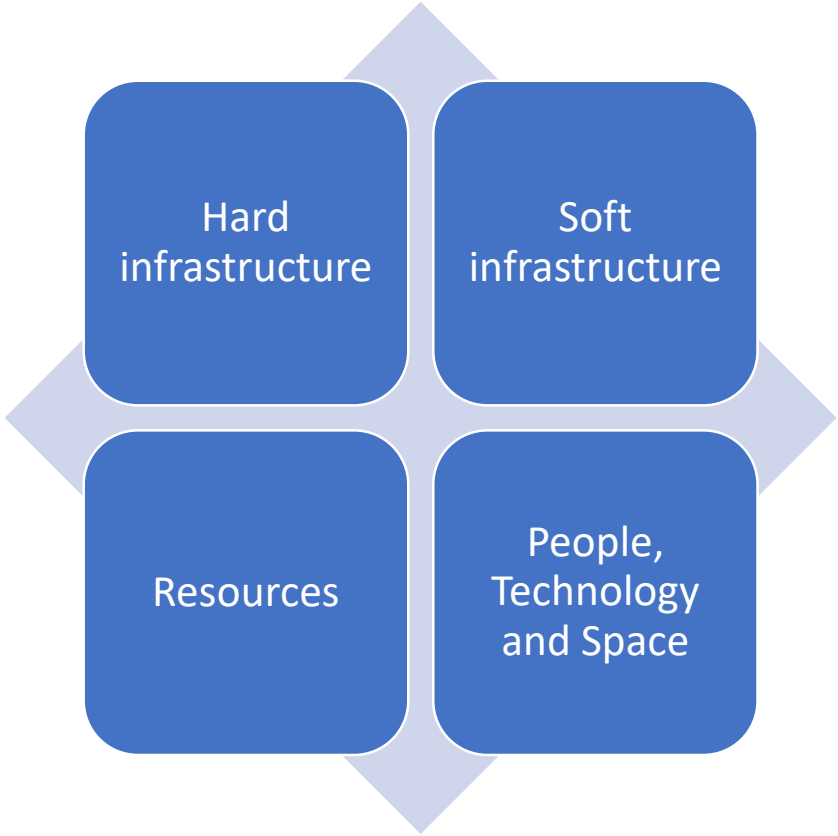
- Challenge-led and cross disciplinary Research & Development
  - Sustainable Development Goals (SDGs) compliance
  - Industry Strategy (IS) compliance
- Connect lower TRL to higher TRL research
- Maximising impact to policy, industry and society
- AREC has established strategic partnerships with:
  - Industry
  - Government
  - Key organisations and communities
- AREC globalisation

Benefits for partners

Partners or AREC, including industry and policy makers, will collaborate directly with the University of Sheffield to design bespoke, innovative research programmes to meet their needs and solve their supply chain challenges. Through an annual subscription our partners will benefit from the following:

- Enhanced supply chain performance
- Cost reduction
- Efficiency improvement
- Increased sustainable competitiveness
- Lab access – access to our world leading research labs and facilities
- Affordable, low risk high reward innovation
- Supply Chain Life Cycle Analysis
- Staff and skills development
- Access to computer modelling power
- IP – New saleable IP will bolster patent portfolios and future research to create the best products on the market and create distinctive competitive advantage
- Collaborative working with one of the best research universities in the world to develop joint capability
- Expertise – Sheffield is home to some of the leading thinkers in these fields who are working to create the most innovative solutions across a broad range of disciplines
- Branding and CSR

AREC Collaboration, Partnership and Sponsorship Opportunities



Engage with AREC

Partnership with AREC is opened to organisations which work in a complementary area or which wishes to participate in support of our programmes.

We have two tiers of partnership

- **Tier 1** partners have an individual seat on the board of the AREC and the opportunity to influence the direction of future research and training. Tier 1 partners participate in, and obtain the results of, all generic projects, and can also propose specific projects which are presented to the board for approval.
- **Tier 2** partners participate in, and obtain the results of, all generic projects. Tier 2 partners are represented by a single board member.

TATA Steel	***"We have been working with the AREC to develop advanced new indicators in SCEnAT which considers recyclability of materials in the supply chain." said Louis Brimacombe, Head of LCA team.***
Rolls-Royce	***"Partnering with AREC provides early access to valuable R&D ideas which helps improve sustainability and efficiency in our supply chain." said Prof Ian Shellard, Former Director of Global Physical Logistics.***

For more details and/or to join AREC, please contact:

Professor Lenny Koh

Director of AREC and Head of AREC Global

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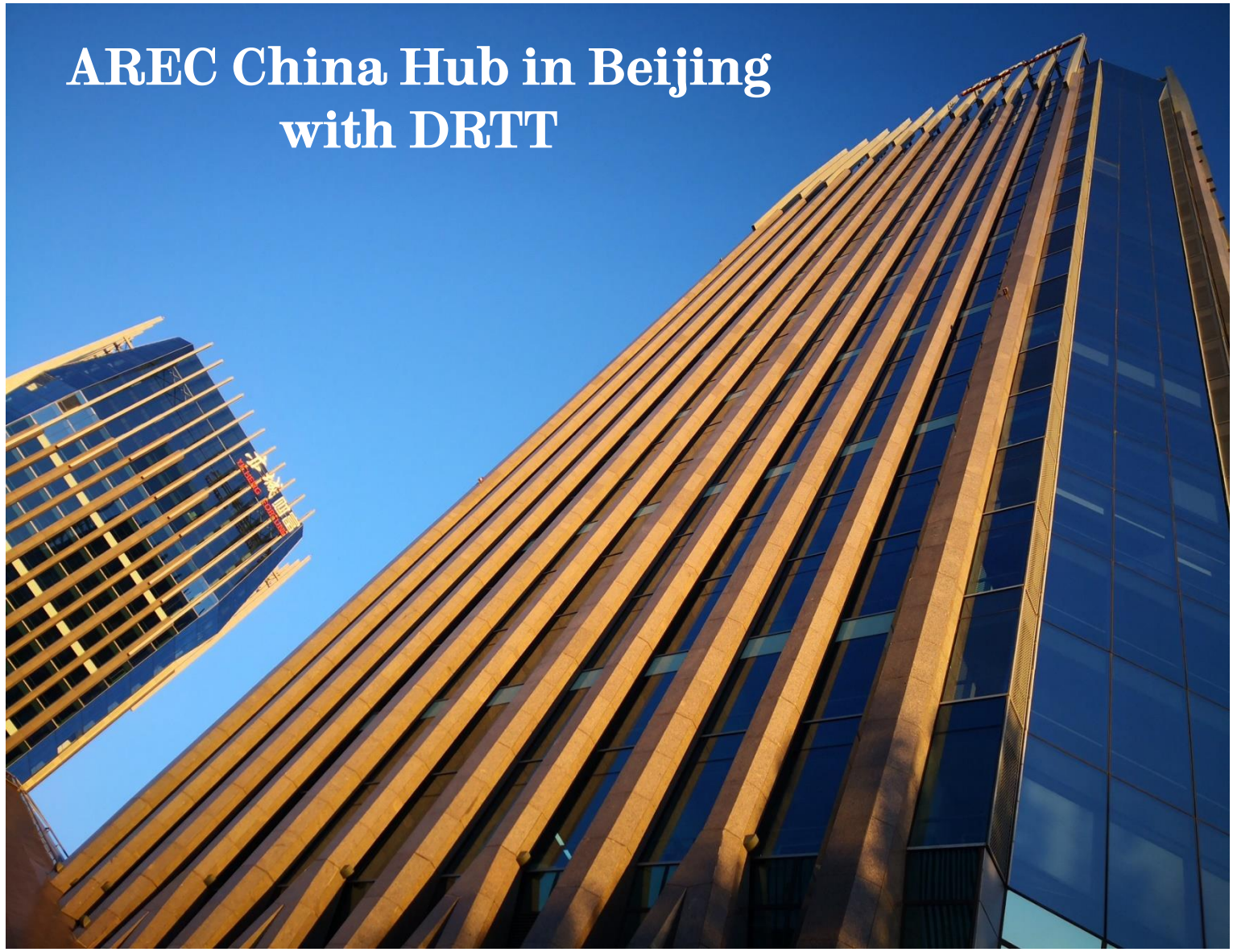
AREC China Hub in Beijing with DRTT



AREC Microsoft Strategic Partnership

Advanced Resource Efficiency Centre

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SCEnAT 4.0

SCEnAT
Blockchain

SCEnAT AI

SCEnAT GIS

Advanced Resource Efficiency Centre

AREC

Creating the Supply Chain of the Future.

To Discover and Understand.

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