UKRI Interdisciplinary Centre for Circular Chemical Economy

UKRI Interdisciplinary Centre for Circular Metals

UKRI Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials

UKRI Interdisciplinary Centre for Technology Metals

UKRI Interdisciplinary Textiles Circularity Centre

NICER (NATIONAL INTERDISCIPLINARY CIRCULAR ECONOMY RESEARCH) PROGRAMME ANNUAL REPORT 2023

Advancing Towards a Circular Economy

CE-HUB
UKRI National Interdisciplinary Circular Economy Research

NICER PROGRAMME

CEctor
Accelerating CE Impact

University of Exeter

UK Research and Innovation

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NICER (National Interdisciplinary Circular Economy Research) Programme

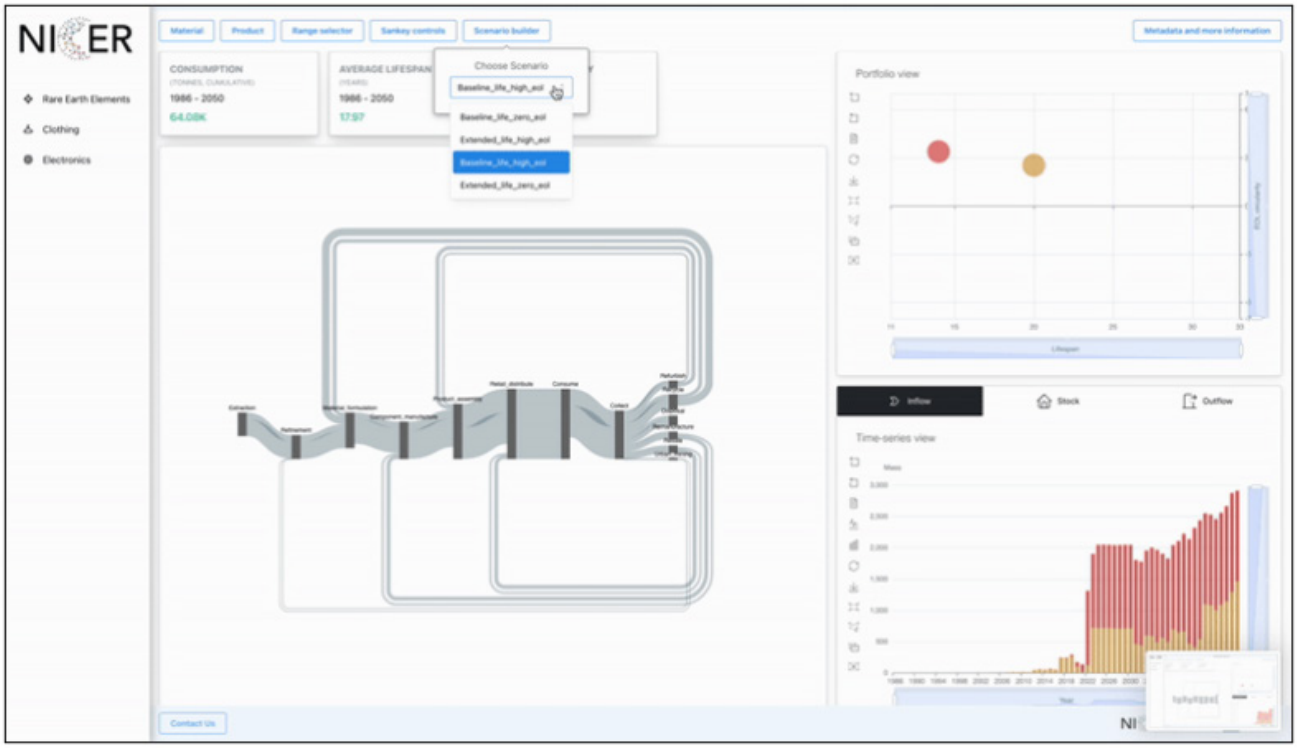
Since its launch in 2021, the UKRI funded NICER programme has been at the forefront of driving scientific advancement, creating new knowledge and technological innovations to accelerate our comprehension of the Circular Economy (CE) and to devise solutions enabling the circularity of specific resource flows and waste streams. This report showcases NICER Programme achievements in 2023.

Scientific and Technological Advancements

Scientific and technological advancements within the NICER programme over the past year have been instrumental in accelerating our understanding of a Circular Economy (CE) and identifying solutions to enable circularity of specific resource flows and waste streams.

Data-driven insights to inform decision-making and CE adoption: The establishment of data-driven tools such as the CE Data Observatory (Figure 1) and the UK Technology Metal Observatory (hosted at BGS) has revolutionized decision-making processes. By pooling public and industry datasets, these initiatives provide valuable insights for government and industry stakeholders. Their adoption by DEFRA and BGS underscores their significance in informing policy and securing a lasting legacy for the programme. Data continues to be an area of interest across the programme and wider community as evidenced by the Circular Data Report publication on the Knowledge Hub.

Figure 1: CE Data Observatory 2023 (CE Hub)



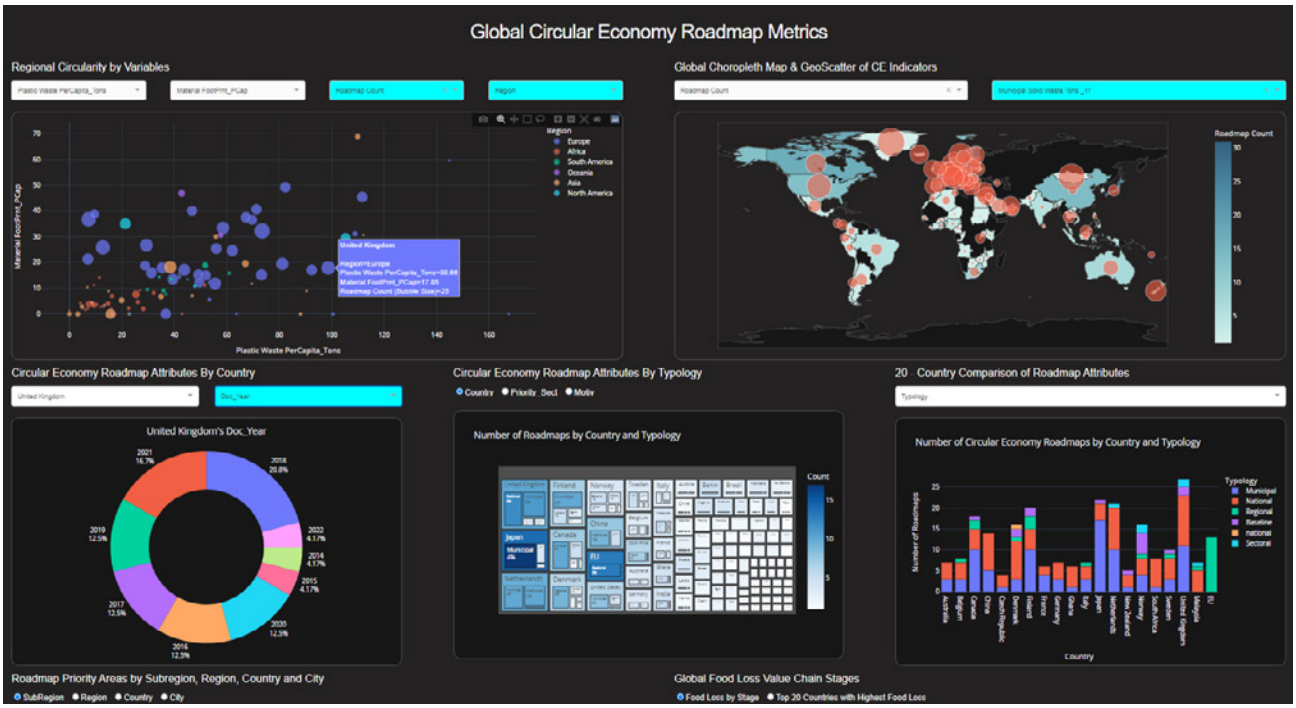
Technological Advancements: Through collaboration with key partners, the programme has seen multiple technological innovations over the last 12-months. Patented and published examples include, 'Technology of electrochemical reduction of CO2 into olefins' demonstrating tangible progress towards circularity in chemical processes. With regard to metals, it has been demonstrated that electrical pulse treatment (EPT) technology can extend fatigue life of steel by up to 300% leading to a significant reduction in the demand for metallic materials. The Circular Metals Centre has also developed a scrap steel identification system for conveyor belt-based scrap sorting to increase the rate of steel recycling. Furthermore, the Circular Materials Design of Use Catalogue has enabled ease of access and use for advanced materials technologies including the integration and translation of underpinning technologies of bio-based recycling.

Scientific Understanding: Fundamental research within the programme has deepened our understanding of specific resource flows and waste streams. Research outcomes such as the identification of compositional limits for good quality RCA and the use of machine learning techniques to predict RCA characteristics have profound implications for reducing reliance on virgin materials and optimizing resource usage. Furthermore, Scenarios and material flow analysis studies (TCC) to increase our understanding of how to reduce the environmental impacts of the UK clothing economy (included in the CE Data Observatory). New UK stocks and flow models (Met4Tech) developed for cobalt and lithium used in EV batteries, and for rare earth elements used in traction motors and permanent magnets for wind power (joint publication: https://doi.org/10.1016/j.spc.2024.03.027).

Case Studies, Tools and Roadmaps: A wealth of resources including case studies, tools and roadmaps have been created and widely disseminated by the NICER Programme to inform evidence-based adoption and implementation of CE. Examples from the last year include the Toolbox for sustainable metal recycling, a 'Roadmap for a sustainable circular economy in lithium-ion and future battery technologies', Technology Metals Case Studies including UNRMS: A Cornwall Case Study - Met4Tech, the Consumer Experience (CX) Wellbeing Framework, the Circular Economy Roadmap Dashboard (Figure 2) and a broad range of resources on the NICER Programme Knowledge Hub. Furthermore, the CX Wellbeing Framework (soon to be published) provides a deep understanding of human wellbeing factors and application within the context of materiality and the Circular Supply Chain Configuration proposes an economy of scale by innovating a networked community-based approach to supply chain design through the concept of the Social Production Network. These resources empower stakeholders with practical guidance for implementing circular solutions.

The NICER programme's scientific and technological advancements have not only accelerated our understanding of a Circular Economy but also provided actionable solutions to enable circularity in resource flows and waste streams. Through data-driven insights, technological innovations, scientific research, and the dissemination of valuable resources, the programme continues to drive progress towards a more sustainable future.

Figure 2: Circular Economy Dashboard, 2023 (CE Hub)



Supporting Government Strategic need

The NICER Programme continues to provide evidence-based contributions to National and International government commitments across the priorities of resource efficiency, circular economy, reduction of embodied GHG emissions and climate change and Net Zero commitments at different scales.

UN Sustainable Resource Management: Several NICER Centres and the CE-Hub have collaborated with DEFRA and DESNZ to progress sustainable resource management commitments resulting in the establishment of a new UN Centre of Excellence in Sustainable Resource Management (more info & Figure 3). The CE-Hub has also been nominated as the UK focal point for the UN Circular Step dialogue platform, an International platform uniting governments, private sector, academic and research institutions, civil society, and other actors from all 56 member States, around the circular economy transition.

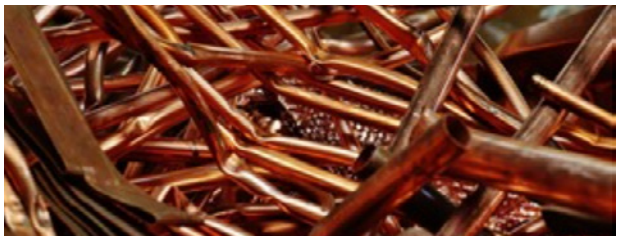


Figure 3: UN Centre of Excellence in Sustainable Resource Management

Resource Efficiency/Circular Economy in the Resources and Waste Strategy: The NICER Programme has contributed towards the development of multiple strategies such as the Circular Economy (Scotland) Bill and the Public Policy Taxonomy for a UK Circular Economy Additionally, policy focused outputs and initiatives focusing on a variety of sectors including Extending Product Lifespans, Extending the Life of Consumer Electronics, Extending the Life of Motor Vehicles and Resource Efficiency of Electrical Appliances in UK Households have been used to influence resource efficiency and circular economy goals.

Reducing Embodied GHG Emissions and Supporting Climate Change and Net Zero Goals: Individually, the NICER Centres have worked closely with UK Government Administrations (including DEFRA and DESNZ) to influence policy changes. For example, the Circular Chemicals Centre's research into chemical recycling challenges has directly influenced the latest legislation and legislation through a joint publication with WRAP 'Non-Technical Challenges to Non-Mechanical Recycling'. Met4Tech and ICEC-MCM, have responded to government initiatives related to circular economy strategies, critical minerals, batteries and electric vehicles and achieving Net Zero targets e.g., Scottish Net Zero Committee Report (Feb 2023). Their involvement in regulatory events and consultations aligns with broader climate change commitments. TCC engaged in ReLondon's report, 'London's fashion footprint', ((Figure 4) an analysis of clothing material flows, emissions and levers for climate action in London.

Figure 4: ReLondon's report 'London's Fashion Footprint'

Other Specific Named Government Commitments: More broadly, the NICER Programme has contributed to other government commitments such as TCC who have provided advice, published by the Council for Science and Technology (CST), to the Prime Minister aimed at capturing economic and societal value from engineering biology, aligning with government commitments to technological innovation and sustainability. Additionally, initiatives like the 'Reuse and Repair Fair' ('Action on Climate Change') hosted by TCC as part of their Sustainability Partnership with Wandsworth Borough Council demonstrates efforts to address climate change and promote circular practices at local levels. The Circular Metals Outreach team have continued promoting the concepts of Design for Repair, Right to Repair, Repair as a System. The Big Repair Project (Figure 5) is ongoing to help develop 'Right to Repair' policy; discussions with stakeholders have evolved around how policy and economic drivers can be aligned and, in turn, and support the UK towards meeting important environmental targets.

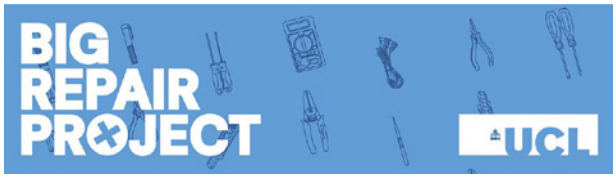


Figure 5: The Big Repair Project, (CircMetals & UCL)

Overall, these programs have actively engaged with international, national and local government stakeholders providing research-based insights to influence future initiatives, commitments and policies in the transition towards a circular economy.

Supporting Integrated Innovation

Various initiatives across the NICER programme have supported and integrated innovation through engagement with a diversity of stakeholders.

Supporting the Third Sector and Businesses: The NICER Programme has made significant progress over the last year in supporting businesses across sectors, including the third sector to make evidence-based decisions, understand barriers to CE adoption and identifying and co-creating solutions. The CE Hub Flexible Fund has enabled 10 high-impact feasibility studies to accelerate innovative solutions, whilst Innovate UK funding (Figure 6) has successfully enabled SMEs and third-sector organizations to engage with expertise from across the programme via 16 research and innovation projects (see Case Studies).

Figure 6: Innovate UK SME Funding, Case Studies on the Knowledge Hub, 2023

Since May 2023, the CEctor project has expanded the CE Hub's research collaborations with industry to influence awareness, behaviour change and the adoption and implementation of CE solutions. Focussed on five sectors, [1] Medtech, [2] Hospitality, [3] Renewables – Solar PV, [4] Defence & Security, and [5] Finance as a CE enabler. The MedTech Spotlight Report (Figure 7) has now been published, launched via a webinar on 7th March 2024 and presented to the Design for Life Advisory Board. A CE and Defence Position Statement has been a CE and Defence Position Statement has been shared with DSTL. Further CEctor reports on additional sectors will follow in 2024.

Figure 7: MedTech Spotlight Report, 2023, CEctor (CE Hub).

Accelerating New Solutions: Much of the NICER Programme work has focused on the co-creation, evaluation and acceleration of new solutions to enable improved sustainability and reduced environmental impact. Multiple solutions have been launched over the last 12-months including:

- The Circular Chemical Centre who are in the process of automating the workflows to quantify the economic, environmental, and social impacts of emerging circular technologies for producing chemicals and fuels, and applied such methodologies to explore opportunities for circular ethylene production on Teesside in collaboration with industrial partner NEPIC, which has significantly advanced their understanding of carbon-based chemical resources flow with a specific context of UK industrial clusters.
- The Circular Business Models for Metals report (Circular Metals Centre)
- The accounting sustainability hybrid tool (ICEC-MCM), the paper on targeting agricultural land take by enabling circular economy,
- TCC continued its engagement with IDEO, contributing to their 'Portfolio of the Future', presented at the Ellen MacArthur Foundation Summit 2023; currently on display at their London studio, and featured in their COP28 activation (Dubai)
- and the CX Scenario Building toolkit was validated with The Circle Rooms, an industry project in Richmond upon Thames and surrounding areas to work on future retail based on second use items, repair, hire and collaboration between sustainable fashion brands.

Figure 8: Regenerative Fashion Hub, London, 2023 (TCC).

These solutions have provided stakeholders with measures and frameworks to assess sustainability and environmental impact.

Leadership and co-ordination

The program has demonstrated strong leadership, coordination, and knowledge exchange with various stakeholders through a wide range of initiatives.

Formation of the International Centre of Excellence: The establishment of the World's first International Centre of Excellence on Sustainable Resource Management in the Circular Economy involving several NICER Centres, signifies national leadership and coordination efforts. This initiative aims to drive sustainable transition pathways for industries and communities, contributing to wider societal benefits, whilst demonstrating a clear route to the legacy of the programme.

CE Roadmap Dashboard and Publications: The CE-Hub launched the CERM Dashboard (Nov, 2023), integrating data from over 700 global CE roadmap documents and policies. This initiative, along with publications such as Navigating the path to circularity: A Guide to Circular Economy Roadmaps -Two-page summary, Towards a Typological Framework for Circular Economy Roadmapping: A Comprehensive Analysis of Global Adoption Strategies', 'Championing systems thinking to create a circular economy for chemicals' and a text book 'An introduction to waste management and circular economy' fosters knowledge exchange and creates a common understanding of definitions and language related to circularity.

Annual NICER Programme Showcase and ECR Summer School: Events such as the NICER Programme Showcase (Birmingham, May 2023) and ECR Summer School (Exeter, Sept 2023) have facilitated knowledge exchange, collaboration, and networking among stakeholders with a focus on ED&I awareness raising. These events enable researchers to learn from each other, establish new collaborations, and delve into in-depth discussions on circular economy topics with stakeholders. The final ECR Summer School & NICER CE Showcase (Figure 9) are to be held in Westminster, London on 24th & 25th Sept 2024.

Figure 9: NICER CE Showcase, 2024

Communication and Engagement Initiatives: The program engages stakeholders through various communication channels, such as the CE stories, CE-Hub Webinar Series, NICER Life Podcast and the Knowledge Hub and monthly Roadmapping and Whole System Transition Webinar Series - Met4Tech, ICEC-MCM lunch time webinars and TCC Seminar Series. These initiatives disseminate research findings, share best practices, and promote dialogue among stakeholders, fostering knowledge exchange and community building. A brand-new Interactive exhibition installation encourages visitors to learn more about critical minerals and the circular economy, Met4Tech Launch Museum Exhibit at Xplore! Wrexham - Met4Tech (Figure 10).

Figure 10: Museum Exhibit at Xplore! Wrexham, UK tour, 2023 (Met4Tech)

Policy Briefs and Industry Showcases: The program contributes to policy discussions through publications like policy briefs and participation in industry showcases, e.g., Future Fabrics Expo, London (The Sustainable Angle), TCC, attended by 2,000 people, reaching suppliers, manufacturers, innovators and brands; and where the Circular Chemicals CEC has our electrochemical CO2-to-olefin technology (Figure 11) has attracted investments from INEOS (UK's largest olefin producer) in the form of innovation fund for sustainable ethylene production.

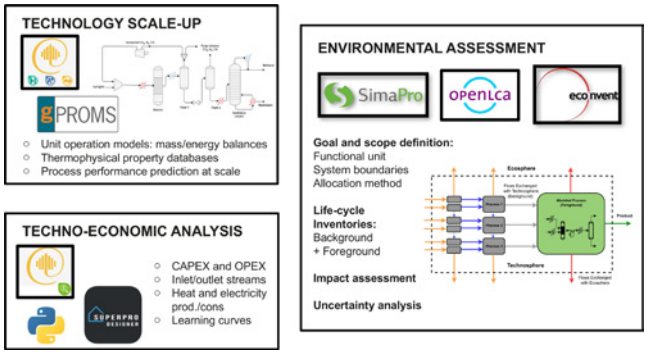


Figure 11: Electrochemical CO2-o-olefin technology, 2023 (CircChemicals)

The release of a policy brief on landfill tax, 'Landfill Tax, Construction and Demolition Waste and the Circular Economy' (ICEC-MCM, Figure 12), and collaboration on greenhouse gas emissions savings e.g., from designing exterior infill wall panels for deconstruction, showcases the program's engagement with policymakers and industry stakeholders, driving knowledge exchange and influencing decision-making. Overall, through these initiatives, the program effectively provides national leadership, coordination, and knowledge exchange across stakeholders, including businesses, policy makers, citizens and third-sector organizations contributing to the advancement of the circular economy agenda.

Figure 12: Dr Freja Lesniewska giving evidence at the Scottish Parliament, 2023 (ICEC-MCM).

Conclusion

Through its multifaceted initiatives, the NICER Programme emerges as a beacon of progress, driving advancements in the Circular Economy agenda. With a focus on scientific rigor, technological innovation, strategic partnerships, and stakeholder engagement, the programme continues to lead the charge towards a more sustainable and circular future.

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