Circular Economy for SMEs – Innovating with the NICER Programme
Round 1 Projects

MineLoop – Integrating high-resolution circular economy metrics within life cycle assessment software to drive resource circulation and reduce criticality of key technology metals

Project Lead: Minviro **GtR Link:** 10024920

Minviro Ltd is a UK SME pioneering world-leading Life Cycle Analysis tools to enable the mineral value-chain to radically improve their environmental credentials. Minviro is currently developing two LCA software products (for use by non LCA experts) to support:

- better design of mines/processing facilities/refineries (cradle-to-refinery-gate) (MineLCA).
- downstream users in battery manufacturing (cradle-to-factory-gate) to select materials with minimal environmental impacts (MineBIT).

By building on pioneering research by the Met4Tech Centre from University of Exeter Circular Economy Group (part of the National Interdisciplinary Circular Economy Research Programme 'NICER'), Minviro will be able to integrate circular metrics to its current LCA digital solutions. This software add-on 'MineLoop' will sit within its existing LCA tools, helping drive circularity at every part of the supply-chain (to lower the carbon footprint of each process step). Integrating MineLoop will enable Minviro to make transparent the environmental impact of CRMs from any Primary *and* Secondary source (including recyclates).

CIRCS - Circular Inhibitors Removing Corrosion Sustainably

Project Lead: Hexigone Inhibitors **GtR Link: tbc**

Hexigone's patented technology is changing the world of corrosion protection with their smart active reservoir technology that increase the lifecycle of assets in a more intelligent manner.

Within this project, Hexigone are investigating the use of a raw material that has historically gone to landfill or incineration, processing it into their intelli-ion technology so that 63% of the final product would be sourced from recycled materials.

The intelligent-ion products are already replacing toxic heavy metal-based inhibitors, providing assets with a longer lifecycle, reducing costs but also reducing the drain on the world's resources.

The grant provided will enable the Hexigone team to expand their capability to investigate the waste materials stream and quickly make an impact, changing to the new material source at the end of 9 months. The results of the grant funded program would fast forward an idea to reality, by being able to create time with extra resource to solely look at recycled products as a credible source of raw materials for the Intelli-ion product range, accelerating an idea and impact by 3-4 years.

ULTRALiC – ULTRAsound-assisted recycling of Lithium and Critical metals from spent lithium-ion batteries

Project Lead: NDT Consultants **GtR Link:** 10025905

This project aims at developing technology that will enable recovery of Lithium and other key metals from spent Lithium-Ion Batteries. The recovery will be carried out directly from the battery's electrodes without shredding the battery's components. Ultrasonics will be used to assist delamination of active metals from electrodes and to recover them. The process will be simple and cost-effective and, unlike the current industrial methods, will enable recovery of metals in a purity grade sufficient to re-use them in new batteries.

Re-Rheon 3D – Re-use of injection moulding waste for Additive Manufacturing Rheon

Project Lead: Rheon Labs **GtR Link:** 10026640

Re-Rheon 3D aims to address the reuse and upcycling of polymer waste generated during injection moulding, while creating the world's first strain-rate sensitive material for 3d printing. This is a collaborative initiative between Rheon Labs Ltd and the Additive Manufacturing Centre of Excellence and will focus on the development of a circular process for 3d printable Rheon. At the core of RHEON(tm) technology is a reactive polymer that intelligently strengthens when subjected to force. The technology can control energy of any amplitude or frequency - from small vibrations to life-threatening single impacts. Thus, the main use of Rheon parts is in helmets and other life-saving applications. Our parts are manufactured using traditional injection moulding, and thus create polymer waste in the process. While injection moulding is the method of choice for mass manufacturing simple geometries, we currently cannot reuse injection moulding waste and sprues in our production facilities in the UK. Thus, we cannot manufacture some of the customers complex and lightweight geometries. Currently about 5% of our material ends up as waste in the injection moulding process, due to sprues used for production parts, or parts that don't comply with the specs. This accounts for 2500 Kg and about £30,000 per year, and is predicted to grow to 6250 Kg and £75,000 in 2022. Thus, it is crucial to develop a process to re-incorporate this material waste into useful end-user parts, creating an environmental and economic benefit. In addition, we currently face customer requirements around lightweight parts with complex geometries, especially in the helmet industry, which we cannot meet using injection moulding. This project aims to address on the one hand the reuse of Rheon waste created in our manufacturing facilities, and on the other hand enable us to meet customer requirements for bespoke lightweight structures and advanced geometries.

Circular Economy Feasibility Study – Ecomar Propulsion – Clean marine propulsion systems for circularity and sustainable materials use

Project Lead: Ecomar Propulsion **GtR Link:** 10026882

Ecomar Propulsion Limited is at the forefront of designing and producing clean electric marine propulsion systems with its state-of-the-art electric outboard engine, electric inboard system and hydrogen/batter electric hybrid energy control systems aimed at large commercial vessels.

In collaboration with specialists in the technology metals circular economy at the University of Exeter's Met4Tech Circular Economy Centre, this project aims to conduct a 'whole-of-life' emissions valuation based on the initial design of Ecomar's product lines, and will explore how valuable materials can be responsibly sourced, recovered, recycled and reused to create a more robust supply-chain.

There are huge potential benefits to be gained from including the circular economy in all stages of the design process. Ecomar will use the results of this project to consider redesign of the products to replace non-recyclable components, creating clean energy systems with 100% recoverable and recyclable materials, and including materials that comply with recognised 'fair trade' measures. Outcomes will set a new benchmark for how large E Machines should be designed and manufactured, and will provide the shipping industry with informed direction as the decarbonisation process accelerates globally.

Digital platform technology research to enable producers to achieve greater product longevity and better end of life solutions

Project Lead: Twist Solutions **GtR Link:** 10026934

Twist Solutions Ltd is developing a digital platform approach to help consumers to move to more sustainable consumption, with producers taking greater responsibility for the longevity and end of life of their products.

In this project, Twist will conduct research to design a novel data prototype which holds a digital twin of each electronic sub-component of popular consumer products, including both environmental and economic impacts. Trials with early adopters will define which components most affect the extension of life, more sustainable sourcing of products, and an eco-design of new circular processes.

PreaDeM – Pre-demolition environmental assessment and decision-making platform

Project Lead: Reusefully **GtR Link:** 10027014

The project will undertake a feasibility study to determine how to measure the type and amount of materials, products and elements in a building and how they can best be a) reused and b) recycled at the end of their life. Currently this is undertaken through pre-refurbishment and pre-demolition audits, but they can be time consuming and are mostly ineffective. By developing an 'automated bill of quantities', better decisions can be made about the future or our buildings. This includes whether buildings should be refurbished or demolished and the impact this will have in terms of the materials arising and their carbon impact balanced with operational energy savings. As part of refurbishment or demolition, it is important that the value in the materials that may arise is retained i.e. they are either reused or recycled at a high value; following the principles of the circular economy. The focus of the project is on social housing since the client (property owner) has an inherent drive to optimise their assets whilst considering the carbon and cost impacts of their operations. There is much attention on the housing stock, in terms of its ability to be upgraded to meet carbon emissions targets and the opportunities this brings for the supply chain and benefits to occupiers. The project will work across two main areas - low carbon refurbishment and optimising value retention at demolition via a simplified approach that will enable development of a platform (PreaDeM) through understanding the user requirements, integration of data and related tools, trialling on housing projects, development of the business model for adoption and a technical specification.

Masterplanning for Circular Development – Beyond Whole Life Carbon

Project Lead: City Science Corporation **GtR Link:** 10027323

This project's vision is to specify and develop a new circular design tool for built environment professionals, which takes account of all impacts of the development (including induced activities such as transport, human activity and consumption). This will embed circular approaches at the earliest stage of design, reducing materials use and designing-out unsustainable consumption to deliver truly sustainable developments.

By embedding circular decision-making within the masterplanning stage, we will support a step-change in the adoption of circular economy approaches within the built environment.

Measuring impact, digitizing supply chains: A Material Impact Tool for the circular textiles economy

Project Lead: Roundrack **GtR Link:** 10027500

GHGs from the global fashion industry will be nearly double the level required to stay within 1.5 degrees of warming by 2030 (McKinsey,2020). With 70% coming from upstream activities, particularly energy-intensive raw material production (McKinsey, 2020), a fundamental shift is required in how textiles are produced.

The market for alternative, 'next-generation' materials designed from waste and bio-engineering is nascent but growing rapidly. These materials reduce reliance on energy-intensive agriculture and are designed specifically to build and support a circular textiles economy. However, the adoption of such materials in the industry remains low (McKinsey,2019) with barriers including cost, lack of material information and operational challenges of integrating new suppliers.

In response, Roundrack has developed an innovative, collaborative platform that addresses these barriers and creates one 'source of truth' for all stakeholders across the supply chain, from sourcing through to manufacture, streamlining and incentivising the integration of next-generation materials.

This project is a collaboration between Roundrack and The Royal College of Art, alongside selected pilot trial partners and potential future customers, to develop understanding of the commercial case for adoption of circular, next-generation materials, and validate additional platform capabilities in preparation for market-entry.

Circular Niobium

Lead Partner: Beta Technology **GtR Link:** 10027790

This feasibility study will assess the economic, technical and environmental opportunity to develop a value chain for the recycling of niobium products.

Globally about 0.3% of niobium is recycled back to a niobium product, which is derived from high content niobium products such as superconducting electromagnets. Niobium is present in very small quantities, ~0.1%, in items such as steel. Although the value of niobium products consumed in the UK is small their impact is high as it leads to high performance steels and new applications such as batteries where the contribution to UK GVA of niobium bearing applications is estimated at £13.5bn. Emerging applications such as high capacity and high charge rate batteries are using niobium.

The UK and Europe have no active primary source, and this creates a theoretical vulnerability for an area of strategic emphasis. This feasibility study seeks to understand the case for recycled vs primary and to develop a roadmap towards a market in secondary niobium.

DISRUPT – Delivering Innovative Steel ReUse ProjecT

Lead Partner: The Alliance for Sustainable Building Products **GtR Link:** 10028038

DISRUPT seeks to explore the innovative reuse of structural steel in construction and encourage the adoption of new circular economy business models that can help tackle the climate emergency. Steel is one of the most widely used and resource intensive materials used in construction. Although commonly recycled at end of life, the reuse of steel is minimal despite the apparent environmental, carbon and circular economy benefits. The high value of steel at end of life can be realised by being reused in a wide range of construction applications.

Previous studies have shown that there are barriers to reuse including economic factors, supply chain issues, availability, and lack of demand. New business models are required to ensure that the benefits of steel reuse are accrued across the value chain and underpin the activities of existing and new actors. DISRUPT seeks

to address these challenges by bringing together the leading actors involved in steel construction reuse - client, contractor, and stockist, and those that will be particularly impacted by the transition from a recycling to a reuse model, such as demolition contractors.

A detailed feasibility study will be undertaken focusing on real life case studies which track the 'journey' of reused steel from start to finish, providing a rich data source covering different sizes and types of projects, and variability in geographical location across the UK.

The project will deliver new costed circular business models that can act as a blueprint for other companies interested in entering the reuse sector, ultimately to achieve a greater supply of reuse steel into the marketplace. If steel reuse is to become mainstream, it is imperative that new business models are profitable and equitable to the whole value chain, and that reused steel is readily available and easy to specify within construction projects.

RevaluRepair: The Repair Economy – Assessing the economic, environmental and social impact of community repair of small electrical goods

Project Lead: Tech-Takeback **GtR Link:** 10028092

Tech-Takeback (TTB) currently offers residents of Brighton and Hove a collection system for end-of-life small electricals, via its service "RevaluElectricals". Since its launch in November 2020, the team have collected over 27,000 small electrical items from over 2,200 households, weighing 25 tonnes and saving a potential 2,000 tonnes of carbon if all items are reused. To date 1.1 tonnes of printed circuit boards have been separated for recycling and over 5,463 items have been repaired and redistributed for reuse. Working with The Restart Project (TRP) and supported by The Interdisciplinary Centre for Circular Metals (CCM), hosted by University College London we will undertake a feasibility study to "RevaluRepair".

Through this feasibility project we will:

- assess the value to the local economy (skills, jobs, revenue) of setting up a high street shop to resell the repaired products,
- quantify the CO2 emissions saved due to reduced consumption emissions, and
- Assess the social impact to the community of the repair service (skills, jobs, social contact, interaction with schools).
- determine the benefits of offering 3D printed parts for repair
- create a new multicriteria assessment matrix to determine the viability of repairing items that have been discarded as waste or sent for reuse.

Sustainable composite material for building surface maintenance

Project Lead: Pennog **GtR Link:** 10028142

Reductions in the toxicity and acidity of rain as a result of the Clean Air Act (1968) led to an uncontrolled proliferation of lichen and algae on surfaced in the built environment. Algae can cause unsightly staining of building surfaces. Lichen, which are a symbiotic relationship between algae and fungi, provide an anchorage point and nutrient source for moss on roofs. Moss growth on roofs block drainage channels and freeze and expand in winter, pushing slates apart leading to water ingress into roof spaces and losses of thermal integrity.

The roof moss cleaning industry currently uses environmentally damaging algaecide sprays to prevent lichen and moss re-growth. A process that needs to be repeated every 2-3 years. Copper wire, bands and ridge tiles, which oxidise and release copper over a roof surface provide a more environmentally-benign alternative

for moss control. However, copper surfaces oxidise rapidly and require roof access for abrasive polishing every 2-3 years to continue working.

In a previous Innovate UK project (103015) the project partners created composite materials composed predominantly of by-products from food and drink manufacturing industries, that could provide up to 15 years of maintenance-free control of algae, lichen and moss growth on a range of surfaces in the built environment. The wider benefits of this technology are a reduced use of organic biocide pollutants, a reduction in cost and potential roof damage risk for householders and use of non-renewable resources use and the re-purposing of waste materials. This project will identify and address the economic and technological challenges for introducing an innovative solution to further enhance environmental sustainability and a Circular Economy business model for commercialising the innovation.

ARMOUR – Artificial Reused Metal Offshore Underwater Reefs

Lead Partner: CCell Renewables **GtR Link:** 10028584

CCell designs electrochemically grown artificial reefs that mimic the wave attenuation properties of natural coral reefs. They grow offshore and are submerged below the water surface where they reduce the impact of waves before they reach the shore. The reefs are formed initially from lightweight steel structures, around which electrolysis causes rock to grow. These structures build themselves up over time using minerals extracted from the seawater itself, they can heal from damage, and they eventually form a self-sufficient long-lasting ecosystem that protects the shoreline behind it.

The UK is the biggest exporter of scrap metal in Europe, a large proportion of which is steel. There is an opportunity to reuse steel from buildings as the base material for CCell reefs, reducing their cost whilst contributing to the circular economy in the UK. The reuse of metal in this way is theoretically feasible; there is no reason why it would not be conductive and strong enough to form the base of CCell reefs. This project aims to address two main challenges:

- how used steel performs electrochemically compared to new and determine any treatment that might be needed to achieve the best rock growth.
- how the forming of reused steel into an appropriate reef shape might affect its strength and identify methods for creating a reef that is strong enough to carry out its coastal protection function.

CCell's vision is to install reefs across the UK that offer a more long-lasting and attractive coastal protection solution than traditional methods, reusing metals to make them as cost-effective and sustainable as possible.

Testing concrete-encased steel from the 1950s for direct reuse

Project Lead: Heyne Tillett Steel **GtR Link:** 10028656

Steel is commonly found in existing buildings. When those buildings are demolished, the steel scrapped, melted and recycled into new steelwork. While it sounds positive, it is very energy-intensive process. Some manufacturing methods cannot accommodate high volumes of scrap steel. In the UK, we generate more scrap than we can deal with, and 75% of it ends up being exported.

We need to close the materials loop and avoid remanufacturing when existing steel can be in perfect shape to be simply reused. Reused steel has a carbon footprint eight times smaller than traditional steel.

Steel made after 1970 was subject to standard manufacturing processes and sizes, so it is easy to validate for reuse. The Steel Construction Institute has a standard method to follow for those sections to be checked for reuse. But modern steelmaking started in 1855, so this leaves out a significant proportion of existing steel.

This project aims to validate a large stock of 1950s steel from four deconstructed buildings in London, by undertaking rigorous materials testing and quality analysis, and coming up with a reuse potential to keep the steel at its highest value. The project extends the scope of knowledge and understanding to a stock of materials that is not covered by current protocols and might facilitate the road to reuse for a larger proportion of existing steelwork, helping to further close the materials loop.

Medicycle – Circular economy solution for clinical plastic waste

Project Lead: Uvamed **GtR Link:** 10028719

Medicycle is a game changing medical plastics recycling system that will pilot the introduction of a circular economy business model by diverting recyclable plastic clinical waste generated in operating theatres away from incineration. Routine use of procedure packs, single use plastics and packaging in surgery contribute 29% of all hospital waste, 40% of which is potentially recyclable. This linear economy value chain produces potentially over 68,000/tonnes of recyclable waste for incineration/pa in the NHS. Current policy for theatre waste is to dispose of in clinical waste bags which require incineration at licensed facilities costing up to £1,000/ton.

Medicycle will improve on the current state-of-the-art in two important ways:

- Reduce the volume of recyclable plastic incinerated to reduce emissions of GHG's, reduce the burden of new polymer from virgin materials and support a circular economy for NHS plastic waste
- Reduce the costs to the NHS for waste incineration

Added benefits will filter through to industry supporting recycled plastics and reduce the burden on incineration capacity for clinical waste.

Medicycle diverts recyclable plastics at point of disposal, renders it safe in line with regulations to introduce into dedicated waste streams of PP, PE and PVC established recycling platforms, thereby supporting a transition to a circular economy for medical plastic waste and reducing dependence on virgin material.