UK Research and Innovation

Shaping the Future for the Foundation Industries in the UK

Projects from **Transforming Foundation Industries Challenge**, a UKRI Industrial Strategy Challenge Fund programme

Bruce Adderley
Challenge Director
UKRI Transforming Foundation Industries Challenge

Introduction

The Foundation Industries exist as we know them today because of a series of crucial innovations that allowed them to move from small craft production to large scale manufacture that is affordable across the globe.

Each industry has continued to innovate and evolve, meaning that if you look out over the London skyline today over 75% of all the man-made materials you see will have been made by these industries.

But now we need to meet the challenges induced by climate change and the need for long-term sustainability in all that we do. Just as in their beginnings, innovation will be key to enabling the Foundation Industries to meet these challenges and continue to underpin our economy.

The Transforming Foundation Industries Challenge is one response to this need and is a programme of interventions designed to stimulate scale-up of the innovation pipeline focused on creating a commercially sustainable future for these industries.

This brochure is a celebration of the inspiring projects now in progress under the programme, all around the UK.

Driven by forward-thinking companies, researchers and communities, together they are showing how we can achieve a sustainable future for the Foundation Industries in the UK.

Each project is different, but they share a common vision: to show that by innovating and working together, communities, businesses and investors can unlock the potential of the Foundation Industries and create sustainable materials to fulfil our future needs.

Bruce Adderley
Challenge Director
May 2022

Transforming Foundation Industries Project Locations

Fast Start

1. South Wales With Both Eyes Open: A Fast Start Project
2. Re-usable net-zero carbon structures
3. Hybrid Sintering for Decarbonisation and Productivity in Manufacturing
4. Intelligent Robotic Inspection for Foundation Industry Optimisation
5. Paper, Ash and Resin: Valorisation of Foundation Industry Waste Streams
6. Power CO2
7. Best practice and heat recovery in gas fired continuous furnaces
8. Enviroash
9. LevWave
10. Upgrading the value of BOS slag by addition of difficult to recycle glass or slags
11. SAFERII
12. Low cost catalytic conversion of methane to high purity hydrogen for use in the Foundation Industries

Large Collaborative R&D

1. AI6S
2. SAMRCD
3. CARBACEM
4. Computational formulation technique for developing resource and energy efficient functional coatings
5. Re-C3
6. Re-imagining industrial by-products to create a circular approach in the steel and cement industries
7. HiFib

Building a Resilient Recovery

1. Continuous production process for 3D printed ceramic foundry filters, suiting all applications
2. Novel EAF Composite Feedstock
3. Recovering cotton fibre from UK post-consumer, mixed composition textile waste for use in paper manufacturing
4. The World's first ceramic glazed tiles – made from 100% recycled materials
5. CLiCCC
6. Foundation Industry Wastes for Cement Encapsulants
7. Low Carbon Concrete Manufacturing Process
8. BACpack
9. GUITAR
10. Concretene
11. Transforming Cement & its Supply Chain with IoT, Machine Learning & Big Data
12. Feasibility of producing artificial pozzolana
13. Bio-based solvent identification and evaluation for use in polyurethane resin binders for the roofing
14. A novel biocatalyst platform for biobased-synthesis of 1,3-propanediol
15. SCI-FI
16. GRIFFIN
17. Breakthrough High Temperature Heat Pump Technology for Foundation Industry Decarbonisation
18. EcoLowNOx

There are also:

14 Small Scale R&D Projects

9 Investor Partnership Projects

TransFIRe Research Hub

Network+

By identifying and addressing common challenges, sharing best practice and new insights, we expect:

£1bn in GVA

8,000 skilled jobs

5 technologies, demonstrated at scale, that each improve efficiency by **>5%**

30 technologies developed with potential to improve process efficiency by **10%**

Alongside a more competitive UK Foundation Industries and a secure supply chain

Transforming Foundation Industries Challenge

4 years of research & innovation projects: 2020–2024

£66m government investment

£83m target for industry investment

>£130m industry investment forecast

60 business-led projects around the UK, involving:

180 businesses, universities, local authorities and other bodies working together

Shaping the Future for the Foundation Industries in the UK – the Vision

For the first time, the Foundation Industries (made of six separate sectors: metal, glass, ceramics, paper, cement and bulk chemicals) are working together to address their common challenges of competitiveness and sustainability. The programme of work will help create a modern, forward looking industry that has relevance in our industrial landscape and underpins our high value manufacturing industry and construction sectors amongst others.

We will achieve this through a mixture of activities that encourage: scale-up and piloting of promising technologies, cross sector working to drive innovation development, technology transfer from universities, private equity investment in fast growing companies, and the development of an identity for the Foundation Industries.

The Challenge will invest in technologies that will improve supply chain resilience, particularly focused on reuse and recycling of materials; develop new materials and services that reduce environmental impact; trial and research process technologies that reduce resource use and improve efficiency; and address cross cutting themes that affect the industry.

A Joined-up Approach

In the race to net zero, progress is now urgent, and a sustainable materials production industry is a large part of the solution.

To unlock this potential, key technologies, processes and business models must be trialled. Some of these are in their infancy, others later stage and need piloting in real plant environments.

The Transforming Foundation Industries Challenge has funded a series of targeted competitions, leading to over 60 projects.

They include:

12 Fast Start projects

18 Building a Resilient Recovery projects

10 detailed design projects

15 Small Scale R&D projects + Investor Partnership

Glass Futures

TransFIRe Hub and Network +

To embed the cross-sector spirit of collaboration engendered as the Challenge was developed, and to get it off to a 'fast start', this competition brought together businesses from different Foundation Industries to work on common resource and energy efficiency opportunities. These were relatively short duration (up to 12 months) industrial research and development (R&D) projects.

12 funded projects, with total project costs of £4.8m and £3.2m of grant costs, are now completed.

Building a Resilient Recovery was launched in response to the barriers to innovation created by the COVID-19 pandemic and aimed to catalyse innovation to support fast recovery and growth from Covid-19 through improvements in productivity and sustainability. A total of 18 projects were funded, with total project costs of £10.5m against £7.4m in grant. Recognising constraints imposed by the pandemic this competition allowed single industry applications, but most are multi-industry. Most of these projects are now complete.

In early 2021, Large CR&D was launched, enabling larger scale cross-sector collaborative R&D projects, seeking to improve the productivity and competitiveness of Foundation Industry companies including their supply chains. Seven projects have been funded with a total of £10.4m project costs and £7.2m grant costs, spanning all six of the Foundation Industries and a range of technological innovations. These projects are all running until late 2023.

Following discussions with the Challenge Advisory Group, who identified a gap within the collaborative R&D offering, Small Scale R&D aimed to primarily support smaller Foundation Industry businesses who are less familiar with Innovate UK competitions. In support of these companies, the minimum project sizes were set at just £25k, with smaller projects, under £75k, using a simplified application process. All 14 projects are now live and will run through to early 2023.

The programme also funds two important initiatives to support the foundation industries. The Network+ aims to form a network across the Foundation Industries, in academia and industry, and disseminate best practice. The TransFIRe Hub, an interdisciplinary, inclusive research and practice driven hub was established to develop interdisciplinary research for solutions that can be rapidly deployed within these industries.

Through all these projects and programmes, collaboration has been vital, with most projects bringing strong cross-Foundation Industry and often cross-supply chain consortium. Each partner brings their own expertise, from industrial or academic experts, to legal representation, consultants and trade bodies.

Each project is different, with its own scope and objectives and has a strong and exciting story to tell as part of the journey to net zero.

Find out more about the projects in this brochure.

"We are looking at a range of ways to maintain the momentum gained as part of this project and further our agenda towards a circular economy for South Wales. It has also provided brilliant insights which we hope other industrial clusters can draw upon and encourage discussions around clean-growth hubs across the UK"

Hannah Watts, Project Lead Sustainability Consultant, Environmental Resources Management

1 South Wales With Both Eyes Open

Facilitating industrial symbiosis in South Wales

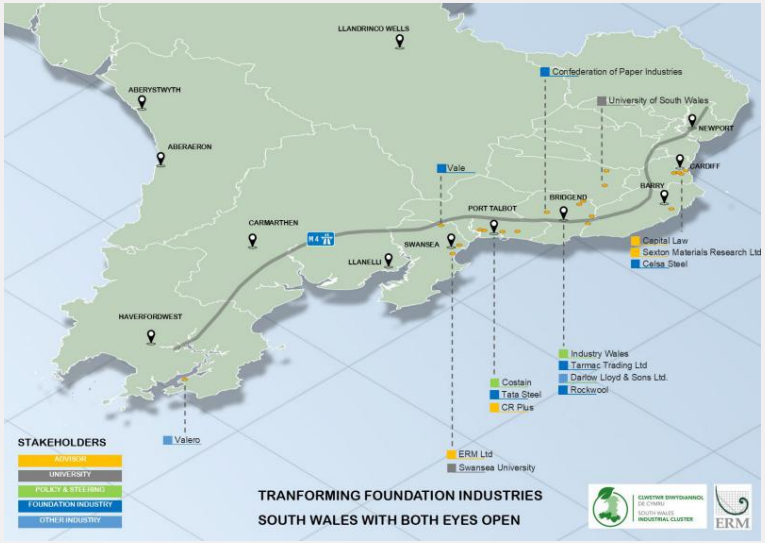
The Foundation Industries are energy- and materials-hungry but there is scope for savings to be made – particularly if industries across the sector work together to find solutions. South Wales with Both Eyes Open, a project set in the industrial heartland of South Wales, aims to remove the barriers to collaboration so industries can identify areas of energy and resource efficiency. Many Foundation Industries businesses are already looking at measures to reduce the amount of energy they use and waste they produce, but these initiatives are often siloed activities and the project team were clear: circular economy goals cannot be achieved in isolation.

The project brought together industries across the region, including paper, steel, insulation, refinery and chemical production. A review of their manufacturing processes – from feedstock input through to production and waste outputs – built a baseline picture of material and energy flows for each of the industrial sites.

Through a series of workshops, the project team facilitated a collaborative approach between the businesses, as well as engagement with key stakeholders, such as Welsh Government and Natural Resources Wales, to explore potential efficiencies on their sites. These raised a number of technology transfer opportunities, where often, the solution already existed within the region.

Key to the success of the project were the involvement of independent consultants, Sexton Materials Research for materials and CR Plus for energy, who could collect data and build a baseline picture from each partner. Legal partners, Capital Law, examined the regulatory and legal implications of these types of energy-related circular economy opportunities.

The project's conclusions will help inform plans for the imminent South Wales Industrial Cluster, which has recently received £1m funding through Innovate UK.



UKRI funding: £225k

Project partners

ERM Ltd

Tarmac Trading Ltd, Swansea University, Costain Ltd, Sexton Materials Research Ltd, Confederation of Paper Industries Ltd, Celsa Manufacturing (UK) Ltd, CR Plus Ltd, Vale Europe Ltd, Capital Law Ltd, Sector Development Wales Partnership Ltd, Rockwool Ltd and Valero Energy Ltd.

More information

https://www.swic.cymru
https://tinyurl.com/299fmazj

2 Re-Usable Net-Zero Carbon Structures

Pioneering energy-efficient, dismantlable reusable building structures

The project aimed to develop and demonstrate a reusable, long-span structural cassette solution made with clinker-free concrete and recycled steel, for commercial office and infrastructure applications. Through applying a prefabrication methodology, targeting 80% offsite, components would arrive on site as sub-assemblies and be installed as a single operation.

Through digital engineering and sensor technology, the project looked to optimise the product design-life and create an end-of-life deconstruction strategy, making elements reusable. The project also targeted ease of manufacture and onsite assembly, reduced complexity, improved safety, logistics and long-term performance.

The modules trialled recycled steel in the structural beams from project partners Hare, and cement-free concrete from DB Group, providing data and learnings from a real construction site for the team.

Compared to traditional construction, this approach will reduce:

- Embodied carbon within the floorplate by up to 80%
- Vehicle movements to site by 40%
- Labour resources for steel frame erection and following trades by 60%

Collaborative efforts between the concrete and steel industries are necessary to develop impactful low-energy solutions to meet the needs of future generations.

Together, the concrete, steel and construction industries are in a powerful position to influence significant change and the project looks to leverage this, showing that being energy efficient can also mean profitability for all three industries.

This project has been vital in demonstrating the potential of innovative technologies for large scale construction projects. It is only through partnerships and early-stage trials, that innovative players can progress in their scale up and commercialisation journeys. Tier 1's are integral to the development of new techniques and processes by providing the platform for validation.

Mace are already using the techniques in live tender bids with huge impacts on delivery time and carbon savings.

"We've used the concept design and a full scale factory test to gain live design feedback from potential future clients through working the cassettes into proposals. The feedback was cycled back into alterations of our mock up design increasing the viability of the product. Through varying details across the mock-up we have therefore effectively developed several assembly solutions which could open up multiple sectors for exploitation when we stand back and evaluate the result"

Martin Pike, Project Lead
Senior Construction Engineer,
Mace Group

UKRI funding: £200k

Project partners
Mace Group
AKTII
William Hare
Oranmore Precast
DB Group
Converge
UCL

More information
https://tinyurl.com/3m9x4am8
https://tinyurl.com/23ufzs3f

❸ Hybrid Sintering for Decarbonisation and Productivity in Manufacturing

Revolutionary densification technique with 50% energy reduction.

Sintering is almost always the most energy-intensive step in manufacturing, currently run over several hours at temperatures from 1000–1800°C, depending on the product. That's a lot of time, and a lot of energy going into the creation of materials that we can't live without.

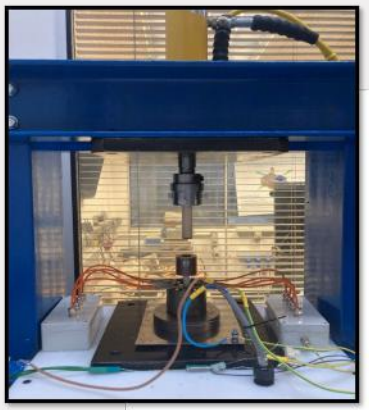
In this project, two new processes are being developed that, in combination, could dramatically reduce the time, cost and environmental impact of glass and ceramics produced from compacted oxide powders.

The potential impact of this project is considerable, given the vast number of applications that glass and ceramics have, including everything from electronic components to kiln linings, jet engines to hip replacements. Faster methods of sintering, which consume less energy, will give a competitive advantage to many different British businesses, as well as benefiting the environment.

The project combines an innovative process that Lucideon had been developing – 'flash sintering', which takes much less time than traditional methods – with an equally innovative technique that was being developed at the University of Sheffield – 'cold sintering', which uses pressure to sinter glass and ceramic compacted powder at much lower temperatures (100–200°C).

The project resulted in the commissioning of a new process demonstrator, relevant to the ceramics and glass industries, testing against benchmarked material through standard processes.

Research is continuing to apply this technique in a number of different applications and scale up the sample size.



UKRI funding: £260k

Project partners
Lucideon
Glass Technology Services
University of Sheffield
Knowles
Vesuvius UK

More information
https://tinyurl.com/mr2jtsd6

"We knew that flash sintering was promising, and that it would have huge potential if it was combined with cold sintering. This could form a combined process that is both quicker and less energy-intensive, hence our decision to apply for grant funding from UKRI and work collaboratively"

Stuart MacLachlan,
Project Lead, Head of R&D,
Lucideon

4 Intelligent Robotic Inspection for Foundation Industry Optimisation

Machine learning, vision systems and robotics are being used to detect defects and improve repeatability in glass and ceramics production processes – increasing productivity and reducing energy consumption.

A tiny inclusion on toughened glass can cause it to shatter, while unevenly dried clay can distort, crack or even explode when fired in a kiln. Imperfections and inconsistencies in Foundation Industries production processes reduce productivity and increase waste, but detecting these flaws can be difficult, energy-intensive and time-consuming.

Intelligent Robotic Inspection for Foundation Industry Optimisation (IRIFIO), aims to create faster, more accurate inspection systems by utilising cutting-edge machine learning and robotics technology. The project explored how vision sensors and associated algorithms could be adapted to create similar improvements to the glass and ceramics production processes.

The UK produces £307m of toughened glass each year for use in architectural and vehicular applications, but around 1% of panels are affected by difficult-to-detect Nickel Sulphide (NiS) inclusions. These can cause failure in panels months and even years after installation, resulting in significant commercial implications for both panel manufacturers and end-users. Through machine learning, the team developed a system that can establish whether flaws are NiS inclusions within the glass or dust sitting on top.

Ceramic production of all types requires hard-to-achieve repeatability. For sanitary ware, there are issues around drying the clay: too wet and energy is wasted firing the kilns; too dry and it risks cracking when fired.

By creating software to overlay thermal data on machine vision sensors, IRIFIO was able accurately assess the critical moisture content of clay, creating potential for significant cost and environmental savings in terms of reduced energy use and increased production yield.

The technology enables highly-accurate, repeatable production processes – reducing waste, energy expenditure and cost. Crucially, it allows the Foundation Industries to respond to the demands of a lower-carbon future.

"This proposed solution will allow for highly accurate, repeatable production process measurements that will highlight defects using in-process, non-destructive testing of materials. This will benefit resource and energy efficiency, producing significant cost reduction"

Richard French,
Project Lead
Senior Systems Scientist, i3d Robotics

UKRI funding: £110k

Project partners
I3D Robotics Ltd
Glass Technology Services Ltd
Lucideon Ltd

More information
https://i3drobotics.com
https://www.lucideon.com
https://www.glass-ts.com
https://tinyurl.com/2ey6xvj3

5 Paper, Ash and Resin: Valorisation of Foundation Industry Waste Streams

Valorisation of waste products from Foundation Industries to create innovative, eco building materials.

Despite significant improvements in recent years, a substantial amount of waste from the Foundation Industries still ends up in landfill. A new project aims to change this with the commercial development of eco-friendly construction boards that not only make use of industry by-products, but offer a lower-carbon, lower-impact alternative for building projects too.

Cambond has created a bio-resin for use as an alternative to oil-based glues, such as urea formaldehyde, which are often used to bond together MDF in construction boards. The resin is made using the waste grain from the bioethanol industry and uses about 40% less carbon than the production of urea formaldehyde. Cambond worked with the world-leading pulp specialist Sappi Biotech and the Bio-Composites Centre at Bangor University to develop and test a new 'eco-board' that is bonded with its bio-resin and also makes use of other waste streams.

By adding paper sludge, which is a waste product from the paper industry, and ash from power stations, this replaced the need for some of the virgin wood that usually makes these boards. But beyond this, these waste materials also contain elements that can give the boards additional properties. The ash, for example, can improve fire resistance, so it removes the need to treat a finished board with more – potentially toxic chemicals.

Crucially, the project team tested manufacture of the eco-boards in a commercial setting, working with a wood panel manufacturer and the Bio-Composites Centre at Bangor University.

Demonstrating the bio-resin can be produced at scale in the UK is important because the quantities required by industry are significant – the UK alone uses around a million tonnes of urea formaldehyde glue and produces 4 million construction boards a year. The project also explored the use of waste ash in composites for ceramics and moulding.

The team is continuing to look at the creation of a pilot plant to start bulk manufacture of the resin.

"Better use of waste streams can reduce the amount going to landfill, replace the use of scarce or expensive virgin resources, and reduce overall carbon footprint – all at a lower cost to these industries – turning environmental problems into commercial opportunities"

Xiaobin Zhao,
Project Lead
Managing Director, Cambond Ltd

UKRI funding: £190k

Project partners
Cambond Ltd
Bangor Universiy
Sappi Biotech Ltd

More information
https://tinyurl.com/tpfhbj48

"As an organization that traditionally has been reluctant to engage outside the realms of day-to-day business our partnership in the PowerCO2 project has proved beneficial way beyond the scope of the project itself. Stepping into the R&D and Innovation arena has been a cultural shift for CELSA UK that could only have been achieved through the Innovate UK TFI programme participation. Cross sector collaborative engagement has facilitated the quality of Knowledge Transfer that is not always possible when staying within industry comfort zones."

Eoin Bailey,
Project Lead, UK Innovation Manager,
Celsa Steel UK

6 PowerCO2

Transformative increases in efficiency for heat recovery in the Foundation Industries.

PowerCO2 is a heat recovery technology which creates electricity from waste heat using an advanced thermodynamic power cycle. It offers a number of key advantages over conventional Organic Rankine Cycle (ORC) systems through the use of CO2 as the working fluid.

Conventional ORC devices typically use working fluids with high global warming potential (GWP) and are limited in the temperature of the waste heat stream due to the requirement to use a heat transfer medium such as thermal oil.

CO2 is environmentally benign and offers good heat transfer properties at high temperatures. A key aspect of the PowerCO2 cycle is the use of a transcritical ejector system to improve the overall efficiency of the cycle. The transcritical ejector system uses the heat energy in a vapour CO2 stream to pressurise a liquid CO2 stream, leading to greater efficiency in an integrated cycle. Overall PowerCO2 heat recovery can offer high efficiency and the ability to operate directly on high temperature waste heat streams with the use of an environmentally benign working fluid.

Calculations completed by the team show the PowerCO2 cycle is able to improve the power output by ~35% on the standard Brayton cycle by extracting more thermal energy from the system whilst improving the cycle efficiency.

After further research, where University of South Wales is hoping to demonstrate their unique pressure uplift shown in their models, they have plans in place to engage with manufacturers so exploitation of a PowerCO2 product can begin in earnest, particularly using the opportunity to utilise the Glass Futures Global Centre of Excellence facility as an at-scale demonstrator.

UKRI funding: £390k

Project partners
Celsa Manufacturing Ltd
Glass Technology Services
Glass Futures
Venturi Jet Pumps
University of South Wales

More information
https://www.celsauk.com

7 Best Practice and Heat Recovery in Gas Fired Continuous Furnaces

A project comparing best practice for waste heat recovery in the brick and steel industries has identified ways to reduce gas use and carbon emissions.

Companies from the UK steel and brick making industries have come together to explore ways of recovering waste heat and making their furnaces more efficient – helping to reduce energy and carbon emissions.

The steel and ceramics sectors both use gas-fired furnaces in continuous operation at temperatures in excess of 1,000°C. Although both industries currently utilise some of the waste heat – for example, to help dry out bricks – this project explored the potential for further energy savings.

The team compared a reheating furnace operated by British Steel with brick kilns operated by Wienerberger UK. They mapped the energy flows of both processes to give a clear understanding of where energy, particularly heat, enters and leaves, where it is recycled, and where it is used in further processes.

The analysis identified opportunities to utilise more of the waste heat, including:

- Re-using heat from the cooling systems to pre-heat the combustion air in brick kilns
- Generate electricity from excess heat in the furnace cooling system
- Use heat from the steel furnace exhaust to generate electricity by installing a heat-capturing turbine called an organic rankine cycle turbine.

Even modest efficiencies can result in significant fuel savings – for example, using waste heat to raise the temperature of combustion air by 40 degrees can reduce the amount of gas used by between 3–9%.

The project findings have been taken on board by partners, with Wienerberger UK investigating waste heat ideas and British Steel exploring future combustion efficiency options. The results have also been shared more widely across the two sectors, which includes more than 40 other brick kilns and 20 steel reheat furnaces.

UKRI funding: £45k

Project partners
Materials Processing Institute
British Steel
Low Carbon Europe Ltd
Wienerberger UK

More information
https://tinyurl.com/ps3spyef
https://tinyurl.com/t2bcu9zj

"This project is a successful example of how the steel and ceramic sectors have worked together, supported by Innovate UK, to share expertise and develop practical solutions to reduce carbon emissions. The outcome of this particular project is encouraging, having identified ways to refine an already highly efficient process by improving heat recovery and combustion technologies"

Chris McDonald,
Chief Executive,
Materials Processing Institute

> **"When there is increasing pressure on brands, retailers and the wider industry to become more sustainable, there's no better time to look into solutions to expand circular economy and the availability of secondary raw materials through industrial symbiosis"**
>
> *Chris Holcroft,*
> *Project Lead, Principal Technologist,*
> *Glass Technology Services*

8 Enviroash

Collaborating to achieve best use of by-products across the Foundation Industries.

EnviroAsh expands upon an established consortium, with a proven track record of developing raw materials from wastes within the UKRI funded EnviroGlass 2 project, introducing new partners from other Foundation Industries (Hanson, Wienerberger, Saica, Glass Futures Ltd) to expand the range of wastes to be investigated and final products that can benefit from these materials.

By taking a cross-sectoral approach and involving a wide range of stakeholders, it has been possible to link producers and users of waste materials together and facilitate coordinated practical research and trials with real world expertise.

EnviroAsh identified routes to convert and optimise waste streams from across the Foundation Industries and energy sectors into new raw materials.

This was achieved through modifying the core process and developing post-processing techniques, converting disposal costs into opportunities for income generation. In doing so, new feedstock inputs were developed, creating lower-cost raw materials, whilst reducing environmental impacts (e.g. reduced landfill and mining operations, lower furnace/kiln temperatures) and exploring how these new waste-derived materials might enable cost-effective routes to improve product performance, thus increasing product value and reducing manufacturing costs.

During the project:

- Slate mine tailings have been trialled on a commercial scale as a raw material for cement manufacture.
- Ash from biomass power stations has been trialled in the laboratory for addition to cement manufacture and brick manufacture.
- Ashes from biomass power stations have been trialled at pilot scale in glass during a previous project and slate waste has been trialled in the lab for glass manufacturing.
- Trials have taken place to investigate beneficiation of waste materials using commercial scale equipment to prove the large scale viability of producing sufficient material of good quality at commercial scale.

UKRI funding: £365k

Project partners
Glass Technology Services Ltd
University of Sheffield
Sheffield Hallam University
Power Minerals Ltd
Glassworks Services Ltd
Glass Futures Ltd
Encirc Ltd, Saica Paper UK Ltd
Drax Group PLC, Wienerberger Ltd
Castle Cement Ltd

More information
https://tinyurl.com/58cnmnnp
https://tinyurl.com/4yur5yjz

9 LevWave

Examining the potential for valorising paper streams in the chemical industry.

Levwave brought together two Foundation Industries, the Paper and Chemical sectors to support the UK drive to achieve a prosperous zero-carbon future by developing a new manufacturing technology of benefit to both industries.

The overarching objective was to assess the commercial viability of the valorisation of cellulose containing streams from the paper industry to produce a sustainable building block for the chemical sector. This was to include both techno-economic and sustainability assessments (TEA, LEA) using new experimental data generated during this project.

Building on previous work, the heart of this concept is the microwave assisted catalytic transformation of aqueous biomass containing streams into levulinic acid, (LA). Focus was on producing LA, which is gaining interest as a green solvent, precursor to advanced polymers and more widely as a versatile platform molecule for pharmaceuticals, plasticisers, fuel additives and commodity chemicals with the potential to replace fossil derived materials. Whilst it has been identified as a key sustainable chemical of the future, it has yet to be produced in the UK. It is felt that a successful exemplar project could be replicated across the UK.

Levwave executed a convergent approach to process optimisation; 30 selected catalysts were synthesised, appropriately characterised and tested at laboratory scale. Three leading candidates were then subjected to an optimisation methodology allowing two final materials to be tested under (semi) continuous flow operations in custom built equipment. In parallel, technoeconomic and environmental assessments were be carried out alongside a competitive study of alternative uses of the feedstock.

The refinement of the business case occurred throughout the lifetime of the project. This culminated in the development of a commercialisation strategy and the identification of next steps. The outcomes from Levwave will enable the paper sector to exploit a potential option to valorise process streams, whilst for the chemical sector it will enable a possible competitive advantage in a key platform molecule.

“Levwave enabled great advances in the field of heterogeneous and synergistic catalysis and shed light on the potential of paper sludge conversion to platform chemicals”

Dr Silvia Tedesco,
Senior Lecturer in Engineering,
Manchester Metropolitan University

UKRI funding: £50k

Project partners
Drochaid Research Services
Croda Europe Ltd
Saica Paper UK Ltd
Manchester Metropolitan University
Britest Ltd

More information
https://tinyurl.com/bdhdzpdp

10 Upgrading the Value of BOS Slag by Addition of Difficult to Recycle Glass or Slags

Extracting the best possible value from steel industry by-products.

The UK steel industry produces around 550,000 tonnes of coarse steelmaking slag annually but its uses are limited by slag chemistry and form. This can result in low grade uses or failure to re-use including landfill. The project objectives were to make a number of new slags, at the kg scale, by taking existing BOS slag and modifying with a number of alternative high silica sources.

Steelmaking slag from the integrated route (BOS slag) is sold to processors such as Tarmac, crushed, and used for road top surfaces. However, it's skid resistance, as measured by its Polished Stone Value (PSV), is not suitable for the top grade of road surface, for which virgin aggregate is used. Modifying the slag to increase the silica content after it is tapped from the BOS vessel should improve its PSV and consistency. The slag modifier could be slags arising elsewhere in the process, such as desulphurisation slag, or secondary steelmaking slag.

Other likely sources of modifier include certain streams arising from the glass industry, including waste streams contaminated by aggregates, mixed colours, and fines, which cannot be returned to the process, and also high silica arising from refractory waste.

Thus this project links a steel company, the glass industry and the slag consumer. It will use material that either goes to landfill or is difficult to reuse, using a modified by-product slag to produce an aggregate replacement of higher value.

Thermodynamic modelling was used to define the mixtures to achieve the aim mineralogy but technical challenges were faced in scaling up the process. The consortium will look to continue this work as the modelling predicted higher value, higher utilisation volume products.

UKRI funding: £70k

Project partners
Materials Processing Institute
British Steel Ltd
Glass Futures
Tarmac Trading Ltd
PWS Road Building Services

More information
https://tinyurl.com/msjv8ay4
https://tinyurl.com/bdf27nu5
https://tinyurl.com/yeyn9vzr

"The UK steel industry produces around 550,000 tonnes of coarse steelmaking slag annually. A commercially viable material will reduce waste, contribute to the circular economy and increase the competitiveness of the steelmaker, glass producer and material processor.
We are confident this investment will pay dividends for the UK economy and further enhance this country's expertise in research and innovation"

Chris McDonald,
Chief Executive,
Materials Processing Institute

11 SAFERII

Developing a safe insulative cladding material using waste materials from Foundation Industries.

Recent tragic events, such as London's Grenfell Tower fire in 2017, clearly highlighted the national and international need for non-combustible building cladding. The SAFER project directly responded to this need for a non-combustible, toxicity free insulative cladding system for domestic applications, and for the much larger industrial market applications. The project incorporated waste materials from blast furnaces as a binder into the insulation core formulation and replace PIR foam core composite cladding with low-temperature ceramic materials.

This project is game-changing as it seeks to deliver an inorganic insulative cladding product for buildings with performance akin to Polyisocyanurate (PIR) foam, with the significant benefits inorganic materials bring in safety from fire, both from non-combustibility and absence of toxic smoke emissions. The current state-of-the-art insulation materials for construction applications is PIR foam and mineral wool materials. With respect to fire performance, mineral wool is currently the only material classed as non-combustible but has a significantly poorer insulation performance compared with PIR materials. The innovative SAFER project was based on the novel Alsitek insulation material FIRETEK and will be sought to match the fire performance of mineral wool whilst attaining PIR level insulation properties.

During the project, a clear method of producing insulating material which would be compliant with thermal performance standards was identified, but it relied on organic additives which may have detrimental effect on our ability to re-cycle the material at end-of-life. Balancing structural integrity properties without costly additives such as graphene was a challenge, as well as constraints on curing time due to line speeds.

If further exploration into feasibility is undertaken, the team have identified several routes which could be explored including the use of aerogels, different grain sizes of PIR and further work with graphene.

UKRI funding: £140k

Project partners
Alsitek Ltd
Tata Steel UK Ltd

More information
https://www.alsitek.com
https://tinyurl.com/ycy6da2y

12 Low Cost Catalytic Conversion of Methane to High Purity Hydrogen for Use in the FIs

Extracting hydrogen as a by-product from manufacture of carbon nanotube for use as a process chemical within the Foundation Industries.

This project aimed to realize shared opportunities for use of hydrogen by-product from functional carbon production as a supply to float-glass manufacturing. The nanocarbon process can be used to provide low cost catalytic conversion of methane to high purity hydrogen for use as a process chemical within the Foundation Industries. In the proposed process carbon is symbiotically produced in the form of high value nanocarbons, resulting in efficient use of resources and a multifunctional process.

This project brought together two Foundational Industries, bulk chemical and glass production, to realize shared opportunities for use of hydrogen by-product from functional carbon production as a supply to float-glass manufacturing. This high-impact feasibility study showed strong potential to add value to key UK industry sectors. The focus prior to this project in developing nanocarbon materials had been on the production of solid, high value, carbon nanotube (CNT) mat, tape and fibre products from methane. This success has led to the realisation that with a re-focusing of effort the nanocarbon process can also be used to provide low cost catalytic conversion of methane to high purity hydrogen for use as a process chemical within the Foundation Industries.

The project successfully brought together the glass and chemicals sector to identify symbiotic partnerships. The team are now looking to scale up their process in a demonstration at the Glass Futures site in St Helens, and a specification has been drawn up within the current project, de-risking scale up.

Key targets are volume production of 'green' hydrogen from methane and establishing Q-Flo as a high value raw material supplier into the UK's Li-ion battery supply chain.

"Q-Flo is establishing its self as a UK based, volume producer of 'green' hydrogen. It achieves this by using waste heat, from the foundation industries, to convert bio and natural as methane into hydrogen and high value carbon products."

Martin Pick,
Project Lead,
COO, Q-Flo

UKRI funding: £250k

Project partners
Q-Flo Ltd
University of Cambridge
Glass Futures Ltd
Accelyo Ltd

More information
https://q-flo.com

1 Continuous Production Process for 3D Printed Ceramic Foundry Filters, Suiting all Applications

Processing of novel filters for industrial applications.

CAT International Ltd, a leading manufacturer of foundry filters and consumables, have developed a novel ceramic formulation (covered by a patent) and process that ensure high quality, reproducible filters for use in the metal casting foundry sector. During the project, they developed an additive manufacturing process and proprietary ceramic formulation (pre-sintered ceramic materials combined with inorganic resin) that can be used to fabricate the filters. Having undertaken initial feasibility work prior to the project, their aim was to continue further industrial research to optimise their manufacturing process and formulation and test the materials in terms of properties and user needs.

By using their new innovative process, the project team sought to enhance performance throughout the supply chain which will minimise materials wastage associated with defective parts. This will then minimise energy usage where the same inputs can create more usable parts as a result of better liquid metal pre-processing.

The team demonstrated their technology in a 1 tonne steel pour and launched the product at CastExpo in the USA. Commercial trials are lined up for Autumn 2022. The team are also applying their flexible technology to create variable pore filters and specialised geometries for other industries.

UKRI funding: £285k

Project partners
CAT International Ltd

More information
https://www.cat-intl.com

2 Novel EAF Composite Feedstock

Novel, lower energy, composite pellets for electric arc furnaces.

This project has developed a novel, composite feedstock for Electric Arc Furnaces (EAF). These composite pellets are designed to feed fresh iron units into the EAF without the need for capital and energy intensive induration. The pellets are produced using a cold process and will be used to create clean, high-quality steel.

The team are targeting 30% cost savings vs other steelmaking additions such as direct reduced iron, hot briquetted iron and scrap metal. These can then be used in both standard steelmaking and in EAFs. The process will significantly reduce energy usage and CO2 emissions in the steel making process.

Not only have the project team been developing the pellets themselves, but also considering the changes to furnace operation practices necessary to introduce the composite pellets, developing standard operating procedures for pellet feed, and adapting a pilot scale EAF for trials.

The technology provides a sustainable solution to help the UK remain competitive in a constantly evolving market place, incentivising investment whilst safeguarding and creating new jobs. A number of customers have been engaged in testing and commercial scale up discussions. The team are currently validating their work with a full independent Life-Cycle Analysis to assist in demonstrating the environmental benefits to customers.

UKRI funding: £755k

Project partners
Binding Solutions Ltd
Materials Processing Institute

More information
https://tinyurl.com/343a3jx4

3 Recovering Cotton Fibre from UK Post-Consumer, Mixed Composition Textile Waste for use in Paper

Developing a novel process to utilise textile waste in the paper industry

Within this project, the team at James Cropper are working on a unique innovation examining the use of alternative natural fibres (sourced from a UK post consumer waste stream) for the papermaking process.

The UK is the fourth largest producer of textile waste in Europe with only 10% currently being recycled – more than 200,000 tonnes of UK textile waste is sent to landfill or burnt every year.

The team will study the use of UK post consumer textile waste used as a raw material in the papermaking and moulded pulp processes.

The project is looking at separating the cotton and polyester using a combination of flotation treatments and surfactants. This has been shown to have a high degree of efficiency and promising for use in paper.

An industrial trial using up to 50% recycled cotton has been trialled in the paper production process. This was successful and produced 3 tonnes of paper using existing paper processes and provides samples ready for commercial marketing.

The product range has been recently launched at Packaging Premiere in Milan alongside other innovations from James Cropper.

The team are now scaling up the separation of fibres at a pilot scale trial. This will optimise their understanding ready to commercialise the product range.

UKRI funding: £50k

Project partners
James Cropper

More information
https://tinyurl.com/2w24xker
https://tinyurl.com/2p8hhpxr

4 The World's First Ceramic Glazed Tiles Made From 100% Recycled Materials

Utilising waste materials to create a tile range from 100% recycled sources

ALUSID's current glazed tile range comprises of around 95% recycled content. The aim of this project was to develop the world's first mass-produced, commercially available tile range made from 100% recycled waste – eliminating any reliance on virgin raw materials.

Producing the world's first and only truly sustainable tile, would offer a paradigm shift in ceramic tile manufacturing, whilst providing ALUSID and the UK tile industry with a significant commercial advantage over global competitors.

During the project, the team explored different glaze formulations using different waste materials, and applied them to tiles on an automated glazing line under scaled production trials. The wastes included recycled glass and ceramic streams and gave three finishes: matt, semi-matt and gloss. Despite initial challenges relating to the particle size of certain raw materials, a methodology was developed for resolving this issue.

All formulations have been chemically analysed to ensure no undesirable or hazardous trace elements are present and that sufficient consistency can be achieved for a commercial product range. The prototype tiles all met BS quality standards.

The team are looking to continue strengthening their relationship with a view to introducing a pilot production range as well as approaching other manufacturers and scaling up production.

UKRI funding: £70k

Project partners
Alusid
Original Style

More information
https://www.alusid.co.uk/

5 Foundation Industry Wastes for Cement Encapsulants

Design of lower carbon cements for encapsulating nuclear wastes

Often nuclear wastes are encapsulated in concrete to protect the people and environment. These cement-based concretes are not only energy intensive, but also not the most efficient in encapsulating nuclear waste, meaning more cement is required, and greater volumes of radioactive contamination to store.

Foundation Industry (FI) wastes such as coal fly ash and ground granulated blast furnace slag can potentially be used in geopolymer cements to give more effective encapsulation of hazardous wastes compared with Portland Cement, which is extensively used at present. These also make the cement less energy intensive to produce.

This project is evaluating sources and types of FI wastes in the UK to select candidates for encapsulation trials and to assess their business potential, namely work focuses to:

Develop geopolymer formulations and process methods to encapsulate simulant wastes using FI wastes as a key cement component.

Maximise the amount encapsulated within the geopolymers

Characterise properties of the composites to indicate compliance with disposal requirements

The project has successfully encapsulated simulants of oils sludges, zeolites and graphite.

The project was presented at WM2022 with content well received. They are now working with potential customers to exploit this technology.

UKRI funding: £110k

Project partners
Lucideon
NUVIA

More information
https://tinyurl.com/2p8kfyxr
https://tinyurl.com/bdh3btn6

6 CLiCCC

Co-production of raw materials for the industrial minerals and battery metals industries.

This project has the potential to significantly enhance productivity for the kaolin industry whilst creating an entirely new lithium industry for the UK economy.

The potential to produce lithium from minerals found in china clay waste (from current and historic material) increases resource efficiency and environmental sustainability, builds a circular economy by reducing waste and generating additional revenue sources, and helps secure the long term viability of the British china clay industry.

During the project, a large number of waste streams have been sampled, a mixture of operational streams and historic waste streams. Each have been analysed for mineral content to give an indication as to lithium potential.

The material was then studied to assess the amenability of lithium processing and extraction alongside kaolin production. Next, the economic potential of extracting lithium was calculated, alongside a review of the technologies and infrastructure options available.

Finally an LCA was completed to consider environmental effects, and an environmental and social assessment to consider the value to the local area and any detrimental effects from new waste streams.

UKRI funding: £715k

Project partners
Cornish Lithium
Imerys
HSSMI

More information
https://tinyurl.com/2p8ujf3u
https://tinyurl.com/39mutxj7
https://tinyurl.com/2ztjw9ah
https://tinyurl.com/5n6sx7uf

7 Low Carbon Concrete Manufacturing Process

Utilisation of waste materials to provide a low carbon solution for the concrete industry

Recycl8 has developed a low carbon concrete manufacturing solution which utilises a waste material otherwise destined for landfill.

This solution will make a significant contribution to improving carbon reduction in the UK, Europe and worldwide and will assist towards satisfying the requirements of the Paris Agreement for carbon reduction.

The development of this solution involves the transformation of Incinerator Bottom Ash (IBA), a waste material from the waste to energy plants, into a cost effective additive in the manufacture of concrete and will partially replace high CO2 emitting cement and reduce the use of virgin quarried materials. This will utilise the waste material and prevent large quantities of IBA being sent to landfill and contribute significantly towards the circular economy.

The project aimed to demonstrate that IBA can be successfully used in the manufacture of concrete, lower the carbon footprint, and allow IBA to be given End of Waste status from the Environment Agency allowing a much more economic business case for its application.

Following a maturation process, which allows the IBA to sequester CO2, absorbing it from the atmosphere, a catalyst is added.

The resultant IBAA (Incinerator Bottom Ash Aggregate) and R8 Mix will reduce the embodied carbon in concrete. The technology also ensures heavy metals are bonded within the concrete and cannot leach into the environment.

The concrete is overall stronger, and with a higher heat resistance to traditional cement with impressive environmental credentials.

UKRI funding: £165k

Project partners
Recycl8

More information
https://www.r8iba.com

8 BACpack

Technical, economic and sustainability assessment of the potential for aluminium manufacturing in the UK

The BACpack feasibility study examined the potential to recycle low carbon scrap for the manufacture of aluminium sheet for packaging and other large-scale applications within the UK. This is an essential development for the aluminium industry as a key part of UK's Foundation Industry (metals) for both its future productivity and sustainability.

The study provided the technical and economic verification of the route for the UK's aluminium industry to re-shore the manufacturing of aluminium sheet packaging products that are all presently imported into the UK.

This was based on efficient manufacturing processes and the use of UK based recycled low carbon aluminium as its feedstock. This will make the manufacturing of aluminium sheet packaging products in the UK both globally competitive and at the same time environmentally friendly particularly as the UK decarbonises its electricity generation capacity.

The economic feasibility considered the sources of UK scrap available, costs of sorting technologies required and manufacturing costs. A life cycle assessment also covered the cost, energy and carbon savings through a recycled route. The team are now working with a wide consortium to establish viability.

UKRI funding: £130k

Project partners
Keen Ltd
Innoval

More information
https://www.keen.biz
https://www.innovaltec.com

9 GUITAR

Developing a concrete free from cement using foundation industry waste products

GUITAR will deliver environmental and sustainability impacts across the glass, cement, steel and bulk chemical industries. GUITAR adopts the principles of a circular economy and industrial symbiosis; converting one business' waste into valuable resource/feedstock for another.

Waterglass, or sodium silicate, is used in a number of applications including textiles, ceramics, silica gel and in compound formulations. It is formed by melting soda with quartz (silica sand) in a high temperature energy intensive process before mixing with water and pressurised steam.

The GUITAR project is demonstrating a manufacturing process for waterglass from waste glass., almost 1000°C lower in temperature and 1/10 of the price.

This waterglass is suitable for producing "cementless" concrete products when used together with cement bypass flue dust (a waste stream from the manufacture of cement) and/or Ground Granulated Blast Furnace Slag (GGBS, a by-product from steel production). The end products will be autoclaved aerated concrete building blocks, normal density blocks, and a pre-bagged one part binder (GGBS with waterglass) that do not use any Portland Cement, instead using waste materials to replace it.

These products will have a significantly lower environmental impact than current concrete products as well as a lower cost of production.

UKRI funding: £475k

Project partners
Regen Waste Ltd
Ecocem GB Ltd
Mannok Build Ltd
Queens University Belfast
T&J Recycling

More information
https://regenwaste.com

10 Concretene

Developing graphene enhanced concrete to enhance strength and reduce cement and steel requirements

This project has developed an enhanced concrete using a graphene additive that will result in a revolutionary construction material capable of vastly streamlining virtually all construction projects whilst halving their carbon footprints.

The project successfully deployed a Graphene Enhanced Concrete on a real construction site, using normal and standard equipment and tools, using an existing batching plant that did not require modification of any hardware and software, without any additional or specific training required to the workforce laying the concrete.

The graphene additions lead to strength enhancements of at least 50%, reduced concrete volume requirements, improved early age crack resistance, and the elimination of large quantities of steel reinforcement. Successfully rolling out these breakthroughs on an industrial scale has the potential to transform the UK construction industry.

Following the pilot demonstrations, product awareness and marketing activities have gathered pace with over 2000 people receiving CPD activities and a number of customers lined up for trials.

The team is now working with consultants to progress their route to accreditation and standards acceptance.

Concretene offers a 30% reduction in CO_2, 20% reduction in cost and can be used in 99% of concrete applications.

UKRI funding: £380k

Project partners
Nationwide Engineering
University of Manchester

More information
https://tinyurl.com/44mws3j4
https://tinyurl.com/5bncap45

11 Transforming Cement and Its Supply Chain with IoT, Machine Learning and Big Data

Developing digital techniques to optimise cement usage

The project centred on developing new technologies in existing areas whereby cutting-edge digital sensor technology on trucks is combined with intelligent cloud-based analytics to generate key insights into fresh concrete quality, redistribution potential and emissions profiling.

The UK cement industry is facing increasing pressure to reduce its emissions profile in line with government targets (net zero 2050) and end-users that are looking for 'low-carbon' concrete solutions. there is a shortage of supply versus significant demand for cement throughout the UK, so the 5% concrete wastage on construction projects and Covid19 pressure on the supply chain exacerbated the supply constraints.

Cloud Cycle's innovation looks to address these issues through digitising ready-mix concrete and providing data to the supply chain, linking into BIM to allow for improved design, procurement, quality control, improving quality to reduce waste, and redistributing surplus concrete onsite when it arises.

This project will also allow for the integration of LCA/emissions reporting functionality, improving oversight of full supply-chain emissions from cement production to end-use. Access to this data and capabilities will make the UK cement industry more sustainable and competitive in the face of extreme production challenges caused by Covid19.

Surplus concrete can then be predictably returned to manufacturers to blend into further batches.

The team have successfully installed their sensors in almost 50 concrete trucks in two countries. The project aims to save HS2 over 10,000m3 of concrete and £1m.

UKRI funding: £585k

Project partners
Cloud Cycle
HS2

More information
https://www.cloudcycle.com

12 Feasibility of Producing Artificial Pozzolana

Exploring the production of artificial supplementary cementing materials (SCM) from clay deposits.

This project is completing an in-depth feasibility study into the possibility of using abundant clay deposits in Northern Ireland to produce an artificial SCM in the form of Natural Calcined Pozzolans (NCPs) for use in cement production. Currently, SCMs are comprised of waste streams such as Pulverised Fuel Ash (PFA) and Granulated Ground Blastfurnace Slag (GGBS) but are in decreasing availability in the UK due to less coal fired power stations and blast furnaces.

The project also considers the commercial viability of processing the product in an existing standard rotary kiln used previously for clinker production.

If shown to be economically viable, this project will create a new cement sector business model through the supply of quality-controlled SCMs direct to construction projects for use in the cement mix required by the construction/ concrete specifications. Additionally, at retail level, a range of new low-carbon cement blends will be made available allowing customers to purchase cements with properties and strengths specific to their application and desired carbon footprint. The manufacturing of artificial SCM will be new to the UK and the introduction of this novel product range will allow new support and technical advisory services to be deployed within the sector.

The project has identified a number of suitable clay sites within the local area, with samples extracted for mineral analysis being completed.

Trial cement blends are being produced alongside the technoeconomic analysis of converting the existing plant and market assessments.

UKRI funding: £240k

Project partners
Mannok

More information
https://www.mannokbuild.com

13 Bio-based Solvent identification and Evaluation for use in Polyurethane Resin Binders for the Roofing Industry

Seeking green alternatives for the roofing industry

This innovative project sought to identify bio-based solvents for the roofing industry. Within the roofing chemicals industry, products rely on petroleum based solvents. These alternative solvents should be more sustainable (bio-based rather than petroleum based) and safe to use.

While the traditional industrial approach is to source and test existing available raw materials, incurring high lab testing costs and long product development times, this project took a new approach that accelerated and de-risked solvent research.

Green Rose Chemistry applied specialist solvent-lead identification software based on the Hansen solubility parameters to mine an extensive database of bio-based solvents, identifying potential greener alternatives that have a much higher probability of successful commercialisation.

The economics and available supply chain for the selected solvents was then considered, identifying the candidates that were commercially viable.

The best prospects were then tested in product development labs to show performance and short-term stability. All results have been positive and there has been no adverse effects by changing the solvent.

The new solvents have also brought benefits – improved safety due to the higher flash point and lower odour – and minimal effect on price point.

The marketing team are now developing the product offering whilst the technical team complete a life cycle analysis to ensure environmental credentials.

UKRI funding: £50k

Project partners
Incorez
Green Rose Chemistry

More information
https://www.incorez.com
https://greenrosechemistry.com

14 A Novel Biocatalyst Platform for Biobased-Synthesis of 1,3-Propanediol

Revolutionising chemical synthesis in the UK

FabricNano have developed a synthetic biology, DNA-based nanoreactor platform technology with the potential to transform the UK's chemical synthesis industry. Their approach vastly improves reaction kinetics of multi-enzyme cascade kinetics to yield product quickly, and can contribute to the greening and sustainability of chemical production.

FabricNano have identified a multi-enzyme cascade that converts waste glycerine into 1,3-Propanediol (PDO).

This project helped to demonstrate the viability of FabricNano's biocatalyst at an industrial scale. It also provef utility of FabricNano technology for coupling cascading enzyme reactions for the conversion of low value renewable feedstocks into high value products, which represents a keystone of renewable green chemistry.Valorisation represents a keystone in the adoption of renewable green chemistry.

Compared to competitors, the technology can immobilise enzymes within 15–30 minutes compared to 16–32h, reducing the inactivation likelihood. The system is also flexible, allowing new gene modifications to be established in days rather than weeks.

The team have now initiated a number of commercial trials to further demonstrate their technology for specific applications.

In the future, the team look to develop and implement pathways within their flow setup as a co-development service with customers.

UKRI funding: £410k

Project partners
Fabric Nano

More information
https://www.fabricnano.com

15 SCI-FI

Digitalising process efficiency for the foundation industries.

Proper maintenance in Foundation Industries (FIs) is crucial: productivity, product quality, reliable deliveries and safe working environments all depend it.

When cost cuts come into play, maintenance budgets are often the first to be hit, which are often seen purely as costs rather than investments. This has resulted in staff reductions, cancellation of third-party maintenance contracts and under-maintained machines with the inevitable consequences for productivity and energy and resource efficiency.

There is a pressing need for automated condition monitoring systems that help maintenance teams sustain their effectiveness with fewer resources. Such systems should scale the expertise of the maintenance team, allowing them to manage more machines with fewer people. They should help them optimise machine performance, avoid unplanned downtime and understand the root causes of failures.

The SCI-FI project was about adapting a proven technology in the automotive sector into a cost-effective approach to automated condition monitoring (CM) and predictive maintenance (PdM) and prognostic techniques for FIs for coupled and continuous processes.

It involves taking techniques, algorithms and user interfaces that were developed for the kinds of discrete, standalone machines common in automotive sector and adapting them.

The project has enabled the team to help customers become more productive by enhancing existing products and taking them into new markets.

They have built in customer feedback and are looking at other areas such as maintenance reduction, sustainability targets and demand forecasting alongside their predictive maintenance.

UKRI funding: £255k

Project partners
Senseye Ltd
Malone Engineering UK Ltd
Smurfit Kappa Corrugated UK Ltd
Tata Steel UK Ltd

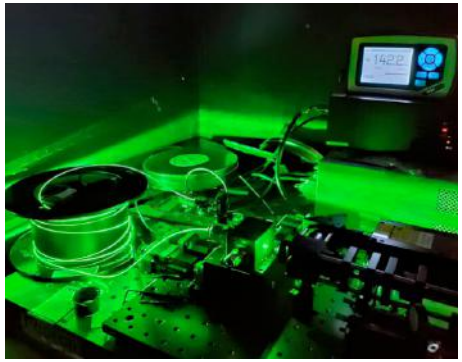
More information
https://tinyurl.com/2s4dbc4t
https://tinyurl.com/5n7ah9cy

16 GRIFFIN

Transformative improvements in process control for reduced energy consumption

This energy efficiency industrial research project aims to deliver a transformative new instrument for the glass, cement and ceramics industries, utilising analytical Raman gas measurement instrumentation, originally developed for nuclear decommissioning by project lead IS-Instruments. The data provided by the instrument will enable these Foundation Industries and others, to make a step-change in process control, energy consumption and environmental emissions monitoring.

Significant energy savings will be directly enabled through accurate, near-to-real-time hot gas measurement, realising the future potential of mixing natural gas with cleaner energy sources such as hydrogen, when combined with more accurate and near-to-real-time burner in-process control. The optimised environmental monitoring capability of this instrument will enable greater understanding and the value added that additional in-process monitoring technologies will deliver a new technology enabling step changes to processing within the Foundation Industries.



Throughout the project the team has scoped out the foundation industry requirements, developed fibres which meet specifications and are robust enough for the extreme environments of the foundation industries and trialled the instrument at test locations. Each industry presents subtly different challenges for instrumentation, however generic mitigation of, temperature, dust, moisture and robustness were the key objectives of this project.

The team are looking to exploit the technology both as in-furnace monitoring to increase processing efficiency and stack / flue monitoring to enable understanding of emissions.

UKRI funding: £560k

Project partners
IS-Instruments
Breedon Cement Ltd
Glass Technology Services
Sheffield Hallam University
University of Southampton
Wienerberger

More information
https://is-instruments.com

17 Breakthrough High Temperature Heat Pump Technology for Foundation Industry Decarbonisation

Developing an innovative waste heat capture technology for low temperature applications

In order to meet Net Zero targets, improving energy efficiency for the foundation industries is vital. Industrial waste heat recovery is seen to be a necessary enabling technology in the reduction of greenhouse gas emissions.

Currently, most heat below 100°C is lost to the environment. However with the right high-efficiency technology, this heat can be captured.

During the project, Futraheat have developed the world's first sub-1MW high temperature heat-pump that can compete commercially with burning fossil fuels.

Previously, technological challenges and the high cost when compared to conventional boilers had prevented industrial uptake.

By overcoming these technological and commercial barriers, the project has developed a demonstration system with the ability to capture waste low-temperature heat at scale, mitigating climate change and supporting the UK's net zero ambition.

During the project, the team have built up a number of potential end users from across the foundation industries and food and drink manufacturers.

Following the project, they will be launching their demonstration at a potential customer's site to enable viewing in operation and further dissemination.

UKRI funding: £520k

Project partners
Futraheat
Projective Ltd

More information
https://futraheat.com/

18 EcoLowNOx

Revolutionising furnace operations and emissions

Glass and Steel manufacturing furnaces frequently operate at temperatures above 1400'C, creating a pressing need for new, cost-effective technologies to reduce NOx emissions and increase furnace efficiency to meet ever tightening regulatory requirements.

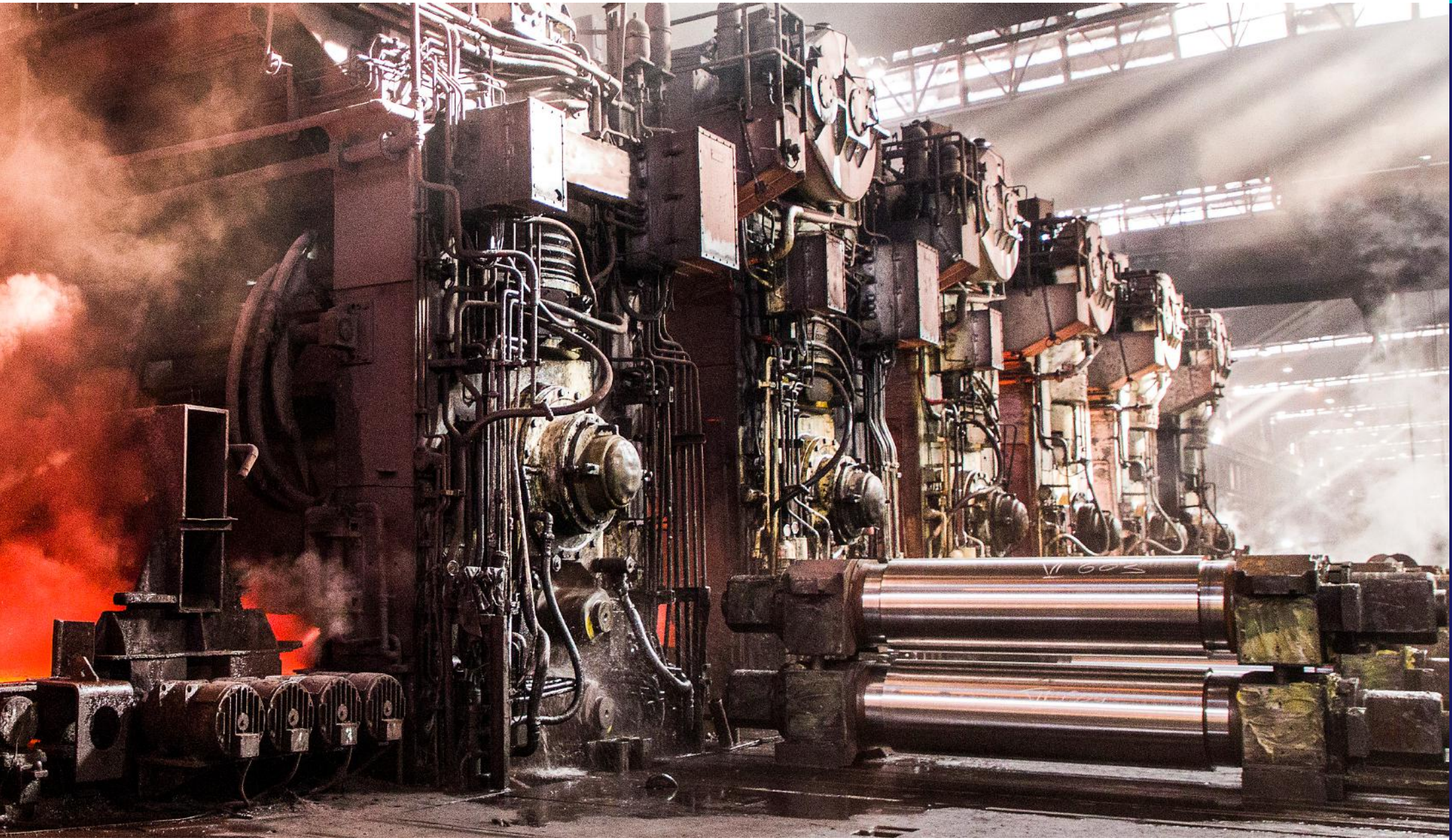
Global Combustion Systems (GCS) have previously demonstrated (at lab and commercial-scale) an 'Auxiliary Injection' combustion technology for end-fired glass furnaces that have the potential to reduce NOx by more than 80% and increase furnace efficiency by as much as 3%.

This project, supported by Tata Steel and Liberty Speciality Steels, will assess the performance of the GCS Auxiliary Injection technology for a range of new glass and steel furnace scenarios, using the Glass Futures 350kW combustion-test-bed furnace.

A techno-economic review will be undertaken to assess the feasibility of the GCS technology for these furnace applications, which will be used to identify the further work required to de-risk the technology to the point at which it can be trialled on commercial furnaces.

UKRI funding: £795k

Project partners
Global Combustion Systems
Glass Futures
University of South Wales
Tata Steel UK



1 AI6S

Using digital tools to optimise process efficiency for the Foundation Industries.

AI6S is looking to develop a novel toolkit for process optimisation in the Foundation Industries, enabling process efficiency improvements resulting in reduced energy consumption and reduced waste and improved ability to meet challenging (and commercially attractive) specifications and short turnaround times.

The project focuses upon application in two key areas. Within both glass and steel production, heat treatment processes are both very energy and therefore carbon intensive processes. These processes are often highly dependent upon operator knowledge and hard to optimise. Within the steel industry, forging processes also face similar challenges and are included in the scope of the project. Within the glass case study, heat treatment is not only necessary for energy savings, but also vital to ensure that varying thicknesses within products are not subject to residual stresses which can lead to cracking within use. The project aims to optimise heat treatments whilst maintaining required mechanical properties.

By developing a Foundation Industries specific six-sigma framework and optimisation platform, and specification for a demonstrator in each the metals and glass industries, this can allow sensor installation and analysis of relevant historic data to ascertain the key process parameters with the largest influence upon process efficiency. The team are now completing process simulations and validating against plant data in order to train the deep learning frameworks. All of these will feed into the six-sigma tool and then expand to ensure relevance to other Foundation Industries. Learnings will be applied in the metals and glass industry demonstrators, with evaluation of the efficiency improvements fed back into the system.

UKRI funding: £1m

Project partners
Hybird Ltd
Abbey Forged Products Ltd
Brunel University
Glass Technology Services
Ivy Tech Ltd
University of Sheffield

More information
https://tinyurl.com/wp2t38ew

2 SAMRCD

Digital optimisation of processing decisions to ascertain environmental impact.

To optimize when, where, which, and how to implement additive manufacturing (AM), we must be able to assess its environmental impact and compare this to conventional manufacturing processes like CNC Machining. The development of the tools proposed within the SAMCRD project would make a profound impact in energy reduction and accelerate additive manufacturing as a viable sustainable production process as part of the UK's manufacturing capabilities.

The aim of SAMCRD (Scalable AM Rule and Dissemination) is to enable a significant step change in the adoption of additive manufacturing for advanced materials. The studies included in the project encompasses energy used in production, the analysis of material properties and the final rules of part acceptance and rejection.

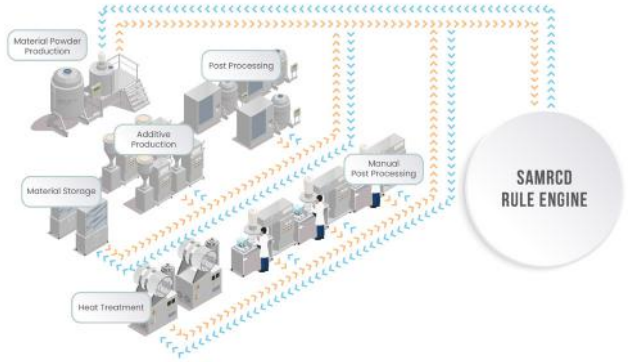
The project's R&D steps include identifying rules and standards from literature, deployment at AM printing sites and materials supplier sites, capture of data and validation of predictions, system creation, training and commercialisation.

It is hoped that these working rules will optimise material workflows and manufacturing parameters to maximise part acceptance rates, improve material efficiency, promote standardisation of operations and powder recycling, and improve repeatability and quality.

UKRI funding: £1.4m

Project partners
Authentise
ICD Applied Technologies
Materials Processing Institute
Photocentric Ltd
TWI Ltd

More information
https://tinyurl.com/3ryb7df2



3 CARBACEM

Connecting the metals and cement production industries to provide environmental, economic and resource efficiency benefits for both

The project solves a difficult waste problem for the aluminium industry, keeps hazardous waste out of landfill while providing a large supply of secondary resources for cement production including carbon, alumina & silicates and mineralising agents, reducing its environmental footprint. The project has the potential significant positive impacts for the economics & resource efficiencies of both industries, with massive environmental & sustainability benefits for society.

One such waste stream is spent pot liners, which are hazardous waste due to levels of sodium, fluoride and cyanide, all leachable in water, with a high pH and very reactive in water creating toxic and explosive gases. Approximately 2m tonnes were produced in 2020 with very few disposal options.

Yet these valuable constituents could, with the right treatment, be captured, made safe and become valuable feedstocks for other industries, particularly for cement. This would facilitate a mutually beneficial symbiosis between aluminium smelting and cement production.

Innovations include downsizing the material to a suitable particle size without producing dangerous gases, and selectively removing non-desirable contaminants, retaining those of use for the cement sector.

UKRI funding: £920k

Project partners
Ultromex Ltd
Aggregate Industries UK Ltd

More information
https://tinyurl.com/2xn8kwr5

4 Computational Formulation Technique for Developing Resource and Energy Efficient Functional Coatings

Intelligent modelling for the formulation of coating materials.

This project will take a whole supply chain view on the readiness of digital technologies to augment and enhance the traditional formulation process together with the ability to capture the knowledge of the experts in the process in terms of manufacture of constituents and application processes, through a digital-first process.

The project will be demonstrated at both pilot and product line facilities in the metals and glass industries.

The project team includes metals, glass and bulk/speciality chemicals supply chain partners and will seek to demonstrate a digital led approach to preparing a formulation for spray deposition on two different kinds of substrate systems.

Initially, the project will focus on antimicrobial coatings, but the approach will de-risk similar approaches with many different products, different substrates and different application mechanisms, bringing together national centres of expertise with industry partners.

The computational approach will include a detailed needs analysis, computational characterisation, correlation with experimental observables and an iterative cycle of modelling an experimentation.

Overall this will enable us to produce high value products at lower cost and with lower energy consumption.

UKRI funding: £935k

Project partners
PTML (Pilkington Technology Management Ltd)
Centre for Process Innovation (CPI)
Becker Industrial Coatings Ltd
Infineum UK Ltd
Spraying Systems Ltd
STFC
Tata Steel UK Ltd
William Blythe Ltd.

More information
https://tinyurl.com/3wtufd98

5 Re-C3

Reclaimed Calcined Clay for low carbon Cements

In this project, waste derived clay from several different sources will be characterised and tested for the properties useful for cement and concrete production. This will improve resource efficiency and symbiosis between UK foundation industries by utilising waste from the ceramics sector to produce high value innovative cement formulations.

These waste clays are generated during extraction of higher-grade clays (used in white ceramics and paper) and production and use of medium-grade clays (used to manufacture bricks and tiles).

Waste derived clays will be prepared using two different heating methods to enable comparisons of the resulting properties. These methods are a rotary kiln, a commonly available technology and 'flash heating', a new and innovative heating technique not yet trialled in the UK.

Both materials will be formulated into cement compositions, tested against EU/UK standards. Concrete will then be produced using enhancing chemical admixtures.

Results will be presented to national standards bodies to modify existing standards, removing the large current barrier to market for new cements, and reducing embodied CO2 of cement by 10–30% compared to the current market leader.

UKRI funding: £835m

Project partners
Mineral Products Association Ltd
Hanson Cement (Heidelberg)
Tarmac Cement (A CRH Company)
Imerys Minerals
Forterra Building Products
University College London
University of Dundee

More information
https://tinyurl.com/yjbd6x2j

6 Re-imagining Industrial by-products to Create a Circular Approach in the Steel and Cement Industries

Transformative technology to reduce the carbon footprint of concrete whilst applying a circular approach to steel.

This research proposes a resource and energy efficiency opportunity in the cement industry, which is the main carbon emitter within concrete, by utilising industrial by-products from the steel industry to create a new cement and establish a circular economy between these two Foundation Industry sectors.

Material Evolution's technology helps the cement industry move from being one of the largest contributors of embodied carbon, towards being the solution that actually eliminates carbon from the concrete manufacturing process.

By using their patented technology, Material Evolution look to transform the cement's chemistry to make concrete that is superior in terms of economics, strength and sustainability. This will allow manufacturers to grow their business whilst shrinking their carbon footprint and rapidly decarbonise two Foundation Industries, using a circular approach.

During the project, the team will analyse a number of waste streams including pond ash, black and white slags. This will help to focus the project on specific applications for each waste stream, building in consistency and supply chain constraints.

The team have developed software which creates a bespoke mix design based upon the application of the material and the characteristics of the various waste streams. Having completed test pours for various applications, structural, durability, workability and curing behaviour tests are being completed to validate the modelling.

UKRI funding: £1.2m

Project partners
Material Evolution
Celsa UK Ltd

More information
https://www.materialevolution.com

7 HiFib: Innovative Fibre Technology for Sustainable Papermaking

Transformative feedstocks for stronger, lighter paper and board.

The project aims to address an identified commercial demand for sustainably produced, lighter, stronger paper and board. This is highly desirable because their use reduces the quantity and weight of packaging and the associated transportation costs and greenhouse gas emissions.

The objective of the project is to build on an hydrodynamic cavitation process that can produce pulp suitable for the production of lighter, stronger products at the scale required by the industry. Hydrodynamic cavitation combined with sonication of pulp produces highly fibrillated cellulose fibres (HFCFs) that contribute to the strength of the finished product but is energy intensive. Alternatively, mechanical, chemical and biological pre-processing methods will be examined to increase energy efficiency and cost-effectiveness.

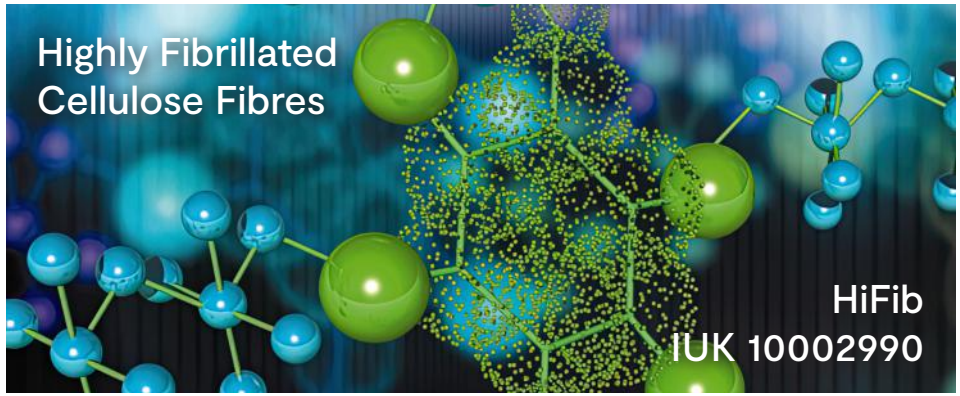
The project will explore currently wasted or under-utilised fibre sources which will help meet the growing demand for sustainable packaging.

Additives to aid water draining and drying of the enriched pulp, reduce paper breakage and enable high speed paper production will also be optimised.

UKRI funding: £710k

Project partners
Axchem International
Agrifood X Ltd
Biopower Technologies
DS Smith PLC
Paper Industry Technical Association
Renaissance Chemicals Ltd.

More information
https://tinyurl.com/2cf8wbmy



Small Scale R&D

In 2021, after consultation with our Advisory Group and industry, we launched the Small Scale R&D competition, aiming to primarily support smaller Foundation Industry businesses who are less familiar with Innovate UK competitions.

Algreen
Algreen aims to achieve the development of environmentally sustainable and formaldehyde-free chipboards. Formaldehyde is a known human carcinogen associated with childhood asthma. Furniture containing formaldehyde can continue to emit gas for several years. Algreen uses underused natural seaweed and recycled paper waste, making production highly scalable.
UKRI funding: £50k Partner: Algreen Ltd

Soil Stabilisation Using Integrated Design Of Low Co2 Alternative Cementitious Binders
Using existing technology developed by Material Evolution (utilising 95% waste and saving 85% Co2 emissions), this project will utilise industrial by-products from the steel industry to create a new cement and establish a circular economy between these two Foundation Industries, reducing import reliance.
UKRI funding: £50k Partner: Material Evolution

Low Carbon Cement Replacement For Pre Cast Concrete Products
This project is a development and demonstration of low-carbon concrete activator. The non-cement based concrete design offers an alternative to cement for pre-cast concrete manufacturers and civil engineering projects, can be produced with seawater instead of freshwater and saves 80–100% of the carbon emissions.
UKRI funding: £50k Partner: ARC Marine Ltd

Enzymatic Upcycling of Waxes, Fats, and Plastic Waste
Scindo is developing enzyme systems to functionalize or cleave the carbon chains in waxes derived from plastics, into molecular building blocks that can serve a broader chemicals industry. Using plastics as a feedstock to create chemicals for industries that are heavily reliant on virgin petrochemicals has a two-fold benefit of 1) unlocking value from plastics that were previously discarded as waste, and 2) decreasing the chemicals industry's reliance on virgin petrochemicals, and thereby reducing its carbon footprint
UKRI funding: £50k Partner: Scindo Ltd

Energy Saving Research into Diffusion Coating by Direct Heating
Diffusion Alloys has investigated and intends to further develop a processing method for diffusion coatings which will change the current state of the art from highly energy intensive to energy efficient. The impact of a significant reduction in processing time and costs will open up new markets for diffusion coatings globally.
UKRI funding: £55k Partner: Diffusion Alloys

Molten Material Thermal & Spectral (Thermo-Chem) Non-Contact Sensing Technologies
This project aims to determine the optimum measurement techniques and technology for non-contact measurement of highly accurate temperature, key elemental liquid iron chemistry and key elemental molten glass chemistry.
UKRI funding: £60k Partners: Pyroptik Instruments Ltd, University of Sheffield

CMCs for Low Energy Kiln Furniture
The environmental sustainability of kiln and furnace processes can be improved by reducing the total heat energy consumed in each run of the equipment, achieved by using furnace furniture with lower mass and equivalent or better mechanical integrity. In this project, materials and structures based on ceramic composites will be developed with superior mechanical properties and mass.
UKRI funding: £60k Partners: Almath Crucibles, Ultrawise Innovation, Glass Futures

Sustainable Transformation of Metallic Wastes from the Steel Industry into Advanced Zinc Oxide
This project uses green catalytic solvents at low temperature to complete direct oxidation of metals, offering enormous energy efficiency improvements over existing technologies. This patent-pending process can treat metal-containing wastes, preventing landfill and reducing reliance upon energy-intensive pyrometallurgical processes.
UKRI funding: £50k Partner: Nanomox Ltd

Remote Monitoring of Concrete Condition

Steel Fibre Reinforced Concrete provides lifetime performance improvements and can reduce or eliminate rebar. Some classes of reinforcing steel fibres can act as passive sensors which can be inspected using external electromagnetic sensing indicating reversible and irreversible effects in concretes during life and provide asset management.

UKRI funding: £60k Partners: Lateral Logic Ltd, University of Warwick, Sonemat Ltd, Fibre Technology Ltd

Two Layer Coatings for Compostable Repulpable Paper

This project will replace packaging formats that consist of a mixture of laminated plastic, paper and metalized layers for long shelf-life applications as many of these cannot be easily recycled at the end of their life. This project is therefore seeking to develop a high barrier packaging material made using a coated paper substrate that can be easily re-pulped at end of life and can therefore be easily recycled back into cardboard materials.

UKRI funding: £60k Partners: Scitech Adhesive Systems Ltd, Bangor University

Development of Low Carbon Innovative Composite Material for the Construction Industry

This project will investigate the potential of using novel low energy binders as alternatives to cement-based products or traditional clay-fired bricks; both having high embodied carbon and energy. They will investigate the optimum combinations of ingredients to ascertain whether such novel materials can meet strict technical requirements demanded by the global building industry.

UKRI funding: £200k Partners: Kenoteq Ltd, Heriot-Watt University, Cellucomp Ltd

Feasibility Study of Modular Energy Conversion System as a Gas Let-down Expander

A key concern of current low-power low-grade energy recovery systems is their high cost and lengthy payback on investment. The team believe their modular concept with innovative low-cost gas bearings could give market advantage and lead to greater uptake across the Foundation Industries.

UKRI funding: £50k Partner: C2 Technology Ltd

Energy Efficient, Low CO2 Refractories for the Foundation Industries

This project aims to find a cost-effective solution to reduce energy consumption in the manufacturing process of ceramic refractories. The addition of dopants to densify the material will be investigated to enable sintering at lower temperatures and shorter firing times, reducing energy consumption and CO2 emissions.

UKRI funding: £55k Partners: Parkinson-Spencer Refractories, Sheffield Hallam University, British Ceramic Confederation

3DCarbide

This project will enable the creation of 3D printed industrial scale production, high quality Silicon Carbide parts, one of the most challenging materials to manufacture, at a price that enables their widespread adoption within the Foundation Industries.

UKRI funding: £175k Partners: Photocentric, Manufacturing Technology Centre, Glass Futures, Cast Metals Federation, Sandvik Materials Technology

High-Performance Graphene Enhanced Cement: A Revolutionary Innovation in Low Carbon Manufacturing Process

This project focuses on the use of graphene in the construction sector – in particular as an additive to help improve the efficiency of the cement manufacturing process, whilst also improving the performance of cement / concrete. It is well-aligned with helping to decarbonise the cement manufacturing process and the project involves an industrial-scale trial with the United Kingdom's largest cement manufacturer to prove the concept.

UKRI funding: £190k Partners: First Graphene, University of Manchester, Morgan Sindall Construction and Infrastructure, Breedon Group Services Ltd

"With this combined investment of £3m from our investors, and almost £700k from UKRI, we've doubled our workforce, purchased vital new equipment, moved to larger premises and are developing our technology so that it's ready for large scale production – it has been transformative and supercharged the growth of our business"

Johan du Plessis, Founder and CEO, Tepeo

Transforming Foundation Industries Investor Partnership Programme

Investor Partnership Programme
UKRI Funding: £6m

The **Transforming Foundation Industries Investor Partner Programme** was specifically instigated to match new sources of private investment with businesses bringing transformative innovations into these sectors at scale, so enabling their sustainably competitive future. The outcome are projects that drive forward high-quality business opportunities, have clear routes to commercialisation, and have attracted significant funding from overseas investors.

Following a process to identify investors with the credibility, capability, capacity, and appetite to invest in such projects the Challenge has worked with five investment funds who see the opportunity to profit from the growing demand for more sustainable products:

- Clean Growth Fund
- HG Ventures
- Midven Ltd
- Speedinvest Industry
- Turquoise International

This has attracted new high growth companies that are helping to re-invent our Foundation Industries with new technologies or business models built on resource efficiency and the circular economy. Many bring new ways of thinking that challenge the traditional "It's all about the volume" approach, instead seeing profitability in producing higher performing, more sustainable products.

The successful companies consequently receive project grant funding from Innovate UK and significant equity from the Investor. The mix of this funding to support both vital research and wider business development, together with the benefit of the investor expertise, is already allowing these companies to scale at pace.

To date seven projects with a total grant funding of £4.8m have started, and which have attracted a total equity investment of £20m.

Glass Futures – Pilot Plant Facility in St Helens

Glass Futures is creating a new, globally unique glassmaking pilot plant facility in St Helens, creating a Global Centre of Excellence for the sustainable manufacture of glass.

The pilot manufacturing facility will provide exportable innovation, training and research for the global glass industry with the potential to drive further economic growth across the North West.

The new pilot plant is being built next to St Helens Rugby League Club's ground, on the site of the former United Glass glassworks. It will have full plant utilities and services, a full-scale Batch Plant, servicing a 30 tonnes per day multi-fuel furnace, complete with abatement and heat recovery, also equipped to assess carbon capture technologies. The glass output can be fed into either a rolled-plate or container forming line, fully equipped with coating, inspection and packing capabilities.

Glass Futures, a "not for profit" Research and Technology Organisation (RTO), operates a membership scheme, with current membership comprising of international glass manufacturers, glass end user customers, industry suppliers and academic institutions.

Glass Futures will use the facility to provide commercially robust training and development activity to meet and exceed the demands of the global glass industry. The total cost of the facility is expected to be £54m with additional funding from Liverpool City Region, St Helens Council and industry partners. The UKRI investment and associated support from the TFI team was instrumental in securing this funding and the wider industry backing.

Businesses and Researchers will collaborate to test:

- Development of alternative fuel technologies
- Robotic operations and automation
- Heat recovery, abatement and CCUS demonstrations
- Secondary raw materials for a circular economy
- Raw material and cullet processing technology
- New compositions and treatments
- Industry 4.0 applications
- Next generation refractories
- Inspection equipment and sensors

The plant will also provide a focal point for collaborating with other Foundation Industries such as ceramics, steel and cement.

"Merseyside has a long and rich history in glass manufacturing, and so I am pleased that this £54 million investment, including £15 million government funding, will launch a new era in highly efficient, low-carbon glass production. This new funding will build on our commitment to cut emissions across heavy industry, create green collar jobs on Merseyside and help us to build back greener"

Kwasi Kwarteng,
Secretary of State for Business, Energy and Industrial Strategy

UKRI funding: £15m

Project partners
Glass Futures

More information
https://www.glass-futures.org

INDUSTRIAL STRATEGY
UK Research and Innovation
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION
Department for Business, Energy & Industrial Strategy
ST HELENS BOROUGH COUNCIL

"For too long, the Foundation Industries have been dismissed as too difficult to clean, too difficult to modernise and too difficult to diversify. TransFIRe shows that the commitment is there from academia, industry and Government to take on those challenges and transform the Foundation Industries that have for generations played such a vital role in the UK economy"

Professor Mark Jolly,
Director of Manufacturing,
Cranfield University

TransFIRe Hub

TransFIRe is an UKRI funded (ISCF TFI Challenge) proactive, interdisciplinary, inclusive research and practice driven Hub with 12 research organisations based in the UK and more than 70 project partners from across the Foundation Industries, trade associations, professional membership bodies, civic sector and government organisations.

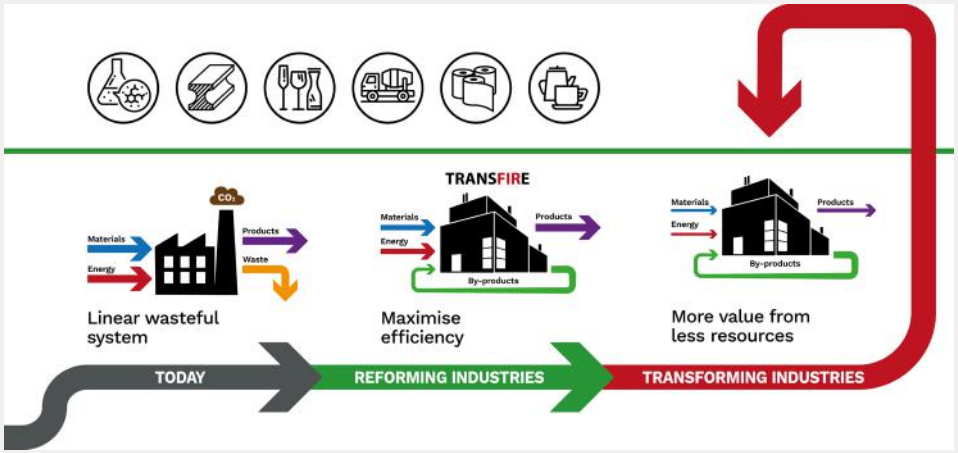
TransFIRe brings Foundation Industries and their communities together through interdisciplinary research, to support resource productivity, competitiveness, equality, diversity, inclusion and climate action.

TransFIRE is about looking at best practice and what common processes can be transferred between the industries, for example the minimising of resource use, lowering energy use and emissions, and using by-products.

TransFIRe will be a proactive, interdisciplinary, inclusive research and practice driven Hub that:

- optimises the flows of all resources within and between the Foundation Industries and their supply chains
- improves their competitiveness
- works with communities in which they are located
- supports UK Net Zero 2050 targets for GHG emissions
- furthers equality, diversity and inclusion within the Foundation Industries.

TRANSFIRE
Transforming Foundation Industries Research and Innnovation Hub



UKRI funding: £5m

Project partners
Cranfield University
Bangor University
British Geological Survey
Cardiff University
Durham University
Northumbria University Newcastle
Sheffield Hallam University
University of Exeter
University of Leeds
The University of Cambridge
The University of Edinburgh
The University of York

More information
https://transfire-hub.org
https://tinyurl.com/ycxdnwch

TFI Network +

The TFI Network+ will assist the foundation industries to remain competitive whilst simultaneously facing challenges from environmental legislation and drive towards net-zero carbon 2050. The core aim of TFI Network+ is to co-create with the Foundation Industries new science and technology that can transform their sustainability and performance by coordinating and channelling a wide range of expertise throughout UK academia in themes such as:

Energy efficiency: Energy costs in foundation industries are high, and each industry faces its own challenges to improve energy efficiency and reduce greenhouse gas emissions. Through knowledge transfer and cross-fertilisation of ideas, the TFI Network+ will seek opportunities to co-create new concepts and to transfer best practice from one sector to another in areas such as heat-pipe technology which can recover energy over a wide temperature range.

Next generation processes: The fundamental properties of materials are often seen as a limiting factor in reducing energy and resource usage but energy consumption can be reduced in all sectors by greater monitoring and digitalisation of the production process through diverse sensing and data collating coupled with the ability to react quickly to a changing process environment through the use of artificial intelligence.

Resource Efficiency: The ability to re-use, recycle or repurpose products and raw materials has significant challenges in the foundation industries, as without careful process analysis this activity can actually increase energy and material costs, or result in inferior products.

We will help evaluate the properties of recycled and substitute feedstocks through improved analytical methods, develop processes that are more forgiving of feedstock quality and ensure that feedstock supplies are geopolitically secure.

Enabling transformation: The Network+ can help create roadmaps for policies, regulations and legislation, to support transformation throughout the whole value chain and systems, to remove barriers and create markets for the adoption of more sustainable materials and technologies.

Equality Diversity and Inclusion (EDI): The Network seeks to promote EDI across the foundation industry sectors, engaging with equity professionals and the arts and humanities to develop case studies of best practice, creating bespoke video content to educate and inspire and delivering workshops that highlight the challenges and solutions to maintaining a diverse, age-balanced and effective workforce.

As well as convening an active network of over 540 members from academia and industry, the team have delivered 12 online events, regularly attracting over 100 participants.

The team have also successfully delivered 3 competitions for academic led small research programmes. 21 projects have been awarded, spanning all foundation industries, with a number being led by Early Career Researchers, a great boost to their career.

UKRI funding: £2m

Project partners
University of Sheffield
University of Swansea
University of Manchester
University of Leeds

More information
https://tfinetworkplus.org

Find out more and stay in touch

The Transforming Foundation Industries is a Challenge programme managed by UK Research and Innovation, as part of the Industrial Strategy Challenge Fund.

The programme is delivered by Innovate UK, part of UKRI. For an overview of the programme see the UKRI website. We aim to share information on the projects' development and progress through case studies on this website.

We would love for you to stay engaged with the Challenge through our ***TFI Network+*** and ***TransFIRe Hub***

#TransformingFoundationIndustries

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