# FISC

Foundation
Industries
Sustainability
Consortium

# EconoMISER Mid-Term Report

January 2024

UKRI Innovate UK

# Foundation Industry Sustainability Consortium

## What is FISC?

The Foundation Industries Sustainability Consortium (FISC) is a partnership between five global leaders in innovation, research and technology from across the cement, metal, glass, ceramics, paper and chemical industries. In December 2022, the five partners agreed to develop ideas for collaborative projects utilising existing capabilities across the partner locations, their technical teams and partnerships within the foundation industries.

EconoMISER is the first major project of FISC, representing a £19.5m investment by UK Research and Innovation.

## Benefit to Industry

FISC will establish a network of scale-up centres to support the foundation industries and deliver cross centre working to address innovation challenges around decarbonisation and sustainability.

Core to the offer, is the delivery of the EconoMISER Programme and the collaboration between centres to develop shared solutions, enabling project partners and industry to learn from best practice to innovate across the foundation industry sectors. The programme will confirm innovation challenges that can be taken forward in future projects supported by private and public investment.

## The FISC Vision

The FISC partners have a shared vision to strengthen the foundation industries in the UK by working together to

**Scale and Accelerate** the innovation needed to drive the transformation of the foundation industries, to create

**Sustainable**, low carbon and resource efficient materials delivered to vital **Supply Chains**, enabled by a

**Skilled and Diverse Workforce** with exciting jobs in vibrant industries that support the UK economy.

## Delivery Strategy

| 6-12 months | 12-24 months | Future Aims | Industry led innovation |
|---|---|---|---|
| Scale up foundation industry innovation centres | Respond to critical foundation industry needs | Industry led, utilisation of innovation centre capability | |
| Identifying industry challenges | Industry facing collaboration | Future 'Transforming Foundation Indsutry' programmes | |
| Establishing collaboration across centres | Laying the ground work for future programmes | Focus on people, materials and fuels | |

## FISC Partners

cpi

Glass Futures

LUCIDEON

HENRY ROYCE INSTITUTE

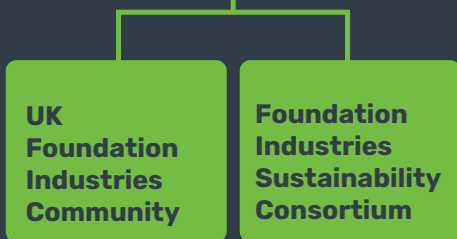Materials Processing Institute

# EconoMISER Lifecycle

## Connect

**Fellows** are engaging with companies and RTOs to landscape the national research and innovation challenges faced by the foundation industries and to identify project partnerships for EconoMISER.

This connection is **establishing cross sector links** throughout technology and manufacturing readiness levels to initiate projects that will extend beyond the lifecycle of EconoMISER.

## Collaborate

**EconoMISER Application Scientists** are working alongside two or more members of FISC and external project partners to deliver R&D solutions for the Foundation Industries.

FISC is comprised of five research facilities who offer a wide range test capability and expertise to help **identify solutions to research and innovation challenges** faced by the foundation industries.
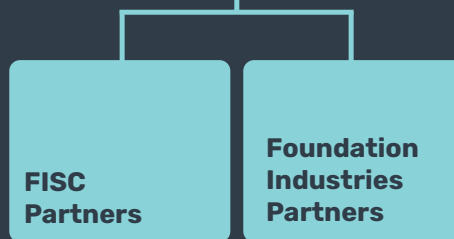
## Innovate

The **EconoMISER team** and **project partners** will develop identified solutions through the network of scale-up centres established by FISC and roll out technology and manufacturing solutions into the foundation industries.

EconoMISER is organised around five research themes and will use FISC facilities to **scale-up research through technology and manufacturing readiness levels.**
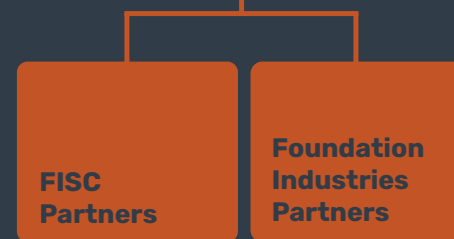
## Impact

**EconoMISER** projects are supporting the decarbonisation and sustainability needs of the **foundation industries** through improved resource efficiency, sustainable products and Industry 4.0 solutions.

Outcomes will add security to raw materials supply chains, improve cost competitiveness, accelerate digitisation, and advance skills and diversity within the workforce.

**Stakeholders:**

| UK Foundation Industries Community | Foundation Industries Sustainability Consortium | FISC Partners | Foundation Industries Partners | FISC Partners | Foundation Industries Partners | UK Foundation Industries Community |

**Supported by:**

| TFI Fellows | Application Scientists | EconoMISER Scale-Up Centres | FISC Partnership |

# Innovation Themes

EconoMISER projects are centred around six research themes. Each research theme is led by a FISC partner who coordinates cross-centre collaboration with other members of the consortium.

### Alternative fuels
Supporting the adoption of green energy solutions, including lower carbon and less polluting fuels such as hydrogen and biofuels.

### Circular economy
Ensuring FI resources are used as effectively and efficiently as possible to adopt a zero waste, recirculating system which will improve security of supply and reduce environmental impact.

### Digital Sensing
Developing process monitoring and data capture practices to support remote and real-time decision making within manufacturing processes. Informing modelling, prediction and simulation and tracking through the make, use and end-of-life cycle.

### Process Optimisation
Designing and improving systems to minimise process variability, maximise resource utilisation and identify best practice. Ensuring companies make the most of their manufacturing ecosystems to reduce waste and energy consumption, boosting cost competitiveness in the UK.

### Sustainable Materials
Improving the recyclability of materials to ensure recovered materials are fit for purpose and developing new manufacturing processes which adopt recycled raw materials. The theme will also identify alternative materials from sustainable sources to reduce reliance on mined raw materials.

### Training and Skills
Working together to identify best practice for the training and development of people across the foundation industries, helping to address the skills gaps and to make these vital industries attractive places to work for everyone.

# Theme Delivery Progress

### Alternative fuels
*Led by Glass Futures*

The partnership has identified significant shared areas of research and innovation interest, including: hydrogen for heat and reduction, electric melting, oxy-fuel, sintering and $CO_2$ capture deployment. Across the partner centres, each has scaled up their alternative fuels capability in the following key areas.

- Glass Futures, upgrading a 30t/day and 350kW combustion test bed to provide capabilities for firing a large range of alternative fuels.
- Lucideon, upgrading furnace capability to 100% hydrogen firing for a 1.5m2 intermittent kiln and a 24m tunnel batch kiln, to provide support to the ceramics sector for retrofitting existing furnace equipment in the changeover to hydrogen usage.
- Materials Processing Institute, upgrading a 2MW pilot reheat / treat heat furnace to run on hydrogen, installing an electrolytic metal refining rig and lab scale hydrogen furnace for refractory testing.

Supported by Royce and CPI the five centres are working on projects to understand the impact on processing, formability and performance of hydrogen and electricity in furnace and kilns.

### Circular economy
*Led by the Henry Royce Institute*

The work is focused on enabling the recycling, reduction and reuse of packaging with a particular focus on biodegradability and compostability end of life plastic packaging.

The partner centres are scaling up their capability in this area by:
- Improving facilities to manufacture cements at a range of scales from 5kg to 1000kg, including milling or pre-processing equipment.
- Investment in coating screening technology and equipment to better understand the circularity of chemical products.
- Development of a Circular Economy Centre for testing and pre-processing of metals at high and low temperatures.

The partnership is developing key concepts, including a Centre of Circular Innovation (focus on paper with Confederation of Paper Industries) and a circular economy building demonstrator. A sprint project led by the EconoMISER Application Scientist will look at future polymers in partnership with an industrial partner.

### Digital Sensing
*Led by CPI*

The investment by the project is in software and hardware capability to accurately measure and control processes to make higher quality and higher value products with less waste. Significant progress has been on the development of two large scale project proposals:

- Asset optimisation through federated learning to explore the scope for techniques that improve processes across the foundation industries. The concept would develop a one stop shop for process modelling and federated learning within FISC that offers long term support (design, prototyping and piloting) to the UK foundation industries.
- Development of new alloy materials using artificial intelligence to develop digital methods of developing and understanding the properties of new alloys.

### Process Optimisation
*Led by Lucideon*

The focus of the theme and work to date has been in two areas. The first is the application of sensoring, time series manufacturing data collection and machine learning analysis to improve operational efficiency, and improve yield. This approach is initially being applied within the ceramics industry to develop more detailed learning which can then be shared across the foundation industries.

The second area of activity is the optimisation of existing furnace and reheat capability to support decarbonisation and lower energy usage. Key to this work is the development of sensors that can report temperature distributions, and systems that can accurately control temperature, improve ramp up rates to an optimum temperature profile and reduce heat loss. The team are assembling demonstrator furnace equipment with the ability to capture operational data, which can be analysed and developed into furnace models using machine learning

to optimise manufacturing operations .

Other areas under consideration are the impact of furnace operation on refractory wear, the location and types of burners to minimise energy use, the use of agitation to prevent cold spots, heat capture and re-use to improve system design and manufacturing layouts.

### Sustainable Materials
*Led by the Materials Processing Institute*

The focus to date of this theme is on advanced coating projects to reduce the impact of coatings on scrap metal quality and to consider the role of coatings in maximising the efficiency of furnaces.

Additionally a geopolymer cement scale-up facility is being established at Lucideon to focus on transfer geopolymer processes from small to large batch sizes, lowering reduce embedded carbon in cements and promote technology take-up. The facility provides the capability to formulate geopolymers for different functions; increase process scale from laboratory scale (5 litre batches) to demonstration level (1,000 litre batches). Characterise product properties and durability against acceptance standards. The facility will also develop novel cements and concretes.

Significant work has been undertaken in the field of 'Rapid Alloy Development' to streamline the process of developing new materials with the objective of increasing the supply of UK materials, control over feedstocks and supporting the continuation of existing assets while future proofing foundation industries within the wider economy.

A series of project opportunities have been identified, with industry support in a range of areas within this theme, including:

- Increasing the power atomisation yield, Ar recover from gas, power recycling.
- New cement testing facilities to ensure innovations in cement development are proven for use in industry.
- Testing the effects of hydrogen on stress cracking, creep ductility and superalloys.
- Projects to reduce the lead content of brass, aiming to reduce lead content by 2035.

# Collaboration

The EconoMISER project started in October 2022 and has since employed three Fellows with experience in the foundation industry. They are working across industry, academia and the Innovation centres to understand their needs and link industry partners with the centres to address common challenges.

## Emerging Ideas

The FISC partners, working through the EconoMISER project have identified a number of small sprint projects and bigger, longer-term projects. The prioritised, medium-term projects include:

- A refractory test facility
- A low carbon and geopolymer cement and concrete test facility
- A UK speciality steels and metals platform
- Federated learning systems centre for the FI industries
- A paper innovation centre
- A furnace and heat, modelling and use group
- An alternative fuels demonstration facility

The EconoMISER sprint portfolio is managed using the project pipeline principle. This ensures enquires are assessed in an objective manner and Application Scientist resource is assigned in an equitable manner. The portfolio (figure 1), currently includes projects for the metals, glass, paper, polymer, composites and textile manufacturing sectors. To date Application Scientists have conducted desk-based studies, experimental investigations and a combination depending on client's requirements. Two sprints have received resource from two FISC partners. All sprints have a direct link to an organisation in the foundation industry supply chain and align to one or more of the EconoMISER research themes. Examples of reported SPRINTS include the following:

- A study to understand the sustainability and environmental impact of paper intended for conversion in to tissue products (sustainability theme).
- Metallurgical assessment of a surface feature present after passivation and galvanising of a steel construction product (process optimisation and reduction of waste, circular economy themes).



## Collaboration Opportunities
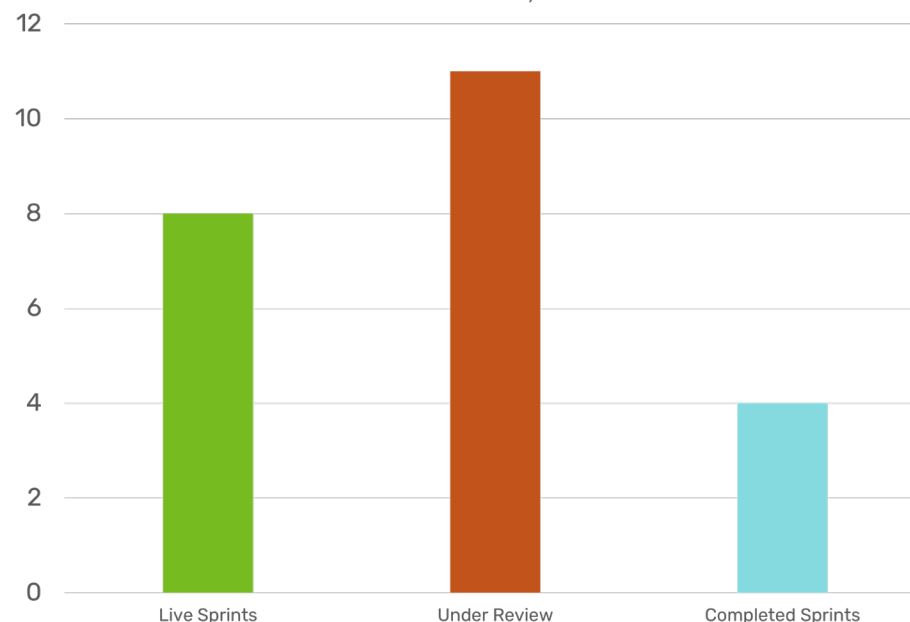### Forecast for January 2024

**Figure 1: The EconoMISER sprint portfolio**

## Progress to Date

The EconoMISER project reports quarterly and this mid-term report covers progress in the first three quarters. Over the first 9 months of the project the following has been completed:

- Two FISC strategy workshops, identifying the strategic priorities for future investment in collaboration across centres.
- All procurement activity commenced.
- FISC Board established with TransFIRe agreed as Advisory Board.
- EconoMISER sprint projects have been facilitated across the research themes led by the Fellows and Application Scientists, working closely across centres and industry partners.
- Secured £18m in funding for EconoMISER 2 to accelerate industry-facing collaboration

**To discuss collaboration opportunities please get in touch**

ukfisc.org