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# Providing Support for Regional Innovation and De-Risking in Decarbonisation and Circular Economy

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COATHAM

Wopen Bewley

River Tees

Materials Processing Institute  
South Bank

Grange



Google Earth

Middlesbrough

A66

A1053

A474

Wilton



# Offerings to help transform our industries [www.mpiuk.com](http://www.mpiuk.com)

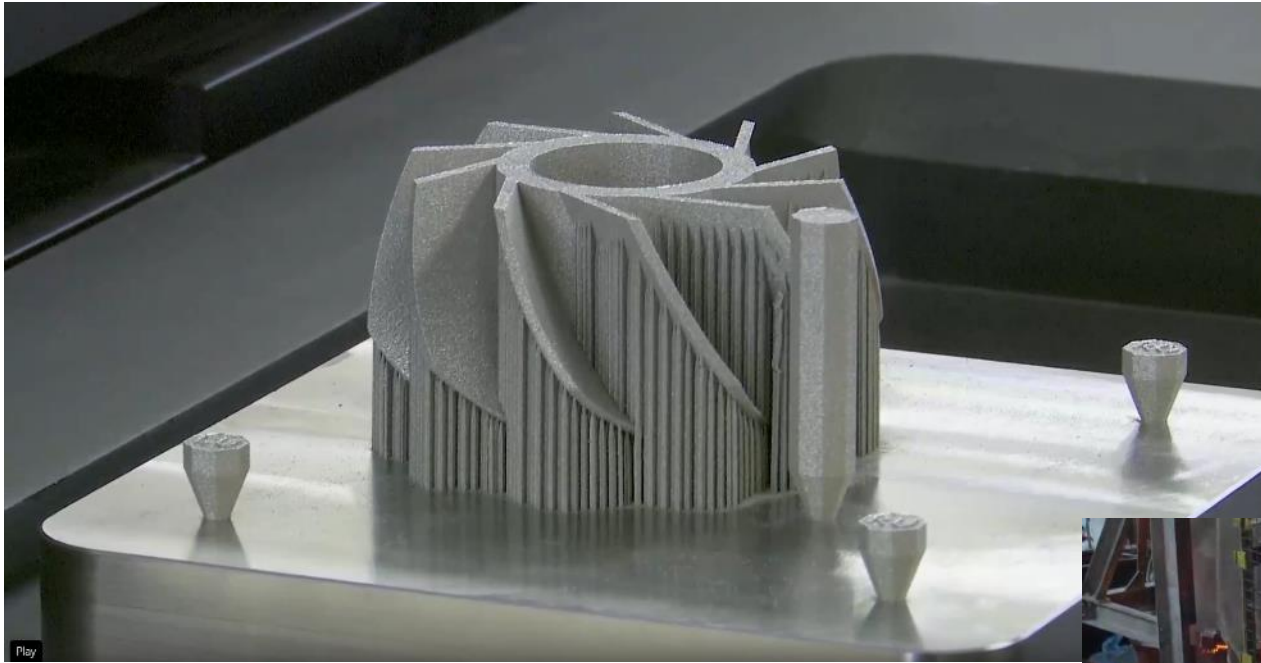
We are the UK's national centre for innovation for the Steel and Metal Sector as well as increasing experience in allied sectors

We've been developing new technologies for industry for almost 80 years now - and getting them to work in real commercial production environments

We're preparing the sector for the decarbonised, circular and digital world of the future.

Our R&D, consultancy and pilot facilities:

- **Advanced Materials** where we're developing new alloys, 3-D additive manufacturing and making state of the art characterisation laboratories available
- **Industrial Decarbonization**, where we're focusing on efficiency now and the transition to the low carbon, hydrogen-electric economy
- **Circular Economy** R&D and demonstration to improve techniques and processes and introduce new ways to join up the loops of valuable material flows
- and **Digital Transformation** in monitoring, big data analysis, AR and AI to link human ingenuity, smarter safer controls and disruptive technologies such as blockchain for material lifecycles







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# Supporting your innovation

## Circular Economy

Physical processes

Thermal processes

Chemical processes

## Decarbonisation

Feasibility study, verification reports

Hydrogen infrastructure on campus

Energy storage, Energy generation

Energy efficiency, Heat recovery

Buildings heating network plug-in

**Scale up hosting and support**

**Collaborative grant funded R&D support**

**Private materials and process investigations**

**Carbon footprint and/or full Life Cycle analysis**

**All supported by world class characterisation equipment**



# THE CIRCULAR ECONOMY

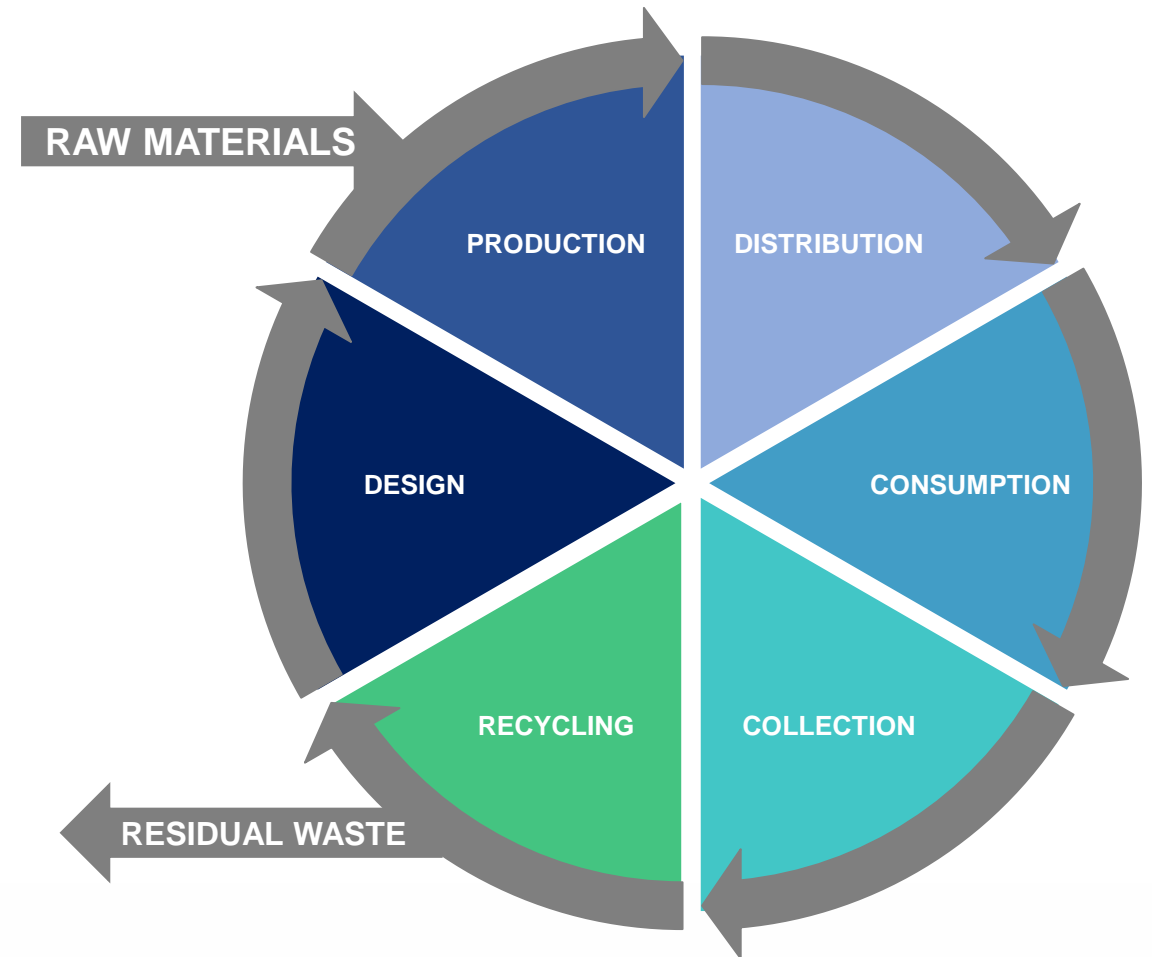


# The Need

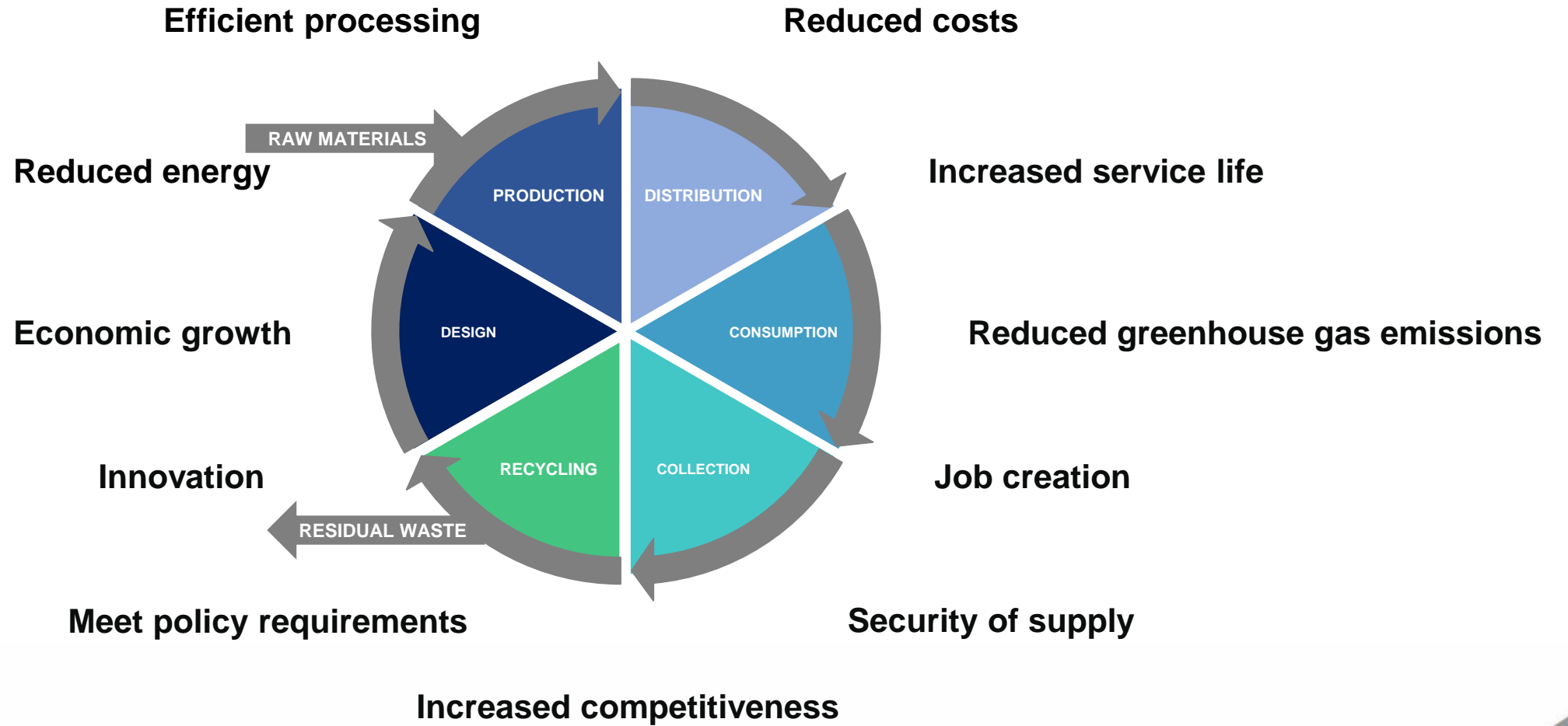
A circular economy prevents the production of waste, thereby ensuring that all materials are recycled back into the supply chain.

While residual materials or by-products may still be produced, in a circular economy these resources are utilised to produce another product.

While the ideal situation would eradicate the requirement for raw material extraction and use in the circular economy, where non-renewable resources are required, they must be acquired in a sustainable manner with no damage to the environment.

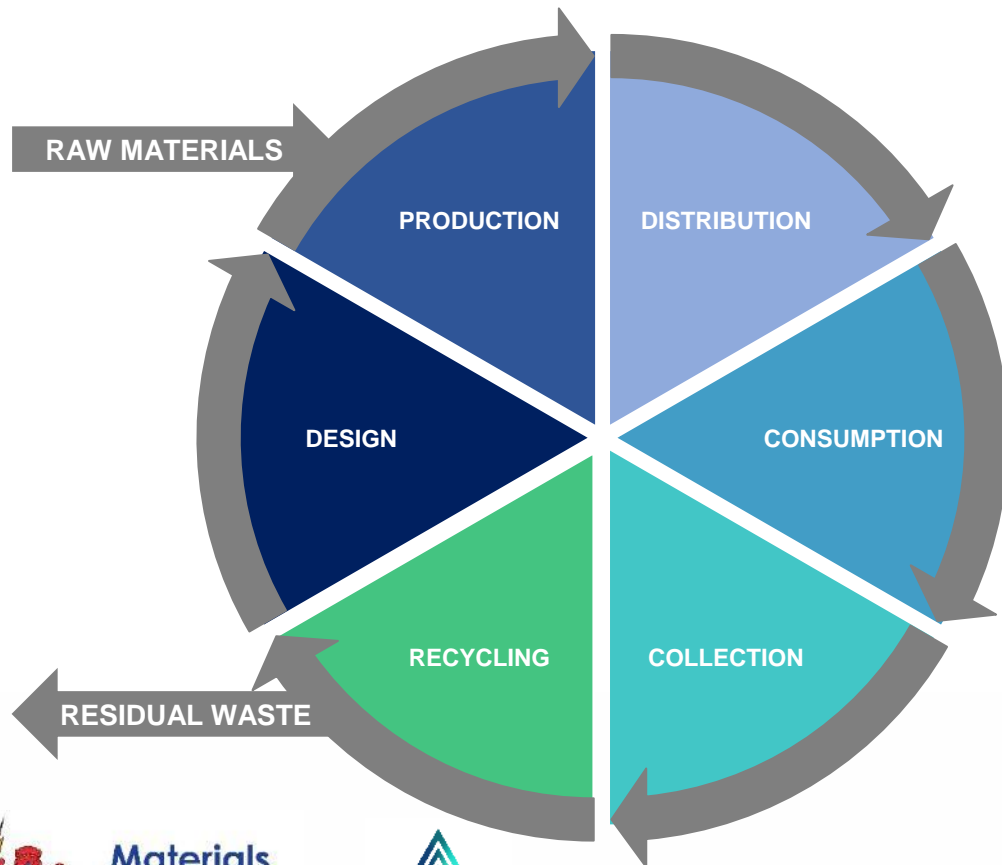


# The Benefits



# The Benefits – prove it and publicise it with LCA

- Application of LCA / Carbon Footprinting can lead to the identification of environmental savings throughout the supply chain.



## Process savings

- Raw materials
- Energy (gas and electricity)
- Water etc.
- Reduced waste

## Business improvements

- Validated data
- Impact reduction plan
- Product / supply chain footprint

# Our Solutions

## Industrial Symbiosis

- The system within which the by-products (or wastes) of one industry become the raw materials i.e., a resource, for another. This creates an interconnected network of energy and material cycles with zero waste production. These structures ensure increased material sustainability, reduced greenhouse gas emissions, and contribute directly to the circular economy framework.

## We provide:

- The technical expertise to identify opportunities for Industrial Symbiosis
- PRISM funding/the expertise to apply for Government Funding.
- Networking opportunities across the Foundation Industries.
- The advanced characterisation techniques to support Industrial Symbiosis.
- Life Cycle Assessment and Carbon Footprinting to assess the environmental impacts of system changes.

# Our Solutions

## Material (waste) Valorisation

- Material valorisation is the process of reusing or recycling (waste) materials and converting them into more useful products such as new materials, chemicals, fuels, or other sources of energy.

## We provide:

- Hydrometallurgical and pyrometallurgical recycling processes for material recovery.
- The technical expertise to identify opportunities for valorisation.
- PRISM funding/the expertise to apply for Government Funding.
- Networking opportunities across the Foundation Industries
- The advanced characterisation techniques to support valorisation.
- Life Cycle Assessment and Carbon Footprinting to assess the environmental impacts of system changes.

# On-site Equipment

## Hydrometallurgy / physical processing

- Crusher
- Dissolution reactor
- Separation, drying
- Solvent regeneration
- Hydrocyclone
- Capable of handling liquid, solid, and gaseous effluent

## Pyrometallurgy / pyrolytic treatment

- Top-Blown Rotary Converter
- Pyrolysis Kiln
- Electric Arc Furnace
- Induction Furnace

**All supported by top-of-the range characterisation equipment.**

# Recent Successful Projects

## Geopolymers

We are working closely with academia and industry to develop low carbon concretes using a range of wastes from the construction sector, steel industry, and energy sector.

## Net-zero cements

We are working in collaboration with whole supply chain to develop innovative processes for cement production.

## Valorisation of Iron and Steelmaking Slags

Developing new and innovative ways to increase the value and volume of iron and steelmaking slags.

# Recent Successful Projects

## Battery recycling

We are working with industry to develop a green battery recycling process that successfully recovers lithium and carbon for reuse in the supply chain. Our research has supported the development of a robust business model to establish a UK-based battery recycling business.

## Zinc recovery

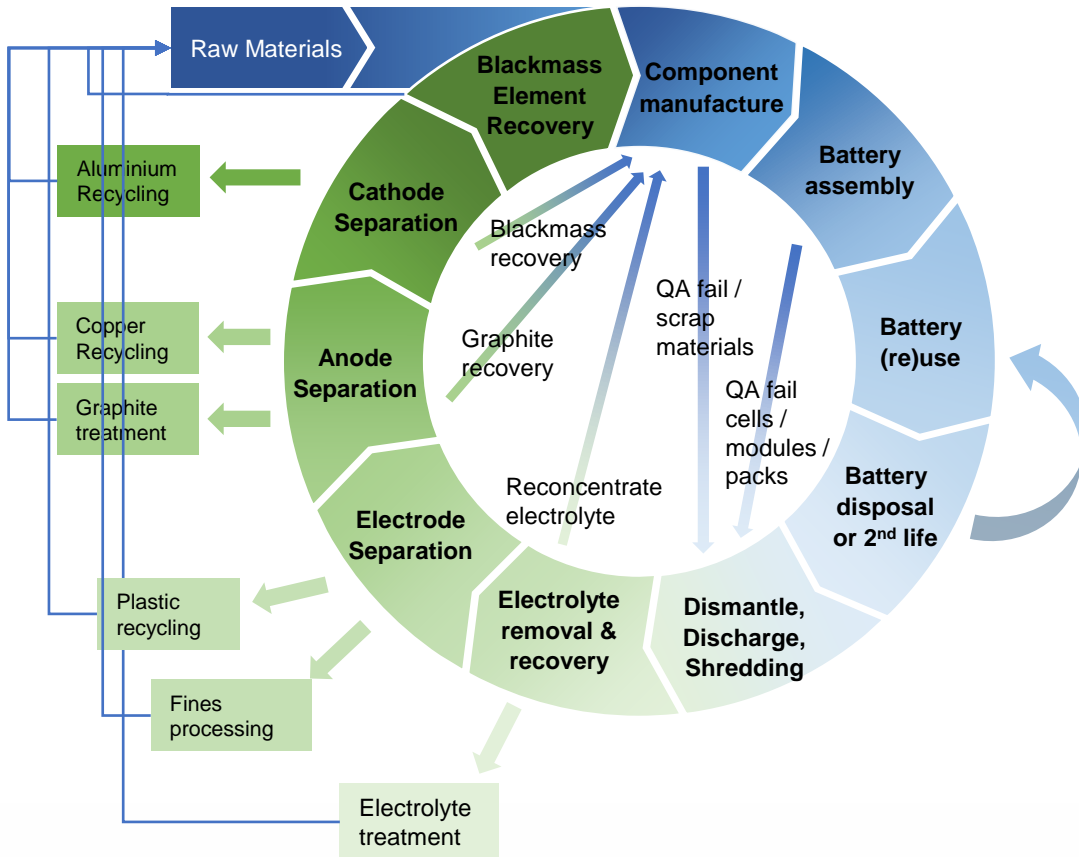
In collaboration with Primary and Secondary Steelmakers, we are working to develop a robust process for zinc recovery from waste sludges and dusts.

## WEEE recovery

Recovery of precious metals from Waste Electronic and Electrical Equipment.



# Battery Recycling Supply Chain



## Current situation

- Lithium widely lost through existing pyrometallurgical routes
- Graphite consumed within pyrometallurgical process
- Both materials on critical raw materials list

Funding: Innovate UK, The Sustainable Innovation Fund: SBRI phase 1, October to December 2020

- Identified route to get to blackmass using existing technology

## Future work

- Use of greener solvents
- Circularise Lithium-ion battery industry
- UK based recycling
  - Instead of paying to export abroad
  - And paying to import materials into the UK for manufacturing



# INDUSTRIAL DECARBONISATION



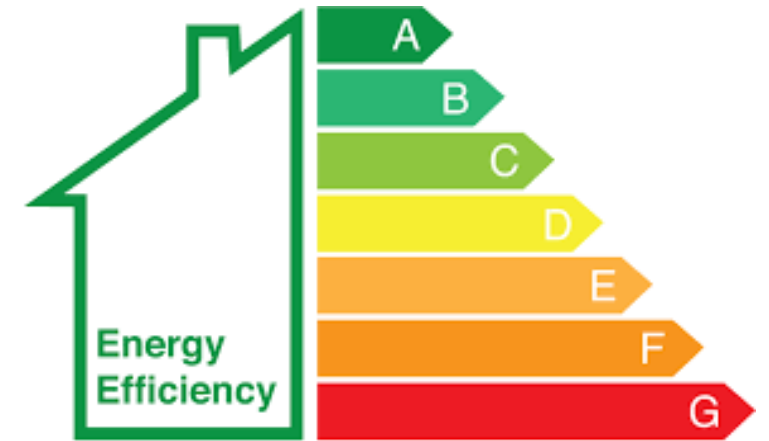
# Innovation stands on the shoulders of best practice

Energy Efficiency measures are very often seen as **dull !**

No shiny new equipment

But these measures usually are:

- Most cost effective
- Least intrusive
- Simple and straightforward
- Shortest lead in and payback
- Best reductions in terms of cost and CO<sub>2</sub>

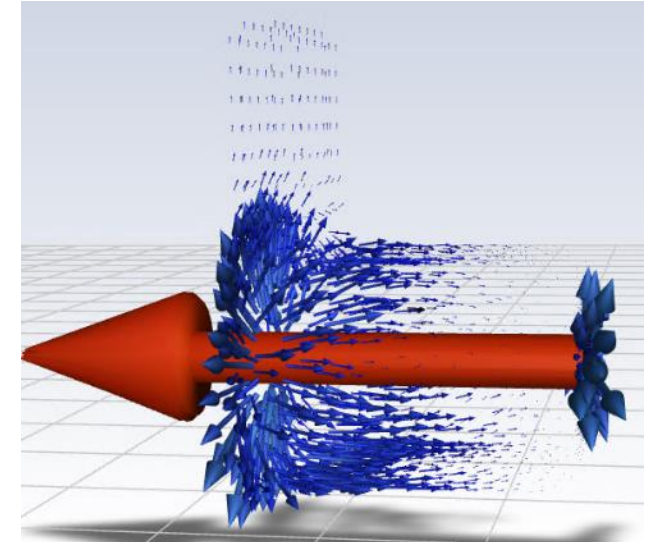


But, if done well and effectively – they become invisible.....

But not to the bank balance or the emissions outputs

# How the Institute will help you decarbonise

- Short term improvements
  - Efficiencies rationalised
  - Company operating procedures evaluated
- Mid term methods for decarbonisation strategies
  - FEED studies
  - Fuel and energy changes
  - Modelling fuel switching



Fluid flow from a hydrogen CFD simulation

10MW Reheat furnace	Heat efficiency %	Cost of Energy £ M	Cost of carbon taxation at set values of UK ETS (£)		
			£50/ tCO <sub>2</sub>	£75/ tCO <sub>2</sub>	£100/ tCO <sub>2</sub>
Natural gas	43	1.114	228,882	343,323	457,764
Hydrogen	43	1.237	0	0	0
Electricity	85	1.502	0	0	0

# Where to start – Identify and Verify

Q: Do you **really** know where your energy is used... and wasted?



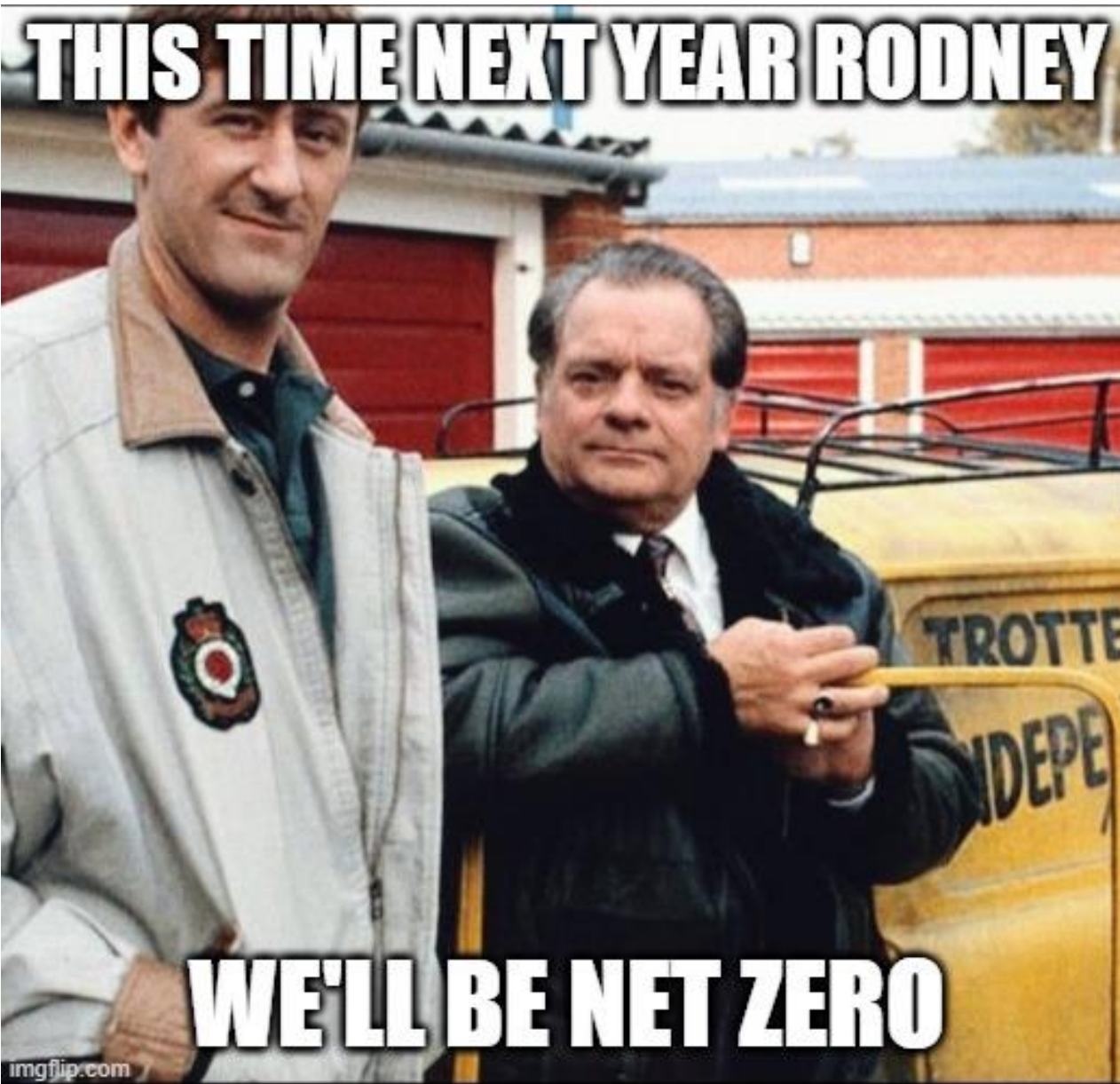
The Institute site is a mix of building types, ages, functions, processes and is split between us and our tenants/partners, we have facilities that reflect many in the UK, with real world problems and issues. Workable solutions are well known to us.

Our own **initial** steps were:

1. Metering and Monitoring
2. Boiler Replacement programme
3. BEMS Controls Systems (Building & Energy Management System)
4. Lighting & Controls replacement Programme
5. VSD Drives for inductive load pumps
6. Utility arrangements and on site generation



Dull – but it truly works



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# Decarbonisation of heating and reheating

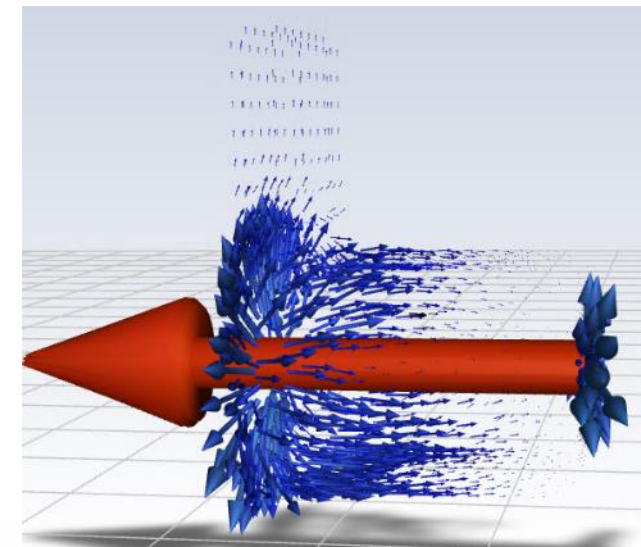
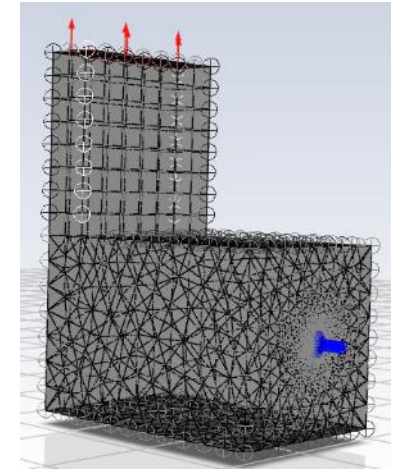
What does the future of furnaces look like for high temperature processes?

- Heating and reheating usually depends on large quantities of natural gas as a fuel.
- The Institute has a team of specialists who can focus on finding decarbonisation solutions
- Energy and heat use evaluation
- Current system efficiency evaluation
- Evaluate UK ETS



# Modelling your future needs

- Current model available
  - Development of hydrogen model for pre/heat reheat furnaces
  - Hydrogen model can be used for gap and comparative analysis
  - Evaluate fuel usage
  - Emissions data
  - NOx comparison
  - Flame and operating temperatures
  - Build into full operational model for any furnace
- What next
  - Electrical model
  - Full range of services as for hydrogen model



Fluid flow from a hydrogen CFD simulation



# Hydrogen Innovation Centre

Hydrogen gas network capable of 1MW of energy delivery for heating and reduction pilot equipment

- Oxy-hydrogen zero carbon low NOx industrial burner demonstrator to assess impact on products and equipment
- CFD modelling for furnace and components for fuel transition all the way to 100% hydrogen
- Certified environment (ATEX rated) confidential development space for scaling up hydrogen generation or applications
- Net-zero reduction of iron ores is a major R&D strand, featuring
  - Hydrogen-electric iron reduction lab facilities and pilot furnace
  - Capability to investigate electrolytic metal production from ore or recovered materials
- Research to scale up to market pipeline partnerships including regional academic centres of excellence and investors

# Recent Successful Projects

## Hydrogen ready heating innovation

Hosting commercial building trials and hydrogen demo of an innovative radiant heating startup, scaling up from development work at Teesside Uni

## Hydrogen generation innovation

Verified the purity of hydrogen output and identified next steps for commercialisation for a novel technology for generating hydrogen from seawater

## Hydrogen pipeline design and installation

Design and commissioning of a dedicated islanded hydrogen pipe network at the Institute to support public and private projects



# Latest News

## CMS installs hydrogen pipework as part of multi-million pound green steelmaking project



Hydrogen pipeline systems are being installed at the Materials Processing Institute as the initial £270,000 phase of a multi-million project to demonstrate UK innovation in green steelmaking.

Commercial Maintenance Services UK Ltd (CMS) is currently installing the infrastructure as part of the development of a proposed permanent national pilot distribution and production facility at the Institute's Teesside campus.

The initial part of the project, codenamed H2DRI, will focus on how production can be scaled up and will build practical and scientific understanding on how best to deliver economically and environmentally sustainable green steelmaking. Part of the government's Net Zero Innovation Portfolio Industrial Fuel Switching Competition that funds low carbon technologies and systems, the project is led by the Institute in partnership with electrical technology developers C-Tech Innovation, Teesside University, the Steel and Metals Institute at Swansea University, and global metals and mining company Rio Tinto.

## Stockton's Torvex Energy can now make hydrogen from seawater

8th April



Dr Richard Birley, Principal Researcher for Industrial Decarbonisation at the Institute with Torvex Directors Rob Hutchinson and Stewart Hudson



By Mike Hughes  
Business and Commercial Editor  
@mikehughes

Share 2 Comments

A Stockton R&D company has unveiled a unique process to create green hydrogen from seawater.

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# Thank you, please get in touch!

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