EPSRC
Engineering and Physical Sciences Research Council

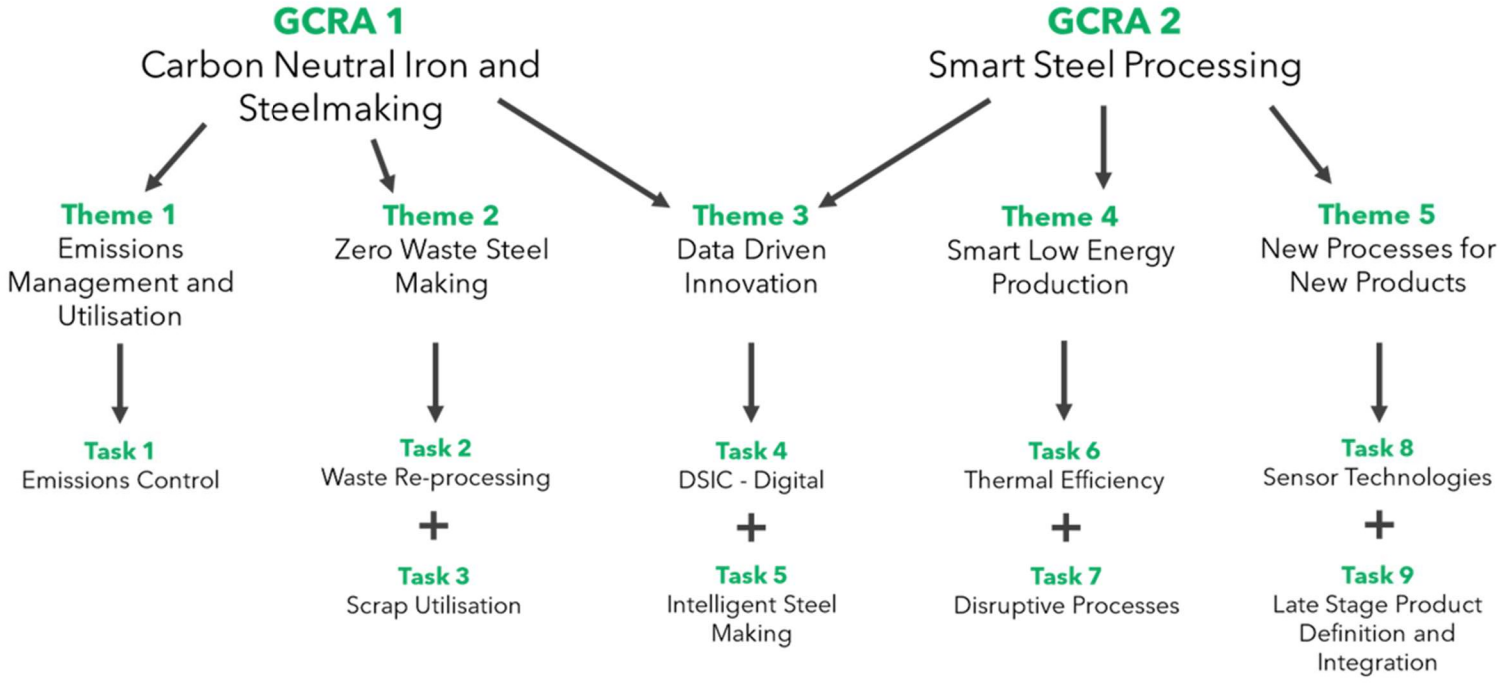
Swansea University
Prifysgol Abertawe

The University Of Sheffield.

WMG
THE UNIVERSITY OF WARWICK

SUSTAIN

Future Steel Manufacturing Research Hub



What is SUSTAIN?

Steelmaking has been prominent in the UK for generations. The SUSTAIN Future Manufacturing Research Hub is a £35M project funded by £10M of EPSRC funds, as well as Universities, Trade Bodies, RTOs and Businesses over 7 years and aims to support the industry as we develop new, more environmentally friendly options to ensure the future of manufacturing in the UK.

The SUSTAIN project aims to deliver cutting edge science and the engineering research required to create carbon neutral, resource-efficient UK steel supply chains. We can enable UK manufacturing sectors to deliver world-leading resilient solutions for tomorrow's transport, energy and building needs, whilst overcoming societal waste and energy challenges. With this we can bring high-value jobs and prosperity to the UK.

Our Vision

- Academic Leadership for Steel – a nucleus for broad multidisciplinary collaboration and influence the UK research agenda for steel
- 21st Century Workforce - Innovation cannot be divorced from skills training, our outreach program aims to influence policy and set agenda for future skills and generate exemplary content
- Carbon Neutrality and Zero Waste - This is the number one techno-economic challenge, we must create and commercialise solutions, influence policy and creates opportunities for the circular economy with supply chain
- Smart Processes for Smart Products - To secure and build these sustainability benefits into the future and to fulfil potential market opportunity, the UK industry must supply a wider range of markets with high quality products. We aim to investigate novel processes and data driven approaches that can deliver this goal.

Our ambitions

- To develop systems for carbon neutral iron and steelmaking by 2040
- To double steel GVA by 2030
- To implement world-leading intelligent infrastructure by 2030

Our Grand Challenges

GCRA1 - Carbon Neutral Iron and Steel Making

Carbon Neutrality & Innovative Steelmaking

Steel is ubiquitous in the modern developed world; its low cost and the highly developed industry that produces it enable the standard of living we are accustomed to. From packaging to construction, transport and energy steel plays a major part in our daily lives without notice. Although the steelmaking process is highly efficient, for every tonne of steel produced, twice the amount of CO_2 is liberated from fossil fuels to drive the process and its energy requirements. The first of SUSTAINs grand challenges aims to develop innovative methods that will eliminate the carbon footprint of steelmaking and provide a sustainable method of production and carbon neutral industry that supports global needs.

GCRA2 - Intelligent Steelmaking

Metrology, Corrosion, Big Data, Industry 4.0, Alloy Processing

This grand challenge aims to revolutionise the steel industry through the development of steels with enhanced mechanical and physical properties, develop increased functionality and utilise the recent developments in sensor technology and digital systems. Focussing upon production and supply chains, the Intelligent Steelmaking Grand Challenge is introducing concepts such as blockchain and tracking technologies into a mature supply chain and customer base that will explicitly describe the manufacturing process and sourced materials on a product by product basis giving the end customer and government bodies full confidence in the products performance, ethical raw material sourcing and production and carbon footprint.

Theme 1 Emissions Management and Utilisation

Prof Andrew R Barron (Swansea) & Dr Enrico Andreoli (Swansea)
Prof Peter Styring (Sheffield)

This theme focusses on the challenges of Carbon Capture and Usage for large point sources of CO_2 and management of other harmful gaseous and particulate emissions. Integrated steel plants create approximately twice the tonnage of CO_2 as steel product when considering the gaseous output through process (from Blast Furnace and Coke ovens through to the rolling mills). Electric Arc Furnace (EAF) plants output significantly less as part of the primary process but may consume more fossil fuel down-stream due to inability to recycle up-stream gasses for product heating as part of rolling and deformation processes. This output would be even greater if steel plants were not already efficient at reusing flammable process off-gasses for heating in down-stream processes such as hot rolling.

The first challenge is demonstrating a robust recovery and separation process to extract the CO_2 from a range of output gas streams that contain other gasses including nitrogen, volatilised compounds and particulate matter.

Following this process a series of parallel activities will investigate the re-use of the captured CO_2 at the laboratory scale before upscaling to industrial scale throughput. This work will focus on novel Carbon Capture and Usage strategies to produce fuels, materials and foods.

Theme 2 Zero Waste Steelmaking

Prof Peter Holliman (Swansea)
Dr Zushu Li (Warwick), Dr Richard Thackray (Sheffield)

This theme concentrates on the reuse of domestic and industrial waste products within the steelmaking process. The projects within this theme currently focus on the substitution of fossil fuels with applicable land fill waste and the reuse of end of life ferrous materials within the steelmaking process.

Non Fossil Fuel Carbon source solutions for fuelling the Blast Furnace and thermo-chemical pre-treatments will be studied together with investigations into the compatibility with existing fuel injection methods. High temperature elemental scavengers will be developed to selectively remove and partition blast furnace poisons into slag.

The UK currently exports approximately 10 M tonnes of scrap steel per year that could be locally recycled. The main challenge in the reuse of this material is the management of unknown elements inherited from a range of steel types, as well as non-ferrous materials entering the scrap steel supply, introducing impurities. This theme investigates novel management through processing methods that will maximise the performance of existing and newly developed metal sorting techniques. Additionally this theme will investigate techniques to facilitate removal of residuals from liquid steel. The ultimate effects of residual elements on product performance, both in use and during the thermomechanical processing stages will be mapped in terms of parameters on steel manufacturing and product qualities.

Process models will be developed to provide dynamic information of environmental impact, and Life Cycle Costing (LCC) will be used to test the technical data to provide auditable macro-economic data (e.g. cost benefits).

Theme 3 Data Driven Innovation

Prof Jan Godsell (Warwick), Prof Giovani Montana (Warwick),
Prof Jonathan Linton (Sheffield), Prof Arnold Beckman (Swansea)
Dr Michael Auinger (Warwick) & Dr Richard Thackray (Sheffield)

The business model of UK steel manufacturing, both integrated and EAF route, needs to transition from a historical inwardly focused supplier/customer relationship to one that embraces the wider end-to-end supply chain and improves productivity more holistically. A number of enabling technologies, grouped under the umbrella term of 'Industry 4.0' or 'digital', have developed to a level of maturity that when combined could provide the basis for and facilitate a step-change in the performance of the end-to-end steel supply chain.

New approaches to process modelling and optimised fast-algorithm techniques will be employed to allow real-time simulation and prediction of complex thermodynamic, kinetic and mechanical processes. This will produce accurate data of the process and product that may be incorporated into complex product information databases and Blockchain descriptors of product quality and process route.

The ambition is to create a data-driven step change improvement in the competitiveness of UK steel supply chains. This will ensure that the UK maximises its opportunity to contribute to the global network of steel supply chains in a sustainable and valuable way. In turn this will secure future competitiveness of companies within the UK steel supply chains.

This will require UK steel supply chains to be effective, efficient and harness the opportunities enabled by recent technological developments. To be transformative, the industry will have to be disruptive. The goal of this task is to ultimately generate disruptive technologies for 21st Century supply chains and business models.

Theme 4 Smart Low Energy Production

Prof Cameron Pleydell-Pearce (Swansea)
Dr Zushu Li (Warwick) & Prof Claire Davis (Warwick)

This theme focusses on using smart techniques, enhanced material properties and non-carbon sourced reactants to reduce the net carbon usage and energy required throughout the steelmaking process.

Thermal energy lost as heat throughout the steel manufacturing process is considered together with both the use of new novel materials to convert conducted and radiated heat into useful electrical energy, as is the performance and durability of existing and future refractory materials. Processing and re-use of refractory material is also considered and the impact that this will have on in-service longevity, reduction in mining of materials for refractories and financial value to industry.

This theme also investigates the use of hydrogen in the production of iron which is currently produced using fossil fuels such as natural gas. Direct Reduced Iron (DRI) is used extensively in Electric Arc Furnace (EAF) steel plants to mitigate the concentration of impurities introduced from the processed scrap metal by dilution. Greater use of DRI in the UK will allow current EAF plants to expand their product mix to include higher quality low alloy products and enable integrated plants to incorporate or move to EAF technology and maintain a large amount of their existing products in the process. Reduced processing manufacturing will also be investigated, focussing on near net-shaped casting and minimised energy input and processing of existing products.

Theme 5 New Processes for New Products

Prof Claire Davis (Warwick) & Cameron Pleydell-Pearce (Swansea)
Prof Eric Palmiere (Sheffield), Prof Mark Rainforth (Sheffield)
& Martin Strangwood (Warwick)

This theme looks at the potential of using novel chemistries, processes and measurements to produce new products or improve the efficiency and consistency of existing high value steels.

Application of electromagnetic sensors to provide improved monitoring of the steel production processes allows for greater digitalisation and control, leading to more efficient, less energy intensive manufacturing. Improved monitoring of processes is a key part to sustainability, growth and modernisation for the steel industry. Great improvements have been made for real-time monitoring and feedback control, but several areas have been highlighted where insufficient information is currently available requiring new and improved sensing approaches.

One area of focus is microstructural monitoring during processing. Research here will focus on modelling and practical experimentation of advanced microstructure measurement and control using electromagnetic sensors. Close measurement and control of microstructure during heat treatment and rolling will enable favorable microstructures to be formed and maintained, maximizing the potential properties of steel alloys for given chemistries and designs.

Another area of focus is the development of ultra- high performance steels for improved processing efficiency, reduced process energy requirements, ultra high strength for equivalent lighter weight products and novel processes which enable late differentiation of the steel into a range of diverse products.

Keep up to date with our progress

sustainsteel.ac.uk

@sustainsteel

SUSTAIN Steel

EPSRC
Engineering and Physical Sciences Research Council

Swansea University
Prifysgol Abertawe

The University Of Sheffield.

WMG
THE UNIVERSITY OF WARWICK

SUSTAIN

Future Steel Manufacturing Research Hub

BRITISH STEEL

CELSA GROUP | CELSA STEEL UK

SHEFFIELD FORGEMASTERS INTERNATIONAL

LIBERTY STEEL

TATA STEEL

@sustainsteel | sustainsteel.ac.uk | SUSTAIN Steel


EPSRC
Engineering and Physical Sciences Research Council
Swansea University
Prifysgol Abertawe
The University Of Sheffield.
WMG
THE UNIVERSITY OF WARWICK
@sustainsteel
sustainsteel.ac.uk
SUSTAIN Steel