The Strategic University Steel Technology and Innovation Network Presents

Task 1: Carbon Conversion & Environmental Pollution

Prof Andrew Barron, Prof Peter Styring,
Dr Enrico Andreoli

SUSTAIN

Future Steel Manufacturing Research Hub

UKRI Engineering and Physical Sciences Research Council

Swansea University Prifysgol Abertawe

The University Of Sheffield.

ESRI

CDUK UK Centre for Carbon Dioxide Utilisation

Names and Organisations

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- Professor Andrew R. Barron – Swansea University

  Sêr Cymru Chair of Low Carbon Energy and Environment

  Director of the Energy Safety Research Institute

- Professor Peter Styring – The University of Sheffield

  Professor of Chemical Engineering & Chemistry

  Director of the CO2Chem Network

- Dr Enrico Andreoli – Swansea University

  Associate Professor - Carbon Capture & Utilisation

Introduction to Project

- Decarbonise steel supply chain

  BF-BOS 2.3 tCO_2/t ; EAF 0.4 tCO_2/t *

- Steelmaking processes will continue generating CO_2 even in the long term
- CO_2 utilisation has the potential to lower the cost of carbon capture and sequestration
- CO_2-derived chemicals and fuels large market scale should allow a future circular economy based on the recycling of carbon dioxide

* Reaching zero carbon emissions from Steel – 2018 Consultation Paper by the ENERGY TRANSITIONS COMMISSION

Aims and Impact

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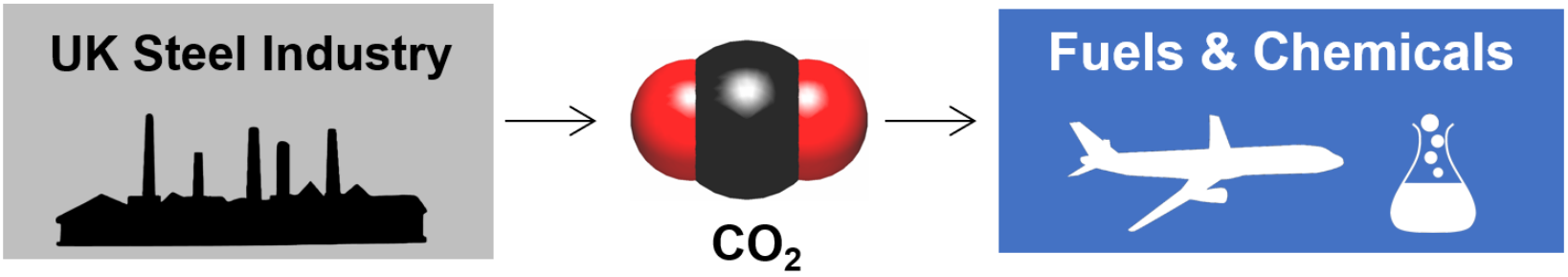
- Overall aim

  Reduce steelmaking carbon emissions by capturing and converting CO_2 into valuable products.

- Overall Impact

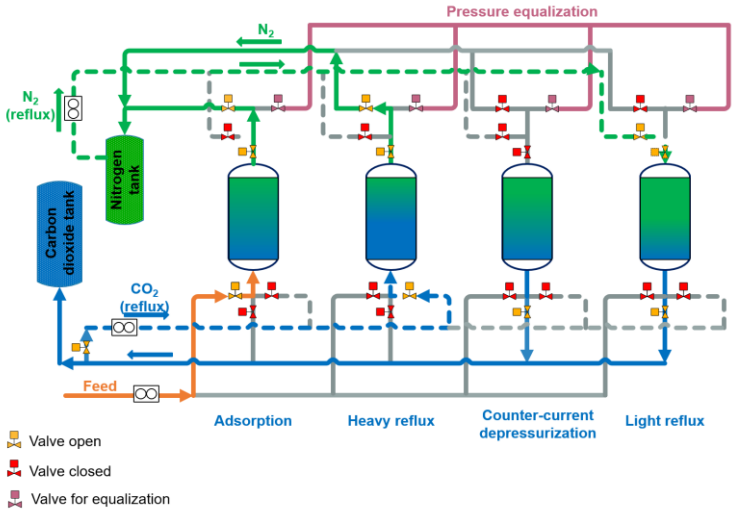
  Providing the UK steel industry with designed scalable options for carbon dioxide valorisation.

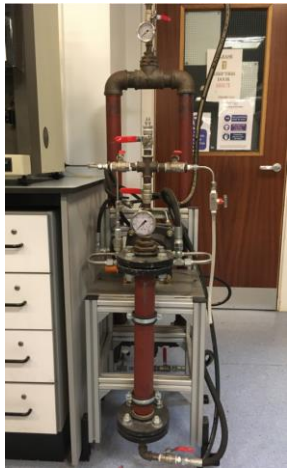


Aims and Impact

- Develop, build, and operate pressure/temperature swing adsorption units with purposely designed sorbents
- Higher CO_2 separation selectivity, lower energy penalty

- Deliver a separation unit and sorption materials for efficient carbon dioxide capture from gas mixtures specific to steelmaking





Aims and Impact

- Deliver improved thermocatalytic and electrocatalytic conversion of CO_2 to CO, C-based fuels, ethylene.
- Increase product selectivity and energy efficiency

Thermal conversion CO_2-to-DME – scalable, with additional funding

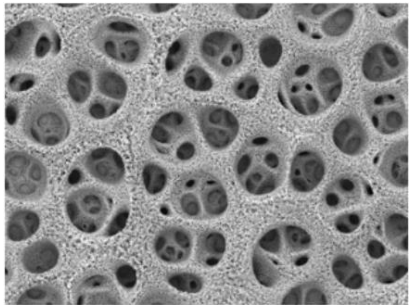
Sheffield

Batch to Flow

0.25 t/day

Electrical conversion CO2-to-Ethylene – novel process (new catalyst, new electrolyser)

Swansea



Aims and Impact

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- Biorefinery for algae feeding and harvesting using industrial CO_2 emissions.
- Algae processing to high value chemicals for the food, pharmaceutical, personal care, & home products industries.

ESRI at Swansea university is developing a large scale algae-based biorfinery

Progress to Date

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- Two postdoctoral researchers hired

  Sheffield: Start June 2020

  PSA, CO_2 sorbents, CO_2 thermo-conversion

  Swansea: Start in Oct 2020

  CO_2 electro-conversion, CO_2 sorbents, biorefinery

- Biorefinery demonstrator almost deployed at Vale's nickel refinery

  Once COVID-19 restrictions are lifted we will have it operational within 1 month.

Upcoming output

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- Preparation and characterisation of CO_2 sorbents:
  (i) porous amine-based;
  (ii) ionic liquids supported cellulose.
- Progress on deployment of integrated biorefinery demonstrator.
- Design of CO_2 electrolyser operating with gas diffusion electrodes.
- Progress on optimisation of thermocatalytic conversion of CO_2 to CO, designed C-based fuels.

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WMG THE UNIVERSITY OF WARWICK

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BRITISH STEEL

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SHEFFIELD FORGEMASTERS INTERNATIONAL

LIBERTY STEEL

TATA STEEL