

# UKRI Interdisciplinary Centre for Circular Chemical Economy– Overview

## 1 Introduction

Our vision is to transform the UK chemical industry into a greener, more efficient economy. We are creating new circular pathways to reuse and recover chemicals from end-of-life materials. This will eliminate waste, reduce the need for fresh resources and ensure the long-term competitiveness of the sector.

## 2 Summary

The Centre brings together stakeholders from academia, industry, government, NGOs and general public to transform the UK's chemical industry into a fossil-independent, climate-positive and environmentally-friendly circular economy. This will be achieved by creating novel circular resources flows of olefins and their complementary feedstocks ( $H_2$ , methanol,  $CO$ , alkanes, etc) to replace the current linear olefins supply-demand network. Olefins, such as ethylene and propylene, account for over 70% of all organic chemical production and are used for the synthesis of a wide range of intermediate products, including polymers, chemical fibres, solvents, synthetic rubber and high-value speciality chemicals. These form the fundamental building blocks for the manufacture of a wide variety of useable consumer goods, such as construction materials, household appliances, textiles, paints and packaging. Despite their importance, there currently is only limited resource recovery from end-of-life materials, resulting in high volumes of waste putting significant strain on the environment. Existing mechanical recycling processes are restricted by the high diversity, contamination and thermal instability of chemical materials. Therefore, our Centre will explore, develop and assess alternative chemical, electrochemical and biological routes to recycle carbon for fresh chemical production to achieve a circular economy.

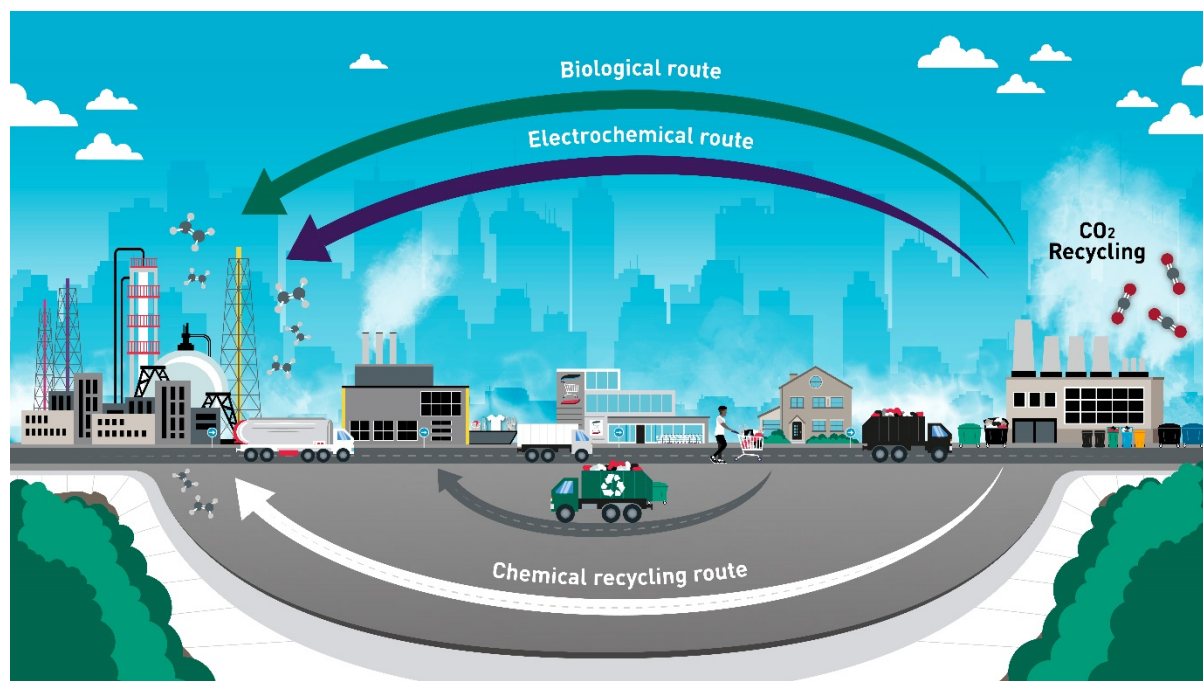


Figure 1: Our vision for a Circular Chemical Economy

### 3 Importance

The UK chemical sector has an average annual turnover of ~£32 billion (GVA: £12.6 billion) with 99,000 direct jobs. It accounts for 6.6% of total UK manufacturing output and 9% of exports. However, to maintain its global competitiveness whilst meeting national emissions and environmental targets, it is vital to reduce its substantial greenhouse gas emissions (16.5% of total industrial energy use) and end-of-life waste, putting increasing pressure on the UK's rapidly shrinking landfill capacity. Despite strong desire from the chemical sector to improve the circularity of its processes, progress has been limited by the current lack of cost-effective chemical recovery technologies, the high complexity of the chemical supply chain and a lack of policy guidance and support to identify and address the non-technical barriers and opportunities. The current linear approach of the UK chemical industry is incompatible with UK emissions and sustainable growth policies. Therefore, an existential threat exists to this industry since it is clear that there is no longer the option of continuing business as usual.

### 4 Research programme

The Centre will take leadership at all levels to achieve its goals of reducing the Chemical Industry's reliance on fossil-based resources and energy use, cutting and capturing carbon emissions, and eliminating waste and pollution associated with chemical production and disposal.

**Theme 1** covers the development of new disruptive chemical recovery technologies, through three different routes (depolymerisation of solid wastes, direct electrochemical transformation of captured CO<sub>2</sub> emissions and indirect conversion of biomass grown on waste CO<sub>2</sub>). There is no one-size-fits-all approach, and therefore we have identified several, most promising routes, which will be developed in parallel to achieve circularity.

**Theme 2** focuses on the integration, evaluation and whole system impacts (both environmental and social) of new and existing processes to identify new circular chemical value chains. We will go beyond individual technologies to understand how they can be combined and interact with each other and the existing infrastructures.

**Theme 3** will develop novel forward-looking methodologies to support government, business, the third sector and consumers to understand and address the non-technical barriers and opportunities to deliver effective real-world solutions. We will work with government, businesses, the third sector and consumers to understand the opportunities, challenges, and deliver effective real-world solutions.

The **responsive programme** provides additional funding for complementary projects ranging from academically driven to user-defined activities. Flexible Grant Projects will extend the most promising research activities from the Core Programme. Up to 10 Industrial Matched PhD projects will be used to initiate exploratory research of common interests with industrial partners. We will adopt a coordinated approach to help our SME partners to develop joint research proposals in response to the dedicated £2.5m InnovateUK Fund. Finally, we will provide service to industrial partners through Consultancy Work for dedicated research needs, whilst exploring opportunities for technology commercialisation.

**Co-creative case studies** will be developed with our users and stakeholders to converge and integrate our three research themes. These case studies will use a whole system approach to simultaneously consider technology development, system integration, business model, financing channels, policy and social incentives. We aim to generate flagship exemplars to showcase how circular chemical productions might effectively be exploited within operations ranging from large businesses to SMEs. These exemplars will drive the required supply chain

changes and motivate various actors across the whole system, to achieve **early impacts within the Centre's lifetime.**