Executive Summary

Key findings and recommendations from policy workshops discussing how to finance a transition to a circular economy in the UK chemical manufacturing sector. Senior representatives from academia, industry, special interest groups and learned societies were invited to contribute their views, requirements and perceived challenges.

Moving to a circular economy is imperative not only for environmental reasons. It has potential for wide-ranging economic and societal benefits, giving the capacity to grow and thrive, create green jobs, upskill the workforce, increase self-sufficiency by reducing import reliance, improving infrastructure and providing a brighter outlook for future generations.

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The Circular Economy

A *Circular Economy* (CE) offers a vision where products and materials are designed to be reused, repaired or remanufactured, ensuring resource extraction, waste generation and pollution are kept to a minimum. By focussing on society-wide benefits, it seeks to redefine growth by gradually decoupling economic activity from the consumption of finite resources. All of this is underpinned by a transition to a *whole systems approach* and identifying sources of low-carbon energy. Three key principles are the foundation: 1) better product design to remove *waste* and pollution; 2) keeping products and materials in use; 3) regenerating natural systems.[1] Current business models are linear and focus on a 'take-make-use-dispose' approach - they are not sustainable (*Figure 1*).

Figure 1: *A linear economy of take-make-use-dispose.*

Crucially, transitioning to a CE also brings many positive benefits, not only addressing the negative aspects of a linear economy. **It represents a fundamental shift that generates business and economic opportunities, provides environmental and societal benefits and builds long-term resilience** (*Figure 2*).

It is estimated that a CE in Britain could create over half a million jobs by 2030.[1] Furthermore, circular models have the potential to identify **reduced production costs and bolster resource security, lessening import dependency and supply chain disruption risks.**

The CE, and Industrial Symbiosis and Resource Efficiency in particular, aims to transform the way we manufacture and consume products. Relying solely on renewable energy solutions to reduce greenhouse gas (GHG) emissions will only address 55% of these emissions. The CE can reduce a significant portion of the remaining 45%.[1] Intense demand for energy and resources can be cut by circulating products and materials, instead of producing new ones.

Moving to a circular economy is imperative not only for environmental reasons. It has potential for wide-ranging economic and societal benefits, giving the capacity to grow and thrive, create green jobs, upskill the workforce, increase self-sufficiency by reducing import reliance, improving infrastructure and providing a brighter outlook for future generations.

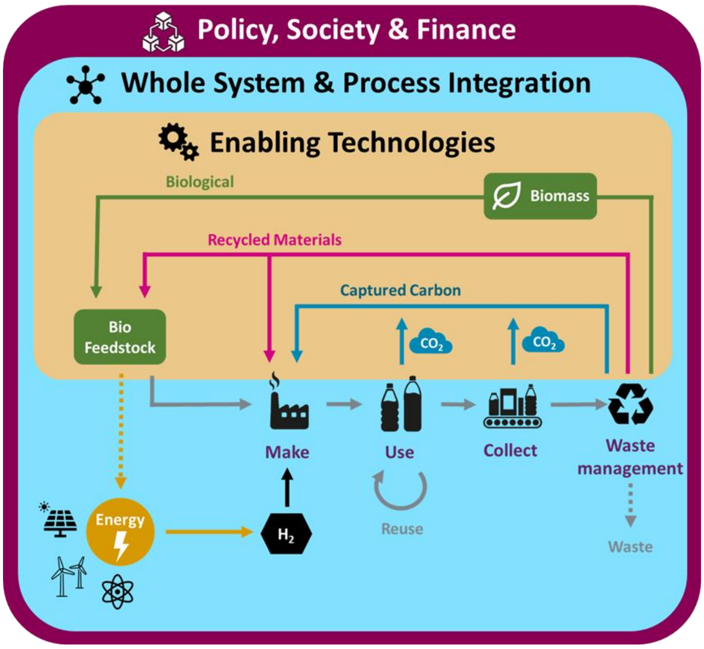

***Figure 2:** A circular economy, where extraction of natural resources is minimised, and recycling of materials is promoted.*

Our Vision

To transform the sector's current linear supply chain model into a fossil-independent, climate positive and environmentally friendly circular economy.

The UK Chemical Industry

The UK chemical sector underpins much of UK industry, such as automotive, aerospace, consumer goods, agriculture, and life sciences. It should be at the heart of every political ambition – technological, economic, environmental, and social. This diversity and influence facilitates advanced research and innovation both within the sector and important customer sectors.[2]

Economically, the contribution made to the UK economy is significant. With annual exports of £61 billion, corresponding to a gross value added (GVA) of £200,000 per employee and 138,000 direct jobs,[2, 3] it is one of the largest export sectors with UK demand predicted to double in the next 10 years.

However, business as usual is no longer an option. The sector is one of the largest consumers of energy and resources and, consequently, one of the largest emitters of CO_2. Carbon-based chemistries are integral to most sectors within the chemical industry. **Therefore, we need to *decarbonise* our energy supplies and *defossilise* our carbon sources.** Alternative, non-fossil derived sources of carbon are needed urgently to achieve our vision.

Base chemical feedstocks, such as *ethylene* and *propylene* (commonly referred to as *olefins*) are currently derived from fossil sources. These are the building blocks of the petrochemical industry, used to formulate commodity products, such as polyethylene and polypropylene plastics, and more speciality or formulated products, which are used based upon their performance or function for specific consumer products. *Olefins* and their complementary feedstocks account for over 70% of all *organic chemical* production.

Current manufacture of *olefins* occurs by a process known as *steam cracking* of *naphtha*, an energy-intensive process that generates large amounts of CO_2 (1.2 – 1.3 tonnes of CO_2 (tCO_2) per tonne of olefin).[4] Their use includes a wide range of intermediate and final products, including plastics, chemical fibres, solvents, fertilisers, synthetic rubber and high-value speciality chemicals. These intermediates are subsequently used by other manufacturing and industrial sectors to produce useable end products (*Figure 3*).[5]

Collectively, inputs from the chemical industry can be found in **96% of all manufactured products in the UK**.[6]

Demand for high-value chemicals is predicted to grow by 50% by 2050, with a forecasted global demand of 340 Mt of *ethylene* alone.[7]

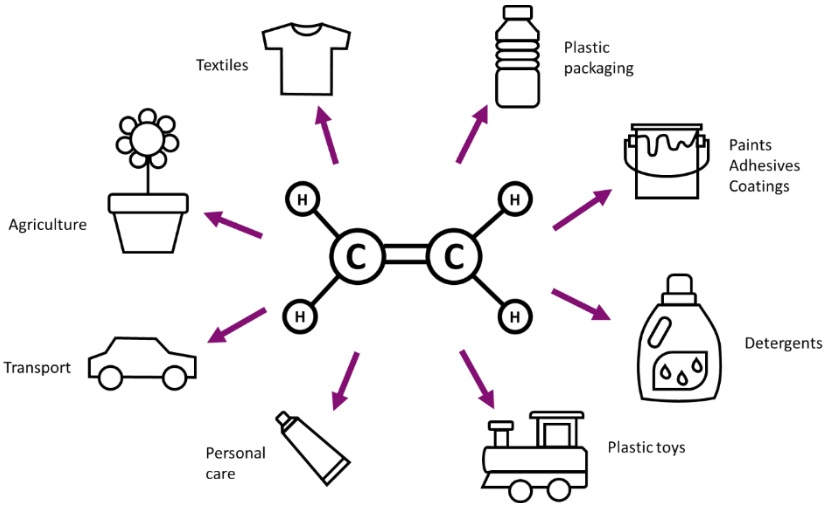

Figure 3: *Chemicals obtained from ethylene can be found in numerous consumer products across many different sectors of the economy.*

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Key Findings

Technologies

CO_2 is currently viewed as a waste product, but it is a valuable commodity resource to reduce costs for many industries within the chemical sector and beyond.

Current UK policies place an **over-importance on waste carbon and biomass for fuels**. Valuable chemical feedstocks can be extracted before conversion into fuels, offering much greater GHG reductions as carbon emissions are not immediately re-released.

Accessing resources and facilities for **scaling-up early-stage research and building demonstrator units** is extremely difficult. A portfolio of demonstrator units would help to boost investor confidence and de-risk these new technologies.

Finance & Fiscal

UK-based finance opportunities are severely lacking which poses a significant barrier to developing and scaling innovation. Increasingly, funding of the scale required is being sought and obtained overseas leading to an outward flow of UK innovations.

Investment risk remains a significant challenge, particularly with business-as-usual activities having greater stability and return on investment. Limited investor understanding of this sector further adds to the perceived degree of risk.

Sector funding requirements are far greater than in other areas, in the billions of GBP, with considerably high seed funding costs, CAPEX costs due to operational scale, and a large gap between the early and pre-commercial stages requiring additional support.

Government collaboration, both inter-administration and the devolved nations, with industry and financial institutions, is needed urgently.

General

The utilisation value of carbon must be recognised. A product-focus on waste generation would help to create efficiencies in the supply chain, such as better product design and **incentivising Carbon Capture & Utilisation (CCU) over Carbon Capture & Storage (CCS)** (which is unsustainable, economically unproductive and likened to landfilling).

While intellectual property (IP) generation is generally strong **the transition to commercialisation and retention of IP is weak**. **The UK is not seen as an attractive investment for scaled infrastructure**, which is compounded by high manufacturing and labour costs. In turn this creates an **outward flow of manufacturing** meaning emissions of embodied carbon are overseas.

Prioritising environment over profit needs to be more attractive, facilitated by a longer-term outlook, increased profit potential and decreased risk to invest in these sectors. An over-focus on return on investment under short timeframes is a barrier to change.

Further education is needed to help investors and policymakers understand this technical space. If the risks are not fully understood, investor confidence will be low.

Competing priorities and strategies of government departments are hindering progress. A unified, multi-department approach is needed, with clear, attainable sustainability targets.

The sole focus on Net Zero can hinder broader sustainability achievements. A more holistic view is required to address overall environmental issues, of which emissions reduction is one aspect.

An impediment to change is that **understanding of the chemical industry and circular business models are underdeveloped and different across UK administrations**.

Key Recommendations

Technology

1. **Support industrial symbiosis clusters.** Promote initiatives that see *waste* as containing resources not for discard but as a valuable feedstock, towards overcoming challenges of meeting *end-of-waste* status to accelerate circular businesses.
2. **Create national, collaborative public sector research institutions operating as a commercial business with industry and academia.** To incentivise partnerships and commercialisation and support early-stage research scale-up, plus the added benefits of employment opportunities and revenue generation.
3. **Support novel technologies and early-stage research through all TRL levels to de-risk investment opportunities.** Greater access to financial support and resources to assess and minimise risk in building demonstrator units should enable quicker scale-up and growth.
4. **CCU should be prioritised over CCS.** CCU can be revenue generating and give rise to economic growth and job creation. A longer-term vision for CCU must be realised with investment in infrastructure.
5. **Obtaining sources of sustainable carbon,** including biomass, recycled plastics, and captured carbon, are fundamental to a circular transition.

"There are a lot of 'stick' approaches but not a lot of 'carrot' in the UK… at the moment everything that we're doing is very much a 'stick' approach. There's going to be emissions taxes… but we don't have any incentives."

Financial & Fiscal

1. **Carbon pricing must be redesigned to provide an incentive for the recirculation of carbon** back into the economy, realising the inherent value of '*waste*' carbon in the creation of new products, thereby displacing virgin fossil carbon that would otherwise be required. Rooting in the *proximity*

principle would help to further prevent offshoring of *waste*. Also consider the carbon emission efficiencies and only subsidise the actual carbon savings.

2. **Greater appreciation of the value of the chemical industry** from an economic, societal, and political perspective, offering security of supply in turbulent times.
3. **Oil and gas tax relief refocussed towards re-skilling and training.** Ensuring minimal job losses and continued sector growth.
4. **Additional support for investment opportunities.** Investment funding guarantees should be offered more frequently and include a requirement of independent investment review to de-risk and boost investor confidence. Public equity, private funds and wider debt and equity instruments are needed to develop and scale CE interventions and technologies.[3]
5. **Redesign of UK ETS to include robust rules for capture projects could act as an incentive for capture-to-chemicals, with current proposals not incentivising this valorisation market.** The carbon offsetting voluntary market is not operating as intended, with the measurement approach vital to its validity.
6. **Embrace longer-term thinking to achieving positive impact.** Sustainable initiatives typically require longer investment and return periods to have measurable impact. Underlying market conditions need government support to ensure future market demand at reasonable production costs.

"The UK is <u>not</u> seen as an attractive place for investment in green tech. It is behind the curve in terms of investment into technology and business growth."

General

1. **Recognise the value of typical waste products**, such as carbon dioxide, and move towards **valorisation through circular utilisation.** Current '*waste*' streams contain valuable resources and feedstocks for many chemical industries, helping to reduce environmental damage and boost economic growth.

2. **Adopt a unified industrial strategy for a CE transition in the chemical sector.** Government administrations need to develop a robust, unified, cross-cutting intra-departmental strategy with industry collaboration.
3. **Refocus strategies for waste carbon and biomass on value extraction before fuel generation.** Valuable commodities and chemical compounds should be extracted first before any remainder is turned into biofuel, thus generating new revenue streams and jobs.
4. **Implement a standardised Life Cycle Assessment (LCA) framework** to assist in determining the degree of risk for investment, but current approaches do not fully consider the whole system and related boundaries.

> ***"We do need to have a more collaborative approach in terms of how the financial institutions and the government could work together."***

Box 1 – Carbon Emission Efficiencies

Carbon emission efficiency refers to the economic benefits of production activities that simultaneously emit carbon, such as carbon capture operations. The fewer carbon emissions generated per unit of production output; the more carbon emission efficient the process is.

In this context, the subsidy incentive for CCUS activities should not be for the total amount of carbon captured, but rather taking the efficiency of the process into account. For example, if a particular process captures 10 tonnes of CO_2, but 9 tonnes of CO_2 are emitted doing so, then the efficiency is just 1 tonne and, therefore, any subsidy should only apply to this 1 tonne (and not the full 10 tonnes).

Adopting this approach would correct incentives towards driving process efficiencies and carbon capture *with value-added purpose*.

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Box 2 – Reallocation of Incentives Through Tax Relief for Oil and Gas

The UK oil and gas sector employs over 200,000 people[4] and incentives through tax relief have been a part of ensuring continued job retention and economic growth. Opponents of phasing out oil and gas extraction often cite job losses as a reason not to do so. A phased reallocation of such incentives will help to address this concern by ensuring minimal job losses through re-skilling and re-training. Many current oil and gas sector employees possess the necessary skills and expertise to transition to green sector jobs with the correct retraining and education.

By way of an example, assuming an annual tax relief of £11 billion:

- Year 1: £10 billion to oil and gas; £1 billion to green sector/retraining
- Year 2: £9 billion to oil and gas; £2 billion to green sector/retraining
    - Continuing until no oil and gas subsidies are present:
- Year 11: £11 billion to green sector/retraining

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(2) *Economics & Business Surveys*. Chemical Industries Association, https://www.cia.org.uk/about/what-we-do/economics-and-business-surveys (accessed 12/10/2024).
(3) *Key figures of the UK chemical industry 2021*. Statista Research Department, 2024. https://www.statista.com/statistics/1174177/united-kingdom-chemical-industry-key-figures/ (accessed 29/08/2024).
(4) Garcia-Garcia, G.; Fernandez, M. C.; Armstrong, K.; Woolass, S.; Styring, P. Analytical Review of Life-Cycle Environmental Impacts of Carbon Capture and Utilization Technologies. *ChemSusChem* **2021**, *14* (4), 995-1015. DOI: 10.1002/cssc.202002126 From NLM PubMed-not-MEDLINE.
(5) Lopez, G.; Keiner, D.; Fasihi, M.; Koiranenb, T.; Breyer, C. From fossil to green chemicals: sustainable pathways and new carbon feedstocks for the global chemical industry. *Energy and Environmental Science* **2023**, *16*, 2879-2909.
(6) Clark, P.; Vanderhoven, J.; Hobson, J.; Higson, D. A.; Mason, S. *UK Chem 2050: Sustainable Carbon Ambition for the UK Chemicals Industry*; IUK, 2024.
(7) Tan, C.; Warrier, S.; Vangipuram, S. *Decarbonisation strategies for the ethylene industry*; Wood Mackenzie, 2024.