

Biobased chemicals – An opportunity for the UK?

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The necessity for change

Petrochemicals are critical to modern life; they are found in over 96% of all products from cosmetics to electric devices and in sectors from transport to construction.

The UK has a long history of chemical production, and the sector has been an important exporter of products, with exports totaling £61bn in 2022¹. However, the industry is challenged by high energy prices and increasing global competition. As a result, chemical industry exports as a percentage of total exports have been in steady decline over the last decade².

Although energy-related emissions dominate the climate change debate, the chemical industry is increasingly in the emissions spotlight³. Chemical production relies on the use of fossil resources, consuming significant quantities of oil, natural gas and coal. The use of fossil resources results in a level of greenhouse gas emissions significantly higher than that of the aviation industry⁴ and representing up to 10% of all global emissions^{5,6}.

Sustainability considerations are becoming an increasingly important driver for chemical markets.

Reductions in chemical industry emissions can be achieved through a variety of actions; reduced consumption through product innovation, moving to renewable energy in production, deploying carbon capture or implementing circular business models. However, achieving net zero emissions will require a shift in the use of fossil resources to alternative sustainable source carbon resources i.e. industrial defossilisation.

Alongside recycled or air captured carbon, the production of chemicals from sustainable biomass offers the ability to transition away from the use of fossil resources⁷.

Globally this transition is already underway⁸. There is an ever-increasing list of commercially available chemicals produced from biomass, either available through dedicated bio-based production or via mass balanced approaches to produce bio-attributed products.

¹ Chemical Industries Association, The Chemical Industry, <https://www.cia.org.uk/the-chemical-industry> [accessed 26 Nov 2024]

² Allianz, Chemicals - Sector report – United Kingdom, https://www.allianz-trade.com/en_GB/insights/economic-research/uk-chemicals-sector-report.html [accessed 26 Nov 2024]

³ The Royal Society, Defossilising the chemical industry, <https://royalsociety.org/news-resources/projects/defossilising-chemicals/> [accessed 26 Nov 2024]

⁴ Our world in data, What share of global CO₂ emissions come from aviation? <https://ourworldindata.org/global-aviation-emissions> <https://ourworldindata.org/global-aviation-emissions> [accessed 26 Nov 2024]

⁵ IEA, Chemicals, <https://www.iea.org/energy-system/industry/chemicals> [accessed 26 Nov 2024]

⁶ Bauer, F., Kulionis, V., Oberschelp, C., Pfister, S., Tilsted, J. P., Finkill, G. D., & Fjäll, S. (2022). Petrochemicals and Climate Change: Tracing Globally Growing Emissions and Key Blind Spots in a Fossil-Based Industry. (IMES/EESS report; Vol. 126). Lund University. https://lucris.lub.lu.se/ws/portalfiles/portal/117494791/Petrochemicals_climate_change_review_web.pdf [accessed 26 Nov 2024]

⁷ Innovate UK, Sustainable carbon ambition for the UK chemicals industry, <https://iuk-business-connect.org.uk/perspectives/sustainable-carbon-ambition-for-the-uk-chemicals-industry/> [accessed 26 Nov 2024]

⁸ IEA Bioenergy, Bio-Based Chemicals A 2020 Update, <https://www.ieabioenergy.com/wp-content/uploads/2020/02/Bio-based-chemicals-a-2020-update-final-200213.pdf> [accessed 26 Nov 2024]

The UK has its bio-based chemical champions. UK specialty company Croda⁹ has a long history of bio-based chemical production and newer companies such as Celtic Renewables¹⁰ and Holiferm¹¹ are commercialising and scaling new bio-based processes.

The 2023 Biomass Strategy¹² recognised an opportunity to use biomass for chemical production in the UK. However, questions were posed around the production potential, biomass availability and the economic and environmental implications of increasing bio-based production.

To address these questions NNFCC, and partners FREY Consulting, Perspective Economics and Imperial College engaged with industry stakeholders to build an understanding of UK interests in bio-based chemical development and where value chain and industry synergies may exist¹³. The study consisted of three key steps, identifying and selecting bio-based chemicals of relevance to the UK, building a scenario describing potential production volumes across three decades to 2050, and finally an assessment of economic and environmental impacts.

A platform for growth

The UK chemical sector has the scale, capacity, and transferable skills to position the country as a leader in the production of bio-based chemicals and materials. This potential is underpinned by the sector's significant economic contribution, including nearly £31 billion in GVA to the UK economy and accounting for almost one-fifth of total UK business R&D expenditure in 2023.

The analysis identified an existing ecosystem from which to grow a bio-based chemical industry. Companies active or strongly aligned with bio-based chemicals and material production currently employ approximately 130,000 people. They represent of turnover of £60 billion, and an annual R&D investment of £680 million.

The UK also has a foundation of bio-based chemicals and materials activity to build upon. UK-based dedicated bio-based chemicals and materials companies collectively generate over £1 billion in turnover and grew their employment base by nearly 20% between 2018 and 2022.

The production opportunity

From a technology perspective, it is possible to replace all current fossil based chemical production with bio-based or bio-attributed alternatives. However not all long processes are technically mature, economically relevant or well aligned to UK demand or supply chains.

To assess the impacts for increasing bio-based production a basket of chemicals was required. Based on literature review and an industry survey, a long list of sixty-nine target chemicals was compiled. This list was then further refined to a short list based on defined selection criteria.

The chemical selection process was driven by the feasibility of production (e.g. production must be credible and achievable), with accessible feedstocks and established production technologies and the practicality of production (e.g. production must be plausible and realistic), supported by clear UK interest in either the production or use of the chemical. Additional consideration was given to the potential for meaningful greenhouse gas emission reductions, with demand and output at a scale capable of delivering significant savings.

⁹ Croda, About us, <https://www.croda.com/en-gb/about-us> [accessed 26 Nov 2024]

¹⁰ Celtic Renewables, About us, <https://www.celtic-renewables.com/> [accessed 26 Nov 2024]

¹¹ Holiferm, About us, <https://holiferm.com/about/> [accessed 26 Nov 2024]

¹² Department for Energy Security and Net Zero, Biomass Strategy 2023, <https://www.gov.uk/government/publications/biomass-strategy> [accessed 26 Nov 2024]

¹³ Study commissioned by The Department for Energy Security and Net Zero - Project contract PS22436 - Economic and climate benefits to the UK of an increased use of bio-based chemicals (RAF097/2223)

Based on these criteria and discussions with industry stakeholders, the long list of sixty-nine chemical targets were refined to the thirteen preferred targets listed in figure 1.

Deployment scenarios were also developed covering three decades from 2030 (figure 1). Chemicals with developed technology and strong stakeholder pull were considered to be deployed by 2030; by 2040 all target chemicals are produced in the UK, and by 2050, all bio-based chemical production had been deployed a full commercial scale.

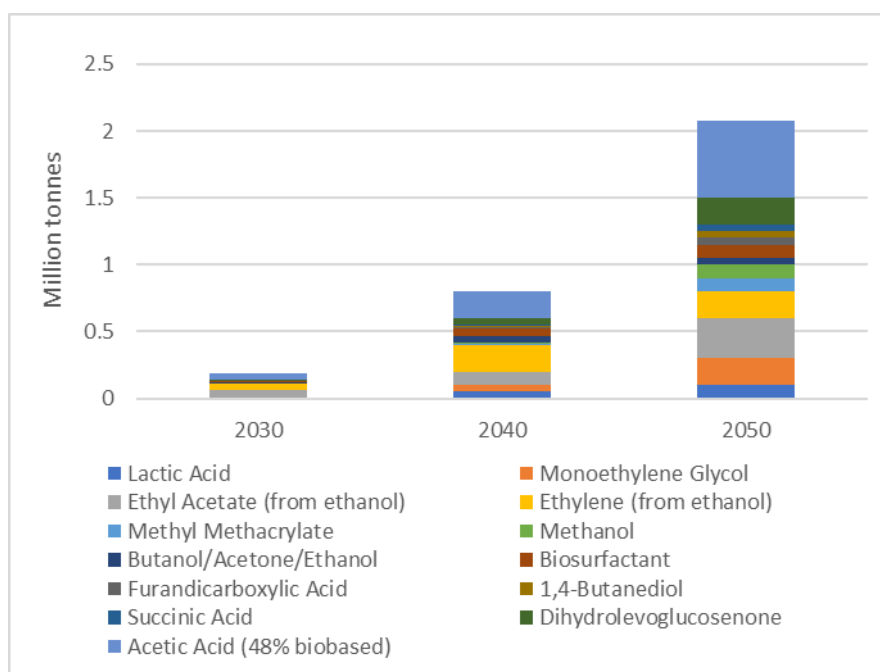


Figure 1. Bio-based chemical production scenario (2030, 2040, 2050).

Although in comparison to countries such as Brazil or the United States, the UK does not have an abundance of biomass feedstock, sufficient feedstock is available to support the proposed production scenarios.

The feedstock portfolio used in the production scenarios is diverse and draws on arable crops, lignocellulosic biomass, biogenic consumer wastes and typical anaerobic digestion feedstocks (figure 2).

To avoid increasing pressure on arable land, the volume of available arable crop feedstock was considered to be the volume currently required by existing biofuel plant capacities. The UK is a large importer of lignocellulosic biomass for electricity generation showing the potential for imports. However, it is reasonable to assume that lignocellulose-based chemical production would take place close to the feedstock source. Therefore, the use of imported material was limited to where chemical production could add value to the bioenergy supply chain (i.e. biomass processed to dihydrolevoglucosenone with large by-product volumes returned to the bioenergy supply chain).

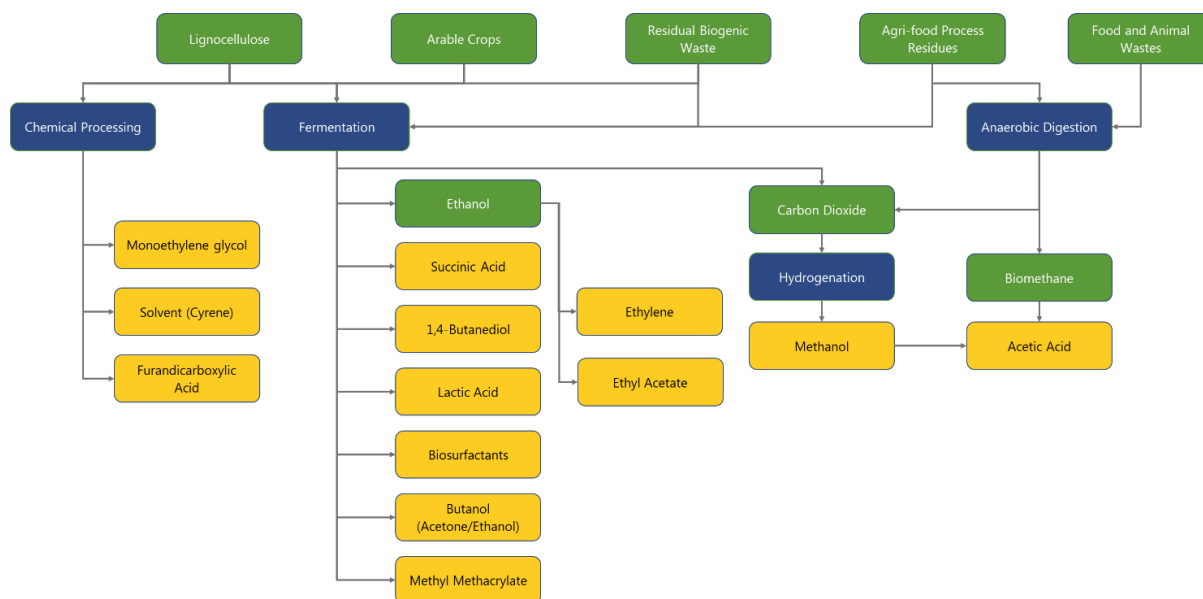


Figure 2. Relationship between biomass feedstock and bio-based chemicals.

The impact of increased production

By 2050, the UK bio-based chemicals industry has the potential to grow significantly, producing over two million tonnes of bio-based chemicals, contributing to 5.2 million tonnes CO₂eq GHG savings and £1.6bn in value to the UK economy.

Realising the potential

However, to realise the full potential of bio-based chemicals and plastics in the UK, it is essential that Government departments not only work together but engage deeply and strategically with both large and small industry players.

An emphasis should be placed on scaling existing bio-based operations and collaborating with larger diversified companies to encourage the adoption of bio-based activities in the UK.

Efforts are required to revitalise the start-up ecosystem for bio-based chemicals and plastics, ideally with support from established market leaders or larger diversified firms. Additionally, support should be directed to high-growth enterprises to help them enhance processes, lower costs, and access new markets.

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