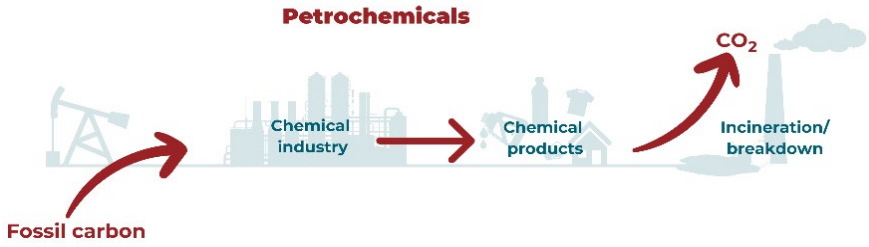
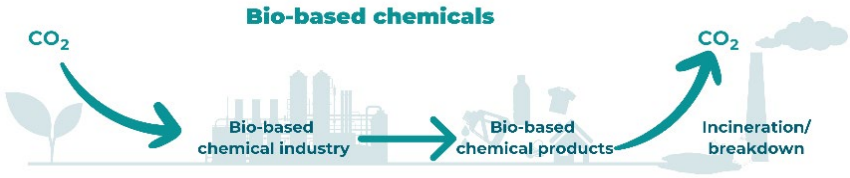
CARBON FOR CHEMICALS: **HOW CAN BIOMASS CONTRIBUTE TO THE DEFOSSILISATION OF THE CHEMICALS SECTOR?** Policy briefing





Supergen Bioenergy

BB Net Biomass Biorefinery Network

Many products in modern society contain carbon. Pharmaceuticals, plastics, textiles, food additives, cosmetics, and cleaning products contain organic, carbon-based chemicals. These chemicals are derived from fossil feedstocks (i.e., they are petrochemicals), contributing to global greenhouse gas (GHG) emissions and climate change. Carbon is embedded in organic chemical products and released when they break down at end-of-life, for example, through incineration.

While demand for fossil fuels in energy is expected to fall in the coming decades, the petrochemicals sector is set to grow significantly. Yet the climate impact of carbon-based chemicals has thus far failed to receive significant attention. To fully address the emissions associated with the chemical system, including those stemming from the carbon in chemicals, systemic change will be required, including moving to a more circular economy, managing supply and demand levels, and transitioning away from fossil feedstocks. Carbon-based chemicals cannot be decarbonised but can be defossilised through a transition to renewable carbon sources such as biomass, recycled carbon, and carbon dioxide.

Bio-based chemicals

Biomass to bio-based chemicals: Biomass feedstocks such as crops, forestry biomass, and wastes and residues can be used to make a wide array of bio-based chemicals. These include drop-in replacements for existing fossil-based chemicals and, thanks to the unique chemical structures found in biomass, novel bio-based chemicals with new structures and properties.

Reduced emissions: Many bio-based chemicals can reduce GHG emissions compared to petrochemicals and appropriate production of bio-based chemicals could even result in negative emissions through long term removal of carbon dioxide from the atmosphere. However, such climate benefits are not universal, and so the focus must be on ways to develop and incentivise those bio-based products that do deliver GHG reductions.

Safe and sustainable products: Some petrochemicals cause harm to people and the environment, so it is important to consider not just what feedstocks we use to make our chemicals, but also what kind of products society will rely on in the future. Some novel bio-based products can reduce risks by replacing harmful chemicals such as additives currently found in plastics and building materials or toxic solvents.

Sustainable feedstocks: Biomass feedstocks come with sustainability risks and benefits. For example, some perennial biomass crops like willow can have environmental benefits compared to crops like maize, but production of some feedstocks is associated with deforestation, biodiversity loss, and damage to communities and health. Policy and regulation must be designed to maximise sustainability benefits, whilst managing such risks.

Priority use: Sustainable biomass is a limited resource with many potential competing uses. Given that there will not be sufficient biomass to fulfil potential future demand across all sectors, prioritisation will be necessary. The 2023 UK Biomass Strategy identified negative emissions and hard-to-decarbonise sectors as priorities for biomass use, and bio-based chemicals offer opportunities to deliver both. Chemicals where these benefits are maximised should be prioritised.

Social and economic opportunities: Alongside the potential for climate and environmental benefits, scaling up the production and use of bio-based chemicals in the UK could offer economic and societal benefits such as provision of green jobs, utilisation of waste, and opportunities for rural economies relating to feedstock production.

Global leadership: The UK has significant academic and industrial research expertise in many disciplines that will underpin the development of sustainable bio-based products. Leveraging this could position the UK as a global leader in bio-based products and sustainability governance. However, to date little of this has manifested as UK-based scale-up and manufacturing, whilst there are numerous examples of UK-led research being scaled up elsewhere.

Challenges for the bio-based chemicals sector: Bio-based chemicals must compete with the products of the established and efficient petrochemicals sector. They often face economic challenges and high investment needs, and there are difficulties associated with scaling up new technologies. In the UK, these challenges are compounded by the lack of explicit incentives that prioritise bio-based chemicals over fossil-based production.

Research and innovation: Most bio-based chemicals remain at the research and development stage. Progress on bio-based chemicals requires ongoing research and innovation to develop new technologies and products that meet society's needs while also being technically feasible, scalable, and economically, socially, and environmentally sustainable. There are evidence gaps relating to the sustainability impacts of many bio-based products and the environmental and economic impacts of increasing UK production. So, further research is also required to support decision-making.

Moving forwards: UK activity in bio-based chemicals could take various forms in the future. It could focus on research and technology development or sustainability certification. However, greater environmental, economic, and social benefits may be possible if the UK goes beyond this to increase uptake of sustainable bio-based chemicals and even more so if it increases domestic manufacturing of such products. Whatever role the UK plays, unlocking the potential benefits of bio-based chemicals will demand action and collaboration across society, from industry, academics, and policymakers.

Recommendations

To address the emissions from carbon in chemicals and accelerate the development of bio-based chemicals, we recommend that UK policymakers take the following actions:

NOW	**Articulate the opportunity and secure cross-government consensus** to create a shared vision for a sustainable chemical system. This should consider the UK's future feedstock and chemicals production and use and how it relates to net zero, agriculture, environment, economy, trade, and just transition policy objectives.
NEXT	**Develop a roadmap for the transition**, outlining how the government's vision will be delivered. Such a strategy must account for the UK's carbon budgets, wider environmental impacts, and the global impacts of UK production and consumption. It must also address the need for regulatory and support frameworks, sustainability governance, waste management, skills, research, business models, and support for scale-up and innovation.
	Improve sustainability governance and regulation in parallel to the growth of the biobased chemicals system to ensure that feedstocks and products are safe and sustainable. This requires a rigorous, trusted, and enforceable approach to sustainability governance for biomass feedstocks, which is harmonised across different biomass-using sectors and considers factors beyond just GHG emissions, as well as improvements to application-specific regulation of chemicals and products.
FUTURE	**Implement policy to accelerate sustainable chemicals**. Policy interventions are needed to encourage the deployment and uptake of bio-based chemicals and other sustainable chemicals. These must be designed to specifically incentivise those that deliver environmental, economic, and social benefits. If the goal is to increase domestic manufacturing, policies that help create an enabling environment for new sustainable chemical production will be needed.

All enquiries related to this publication should be sent to: **supergen-policy@aston.ac.uk**. More information can be found in the full report on the **Supergen Bioenergy Hub** website: **www.supergen-bioenergy.net/output/carbon-for-chemicals**.