BB-REG-NET

BBIA
CHAMPIONING THE INDUSTRIAL BIOECONOMY

Growing the UK's Modern Industrial Bioeconomy

Driving Economic Growth with Bio-based Solutions for People and Planet


Contents

> *The modern industrial bioeconomy offers huge potential for the UK, providing jobs and economic growth across a wide range of market and industry sectors.*
>
> *It can mitigate climate change through the development of greener, cleaner manufacturing processes, as well as offering opportunities for waste utilisation and new products that benefit society which cannot be made any other way.*
>
> Alistair Carmichael, Chair of the Environment, Food and Rural Affairs (EFRA) Committee

Alistair Carmichael

Chair of the UK Parliament's
Environment, Food and Rural Affairs (EFRA)
Commons Select Committee

The transition to a circular, resource-efficient economy is one of the great industrial and economic opportunities of our generation. Reducing the UK's reliance on fossil carbon, cutting waste, curtailing plastic pollution and building resilience into supply chains is essential to achieving net zero and protecting the natural environment.

Across the UK, researchers, innovators, and manufacturers are finding new ways to harness renewable biological resources to createbio-based solutions that meet everyday needs – from packaging and textiles to chemicals and materials for batteries and semiconductors, specialist coatings, components for defence and medical applications.

This emerging modern industrial bioeconomy, where biogenic carbon replaces fossil carbon, creates highly paid skilled jobs, can revitalise regional industries, and has the potential to make the UK a world leader in harnessing biology for people and planet.

Yet, as this white paper makes clear, opportunity must be matched by realism. Growth in bio-based industries will depend on well-aligned policy across government, robust streamlined regulations, clear standards and fair taxation. The authors pose important challenges, highlighting the necessity of consistent definitions, proportionate regulation, and better-targeted investment.

I welcome this white paper as a crucial contribution to the debate at a time when government is preparing its forthcoming Circular Economy Growth Plan. The paper sets out practical, evidence-based proposals for how the UK can strengthen the market conditions that support innovation, while maintaining environmental integrity. Its focus on public procurement and fiscal reform demonstrates that this agenda is not only about research and development, or about waste management, but about creating a stronger, greener modern industrial base.

Whitehall must continue to work closely with industry and the research community to ensure that regulation keeps pace with innovation, and that the UK's transition to a low-carbon, circular economy is both environmentally sound and drives economic impact.

I thank the authors of this white paper, and the wider BB-REG-NET and BBIA community, for the rigour of their research and for highlighting the barriers that must be overcome if the UK is to realise the full promise of the remarkable bio-based innovation taking place across our nation.

The dialogue this paper encourages between government, business and academia will be vital as we chart the next phase of our journey towards a resource-efficient and prosperous future for people and the planet.

Alistair Carmichael.

The Modern Industrial Bioeconomy - Driving Economic Growth with Bio-based Solutions for People and Planet

Dr Jen Vanderhoven

CEO, Bio-based and Biodegradable Industries Association (BBIA) and Project Lead for BB-REG-NET

Significance of the Modern Industrial Bioeconomy for the UK

Manufactured chemicals are in everything we use in our daily lives – plastics, food, textiles, energy, batteries, clothing, defence products, mobile phones and medicines. Across these applications, chemicals have one thing in common: almost all are manufactured from fossil oil and gas[1] and are responsible for ~10% of global greenhouse gas emissions.

The modern industrial bioeconomy offers a powerful pathway away from our dependence on fossil resources and environmentally damaging production systems.

At the crossroads of biology, engineering, and artificial intelligence lies modern industrial biotechnology. As a rapidly expanding and highly innovative field, it serves as the technological foundation of today's modern industrial bioeconomy.

Powered by these technological advances, the modern industrial bioeconomy is delivering the bio-based solutions of the future - today. By harnessing renewable biological resources such as plants, microorganisms, and organic wastes, it enables the sustainable production and national resilience of bio-based chemicals, materials, and energy supply chains, and reduces our reliance on fossil resources. This transformation not only cuts greenhouse gas emissions and reduces waste but also drives the transition toward a more circular, resilient, and resource-efficient economy.

The UK's modern industrial bioeconomy sector, comprising bio-based chemicals and materials, already boasts more than 1,200 businesses, of which ~1,100 are SMEs. In 2024 the sector generated over £12.5bn in revenues, £5.1bn in GVA and supported 20,300 employees[2].

Modern Industrial Bioeconomy and the UK Modern Industrial Strategy

Recognised as a foundational industry, chemicals underpin the UK's Modern Industrial Strategy, including support for the development and deployment of the IS-8[3], the eight key industries identified by the UK government as essential for driving future economic growth - highlighting their critical role in driving innovation, economic growth, and industrial resilience.

At COP30, the UK government signed the *'Biofuture Platform Declaration on Sustainable Chemicals and Materials'[4]*. The declaration signals a shared international vision to create clear and consistent frameworks for sustainable carbon feedstocks, while encouraging innovation, policy alignment, and investment to create resilient and sustainable global chemical and material supply chains - with the bioeconomy driving the sector. It provides an opportunity for the UK to lead on developing a competitive global market for sustainable bio-based chemcials and materials, but first we must accelerate the development of our own market to ensure competitiveness.

The Government's forthcoming Circular Economy Growth Plan, due in early 2026, must embed bio-based and biodegradable innovation within national efforts to design out waste, keep materials in use, and regenerate natural systems.

The modern industrial bioeconomy has high growth potential for the circular economy, and it can be a crown jewel of the UK's circular economy transition.

The bio-based chemicals and materials sector directly supports Labour's five national missions[5]:

1 **Kickstart economic growth**

The UK's modern industrial bioeconomy sector is a key driver of high-value, innovation-led growth. By capitalising on the nation's academic excellence in industrial biotechnology, engineering biology and AI, and fostering collaboration between universities, SMEs, and multinationals, the sector supports regional development, creates skilled green jobs, and boosts productivity across the UK. Expanding these capabilities aligns directly with Labour's mission to deliver sustainable economic growth that benefits every community.

2 **Make Britain a clean energy superpower**

Modern industrial biotechnologies replace fossil-derived feedstocks with renewable bio-based solutions, reducing emissions and dependence on imported oil and gas. Through advances in biofuels, biochemicals, and waste-to-value innovations, the sector underpins Labour's ambition to establish Britain as a clean energy leader – accelerating progress towards affordable, zero-carbon energy and manufacturing systems.

3 **Take back our streets**

A thriving modern industrial bioeconomy supports cleaner, safer local environments by cutting waste, improving air quality, and reducing chemical and plastic pollution. The development of sustainable materials and circular manufacturing practices promotes community pride and local green industries, reinforcing Labour's goal of building safer, more confident communities.

4 **Break down barriers to opportunity**

A thriving modern industrial bioeconomy relies on a highly skilled workforce trained in science, engineering, and digital innovation. Its growth encourages investment in modern education and vocational pathways, ensuring people of all ages across all regions have access to rewarding careers in advanced manufacturing and the green economy. This directly supports Labour's commitment to removing regional and social barriers to opportunity.

5 **Build an NHS fit for the future**

Advances in biomanufacturing and the production of bio-based chemicals and materials contribute to improved healthcare, cleaner air, and reduced exposure to potentially harmful incumbent chemicals. Innovations in biodegradable and bio-derived medical products will help build a healthier environment and enhance public health outcomes – supporting Labour's mission to deliver a fairer, more resilient NHS and a healthier Britain.

BB-REG-NET

Accelerating the UK's Bio-based and Biodegradable Materials of the Future, Today

To accelerate progress in this transformative field, the Bio-based and Biodegradable Materials Regulatory Network (BB-REG-NET) was established in 2024 as the UK's first regulatory science network dedicated to bio-based and biodegradable chemicals and materials.

Funded by the Department for Science, Innovation and Technology (DSIT) through UK Research and Innovation (UKRI), BB-REG-NET unites leaders from academia, industry, policy, regulation, and civil society. Together, we are developing innovative tools, standards, and approaches to advance bio-based and biodegradable materials – essential enablers of the emerging modern industrial bioeconomy.

BB-REG-NET objectives sit under four pillars:

Evidence

Generate robust scientific evidence using regulatory science tools, standards and metrics to inform policy and support complex regulatory decisions.

Partnerships

Foster stronger collaborations across the regulatory innovation ecosystem, bringing together diverse disciplines and expertise.

Knowledge share

Facilitate knowledge exchange to enable evidence-based policymaking and sound assessment of bio-based chemicals and materials' risks and benefits.

Business growth

Provide business-growth opportunities by removing barriers to the commercialisation of bio-based chemicals and materials, which are essential for sustainable economic growth.

BB-REG-NET is a pioneering network uniting experts from academia, industry, policy, regulatory bodies and NGOs. Together, we're developing innovative tools, standards and approaches to evaluate and enhance bio-based and biodegradable chemicals and materials. Our work is shaping the future of sustainable materials in the UK, driving innovation whilst ensuring sound regulatory decision-making.

Our Vision

The UK stands at the threshold of a transformative opportunity. By transitioning to bio-based and biodegradable solutions, we can generate upward of £204 billion in annual revenue whilst significantly advancing our net zero goals. Our vision is to establish the UK as a global leader in developing, manufacturing, using and exporting bio-based solutions, creating a resilient engine for green growth and innovation.

BB-REG-NET is led by the Bio-based and Biodegradable Industries Association (BBIA), alongside Alder BioInsights, Higginson Strategy, Perspective Economics, Resource Media and the University of Sheffield. Oversight is provided by an expert advisory board comprising representatives from Biome Bioplastics, the Biorenewables Development Centre, British Standards Institution, CPI, Scottish Forestry, Holiferm, Imperial College London, National Physical Laboratory, Renewable Energy Association, and WRAP.

Throughout 2025, BB-REG-NET has brought together hundreds of experts and published more than a dozen research and policy papers exploring how to unlock the full potential of the modern industrial bioeconomy.

Its work demonstrates that coherent strategy and policy, streamlined regulation, fair and consistent taxation, aligned standards, targeted investment, and effective communication are all critical to enabling a thriving modern industrial bioeconomy – one that supports resource efficiency, industrial renewal, and sustainable economic growth.

This white paper distils a year of research and evidence generation into a single clear message: The modern industrial bioeconomy is not a niche environmental opportunity – it is a cornerstone of future prosperity. It represents a powerful opportunity for economic growth, industrial renewal, and climate leadership, transforming world-class UK science into world-leading industry.

> *After more than two decades working in biomanufacturing, I have never seen a more exciting time for our sector. The modern industrial bioeconomy is no longer a distant vision – it is here, delivering real economic impact and sustainable bio-based solutions that are transforming industries, protecting our planet, and driving the green growth of tomorrow's economy, today.*

Dr Jen Vanderhoven, CEO, BBIA

Demystifying Bio-based and Biodegradable Chemicals and Materials

Across government, industry, and consumer sectors, there remains significant confusion about the differences between bio-based and biodegradable chemicals and materials[6]. This confusion is compounded by the absence of standardised terminologies, which prevents clear and consistent communication among key stakeholders.

As a result, bio-based and biodegradable chemicals and materials are often grouped together under a single umbrella, obscuring their distinct benefits, performance characteristics, and environmental benefits. This conflation limits the ability of policymakers and industry leaders to appropriately recognise and reward each chemical and material type through tailored policies, regulations, and tax incentives.

A common example of this misunderstanding is the term ‘bioplastic”. Frequently used as a catch-all label, it fails to differentiate between plastics derived from biological sources (bio-based), those capable of breaking down under specific conditions (biodegradable), and those that combine both attributes.

Such lack of clarity has far-reaching consequences for policy development, market growth, and consumer perception–ultimately slowing the shift toward genuinely more sustainable chemical and material systems.

The following defines the differences in these material types and exemplifies how these fit within the UK waste hierarchy and contribute to a truly circular economy.

Bio-based

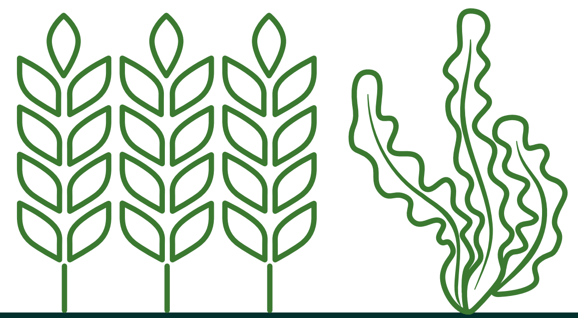
Definition: Derived wholly or partly from renewable biological sources such as plants, algae, or microorganisms. Their primary environmental advantage lies in the potential reduction of fossil fuel dependency and associated greenhouse gas emissions. However, bio-based materials are not necessarily biodegradable.

Recommended uses: Bio-based materials are best suited for durable applications where longevity, strength, and recyclability are priorities, such as packaging with existing recycling pathways (e.g., bio-based PET), automotive components, construction, textiles, and consumer goods. These applications leverage their renewable origin while maintaining circularity through established material recovery systems.

Biodegradable

Definition: Designed to break down through microbial activity into natural substances such as water, carbon dioxide, and biomass under specific environmental conditions. They may be derived from biological and/or fossil sources. The key benefit of biodegradable materials lies in their capacity to reduce environmental persistence where recovery or recycling is impractical.

Recommended uses: Biodegradable materials are suitable for hard-to-recover products, such as non-recoverable polymers (e.g. personal care products), and products used in the open environment (e.g. seed coatings, agricultural mulch films and tree guards).



Compostable

Definition: Compostable materials are a subset of biodegradable materials that meet specific standards (such as BS EN 13432:2000 or ASTM D6400:1999) for biodegradation and disintegration under industrial composting conditions. These standards ensure that materials break down within a defined timeframe, leaving no toxic residues and contributing to high-quality, nutrient-rich compost. Some materials may also be home compostable, breaking down at lower temperatures and longer timescales.

Recommended uses: Certified compostable materials are best applied in short-lived or food-contaminated products, such as food service packaging, where they can help divert organic waste to composting such as food waste caddy liners, coffee pods, tea bags, and single-use catering items. Their strength is increasing capture of food waste, which can then be turned into high value products such as compost or biogas.

Natural Polymer

Definition: Under the European Union’s Single-Use Plastics Directive, natural polymers - that have not been chemically modified - are not classified as plastic.

Recommended uses: Natural polymers are well-suited to applications prioritising renewability and low toxicity, such as coatings, films, adhesives, and paper-based packaging. Their biodegradability and compatibility with natural cycles make them ideal candidates for truly circular material systems, provided performance requirements can be met.

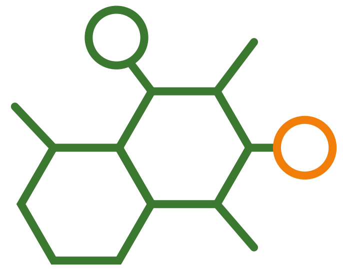
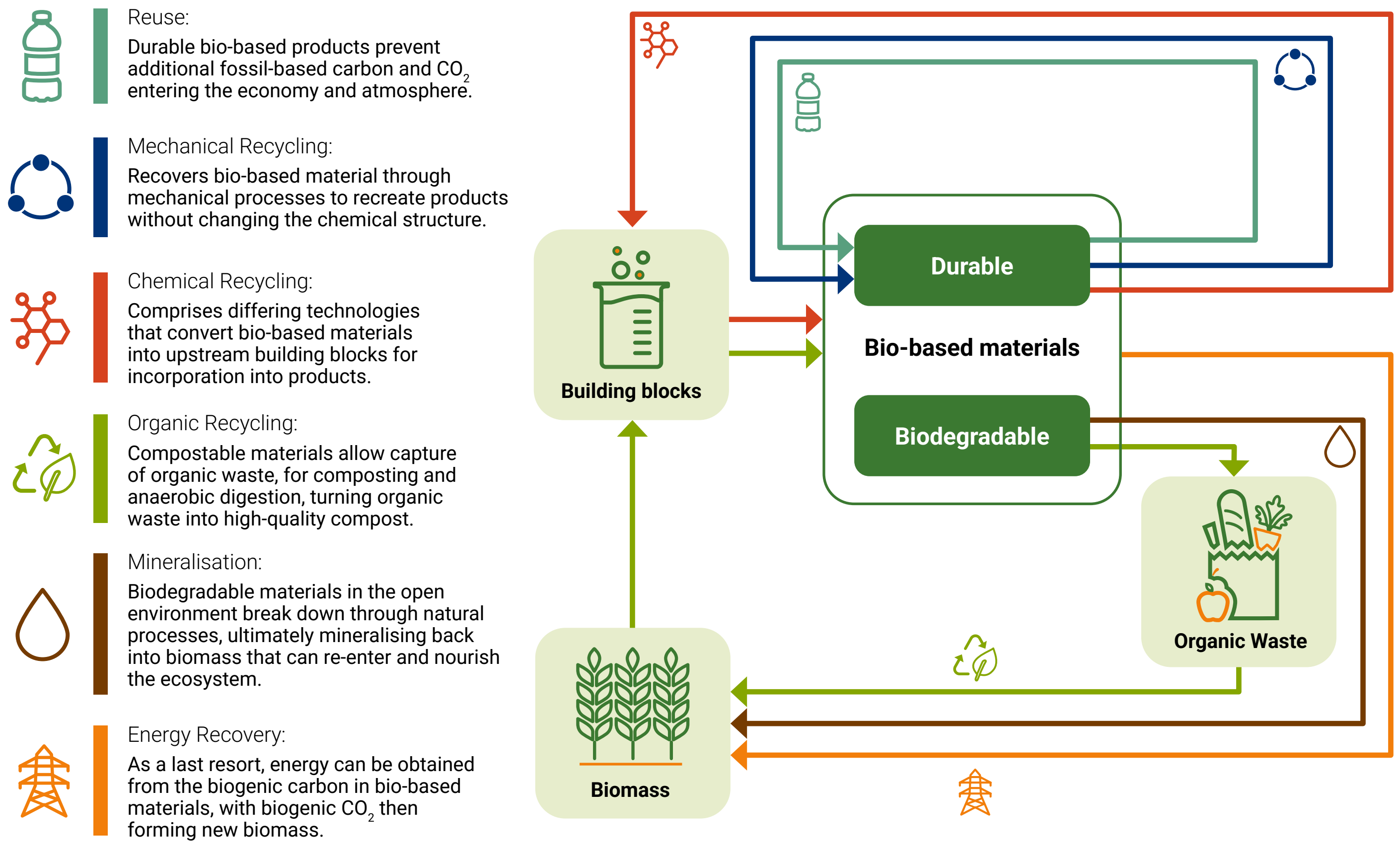
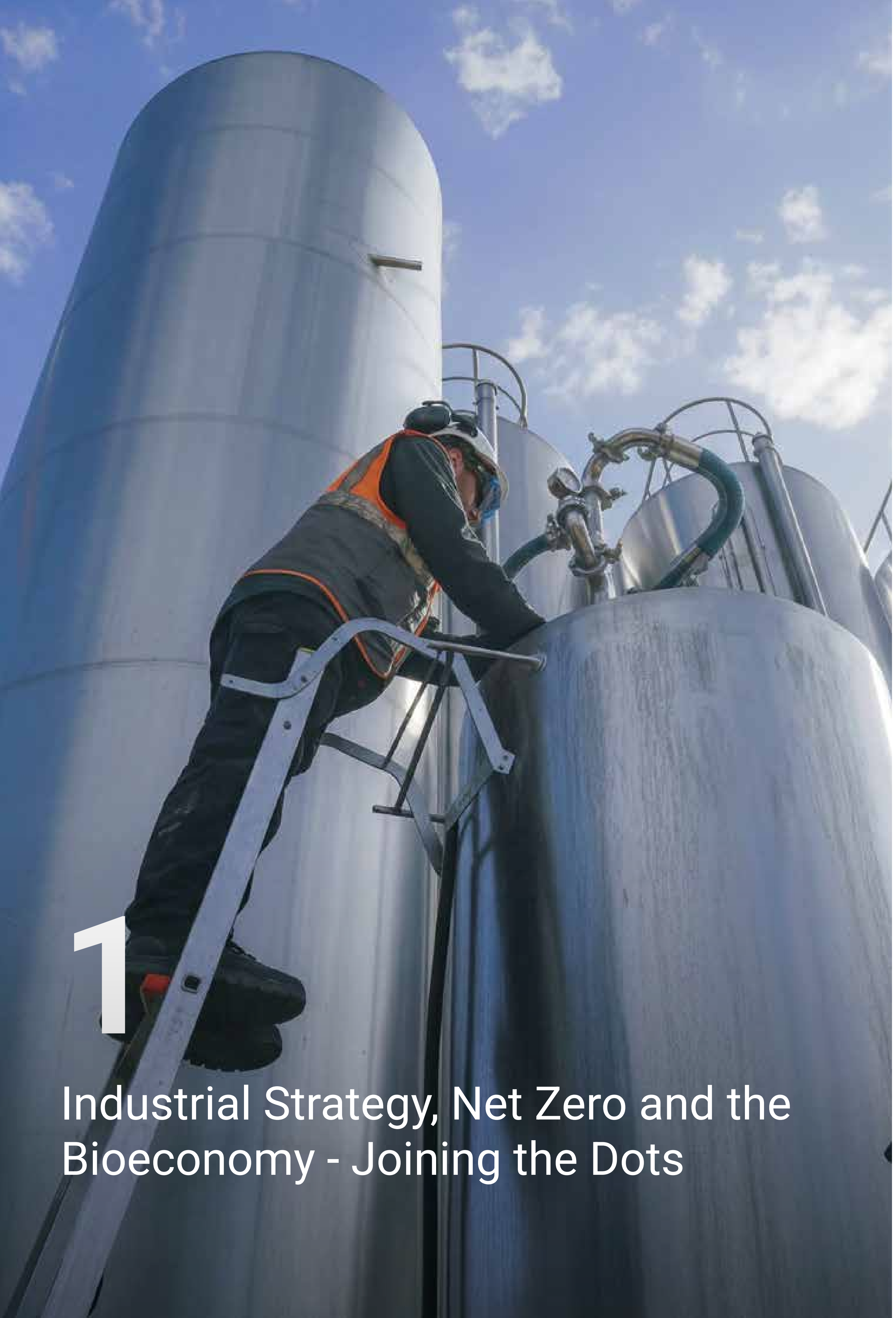


Figure 1

Optimised Circular Economy Material Flow of Bio-based Materials*



*Adapted from European Bioplastics ‘End-of-life options for bioplastic products’



1

Industrial Strategy, Net Zero and the Bioeconomy - Joining the Dots

Turning bold ambitions into real impact means converting vision into results. The process starts with strategy - defining long-term goals and translating policy into action. Policy then drives regulations and mandates, forming the legal and operational base for compliance and change. From there, standards and certification set measurable benchmarks and trusted verification systems to ensure ambitions are implemented, monitored, and recognised.

Together, these mechanisms build credibility, open markets, support trade, and drive innovation in new bio-based materials and technologies. They also strengthen trust among consumers, policymakers, and the public, giving businesses a competitive edge.

BB-REG-NET brings these elements together – linking strategy, policy, regulation, standards, and certification – to create a coherent framework that accelerates real-world impact across the bio-based and biodegradable chemical and material sectors, providing the bio-based solutions of tomorrow, today.

The Government's vision is for the UK to be, by 2035, one of the top three places in the world to create, invest in and scale-up fast-growing businesses. The modern industrial bioeconomy is key to achieving this ambition, positioning the UK to capture a significant share of the global bioeconomy market, which is projected to reach $30 trillion (£22 trillion) by 2050[7].

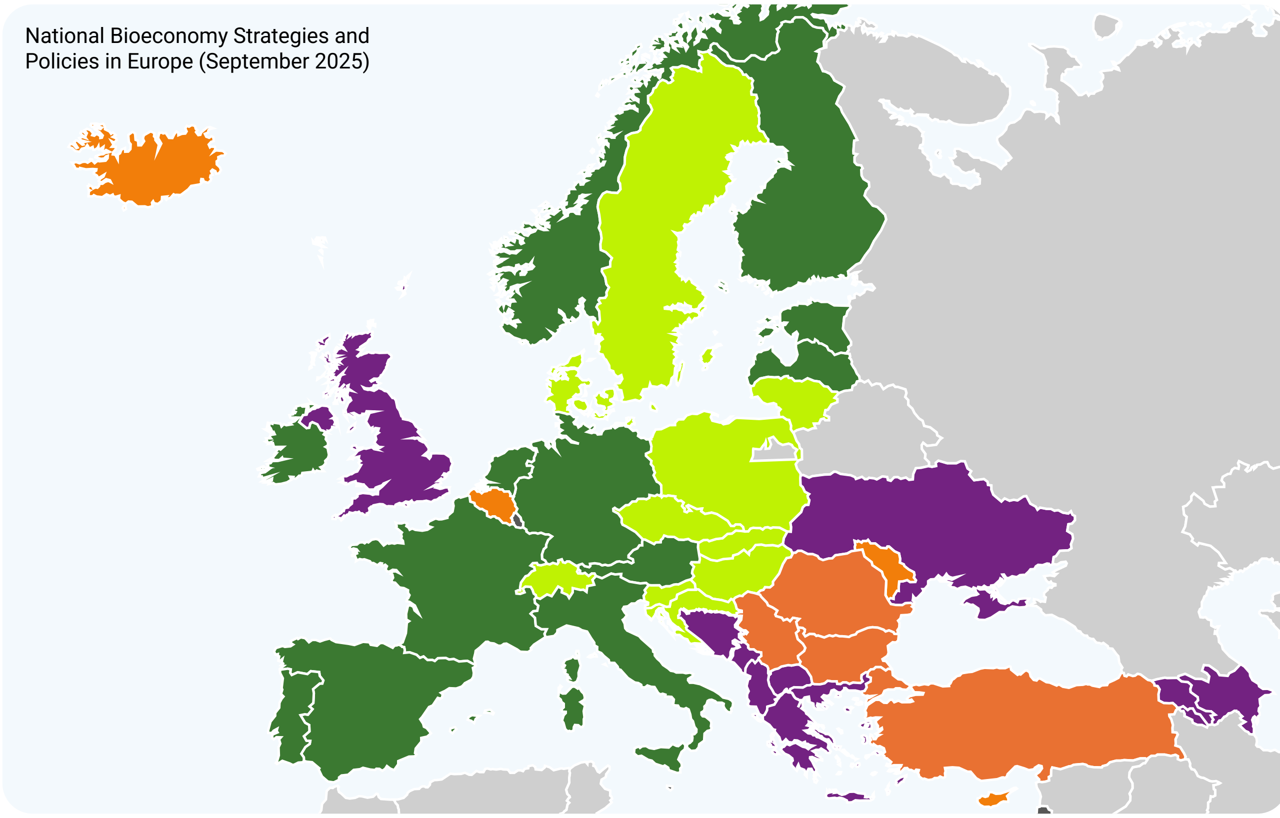
More than 50 nations now have published bioeconomy strategies or have policies steering towards a sustainable bioeconomy. As of September 2025, this map (below) shows the status of bioeconomy strategies and policies across Europe[8]:

12 countries (11 in EU-27) have dedicated bioeconomy strategies: Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Netherlands, Norway, Portugal and Spain.

10 countries (8 in EU-27) have dedicated bioeconomy strategies under development: Croatia, Czechia, Denmark, Hungary, Lithuania, Poland, Slovakia, Slovenia, Switzerland and Sweden.

8 countries (3 in EU-27) have other policy initiatives dedicated to bioeconomy: Belgium, Iceland, Kosovo, Moldova, Serbia, Türkiye, Romania and Bulgaria.

12 countries (4 in EU-27) have related strategies at the national level: Albania, Armenia, Bosnia and Herzegovina, Cyprus, United Kingdom, Georgia, Greece, Luxembourg, Montenegro, Malta, North Macedonia and Ukraine.



National Bioeconomy Strategies and Policies in Europe (September 2025)

1. Industrial Strategy, Net Zero and the Bioeconomy - Joining the Dots

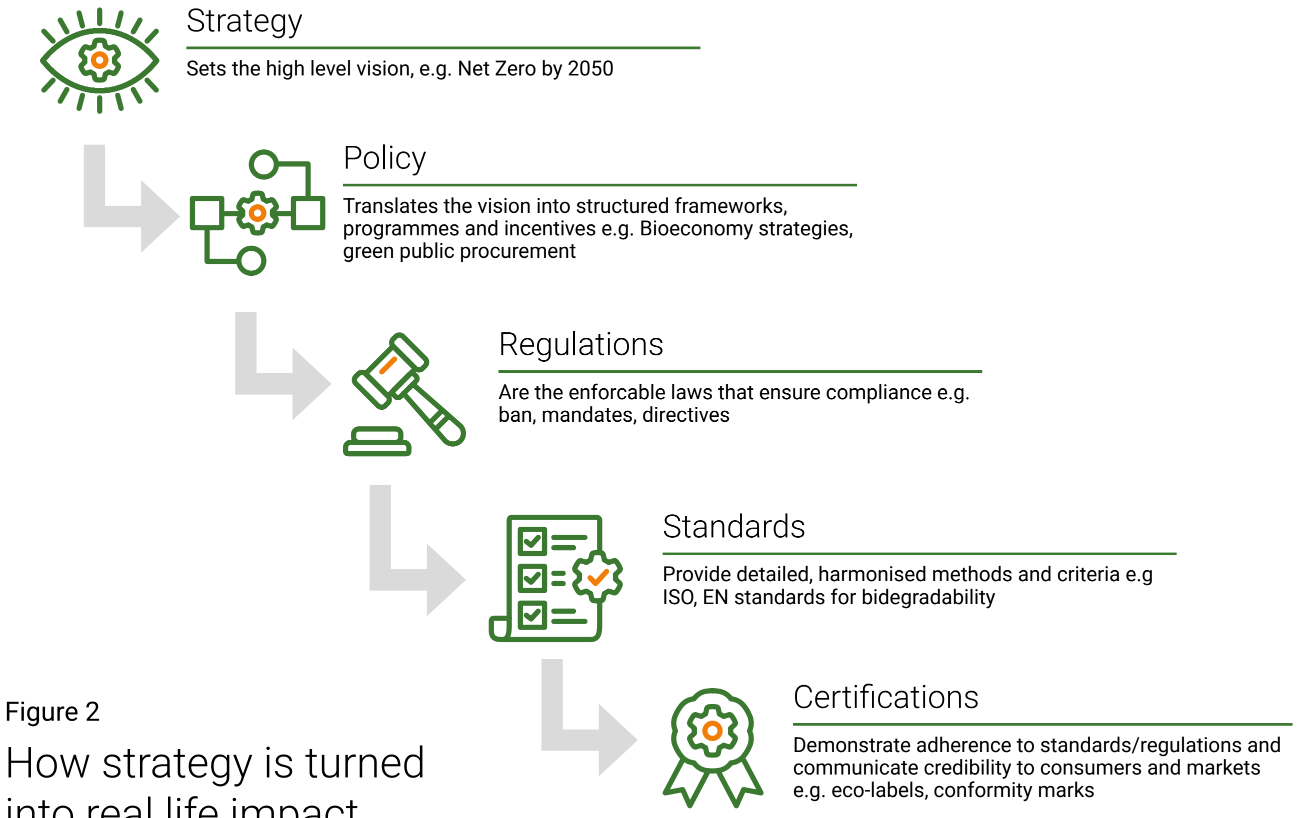


Figure 2
How strategy is turned into real life impact

The EU *Bioeconomy Strategy*[9] prioritises the sustainable use of biomass by following a clear hierarchy that places food security and ecosystem protection first, material use second, and energy use last. It emphasises that biomass should primarily be used to create materials that deliver tangible climate and environmental benefits, recognising that bio-based chemicals and materials store carbon and can replace fossil-based alternatives. Only when material use is not feasible should biomass be used for energy generation, making use of available co-generation, fermentation, and biorefinery technologies.

In the UK, various current and anticipated government policies and industry initiatives, including *The UK's Modern Industrial Strategy 2025*[10], the *National Materials Innovation Strategy*[11], The *UK Packaging Pact*[12], the *Delivering a Net Zero National Health Service Strategy*[13] see bio-based chemicals, materials and products as being central to delivering economic and environmental benefits.

However, BB-REG-NET research has found that the UK is rich in innovation and scientific talent, but lacks the policy coherence to support businesses beyond scale-up stage. Between 2018 and 2024, more than £450 million in UKRI funding was directed towards research and early-stage innovation in the sector, yet these investments have not produced the scale of economic transformation seen in comparable sectors or nations[14]. In short, the UK funds bio-based innovation with one hand and regulates against it with the other.

> *There is a real opportunity for engineering biology to provide immense benefits to the UK. It can help us to address the challenges we face in health, sustainability, and in addressing climate change. There are major opportunities to grow the economy by applying this technology. We have many of the ingredients to make this a success. But this reaction requires a catalyst. we have a small–and closing–window of opportunity to realise these benefits in the UK. We cannot afford to miss it.*
>
> **Lord Vallance, Minister for Science, Innovation, Research and Nuclear in the Department for Science, Innovation and Technology (DSIT) and the Department for Energy Security and Net Zero (DESNZ), April 2025[15]**

1.1.0 Contrast with International Frameworks

The contrast with international peers is striking. In the European Union, the bioeconomy forms a central pillar[16] of the *European Green Deal*[17] and *Circular Economy Action Plan*[18]. They establish a common taxonomy of bio-based products, align standards (BS EN 16575:2014)[19], (BS EN 18027:2025)[20], and coordinated funding through Horizon Europe[21] and the Circular Bio-based Europe Joint Undertaking[22]. The EU's modern industrial bioeconomy is not siloed in agriculture or waste policies but embraces the full supply chain from cradle to cradle[23].

Further afield, in 2019 Japan published its Bioeconomy Strategy[24], which was subsequently updated in 2024, at the Integrated Innovation Strategy Promotion Council[25]. In this, to contribute to both sustainable economic growth and solving climate change and plastic pollution, five market areas were identified including biomanufacturing for bio-derived products. This strategy was followed by a '*Roadmap for Bioplastics Introduction*,[26]' and an overarching goal to create a 100 trillion-yen (£500 billion) market in Japan and overseas by 2030.

In the United States, the *BioPreferred Program*[27] administered by the Department of Agriculture mandates a federal-procurement preference for certified bio-based goods, while the *Inflation Reduction Act*[28] extends tax credits for low-carbon manufacturing. Leadership is unambiguous: responsibility sits within the Executive Office of the President, ensuring cross-departmental alignment. All three models share traits missing in the UK: clear ministerial accountability and measurable objectives.

1.1.1 Siloed Responsibility

The UK did once have a national framework for the bioeconomy - the 2018 *Growing the Bioeconomy Strategy'*[29]**,** co-authored by BEIS and DEFRA, aimed to *'make the UK a global leader in developing, manufacturing, using and exporting BioSolutions.'* It was complemented by the *Industrial Biotechnology Strategy to 2030*[30], developed by the UK Industrial Biotechnology Leadership Forum. Together, these documents offered a coherent roadmap linking research, manufacturing and sustainability, to create a modern industrial bioeconomy.

By 2021, however, the *Growing the Bioeconomy Strategy* was quietly withdrawn, with responsibility for industrial biotechnology being folded into the *UK Innovation Strategy*[31] and *Net Zero Strategy*[32] , with references and commitments to bio-based chemicals and materials diminished.

Once BEIS was dissolved and its functions split, accountability for the bioeconomy disappeared, leaving us where we are today, with no single department being responsible. The withdrawal of the strategy has left a policy vacuum – without a national framework, initiatives have proliferated but without coordination or evaluation.

In the absence of a clear cross-government strategy, the modern industrial bioeconomy touches on the policy agendas of multiple departments and agencies. The three core protagonists are the Department for the Environment and Rural Affairs (DEFRA), the Department for Energy Security and Net Zero (DESNZ) and the Department for Science, Innovation and Technology (DSIT). The Department for Transport is also a key government stakeholder, aligned alongside DESNZ in the use of biomass in bioenergy applications such as transport biofuels[33].

1. Industrial Strategy, Net Zero and the Bioeconomy - Joining the Dots

1.1.2 DEFRA and the Environment

DEFRA's *25 Year Environment Plan*[34] details the Government's strategy to halt the decline in biodiversity and improve the quality of the environment in England. The Plan describes the department's approach to protecting and enhancing England's ecology and therefore has a significant role in steering the direction and setting the boundaries for the bioeconomy. Although the Plan has a focus on England, it has implications for the entirety of the UK.

The Plan recognises the need for a *'Land Use Framework'* in order to balance the multiple demands on land, which in turn will influence the availability of biomass. This sits alongside the aim to build a sustainable and long-term supply of UK timber, directly feeding the modern industrial bioeconomy. However, the Plan does not explicitly integrate either the potential of biotechnology or the use of biomass into its proposed actions. The term 'bioeconomy' only appears three times in the Plan (each time referring to a planned bioeconomy strategy), 'biotechnology' appears once in relation to the bioeconomy strategy, and 'biomass' doesn't appear in the Plan.

Moreover, policies and regulations from DEFRA have hindered market penetration for bio-based and biodegradable materials[35]. For example, the Extended Producer Responsibility Scheme (EPR)[36], via DEFRA's Recycling Assessment Methodology (RAM)[37] has labelled compostable packaging 'RED', meaning compostable packaging placed on the market is subject to higher fees than other types of packaging.

In addition, via the Simpler Recycling Policy[38], compostable materials are likely to be labelled 'do not recycle', instead of 'dispose of with food waste' - their intended end-of-life processing. In doing so, these regulations favour established fossil-based materials and hinder the development and deployment of innovative products, with better environmental credentials. This was also highlighted as a key issue in the recent report *'Simpler Recycling: Hidden Impacts for Circular Plastics Systems'*[39].

1.1.3 DSIT and Engineering Biology

The *National Vision for Engineering Biology*[40] describes the UK's aspiration for engineering biology and its position within an innovative modern industrial bioeconomy. The vision plays on engineering biology as an underpinning technology capable of driving innovation in multiple sectors from agriculture and the chemical industry, through to healthcare and defence.

The vision focuses on innovation needs (the term 'innovation' appears 97 times) rather than on the need for biomass as a UK resource. The term biomass appears three times, referencing the *Biomass Strategy*[41] and highlighting how sustainable biomass can help reduce carbon emissions and support the future development of the UK chemicals and materials sector. Since the focus is on innovation, and not manufacturing, the vision is largely agnostic in respect to where products are produced, with no significant emphasis placed on UK production.

1.1.4 DESNZ and the Biomass Strategy

The *Biomass Strategy* published in 2023 describes the role that sustainable biomass can play in reaching net zero. It is, however, heavily focused on the supply of bioenergy, although it does recognise the potential of bio-based construction materials and bio-based chemicals in achieving net zero objectives.

Engineering Biology is discussed within the strategy, with the term appearing 12 times in one specific section under non-energy uses of biomass. However, its positioning is hardly in line with engineering biology being a strategic technology priority within the UK's ambition to be a global science and technology superpower.

The strategy concedes that 'non-energy uses of biomass present real economic and job opportunities', however it states, 'there is significant uncertainty on the potential demand these end uses generate for biomass, the size of these markets, and the GHG emissions reductions some of these uses will offer in the future'.

Since its publication, DESNZ commissioned a study *Economic and climate benefits to the UK of an increased use of bio-based chemicals (RAF097/2223)*[42], which showed that the adoption of just twelve high-potential bio-based chemicals could generate over £2 billion revenue each year, and achieve more than 5.2 million-tonnes CO_2eq GHG-savings[43]. This is greater than the CO_2eq GHG-savings generated through the Road Traffic Fuel Obligation in 2021[44].

A further Innovate UK sponsored study *'Sustainable carbon ambition for the UK chemicals industry'*[45] highlights the desire of the UK chemicals industry to transition toward sustainable bio-based chemicals. With the right support, the industry could double in size by 2050 and source 30% of its carbon feedstock from biomass. Under this scenario, chemicals and materials have the potential to generate upwards of £204 billion annual revenue for UK plc and significantly contribute to the UK's Net Zero commitment.

Recommendation:

Develop a National Bioeconomy Plan, reviewed every five years, and monitored by the cross-government Bioeconomy Delivery Council, consolidating departmental initiatives into a single framework that links innovation, industrial policy and sustainability outcomes. A designated Minister of State should be appointed to the Plan, matching arrangements for net zero and space.

1.1.5 HM Treasury and Taxation

HM Treasury shapes the modern industrial bioeconomy market through fiscal instruments such as the *Plastic Packaging Tax* (PPT)[46]. Yet this is not coordinated with research or industrial-innovation policy. The PPT rewards recycled fossil content, but provides no recognition for renewable-carbon materials, and plastics design to biodegrade as not exempt from the tax.

Conclusion

Without a clear vision and direction, the UK's modern industrial bioeconomy risks stagnation, as limited financial resources, time, and effort are spread too thinly across disconnected initiatives. Developers of bio-based chemicals and materials face uncertainty in the absence of a clear strategy for biomass provision, making it difficult to secure reliable feedstock supplies.

The evidence is clear that a cohesive national strategy is needed to align industry, research, and government efforts. A coordinated framework would drive economic growth, provide national resilience, enhance sustainability, and secure the UK's global leadership in this critical sector. Without such alignment, the nation risks falling behind international competitors in shaping the future of sustainable economic development.

2

The Environmental Case across Lifecycles

Globally, failing to reach net zero could cost $38 trillion per year by 2050 - roughly 17% of world GDP - through extreme weather, lost productivity, and ecosystem damage[48]. For the UK, inaction is projected to cost up to 7.4% of GDP by 2100 (over £100 billion annually by the middle of this century), driven by flooding, heatwaves, and wider global economic disruption[49].

The modern industrial bioeconomy is a critical tool in the UK's net zero arsenal needed to restrain catastrophic climate change, and a key part of tackling the pollution crisis threatening our natural environment. It is estimated that, globally, 2.5 billion tonnes of carbon dioxide per annum could be saved by developing modern industrial biotechnology products[50].

In this section, we explore the potential of bio-based and biodegradable chemicals and materials in reducing microplastic pollution in our seas and soils, contributing to the circular economy and in reducing the overall lifecycle impact of materials in every sector from packaging to construction.

2.0.1 Microplastics

Microplastics - plastic particles less than five millimetres in diameter[51] - have emerged as a widespread environmental concern, drawing attention through the media such as the BBC's *Blue Planet*[52].

They are found across marine, freshwater, terrestrial, and atmospheric systems, originating both from intentionally manufactured sources such as microbeads and from the fragmentation of larger plastic items. Their durability and microscopic size see them accumulate in ecosystems, from soils[53] and waterways[54] to the food chain[55], where their removal becomes exceedingly difficult.

Scientific research has linked microplastics to disruptions in soil health[56], reduced water retention[57], impaired plant growth[58], and adverse impacts on aquatic environments[59]. They can also carry hazardous chemicals such as heavy metals and persistent organic pollutants, potentially amplifying the toxicological impact when ingested by wildlife or humans[60].

2.0.2 Biodegradable Plastics

Biodegradable plastics have been developed with the specific aim of mitigating the long-term environmental persistence of microplastics. These materials are engineered to undergo microbial biodegradation, yielding carbon dioxide, water and biomass as end products[61].

Although the fragmentation of biodegradable plastics does generate microplastic particles as part of the biodegradation process, their fate differs fundamentally from that of conventional (non-biodegradable) plastics. In biodegradable systems, microplastic formation represents an intermediate stage in a dynamic biodegradation pathway, with subsequent microbial colonisation and enzymatic activity, driving further breakdown and eventual mineralisation into naturally occurring compounds[62].

Nonetheless, the government is concerned that '*without robust standards or certification criteria, claims about the benefits that such materials may bring, cannot be verified and uncertainty about unintended consequences will remain*'[63]. It concluded that '*more research is required to fully understand whether in practice biodegradable plastics do not simply accelerate the fragmentation of plastic into microplastic*.'

In response to this, BB-REG-NET undertook a literature review of the evidence on microplastics in the open environment due to the use of biodegradable materials. To incorporate real-world insights, interviews were conducted with key stakeholders to understand industry perspectives.

Our report '*Addressing Persistent Plastic Pollution: The Case for Biodegradable Solutions*'[64] documents evidence from case studies in agriculture, forestry, and composting, and shows that, with proper use and supportive regulatory frameworks, biodegradable plastics reduce residual microplastic pollution in soils and waterways.

In Section 1 (on the next page) we present case studies that explore the use of biodegradable plastics in open environments both with and without regulatory oversight. These include their application in agricultural mulch films, tree guards and seed coatings, and the role of compostable packaging in organic recycling.

Section 1: Applications for Biodegradable Plastics

Biodegradable Mulch Films

Global Biodegradable Mulch Films Market Value in 2024:

£39.3 billion[65]

Projected Compound Annual Growth Rate:

8.7%[66]

Biodegradable mulch films are used in agriculture to suppress weeds, conserve moisture, and protect crops[67]. After use, conventional non-biodegradable plastic mulch films require labor-intensive retrieval and disposal. By contrast, biodegradable films are designed to be ploughed directly into the soil after use where they gradually break down and biodegrade into naturally occurring molecules, due to microorganism activity. BS EN 17033:2018[68] was established to ensure consistency, environmental security, and performance of these films. It requires that at least 90% of the organic carbon in the film be converted to carbon dioxide within 24 months of use, under controlled aerobic and temperature conditions (20–28°C). The standard also requires comprehensive testing addressing acute toxicity to plants, earthworms, and soil microorganisms and restricts levels of heavy metals and substances of high concern to safeguard soil health. Whilst real-world field conditions (such as fluctuating temperatures and exposure to UV radiation) can slow this process, studies show that biodegradable films do in fact continue to degrade[69]. This suggests that full mineralisation is achievable with proper use and adequate time, offering a more sustainable long-term solution compared to conventional non-biodegradable plastics. Furthermore, the EU Fertilising Products Regulation (Regulation (EU) 1009/2019)[70] recognises certified biodegradable mulch films as fertilisers. The regulation specifies a set of biodegradability criteria that the films must satisfy in both soil and water.

Biodegradable Tree Guards

Global Biodegradable Tree Guards Market Value in 2024:

£890 million

Projected Compound Annual Growth Rate:

9.6%[71]

Tree guards play a crucial role in safeguarding young saplings during their early stages of growth, for up to 10 years, providing protection against browsing animals, mechanical damage, and harsh environmental conditions[72]. Current UK forestry guidelines emphasise the importance of reducing plastic use and stipulate that redundant guards must be removed and disposed of responsibly at the end of their functional life[73]. However, tree guards often become environmental liabilities. Over time, exposure to weathering, animal damage, or the inaccessibility of remote planting sites can prevent their retrieval, leading to long-term plastic pollution within forest ecosystems. To mitigate these issues, biodegradable tree guards have been developed as a more sustainable alternative. These materials are designed to break down naturally under environmental conditions, reducing plastic waste accumulation and ecological harm. While the complete mineralisation of biodegradable materials in situ may take longer than under controlled laboratory conditions, their overall environmental footprint is substantially lower than that of traditional plastics, which can persist in the landscape for decades[74].

Seed Coatings

Global Biodegradable Seed Coatings Market Value in 2024:

£1.56 billion

Projected Compound Annual Growth Rate:

4.2%[75]

Fossil-based, non-degradable polymers are universally used as binders in seed coatings and controlled-release fertilisers. While these products aim to improve crop yields, they leave behind microplastic residues in the soil. Studies link these microplastics to stressed soil microbial life and impaired earthworm development[76]. In response to this, the EU has adopted the Microplastics Regulation[77], which requires that polymers used in seed coatings and similar products must achieve at least 90% biodegradation or mineralisation within 48 months of their functional period. The sale of seed coatings with intentionally added non-biodegradable polymers is prohibited from October 17, 2028. For coatings containing plant protection products, the deadline extends to October 17, 2031. Seed coatings must also degrade effectively in both soil and aquatic environments to minimise their environmental impact. The UK currently has no equivalent regulations or incentives in place. As a result, many UK farmers unknowingly apply non-degradable polymer-coated seeds and fertilisers, contributing to persistent microplastic accumulation in soils. This not only risks environmental damage but may undermine the UK's standing in sustainable agriculture and agri-tech innovation.

Compostable Packaging

Global Biodegradable Compostable Packaging Market Value in 2024:

£61.6 billion

Projected Compound Annual Growth Rate:

6.51%[78]

Compostable materials are specifically designed to break down under industrial composting conditions, characterised by high temperatures, active microbial populations, and controlled aeration. Compostable materials can degrade rapidly and thoroughly under these optimal conditions[79]. As determined by BS EN 13432:2000[80], compostable plastics must disintegrate into particles smaller than 2 mm within 12 weeks and achieve at least 90% mineralisation within six months. It also mandates that the product passes specific ecotoxicological testing to demonstrate that the compost does not negatively affect plant growth or soil quality, as well as setting a limit on heavy metals and other chemical contaminants. All certified compostable plastics meet the BS EN 13432:2000 criteria. The rate at which materials compost depends on factors such as facility conditions, feedstock composition, and layout. To improve composting efficiency, compostable materials must be processed correctly within the organic waste stream. However, evidence shows that any remaining residues in the resulting compost will continue to break down naturally in soil or cooler environments, unlike conventional plastics that do not fully degrade[81].

Recommendation:

For biodegradable materials utilised in the open environment, Government should develop or adopt clear, verifiable biodegradation standards for specific uses and environmental conditions, referencing EN 17033:2018 where applicable. New standards should be created where none exist.

Recommendation:

Government should fund work to determine what constitutes an acceptable timeframe for full mineralisation of biodegradable plastics under different environmental conditions, developing predictive models and accelerated testing methodologies and recognise these in future standards and policies.

2. The Environmental Case across Lifecycles

2.1 Circular Economy Principles

The UK's forthcoming Circular Economy Growth Plan in early 2026 must embed bio-based and biodegradable innovation within national efforts to design out waste, keep materials in use, and regenerate natural systems.

The modern industrial bioeconomy offers substantial growth opportunities for the circular economy and has the potential to become a defining strength of the UK's circular transition.

Bio-based and biodegradable chemicals and materials are pivotal in driving the transition towards a truly circular economy. Unlike conventional, fossil-derived products, which rely on finite resources and often contribute to long-term environmental pollution, bio-based alternatives are derived from renewable sources.

These materials can be engineered to meet specific end-of-life requirements, including mechanical and chemical recyclability, biodegradability, or compostability, offering a versatile solution to reduce waste and environmental impact. By integrating these sustainable materials into production and consumption systems, industries can close the loop on material use, supporting a more resilient and regenerative economic model.

In recognition of the urgent need to address plastic waste, the UK has committed to the Ellen MacArthur Foundation's *Plastics Pact Network*[82], a global initiative promoting collaboration across the value chain to reduce plastic pollution. The UK Packaging Pact[83], coordinated by WRAP, sets ambitious targets for the packaging sector. These include ensuring 70% of packaging is effectively recycled or composted and that all packaging in the market is designed to be reusable, recyclable, or compostable.

By aligning with these goals, the UK is taking concrete steps to foster a circular approach to packaging, demonstrating how sustainable materials and strategic policy frameworks can work together to reduce environmental impact and promote long-term resource efficiency.

2.1.1 Mechanical Recycling

Drop-in bio-based materials, including bio-derived polyethylene (bio-PE) and bio-based polyethylene terephthalate (bio-PET), are chemically identical to their fossil-based counterparts. This chemical equivalence allows them to be processed through existing mechanical recycling streams without the need for any modifications to current waste management infrastructure[84]. By eliminating the need for specialised recycling pathways, these materials offer a practical and highly scalable solution for reducing the carbon footprint of plastic packaging.

This development marks a significant milestone for the bio-based plastics industry, particularly in applications such as thin films, which have historically presented substantial challenges in recycling and reprocessing. By enabling easier integration into established recycling processes, these innovations help address critical regulatory frameworks, including the European Strategy for Plastics, which mandates that by 2030 all plastic packaging must be reusable or readily recyclable[85]. Such advancements position bio-based plastics as a viable tool for meeting both environmental goals and legislative targets.

In addition to polyolefin and PET-based materials, wood cellulose-derived materials are emerging as highly promising alternatives for rigid packaging applications. These materials exhibit recyclability through both mechanical and chemical recycling pathways, combining environmental sustainability with the structural strength and protective qualities required for containers, bottles, and trays. The ability to maintain performance while enabling circularity addresses one of the primary barriers to widespread adoption of bio-based rigid packaging.

Overall, the compatibility of renewable, bio-based materials with existing recycling infrastructure represents a major advancement for the industry. By seamlessly integrating into established waste management systems, these materials provide a pathway toward more sustainable, circular, and regulation-compliant packaging solutions, reducing reliance on fossil resources while supporting global recycling initiatives.

Recommendation:

Promote and incentivise the scaling of innovative bio-based materials that are suitable for mechanical and chemical recycling systems in the UK. During their scaling up stage, allow an exemption from EPR and the PPT, until materials are at significant scale to be considered commercially viable.

2.1.2 Chemical Recycling

Chemical recycling encompasses a diverse range of technologies designed to recover value from plastics by breaking them down into their constituent components[86]. Key approaches include solvolysis, where polymers are dissolved to separate individual components; depolymerisation, which breaks polymers down into monomers; and thermal processes, such as pyrolysis and gasification, which convert plastics into oils, gases, or other chemical feedstocks[87]. These technologies offer pathways to reduce plastic waste while producing materials suitable for reuse in high-quality applications.

Drop-in bio-based plastics, such as bio-polyethylene (bio-PE) and bio-polyethylene terephthalate (bio-PET) – which are chemically identical to conventional fossil-based polymers – can be seamlessly processed alongside their fossil-derived counterparts. This compatibility allows these materials to enter existing recycling streams without requiring specialised infrastructure, maximising recycling efficiency and flexibility. As a result, they can integrate directly into existing chemical recycling operations, providing a straightforward pathway to increase the proportion of recycled content in end products.

Many innovative bio-based plastics, including polylactic acid (PLA), which belongs to the polyester family, are particularly amenable to chemical recycling via depolymerisation, which enables the recovery of high-purity and quality monomers[88]. These monomers can then be repolymerised into new materials with properties comparable to virgin plastics, supporting the development of high-quality, circular products. This process not only preserves material value but also supports circular material flows, helping to reduce reliance on fossil resources and minimise environmental impact.

2.1.3 Organic Recycling

Organic recycling – the process through which certified compostable materials are transformed into compost, digestate, or renewable bioenergy – represents the most authentic and impactful form of circularity. At its core, composting is a key subset of organic recycling, harnessing natural biological processes to return nutrients to the soil. This system mirrors nature's own circular economy: it replenishes nutrient rich soils[89], supports ecosystem health[90], and completes the biological loop, ensuring that what might otherwise be considered waste becomes a valuable resource and feedstock for new growth.

By diverting organic materials from landfill or incineration (a legal requirement from 2026 in the UK[91]), organic recycling actively reinforces the principles of DEFRA's *Waste Hierarchy*[92]. Organic materials, particularly food waste, are prevented from contributing to harmful emissions or resource loss and are instead reintegrated into natural cycles where they continue to provide value. In doing so, organic recycling exemplifies a practical, environmentally responsible pathway toward a truly circular economy, where waste is not an endpoint but the beginning of a new cycle of life.

In the European Union, regulations already define which materials in which applications should enter the organic recycling stream. Under the Packaging and Packaging Waste Regulation, there is already a mandate for the following to be compostable[93]:

- Tea, coffee and other beverage bags
- Soft-after-use system single-serve units for coffee and tea, used in a machine
- Sticky labels for fruit and vegetables

In addition, lightweight <50µ, very light weight <15µ carrier bags, dual purpose compostable shopping bags, and small sachets for sauces (small format flexible, food contaminated) are highly suitable for organic recycling.

Recommendation

The UK should align with the European Union's PPWR on mandating compostable materials for use in tea and coffee bags/pods and for sticky fruit and vegetable labels. In addition, the UK should go further, mandating the use of bio-based and compostable light weight bags, dual purpose shopping bags, caddy liners and small format food sachets.

2.2.0 Classification of Waste

One persistent barrier to advancing a circular economy lies in the regulatory requirements surrounding the definition of 'end-of-waste' and, more specifically, the procedures used to determine when materials meet this status[94]. This challenge is particularly pronounced for less common bio-based chemicals and materials or novel applications, where guidance is limited or ambiguous.

The BS 8001 Standard Framework for implementing circular economy principles in organisations highlights the limitations of the current regulatory landscape, '*The prevailing regulatory framework is usually fit for purpose for waste management, but it is currently unlikely to be favourable for secondary raw materials … the recycling and reuse of items that could remain in the economic chain of utility without increased risk of harm to human health and/or the environment is hindered.*'

At present, the regulatory framework and associated process for determining end-of-waste status includes several key components:

- Compliance with end-of-waste regulations: Defined under the EU Waste Framework Directive and administered in the UK by the Environment Agency (EA) on behalf of DEFRA, these regulations specify when certain wastes cease to be classified as waste and gain status as a product or secondary raw material. The European Waste Commission emphasises end-of-waste criteria require materials to meet technical standards applicable to products.
- Meeting the requirements of quality protocols: Quality protocols have been established for 13 material categories, defining technical standards and conditions under which secondary materials can be safely reused without being classified as waste.
- Submitting an end-of-waste request to the EA: For waste streams not covered by existing regulations or quality protocols, producers must submit a case-by-case assessment to the EA, seeking an opinion on whether their material can be considered a secondary raw material.

Stakeholders report that the current system '*unduly inhibits the adoption of circular economy principles and fails to reflect the full potential of available resources from a modern industrial bioeconomy perspective*'. Consequently, these regulatory hurdles significantly reduce the volume of waste materials captured and repurposed as secondary resources. In doing so modern industrial bioeconomy innovations – which could safely convert a wide range of materials, including agricultural residues and industrial by-products, into valuable inputs – remain underutilised.

Recommendation:

Adapt Environment Agency processes for end-of-waste and develop a resource-first mindset to better support capture, valorisation and re-use of waste in modern industrial bioeconomy applications such as bio-based chemicals and materials.

2.2.1 Biomass Utilisation and Life Cycle Assessment (LCA)

As mentioned in section 1.1.4 in 2023, the Department for Energy Security and Net Zero (DESNZ) commissioned a study to evaluate the economic and environmental potential of bio-based chemicals in the United Kingdom[95]. Beyond the clear environmental benefits, the study also demonstrated the feasibility of sustainably scaling domestic bio-based chemical production. It estimated that 2 million tonnes of bio-based chemicals could be manufactured using only 24% of the UK's available biomass by 2050, with no associated land-use change. This finding underscores the potential to grow a sustainable modern industrial bioeconomy, without competing with food production or causing environmental harm.

In line with these findings, the Green Alliance has published a paper advocating for the establishment of a biomass hierarchy utilisation for the UK[96]. Such a framework should prioritise the use of biomass for higher-value applications - such as the production of bio-based chemicals and materials - before diverting it to lower-value energy uses, such as bioenergy generation. Adopting this approach would ensure that the UK derives maximum economic and environmental value from its limited biomass resources.

Recommendation:

Collaborate with relevant stakeholders to design a UK biomass utilisation hierarchy that prioritises the use of biomass as a feedstock for high-value bio-based chemicals and materials, before its use in bioenergy generation.

Recommendation:

Accelerate the publication of the biomass sustainability framework and work collaboratively with stakeholders across the modern industrial bioeconomy sector to co-develop clear, practical guidelines that promote sustainable biomass production, utilisation, and innovation.

2.2.2 Life Cycle Assessments

Life Cycle Assessment (LCA) has repeatedly shown that bio-based chemicals and materials can offer significant environmental impact advantages over fossil equivalents, including reduced CO_2 emissions[97].

LCA plays a crucial role in comparing the environmental performance of different materials or technologies. However, for nascent sectors such as bio-based chemicals and materials, LCA can present significant challenges. Existing standards were often developed with mature, fossil-based systems in mind, resulting in frameworks that inadvertently disadvantage newer technologies and products.

These shortcomings include inconsistent treatment of biogenic carbon, limited recognition of novel end-of-life pathways such as composting, and rigid comparability criteria that fail to account for innovation-driven variability. As a result, LCA can sometimes misrepresent the true environmental potential of emerging solutions, impeding their development and acceptance in markets and policy.

Our BB-REG-NET report *Standardised but Unfair*[98], examined whether current standards enable fair comparison between fossil-based, and bio-based and biodegradable materials using LCA. The study assessed 8 ISO and 6 EN LCA standards against three critical issues, namely incomparability, implicit bias, and end-of-life treatment. Each standard was evaluated using a structured scoring system to determine whether it enabled fair comparison, disabled or discouraged fair comparison, or had no effect on fair comparison between fossil-based and bio-based and biodegradable materials using LCA.

The key issues this evaluation identified were:

- Biogenic carbon treatment: inconsistently or inaccurately handled across standards
- End-of-life classification: especially for materials destined for composting, often misrepresented or excluded
- Comparative consistency: the same rule applied differently between cases

Among the three issues, end-of-life treatment had the most significant negative impact on comparability, followed by implicit bias in methodology or rules, and incomparability between material types.

Across the standards assessed, most were either neutral or disabling of fair comparison; end-of-life treatment was the single largest barrier. The recently published BS EN 18027:2025 Bio-based Products – Life Cycle Assessment, by contrast, explicitly corrects these biases. For organic recycling, it allows composting and anaerobic digestion to be modelled as legitimate end-of-life routes and standardises treatment of biogenic carbon.

The forthcoming EU *Bioeconomy Strategy*[99] offers an opportunity to support the universal adoption of BS EN 18027:2025 as a standard for comparative assessment using LCA. The strategy aims to propose a strategic framework for bioeconomy standards and metrology, within which the recommendation of BS EN 18027:2025 would promote fair comparison.

Our BB-REG-NET work on methodology guidelines for LCA found that most Impact Assessment Methods were developed during the era of fossil material incumbency, when products requiring assessment were more likely to be fossil-based than bio-based, and were more likely to be designed for linear economy disposal methods such as landfill, incineration or recycling than biodegradation. The impact categories used in common Impact Assessment Methods are therefore those which enable the assessment of these products and end-of-life treatment methods. Impact categories which were not relevant or not advantageous to fossil materials are not included in these assessment methods.

To enable LCA to be used to compare fossil-based materials and products to those which are bio-based, biodegradable or both, additional impact categories are required to ensure comparison is undertaken in categories which reflect the advantages of both products. We propose seven impact categories which would enable this fair comparison, when used in addition to standard impact categories such as those in ReCiPe[100] or Environmental Footprint methods[101].

Recommendation:

Require Life Cycle Assessments used to compare bio-based and fossil-based chemicals and materials to be conducted to BS EN 18027:2025

The use of LCA to compare fossil-based and bio-based or biodegradable materials requires further development of robust methods that ensure fair, accurate, and meaningful evaluations. Polymers in Liquid Formulations (PLFs) are an active area of methodological development[102] and present unique challenges, for example assessing product interactions within wastewater systems, to understand the environmental impacts of products that may come into contact during water treatment processes.

Fossil-based materials tend to persist in the environment, while biodegradable products degrade over time, creating a dynamic environmental context with changing concentrations[103]. Collaborative efforts through BB-REG-NET, in conjunction with the Royal Society of Chemistry, and other partners, are focused on developing methods to model these interactions for chemicals and materials of both fossil and bio-based origin. The insights gained will support ongoing initiatives to define and characterise bio-based chemicals, materials and products.

Recommendation:

Commission further research to advance LCA methodologies for the comparative assessment of fossil-based and bio-based or biodegradable materials. Encourage the integration of additional impact categories, e.g. Biodegradability, Bioaccumulation, Persistence, Microplastic formation, Biodiversity impact, Litter risk, and the inclusion of a specific biogenic carbon impact category.

2.3.0 Biodegradable Materials and Littering Behaviour

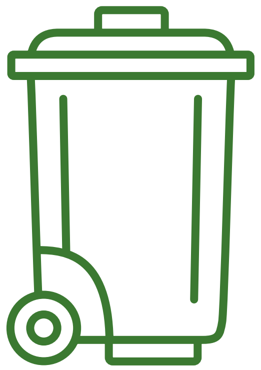
In 2021, the government published a call for evidence on *Standards for bio-based, biodegradable and compostable plastics*[104], citing concerns that an increased use of biodegradable plastics may be counter-productive to the Government's strategy of addressing plastic pollution through preventing it from entering the natural environment.

To test the validity of that claim, BB-REG-NET conducted a review of the literature available to understand the depth of the knowledge base, and what, if any, uncertainties existed around any evidence that biodegradable plastics increase the propensity of littering.

Our findings, published in full in *Do Biodegradable Plastics Encourage Littering?*[105] conclude that this claim is largely hearsay rather than backed by evidence. Claims that biodegradable materials encourage littering, by creating a false sense of environmental safety, remain unsubstantiated.

A 2024 study by Zero Waste Scotland and the UCL Centre for Behaviour Change mapped 61 drivers of littering behaviour[106]. It found that the belief that "food and biodegradable products decompose rapidly" has little influence on whether people litter. The dominant factors were lack of appropriate bins, inconvenience, social norms, and limited awareness of environmental impacts.

Our research therefore shows, in short, that littering is driven by context and behaviour – not by the material properties of the item.



2.3.1 Public Support for Bio-Based and Biodegradable Materials

Our *Bio-Barometer Survey*[107] engaged manufacturers, researchers, and policymakers, finding broad support for bio-based and biodegradable materials. Across all groups, respondents agreed that meeting the UK's green-growth ambitions over the next decade will depend on increased availability of such products.

However, strong conceptual support has not yet translated into widespread adoption. Our *Bio-Barometer Survey* rated stakeholder understanding of key terms at 3.16 out of 5, revealing limited grasp of the legitimacy and differences between bio-based, biodegradable and compostable materials.

2.3.2 Lack of Understanding of Key Terms

Industry stakeholders report persistent confusion among consumers, retailers and even policymakers, who often assume that 'bio-based' automatically means 'biodegradable.' In reality, the two concepts are distinct: fossil-based materials can be engineered to biodegrade, while bio-based materials can be designed for durability.

This misunderstanding undermines both policy design and consumer trust. Each of our reports – *Bio-Barometer Survey*; *Do Biodegradable Plastics Encourage Littering?*[108]; and *How to Talk about Bio-based and Biodegradable Chemicals and Materials*[109] – highlight how this lack of linguistic clarity erodes confidence and hampers market growth.

Our recommendations for more effective communication around bio-based and biodegradable chemicals and materials are based on the results of our corpus-linguistic research – which analyses large bodies of naturally occurring language (a "corpus" singular, or "corpora" plural), often containing millions of words, using computer software. We can see, for example, how frequently particular terms are used in everyday language, by which kinds of speakers and writers, and with what other terms and concepts they tend to be associated with.

Between 1980 and 2025, public use of "bio-based" rose from 0.0067 to 0.49 times per million words, "biodegradable" from 0.4 to 1.1, "compostable" from 0.012 to 0.49, and "bioplastic" from 0.005 to 0.074. However, "compostable" and "bioplastic" have declined since peaking in 2020 (0.76 and 0.09 respectively), possibly reflecting reduced public understanding in these terms.

According to Oxford Languages, words used less than 0.01 times per million words fall outside normal discourse. Those between 0.01 and 0.1 (like "bioplastic") are rarely found in general writing, while terms between 0.1 and 1.0 ("bio-based," "biodegradable," "compostable") are specialised but still recognisable. Even so, these remain uncommon in everyday language.

Data from the enTenTen21 corpus (52 billion words, collected to 2022) confirms that such terms appear mainly in scientific, news, and business contexts, not in general communication. This limited usage suggests low public understanding and little mainstream relevance.

Moreover, these terms often appear with other technical or vague words – e.g., "bio-based polymer," "biodegradable stent," or "biodegradable plastic" – which restricts clarity and accessibility for non-specialist audiences.

This lack of precision contributes to confusion and mistrust. We therefore support WRAP's recommendation to avoid unqualified terms like "biodegradable" and "compostable," which omit essential details on breakdown conditions or by-products. Similarly, vague claims such as "sustainable," "green," or "eco-friendly" enable greenwashing and should be avoided.

Public communication should use clear, practical language on products to guide disposal. Direct negative instructions (e.g., "Do not put in recycling bin," "Do not litter") are especially effective for prompting correct actions.

Our *Beyond the Label: UK Public Attitudes and Policy Gaps on Bio-Based, Biodegradable, and Compostable Materials* report[110] found that while 58 per cent of participants believe packaging labels make disposal straightforward, only 22 per cent understand what actually happens to waste once it is collected, and just 48 per cent are confident that their recycling is genuinely recycled.

For compostable materials, this gap is even wider. Although 74 per cent of respondents want the government to promote compostable alternatives, only 27 per cent have intentionally purchased compostable packaging in the past year. Barriers include limited availability, and price sensitivity.

These obstacles point to a deeper misalignment between consumer messaging, net zero ambitions, waste-management capabilities, and regulation. Current systems continue to favour mechanical and chemical recycling streams over organic recycling[111], despite growing evidence that compostable materials can increase food-waste capture and valorisation, reducing residual waste overall[112]. Studies have shown that when compostable packaging and certified compostable caddy liners are provided, households are more likely to separate food waste correctly, leading to higher collection rates and better-quality compost outputs[113].

Confusion is further compounded by inconsistent waste-collection systems across the UK. Organic recovery and composting infrastructure vary significantly between local authorities, meaning the practical reality for consumers often lags behind their willingness to act sustainably. As a result, public support for compostable solutions remains aspirational rather than actionable.

With universal food-waste collections due to be implemented across England by 2026 and a new Circular Economy Growth Plan expected in early 2026, there is a timely opportunity to align policy, infrastructure, and labelling standards. Establishing clearer national guidance on compostable packaging and caddy liners could help unlock their potential to enhance food-waste recovery, strengthen public confidence, and accelerate the UK's transition toward a more circular, low-carbon packaging system.

Recommendation

Government, regulators, and industry should adopt a shared, science-based lexicon distinguishing bio-based, biodegradable, and compostable materials in policy, labelling, and public messaging.

Recommendation

Consumer communications on biodegradable and compostable packaging should clarify that '*no packaging belongs in the environment*', in line with UK ASA guidance[67].

Recommendation

The term "biodegradable" should only apply to and be utilised for products designed for open-environment degradation (e.g., mulch films) with reference to relevant standards.

3
Regulations, Taxation, Standards and Investment

BB-REG-NET analysis finds the UK's current environmental tax structure – in particular Extended Producer Responsibility (EPR)[115] and the Plastic Packaging Tax (PPT)[116] – unintentionally disadvantage bio-based and biodegradable materials.

3.0.1 The Policy Trap

Bio-based chemicals and materials are typically 2-3 times more expensive to manufacture than fossil-based incumbents (up to 7 times more expensive in some applications), and the UK's current environmental tax structure widens, rather than narrows, this differential:

- EPR places biodegradable and compostable materials in the 'other category', automatically giving them a RED rating, and higher fees).
- The Recyclability Assessment Methodology (RAM)[118] aims to inform EPR modulated fees and incentivise the use of more recyclable packaging. The system favours materials capable of mechanical recycling, and disincentivises compostable polymers, by placing them in the "hard-to-recycle" RED band, triggering ~20% higher fees. In addition, the RAM is predicated on the likely end-of-life for a material, with no reference to its feedstock type and no recognition of the environmental benefits of bio-based content.
- The PPT, at £225/tonne[119], applies uniformly mechanically recyclable plastics (and soon chemically recyclable plastics[120]), while exempting plastics with over 30% recycled content. Plastics intended for organic recycling are not exempt, leading to a significant economic disadvantage.

The Emissions Trading Scheme (ETS) does pose benefits for biogenic carbon, which although welcomed, are insufficient to offset the penalties imposed for bio-based materials through EPR, RAM and the PPT. This creates a policy trap where materials that could most reduce environmental harm are the least commercially viable – and this significantly stifles innovation from becoming a reality.

DEFRA is due to review the RAM, as it relates to bio-based materials and compostables in 2029, but this will be too late for the sector - due to loss of investor confidence, lack of commercial viability and exodus of companies from the UK.

The European Union is set to act at greater pace, though still more slowly than industry needs. Under PPWR, the Commission is required to review (by February 2028) the technological development and environmental performance of bio-based plastic packaging[121].

The EU Bioeconomy Strategy[122] states that the Commission will then, if appropriate, bring forward sustainability requirements and targets for such plastics, as well as the recognition of novel bio-based materials. It will do so with a view to increasing the uptake of such materials *'in complementarity with recycled content'*.

The Commission is also set to examine the measures required to accelerate authorisation processes for bio-based chemicals[123].

Recommendation

Bring forward DEFRA's RAM review of bioplastics and compostables to no later than 2026, clearly distinguishing compostable and natural polymer materials in their own EPR categories, with RAM considering product feedstocks (and thereby full life cycle impact) as well as end-of-life waste management.

Recommendation

Amend the Finance Act 2021 and reform the Plastic Packaging Tax (PPT) frameworks to exclude biodegradable materials intended for organic recycling and derived from bio-based content from PPT scope.

Recommendation

Undertake a Treasury-led review to ensure alignment between the Emissions Trading Scheme (ETS), Extended Producer Responsibility (EPR) and Plastic Packaging Tax (PPT), and the UK's Net Zero and circular-economy objectives – including the consistent treatment and recognition of biogenic content across these frameworks.

Recommendation

Implement targeted tariff exemptions for imported bio-based feedstocks used in the manufacture of bio-based chemicals and materials to enhance the competitiveness of the UK modern industrial bioeconomy, encouraging the substitution of fossil-based inputs with renewable alternatives.

3. Regulations, Taxation, Standards and Investment

3.1.0 Toward a Fair Fiscal Framework

To reinforce the essential transition towards bio-based content in chemicals and materials, fiscal reform must be implemented to disincentivise fossil use and de-risk bio-based investment. Taxes alone will not close the competitiveness gap, but smarter policy and regulatory design can bring price parity closer, sooner.

Our *Plastic Definitions in UK Regulation* report[124] highlights the deficiencies of the status quo. The Single-Use Plastics Ban (SUPB, DEFRA, 2023), the Plastic Packaging Tax (PPT, HMT, 2021) and the REACH Chemicals Framework (UK REACH, 2021) work to different definitions of what consitutes plastic.

All three rely on REACH's polymer definition but adapt it differently to suit departmental intent. Under the SUPB, "plastic" is any finished material consisting of a polymer, excluding natural polymers that have not been chemically modified. Under the PPT, the exemption is narrower – limited to cellulose-based polymers that are unmodified.

Neither regulation defines what "chemically modified" means, nor what qualifies as a "natural polymer". Consequently, the same bio-based material can be classed as a plastic under one regulation but exempt under another.

A recurring theme in our report is the need to clarify the legal status of natural polymers. Under SUPB, these are theoretically excluded, but the absence of a definition leaves ambiguity over materials such as starch blends, chitosan, or plant-protein based products.

Creating a fair fiscal framework requires a consistent cross-regulatory definition of plastic, explicitly recognising bio-based, biodegradable and natural polymers as distinct from each other and from fossil-derived plastics. This definition should be referenced across all relevant legislation and linked to verified standards.

A starting point for the new cross-regulatory standard should be revision of the definitions behind the Plastics Packaging Tax in the Finance Act 2021. Such revisions can be brought forward without primary legislation under Section 49(8) of the Act.

Recommendation

Establish a single, consistent definition of "plastic" across all UK regulations that explicitly excludes unmodified natural polymers and clearly distinguishes between fossil-derived, bio-based, and natural polymers. This will reduce unnecessary regulatory burden, provide clarity to industry, and ensure alignment with scientific understanding of the fundamental differences between these material types.

3.1.1 Incentives to Investment

Survey respondents to our '*Bio-barometer Survey*'[125] report that the UK's fragmented policy landscape and perverse taxation structure make it difficult to progress from pilot to production: grants are available for R&D, but capital allowances and procurement rules rarely favour renewable materials. Without intervention, the UK risks repeating the pattern seen in solar PV and batteries – where home-grown innovation ends up scaling abroad.

As the House of Lords Science and Technology Committee recently concluded, '*the UK has seen many promising companies listing overseas or being acquired by overseas buyers. This results in a reduced UK 'home bias' for these companies, cutting UK employment, investment, and tax revenue.*'[126]

Our research indicates that the UK's fragmented policy landscape risks exporting both intellectual property and industrial growth. Of 45 companies interviewed for our BB-REG-NET report *From Research to Revenue*[127], more than half indicated they were considering scaling production elsewhere, in either the EU or North America, to access more stable regulatory and fiscal frameworks.

Between 2018 and 2024, over £450 million of UKRI funding – taxpayers' money – supported bio-based research and demonstration projects. However, less than 10 per cent of funded innovations have reached commercial production in the UK[128].

Our BB-REG-NET *Bio-Barometer Survey* found that more than 80 per cent of industry respondents view bio-based materials as central to achieving the UK's net-zero goals, and over two-thirds believe they could support regional economic renewal in former

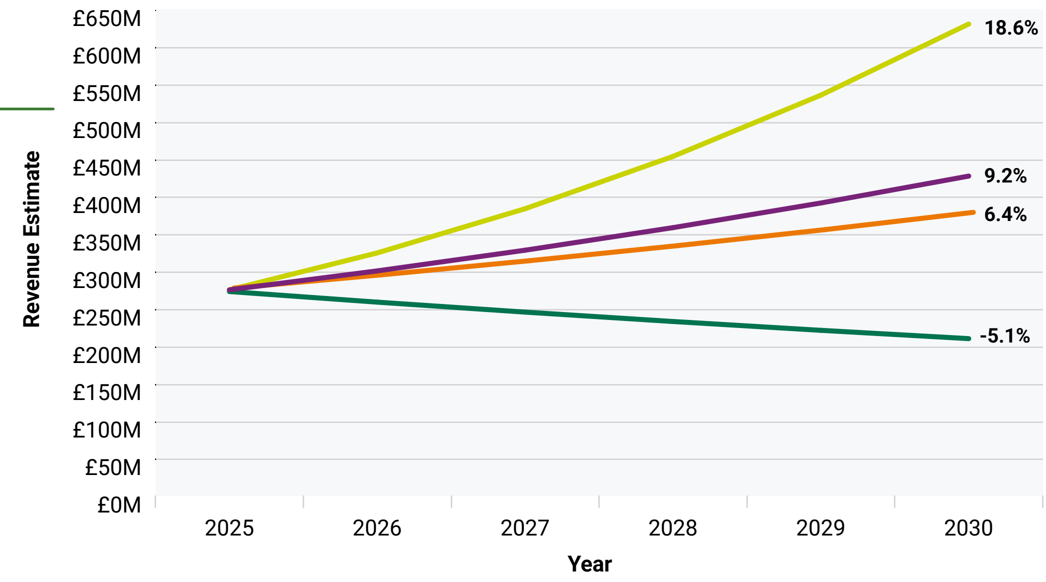


Figure 3

Projected UK Bio-based Sector Revenue (2025–2030) Under Various Policy Scenarios

Infrastructure Investment **18.6%**

Feedstock Mobilisation **9.2%**

Government Coordination **6.4%**

Status Quo **-5.1%**

manufacturing and agricultural heartlands. Yet, as our *From Research to Revenue* report observes, '*the UK's bioeconomy remains a science-rich, but commercially under-developed sector*.' The report reveals that the UK excels at creating bio-based startups but struggles to scale them domestically, with many relocating abroad to benefit from more supportive business environments.

Our research shows internationally active firms employ more staff and generate nearly twice the revenue of UK-focused counterparts and concludes that addressing scale-up barriers could create 4,230 new jobs and add £300-500 million in GVA annually. The principal barrier is the "missing middle" of finance and infrastructure – the absence of scale-up facilities, manufacturing incentives, and patient capital. In addition, venture investment in the bio-based sector remains dominated by early-stage seed funding, whilst Series B and C rounds are frequently raised overseas.

Survey data from our *Bio-barometer Survey*[129] reinforces this: 72 per cent of respondents said they would expand UK operations if long-term financing or offtake guarantees were available. Many cited the US *Inflation Reduction Act* and the EU's *Green Deal Industrial Plan* as examples of "policy confidence" currently missing in the UK.

BB-REG-NET's financial analysis[130] shows that manufacturing bio-based chemicals and materials can cost at least twice as much as the equivalent fossil-based counterpart[131]. Without targeted fiscal support, the private sector is unlikely to bridge the investment gap required to reach scale and bring price parity nearer at hand. We therefore call for a mix of instruments – tax credits, loan guarantees and demand-side procurement – to attract long-term investors. The National Wealth Fund and a revitalised Green Investment Bank are natural vehicles to deliver patient capital for investment in infrastructure.

Doing so would be the single biggest intervention government could make to advance the modern industrial bioeconomy, as determined by recent research commissioned by the Biomass Biorefinery Network[132], and illustrated in the graph (Figure 3) above.

Survey respondents were asked to estimate how their business would change, in terms of annual revenue and employment, under four future scenarios:

Infrastructure investment: Government successfully establishes shared scale-up facilities and industrial clusters with co-location incentives, enabling companies to access pilot plants and demonstration facilities. Feedstock remains at market rates with limited coordination, and sector oversight stays fragmented across departments.

Feedstock mobilisation: The UK secures long-term agreements for affordable feedstock through international partnerships and domestic feedstock mobilisation. However, businesses have to fund their own scale-up facilities, and government coordination remains limited with fragmented policies across departments.

Government coordination: A dedicated biorefining council coordinates activity across departments, streamlines regulations, and aligns policies between devolved nations. However, feedstock costs remain as is, and public investment in scale-up infrastructure is limited.

Status quo: Government maintains current levels of bio-based sector support without significant expansion or reduction, with existing R&D programmes continuing at present funding levels. Familiar regulatory processes remain in place alongside modest private investment and existing skills ecosystem.

3. Regulations, Taxation, Standards and Investment

Research concluded respondents believe investment in scale-up infrastructure would have the most positive impact on growth (+18%) followed by feedstock mobilisation and government coordination (+9% and +6% respectively). Results also suggest that any of the proposed actions are better than taking no action – as reflected in overall negative growth estimates (-5%) returned under that scenario. The gap between future revenue under the status quo and highest impact scenarios is wide – amounting to almost £0.5bn in lost revenues to bio-based SMEs.

Recommendation

Establish dedicated scale-up support for bio-based and biodegradable chemicals and materials through the National Wealth Fund or British Business Bank, modelled on the energy-transition funding mechanisms that underpinned offshore-wind expansion.

Recommendation

Through the £184 million committed for an Engineering Biology Scale-up Infrastructure Programme, encourage applications to build and upgrade pilot and scale-up facilities dedicated to scaling up bio-based and biodegradable chemicals and materials, to enable cost parity with their fossil incumbents.

Recommendation

Extend R&D tax credits to include scale-up activities, supporting the transition from research and development to commercial deployment and accelerating the adoption of innovative technologies and products.

Recommendation

The government should commission research into how the RTFO framework could be adapted for a full range of non-fuel bio-based and biodegradable products.

The Industrial Strategy published by the UK Government in June 2025[133] identifies engineering biology as one of the nation's six frontier technologies and commits £380 million to new infrastructure and innovation funding to help companies '*set up and scale up in Britain*'.

To deliver maximum impact, the Government should encourage applications to build and upgrade pilot and scale-up facilities dedicated to scaling up bio-based and biodegradable chemicals and materials, to enable cost parity with their fossil incumbents. Such a facility would translate UK research excellence into production capacity, reduce reliance on fossil-derived inputs, and drive cost convergence between bio-based and conventional fossil-based materials.

To reinforce longer term confidence, the UK could explore introducing a Low Carbon Chemicals and Materials Mandate, modelled on California's Low Carbon Fuel Standard[134]. Such a framework would set declining carbon-intensity benchmarks for key industrial chemicals and materials – such as polymers, packaging and construction inputs – rewarding producers who achieve verified emissions reductions through the incorporation of biogenic carbon into products.

The mandate could build on the same principles that underpin the UK's Renewable Transport Fuel Obligation (RTFO)[135]. Under the RTFO, fuel suppliers are required to ensure a rising proportion of the fuel they supply is renewable or low-carbon, measured through verified greenhouse gas reduction certificates. Those exceeding the target generate tradeable credits; those falling short must purchase them or pay a buy-out price.

This market-based mechanism has successfully stimulated investment in low-carbon fuels and bio-refineries, created transparent carbon-accounting infrastructure, and driven year-on-year emissions reductions in the transport sector. A similar credit-based obligation could be designed for industrial materials and chemicals, rewarding bio-based production pathways that deliver verifiable lifecycle emissions savings.

This would provide a predictable policy signal for investors, analogous to the RTFO in transport, while dovetailing with emerging carbon disclosure and product footprint requirements.

3.2.0 Regulations

While the UK is a global leader in research and early-stage innovation in bio-based technologies, companies face regulatory systems that are outdated, fragmented, and ill-suited to the novel characteristics of bio-based products[136]. Although UK regulations are theoretically feedstock-neutral, in practice they remain biased toward fossil-based materials, reflecting legacy testing standards, performance benchmarks, and cost structures designed around fossil-based products. This misalignment slows commercialisation, deters investment, and disproportionately impacts SMEs.

Our *Bio-Barometer Survey*[137] assessed the current landscape, opportunities, and challenges in the bio-based chemicals and materials sector, gathering insights from over 100 stakeholders, including manufacturers, policymakers, and researchers. Stakeholders identified strategy and policy – including regulations – as the second-largest barrier to commercialisation. The UK's bio-based policy framework was rated poorly (2.49/5), highlighting a lack of strong incentives and positive regulatory support for market development. Within the policy and regulatory landscape, regulations themselves were cited as the most significant barrier, followed by broader policy issues, standards, and certifications.

The UK's outdated and fragmented regulatory framework poses a significant threat to maintaining global leadership in bio-based innovation. Without urgent reform, the UK risks losing ground to international competitors such as the US, EU, and Singapore, who are actively modernising their regulatory environments.

The cumbersome regulatory landscape leads to three critical risks:

- **Company exodus:** UK bio-based SMEs are relocating to countries with more supportive regulatory ecosystems, resulting in the loss of jobs, intellectual property, and taxpayer-funded innovation.
- **Investment drain & company failure:** Regulatory uncertainty and prolonged timelines increase perceived risk for investors, causing startups to fail or downscale and putting billions of pounds of public R&D at risk.
- **Delayed economic gains:** Every regulatory delay postpones significant economic and environmental benefits, including green jobs, tax revenues, and market leadership.

For just 3 UK bio-based SMEs, the UK is losing £35.7 million in annual GVA, and over 473 potential jobs remain unrealised – a clear and avoidable economic drain[138]. With hundreds of similar bio-based SMEs across the UK, the total annual loss could easily run into tens of billions.

Through the *Modern Industrial Strategy*, the government has committed to reducing regulatory administrative costs for businesses by 25% by the end of this Parliament[139]. For the bio-based chemicals and materials sector, this underscores the urgent need for a co-developed regulatory roadmap for bio-based products – one that is clear, pragmatic, and future-focused. This roadmap should be developed collaboratively, bringing together government bodies, regulatory agencies, and industry leaders to ensure it is robust and aligned with innovation trajectories. Leadership should come from DSIT's Regulatory Innovation Office (RIO) and include the DBT's Office for Product Safety and Standards (OPSS), Defra's REACH Team, the Food Standards Agency (FSA), and the Regulatory Horizons Council.

Recommendation

Utilise the Engineering Biology Sandbox Fund to co-develop a regulatory roadmap for novel bio-based and biodegradable chemicals and materials in the UK, unlocking economic growth and securing the nation's leadership in sustainable innovation.

Regulatory reform is the key to private sector investment in, and scaling of, the modern industrial bioeconomy. But there is an opportunity – in parallel – for public procurement to catalyse UK biomanufacturing at scale.

BB-REG-NET research explored international experience of how government procurement can create reliable domestic demand for emerging green industries. As outlined in Section 2.1, the US Department of Agriculture's *BioPreferred Program*[140], established under the 2002 Farm Bill, mandates federal purchasing of more than 7,000 certified bio-based products across 139 categories. The US has seen more than a 536% increase in certification of bio-based upstream materials between 2015 and 2022, including binders, chemicals, cleaner components, fibres and fabrics, foams, lubricants, oils, fats and waxes, paint and coating compounds, personal care product components, plastic resins, rubber materials, and textile processing materials.[141]

The House of Lords Science and Technology Committee has endorsed a similar approach for the UK, in its *Seizing the Opportunity of Engineering Biology report.*[142]

Similarly, the EU's *Green Public Procurement Framework*[143], developed through the *Circular Economy Action Plan*[144], encourages Member States to set renewable-content criteria in tenders for packaging and cleaning goods. Countries such as Italy and the Netherlands have gone further by introducing mandatory bio-based thresholds in public contracts.

4.0.1 The NHS Opportunity

The UK has a powerful mechanism at its disposal to accelerate the demand for emerging markets: the National Health Service (NHS). As one of the largest employers in the world and the single biggest public purchaser in the UK[145], the NHS represents a uniquely concentrated source of demand in categories dominated by plastics, particularly high-volume disposable items used in clinical settings.

Our analysis in our report *Buying into Biomanufacturing: Harnessing Public Procurement for the UK Bioeconomy*[146] identified hundreds of NHS contracts for single-use items such as gowns, gloves, masks, labware and patient-care consumables, the majority technically suitable for bio-based alternatives.

Unlike fragmented healthcare systems elsewhere, this purchasing power is centralised under state control, allowing policy intent to translate quickly into procurement practice. The NHS *Net Zero Supplier Roadmap* (2022)[147] already demonstrates how central direction can drive market change: suppliers are now required to measure and report emissions as a condition of future contracts.

Extending that logic to include bio-based and low-carbon material criteria would not only advance the NHS's own sustainability goals but also send a powerful demand signal across bio-based and biodegradable products' supply chains. *Delivering a Net Zero NHS* (2022) anticipates that a switch to bio-based polymers will deliver carbon savings of 498 $ktCO_2e$.[148]

In short, the NHS is not just a healthcare provider but a strategic industrial policy instrument, capable of accelerating the UK's transition to sustainable materials through the weight of its purchasing decisions.

The NHS spends an estimated £8 billion annually on medical equipment and consumables. BB-REG-NET analysis of publicly available contract data identified 670 NHS contracts for single-use plastic products, worth £6.7 billion, of which 60 per cent had high potential for substitution with bio-based alternatives[149]. These contracts – valued at around £5.5 billion – covered more than a thousand unique items, including personal protective equipment, medical-device components and packaging materials.

The COVID-19 pandemic further underscored this opportunity: £4 billion was awarded in NHS Supply Chain contracts for single-use protective theatre clothing in 2020 alone, much of which could feasibly have been manufactured using bio-based materials.

4. Leading by Example: Public Procurement as a Market Driver

4.0.2 Barriers to Bio-Based Procurements

Despite this potential, significant barriers prevent market transformation. Our analysis revealed that within a highly centralised model, NHS procurement is nonetheless decentralised, with 117 different buyers issuing the 407 high-potential contracts and approximately 260 unique suppliers fulfilling them[150]. This fragmentation dilutes market signals and makes it difficult for bio-based suppliers to achieve the scale necessary for competitive pricing.

Meanwhile, most NHS suppliers are resellers with limited UK manufacturing capacity or control over global supply chains. Our review of supplier websites found little evidence of bio-based products within existing portfolios: NHS Supply Chain's catalogue of approximately 500,000 products yielded just one result when searching for 'bio-based' materials[151]. This supply-side readiness gap, combined with the absence of coordinated demand signals, creates a classic market failure that requires deliberate strategic intervention from the Department of Health and Social Care.

4.0.3 Strategic Procurement Roadmap

A *Bio-Preferred Procurement Scheme* should be implemented within the NHS, beginning with categories where bio-based alternatives are already proven and regulatory pathways are well established – including surgical gowns and drapes, catering disposables, and patient slings. These are high-volume, technically mature product lines suitable for pilot substitution.

A pilot should be coordinated with the NHS's major purchasing bodies – NHS Supply Chain, NHS National Services Scotland, and NHS Wales Shared Services Partnership – which together manage several billion pounds of procurement spend. These agencies could form a *Bio-Based NHS Procurement Consortium* to aggregate demand, harmonise product specifications, and run joint tenders. A coordinated consortium model would provide market certainty for suppliers and support capital investment in domestic bio-manufacturing.

Recognising that suppliers face significant upfront costs to transition, we additionally support a supplier transition mechanism offering partial cost recovery for bio-based production and certification. This support could take the form of targeted tax credits to de-risk early adoption and incentivise UK production.

Recommendation

Establish a *UK Bio-Preferred Procurement Scheme* to provide predictable demand signals that enable UK manufacturers to invest confidently in production capacity.

Recommendation

Launch a pilot *NHS bio-based procurement programme* targeting high-volume single-use products, coordinated through NHS Supply Chain and assessed using triple-bottom-line metrics encompassing economic viability, environmental performance, and social value, including UK manufacturing capacity.

Recommendation

Establish a supplier transition mechanism to offset the costs of converting to bio-based production through matched tax relief for suppliers participating in NHS pilot contracts.

4. Leading by Example: Public Procurement as a Market Driver

4.1 Medically Contaminated Materials

As stated, the NHS in England is one of the largest single organisations by footprint in the UK – and that includes its material use and waste generation. Healthcare settings rely heavily on plastics: from single-use syringes, tubing and PPE to packaging, disposable trays and sharps containers. Plastics are often chosen for clinical safety, sterilisation and convenience, yet their widespread use brings an escalating environmental burden, and in the near future an economic burden for incineration costs under the UK Emissions Trading Scheme (ETS).

Each year, NHS providers across England generate approximately 156,000 tonnes of clinical waste that requires either high-temperature incineration (HTI) or alternative treatment[152]. Many of these materials cannot be recycled, due to medical contamination, mixed materials, or regulatory classification, or are deemed too risky to divert from disposal by incineration. This means that a large proportion of NHS plastic waste is ultimately burned, releasing fossil-derived carbon and associated emissions.

The dependency on single-use plastics, coupled with a waste stream that is dominated by incineration, presents a significant challenge for the NHS in achieving its sustainability ambitions[153]. And yet research shows many NHS trusts still lack robust policies for reducing single-use plastics: more than half of hospital trusts surveyed have no plan in place to reduce single-use plastic consumption, despite the fact that single-use plastics account for around a quarter of all NHS waste in England and Wales[154].

In this context, plastics that will inevitably be incinerated represent a key intervention point. If such materials could be switched from fossil-derived plastics to bio-based alternatives, the incinerated carbon would no longer be fossil in origin – thereby helping to reduce the healthcare sector's fossil carbon footprint, even if recycling is not possible.

Moreover, within the framework of the UK ETS, reducing fossil-based emissions through the use of bio-based plastics could provide additional financial incentives or compliance benefits. By lowering the volume of reportable fossil CO_2 emissions, healthcare organisations could either reduce their need to purchase emission allowances or generate tradeable credits, thereby aligning environmental and economic objectives.

> **Recommendation**
>
> For materials that will likely always need to be incinerated at end-of-life, mandate bio-based materials be used to eliminate fossil carbon emissions.

4.2 Building Bio-Based – the Future of Construction

The built environment is responsible for 25% of the UK's carbon emissions[155]. Meanwhile, nearly 200,000 homes were built in England alone in 2023/24[156], and almost 50% of English homes need energy efficiency upgrades[157].

The traditional construction methods used to build new homes and retrofit existing properties rely heavily on resource-intensive and environmentally damaging materials, resulting in a significant ecological footprint. With the pressure on to meet housing demands while significantly reducing emissions, bio-based construction materials are fast becoming a key part of the solution. For example, France, through its *RE2020* policy[158], now requires 50% bio-based content in new buildings. In the US, the *BioPreferred* Program directs 70% of its spend towards bio-based construction. The UK must act now to stay competitive and climate-aligned.

Replacing a proportion of high-carbon materials with certified, sustainably sourced bio-based materials would reduce life-cycle CO_2 from manufacture and end-of-life, and support circular design that keeps materials in productive use.

Scaling these solutions will directly support the UK's legally binding Net Zero target and interim ambition to reduce emissions from the built environment by at least 68% by 2030. Embodied carbon reductions in construction should therefore be a policy priority.

In particular, widespread adoption of bio-based plastics into construction products would reduce demand for fossil-based plastics, ease downstream waste management pressures outlined in the Waste Prevention Programme[159] and help meet the government's longer-term ambition to eliminate avoidable plastic waste.

Integrated action across planning, building regulations, public procurement and waste policy will be essential to help bring bio-based materials into mainstream supply chains. With the 2023 *Procurement Act* enabling more flexible and strategic procurement practices, the regulatory environment is now well positioned to support this transition.

4.2.1 Other Sectors

Our research identified substantial bio-based procurement opportunities across the wider public sector. Analysis of contracts for catering disposables and refuse sacks alone revealed £177 million in potential demand across local authorities, central government departments, and housing associations[160]. Strategic buyers, including the Ministry of Justice, Ministry of Defence, and major city councils, represent immediate opportunities for bio-based product adoption.

> **Recommendation**
>
> The Cabinet Office and Crown Commercial Service should mandate the use of compostable food service ware – including cutlery, paper products, bowls, and cups – within national procurement frameworks. These materials should be collected through closed-loop systems across settings such as the NHS, prisons, festivals, and sports events, where dedicated waste management services can ensure proper delivery to in-vessel composting facilities.

> **Recommendation**
>
> Commission a time-bound review of bio-based chemicals and materials in the built environment.

5

Bio-Based Chemicals and Materials in Action

Case Studies

Agriculture:

In agricultural applications, bio-based and biodegradable materials are being used for mulch films, plant pots, seed coatings, and controlled-release fertilisers. Biodegradable mulch films protect soil moisture, suppress weeds, and regulate temperature, just like traditional plastic films–but unlike plastics, they can biodegrade naturally into non-toxic residues, reducing labour and disposal costs. Similarly, biodegradable plant pots made from natural fibres or biopolymers allow seedlings to be transplanted directly into the soil without generating waste.

Beyond practical benefits, these materials contribute to long-term soil health and environmental conservation. As they break down, they enrich the soil with organic matter, improving its structure and fertility. Moreover, they help reduce plastic pollution in agricultural lands–a growing concern worldwide. By integrating bio-based and biodegradable materials into farming systems, agriculture can become more eco-efficient, resilient, and aligned with global sustainability goals, such as reducing carbon emissions and protecting ecosystems.

Case Study Biome Bioplastics

Originally funded by Innovate UK, Biome Bioplastics is one of the UK's leaders in developing natural plastics in the agriculture industry. Biome's products are 100% biodegradable and compostable. The company's revenues grew 44% to £2.3 million in 2017 with the coffee market also adopting the company's BiomeMesh filter material.

The company has also developed innovative new tree guards to aid in reforesting the UK, which have the same performance as conventional plastic but critically can be left on site and biodegrade in a timely manner, leaving no toxic residue and instead further enriching the soil.

Automotive:

The automotive bio-based plastics market is also expanding, with an estimated value of USD 933.3 million in 2025 and a projected CAGR of 10.3%[161]. Bio-based materials and chemicals are playing an increasingly important role in the automotive industry, driven by sustainability goals, regulatory pressures, and growing consumer demand for eco-friendly solutions.

In interior components, materials such as soy-based foams, natural fibres, and biodegradable plastics are commonly used in seats, dashboards, and door panels. Exterior parts, including bumpers and trim components, increasingly utilise bio-composites and bio-based plastics, while under-the-hood applications benefit from bio-based composites and foams that offer heat resistance and reduce vehicle weight. The shift toward heavier electric vehicles has further accelerated the adoption of lightweight bio-based materials to improve energy efficiency.

Case Study: Floreon

Floreon offers a renewable, recyclable bio-based alternative to traditional plastics, delivering up to six times lower carbon emissions. Its lightweight composition allows it to replace heavier components, even aluminium, for commercial vehicles.

The material's excellent performance in terms of toughness and heat stability has made it ideal for a wide range of automotive applications. Floreon has secured £250k in funding from the Centre for Process Innovation (CPI).

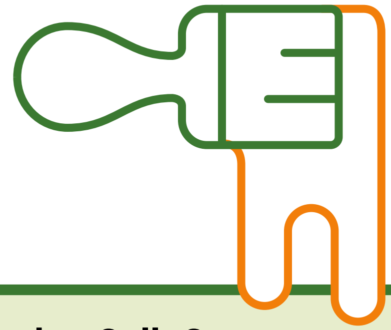
5. Bio-Based Chemicals and Materials in Action

Paints and Coatings:

The global bio-based coatings market has been experiencing significant growth. Valued at approximately $13.6 billion in 2025, it is projected to reach around $22.6 billion by 2030, reflecting a compound annual growth rate (CAGR) of about 10.7%[162].

This expansion is driven by increasing environmental awareness, stringent regulations, and a shift towards sustainable building materials. Bio-based paints and coatings are environmentally friendly alternatives to traditional fossil-based products, formulated using renewable raw materials such as vegetable oils, natural resins, cellulose, and starch derivatives. These sustainable ingredients significantly reduce dependence on fossil fuels and help lower the carbon footprint associated with paint production. In addition to their environmental benefits, bio-based coatings often emit fewer volatile organic compounds (VOCs), improving indoor air quality and creating healthier living environments.

Advances in green chemistry have also enhanced their performance, durability, and colour stability, making them suitable for a wide range of architectural, industrial, and decorative applications. As industries move towards circular economy principles, bio-based paints and coatings play a vital role in providing sustainability throughout the product life cycle.



Case Study - CelluComp

CelluComp is a Scottish-based company located in Fife which has commercialised Curran, a material developed from the extraction of nanocellulose fibres from waste streams, primarily from sugar beet pulp, which is a by-product of the sugar industry. Curran granules are used as a film enhancer for water-based coatings providing improved crack resistance and reducing film defects.

From their Fife factory, they distribute Curran globally. The company has raised a total of £7.1 million in funding including investments from the Scottish Investment Bank. The company's success has led to expansion into the US market, with a new factory opening in Minnesota.

Textiles:

In textiles, bio-based and biodegradable fibres offer a balance of performance, comfort, and environmental responsibility. They can be used in clothing, home furnishings, and industrial fabrics without compromising quality. For example, biodegradable polyester alternatives such as polyhydroxyalkanoates (PHA) and polylactic acid (PLA) can mimic the durability and flexibility of synthetic fibres while at end of life, biodegrading under composting conditions. Natural dyes and finishes derived from plants and microorganisms further complement these materials, reducing the use of harmful chemicals in textile processing.

Case Study: Solena Materials

Spun out of Imperial College London, London-based biotech company Solena Materials uses AI and synthetic biology to design novel protein-based fibres at the molecular level to create the next generation of sustainable fibres. In 2025, the company secured £5.1 million in seed funding following a pre-seed funding round of £3.1 million in 2022.

Solena's sustainable fibres are produced by engineered microbes to build high-performance textiles for apparel, sportswear, and technical textiles that are biodegradable and offer strong performance for wearers compared with traditional synthetic fibres.

Plastic Packaging:

The global bio-based packaging market is witnessing robust expansion as sustainability and circular economy principles reshape the sector. Valued at $12.3 billion in 2025, the market is projected to reach approximately USD 24.5 billion by 2030, growing at a compound annual growth rate (CAGR) of about 14%. This surge is driven by rising consumer demand for alternatives, regulatory pressure to reduce plastic waste, and advancements in biopolymer technologies. Bio-based packaging is derived from renewable feedstocks such as corn starch, sugarcane, cellulose, and algae, offering a lower-carbon alternative to conventional fossil-based plastics. They help reduce reliance on fossil resources while contributing to lower greenhouse gas emissions throughout the value chain. Recent innovations have improved their mechanical strength, barrier properties, and recyclability, expanding their use in food and beverage packaging, consumer goods, and industrial applications. As companies increasingly adopt sustainable packaging strategies, bio-based packaging is set to play a pivotal role in reducing plastic pollution and supporting global efforts toward a low-carbon, circular materials economy.

Case Study: Woodly

Woodly has developed a renewable, wood-derived alternative to conventional plastics. Its material, Woodly, is a transparent, durable bio-based plastic made from wood sourced from sustainably managed forests. Unlike traditional plastics, Woodly is based on renewable carbon and designed for mechanical recyclability, enabling it to fit seamlessly into existing waste-collection systems.

Woodly packaging offers equivalent clarity, strength and sealability to fossil-based polyethylene terephthalate (PET) and polypropylene (PP), but with up to 80% lower carbon emissions across its lifecycle. It runs efficiently on standard extrusion and thermoforming lines, allowing converters and brand owners to transition without costly additional equipment needs. The company partners with major food and consumer-goods brands to replace fossil plastics in films, pouches and rigid packaging.

5. Bio-Based Chemicals and Materials in Action

Cosmetics and Beauty

In 2022, the global cosmetics and beauty market was valued at approximately US $430 billion163, and it is projected to grow to around US $580 billion by 2027, reflecting a steady annual growth rate of around six per cent. This momentum is mirrored in the UK, where the beauty sector grew by 11 per cent in 2023, reaching total sales of £27.2 billion164. Despite wider economic uncertainty and global market volatility, the cosmetics and beauty industry has demonstrated remarkable resilience, continuing to attract strong investment and expanding its influence across related sectors such as wellness, personal care, and luxury retail.

As the market grows, consumer expectations are shifting. There is a rising demand for products that are not only high-performing but also sustainably sourced, ethically produced, and transparent in their environmental footprint. This shift has made sustainability a key market differentiator, with companies increasingly leveraging bio-based ingredients, more circular packaging solutions, and responsible supply chains to stand out in an increasingly crowded and competitive landscape. The trend is reshaping product development strategies and pushing brands to innovate, creating new opportunities for bio-based cosmetic ingredients, materials and technologies within the wider beauty ecosystem.

Case Study - twig

London-based biotech company twig, founded in 2022, uses an AI-driven microbial design platform ("twig:tech") to engineer fermentation pathways that produce sustainable alternatives to everyday cosmetic ingredients such as solvents or emollients. Twig's innovations are the next-generation, biology-derived substances that will not just aim to match fossil-based equivalents, but are being designed to surpass them in functionality, safety, and circularity.

The company has raised over £3 million seed funding and is positioning its ingredient catalogue for personal-care brands seeking drop-in substitutes for fossil based inputs. Twig's technology aligns beauty market growth with the ethical and environmental demands of consumers.

Case Study: Holiferm

Holiferm is a UK-based biotech company that has emerged as a key innovator in the production of sustainable biosurfactants for the cosmetics industry. Leveraging a patented gravity-based fermentation process, Holiferm produces sophorolipids–mild, biodegradable surfactants derived from natural feedstocks such as rapeseed oil.

These ingredients are particularly attractive for personal care applications due to their low irritation profile and compatibility with microbiome-friendly formulations. Holiferm's biosurfactants are COSMOS-approved, EU Ecolabel certified, and recently achieved MyMicrobiome Standard certification for face and scalp applications. Holiferm's innovative approach is helping to accelerate the cosmetics industry's transition to cleaner, more sustainable ingredient systems.

Construction

The bio-based construction sector is poised for substantial growth, driven by rising demand for sustainable building solutions and supportive regulatory frameworks. The global bio-based building materials market is projected to reach $195.2 billion by 2035, growing at a CAGR of 19.0%[165].

In the UK, the government has committed to delivering 1.5 million new homes over the next five years, alongside retrofitting 19 million existing homes by 2050 to improve energy performance. With the built environment responsible for 33% of the UK's carbon emissions, a critical question arises: how can the UK achieve its ambitious housing targets while reducing its carbon footprint to meet legally binding Net Zero commitments? Bio-based materials in construction offer a vital part of the solution. Countries such as France are already leading the way, mandating 50% bio-based content in new buildings through the *RE2020* regulations[166]. In the USA, the *BioPreferred Program* directs 70% of government procurement in construction toward bio-based products[167].

Case Study: Carbon Cell

Carbon Cell is a London-based materials company developing a carbon-negative, plastic-free foam made from biochar and natural polymers to replace petrochemical foams such as EPS, EPP, and polyurethane. Its mission is to decarbonise the built environment by offering a high-performance, alternative to conventional insulation and packaging materials used in construction.

The company's patent-pending process transforms agricultural waste into lightweight foam beads that can be moulded or machined using existing infrastructure, delivering comparable thermal insulation and strength to traditional foams while locking carbon into a stable form. In 2025, the company raised £1.2 million to scale production and validate its foam in real-world manufacturing trials.

Medical Devices

The global market for bio-based and biodegradable materials in medical devices is gaining traction, driven by the ability to design materials with superior properties, sustainability mandates, regulatory pressures, and increasing adoption of renewable-feedstock technologies in healthcare products.

In addition to sustainability drivers, advances in performance (e.g., mechanical strength, degradation control) are enabling broader adoption of these materials in medical-grade device manufacture.

As healthcare systems globally face tighter sustainability targets and higher scrutiny of device lifecycle impacts, bio-based and biodegradable materials are increasingly seen not just as niche alternatives but as strategic components of device design and procurement strategies.

Case Study – Ambu

Ambu is integrating bio-based plastics made from second-generation feedstocks, such as used cooking oil, into single-use endoscopes. These biomaterials reduce cradle-to-gate CO_2 emissions by up to 70% compared with conventional fossil-based plastics, without compromising device performance or sterility.

Beyond endoscope handles, Ambu is also introducing bio-based mask cuff protectors that achieve around 65% lower CO_2 emissions. These developments align with the company's broader sustainability strategy to reduce emissions across its product lifecycle while maintaining the safety, performance, and sterility standards required in clinical settings.

UK Government Policy

- Environment Plan/Land Use
- Modern Industrial Strategy
- Circular Economy Growth Plan
- Packaging Pact
- National Materials Innovation Strategy
- RTFO Mandate
- Engineering Biology Vision
- Biomass Strategy
- NHS Net Zero

	Strategy	Policy	Regulations	Taxes	Definitions, standards, certifications and communication
Biomass feedstock	Develop a National Bioeconomy Plan, reviewed every five years, and monitored by the cross-government Bioeconomy Delivery Council, consolidating departmental initiatives into a single framework that links innovation, industrial policy and sustainability outcomes. A designated Minister of State should be appointed to the Plan, matching arrangements for net zero and space.	Design a UK biomass utilisation hierarchy that prioritises the use of biomass as a feedstock for high-value bio-based chemicals and materials, before its use in bioenergy generation. Government should commission a time-bound review of bio-based chemicals and materials in the built environment.	The government should commission research into how the RTFO framework could be adapted for a full range of non-fuel bio-based and biodegradable products.	Implement targeted tariff exemptions for imported bio-based feedstocks used in the manufacture of bio-based chemicals and materials to enhance the competitiveness of the UK modern industrial bioeconomy, encourage the substitution of fossil-based inputs with renewable alternatives.	Accelerate the publication of the biomass sustainability framework and work collaboratively with stakeholders across the modern industrial bioeconomy sector to co-develop clear, practical guidelines that promote sustainable biomass production, utilisation, and innovation.
R&D		Promote development of bio-based chemicals and materials from second generation and waste biomass.	Promote and incentivise the scaling of innovative bio-based materials that are suitable for mechanical and chemical recycling systems in the UK. During their scaling up stage, allow an exemption from EPR and the PPT, until materials are at significant scale to be considered commercially viable.		Government should commission long-term environmental fate studies to understand the behaviour of biodegradable plastics in-situ compare with conventional plastic behaviour. Government should fund research defining acceptable mineralisation timeframes for biodegradable plastics under varying conditions, developing predictive models and testing methods for future standards and policies.
Scale up		£184M Engineering Biology Scale-up Infrastructure Programme should encourage applications to build and upgrade facilities for bio-based and biodegradable chemicals and materials, enabling cost parity with fossil incumbents Establish scale-up support for bio-based and biodegradable chemicals and materials via the National Wealth Fund or British Business Bank, modelled on offshore-wind energy-transition funding.	Utilise the Engineering Biology Sandbox Fund to co-develop a regulatory roadmap for novel bio-based and biodegradable chemicals and materials in the UK, unlocking economic growth and securing the nation's leadership in sustainable innovation.	Extend R&D tax credits to include scale-up activities, supporting the transition from research and development to commercial deployment and accelerating the adoption of innovative bio-based technologies and products.	Government, regulators, and industry should adopt a shared, science-based lexicon distinguishing bio-based, biodegradable, and compostable materials in policy, labelling, and public messaging.
Commercialisation		Establish a UK "Bio-Preferred" Procurement Scheme to provide predictable demand signals that enable UK manufacturers to invest confidently in production capacity. Launch a pilot NHS bio-based procurement programme targeting high-volume single-use products, coordinated through NHS Supply Chain and assessed using triple-bottom-line metrics encompassing economic viability, environmental performance, and social value, including UK manufacturing capacity.	The term "biodegradable" should only apply to and be utilised for products designed for open-environment degradation (e.g., mulch films) with reference to relevant standards.	Amend the Finance Act 2021 and reform the Plastic Packaging Tax (PPT) frameworks to exclude biodegradable materials intended for organic recycling and derived from bio-based content from the PPT scope. Establish a supplier transition mechanism to offset the costs of converting to bio-based production through matched grants or tax relief for suppliers participating in NHS pilot contracts.	Establish a single, consistent definition of "plastic" across all UK regulations that explicitly excludes unmodified natural polymers and clearly distinguishes between fossil-derived, bio-based, and natural polymers. This will reduce unnecessary regulatory burden, provide clarity to industry, and ensure alignment with scientific understanding of the fundamental differences between these material types. Consumer communications on biodegradable and compostable packaging should clarify that no packaging belongs in the environment, in line with UK ASA guidance.
End-of-Life		For hard-to-recycle materials and those that will always need to be incinerated (e.g. medically contaminated), mandate bio-based materials be used to eliminate fossil carbon emissions.	The UK should align with the EU's PPWR on compostable tea and coffee bags/pods and sticky produce labels, and go further by requiring bio-based, compostable lightweight bags, dual-purpose shopping bags, caddy liners and small food sachets. Cabinet Office and Crown Commercial Service should mandate compostable food service ware (cutlery, paper, bowls, cups) in national procurement. Closed-loop systems, such as the NHS, prisons, festivals, and sports events, should deliver materials to in-vessel composting facilities. Develop Environment Agency processes for end-of-waste and develop a resource-first mindset to better support capture, valorisation and re-use of waste in modern industrial bioeconomy applications such as bio-based chemicals and materials. Bring forward DEFRA's RAM review of bioplastics and compostables to no later than 2026, distinguishing compostable and natural polymer materials in distinct EPR categories, with RAM considering product feedstocks and full life cycle impacts and end-of-life waste management.	Undertake a Treasury-led review to ensure alignment between the Emissions Trading Scheme (ETS), Extended Producer Responsibility (EPR) and Plastic Packaging Tax (PPT), and the UK's Net Zero and circular-economy objectives – including the consistent treatment and recognition of biogenic content across these frameworks.	For biodegradable materials utilised in the open environment, Government should develop or adopt clear, verifiable biodegradation standards for specific uses and environmental conditions, referencing EU 17033:2018 where applicable. New standards should be created where none exist. Require Life Cycle Assessments used to compare bio-based and fossil-based chemicals and materials to be conducted to EN 18027: 2025 Commission further research to advance LCA methodologies for the comparative assessment of fossil-based and bio-based or biodegradable materials. Encourage the integration of additional impact categories (Biodegradability, Bioaccumulation, Persistence, Microplastic formation, Biodiversity impact, Litter risk) and inclusion of a specific biogenic carbon impact category.

Government department key: Cabinet Office, DBT, DEFRA, DESNZ, DfT, DHSC, DSIT, HMT

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