BB-REG-NET

From Research to Revenue: The Case for Scaling UK Bio-based Innovation

An analysis of the potential GVA and employment benefits of addressing UK scale-up market failures

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1 Executive Summary

Science and technology are vital to the UK's future prosperity and wellbeing. The nation boasts a world-class research base, leading universities, and a vibrant ecosystem of spinouts and start-ups. Yet, the Government recognises that the UK often struggles to convert these strengths in research, development, and innovation into thriving domestic companies and sustained economic growth[1].

This BB-REG-NET-funded research investigates the untapped economic potential of the UK's Bio-based sector. It provides a detailed economic analysis of publicly funded UK Bio-based companies and quantifies the potential gains in gross value added (GVA) and employment if more micro and small-sized businesses were supported to scale successfully in the UK. At the heart of the report are three key questions:

1. How do UK-focused Bio-based organisations differ from those with international operations?
2. What drives the international growth journeys of innovative UK Bio-based organisations?
3. What could the economic impact be if UK Bio-based SMEs received more effective support to scale?

To answer these, the research followed a structured six-week approach, analysing a refined list of ~430 in-scope companies from an initial pool of 2,800 identified, via nine open and proprietary data sources.

1.1 Key Findings

Addressing scale-up challenges faced by UK Bio-based SMEs could lever additional value from UK Bio-based research and innovation, providing additional high-value jobs, generating additional GVA and helping the UK to maintain its position as a global bioeconomy leader.

The research reveals a clear opportunity to better-support domestic scale-up activity, helping to ensure that the UK derives greater economic benefit from high-growth Bio-based SMEs. A significant proportion of UK Bio-based SMEs are finding scale-up capital, access to scale-up facilities and larger, more favourable markets internationally, allowing them to add more jobs and generate more revenue than their UK-focused peers:

- Only 24% of UK Bio-based companies have international operations, yet they employ more people and generate nearly double the revenue.
- International expansion is closely tied to job creation—supporting scale-up could deliver **4,230 new jobs** and **£300–£500 million in additional GVA for the UK**.
- Several high-potential UK Bio-based companies have already moved operations entirely abroad (e.g., to the Netherlands, Sweden and Portugal) for access to better scale-up infrastructure.

1.2 What Needs to Happen Now?

Consultation with industry highlights that to generate additional economic value from UK Bio-based talent and research and innovation, the UK should take decisive action to:

1. **Audit and enhance existing infrastructure access**, plugging gaps in the UK scale-up ecosystem.
2. **Introduce targeted patient capital**, via the National Wealth Fund, and incentives such as **scale-up tax credits**.
3. **Streamline regulation** to reduce time-to-market for novel Bio-based technologies.
4. **Strengthen cross-sector collaboration** between government, academia, and industry.
5. **Address skills gaps**, especially by developing a new cadre of 'scale-up' scientists.

Without immediate action, the UK risks becoming a launchpad for innovation that delivers its economic and environmental benefits elsewhere. Strategic intervention now can reverse this trend and position the UK as a world leader in sustainable, Bio-based innovation—powering green growth and a resilient net-zero future.

[1] Invest 2035: the UK's modern industrial strategy - GOV.UK

2 Research Context & Objectives

Science and technology are vital to the UK's future prosperity and wellbeing. The nation boasts a world-class research base, leading universities, and a vibrant ecosystem of spinouts and start-ups. Yet, the Government recognises that the UK often struggles to convert these strengths in research, development, and innovation into thriving domestic companies and sustained economic growth[2]. During the last fifteen years of sluggish economic performance, despite substantial investment in R&D, there is a growing concern that the UK consistently falls short in capitalising on its scientific and technological excellence—particularly in nurturing large, homegrown technology firms, which frequently relocate overseas after their initial development[3].

The biobased and biodegradable chemicals and materials sector is an emerging yet increasingly pivotal pillar of the UK's chemical industry and broader bioeconomy[4]. Centred on the production of chemicals, polymers, and materials derived from renewable biological feedstocks—rather than finite fossil resources—this sector underpins the transition to a more sustainable, circular economy.

Operating within a dynamic and often volatile global landscape marked by shifting supply chains, fluctuating commodity markets, and evolving regulatory frameworks, the UK Bio-based sector holds strategic importance. Economic analyses have shown that the bioeconomy as a whole delivers around £220 billion in gross value added (GVA) and supports over 5 million jobs across the UK[5]—highlighting its significant contribution to national prosperity.

Demand for Bio-based chemicals and materials continues to accelerate, fuelled by growing consumer preference for sustainable alternatives, ambitious corporate ESG goals, and advances in R&D. Key downstream sectors—including packaging, textiles, construction, and automotive manufacturing—are increasingly turning to Bio-based products, with notable momentum in biodegradable packaging and next-generation biocomposites[6,7].

Positioned at the intersection of innovation, green growth, and industrial strategy[8], the Bio-based sector is integral to the UK's net-zero ambitions. It represents a high-potential growth area, offering the dual promise of economic resilience and environmental leadership on the global stage[9].

2.1 BB-REG-NET Research Objectives & Outputs

The overarching research project through which this report has been produced – BB-REG-NET – is a pioneering network uniting experts from academia, industry, policy, regulatory bodies and NGOs, with the aim of developing new tools, standards and approaches to evaluate the quality, performance and environmental and economic impact of BB- Materials, to assess benefit-risk and facilitate sound and transparent regulatory decision-making. BB-REG-NET will provide business-growth opportunities by removing barriers to the commercialisation of Bio-based chemicals and materials, which are essential to a UK circular bioeconomy and sustainable economic growth.

This report presents a focused economic analysis of Bio-based companies that have received public funding from UK government sources, and has two primary objectives: first, to evaluate the economic performance

[2] Invest 2035: the UK's modern industrial strategy - GOV.UK
[3] Financing and Scaling UK Science and Technology – Inquiry Launched - Committees - UK Parliament
[4] And fossil-based materials that are biodegradable
[5] https://bbia.org.uk/wp-content/uploads/2018/05/The-UK-Bioeconomy-May-2018-BBIA.pdf
[6] https://www.food.gov.uk/research/alternatives-to-single-use-plastics-results
[7] https://www.bbnet-nibb.co.uk/wp-content/uploads/2019/08/LBNet-UKBioChem10_UK-Top-Bio-based-Chemicals-Opportunities_Dec2017.pdf
[8] https://www.gov.uk/government/consultations/invest-2035-the-uks-modern-industrial-strategy/invest-2035-the-uks-modern-industrial-strategy
[9] https://www.ukri.org/wp-content/uploads/2021/12/BBSRC-01122021-Forward-Look-for-UK-Bioscience.pdf

and impact of these publicly supported companies, shedding light on their contributions to the UK bioeconomy in terms of gross value added (GVA), employment, and innovation capacity; and second, to model the potential economic uplift that could be realised if a larger proportion of the UK's micro and small-sized Bio-based businesses were able to successfully scale their operations within the UK.

The research addresses several critical questions regarding market potential, barriers to adoption, and policy interventions that could accelerate the transition toward Bio-based products as alternatives to fossil derived products in key sectors of the UK economy, namely:

1. How do UK-focused Bio-based organisations differ from those with international operations?
2. What drives the international growth journeys of innovative UK Bio-based organisations?
3. What could the economic impact be if UK Bio-based SMEs received more effective support to scale?

This work aligns with the UK's broader commitments to reduce carbon emissions and transition toward a more circular economy, as outlined in the government's Environmental Improvement Plan (England and Northern Ireland), the Climate Change Plan (Scotland) and associated legislative commitments.

2.2 Research Timeline and Methodology

The research plan for identifying and analysing Bio-based companies followed a structured six-week approach, beginning in January 2025 and concluding in March 2025 (Table 1).

Table 1 – Overview of Research Activity

Date (w/c)	Task	Details
06/01/2025	Conduct preliminary search	Initial scoping of the Bio-based sector landscape in the UK.
13/01/2025	Agree search parameters	Establish criteria for company identification, including UK registration status; Receipt of public funding; Relevant sector classification.
27/01/2025	Conduct main search	Conduct comprehensive search based on agreed parameters.
10/02/2025	Test initial search results	Validate findings and refine search criteria as necessary.
24/02/2025	Enrich company data	Enhance dataset with additional information: International presence identification; Company information from Companies House; Annual reports and financial statements; Investor information and funding rounds.
10/03/2025	Analyse & Report	Produce final analysis focusing on: Total number of identified companies; International expansion; Economic growth metrics (revenue, employment); Assessment of potential lost UK economic growth.

2.3 Methodological Considerations

The Bio-based sector presents unique classification challenges as it often spans multiple traditional Standard Industrial Classification (SIC) codes and includes emerging technologies not currently captured by the codes. This means that a hybrid approach to company identification can provide a better understanding of economic activity, incorporating both SIC codes and keyword-based searches of company activities.

2.3.1 Data Collection

The research plan for identifying Bio-based scale-up companies started with compiling an extensive longlist of potentially in-scope companies. This initial database comprised approximately 2,800 Bio-based companies operating within the UK, gathered from nine sources as follows:

- Beauhurst
- Gateway to Research
- Innovate UK
- Biobased Britain
- Industrial Biotechnology Innovation Centre (IBioIC)[10]
- Bio-based and Biodegradable Industries Association (BBIA)[11]
- Bureau van Dijk
- Department for Science Innovation and Technology (DSIT)
- Centre for Process Innovation (CPI) [12]

Refinement Criteria

From the initial pool of 2,800 companies, a rigorous filtering process was applied to identify the most relevant organisations deemed to be within the scope of the analysis. This refinement process yielded ~430 companies that met all of the following criteria:

Public Funding Requirement: Companies must have received funding from UK public sources, demonstrating governmental recognition of their potential contribution to the bioeconomy.

Information Availability: Selected companies needed to have readily accessible and comprehensive information through official data sources and active websites, ensuring the research could draw upon reliable and current information.

Relevant Activity Focus: Companies were required to operate within specified sectors of interest, including:

- Agricultural biotechnology.
- Industrial biotechnology.
- Bio-based research and development.
- Other related bioeconomy activity (e.g., liquid biofuels and bioenergy).

2.3.3 In-Scope Industry Segments

In-scope companies were classified into ‘best-fit’ industry segments using industry-leading large language models. Illustrative examples of companies within defined industry segments are provided in Appendix, Table A1.

[10] https://www.ibioic.com/
[11] https://bbia.org.uk/
[12] https://www.uk-cpi.com/

3 International Activity in the UK Bio-based Sector

Among the dataset produced to inform this study, approximately 24% of all companies maintain operations beyond the UK (n=104). The distribution of international operations reveals strategic prioritisation of key markets, including:

- **United States:** 41% (43 companies) have established a presence in the US market, making it the most popular international destination.
- **China:** 18% (19 companies) have operations in China, recognising the importance of engaging with the world's second-largest economy and its rapidly expanding Bio-based market.
- **European Presence:** Germany (12%), France (10%), Netherlands, Italy and Spain (each 4-7%) represent significant European destinations, highlighting the continued importance of the European market.
- **Emerging Markets:** India (10%) and Brazil (7%) feature prominently, indicating UK companies' engagement with high-growth emerging economies with substantial potential for biochemical applications.
- **Commonwealth Nations:** Canada (7%) and Australia (8%) show meaningful connections, potentially leveraging historical ties and similar regulatory frameworks.

Thirty percent of these companies are internationally owned (n=31). The United States, Germany, the Netherlands, Switzerland and Denmark are among the most common ownership locations (55% of internationally owned companies in total, n= 5, 4, 3, 3, 2 respectively).

3.1 Scale-up Activities of SMEs Internationally

Approximately 40 companies (38% of those with an international presence) demonstrate particularly relevant international operations, since a) they are SMEs and b) that they have received media coverage specifically highlighting international scale-up activity[13].

3.1.1 Identifying UK-centred and internationally oriented comparator companies

To understand differences between UK-centred companies and those with international activity the study team matched companies based on business age (a maximum threshold of 5 years difference in age) and similarity of descriptive information (companies were matched based on similar operational characteristics and business descriptions).

The matching process identified 97 companies with international activity that could be usefully compared with UK-focused counterparts (i.e., of those of similar age, size and activity without evidence of international activity) that had similar characteristics.

3.1.2 Key differentiating characteristics

The analysis showed several differences between internationally active companies and their domestic-focused counterparts:

- A notably higher proportion of medium and large enterprises with international activity.
- The median employment figure for companies with international activity (18 employees) was double that of UK-focused companies (8 employees).
- Internationally focused companies demonstrated substantially higher revenue generation, with median revenue 1.8 times higher than UK-focused businesses (£3.1 million versus £1.7 million).

[13] Media coverage was identified using a series of scripts to collate news regarding international activity, parse and analyse text using an industry leading large language model.

To allow for more targeted insights, subsequent analysis excluded large companies and focussed specifically on micro, small and medium-sized Bio-based businesses that are headquartered in the UK.

3.1.3 Results: All Bio-based Businesses

The analysis shows notable differences in employment patterns between Bio-based Small and Medium Enterprises (SMEs) with international activity compared to those focused primarily on the UK market (figure 1).

- Compared to UK-focused comparators of similar age, Bio-based SMEs with international activity are generally larger and demonstrate stronger growth trajectories[14].
- The employment differences between internationally active and UK-focused Bio-based SMEs vary considerably by company size:
  - Internationally active medium-sized Bio-based companies employ 2.4 times more people than their UK-focused counterparts (based on latest available data).
  - These internationally active firms have added considerably more employees since 2019, suggesting stronger growth momentum.

This trend aligns with broader patterns in the UK manufacturing sector, where export-oriented medium-sized enterprises typically maintain larger workforces to manage international operations[15].

Figure 1 – Employment & Employment Growth (UK vs Intl. SMEs). ***Source: Bureau van Dijk, Perspective Economics***

[14] It is not possible from the data to robustly determine the causal nature of international activity i.e., whether scale enables international activity or vice versa.

[15] https://www.mta.org.uk/wp-content/uploads/2024/04/Manufacturing-Technologies-Association-The-true-impact-of-British-Manufacturing.pdf

3.1.4 Results: Micro and Small Businesses

Contrary to the pattern seen in medium-sized firms, UK-focused micro and small Bio-based businesses employ more people overall than their internationally active counterparts.

These UK-focused smaller enterprises have also added more people to their workforces since 2019. This suggests that the UK is good at creating and growing Bio-based businesses to a certain scale.

This divergence in employment patterns between different sizes of Bio-based enterprises highlights the complex relationship between market focus and growth potential at different stages of business development.

3.2 Growth Journeys of UK-Headquartered International Bio-based Companies

The United Kingdom has established itself as a significant hub for innovative Bio-based companies, with many firms following diverse growth trajectories that frequently involve substantial international capital investment. The following case studies illustrate typical development patterns of successful UK Bio-based businesses, highlighting the importance of international investment, strategic partnerships, and technological innovation (Table 2).

Table 2 – Diverse Growth Journeys (Illustrative Companies)

Biocatalysts (BRAIN Biotech)	• **Specialty Enzymes || 1980s:** founded in Wales **> 2018:** German firm BRAIN AG took shareholding > 2023: Built new facility in Cardiff **> 2023:** BRAIN AG takes full ownership **> 2023:** BRAIN AG transfers 3x enzyme businesses to Biocatalysts Ltd. This case demonstrates how UK biotechnology expertise can attract international strategic investment, with the company maintaining its UK operational base while benefiting from integration into a larger European biotechnology group.
Ensus	• **Biofuel || 2006:** founded in the UK (Wilton, Teesside) **> 2010:** Opened one of Europe's largest bioethanol plants **> 2011 - 2013:** Forced to temporarily shut down several times due to poor market conditions **> 2013: Acquired by German firm CropEnergies AG (Sudzuker Group) > 2021:** Involved in E10 petrol advocacy **> 2025:** Remains part of CropEnergies / Sudzuker. The Ensus case demonstrates how volatile commodity markets can challenge even well-established bioeconomy companies, and the potential impact of differences in government policy.
Colorifx	• **Textile Dyes || 2016:** first entirely biological process to produce, deposit and fix pigments onto textiles, spun-out of the University of Cambridge **> 2018:** Secured £3m seed funding (Textile Innovation Fund, Cambridge Enterprise) **> 2019:** Secured **Series A funding led by H&M Co:Lab > 2022:** £18m Series B funding led by H&M **> 2023:** Manufacturing presence in Portugal. Colorifix exemplifies how university-based intellectual property can successfully transition to commercial application through strategic funding partnerships, particularly with industry-specific investment partners like H&M that offer both capital and market access.

3.2.1 Understanding Drivers of International Growth

These diverse growth journeys highlight the importance of international capital, strategic corporate partnerships, and government support in scaling UK Bio-based businesses to become globally significant.

Consultation with industry representatives emphasised the extent to which these and related issues inhibit domestic scale-up ambitions. The sector faces several challenges, including scaling production processes from laboratory to commercial levels, securing consistent biomass feedstock supplies, and competing on price with established petroleum-based alternatives.

However, strengthening regulatory frameworks around carbon emissions and growing consumer demand for sustainable products present significant opportunities for growth[16]. For example, the expansion of the UK Emissions Trading Scheme (ETS) to include Energy from Waste facility emissions offers a notable opportunity to encourage the use of Bio-based materials for those materials that must be incinerated (e.g. hospital contaminated waste), through lower carbon costs. Further, there is an opportunity (currently unrealised) to treat Bio-based materials differently under the Plastic Packaging Tax (PPT), at least commensurate with packaging that contains 30% recycled content.

One of the challenges most cited by attendees at a recent BB-REG-NET workshop (further detail in subsequent sections), was the availability and cost of infrastructure to enable manufacturing scale-up activity beyond pilot scale. Within the study dataset seven companies were identified as having moved abroad specifically to address this challenge (Table 3).

Table 3 – International Access to Scale-Up Infrastructure

Cashew Shell Biorefinery (CSBR)	• **Cashew Shell Biorefinery (CSBR) || 2023:** incorporated in Scotland, CSBR secured £44k from Innovate UK to transform the production of important aromatic chemicals that are currently predominantly made from petrol to production from cashew nutshell liquid (CNSL) using a license for research produced by the University of St Andrews. **> 2024:** Received a grant from the EU's Just Transition Fund (JTF)[17] and established operations at the Brightlands Chemelot Campus in Sittard-Galeen, Netherlands. Brightlands provides access to a multi-purpose pilot plant designed to bridge the gap between laboratory research and full-scale commercial production - a 'flexible, scalable environment' for testing, optimising and scaling sustainable chemistry, biotechnology and circular materials technologies. **> 2025:** CSBR expects to produce 1 tonne per year by 2026 and up to 5,000 tonnes per year by 2028.
Deep Branch Technology (Aerbio)	• **Deep Branch Technology (Acquired by Aerbio) || 2018:** incorporated in Nottingham with the aim of developing sustainable protein sources by converting carbon dioxide into single cell protein using gas fermentation technology. Strong ties to the University of Nottingham's Synthetic Biology Research Centre[18] and a graduate of the BioCity Accelerator Programme **> 2019:** Founders Peter Rowe and Rob Mansfield recognised for their innovative work in biotechnology[19]. **> 2021:** Secured $8 million in Series A funding from investors including Novo Holdings, DSM Venturing, Total Carbon Neutrality Ventures, and Barclays Sustainable Impact Capital. **> 2022:** Received £4.8 million from the UK government's Net Zero Innovation Portfolio to fund the "Deep Blue C" project, focusing on integrating carbon capture and low-carbon hydrogen ecosystems. **> 2022:** Commissioned a mobile pilot unit (MPU) in the Port of Rotterdam (due to existing CO2 infrastructure and collaborations with Linde and Duijvestein Tomaten) to validate and de-risk its gas fermentation technology in a real-world industrial setting. **> 2024:** Deep Branch was acquired via management buyout and rebranded to Aerbio[20] and continues to scale production in the Netherlands while retaining R&D activity in Nottingham.
Lixea	• **Lixea || 2017:** incorporated in London as a spin-out from Imperial College London to exploit research that created the company's core 'Dendronic' process that uses ionic liquids to fractionate biomass into its constituent components – cellulose, hemicellulose, and lignin. Lixea focusses on developing innovative processes for converting lignocellulosic biomass into valuable chemical products. **> 2021/22:** Established pilot plant in Kristinehamn, Sweden with feedstock scale of 20kg/batch **> 2025:** Lixea is preparing to build a 25,000 tonne/ year demonstrator plant in Sweden. When completed it is expected to be the largest ionic liquid extraction process

[16] https://www.gov.uk/government/publications/bioeconomy-strategy-2018-to-2030/growing-the-bioeconomy-a-national-bioeconomy-strategy-to-2030
[17] https://ec.europa.eu/regional_policy/funding/just-transition-fund_en
[18] https://sbrc-nottingham.ac.uk/about/about.aspx
[19] https://www.forbes.com/profile/deep-branch-biotechnology
[20] https://www.aquafeed.com/products/suppliers-news/new-company-emerges-from-deep-branch-buyout/

	anywhere in the world. The company is currently finalising the details of a grant agreement with the European Commission to access funding via the €40bn Innovation Fund[21] and has also been awarded the STEP Seal in recognition of its contribution to the objectives of the "Strategic Technologies for Europe Platform"[22].
NaturBeads	• **Naturbeads || 2018:** incorporated in Malmesbury to commercialise research produced at the University of Bath by Dr. Giovanna Laudisio (CEO) and Professor Davide Mattia (CTO). **> 2019 – 2021:** Received multiple Innovate UK grants totaling approximately £1.4m to build two pilot plants and expand application areas from personal care and cosmetics to paints and coatings. Secured numerous accolades including as a finalist in the Royal Society of Chemistry's Emerging Technology Competition. **> 2022 – 2023:** Secured additional contracts, including a £200K agreement with the UK government for research into biocatalysis applications. Participated in the Eureka Project, receiving £250K to advance technology readiness levels. Expanded collaborations with global manufacturers to integrate cellulose microspheres into various industrial applications. **> 2024:** closed a £7.8 million Series A funding round led by Eos Advisory, with participation from MITO Technology, CDP Venture Capital SGR, PI-NB, and Paragon Capital Management Singapore. **> 2025:** Expects to complete construction of first commercial production plant in Puglia, Italy.
Revive	• **Revive Eco || 2015:** incorporated in Scotland based on research from the University of Strathclyde that uses coffee grounds to produce eco-friendly soil enhancers. **> 2018:** discovered that coffee grounds contain valuable oils suitable for applications in cosmetics, food, and pharmaceuticals. **> 2019:** attended Entrepreneur Accelerator and secures approximately £450,000 in grants and investment funding to develop a sustainable extraction process for coffee oil. **> 2020:** partnered with an industrial facility in France to scale up the extraction of coffee oil, marking a significant step in commercialisation. **> 2021 – 2024:** secured several additional sources of funding including multiple investments by the Scottish Co-Investment Fund. **> 2024:** secured significant contract with French firm SAS Pivert to industrialise process, using surplus coffee grounds from Costa Coffee to produce coffee oil for various industries.
CelluComp	• **CelluComp || 2004:** incorporated in Scotland based on research conducted at the University of Reading. **> 2006:** established headquarters in Burntisland. > 2011: Appointed Christian Kemp-Griffin joined as CEO to bring in new investments and strengthen management capabilities. **> 2013:** commenced commercial production of Curran®, a micro-fibrillated cellulose material, targeting the paint and coatings industry. **> 2015:** developed new production factility in Glenrothes, Scotland, increasing Curran® production capacity to 400 tonnes/year, with plans to scale up to 2,000 tonnes/year. **> 2016:** secured $5.26 million in Series A funding, led by Sofinnova Partners and the Scottish Investment Bank, contributing to a total funding of $9.14 million. > 2018: diversified applications of Curran® for fibre-based barrier packaging. **> 2020:** developed a proprietary pulp named Nest and a barrier coating called Reef, enhancing their packaging solutions. **> 2023:** partnered with US firm RyPax to create the industry's first all-fibre bottle solution, targeting sustainable packaging alternatives. **> 2024:** established CelluComp Public Benefit Corporation in Minnesota, USA, laying the groundwork for a new full-scale production facility. > 2025: commenced production of Curran® at 15,000-square-foot facility in Renville, Minnesota, using up to 7,000 tonnes of sugar beet pulp, with plans to scale up to 24,000 tonnes.
Aqdot	• **Aqdot || 2002:** incorporated in Cambridge as a spin-out from the University of Cambridge by Dr. Roger Coulston, Dr. Jing Zhang, Dr. Chris Abell, and Dr. Oren Scherman. **> 2013:** won the Royal Society of Chemistry's Emerging Technologies Competition, gaining access to industry leaders such as GSK, Croda, and P&G. **> 2013**

[21] https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund_en
[22] https://strategic-technologies.europa.eu/index_en

	– 2016: doubled employee count and secured nearly £9m in equity investment. Expanded its laboratory facilities and engaged in multiple collaborative projects. **> 2016 – 2021:** raised approximately $38.8 million through a combination of venture capital and grants, including a later-stage VC round in November 2021 which secured $18.1 million. **> 2024:** entered a strategic partnership with Swiss firm Clariant to commercialise patented odour elimination technology, AqFresh™, targeting the laundry and automatic dishwashing markets. Expanded manufacturing capabilities by partnering with Spanish specialty chemicals company Menadiona. A modular production system was installed at Menadiona's facility in Palafolls, Barcelona, to produce AqFresh™, increasing manufacturing capacity from 30 tonnes to 500 tonnes annually to meet growing demand across Europe.

3.3 Employment and Employment Growth in Manufacturing

UK Bio-based manufacturers are particularly active in developing:

- Bio-based plastics and biodegradable packaging materials.
- Bio-based construction materials and insulation.
- Speciality chemicals for pharmaceutical and personal care applications.
- Bio-based lubricants and industrial fluids.
- Advanced materials derived from agricultural by-products.

The employment landscape within the UK's Bio-based manufacturing sector reveals interesting patterns when comparing businesses of different sizes and market orientations. For example, the difference in total employment among UK vs internationally oriented Bio-based manufacturing companies is less pronounced than differences in total employment across the wider dataset – likely reflecting the place-based nature of manufacturing[23].

Manufacturing companies primarily focused on the UK market appear to be experiencing growth challenges (Figure 2). The data indicates an overall negative employment growth trend among these UK-focused manufacturing businesses. This contrasts with manufacturing firms that have more diversified market exposure or stronger international presence.

3.3.1 Results: Focus Companies

The analysis of employment and employment growth trends among focus companies shows consistent patterns when examining businesses with documented evidence of relevant growth trajectories. This section explores these patterns in detail, with particular emphasis on the differential growth rates across various business size categories.

Micro and Small Sized Businesses

Since 2019, micro and small businesses in the Bio-based sector—whether UK-focused or internationally oriented—have shown strikingly similar trends in total employment and growth rates. In contrast, medium-sized companies with international operations have experienced employment growth nearly seven times higher than their UK-focused peers. This stark difference underscores the substantial employment advantage linked to international expansion. Notable examples include:

- Colorfix - Known for their sustainable dyeing technology that reduces the environmental impact of textile colouration, established manufacturing operations in Portugal following a deal with major textile manufacturer Impetus Group, resulting in the addition of approximately 70 personnel to their workforce.

[23] It should be noted that sample sizes for some segments are small.

- SHD Composite Materials - Expanded manufacturing capacity in Slovenia, creating approximately 20 new positions. SHD specialises in the development and manufacture of advanced composite materials for various industries including aerospace, automotive, and renewable energy sectors.

3.3.2 Implications for Sector Development

The pronounced difference in employment growth rates between internationally focused and UK-focused medium-sized companies suggests several important considerations for the biochemicals and materials sector:

1. International expansion appears to be a critical pathway for substantial employment growth within the sector.
2. Companies focused primarily on the UK market may face inherent limitations on their growth potential due to a combination of factors including the availability of scale-up facilities and incentives, availability of later-stage investment, and the limited scale of the UK market.
3. Scale-up support should include access to a wider range of scale-up facilities (and the resources required to use them) and should be offered together with support for international expansion.

Figure 2 – UK Bio-based Manufacturing Growth Challenges. ***Source: Bureau van Dijk, Perspective Economics***

3.4 Employment and Growth in the UK Bio-based Sector

This section illustrates growth trajectories of several focus companies in the UK Bio-based sector, highlighting key milestones in their development (Table 4).

Table 4 - Growth trajectories of some companies in the UK Bio-based sector

Celtic Renewables	**Celtic Renewables,** founded in Scotland in 2012, has pioneered innovative processes for creating biofuels from whisky by-products. In 2014, they established a strategic partnership with Bio Base Europe Pilot Plant in Ghent, Belgium, to scale up fermentation processes. This collaboration allowed them to refine their production methods for converting whisky distillation by-products into valuable chemicals[24]. By 2021, the company had secured patents across multiple international jurisdictions including Europe, China, Japan, Canada, Australia, and India, with US patents pending. A significant milestone was reached in 2024 with the dispatch of their first commercial tanker of acetone and butanol, marking their transition from research and development to commercial production.
Straw Innovations	**Straw Innovations** was founded in the Philippines in 2016, building on collaborative research with Aston University in the UK. Their work addresses the significant methane emissions associated with rice cultivation, which account for approximately 1.5% of total global greenhouse gas emissions. In 2019, the company established a pilot facility in Laguna province, Philippines, to test and implement its emissions reduction technology. By 2022, they had launched the Rice Straw Biogas Hub project with the aim of scaling their technology to commercial viability. Most recently, in 2024, Straw Innovations initiated a collaboration with Indian enterprise Takachar to explore wider bioproduct potential from agricultural waste streams.
Maginal Mushroom Company	Founded in 2019, the Magical Mushroom Company specialises in utilising mycelium to create sustainable packaging alternatives. Their innovative approach offers biodegradable alternatives to conventional packaging materials derived from fossil fuels. The company secured €3.4 million in seed funding from US-based Ecoactive Design in 2022, providing capital for expansion. This was followed in 2023 by the opening of a 15,000 square foot manufacturing facility in Bulgaria, significantly increasing their production capacity. By 2024, the company had established a network of five manufacturing facilities across the UK and Europe, while maintaining their research and development operations in Nottingham.

3.4.1 Future Growth Potential

Based on the analysis presented in this report, successfully scaling a micro or small sized UK company that only has UK operations to become a medium sized business with international operations business could add on average up to 132 additional employees to the size of the UK entity. Assuming that:

- Estimates regarding the number of UK centred micro and small sized Bio-based manufacturing companies identified in the analysis are reasonable (n=78);
- 42% of those businesses survive for long enough to grow (i.e. 5 years, see: ONS business demography tables for assumed survival rate); and
- Just 2% of those companies will scale in the absence of intervention[25]

Then it is possible to estimate that, with effective support to scale up and expand internationally, these businesses could add up to 4,230 additional jobs, contributing between £300m and £0.5bn in additional GVA to the UK economy.

[24] https://renewable-carbon.eu/news/nnfcc-assists-celtic-renewables-partnership-bio-base-europe-pilot-plant/
[25] https://www.wbs.ac.uk/news/business-growth-faltering-as-just-2-of-uk-start-ups-reach-1m-turnover-since-2020/

4 Actions to Support Scale-Up Activity

Emerging findings were presented at the first BB-REG-NET in-person stakeholder engagement event in early March 2025. Two workshops involving ~30 stakeholders verified emerging findings and offered the following suggestions for addressing barriers to growth:

Making UK manufacturing a priority: As artificial intelligence and machine learning account for increasing amounts of 'value' within the UK's predominant services sector, the comparative value of UK manufacturing activity is likely to increase (i.e., manufacturing will be an increasingly important source of productive economic activity). Workshop participants called first and foremost for greater clarity regarding the government's view on UK manufacturing within a more detailed industrial strategy.

Increasing availability of patient capital: Channelling greater investment into capital-intensive sectors has long been a strategic goal of the UK government, with growing recognition that long-term or 'patient' capital is essential to help these businesses navigate the so-called 'valley of death'. Feedback from the BB-REG-NET industry workshops confirms a persistent and unmet need for such capital among UK Bio-based manufacturers. However, data from past initiatives—such as Future Fund Breakthrough—reveals that funding remains skewed toward less capital-intensive ventures offering quicker returns. For instance, manufacturing accounted for under 10% of total Future Fund investment, while over 50% went to IT, communications, finance, and insurance (Figure 3). Recent policy developments offer hope. The proposed UK National Wealth Fund aims to drive investment into strategic sectors like advanced manufacturing and clean tech, potentially unlocking the patient capital needed for engineering biology and other deep tech industries. Complementing this, the government's £100 million commitment to engineering biology, announced in 2023 under its Science and Technology Framework, signals a growing acknowledgment of the sector's strategic importance and capital demands. Workshop participants also called for clearer investor accountability—such as standardized pitch requirements and faster decision timelines—to make fundraising more transparent and effective for start-ups. Additionally, the introduction of 'scale-up tax credits', modelled on R&D tax incentives, was proposed as a means to stimulate fixed capital investment.

Maximise productivity of existing scale-up infrastructure and resources: Workshop participants expressed appreciation for existing government-backed scale-up support—such as that provided by the Centre for Process Innovation (CPI) and university-based facilities. However, they also highlighted several challenges Bio-based businesses face in accessing and fully leveraging this infrastructure. Key barriers included high costs, limited accessibility, administrative burdens, and constraints on scaling volumes. A particular gap was noted in scale-up capabilities beyond 750 litres—the critical stage between lab-scale and commercial production—as well as in key skill areas, notably process science. Industrial contract research with universities was also flagged as prohibitively expensive and often misaligned with commercial incentives, focusing primarily on fundamental research. To address these issues, participants called for:

- A comprehensive and accessible 'UK facilities audit' to improve awareness of available infrastructure.
- A more integrated and competitive scale-up support offer that fills current gaps.
- Stronger incentives for universities to support industrial scale-up; and
- Targeted development of scale-up-relevant skills (see next bullet).

Closing gaps in scale-up expertise: several Bio-based manufacturing start-ups involved in the BB-REG-NET workshops highlighted a need for people with a combination of scientific and engineering knowledge to support scale-up activity. Coined 'Scale-Up Scientists' this new pool of talent should have sufficient knowledge of the fundamental science involved in the manufacturing processes, while also knowing how to operate the machinery required in production. This requirement for people with relevant experience and expertise extended to government, where participants are keen to see more Bio-based experts in roles that can have a

tangible impact on commercial success. The UK's recent Carbon Capture Utilisation and Storage strand of the BEIS/DESNZ-funded Net Zero Innovation Portfolio (NZIP) was offered as a useful example of the effective use of industry experts within government.

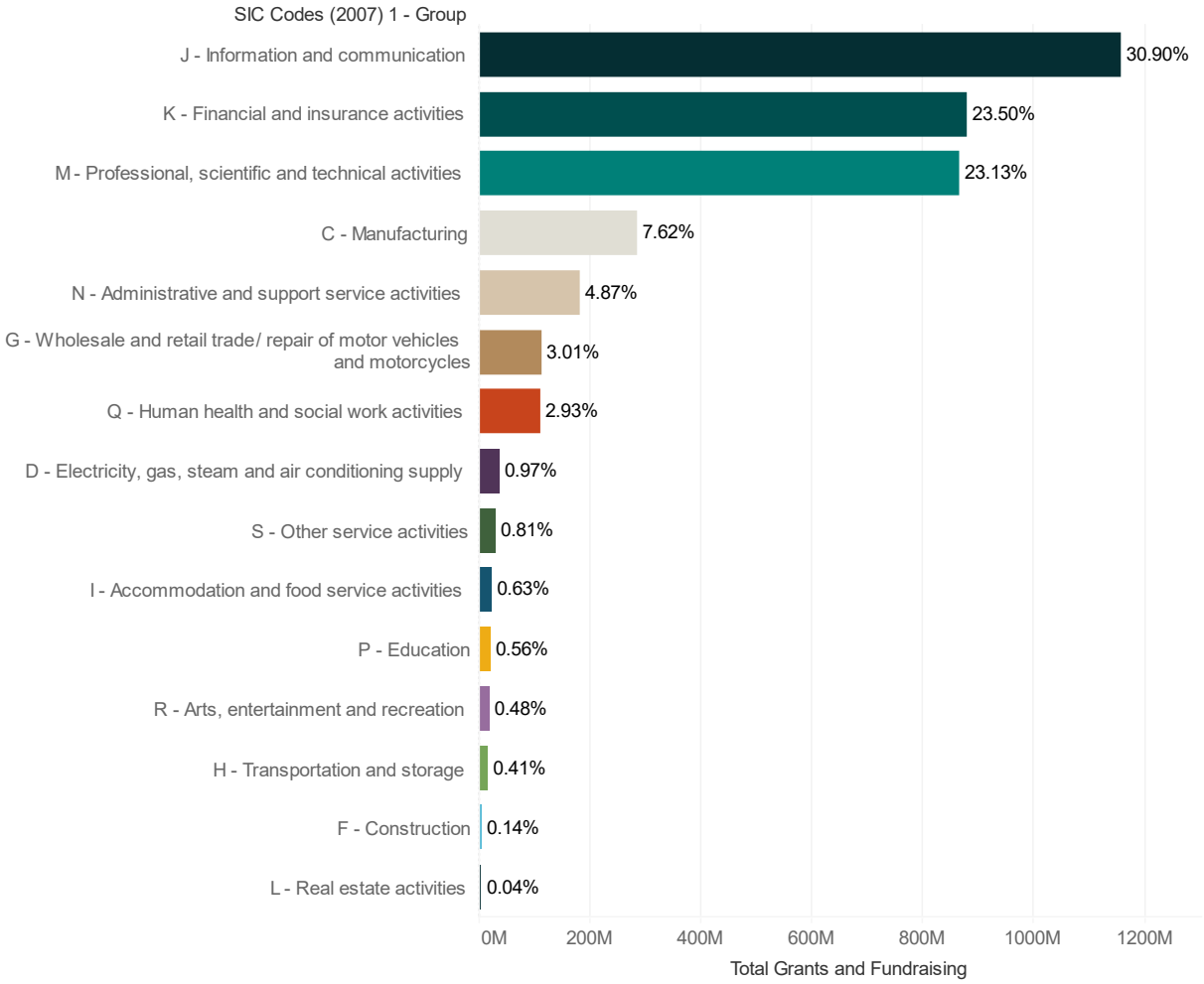

Figure 3 – Future Fund Investment by SIC Code. ***Source: British Business Bank, Beauhurst, Perspective Economics***

5 Summary and Conclusions

This report, funded by BB-REG-NET, presents an urgent call to action for unlocking the economic and environmental potential of the UK's Bio-based sector. It provides a comprehensive analysis of over 430 UK-based companies—filtered from an initial pool of 2,800—that have received public funding and are engaged in Bio-based innovation.

5.1 Key Findings

- **Critical Growth Barriers:** Many UK micro and small-sized Bio-based businesses face systemic obstacles to scaling—primarily due to limited manufacturing infrastructure, lack of patient capital, and restrictive regulatory environments.
- **International Advantage:** Only 24% of Bio-based organisations in the UK operate internationally, yet these companies are significantly more productive, employing more staff and generating nearly twice the revenue of their UK-focused counterparts.
- **Missed Economic Potential:** With effective support, scaling UK Bio-based SMEs could create up to 4,230 jobs and contribute between £300 million and £500 million in additional GVA.
- **Relocation Risk:** Several high-potential UK firms have moved operations abroad (e.g., to the Netherlands, Sweden, Portugal) in search of better scale-up environments—posing a major risk to retaining UK innovation and economic value.

5.2 Growth Dynamics

- Medium-sized internationally active firms have seen employment growth 7 times higher than similar UK-focused companies since 2019.
- Smaller UK-focused firms tend to outperform internationally active peers in early-stage job creation but hit a ceiling without adequate scale-up support.

5.3 Key Recommendations

6. **Audit and enhance existing infrastructure access**, plugging gaps in the UK scale-up ecosystem.
7. **Introduce targeted patient capital**, via the National Wealth Fund, and incentives such as **scale-up tax credits**.
8. **Streamline regulation** to reduce time-to-market for novel Bio-based technologies.
9. **Strengthen cross-sector collaboration** between government, academia, and industry.
10. **Address skills gaps**, especially by developing a new cadre of 'scale-up' scientists.

5.4 Conclusion

Without immediate policy and funding interventions, the UK risks becoming a global incubator that fails to retain its own Bio-based innovation. By acting now, the UK can position itself as a world leader in sustainable chemistry and advanced manufacturing, ensuring long-term economic and environmental returns in the race to net zero.

APPENDIX

Appendix Table A1 – In-Scope Industry Segments (Illustrative Companies)

Segment	Company	Brief Description
Agricultural Biotechnology	Azotic	Azotic was formed to introduce sustainable biofertilizer options around the world. With its headquarters in York, Azotic has become a global leader in N-fixing technology, with offices in the United States and Canada.
	Andermatt	Andermatt UK is a subsidiary of Andermatt Biocontrol AG, founded in 1988. The company specialises in biological plant protection, pest control, and sustainable agricultural solutions.
Bio-based chemicals	BASF	BASF creates chemistry for a sustainable future across multiple industries. It has significant operations in research and development, particularly in agricultural innovations and environmental technologies.
	Celtic Renewables	Pioneering a unique and circular solution that converts by-products and waste from a wide range of industries such as food, drink, and agriculture into green chemicals.
Alternatives to Plastics	Erthos Inc	Actively transforming Bio-based inputs into plant-powered alternatives for traditional plastics.
	AquaPak	Specialist polymer manufacturer and pioneers in the design and development of innovative planet-friendly materials.
Recycled Materials	Pangaia	A materials science company focussed on developing sustainable materials and alternatives to traditional textiles, including Bio-based leather alternatives, recycled materials, and plant-based fibres.
	Saica	Saica Group is a multinational company focused on sustainable solutions for paper and packaging manufacturing, as well as waste management and recovery.
Clean Energy	Green Energy UK	Green Energy UK provides renewable energy solutions, including "green gas" produced from sustainable sources such as anaerobic digestion of organic waste.
	Drax	Drax is an international renewable energy company focused on sustainable biomass, hydroelectric power generation and carbon capture technologies. The company operates one of the largest decarbonised power stations in Europe.
Biofuels	Ensus	Ensus produces sustainable ethanol from wheat, creating renewable fuel that can reduce greenhouse gas emissions compared to fossil fuels. Their biorefinery in Teesside is one of the largest in Europe.
	Green Fuels	Green Fuels specialises in biodiesel production technology, enabling the conversion of various feedstocks including used cooking oil into renewable diesel fuel.
Industrial Biotechnology	AerBio	AerBio develops greener protein production methods using biotechnology to create sustainable protein alternatives with lower environmental footprints than conventional sources.
	Holiferm	Holiferm accelerates the transition to a biosurfactant based economy by using renewable materials to manufacture non-toxic ingredients for industrial and consumer products.
	TorfTech	TorfTech develops industrial biotechnology solutions, creating technologies that enable more sustainable manufacturing processes across various sectors.