High Value Biorenewables

# USING BIOLOGICAL SYSTEMS TO DEVELOP HIGH VALUE PRODUCTS AND PROCESSES

## Policy makers' briefing note

Many industries essential to the UK economy are increasingly under domestic and international scrutiny from economic, societal and environmental perspectives. The result is a demand to replace fossil-based chemicals and processes with sustainable alternatives that simultaneously meet the needs of industry and its supply chains, support a growing population, and promote the net zero circular economy and protect the natural environment. The industries impacted include pharmaceuticals, agrochemicals, foods, home and personal care, cosmetics, and fine chemicals.

The UK is a global leader in the research and development underpinning the use of biological systems and bio-based feedstocks to produce high-value, low-volume products (>£10 per kg, and <1000 metric tonnes per year). Specifically, those made using industrial biotechnology (IB)[1] and referred to as 'high value biorenewables' are the focus on this briefing and the associated report. They range from small bio-derived molecules to large and complex biological molecules (e.g., polymers, proteins, and enzymes) and even cells. The process of making high value biorenewables using plants, algae, microbes and enzymes is summarised in Figure 1. Inputs required vary by the platform used: plants and algae use light, carbon dioxide, water, and nutrients, whereas microbes and enzymes convert biomass feedstocks (e.g., crops, forestry biomass, wastes and residues) or bio-derived compounds (e.g., sugar or polymers from biomass feedstocks) into desired products.

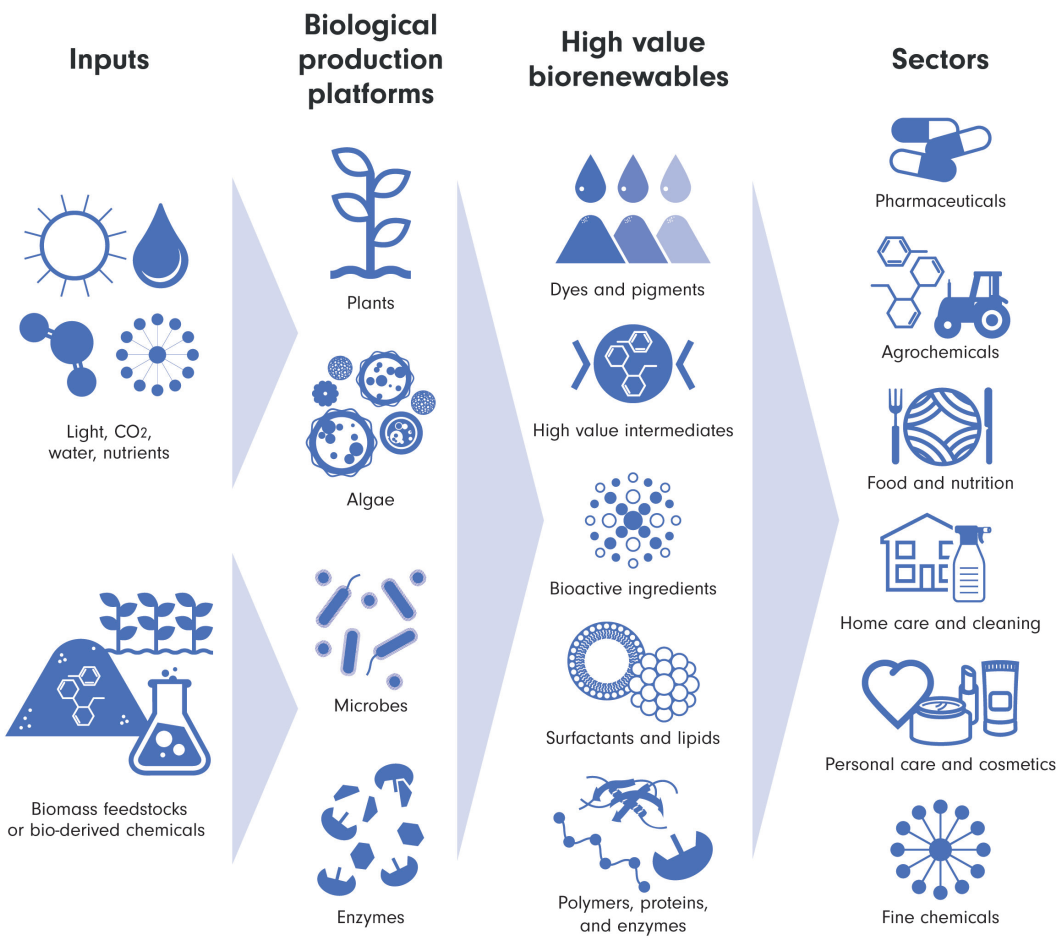


**Figure 1.** Production of high value biorenewables using biological systems

1. **Industrial biotechnology (IB)** uses biological systems to turn biological resources into products with industrial and/or societal value (e.g. chemicals, materials, or energy). Industrial biotechnology can employ naturally occurring biological systems or systems that have been engineered to improve performance in industrial conditions or make different products.

Each biological production platform has advantages and limitations, but there are common themes. For example, biological systems can use feedstocks and carry out chemical transformations that would be difficult, expensive, or impossible via synthetic chemistry routes, enabling complex chemical structures to be synthesised. There are also common technical challenges to be overcome, in addressing low yields, or extensive downstream processing to recover the desired product which could negatively affect economic and environmental performance.
However, whilst many high value biorenewables have been demonstrated at lab scale, fewer have been commercialised even when performance or sustainability benefits have been proven. Often there are technical challenges to be overcome which impact the feasibility and economic viability at scale. Successfully scaling up also means navigating issues such as accessing suitable pilot scale facilities, intellectual property, regulation, and competition with existing products whose true environmental costs are not perceived by the end-user.

## Opportunities and challenges

The main opportunities and challenges identified and discussed in the report are depicted in Figure 2.

| OPPORTUNITIES | CHALLENGES |
|---|---|
| Reducing GHG emissions and supporting net zero | Cost of development and deployment versus status quo |
| Waste valorisation and circular economy | Feedstock availability |
| Sustainable farming and benefits to rural economy | Sustainability: economic, social, environmental |
| Reducing pollution and chemical exposure | Regulation and standards |
| Novel products for societal benefits | Scale up and commercial deployment |
| Global leadership in science and technology | Workforce skills along technology pipeline and supporting industries |
| Green growth | Public profile and concerns over new technology |

**Figure 2.** Opportunities and challenges in developing and deploying high value biorenewables

Many of these extend to other applications of IB and the circular economy with common areas around regulation, skills training, and social justice, so that the benefits of engaging with IB are realised by all stakeholders. However, there is scope to redefine challenges as opportunities. For example, in cases of feedstock availability, judicious exploration of the location of biomass and regulations associated with waste categorisation, combined with ongoing strides over legislation of modified organisms and product regulations, could result in an opportunity to better utilise feedstock, develop platforms as in Figure 1, and bring all of the benefits on the left side of Figure 2. As this briefing focusses on high value biorenewables the economic return might be selective, but could be significant (e.g. diabetes treatment, chemotherapy, fragrances, and flavourings as described in the report).

## The role of government

The UK is well positioned to reap the potential environmental, economic, and societal benefits of high value biorenewables. Developing new products requires multidisciplinary research and innovation, which must include collaboration and engagement with industry, government, and society to support the creation of scalable and sustainable high value biorenewables that meet industry needs and fit social values. The role of government is particularly appropriate in supporting and funding research, development and deployment along the value chain from basic research to deployment at scale. This includes addressing skills needs and opportunities. An enabling and supportive policy and regulatory environment will be critical in ensuring success and in the UK maintaining its position as a global leader.

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This briefing was produced by the High Value Biorenewables Network. It summarises a longer report developed through review of scientific literature, engagement with members of the Network and a series of stakeholder workshops with cross-sector academic and industry experts.