Written evidence from the Centre for Process Innovation (CPI) (ENB0027)

CPI is a deep tech innovation organisation working with industry, academia, government, and investors to help develop, prove, scale-up and commercialise disruptive and market-creating innovations that enable a healthier and more sustainable future.

Recognised in the National Vision for Engineering Biology as the UK's flagship facility for scaling bioprocesses, CPI supports strain, cell line and bioprocess development, modelling and simulation, process engineering design and downstream processing. Our national centres of excellence include the Novel Foods Innovation Centre (in Wilton, Redcar), the Medicines Manufacturing Innovation Centre (in Glasgow), and the National Biologics Manufacturing Centre and RNA Centre of Excellence (in Darlington).

Summary

We welcome this opportunity to share evidence in support of five key points:

1. The UK has considerable strengths across the Engineering Biology (EB) value chain from academic biofoundries and development laboratories to Catapult scale-up centres. These capabilities are not always aligned with industry and societal needs, and often compete for the same funding. New funding models that provide academics with security of tenure in conjunction with mechanisms that actively foster collaboration between academia and Catapults in support of industry would help to unlock opportunities.
2. Working capital funding routes through UKRI have evolved considerably. This journey could be turbo charged over the next decade to deliver real impact through the adoption of mechanisms such as DoD/DARPA technology contracts or of the public/private investment model recently piloted by Innovate UK in the agriculture sector.
3. A perceived lack of scale-up facilities is at odds with the message that existing UK facilities are under-utilised and have capacity. The fermentation volume is often the simplest mechanism to describe scale-up, but this is often misleading and overly simplistic. The UK should develop an asset roadmap and centres of excellence for development and scale-up that are funded to specialise in specific market segments, offering purpose-built capabilities and experts.
4. Conflicting priorities between government departments can sometimes result in legislation that has unintended consequences, including resource inefficiencies and missed opportunities for the UK to take a global leadership position. We ask that a cross-departmental body be

established, with responsibility for bringing together a system-wide approach to policy development across the full scope of industry from electricity generation to waste recycling and reuse.

5. Engineering Biology is an enabling technology and to maximise the impact it can have on society and the economy it should be used in conjunction with other technologies such as process chemistry to (re)build supply chains in the UK to meet, primarily, our domestic needs for energy, fuels, materials, and consumer goods. The journey to Net Zero is evolutionary over the next 25+ years and technology will move through various generations of development, which should be recognised and supported.

Q1. What are the UK's key strengths in the area of engineering biology?

The UK has world leading science excellence in some of the underpinning technologies and tools needed including genomics, systems biology, metabolic engineering in applications especially in life sciences of human health. The pharmaceutical sector, specifically, has seen significant investment and growth. The UK has a strong history in biotechnology for which it possesses significant infrastructure to support the scale up and commercialisation of EB-enabled products. The industrial chemical sector has lagged significantly as the public stimulus (grants) were largely spent in academia. Strong academic networks and capabilities across the breadth of the country which could be enhanced further by closer alignment and collaboration in how they think or construct technologies to meet industrial challenges or market needs.

It is important to note that EB is not in itself a silver bullet. To achieve the benefits of this technology, utilising the appropriate combination of tools (chemistry, engineering etc) will be key. EB's impact in the pharmaceuticals sector will continue to be significant. From a chemicals, fuels, and materials perspective it will be moderate. EB is one of several tools to enable the UK to achieve its Net Zero ambitions and must be used in conjunction with the existing process chemistry and mature technologies that will serve some of the ambitions.

Q2. What are the key applications for engineering biology?

Exciting areas of development (but not yet fully mature):

- Healthcare: EB is a critical tool in the prevention (e.g. vaccine development), diagnosis (e.g. biosensors) and treatment of disease (e.g. novel therapeutics, including new medicine modalities such as gene therapies).
- Food production: Biofertilisers/stimulants and pesticides (e.g. spider venom proteins expressed in microbes to protect crops which only work on specific pests) and the production of proteins which provide

alternative sources of meat, seafood, and dairy products, as well as oils and fats as alternatives to palm oil.

- Sustainable energy sector: EB is used for carbon (and other greenhouse gas) capture and conversion into e.g. biofuels, but challenges are high.
- In manufacturing, EB is being applied to efficiently convert low cost starting compounds and waste materials into high-value chemicals which avoid the use of toxic chemicals, prevent the formation of unwanted side-products, and reduce waste.

Areas where hype exceeds reality:

- Cultivated meat: The excitement around this technology is well deserved, however there are significant challenges to delivering commercial success, with perhaps the most substantial being that of scaling the process to produce cost-effective products. Other key barriers include regulatory and consumer acceptance.
- Gene therapy: In the pharma industry, gene therapy is a particularly exciting EB application, however the tremendous benefits on offer are at risk of stalling as treatment costs making them inaccessible to many patients. Innovation is needed to streamline the development. There are also challenges around regulation and intellectual property.
- Chemicals: EB is highly unlikely to replace high-volume low-cost chemicals. Ethanol production is an exception to this, however that technology is already established and largely dependent on feedstock price. EB will work best in combination with process chemistry to transition commodity feedstocks through production of intermediates to the specialty chemicals used by industries such as detergents, plastics, and materials.

EB adds value in sustainable processing:

- Ability to utilise waste materials as feedstocks, to create new chemicals and materials as well as lower energy-use processing and minimising side products and waste.
- Potential to make new materials with added functionality from foods to textiles.
- Remediation/removal of hazardous compounds from waste streams, recovery of precious metals and recycling of plastic waste.
- Any biotechnological approach must be considered in comparison to alternative physical and chemical recycling options.
- The specificity of bio-catalysed reactions enables the manufacture of a broad range of complex materials (including pharmaceuticals) by shorter and more efficient routes, opening the door to many more applications.

How does the UK compare with other countries: The UK investment climate is considerably more conservative than the US making it more difficult to build spinouts and micro companies into world leading organisations. EB requires significant patient capital investment, with returns on investment taking a decade or longer to realise. The US has initiated multiple programmes over the past decades to stimulate investment in EB including public procurement activities such as "Biopreferred" and significant grants from the Department of Defence and DARPA in new and novel biotechnologies. The Inflation Reduction Act has invested considerable capital and provided stimulus to the US market to advance elements of EB and the Executive Order for National Biotechnology and Biomanufacturing Initiative has set a clear vision and strategic goals.

Q3. How can Government policy support the development of engineering biology?

It is essential that a system-wide approach is taken to considering the policy and legislative landscape for EB, from sustainable energy production to carbon sequestration and carbon value, to the applications of EB for agrifood and chemical/material production, alongside the environmental impact of emissions and water usage. A cross-departmental initiative, including DESNZ, DSIT, DBT, DEFRA, MHCLG, GO-Science and HM Treasury, would maximise opportunities and minimise any 'unintended consequences' of individual policy actions that might adversely impact markets and technologies or drive undesired behaviours such as the diversion of biomass to energy production from farms for soil regeneration or from chemical/liquid fuel production.

National vision: The UK is seen as world leading in EB technology but risks losing ground to Europe and Asia. While the UK has considerable assets and expertise, the ability of the broader community to access these assets is limited due to the types of funding available. Mechanisms and funding across the spectrum of TRL's are needed to generate a pipeline of projects ready for commercialisation. For instance, several UK companies have previously accessed scale-up assets in Europe rather than those available in the UK due to the availability of €50k grants offering substantially subsidised access over what the UK could provide. Government policy can directly stimulate the commercialisation of EB by implementing mechanisms such as "Biopreferred" across public spending and leveraging defence R&D investment to develop novel EB solutions. Levelling the playing field across existing subsidy mechanisms for areas such as electricity production and fuel production would help to change behaviours that can often inhibit development of non-regulated markets.

Role of UKRI: Long-term sustainable funding is essential, to enable translation of academic research into processes that can be commercialised. Biofoundries have received a lot of funding and attention addressing many of the front-end issues of EB processes, however, they are only part of the solution and do not directly address the translation from research to application. Interaction between the research-base and organisations capable of translating inventions into practical processes is an area requiring improvement.

Programmes comparable to recent ATI/APC initiatives that pose specific challenges and provide funding to help technology pass through the TRL stages would be ideal, especially co-investment model with industry. The relationships between academia and the UK RTO network/Catapults could be stronger through the availability of more collaborative funding. In many IUK CRD projects today, the Catapults and academia can only share between 30-50% of the grant value. This makes it difficult for these organisations to collaborate. Deliberate co-funding to stimulate academic and Catapult collaboration across an industry challenge could be considered, e.g. 30% each rather than 30% between collaborators. The recent IUK initiative of co-investing with VCs is showing significant promise and turbocharging of these recent programmes could provide more impact sooner.

Engagement across all departments and all public bodies (e.g. MHRA for biopharmaceuticals, FSA for novel foods) is critical as new products and processes or entirely new value and supply chains are developed. A cross-department team to create the right framework to deliver a strategy for all manufacturing sectors and to develop legislation that supports technology development will be central to achieving success.

Key enabling technologies:

- Fundamental understanding of developing living ‘cell factories’. The ability to evolve or engineer cells and proteins with properties more suitable to application under industrial conditions.
- 3D Bioprinting can be used to generate functional tissues for regenerative medicine and has applications in other industries such as food (e.g. steaks), textiles (e.g. leather).
- Data storage and modelling through predictive algorithms to machine learning and AI supports EB developments with the organisms through to rapid screening, development, and optimisation of a process for scale-up and deployment.

Value from existing facilities: The UK has world leading EB development and scale-up facilities across the breadth of technology areas from pharmaceuticals to food. Whilst these facilities are open access and readily available, many micro and small companies seeking to access these resources can struggle due to their inability to raise the venture capital required from the UK market. The grant mechanisms available in the UK are highly competitive and do not always fund the necessary scopes of work. This has, at times, led to calls for more facilities, however these are unlikely to be less costly to access than existing facilities and would require significant additional capital investment.

A perennial issue with academic research funding is its short-term nature which does not fit well with developing and translating new technologies into commercial application, or the expertise required to operate facilities with fixed-term academic funding. Typical funding periods of 3-5 years means that post-doctoral researchers need to be looking for a follow-on career opportunity well before their current grant is completed, which disrupts focus and project progress. Better defined academic career paths could help to alleviate this problem.

Q4. How can the UK maximise the economic potential of developments in engineering biology?

Government support to start-ups/SMEs: Most academics and start-ups lack the necessary experience to take a biotechnological idea from the laboratory to commercial scale manufacture. A mechanism for mentorship of start-ups by experienced scientists with a track record of successful scale-up could help to bridge that gap. Government can best support EB start-ups by optimising financial support mechanisms to generate maximum value from existing scale up support services and infrastructure, and by funding the development of complementary facilities to address emerging market needs. Extending the successful collaboration of IUK with venture capital to co-invest and grant fund projects / businesses would help to eliminate the need for companies to rely entirely on grants to fund activities and inject commercial imperative with a VC investor. The government should work with industry and public sector funders to establish infrastructure where clear innovation gaps exist around translating EB-based technologies to the emerging commercial markets and where they will create economic and societal impact. Specific facilities could include a Microbiome Bioprocess Innovation Centre.

Large companies: Outside of the pharma industry, where EB is routinely used by incumbents, some major chemical companies (e.g. Croda, Unilever) have their own strategies for EB. The UK would benefit from establishing clear industrial supply chains that offer security of supply and, to some degree, sovereignty of supply, into which products made using EB can be introduced. The challenge of introducing a new product to market is being able to provide the scale and, without existing supply chains EB products will struggle to overcome Market Readiness factors. Creating supply chains in conjunction with well-established process chemistry offers EB the most significant probability of success.

Investors: A lack of scientific knowledge amongst many investors poses a risk that poor outcomes from unrealistic opportunities affect future decisions to invest in this area. Co-investment programmes such as those being established by IUK, coupled with independent technical experts (such as Catapults) undertaking due diligence, have the potential to derisk this kind of investment and build investor confidence. Government support through direct contracts (the DARPA model) or co-investment alongside the venture capital market would provide confidence and capital into the ecosystem.

07 May 2024