Call for Evidence: Engineering Biology

Introduction

Engineering biology is currently driving extraordinary progress across the bioeconomy. It is creating opportunities including replacing petrochemicals, transforming the agricultural sector, and revolutionising healthcare. It can contribute to a society that is healthier, wealthier, and more environmentally sustainable.

Engineering biology describes the application of rigorous engineering principles to biology, enabling the construction of new or redesigned biological systems, such as cells or proteins. The UK has strengths across the breadth of engineering biology, from foundational tools in DNA sequencing and synthesis through to applications poised to transform multiple industries (figure 1).

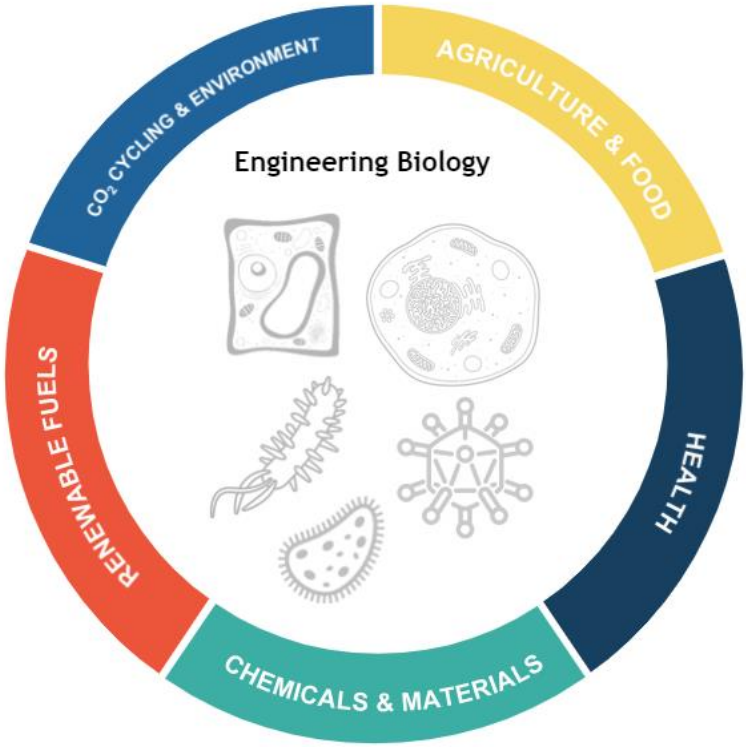

Figure 1: The impacts of engineering biology can be mapped across five sectors of the bioeconomy[1].

As set out in the Science and Technology Framework the UK has identified engineering biology as a critical technology that will underpin a range of transformative advances[2]. The Government has a vision to grow engineering biology as an industry of tomorrow where the UK can lead the world in regulations, standards, and ethical responsible innovation for the sector. This will be done by maintaining and improving the underlying technology, research and industrial components of the sector, with the aim of building a broad ecosystem able to develop and commercialise the many opportunities of engineering biology.

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[1] Figure from the Industrial Biotechnology Leadership Forum

[2] https://www.gov.uk/government/publications/uk-science-and-technology-framework

Current state of play

The UK is a leader in engineering biology thanks in part to early, forward-thinking investment by government over the last decade[3]. The UK is amongst the global leaders in engineering biology research, both in quantity, breadth of capabilities and quality, second only to the US in recorded grant research investment globally[4]. UK firms using engineering biology received over $3 billion in private equity finance in 2021[5] and the UK ranked 4th by number of modern industrial biotechnology companies, behind China, the US and Canada[6]. Engineering biology is a UK strength, with clusters spread across the country (figure 2).

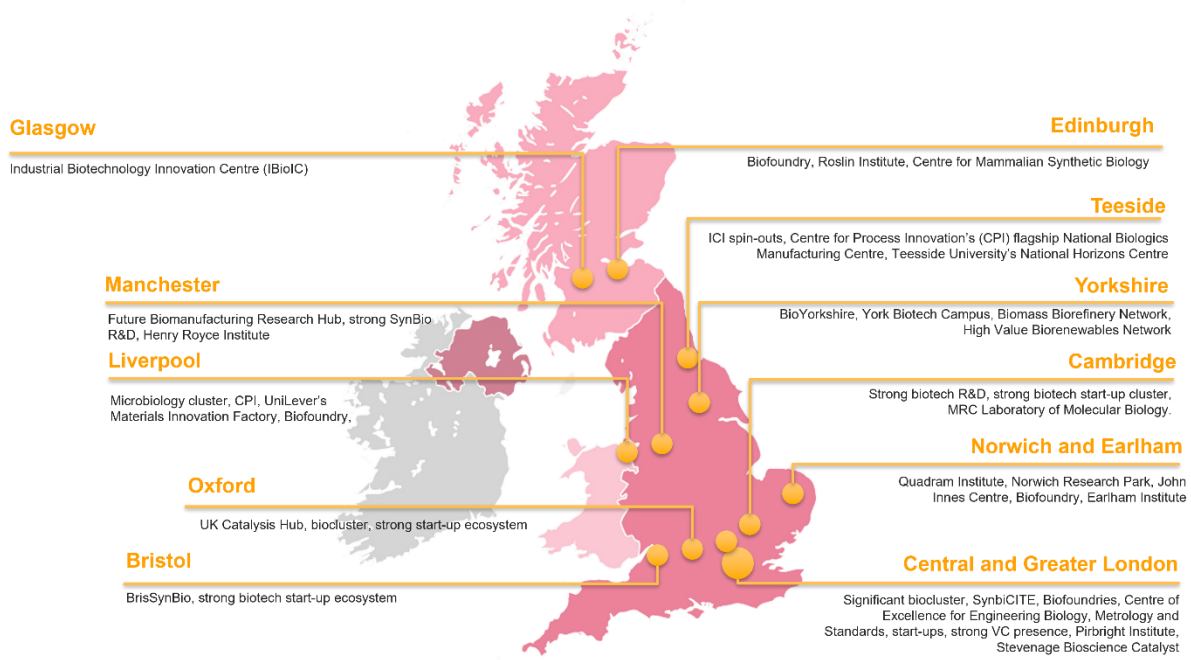

Figure 2: A selection of the UK's industrial biotechnology clusters and strengths[7].

To continue to grow the engineering biology sector in the UK, UKRI have launched the £73.6 million Engineering Biology Missions Hubs and Mission Awards[7]. This will create hubs for specific challenges engineering biology can tackle that will be funded for 60 months, and missions that will be funded for 24 months.

There is still much to do to cement the UK's position as an engineering biology world leader and to ensure the engineering biology sector continues to grow at every level from research through to mass manufacturing. Our opportunities are highlighted by the recent Council for Science and Technology advice to government on engineering biology[4], and the Government Chief Scientific Advisor's review on pro-innovation regulation for life sciences[8]. Views from across the entire engineering biology community and sector will be critical in identifying the priority issues to be addressed and implementing the changes required.

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[3] https://www.ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/synthetic-biology-for-growth/
[4] https://www.gov.uk/government/publications/advice-on-engineering-biology
[5] https://resourcecenter.biotechgate.com/2023/05/uk-life-science-trend-analysis-2023/
[6] Adapted from: Cambridge Industrial Innovation Policy (2023). *Life Sciences beyond human health: modern industrial biotechnology in the UK*.
[7] https://www.ukri.org/opportunity/engineering-biology-missions-hubs-and-mission-awards/
[8] https://www.gov.uk/government/publications/pro-innovation-regulation-of-technologies-review-life-sciences

What's next?

Government will use the outcomes of this call for evidence to inform policy that will support across the engineering biology ecosystem.

DSIT has mapped the engineering biology value chain to better understand the engineering biology ecosystem. The technical elements of this value chain represent the capabilities that firms draw on to develop, scale and commercialise products derived using engineering biology. In addition to these technical capabilities, we have also identified a broader set of policy enablers: R&D and innovation funding, talent and skills pipelines, regulation and standards, business finance, improving public understanding and international collaboration and markets. The engineering biology action plan will consider all these technical and policy elements of the value chain. It will also consider the public's interest and uptake of engineering biology and its applications.

This call for evidence asks for your experiences and insights into the strengths, weakness and opportunities for the UK's engineering biology ecosystem using the structure provided by this value chain analysis.

How your responses will be used

See DSIT's privacy notice here. In our response to the call for evidence we may quote answers provided to us. We will not attribute these to any individual or organisations and no personal data will be published.

CFE questions

Do not feel you have to answer every question.

1. About you

1.1. If you are happy to do so include your name and organisation here.
Name: [Free text]
Organisation: [Free text]

1.2. What kind of respondent are you? Tick all that apply.

- An academic working on, or with, engineering biology
- A business in the sector with less than 250 employees
- A large business
- A contract research or contract manufacturing organisation
- A trade organisation
- An investor
- A member of the public
- Other

If 'other', please explain your answer.
[Free text]

1.3. Please select the nation or region you are headquartered

- Cymru/Wales
- East Midlands
- East of England
- London
- North East & Cumbria
- North West
- Northern Ireland
- Scotland
- South East
- South West
- West Midlands
- Yorkshire & the Humber
- Not headquartered in the UK

1.4. Which application areas do you consider yourselves involved with? Tick all that apply.

- Human health
- Agriculture and food
- Chemicals and materials
- Renewable fuels
- The environment
- Underpinning technologies
- Other

If 'other', please explain your answer.
[Free text]

2. Public interest, and uptake of engineering biology products

2.1. How do you approach building the public's interest and uptake of innovations and products derived from engineering biology? What are the factors to consider when going about this?
[Free text]

2.2. Where and how are government, industry and academia each best placed to build public interest, and more broadly uptake of products? How can we involve the public in this conversation? What can we learn from other countries?
[Free text]

3. UK value chain for engineering biology

3.1. With regards to the whole sector, what do you think the UK's three key strengths are in engineering biology?
[Free text]

3.2. With regards to the whole sector, what do you think are the UK's three key challenges over the next five years?
[Free text]

3.3. Detail your own personal experiences with the engineering biology value chain outlined below. Where do you source these inputs to your work? What difficulties have you experienced? And what do you think needs to change? Please mention where appropriate any scientific and technical advances required. (Fill in any which apply)

- **Small scale equipment:** All hardware needed for proof of concept, from pipettes, glassware, benchtop centrifuges, through to autoclaves and automated platforms such as liquid handling robots.
[500 word limit text]
- **Pilot scale assets:** The equipment and skills needed for running pilots and proof of scalability for engineering biology services and products.
[500 word limit text]
- **Mass Manufacturing assets:** The infrastructure and the skills needed to construct and maintain the equipment required to produce engineering biology services and products at commercial scale (e.g. bioreactors >100 kL)
[500 word limit text]
- **Biological materials and reagents:** Pre-processed intermediate commodities. This includes enzymes, chemicals, biological chassis, strains, and media supplements.
[500 word limit text]
- **Feedstocks:** The largely unprocessed primary commodities and processed primary commodities for media. This includes biomass.
[500 word limit text]
- **DNA sequencing and synthesis capabilities:** The equipment and suppliers for DNA sequencing and synthesis, as well as of other nucleotides.
[500 word limit text]

- **Diagnostics:** The equipment for diagnostics including for quality assurance and control
  [500 word limit text]
- **Omics and compute:** Both the hardware such as servers, GPUs, and high-performance computer clusters, and the software and data used for bioinformatics, omics, and any other program required for your work from simple scripts through to machine learning platforms.
  [500 word limit text]

4. Knowledge pipeline

4.1. Within your domain, what are the key scientific and technical opportunities over the next five years for advancing the development of engineering biology, including its foundational technologies?

4.2. Within your domain, what are the key scientific and technical challenges over the next five years for advancing the development of engineering biology, including its foundational technologies?

4.3. What works well within the current landscape of UK research institutions? What is missing? Are there examples from other countries we can learn from?

[Free text]

5. Talent and skills

Talent refers to influential named individuals and our ability to attract and retain them. Skills refers to the development of scientific or technical capabilities through training for the wider workforce.

5.1. In order for your domain or the domains of those you represent to develop, scale and commercialise products derived from engineering biology, what are the key technical and non-technical skills?
[Free text]

5.2. Please indicate what is working, not working or not to a sufficient scale.
Scale 1= working well, 3= working but not to a sufficient scale/remit, 5 = not working or not happening, 6 = not relevant to me):

- Support for early-career researchers
- Support for mid-career researchers
- Support for late-career researchers
- Programmes to support technicians careers
- Programmes to support regulatory skills
- Programmes to support entrepreneurship

Please explain your answer
[Free text]

6. Business ecosystem

Finding customers

6.1. How do we create mechanisms which bring engineering biology small and medium enterprises (SMEs) together with their customers (including larger firms) in a way that promotes a clear understanding of each others' requirements? What are the barriers to this in practice? What can we learn from other countries?
[Free text]

6.2. How is your firm considering overseas production of your products, or exporting to international markets? What are, or would be, the implications of these decisions for your UK-based activities?
[Free text]

Business finance

6.3. At what stage and investment size have your company (or those you represent) found it challenging to raise finance? What were the barriers you faced at each of these stages? How did you solve these barriers?

(Difficulty level 1= secured investment with relative ease, 3 = challenging but achievable, 5 = very challenging, 6 = don't know or not relevant).

- >£500K
- £500k - £1 million
- £1 million - £2 million
- £2 million - £20 million
- £20 million +

Please explain your responses
[Free text]

7. Regulatory environment

7.1. Do you expect, or have you encountered, any specific regulatory issues when developing, scaling and commercialising products using engineering biology? Please provide as much technical background as needed to fully explain the issue, and an outline of how you navigated the regulatory system.

[Free text]

7.2. How should Government look to influence the development of international regulations, standards, and norms to help grow the UK sector and protect the UK's capabilities?

[Free text]

8. Future expectations

8.1. For your own domain or the domains you represent, please select the top three areas from the UK's Science and Technology Framework you would want government to prioritise in any future plans for engineering biology. These are outlined further in The UK Science and Technology Framework linked here.

- **Signalling UK strengths and ambitions**: Promoting domestic and international recognition of the UK's strengths and ambitions in science and technology to ensure

that all stakeholders have the confidence to invest their time, money and effort supporting our science and technology vision.

- **Investment in research and development**: Focus UK R&D investment to match the scale of the Science and Technology Superpower ambition, and have the private sector take a leading role in delivering this.

- **Talent and Skills**: Secure a large, varied base of skilled, technical and entrepreneurial talent which is agile and can quickly respond to the needs of industry, academia and government.

- **Financing innovative science and technology companies**: Improve access to capital at all stages with increased participation from domestic investors, and an environment to grow and scale large globally competitive science and technology companies that drive growth in the economy and high-skilled employment opportunities for citizens.

- **Procurement**: Investigate how Government departments create a demand for innovation that can catalyse their buying power into economic growth, through the departments own procurement strategies.

- **International opportunities**: Secure international partnerships which support critical technologies and the growth of our sectors.

- **Access to physical and digital infrastructure**: Make certain that infrastructure is accessible and that coordination of infrastructure attracts talent and investment, establishing anchors for innovation clusters and enabling companies to scale.

- **Regulations and standards**: Utilise post-Brexit freedoms and put the UK at the frontier of setting technical standards and shaping international regulations.

- **Innovative public sector**: Work to ensure the public sector has a pro-innovation culture, with a system that adequately supports and rewards innovation while unblocking systemic barriers.