**ANNEX B**

**SSAC REPORT – Engineering Biology: Opportunities for Scotland**

**ROUNDTABLE PROGRAMME, ATTENDEES AND BREAKOUT GROUP NOTES**

**SSAC VIRTUAL ROUNDTABLE**

**4 March 2025, 09.30-12.30**

**Programme**

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| 09.30-09.40 | Welcome and objectives | Professor Louise Horsfall<br>SSAC Project Lead |
| 09.35-09.40 | Brief Background to SSAC | Professor Julian Jones,<br>SSAC Chair |
| 09.40-09.50 | Brief overview of project | Professor Louise Horsfall<br>SSAC Project Lead |
| 09.50-10.05 | Summary of information collated<br>Introduction to questions | Fiona Bunn, SSAC<br>Working Group Member |
| 10.05-10.55 | **Breakout Session 1 – (50 mins)**<br>**Strengths, opportunities and challenges**<br>1. What are the key existing and potential strengths in Scotland's research and industry that could contribute to broader national and international goals, both within and out with the field of Engineering Biology?<br>2. Where are the greatest opportunities in Engineering Biology in the next 10-20 years for Scotland?<br>3. What are the risks and barriers to stability and growth in the Scottish Engineering Biology sector? | **Chaired by:**<br><br>Breakout Group 1<br>Sir Michael Ferguson<br><br>Breakout Group 2<br>Dr Rita Cruz<br><br>Breakout Group 3<br>Professor Martyn Pickersgill |
| 10.55-11.10 | **Comfort Break** | |
| 11.10-12.00 | **Breakout Session 2 – (50 mins)**<br>**Actions**<br>1. What skills will be needed in the Scottish workforce to support the expanding Engineering Biology sector in the next two decades?<br>2. What actions are required, and by whom, to ensure Scotland maximizes the benefits of Engineering Biology for the Scottish economy?<br>3. What role do you see for public-private partnerships in advancing Scotland's engineering biology sector? What models or | **Chaired by:**<br><br>Breakout Group 1<br>Sir Michael Ferguson<br><br>Breakout Group 2<br>Dr Rita Cruz<br><br>Breakout Group 3<br>Professor Martyn Pickersgill |

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| | examples could we look to for successful collaboration? | |
| 12.00-12.25 | **Plenary** | Professor Julian Jones, SSAC Chair |
| 12.25-12.30 | Summing up and next steps | Professor Louise Horsfall SSAC Project Lead |

**FRAMEWORK FOR BREAKOUT DISCUSSION**

The project is intended to review current Scottish engineering biology expertise and collaborations and provide recommendations to highlight the future opportunities that are best aligned to the existing and potential strengths of Scottish industries, taking into consideration existing areas of industrial capability within and out-with those that have already engaged with the developing technology and its academic research.

The project will also seek to set out the actions that the collective ecosystem should look to progress in order to position Scotland to maximise the emerging economic opportunities including setting out where the respective ownership of relevant actions best sit.

**Breakout Groups**

Attendees will be split into three pre-determined breakout groups. While each group will discuss all of the questions outlined in the programme, they will do so in a different order to ensure each question gets sufficient consideration if some groups do not get round to discussing all three.

**SSAC Working Group Members:**

Fiona Bunn, University of Edinburgh
Rita Cruz, Ingenza
Dame Anna Dominiczak, Scottish Government
Sir Michael Ferguson, University of Dundee
Julie Fitzpatrick, Scottish Government
Liz Fletcher, IbioIC
Louise Horsfall, SSAC Member (Project Lead)
Julian Jones, SSAC Chair
Martyn Pickersgill, SSAC Member
Susan Rosser, University of Edinburgh
Derek Stewart, James Hutton Institute

**Roundtable Attendees:**

Soufi Abdenour, University of Edinburgh
Laura Aitken, University of St Andrews
Ian Archer, James Hutton Ltd
Davide Bulgarelli, University of Dundee
Dominic Campopiano, University of Edinburgh
Jamie Davies, University of Edinburgh
Katherine Dunn, University of Edinburgh
Alistair Elfick, University of Edinburgh
Helen Ewles, Royal Academy of Engineering

Rennos Fragkoudis, University of Edinburgh
Tracey Gloster, University of St Andrews
Rebecca Goss, University of St Andrews
Samantha Groessler, Scottish Government
Alison Hughes, University of Glasgow
Sarah Hunt, Skills Development Scotland
Josephine Martin, Scottish Enterprise
Karen McAvenue, Scottish Enterprise
Alistair McCormick, University of Edinburgh
Deborah McGregor, Scottish Enterprise
Diego Oyarzun, University of Edinburgh
Nicolas Peyret, Scottish Enterprise
Susan Rosser, University of Edinburgh
Wilber Sabiiti, University of St Andrews
Finn Slattery, Celtic Renewables
Ioannis Stasinopoulos, Prozymibiolabs
Mark Stevens, Roslin Institute, University of Edinburgh
Derek Stewart, James Hutton Institute
Ernst Van Orsouw, Roslin Technologies
Nik Willoughby, Horizon Proteins
Huabing Yin, University of Glasgow
Runxuan Zhang, James Hutton Institute

**Breakout Group Chairs:**
Rita Cruz, SSAC Working Group Member
Sir Michael Ferguson, SSAC Working Group Member
Martyn Pickersgill, SSAC Member

**Breakout Group Scribes:**
Fona Bunn, University of Edinburgh
Michael Capeness, University of Edinburgh
Sam Cox, Scottish Government

**NOTES FROM BREAKOUT SESSIONS**
**These notes were prepared to enumerate key points made by individuals in the sessions. They do not necessarily reflect majority or consensus views.**

**Breakout Session One**

**Question One - What are the key existing and potential strengths in Scotland's research and industry that could contribute to broader national and international goals, both within and out with the field of Engineering Biology (EngBio)?**

- The point was raised that with the framing of the project/question, there is a concern that EngBio becomes "a solution in search of a problem"
- The strength and weakness of EngBio is that it is an enabling technology that has a broad range of applications. This makes it more challenging to articulate its potential impact economically because you end up with a long list of potential impacts.
- Response from Chair mentioned that EngBio is a specific remit as defined by UK Government and we should stick to this in our discussion

- **Academic strengths** - consistently punch above our weight:
    - SynBio applied to mammalian systems - cell and gene therapy, biomanufacturing space
    - Sustainability sector - sustainable manufacturing of chemicals
    - Both areas are well funded (at least at Edinburgh), and unique facilities such as Edinburgh Genome Foundry (EGF) support this, as a globally unique and world-leading biofoundry

- **Facilities:**
    - **EGF provision** - species agnostic, end-to-end project support with the capability to take all the way from conception to testing. They use bespoke software (also used by world-leaders such as Gingko etc), to assemble constructs, test in organisms, and have expanded capability on the mammalian side in particular.
    - They are well-equipped to support the developing ecosystem in Scotland but also internationally, with the £2 million Berkeley Lights Cellular Analysis Beacon System being the only instrument of its kind in Europe
    - Considered to be a leader in the field, people come to EGF when designing similar projects as an example. Can do more than 2,500 assemblies a week on fully automated schedule, but not currently operating at capacity
    - Usage of EGF - Suitable for projects "thinking big"
    - Academic usage - currently no other Scottish universities aside from Edinburgh are using the EGF (although possibly some are accessing via

collaborations). Through the new EngBio hub Glasgow will also be using it more. More academic users are currently coming from universities in the South of England.
    - Academia vs industry split - on the most expensive platform (Beacon) currently it is ~10% academic research and rest is industry. The automated DNA assembly platform currently is used ~20% academia, rest industry.
    - Better communication/marketing required to make potential clients aware of the capabilities offered by the EGF
    - The Earlham Institute in Norwich who have their own on-site biofoundry but chose EGF to deliver their big project, which speaks to the quality of the service provided
    - Expensive - capital spend funding was provided, but did not receive core funding for the staff, so need to operate on a cost recovery basis which sets a high barrier for access

- **DNA Synthesis**
    - Synthesis of small DNA is not currently supported in Scotland (a potential gap in Scottish/UK capacity) but EGF have negotiated good rates with suppliers and in practise it has not been an issue. The only other biofoundry in the UK with DNA synthesis capability is the London Biofoundry, but this, like most bench-top synthesisers, is expensive to run, only produces very small pieces of DNA and is not really very useful for most applications - the synthesis companies are totally dominant in this area and DNA synthesis as a service is probably commodified to such an extent that it is not a necessity to have local capacity. There were discussions quite a few years ago about trying to persuade one to move to Scotland but post Brexit the UK market alone is not large enough.
    - cost of screening sequences to be in line with biosafety regulations would also come with an associated cost that is probably prohibitive
    - The absence of any synthesis company based in the UK could be seen as a national gap, but in practice has not been a major issue. It was however raised as a barrier in some projects/collaborations, especially with infectious disease research, as understandably there are lots of barriers to import sequences for infectious agents.
- **Other**
    - Noted that Scotland in general is not very good at self-promotion and flagging the great work that is going on. Make sure this comes across in the report.
    - There is a very connected nature between the public/private sector with regards to EngBio and beyond, meaning it is easier to mobilise momentum and respond to funding calls and opportunities

- In terms of industry, we have great people, lots of expertise in the building and manufacturing sector and should be considered a resource for development or adaption of facilities
- Economic development agencies are jealous of the devolved government in Scotland, it gives use of locally focused power, with smaller turnaround time. It is also possible to 'double dip' to access separate pots of funding. We need even better joining up of what we have, and we need mechanisms to facilitate people access to these connections.
- We can do a 'reverse of the golden triangle' if we work hard at it
- EngBio is mainly focussed on bioscience, but should be very interdisciplinary with our available platforms. This should/would be used to attract more industry and start-ups.
- We have a lot of land for development, and is cheaper than the rest of the UK. Because the places are spread out, there is a greater cost associated with travel, so more uniform and localised development is needed to lower costs, and it is more achievable in Scotland. There are many limits, environment concerns and hurdles when developing or expanding new sites. Scotland is very protective of land and development on it so this means it would be difficult to develop new sites.
- Because of access to green/clean power, Scotland is more attractive to start-ups or upscale development, and using life cycle assessment can be a good way to advocate this
- There has been significant development in therapeutics research at Edinburgh and Dundee, with immense possibility for collaboration
- We are surrounded by lots of sea, marine industry and marine biology - manufacturing of marine-based biology is a great opportunity in both research and industry
- We have also had companies relocate here because of our resources - the feedstocks
- We are short of incubator/wet lab space though
- Access to green/clean energy is an interesting potential opportunity

**Grangemouth**

- Innovation Agenda for Great Smart Future in report – collaboration with partners to develop innovation plan for bridge modelling to the divorce chemical de-fossilisation using EngBio. Developing innovation hub for green smart.
- Project in development leading to knowledge that there are many building blocks that need to be put in place before the 10-20 year vision. At present, three-year building blocks with focus on the ecosystem, infrastructure and investment being tried. Focussed on developing a plan to deal with larger investment and for SMEs and ID components. Momentum in and for this programme from partners (universities, council, etc.) and identifying gaps/opportunities to keep everyone aligned.

**Strengths**

- Scotland has a well-connected community, quite unique internationally, ex. Research Innovation Scotland which brings together Scotland's innovation centres, the research pools and the alliances for research challenges. These are all somewhat unusual and special organisations. They are groups that help support the ecosystem across the board, and they all work collaboratively with one another.
- Great support system in terms of start-up and spin-out - Scottish Enterprise offers a lot of support in that area; great competitions like Converge and Scottish Edge that help to bridge the gap between academic research and then and spinning out or creating a new start-up
- Community in Scotland works for the good of Scotland rather than putting individual first, unique in comparison to the rest of the world
- Huge strength in collaborative attitude towards the greater good and innovation
- colleagues across research and innovation are willing to be links between areas and meeting the right people
- The collaboration and communication between Scottish HEIs have impressed international partners in the past. Noted that this should be amplified across Scotland, important for working towards the common good despite competition between universities. Further highlighted that this makes Scotland an attractive place to come as an innovator/entrepreneur and makes it an attractive place to stay long term as a researcher if you are keen to have community as you develop your career.
- Strength in renewable energy – everything that ultimately comes out of renewable comes down to energy. Security of the energy system is strong and Scotland has potential to generate much of its own energy locally/sustainably.
- Fear that Scotland is not investing enough into capacity for renewables – need to be in a position where the order for energy can be valuable to EngBio and that it effectively needs to be free
- Electricity can become a large political challenge because it is not a great investment proposition if it has given away for free – means needing a nationalised industry. Electricity is biggest asset but will create issues if public is not given free/subsided electricity as well – cannot expect to give part of the economy cheap electricity while still charging everyone else.
- Scotland does not have a huge biomass or population but does have good universities and great support. Fundamentals are that Scotland can generate as much energy as it could ever need and that is the ultimate cost: how much energy is spent turning a wild resource into a real thing.
- This offers opportunities for where companies might choose to go – ex. Orkney that produces 140% of its energy; this is constrained meaning things have to be turned off rather than used. Can look at alternative energies rather than wind, if desire to avoid Orkney/Shetland/islands.

- Accessing cheap energy could be difficult because some/all of the rights have been sold off and not sure if it would be possible to get back. Still opportunities of working with environments where there is a lot of power being created.
- Scottish National Investment Bank (SNIB) – great green policy and a desire to invest in green technology. Current highlight is Indian Nature who are taking unspent cellulose and converting it into building materials. No equivalent to SNIB across the UK. SNIB need more money to invest in helping companies get over the barrier.
- It would be important for how this generation trains the next and what legacy will be left for them
- Suggestion that postgraduate courses could be converted into being sustainability by biotechnologists or chemists (similar to computer side/AI). Need to consider needing fundamental science and initially, possibly, not needed the fundamental data science and then applying that to anything after the fact.
- A transition to system science and mixing companies (co-located and co-built) in relation to energy - all agreed that everything comes down to energy
- Flat funding to Institutes for over a decade (eroded by inflation), plus disparity in REG income to Universities between England and Scotland risk us falling behind. In cash terms, REG funding in England increased by 24.7% from 2014-15 to 2023-24, compared with an increase of 0.9% in Scotland.
- https://www.ft.com/content/a37d0ddf-8fb1-4b47-9fba-7ebde29fc510
- https://www.thebank.scot/
- The diversity of Scotland's sector is also a key strength across a number of strategically important areas like food/agri/drink, pharma/drug discovery/ biomedicine, manufacturing, marine and environment to name a few

**Question Two - Where are the greatest opportunities in EngBio in the next 10-20 years for Scotland?**

Define “opportunity”? Clarified in terms of Scottish Government interests - what will translate into the economy.

**Advanced therapeutics and conventional therapeutics**

- A lot of academic strength in and around Edinburgh including the £14M UKRI funded UK EngBio Hub for Advanced Therapeutics. The Cell and Gene Therapy Catapult have a base in Edinburgh.
- A great cluster of expertise around Dundee in pharmacology and conventional and protein-degrader drug discovery
- Suggested that EngBio could contribute to design of improved assay systems for drug screening etc. that will boost conventional pharmacology drug development pipelines etc.
- Lab to clinical application in humans is a long and slow process for advanced therapies (except perhaps in rare diseases where clinical trials could be accelerated), therefore it is beneficial to target some quicker wins whilst on the

way to high tech therapeutics, such as using EngBio as a tool to accelerate existing therapies to market

**Commercialisation/translation**

- Lack of lab space - this is a huge issue for Scottish start-ups and spin-outs
- Spin-out companies start-up and get bought out - this still has a positive economic impact for Scotland
- Biggest issue is getting small company activity going in Scotland - a lack of lab space and Venture Capitalists (VC) is a major barrier
- Lack of relatively small public-sector non-dilutive Proof-of-Concept funding to convert innovations to investible assets is a major impediment to bringing VC inward investment to Scotland
- After this, retaining small companies is important to keep jobs and economic impact in Scotland. Aim to build an industry with critical mass in Scotland and not just intellectual mass in Scotland. Need for Public-Private Partnerships with Real Estate specialists for commercial follow-on space.

**Any opportunities in addition to the five categories?**

- Should not forget materials and advanced materials e.g. replacement of plastics, new smart/responsive/meta materials. Huge areas with much less regulatory burden associated with them.
- Scotland resources and biomass - should not only consider the outcome/ application, but also the sources
- Historic background in brewing and manufacturing skillsets (fermentable cell-culture based industries and manufacturing - broadly linked - we have ability to train in both spaces and skillsets to work around both. Not suggesting we lift people from the brewing industry, but a good landscape that can support the transition to process scale).
- The transition to e-fuels and to net zero and the desire/production of sustainable chemicals, shows there is a huge opportunity to something very transformative
- Huge opportunity for the engineering of crops and plants, with little competition from the rest of the UK other than the John Innes Centre
- Should the question be about five years, as we cannot afford to wait 10 years
- It should be focused on where we can get the most traction
- Technologies such as biomedicine should be a strong focus and on human health, it is very understanded, very desirable, and better funded from investors.
- Great opportunity in therapeutics, vaccine development and rapid diagnostics, with a global reach
- Scotland works well with foreign bodies, and the development of tools would translate well abroad
- We have the Universities, the facilities, and great scientific bodies - these are great resources, that need to come together more
- The revelation of machine learning and AI, what does this mean to EngBio

- From academic point of view, they are still struggling with how to use AI, especially with students and how (and if) it should be used/taught
- Small start-up using AI for epitope design and rapid diagnostics (EpitogenX – Aberdeen)
- Understanding the capability of AI, how to upscale the new and upcoming workforce - we need to ensure we bring the work force along with it
- Smaller country means we are more in touch with local communities, so could address local concerns with applications further afield
- Development of human-health focused industries is few and far between in Scotland so there is great opportunity for new ventures.
- Industrial biotechnology sector is growing fast, but most do not use EngBio, but could evolve into ones that do over the coming years
- End of life plans for green technologies, such as wind farms, new battery technologies, present an opportunity for critical metals that which Scotland plans to use in its green energy transition
- Development of greener chemical production sites and assessment around the repurposing of existing sites (e.g. project Willow at Grangemouth).

**Diversity**

- Not difficult to move between sectors as an individual with the right skill set and if you have the right training in place.
- Looks odd when you see it to begin with because it looks diverse, but the same people could work in all of these sectors by adapting their skillsets

**Data / Computing**

- Opportunity to align EngBio with data economy and the advances being made there. Getting to an end point is increasingly faster. New entrants are coming from data science and computing, rather than from biology. Problem in skills gap in biology going forward but computing is growing substantially.
- In terms of data and the use of it/AI and computational high performance computing – high environmental cost to them. Overarching aim of EngBio to do things in a more sustainable fashion. Need to be careful how AI and high performance computing are utilised because it could make EngBio less sustainable to use these tools due to their immense energy and water needs.
- Opportunity in Scotland – if Scotland can generate 200% of the electricity needed at the moment then we could become one of the most sustainable places on earth to do this work
- Less concerned about electricity and where it comes from (wind turbine, solar panel) and more concerned if it is being done. Note that water is the biggest resource in terms of cooling down computers.
- Chemists/chemistry are struggling with what are they going to do with their lives; note that many are going into AI and similar fields.

- Taught course on sustainable chemistry is very popular – taught in first and fourth year; well-loved by students. Telling chemists they can do anything and this is the line that needs to be pushed across the whole science field.
- Thought about if this is a transition to system science
- The Grangemouth vision will support the EngBio as Grangemouth is a globally competitive location for the creation of a highly diversified, high GVA cluster of companies providing skilled and secure jobs. The cluster will be an essential driver of the sustainable transition of the UK chemicals industry and the circular economy, in the face of changing global demand.

**Question Three - What are the risks and barriers to stability and growth in the Scottish EngBio sector?**

**Any additional risks/barriers not mentioned in list?**

- Challenge of scaling - moving companies from development to process scale
- look at data of commercial electricity prices compared to international competitors - brutal and still tied to variable gas prices even when using renewables
- Investors need to know future energy prices are not a problem/risk for moving to large scale production - currently not an attractive/suitable place to base yourself.
- Relatively small UK market size when compared to the US and the EU
- There are more facilities for scale up in the US and EU and the EU provides grants and subsidies (in addition to the energy costs already mentioned)
- The Golden Triangle has more lab space, more VCs, a vibrant existing bioeconomy, fantastic universities and better global name recognition
- Food grade facilities are lacking in Scotland - would typically have to go South for this as a company wanting to work in this space
- Golden Triangle advantage – two body problem for high-tech jobs
- Talented couples need to be able to settle somewhere where they both have access to jobs - basic infrastructure problem in Scotland versus the South East
- There are also more skills-based jobs to be created in bioproduction/ fermentation/processing which we ought to be factoring into the conversation

**Regulation**

- How much impediment is current Scottish-specific regulation (in the area of plant GMOs) to development in Scotland? No specific answers to this but something to follow up on with a relevant expert
- Mention of the Scottish Bioeconomy Council report of Genetic Technologies – need to tread carefully around how we present the case for regulatory alignment with the rest of the UK on genetic technologies such as the Precision Breeding Bill if we would like to be able to utilise the newest technologies commercially. There is a risk over presenting gene editing as safer than GM (e.g. to enable alignment with the Precision Breeding bill), as this is a misleading message to get across and could create misinformation regarding the safety of GMOs vs gene edited organisms.

- Current stance by Scottish Government is not a “good look” - gives impression of Scotland as anti-technology/innovation
- Regulation based on product not on technology would be a sensible direction of travel

**Facilities**

- Expense is a barrier for access to facilities because the funding model is based around funding capital and not the support of staff - acknowledged that it is hard to sign off on an ongoing cost vs one-off capital costs, but still important to consider
- Facilities need to be designed to break even without financial support for them to operate in a useful way and serve their function:
    - (see also EGF discussion from Q1)
    - E.g. CPI too expensive for companies to access without grant funding
    - FlexBio is better but still need to fund their staff (a good deal with Heriot-Watt regarding cost of rent helps to make this more feasible)
    - One possible solution would be government provision of access vouchers to enable SME’s to access facilities
- Lacking mid-range prototyping EGF-style scale-up options (15-150 mL) - expensive (~£1 million)
- Recognised need for scale-up facilities - discussion around distribution of specialist facilities vs centralised centre of excellence model, diversification beyond central-belt for some technologies
- Sheer diversity of companies, products - challenging to identify facilities required by all companies/areas - need to provide the necessary support to get companies to the point where they can use their own specialist facilities
- Lacking accelerator facilities (info going to DSIT flags that Scotland has a real lack of lab space)
- Oxford/Cambridge are offering money for companies to relocate - disastrous economically
- Building these facilities with City Deals (BioHubs etc) - but insufficient to scale Scotland’s ambitions

**Market and follow-on space**

- No follow-on space - even if retained, once grown (to 40-50 employees) we will lose them
- Market size has been much smaller since Brexit

**Investment**

- Need the companies first as substrate for attracting investment
- Lack Proof-of-Concept funding in Scotland - improving this could get far more companies Series A funded etc
- Americans are looking to UK and seeing cheap companies - not good

- Bigger picture needs to be considered to create sustainable investment opportunities
- SNIB was set up to address these challenges, but on a number of occasions has refused to match inward investment or get involved with inward investment because their perceived risk balance was different to the investors. Was not sure if their risk perception turned out to be right or wrong in these cases, but suggested to achieve the strategic goals and fulfil its role, SNIB should be more guided by risk analysis of external money coming in.
- One of the key risks is retaining and attracting the right researchers that are lost due to immigration or emigration
- We need well-funded infrastructure to retain the and attract the talent - we need to do the best we can to stabilise what we have already
- The changes in migration law have affected the pool we can draw from making it difficult to attract outside talent
- We need to be supporting the breadth of talent as well, those who are still in education (the secondary phases) - we are at risk of competing with the rest of the UK and other sectors in Scotland as well
- Very difficult to recruit people in Scotland in this area, across the UK there are other university that are more attractive than Scotland - should Scotland Universities work together to showcase that Scotland is an attractive place to work and develop - we are not seen as a playground for synthetic biology
- Universities are a big part of the economy/system and are under huge financial pressures leading to cost cutting measures as well as a hiring freeze, this is having a big effect on hiring and retaining people
- How does Scotland make research/income effective but without running into a deficit
- Attracting new and wide talents is paramount - we should do more as academics to engage with the pool of prospective scientists such as students
- Communicating with the people could be a relatively small cost with a big payout
- It is harder to get funding to go from basic research to an application stage
- Another barrier is genetic modification, and the outlined issues with politics and engaging with people and how it can benefit them
- There is still a problem with people’s perception of GM, so it comes across as less attractive
- The cost of energy is also high (despite having renewables in Scotland) - addressing these issues could attract more industrial companies and collaborations
- Looking at Scotland as a whole, especially outside the central belt, into the highlands, it is very difficult to run and operate future industrial resources
- Beyond the skills, there are many barriers, such as feedstocks and competition for them, as well as environmental policies and access to the small number of spaces that exist to carry out the work

- The need to keep the UK research skills fresh in the area of control and engineering of biosystems is important
- There are uncertainties about the markets and pull through that EngBio has in Scotland, need to assess where the real barriers are to facilities
- Clarity of rules regarding movement of people is needed

**Policy**

- Policy is biggest blocker - can do research but cannot translate outcomes and impacts in Scotland; run the risk of losing first mover adoption and potential to translate economic growth in Scotland which is ironic because climate change suggests that agricultural land availability will increase due to this going forward
- In England, there is a call coming out for precision breeding from Defra
- Note that pollen does not understand geographic barriers, so those engineered pollen will just blow off - policies will not stop the biology
- Change in policy might come, there is a need for it and it is currently blocking investments in agriculture
- Would sugar beet be a viable crop option to support a bio based chemical sector in Scotland – conclusion is that maybe, but Scotland is too small to manage it
- Concerns about trying to create an industry that cannot actually support the amount of biomass than could be made here
- Thought that in Scotland, all polyethylene that is made in Grangemouth by Ineos with bio based polyethylene, this would capture an enormous amount of CO2 rather than the 200,000 tonnes a year of polyethylene
- Based on the feedstock that in US shale gas originally is ethane that gets shipped across the ocean and then converted into polyethylene that emits two tonnes of CO2 for every tonne that you make - so that is 400,000 tonnes of CO2 associated with it
- In Scotland, this could theoretically be grown, converted to ethanol, then to ethylene and then finally to polyethylene
- This would lead to two tonnes of CO2 being captured for every tonne made which is a big swing - this would be 400k tonnes captured and have a sustainable material
- To do this, ten percent of Scottish arable land would need to be converted to sugar beet every year over six year rotation - so this means that 60% of the land is needed to be available at some point in its lifetime
- Important to keep context in mind that Scotland is doing okay with a quarter of this amount -do not want to replace everything but a quarter would be good - helpful to keep these numbers in mind
- There is an opportunity here, but limited land at present - more land might come up but if sugar beets are to have climate impact, this is big chem manufacturing and its big land use - not necessarily a bad thing but important to realise what is being discussed

- Not just policy around EngBio, but how that marries up with other areas like agricultural policy more widely

**EngBio Champion**

- Scottish Biotechnology Advisory Council – have spent a long time explaining to Ministers (Mr Lochhead at present) what industrial biotechnology is. No champion in SG who understands this; is a champion needed in Parliament to lead on this and take advantage of opportunities? Noted that other areas like AI have massive champions. Lacking on industrial biotechnology and EngBio need a champion in government, specifically a long-term one who is going to be around for a long time.
- Champion does not necessarily need to be an MSP – difficult to find some with the skill set and academic background. Ideally champion would be able to articulate what the issues are and also can understand the science because it is frustrating re-starting every time a new person comes in. Highlighted importance of champion being good at communicating with the public – noting that huge amount of misunderstanding/fear mongering across media (and social media) are an ongoing problem. Champion would need to be able to explain complex ideas to laypeople and getting them on board with EngBio and different industrial biotechnology approaches.
- Disparity between synthetic biology applied to food in comparison to other things (ex. Drugs using GM organisms); noted challenges that when it comes to food/consumables, people suddenly have huge opinions but no information. Noted that champion would need to be someone who can "fight on their feet." Suggestion that they would be similar to James Withers (of Food and Drink Scotland), who was successful at balancing industry and innovation.
- How important is it for this potential champion to be able to bridge research – ex. University and industry research?
- A champion would understand the different players in R&D or research and innovation ecosystems and highlighting the strengths of these individual players as well as supporting skill development across the board.

**Research & Development**

- Problems with R&D being conflated when they are two very different things; noted that science/scientists can struggle with translation – ongoing problems with translating research, even if the research itself is top notch and that development is massively undervalued
- Development happens in industry while research happens in universities is a simple way to divvy them up but not as simple as this
- University research is great, but not great at developing it. Then development work is tended to be putting all the value on inventors in terms of ownership without recognizing the 80/20 rule. This also contributes to undervaluing the fundamental science in this work.

- Universities do not value the industry contribution to their work/overall programme and then insist that they were the inventors and were the people that came up with that work and that industry had minimal contributions that has not contributed to the development work. Noted that this causes arguments about benefit sharing in the future.
- Fundamental issue with lack of understand between research and development and universities undervaluing development overall. Noted that universities cannot publish papers on development work, papers re focused on novelty rather than developing something that was novel into something that someone can buy in a shop or can spread on a field.
- Noted the importance that even if universities do not value development, everyone else needed to if they were going to turn things into products
- Opinion across universities is that industry contribution in monetary while industry sees universities value as low-cost labour which is not the case. This attitude can limit partnerships and collaboration.
- Overall, work seems to be trending toward applied research and innovative research but there is a need to grow the base of fundamental and foundational research. Universities are skilled at this – good place for this to happen because the work can be high risk or it is long/tedious that does not always have a tangible output but it forms the basis of lots of applied research and the research, development and innovation that come out of this.
- Really important to work across sectors and have the champion bridge the gap to ensure fundamental science is still being considered to support the applied science, leading to innovation and development

**Risks**

- Need to consider risks/barriers of EngBio to reflect wider incentives within an overarching area
- Obvious risks from new technology in this field. Ex. Genome editing in humans is a great technology and there is vision of governments investing money and translating it into reality. But carries a lot of risk because it is new, and risk will not be immediately apparent.
- Noted that a strategy would be needed to take risks and for risk assessments before there is too much excitement and development and making it into industry before finding out that it was not the best course of action. Risk assessment needs to be carefully considered.
- There is enthusiasm to support EngBio but the risk assessments cannot be sidestepped
- Noted that cellular agriculture would likely diminish in the US under the current administration, leaving it to Europe to pick this up because of their regulatory and investment environments and seeing this as something they want to support

- Further noting that the political situation in the US could drive investments that would typically go there, to go elsewhere instead, which could be beneficial to the UK
- Major risk in spinning out and growing right now due to suspended environment of investment. Difficult time to create any spin-outs or small company growth. Noted that all policies from UKG to SG and internationally are all linked.
- Risk of resource availability and scale – a risk to EngBio sector in Scotland is extreme weather. So water is key to EngBio in its scale up, might affect Scotland less than England but lack of water availability is still going to be problematic
- Climate change is going to have as rapid impacts on EngBio in the UK and Scotland, and certainly seasonable biomass, including tensions with food crops. Need to remove reliance on glucose for it to be a viable sector.
- Risks around climate change at large
- Lack of alignment with the Genetic Technologies (Precision Breeding) Act suggests a more hostile position on EngBio as it relates to the food system
- Overall do we have to simply accept the current paradigm of created-here & scaled-up/translated elsewhere? This does mean UK/Scotland plc still gains.
- That certainly applies to engineered crops and animals
- Some opportunities are appropriate locally - but that does not mean we cannot benefit from exporting tech and services
- A great story that has gone on for many, many years, is the GSK Irvine antibiotics/penicillin production that relies on a bug fed on pure glucose to produce the antibiotic
- Yet almost all cheese uses GM rennet
- Scotland did have an official drought last year - Possible water monitoring and higher taxes/payments

**Breakout Session Two**

**Question One - What skills will be needed in the Scottish workforce to support the expanding EngBio sector in the next two decades?**

- Highly skilled researchers (PhD+)
- Technical production staff
- Engineering
- Digital/data skills
- Legal expertise
- Quality control and biosafety
- Clinical trial skills
- Business development
- Social and economic sciences
- Carbon accounting and LCA
- Automation skills

- General numeracy
- Other
- Added computational biology to list.
- Highly skilled people with these skills can get a lot of money in industry, need to create attractive opportunities for them.
- An example of someone with a few computational PhD projects advertised. No UK candidates applying, but very high calibre of candidates applying from overseas. Limited by the restrictions on international students from research councils and universities and by punitive visa conditions for postdocs. Must internationalise talent acquisition at every level to solve skills problems.

**Automation skills**

- Should be one of the areas prioritised – the ability to program and operate robotic systems is quite specialised and usually have to learn on the job. Have trouble with retention for automation engineers in biological sciences.
- Is that retention of automation experts in biological sciences as a whole, or specifically/additionally in Scotland? Both. There is a lack of people with these skills globally.
- Retention of lots of roles is a challenge in this sector

**Areas not so prioritised**

- Legal expertise - who are we trying to give these skills?
- Should biologists/practitioners have a greater understanding, or can this be served by those outside of the sector
- Clinical trial skills - probably well-served already in Scotland
- A general challenge of losing staff from research because they are paid better in commercial sector → we should challenge the constraint over funding in academia and pay the going rate rather than sticking rigidly to the academic model pay-scale to encourage innovation
- Regarding pay, our affordability is a key competitive advantage - climate sometimes less so

**General points on skills**

- Strongly stressed that in addition to highly specific value-added skills, it is critical to have a strong basis of **fundamental skills**. Excellence in analysis, cloning and general scientific method cannot be displaced by additional skills training, as can often happen in attempts to address specialist skills gaps.
- Prioritise skills where we need a physical presence in Scotland vs those that can be done remotely.
- Should differentiate areas where we need new skills training and where do we need to bring in and retain people who already have the skills

**Entrepreneurship**

- Is entrepreneurship a skill we are under-training?

- Scottish Enterprise response - training more people would be helpful, commented on the usefulness of Converge Challenge and other Scottish events in entrepreneurship.
- The next two decades are a very long time, so a five-year limit would be more suitable, asking industry to predict over a longer period of time is difficult. As changes to industry and the curriculum are inevitable in that long time suggested.
- If the workforce included undergraduates or younger peoples, the timeframe could be appropriate.
- There are no teaching professions mentioned in the list, re-training and ‘re-wiring’ with regards to EngBio is going to be essential.
- Skills around the development using AI, to design, model, engineer, scale up – can current generation use it and are they being taught it? If not than we will be left behind.
- AI will be key to newer technologies, unaware about how it is taught? Five years ago it did not exist, how AI is used and to what ends is going to be critical.
- Science communication needs to be added to the list to make sure we are talking to the public, and bring them along as things develop
- A lot of the skills in the list, are add on skills not core skills like ‘Bioscience’
- Skills involved in carbon counting and LCA assessments are crucial as we go towards carbon zero. It is not well known/understood/used currently.
- Quality of graduates decreasing, (broad comment from industry). The current generation of entry level staff/students have low hands-on skills.
- Senior executives with ‘been there, done that’ experience in building companies of scale.
- We need to be clear what the roles of the public sector and businesses are in developing skills in this space. There will be very specific industry skills that employers are better placed to develop.
- Scientifically literate politicians would be useful too
- In the past few years there has been a proliferation of 'skills taskforces' set up by the UK government, for quantum, for AI, for nuclear...they all identify engineers as a skills need, but by not being coordinated there is a real risk of different taskforces making different assumptions about one pool of people and vice versa
- Hopefully, Skills England will try to address this for England - encourage Scotland to be as coordinated as it can be across all its workforce needs
- Technology economic analysis too

**Skills**

- Business development skills are required but they need to be specialised – this means that the person doing the business development should also be technologically inclined rather than just any normal business development
- Leadership skills are also important to take the company to the next level
- General technical skills are important – having a general science background without specialising too early is important

- Skills in many different disciplines of science that can be transferred and having a background in one can help you bring perspective into another
- Diversity of scientific skills is important, especially in EngBio which is interdisciplinary
- Do not need a university degree for every type of job in EngBio - huge amount of highly educated people and not necessarily highly skilled people
- Colleges can be utilized in providing skills provision
- There should be more emphasis on meta/transferrable skills as well as technical skills training across any sort of degree programme
- Ex. PhD programme though IBioIC allowing for the research portion and developing skills that were useful to the industrial sector - noted that this can make it easier for conversations to be had with different people/stakeholders
- Putting an emphasis on having technical/meta skills as part of scientific degrees and training is very important
- IBioIC's programme was designed to make PhD students 'ready for industry' and give them skills that industry had told IBioIC that they were looking for
- We are not specially trying to train individuals to go straight to companies and do a job, trying to give them skills that allowed them to communicate with lots of people
- PhD students in industry will need to be able to speak to everyone – business people, technicians at plants, engineers they would work alongside, etc. – all about if these students can communicate in language that is not siloed to their field
- Noted that champion would need ability to communicate without using any of their jargon - if everyone can get to this point, then a champion will not be necessary because everyone could be a champion

**Question Two - What actions are required, and by whom, to ensure Scotland maximizes the benefits of EngBio for the Scottish economy?**

- Innovation support
- Funding and investment, public and private
- Public-private partnerships
- Infrastructure
- Regulation and policy
- Standards/responsible research and innovation
- Collaborations, partnerships and networks
- Industry-academia
- Social dimensions
- Skills

**Funding and investment**

- Proof-of-concept funding - innovation to investible asset. Examples of where this is done well: Israel, Singapore, Denmark, Ireland
- Some UKRI-level opportunities exist, e.g. NIBBS and most recently UKRI Proof-of-Concept, but if we want regional (Scottish) advantage, a local solution needs to be found
- Expense for accessing facilities - grants and funds to help companies access these facilities (Scottish Enterprise could address this)
- Scottish Government could give early-stage investors like angel investors incentives such as tax reliefs to encourage investment e.g. SEIS for Scotland, some regional schemes in Spain as examples

**Facilities**

- Demonstrator site at scale - integrated biorefinery e.g. Moray Firth (freeport, biomass from industry, skills) - could be a flagship for Scotland and contribute to geographical diversification of facilities and investment
- Point on funding to improve access from earlier

**Big annual Scottish start-up showcase (a cheap win)**

- Gather together a group of VCs from South East/US and introduce Scottish companies to them - it is often challenging to make connections so something to bring the people with money together with the people who need money. Many universities are independently doing this but need co-ordination. Create a buzz and a vibe. Relatively cheap. SDI do some of this already.
- Rebecca Goss has written this into a grant that they have just won. Requires navigating the tax landscapes (big consideration for smaller investors)
- Did something similar a few years ago with SHINE. Bringing the right clientele to the table (make the event sufficiently big and important that all major VCs attend)' use Scottish assets like Edinburgh Castle, Holyrood Palace to create a draw

**Industry-academia**

- Links between academia and industry - really good, unfortunate that IBioIC has been defunded but revisit this
- Expand more into England? – should Scotland embrace parts of Northern England (e.g. Newcastle) in initiatives
- Expose PhD students to working in industry – PIPS scheme in e.g. BBSRC PhD programmes a good start but this could be strengthened, further encouraged and enabled
- Some specific funding to expand this (e.g. to SULSA that organises PIPS for Life Sciences PhDs) could be a low-cost but high-yield option
- Training to link academics to industry partners and catalyse this process in a formal way - aware of schemes like this at the University of Oxford and University of Portsmouth

- For an academic to speak to industry there is a time barrier - not built into workload models, but should be - in the gift of HEIs themselves
- Funding secondments into industry for academics - Royal Society runs a scheme which is a little undersubscribed currently, important to enable the fluidity
- For SME/start-ups collaborating on student PhD projects generates concerns over IP, however, this is navigable if addressed upfront
- Grants and vouchers through Interface are useful but perhaps underpowered – we should bolster mechanisms that we already have
- We have a lot of resources, with a fair bit of goodwill that needs to be coordinated and signposted - there is already quite a lot of collaboration
- We need great champions from both/across the sectors - asking more money for this is hugely difficult, so need to rely on what we have
- We need a visible and charismatic Champion for EngBio in Scotland
- We have lots of great examples with the Scottish Bioeconomy Council – increasing understanding by the public/supply chain/ career changers/industry need to maximise what we have using existing resources
- The people and their skills need to be very evident, it is about bringing and attracting industry into this from the ground up even at the education level
- We need to ensure EngBio is part of the wider science remit, things like apprenticeship definitely help this
- Public funding will be limited in the years to come, so attractive private investment is essential - we potentially need a broader reach – need to ensure we look strong to outside investment to attract more
- We need to bring in industry to inform curriculums and identify fit-for-purpose apprenticeships in order to ensure the pipeline of talent will meet industry needs
- Help is needed to create better understanding by the public and industry with a focus on the use of renewables. Using the governments voice to promote this understanding and engagement would be key. Renewables are a luxury, with lots of upfront costs. Government incentivising new industry to use renewables would be a big help to promote their use and the research behind them. Similarly, there should also be a disincentivise larger companies from using non-renewable.
- There is unclear policy surrounding GM use in renewables, with government clarification needed to de-risk and promoter investors
- Inclusion of deeper Scotland requires the use of government to incentivise and implement policies and joint ventures to promote technologies
- There is a bioresource dataset/tool from the IBioIC that can be used as a trading platform to find available resources - the practice of which needs to be continued with the buying of bio-based resources to be incentivised
- Embracing technology to promote public acceptance is important – it is very different per domain such with regards to GM, and the landscape changes dramatically, therapeutics its generally more accepted of bio/GM based solutions
- This is the fresh OECD report https://www.oecd.org/en/publications/synthetic-biology-in-focus_3e6510cf-en.html published last week - focus is on policy

challenges that Scotland should be aware of to pre-empt changes in the landscape
- The Bioresource Mapping Tool - database of bioresources in Scotland
- USA BioProferred Programme

**Start-Ups / Spin-Out Companies**
- Some bench spaces in universities for industry entrepreneurs to spin-out from. Start-ups can co-exist in this system leading to cross pollination of ideas; more access to advice. Need to support young academics that are interested in this step and then supporting their start-up/spin-out companies who do not have funds but need access to specialist equipment.
- To tie this back to skills – looking for specialist skills and having facilities within universities that are often expensive to run so needing to have another kind of revenue. This would mean needing more skilled technicians in that area. Potential work being done by SE and HIE on this – these could be appropriate groups to start with on this. Important to pull together universities and start-ups/ spin-outs into some kind of entrepreneurial ecosystem would help to realise these across the board.
- IBioIC PhD programme – funded through collaborative training partnership with BBSRC. Worked well because they had SMEs they were working with and what IBioIC would do was hold the 10 PhDs and they can apply for them, and then they would get the students. This gave SMEs an opportunity to work in this area and was an easy way to get industry and academia to work together because some of those SMEs did not need to put in any funding. This meant they essentially got a student for four years working with them. The placement not only gets them the student, but a link to the academic inputs as well. Companies get to build a four-year relationship with an academic that is an expert in the field that the SME is interested in. Really good way of funding industry and academic collaborations. If something like this could be replicated in Scotland (costing £25,000-£30,000 per student per year – not a huge cost) then it could generate a huge amount of industry and academic collaboration where each one is a four year partnership – so quite cheap overall as well as being tangible, and put in place quickly and would be unique to Scotland.
- Is there a role for the consortia of industry players to come together to fund some kind of doctoral training partnership rather than going down the traditional academic route for funding?
- This could be a challenge because SMEs do not have this kind of money - £25,000 is a lot to a SME. Difference between large company (ex. Fuji) sponsoring a PhD student vs a SME is that they will not have the student working on something which is on their critical path, they would be working on ‘Friday afternoon’ projects instead. In SMEs, the student is a part of the company, spending four years with them working closely and flitting between the company and the academic lab on a regular basis. And then there is the relationship between them that is built over this timeframe – doubts that companies have

cash to cover that themselves. But big benefit to the answer on the academic side as well – if funding was coming from government.

- Results of Doctoral Focal Award funding applications is critical – causes madness across academic community. Critical to get at least one of these in Scotland. Chemistry is lacking one in Scotland leading to pairing up. Noted importance of pulling together for these flagship programmes for the good of Scotland.
- Probably the greatest benefit of a subject agnostic industrial biotech PhD programme was the vast network we built over four years, across sectors, disciplines and research areas. Banging the drum again for generalised technical and meta skills training, specialising too early is not an advantage when considering the bigger picture of someone's work and the impact it can generate.
- The IBioIC students are probably the best industrially networked students anywhere in the world. They are one link away from about one hundred companies.
- The results of the DFA funding apps are critical, Scotland MUST get one
- Upskilling via micro-credential routes should be considered also

**Question Three - What role do you see for public-private partnerships in advancing Scotland's EngBio sector? What models or examples could we look to for successful collaboration?**

**Follow-on space**

- Nowhere for companies to go when growing to 40-50 employees - opportunity for Scottish public sector to work with specialist scientific real estate private sector like Kadans, Bruntwood, Pioneer Group etc.
- We have the substrate (great science) but do require government intervention to convert it
- Location of follow-on space too - cool kids we want to recruit want urban location not cheap out of town

**Exemplars (UK/Scotland)**

- IBioIC for Industrial Biotechnology has pushed the landscape forwards, expanded at one stage into England, highlighting the need in England for something here too. Can look at CPI at what works well and what does not
- For EngBio an Innovation Centre might be required, probably Hub-and-spoke model - hub likely Edinburgh
- Science centres in Bristol are doing great stuff in terms of facilities and support for spin-outs/start-ups - currently focussed on South West, but interested in looking at Scotland locations in long-term future

**Exemplars (internationally)**

- Denmark (Novo Nordisk foundation - helping to spin out companies, academic/ industry co-operation) https://bii.dk

- Israel
- Ireland (SFI)
- Singapore
- Estonia – not for EngBio but from the marketing perspective of what companies they have there
- US – centres like Boston, Bay Area, Princeton, North Carolina (many others) provide “research hotels” and innovation hubs to help grow small companies to the point where an investment arm of a big company invests in them to scale

**Anything else**

- Difficulties of finding lab space and also space to operate in e.g. non-mammalian cells work is hard to get access to Centre of Excellence facilities
- Ensuring that the positive impact of EngBio is felt outside of the central belt - opportunities that impact distributed communities
- Should be vaguely compatible with the rest of the UK - can be competitive but no clash
- An example that worked well at Ingenza was hosting PhD and Master students in collaboration with universities to research particular topics that has immediate application in industry - wherever we can, we should bring closer the public and private sectors
- An example of success is MMIC [Medicines Manufacturing Innovation Centre] public/private project
- Looking to the end of TRL, should be a focus as that is what industry want to focus on, and will come across as more attractive to develop together
- Work of best practice looking at modelling in industrial practices could be shared with academic partners
- Is it University/Industry led - there is definite value bring together SME, industry and university to more industries on e.g. Prosperity Partnerships
- CPI do they do what they are supposed to do - there has been problems with overpricing, whether they are serving the needs of the growing sector, whether it is a good use of public money, and are delivering what they set out to - it is important to look at what does not work as well as what does
- CTP-type programs with industry partners are a great avenue to explore
- There will always be an element of friction with industry and academia, academia wants to announce findings while industry does not
- It is an important partnership that is good and should be nurtured
- Public sector/academia collaboration example: Advanced Therapies Skills Training Network (ATSTN) - there has been a challenge around short term funding
- Sharing evidence from industry together with academic expertise is good for example the RESILIENCE program (IBioIC)
- EngBio needs to be application and problem driven - industrial partnerships in Glasgow involving the training of industry staff and SME employees at university

to achieve PhD - this is helpful to cover tuition fees UK students and a good way to foster relationships
- Sharing of university lab space with spin-out companies, is great to nurture relationships when industries first begin, this leads to companies hiring from these universities so helps to insulate talent - every industry is slightly different, success stories include Ingenza, MiAlgae, and working with Scottish Enterprise
- Different countries have different constraints around what EngBio can achieve. (e.g. Supply chains in Australia) - Scotland has some unique supply train benefits that could be tapped into the development pipeline, especially with natural resources and Scotland-specific waste streams
- Helping to fill in the skills gap is promoted by industry/academic collaboration - can this be expanded to undergraduate levels or to higher education - not everyone will go on to do a PhD, there is opportunity to make this an inward investment to retain talent - new public/private partnerships focused around Scotland specific problems
- Most collaboration is between businesses as there is an associated de-risk of new technology
- Two examples - Advanced Therapies Skills Training Network (ATSTN) and RESILIENCE Medicines Manufacturing Skills: Centre of Excellence

**Skills into Public/Private Partnerships**

- How do skills connect to public/private partnerships – what role do you see for them and what are good examples of them; and what skills do you think people need to move across these workspaces
- This is dependent on the individual and where their path will lead – change in mentality across generations about not needing a job for life, younger people are looking for options to change - this leads to need to bring in early adopters, bringing in collaborative training programmes is actually building in entrepreneurial programmes but also building in policy programmes as well - this provides exposure to a little bit of everything and allows them to decide what they like (e.g. liking industry and heading that direction or deciding it is not for them because they are more process bound and wanting to go down the policy route) - getting early exposure is key to making these decisions
- Kent to develop PhD programmes that will allow the student to transfer their degree into a business class – so if there is a student early on who is not driven by publishing scientific papers, but business will drive them, then their degree could be transitioned into something that would ultimately become a business at the end of their degree - this is something that is not very common but there are potential advantages and could be an area in specific sectors where you can get a public/private partnership set up to facilitate
- Doctoral Focus Awards – key thing that is trying to be introduced with it is that the students can drive not only the route of the project into translation and entrepreneurship but also to choose what kind of training they want (including a

drop down menu where they can choose) – can be responsible innovation, section on policy, etc. - this allows for students to go down the entrepreneurship route or they can choose to try a different project in a different area
- This echoes previous points on the importance of transferrable skills - important to tie everything together for the training programmes for developing future leaders – this can be delivered through collaboration already in place across Scotland

**Potential for New University Training Programmes/Degrees**

- Question if there is a role for a qualification from universities that is not like a standard MSc and is not a lifetime requirement like a PhD, but something like an MRes, a two-year programme, that is much more embedded with industry – would this be a useful approach in thinking about training might be redesigned not just in terms of what is already offered, but with new structures
- Noted that this had been done previously and was a difficult progress with students in MChem were starting in Edinburgh, applying to go abroad or into industry, and then returning to Edinburgh for 4th year (and having to struggle to find accommodation in Edinburgh), they would then have exams to sit and all the other requirements of their degree
- Another degree was also flipped – four years at Edinburgh and then in 4th year, after exams were completed, they apply for industry and a year abroad and this leads to better chemistry and leads to students all over the place
- Further noted that students are interested in analytical chemistry and that they need to be trained in this area due to its popularity - an advantage of the Scottish system is the one-year master's degree
- Could be beneficial to have a one-year EngBio degree, similar to IBioIC's model
- IBioIC's master's programme – what works well in it is that the final three months of the one-year programme have students in placement with industry. Organisations are relatively used to setting up these placements is because of the IBioIC industrial membership, giving access to two or three hundred companies that also have membership and each of them can offer placements. When it was initially set up, they tried to tell it to companies that they would get an extra set of hands for three months but in practice, this is not useful for the companies because it is not enough time to get anything useful from the student. This meant that the students were a drain on company resources during that time but what companies do use it as a recruitment tool so the companies pick up these students and then offer them a job at the end of it. Companies would also recruit students because they had done this degree programme even if they had not worked with them because they had done a placement.
- Companies have put money into this because it gives their staff an opportunity to 'stretch their wings' and gain broader knowledge along with accessing the talent that they might need in the future. Many students are potential recruits once their PhDs are complete and this was essentially a four-year interview with them and

during this, they could be developed to the companies' preferences, allowing them to come into the company with knowledge. Finally, the companies are interested in the actual research.
- From the academic perspective, they are really into their own science and need to publish papers, they want positive outcomes for students and they are not concerned about company specifics. It did not matter that this kind of collaboration had diametrically opposed interests because at the heart of it was good experience for students. This is a good example of industry/academic collaboration.
- The companies that students are sent into, need to really embrace the training aspect of it

**Skills / Re-training for EngBio**
- Strong support for these partnerships in principle in terms of know they develop training and mutual understanding of different sectors. Is there anything distinctive about EngBio in this context? Is there a particular utility for partnerships in this space for EngBio or is EngBio no different to any other industry in that similar broad lessons apply?
- Need discussions around retraining – there are likely highly skilled technicians in other fields that could be retrained for EngBio, especially in academic research – many technicians that cannot be sustained because the project has ended and they need to go elsewhere and might struggle to find employment because they do not have a set of skills that can be easily supplied and retrained. Rather than losing the skills they currently carry, could be retrained to provide diversity that organisations might not have. Some people have experience in other areas that can be retrained in EngBio and provide that kind of is currently missing.
- Missing from the list is entrepreneurial skills. Huge amount of investment in the UK for training for commercialisation, so not the business development of collaborating with a company and being taken on by that company, but actually what skills do you need to start your own company to take this forward. Need to skill students in opportunities and commercialisation, in being able to take risks. University academics might not be the best people to advise on risk, suggestion of bringing in externals to give this training, or work with people like IBioIC to provide this training. Hard to empower and enrich someone to do this when you are comfortable and are not going to take these risks.

**Spin-Outs / Start-Ups**
- Does it feel like there are plenty of ideas for companies and for things to spin out around or do you think that the idea is there but people just do not know how to then turn that into something tangible in a company? Or is the gap because students are not trained to think of new opportunities and new applications of things in terms of that type of innovation?
- Quite a number of opportunities that could be taken to come up with. Important to empower those in the labs to do this when you are in a comfortable position (one

where you are not likely to take a step out from a secure job to start your own company) and encourage them to undertake training programmes to help them do this. Important that everyone has to make their own decisions about what to do next, cannot expect every student that does a training programme to then go yes, this is what I want to. There cannot be an expectation for everyone who goes on a programme to have a company at the end of it.

- Ongoing entrepreneurial campus work in Scotland – lots of work being done to bring through entrepreneurial thinking, confidence networks, skills, kind of covering across the board in entrepreneurialism. This is a connected programme with a number of entrepreneurs in residence. Many of the universities across Scotland now have an entrepreneur in residence who is available to support people wanting to take that step. This is important because academics might not necessarily be that person unless they have experience or an entrepreneurial mindset and/or relevant experience in spinning out companies. Having a separate entrepreneur in residence can help guide and act as a mentor that can be pulled in for advice. Noted that this has not been promoted across the universities but is something that is happening and should be helped with. Noted that empowerment is key.
- Need movement into entrepreneurial education space. What is lacking is the confidence to get networks going – there are ideas there, but getting people into the entrepreneurial mindset of recognising when a research idea could be commercialised is only the first step. Once that seed is planted, getting people to think differently about their research and also equipping them with confidence and empowering them to actually follow through. Many of the skills are there already, just needing support and help. If people are more empowered then they will go and look for that and find those resources. At the moment, people need to be inspired to go and do it before considering what additional supports are there because there are things happening in this space.
- Edinburgh acknowledges students that publish their work during a degree with a publication prize in the Chemistry department, but they could consider putting together a business idea prize within the sustainable chemistry course asking students to come up with a save the world idea, spin out a company to save the world
- Scotland does not toot its own horn enough in terms of successes and strengths
- For spin-outs, there is a fear of failure because it is looked down upon here, rather than in the US where you are unlikely to be hired without learning from a few business failures. Unsure how to get around this in the UK
- SNIB – they want a full formed business plan that is going to deliver – suggestion that students could present to them, Dragon's Den style, and earn funding from them for spin-outs. SNIB could support young people's ideas, that are not fully fledged, but when they are, they would have SNIB ready and available to help take them to the next level. BBSRC also sometimes run something similar.

- Questions about whether this would be supported by PhD supervisors – some would object to their students doing training/work that is not directly related to their degree or the next publication and would take them out of the lab
- Potential for one chapter of a PhD thesis could focus on the student having done financial or commercial analysis of an opportunity towards how their research could be commercialised and their analysis could centre on why/why not this would work and/or these are the things that would need to change to make it viable - would be good experience for the students, but questions if this would be accepted
- If the analysis was positive and it looks like a viable idea, then the student could start moving down programmes that would provide spin-out support to turn it into something tangible
- Noted that this is asking a lot of PhDs and postdocs – asking them to do the research, convert it into papers to get the next batch of funding in, but also be entrepreneurs as well. Academics/universities are frequently asked to do too much.
- Have to identify the mix between the academic career path hamster wheel, which is papers publications, whereas industry is looking for tangible economic impact - difficult to marry these together and can only be done by someone who is hardwired differently than a typical academic
- If Scotland under-performs in scale-up and commercialisation in EngBio (as noted to be an emerging theme) then more support for this would seem wise
- Internships and secondments across sectors could completely change how we work with other sectors - communication is a key to this but actually listening to one another is the part of communication that we skip over and embedding people in different job families would bring a level of cross-pollination that could have lasting impact
- Funding schemes that leverage business contributions to academic projects are hugely valuable for growing partnerships (e.g. CASE, IPA, LINK, Innovate UK)
- Public-private partnership is absolutely vital for EngBio for the food system - breeders can implement genetic gain at global scale
- All these types of programmes are essential for graduate retention and therefore skills and knowledge retention

**Plenary session**

- Strong desire of Scottish academic community to generate spin-out and economic impact
- Lack of lab space and follow-on space to capitalise on Scottish IP
- Desire to see better engagement with investment community - annual spin-out showcase for Scotland a great idea (low cost, high impact)
- More scale-up facilities - specific focus, should be distributed to relevant areas of industry

- Scale-up need cap-ex and recurrent cost supported, otherwise facilities become too expensive to use if only support cap-ex
- EngBio is a long game and there are some intermediate steps e.g. cellular assay systems to enhance conventional drug discovery / therapeutic development
- Electricity - cost of power still linked to gas price. Can we decouple - use and guarantee low price clean power to companies to generate investment
- International talent acquisition
- Advanced materials, smart materials, meta materials, plastic replacements an important EngBio-relevant high-growth area
- Small country - very connected public and private sector so very agile in mobilising the community where needed - just the right size to enable different sectors to work together - need to make it more practical and specific and less specific
- Opportunities in decommissioning oil/gas sector
- Natural resources and feedstocks
- Grangemouth as a future home for green chemicals
- Strength in human health
- Risks - recent changes in migration policy
- Hiring freezes in universities could impact talent pool
- Need to support more translational research
- Very long list of specific actions e.g. visible champion for EngBio for Scotland, public promotion and changing the public perception on what EngBio actually is, and what it can do for us
- Policy and regulation - improve clarity - become champions in that sense to make a more friendly environment
- Context
- Policy - policy champion – clear advocate to politicians, public sector, wider public - reassure people whilst not obfuscating risks
- Environmental:
    - geography and climate are great - renewable energy – energy costs
    - water availability and challenge sand opportunities therein
    - connectedness of communities in Central belt
    - openness of stakeholders within Scotland, prioritising the wider social good
- Geopolitical:
    - uncertainty - patterns of international investment, energy prices
    - challenging international context
- Collaboration
- Student training
- Challenges of how to represent and sell these opportunities to traditional academic funders - huge workload involved in this

**Final discussion**

- Completely agree that the scale up facilities need operational funding so they can offer cheap services to industry - this is crucial to small companies in particular - it is clearly an indirect subsidy to our SMEs but all other countries do this
- Notion of champions great - inclusion of an external champion and advisor, for example the director of the Joint Genome Institute, (DOE funded and based at Berkeley labs) who was previously at Dow and has Scottish roots, could be very helpful start
- A shout-out to SFC and Scottish Enterprise for supporting the IBioIC FlexBIO scale up facility at HWU - this is a real asset for Scotland - public funding is needed to enable the translational support needed in the sector
- Research knowledge exchange project - value of research project for SFC - highlight the value that research contributes to Scotland achieving its strategic goals
- Investment, not just a subsidy
- Chair's comments - in context of other work from SSAC - challenge for renewables is capital cost rather than revenue cost. Public investment needs a high degree of confidence. Scotland has plenty of resource for wind energy but lacking infrastructure for transmission of energy. Onshore wind often has local objection. Interesting opportunities - AI facilities in Scotland (lots of energy requirement, easier to transmit data via optical fibre vs energy).
- Effective and efficient use of renewables for economic growth