

National Plan for Industrial Biotechnology

Realising our net zero ambitions

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Ministerial Foreword



Ms Kate Forbes, MSP
Cabinet Secretary for Finance and the Economy

Our vision for Scotland is a strong economy with well-paid jobs and growing businesses, that maximises Scotland’s strengths and natural assets to increase prosperity, productivity and international competitiveness, and enables a just transition to net zero.

The National Strategy for Economic Transformation, launched earlier this year, sets out how we aim to deliver this plan over the next ten years. This includes identifying new market opportunities where Scotland has the potential to develop world-leading industries, building on our technological strengths. Industrial Biotechnology is highlighted as one of these key industries. Its innovative and sustainable methods of using biological processes to create the products we need, designates it a crucial sector for transitioning Scotland away from fossil fuel based manufacturing to greener alternatives.

It is therefore encouraging that the bold targets published in Scotland’s National Plan for Industrial Biotechnology back in 2013 will be met ahead of schedule. We could not have imagined ten years ago that we would exceed the target trajectory to the extent that the Industrial Biotechnology Innovation Centre (IBioIC) has set out new stretch targets in this final refresh of the Plan: of 220 active industrial biotechnology companies, £1.2bn turnover and over 4,000 direct employees by 2025.

IBioIC’s work to support and develop the industry should be recognised as a significant factor in this growth. Since it was established in 2014, IBioIC has excelled at providing technical expertise and advice to companies, opportunities for networking and collaboration, and exceptional training and development programmes delivered in conjunction with its academic partners.

We are proud that Scotland is becoming known internationally for its Industrial Biotechnology expertise, of its success to date, and that the sector is continuing to expand and attract investment. As we look not only to our own net zero target of 2045, but to the impact that the climate emergency is already having on communities across the globe, we must embrace the opportunity to be leaders in new markets and industries like industrial biotechnology to enable Scotland to transform its own economy, while providing a model of innovation and sustainability to others.



Mr Ivan McKee, MSP
Minister for Business, Trade, Tourism and Enterprise

Introduction

Industrial Biotechnology (IB) offers green and sustainable ways to reduce our dependence on fossil fuels, which underpin so many of the products we use as part of everyday life. IB provides a way to secure local supply chains, reduce our impact on the environment, achieve net zero by 2045, create green jobs, and fuel economic growth.

In 2013, the National Plan for Industrial Biotechnology (National Plan) set out a roadmap to transform the competitiveness and sustainability of multiple sectors across Scotland, under the IB umbrella, ensuring we can manufacture everything we need without relying on fossil fuels. Over the past decade, significant progress has been made towards that transformation. However, with a climate emergency upon us, there has never been a greater need for the nation to transition to bio-based manufacturing, and to do it swiftly.

Scotland's National Strategy for Economic Transformation (NSET) – published in March 2022 – reiterates that need. The report outlines Scotland's ambition to become a nation of entrepreneurs and innovators, building resilient supply chains in new industries, embracing technological change and scientific advances to respond to the climate and nature crisis. IB is specified as one of the key industries that will accelerate the economy towards net zero.

This refresh of the National Plan aligns with many key aspects of the NSET, in relation to innovation, skills, economic growth and sustainable supply chains.

As well as outlining the progress to date and future ambitions, the updated National Plan sets out the priority actions needed to accelerate growth of the prospering IB industry, centred around six themes:



POLICY: Creating a policy environment that facilitates the adoption of IB.



INDUSTRY ENGAGEMENT: Increasing awareness of biotechnology as a tool for transformation and sustainable growth.



INNOVATION: Facilitating innovation in IB and enhancing its adoption across multiple industries.



SKILLS: Generating rewarding and high-quality careers in biotechnology and providing the skills to meet the changing needs of the growing workforce.



SUSTAINABLE MANUFACTURING: Greening supply chains and transitioning industries towards sustainable production.



INFRASTRUCTURE: Making Scotland the go-to destination to incubate and grow bioeconomy businesses to scale.

Scotland's vision

Scotland will be the go-to destination to incubate and grow bioeconomy businesses to scale and to manufacture products and services, desired by consumers and end-users, that will facilitate the nation's net zero 2045 ambition.

Scotland offers a world-class innovation ecosystem that will enable great ideas to become investable business propositions and marketable products through timely and targeted support for start-ups, access to state of art technology and facilities, provision of local scale-up infrastructure, access to

industry-ready skills, and a supportive policy and regulatory framework.

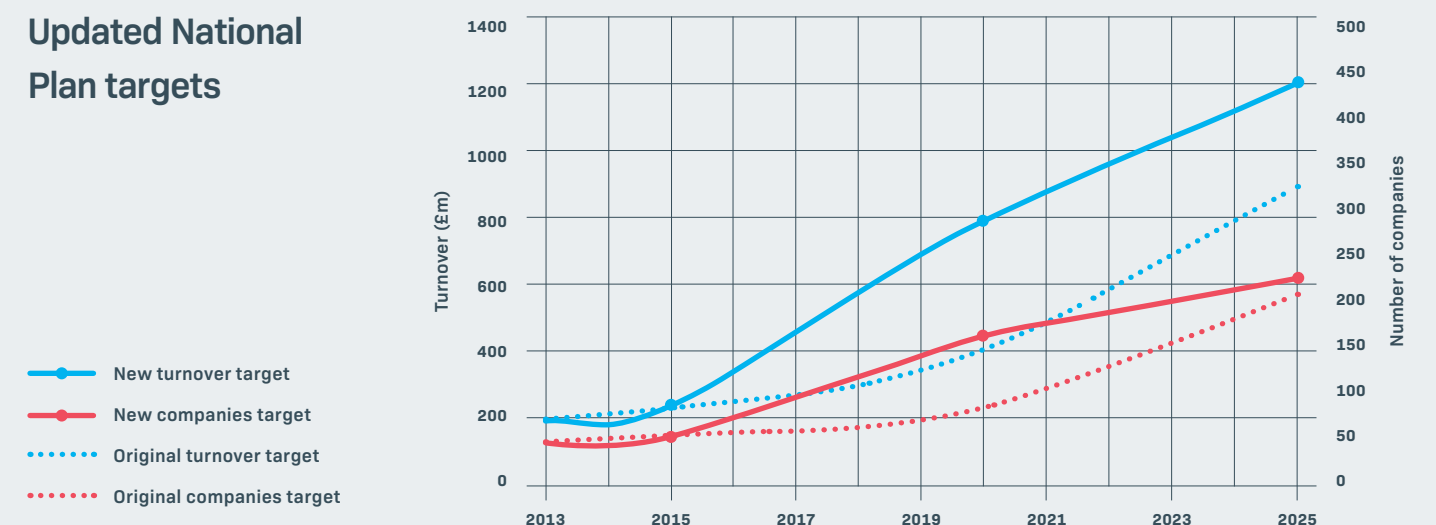
The original National Plan set targets of 200 active IB companies, £900m turnover and over 2,500 direct employees by 2025. The industry has already achieved great success and is well ahead of schedule, therefore,

new stretch targets have been set.

Scotland has a vibrant and prosperous bioeconomy and by 2025 has ambition to further increase the number of companies active in IB to over 220, increasing associated turnover to £1.2bn, and creating an industry with over 4,000 employees.

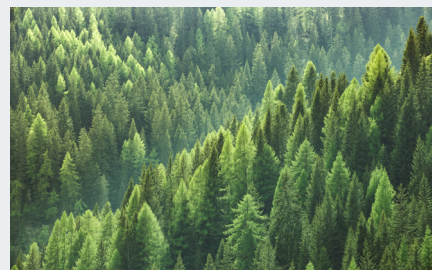
	State of play in 2013	Original targets for 2025	State of play in 2020	New targets for 2025
Companies actively involved in IB	43	200	147	220
Estimated turnover	£189m	£900m	£797m	£1.2bn
Direct employees	1,103	>2,500	>3,000	>4,000
GVA contribution	£61m	>£250m	>£235m	>£360m

Updated National Plan targets



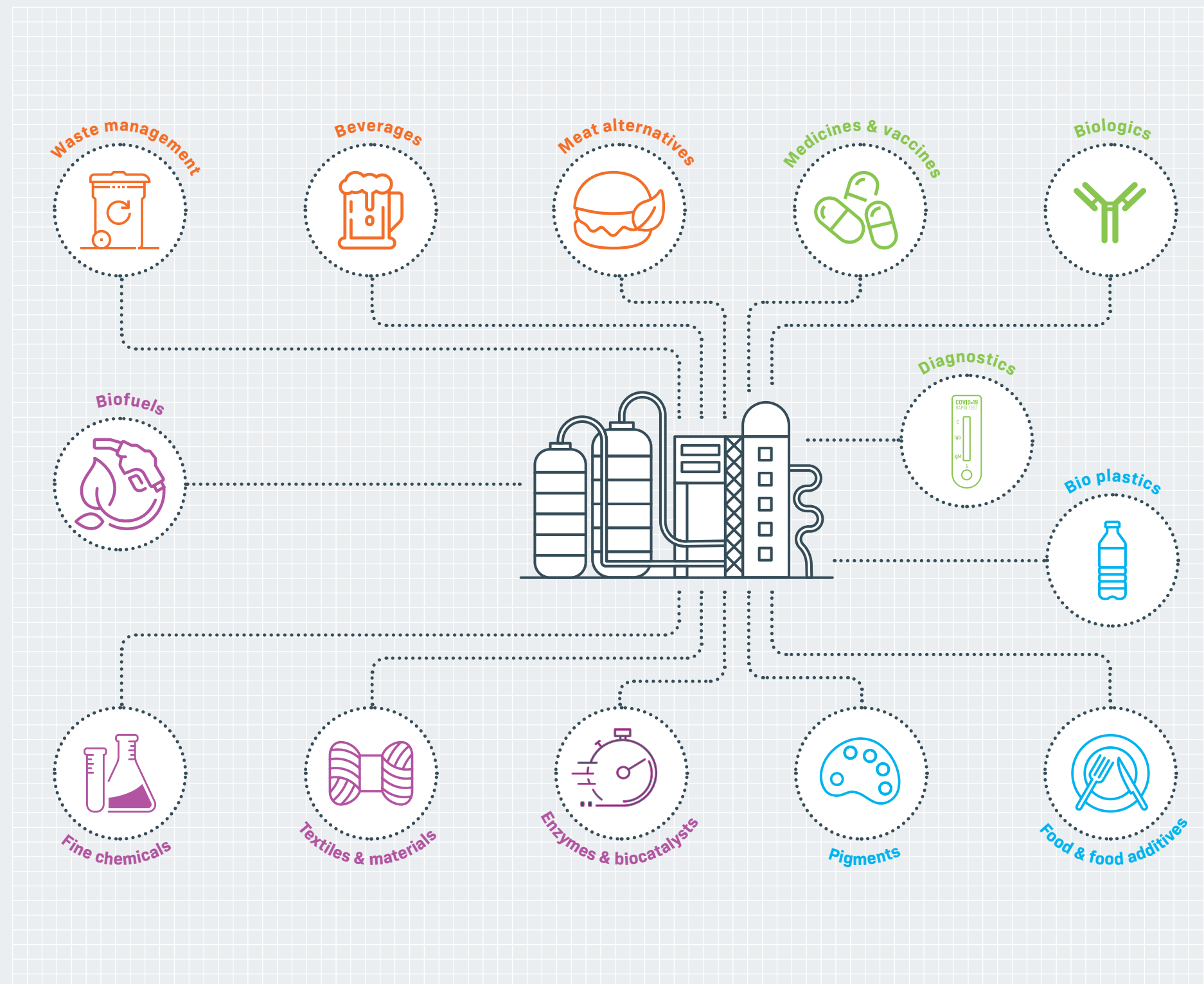
What is industrial biotechnology

Industrial Biotechnology uses plant-based and waste resources (biomass), and/or bio-based processes to create chemicals, materials, consumer products, novel foods and feed and medicines. It offers green and sustainable alternatives to fossil fuels to produce a wide range of products and energy.



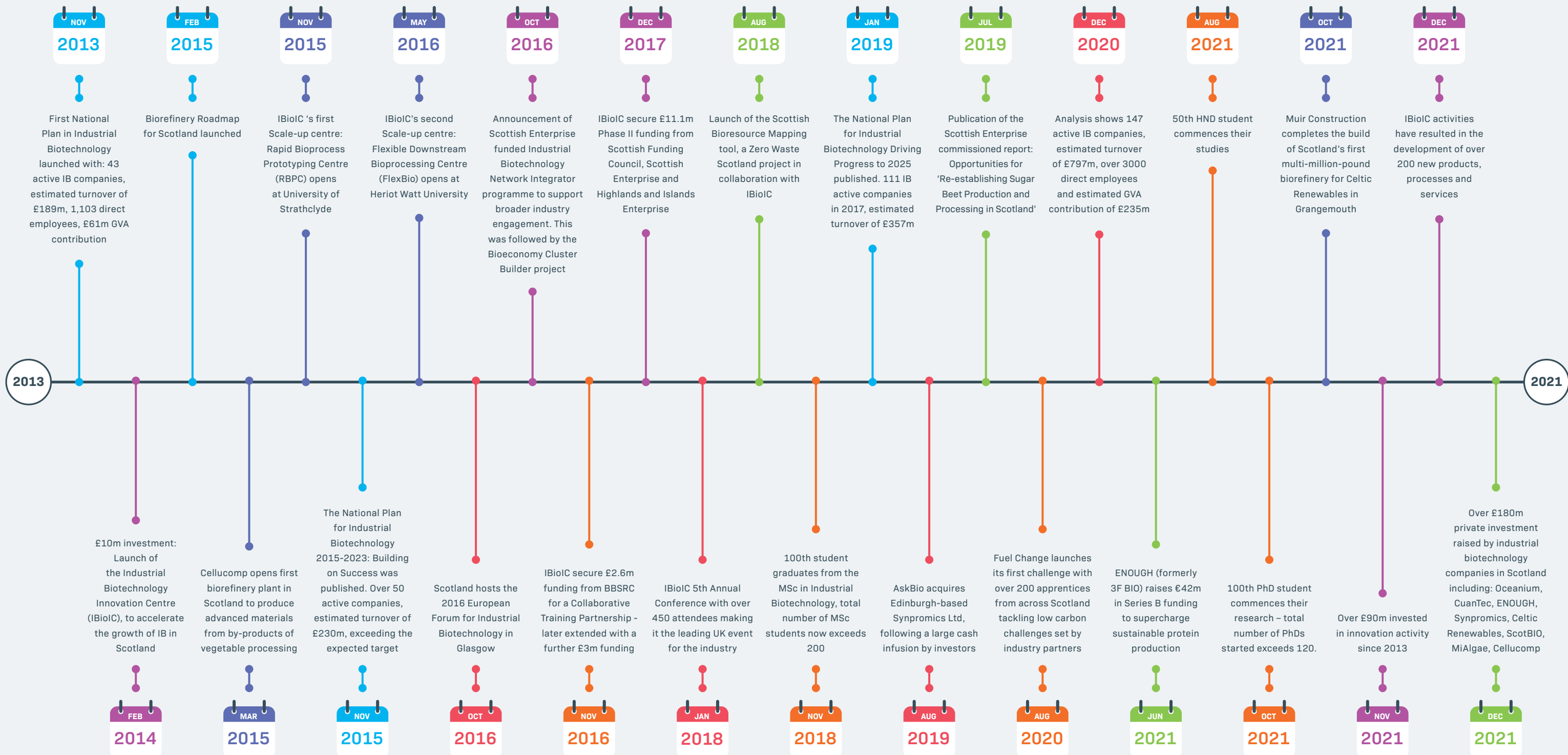
Biomass inputs could include:

- ▶ Agricultural biomass
- ▶ Forestry biomass
- ▶ Marine biomass
- ▶ Food and food processing by-products
- ▶ Whisky co-products
- ▶ Carbon dioxide



Key achievements timeline

KEY: POLICY INDUSTRY ENGAGEMENT INNOVATION SKILLS SUSTAINABLE MANUFACTURING INFRASTRUCTURE





POLICY

Creating a policy environment that facilitates the adoption of IB

Following the first publication of the National Plan in 2013, and the establishment of IBioIC in 2014, the public profile of IB has been on the rise.

Scottish Government policies have increasingly shown support for IB as a key industry for growth and for transitioning Scotland's manufacturing sector from petrochemical-based industries to sustainable alternatives. The inclusion of IB in the recent National Strategy for Economic Transformation (2022) is recognition of the vital role that IB can play in Scotland's economic growth and drive to net zero.

Further progress has been made in the policy arena since the 2019 refresh of

the National Plan. IB features strongly as a key opportunity within Scottish Government strategies including [Climate Emergency Skills Action Plan \(2020\)](#), [Global Capital Investment \(2021\)](#), Scottish Government plans for [Inward Investment \(2020\)](#)

In addition, leading economic influencers have voiced support for biotechnology, including the Scottish Council for Development and Industry's (SCDI) 2030 [Blueprint for Scotland's Economy \(2021\)](#).

Looking to the wider UK, the [UK Innovation Strategy \(2021\)](#) champions many of the ambitions of the National Plan and recognises engineering biology as one of the seven technology families of UK strength and opportunity.

Though there have been many positives, there is still much to be done in securing IB positive policy. The more recent focus from governments on flagship net zero and just transition policies for the future will support the overarching ambitions of the National Plan: IB is an essential cross-cutting technology that can help deliver sustainability targets.

Public acceptance and trust in IB technology is also essential to create future consumers and viable markets. This will require future policy levers to accentuate the positive contributions IB can have relating to economic growth, mitigating climate change and building sustainable futures.



Public acceptance and trust in IB technology is also essential to create future consumers and viable markets.



Key Target Areas for Securing Policy Support:

- ✓ Chemicals
- ✓ Food and Drink
- ✓ Agriculture
- ✓ Pharmaceuticals
- ✓ Waste Management
- ✓ Sustainable Fuels
- ✓ Aquaculture
- ✓ Circular Economy

Ambition	Action
All IB active organisations to make net zero commitments, showing their dedication to meeting the Scottish Government's net zero targets for 2045.	Engage and support IB active organisations encompassing the industry, business, public sector, research communities, and further education, to make their net zero commitments public.
Promote greener public procurement and drive change in supply chains.	Explore international examples of successful use of policy levers to change behaviours and work with UK Government, Scottish Government and Local Authorities to consider measures to promote bio-based products. Work collaboratively with industry to create industry standards supporting bio-based labelling.
Enhance the wider public understanding and acceptance of IB.	Drive broader and deeper engagement with key stakeholders and public facing trusted organisations, increasing public awareness, and encouraging a positive opinion of IB technology.
Ensure Scotland has a positive policy environment to grow bio-based businesses and increase trade and investment for the benefit of the economy.	IBioIC's new Policy Forum will work with the Scottish Bioeconomy Council to inform Scottish Government policy ensuring it is supportive of IB and provides knowledge-based decision making. Partner with SDI to engage with the global private investor community to increase inward investment in IB projects in Scotland.
To make life-long careers in IB more attractive.	Support the Scotland-wide policy for increasing green jobs as part of a just transition and support the industries and economies of the future while ensuring there is appropriate skills and training policy provision.



INDUSTRY ENGAGEMENT

Increasing awareness of biotechnology as a tool for transformation and sustainable growth

Alongside the climate emergency, the Covid-19 pandemic and Brexit have undoubtedly impacted Scottish businesses and highlighted a significant opportunity to both secure and green supply chains. Businesses large and small, across a range of sectors from consumer products to chemicals, have begun to take action towards net zero, with many of the alternative products and processes underpinned by biotechnology.

Since the last update of the National Plan in 2019 the number of companies that deploy IB has risen from 111 to 147, an increase of over 30%. The turnover attributed to those companies has also increased from £357m to £797m, an increase of over 220%. Although some of this growth will be attributed to the maturing of businesses already active within the Scottish bioeconomy, the activity of the bioeconomy is growing at pace and IBioIC has been a key driver through the connection of industry, academia and government, catalysing innovation, and accelerating commercialisation.

IBioIC engages with industry through:

- ▶ Supporting the creation of new companies and university spin-outs: collaborating with Scottish Edge, Converge Challenge, the Royal Society of Edinburgh Enterprise Fellowship scheme, launching a new spin-out award programme and providing mentorship and technical consultancy.
- ▶ Accelerating the growth of existing companies active in IB: linking to investors, de-risking innovation through project funding, and providing practical scale-up support and bioprocess training.

- ▶ Raising awareness and encouraging broader adoption of IB across non-traditional sectors. The Bioeconomy Cluster Builder project, working in partnership with other networks, has hosted 22 events with over 1200 participants to date.

While the IB sector in Scotland continues to grow, it still needs intervention and support to rise to the challenge ahead. The continued presence of support networks such as IBioIC is crucial to engage and support both existing IB businesses and those looking to adopt it in the future. Work is also still needed to cement the growing IB cluster within Scotland and make it an attractive proposition for inward investment from global companies.

Key sectors for growth:

- ✓ Biopharmaceuticals and pharmaceuticals
- ✓ Food and drink
- ✓ Consumer products
- ✓ Textiles
- ✓ Construction
- ✓ Marine
- ✓ Agritech

Ambition	Action
Increase adoption of biotechnology across Scottish industries to grow the bioeconomy and support the drive towards net zero	Continue funding of IBioIC as a vehicle to promote the benefits of adopting biotechnology across multiple industries.
Support the greening of existing and new supply chains through biotechnology, including more local and circular solutions.	Work with industry, government, and enterprise agencies to develop more sustainable supply chains and create a standard approach for assessing carbon impact of full value chains, driving the change to net zero.
Enhance the wider public understanding and acceptance of IB.	Drive broader and deeper engagement with key stakeholders and public facing trusted organisations, increasing public awareness, and encouraging a positive opinion of IB technology.
Position companies utilising biotechnology as attractive inward investment opportunities for Scotland.	Work with government and enterprise agencies to develop a compelling proposition to promote Scotland as the go-to destination to incubate and grow bioeconomy businesses to scale.
Help companies access finance to support their innovation journeys.	Looking at best practice, design and deliver an accelerator programme to enable companies to secure investment.



INNOVATION

Facilitating innovation in IB and enhancing its adoption across multiple industries

Innovators develop new, or refresh existing, products or services to create value, which can be technological, environmental, social, and economic. By its very nature, innovation drives change, and change is imperative if we are to address the climate emergency.

IB offers innovative solutions to help society reduce its dependence on petrochemical-derived products and services, thereby transitioning to greener, bio-based alternatives. As Scotland strives to achieve net zero, there is an important opportunity to nurture biotechnology innovation and accelerate its deployment.

Scotland continues to deliver world-class research and innovation in biotechnology, which has been translated into new businesses and company growth. Since its inception, IBioIC has seeded 120 collaborative research and development projects with over 60 companies – an investment of ~£6.4m which has leveraged over £28m in funding and led to the development of >200 new products, processes, and services. IBioIC has also supported over 200 companies in their innovation journeys, providing information, guidance, technical expertise, funding, skilled people and training to enable them to deploy biotechnology for business growth.

Scotland is a key location for investment in the emerging biotechnology industry, winning 3% of the new jobs created in the field in Europe over the last three years and Scotland’s chemical sciences research base is consistently ranked within the top three in the world. This gives a strong base to drive growth of the bioeconomy for Scotland.

However, continued public and private investment in innovation is essential to drive forward new ways of delivering essential green products and services.

► **There is still a need to demonstrate the role of bio-based processes in the decarbonisation of our world, beyond energy and fuel – whether in food and drink, materials and textiles, medicines, consumer products, packaging, and construction.**

► **The adoption of biotechnology innovation will require ongoing encouragement and support. In particular, industry needs access to the scale-up infrastructure needed to successfully translate innovation into industry-ready products and processes, which can be commercialised on global markets.**

“ Scotland is a key location for investment in the emerging biotechnology industry, winning 3% of the new jobs created in the field in Europe over the last three years ”

Ambition	Action
Clearly articulate and champion the application of IB in the decarbonisation of products and services.	IBioIC to continue to be the key advocate and champion for IB in Scotland, raising its profile internationally and being the single point of contact for all stakeholders.
Accelerate the adoption of IB across multiple sectors to improve their sustainability and longer-term growth, while achieving the end goal of net zero.	Continue to broker and fund collaborative partnerships that can deliver biotechnology solutions to meet the pre-competitive needs of industry.
Build mechanisms that can generate new collaborations which facilitate value chains, business growth and new market opportunities for biotechnology.	Create an online tool that maps IB supply chains and enables companies to identify potential suppliers and customers, optimising new supply chains.
Communicate the benefits and values of IB, ensuring practitioners can clearly articulate the benefits of applying biotechnology in industry.	Nurture communication between sectors to enable the exchange of new ideas that help to improve business efficiency and de-risk new product development, using case studies to articulate benefits and value.
Create an entrepreneurial environment with the skilled talent pool needed to drive business creation and growth.	Secure talent for growth through continued investment in skills and training.
Enable companies to measure and reduce emissions associated with their innovations during development.	Develop expertise and tools to support companies and enable them to measure, benchmark and reduce their emissions and other environmental impacts.

SKILLS

Generating rewarding and high-quality careers in biotechnology, and providing the skills to meet the changing needs of the growing workforce

The IB workforce in Scotland grew from 1,100 jobs in 2013 to over 3,000 jobs in 2020, well ahead of the original target of 2,500 jobs by 2025. However, if we are to embrace the opportunity to green our supply chains, and grow the sector, we need to continue this upward trend. The development and delivery of skills to meet changing industry needs is essential.

Since 2012, increased STEM activity through the Raising Aspirations in Science Education programme (RAISE), the Leaders in Science programme and the creation of Foundation and Modern Apprenticeships in scientific disciplines has enhanced the skills base.

“ Current and projected demand for qualified people in the sector significantly exceeds supply. ”

To date, IBioIC’s Skills Programme, driven by industrial demand, has delivered

- ▶ 50 HND students in IB,
- ▶ more than 200 MSc students in IB, and
- ▶ more than 100 PhD students.

Other achievements in skills and training include:

- ▶ Fuel Change (see included success story), an initiative that encourages apprenticeships and graduates to develop low carbon solutions for industry challenges.
- ▶ Launch of the UK Advanced Therapies Skills Training Networks, led by Roslin Cell Therapies in collaboration with the Scottish Universities Life Sciences Alliance (SULSA), IBioIC and academic institutions.
- ▶ Establishment of the National Transition Training Fund, delivering upskilling and reskilling courses for life and chemical sciences.
- ▶ Development of the Green Jobs Workforce Academy by Skills Development Scotland.

Skills are crucial in facilitating Scotland’s transition to net zero and will continue to play an important role in realising the ambition of a just transition that is both fair and inclusive. We need to adapt to the changing demand for skills, creating an education and training system and a labour market that are more agile, proactive, responsive, and resilient than ever before. Even accounting for the increase in provision of training, current and projected demand for qualified people in the sector significantly exceeds supply.

As companies grow and move to manufacture products at commercial scale, the demand for technician-level skills increases dramatically. This is already proving challenging for the early adopters of biotechnology. There is also an increasing need for skills that support related industries to transition to a greener workforce. The UK Innovation Skills Transition Centre project, a £4m Investment as part of the Falkirk Growth Deal, will start to address this need.

Finally, to progress to net zero, industry will also need to be equipped with the skills and tools to measure the environmental impact and sustainability of their new processes and products, ensuring the advantage of bio-based over traditional chemically derived products.

Ambition	Action
Develop education pathways with clear progression routes and career options, supporting the creation of a diverse workforce.	Establish a Biotechnology Skills Advisory Board to recognise industry needs, identify gaps in skills and training, develop education pathways and promote equality, diversity and inclusion.
Greater engagement and education around the possibilities of biotechnology.	Broaden engagement with STEM activity through the expansion of the RAiSE scheme and the UK Innovation Skills Transition Centre to raise awareness of IB as a technology and career option.
Increase uptake in skills training relative to technician roles.	Promote more broadly the opportunities in modern and foundation apprenticeships and HND courses to address the technician-level skills shortage.
Support the workforce to upskill and reskill enabling transition into new green jobs.	Develop CPD courses to support lifelong learning aligned with industry skills needs and engage with the appropriate growth and city deals.
Support companies with skills development to enable net zero ambitions.	Develop a suite of tools for life cycle analysis that can be embedded within the industry alongside appropriate skills training and support.

SUSTAINABLE MANUFACTURING

Greening supply chains and transitioning industries towards sustainable manufacturing

Scotland is well-positioned to lower its reliance on petrochemicals, to grow the bioeconomy and increase sustainable green jobs. The future plans for delivering renewable energy will power bio-based manufacturing and contribute to net zero carbon targets.

At present, fossil fuel-derived feedstocks are essential manufacturing building blocks for industries ranging from fuels, chemicals and pharmaceuticals to the consumer goods and polymers sectors. A sustained focus not only on primary production but on proactively constructing new low carbon supply chains is needed and this will require growth in infrastructure, innovation support and skills. Mapping bio-based manufacturing solutions onto the challenges of the main carbon-emitting regions in Scotland will be essential and the need to identify and quantify significant resources of sustainable biomass or waste streams on which to base this manufacturing must continue.

Scotland has made good progress developing its bio-based economy, with notable activity around whisky co-products (e.g. Celtic Renewables, MiAlgae, Horizon Proteins, BioPower Technologies, Scotch Whisky Research Institute and IBioIC), food processing by-products (e.g. CelluComp, Revive Eco) and marine biomass (e.g. CuanTec, Oceanium).

However, techno-economic barriers still exist for using inputs such as forestry biomass, other than for the generation of bioenergy through combustion. The Scottish Crown Estate Act 2019 prohibits the wild harvest of certain kelp species inhibiting the growth or recovery of the plant, but small-scale wild harvesting does take place in Scotland and there is growing interest from industry in the cultivation of seaweed at scale.

The most significant progress has been made around the use of agricultural biomass and a successful Scottish Enterprise-funded viability study, led by IBioIC, has demonstrated the potential for the reintroduction of sugar beet as a break crop and its subsequent biorefining to a sugar feedstock for a range of bio-based manufacturing processes.

Zero Waste Scotland, Scotland's circular economy expert with dedicated bioeconomy expertise and resources,

will soon deliver an update of the highly successful Scottish Bioresource Mapping Tool (launched in 2018). This will continue to be a key asset for businesses looking for sustainable bio-based feedstocks.

Challenges still exist for businesses in making the transition from research and development into manufacturing at scale. Scotland has an opportunity to create demonstrator-scale infrastructure that can accelerate the commercialisation of cutting-edge science. Investments in advanced manufacturing innovation in Scotland such as the National Manufacturing Institute for Scotland (NMIS) and Medicines Manufacturing Innovation Centre (MMIC) should also be harnessed to drive opportunities to create new indigenous, sustainable bio-based manufacturing and secure income from inward investment and the export of cutting-edge technologies.

Scotland's key bio-based resource streams:

- ✓ Agricultural biomass
- ✓ Forestry biomass
- ✓ Marine biomass
- ✓ Food and food processing by-products
- ✓ Whisky co-products
- ✓ Carbon dioxide

Ambition	Action
Provision of up-to-date data for industry on the quantities, composition and location of usable biomass or waste appropriate for conversion to high value products via IB.	Refresh and enhance the Bioresource Mapping Tool regularly to capture the six key resource streams.
Provide scale-up capabilities available to support the transition from R&D to manufacturing and de-risk larger scale investment.	Continue to grow IBioIC's Scale-Up Centre capability and establish a further Bioeconomy Accelerator Pilot Plant at Grangemouth.
Work closely with carbon-intensive regions in Scotland to provide sustainable manufacturing solutions, contributing to net zero carbon targets.	Engage with relevant city growth deals and key regional initiatives such as the Grangemouth Future Industry Board to transition major petrochemical clusters and carbon-intensive industries and support proposed innovation and infrastructure projects in these clusters.
Grow IB opportunities based on bioresource feedstocks to develop new supply chains across related sectors.	Apply the bio-based manufacturing expertise developed in IB across wider sectors such as advanced therapies, pharmaceuticals, textiles and food and drink.
Develop an indigenous sustainable supply chain of sugar beet to form the foundations of Scotland's future bio-based manufacturing sector.	Continue to drive all stakeholders – agriculture, manufacturing, finance and government – towards creation of sugar beet agriculture and associated infrastructure.

INFRASTRUCTURE

Facilitating innovation in IB and enhancing its adoption across multiple industries

Scotland's world class expertise and facilities provide the nation with a competitive advantage in IB and green tech.

Scotland has world class academic expertise in the underpinning enablers for IB (including engineered biology, big data, advanced metrology, fermentation, automation and robotics) and unique facilities such as the University of Edinburgh's Genome Foundry and the International Centre for Brewing and Distilling hosted by Heriot-Watt University. The IBioIC Scale-up Centres have a highly skilled team to offer support for upstream process optimisation, downstream processing and data analysis up to 30L scale. These assets support a healthy pipeline of IB start-ups, spin-outs and inward investment opportunities.

However, three gaps in Scotland's infrastructure are restricting faster growth of the sector:

- **There is a gap between strain engineering and initial scale-up, which could be addressed by improved integration of publicly funded research facilities.**
- **Scotland is home to several successful business incubators – BioCity Scotland, Edinburgh BioQuarter, Roslin Innovation Centre, Heriot-Watt Research Park, the European Marine Science Park and the forthcoming Edinburgh Innovation Park – these are all operating at or near capacity. New companies are forced to move further south to access suitable space.**

- **A lack of local pilot plant scale capacity (up to 2,000L) results in Scotland's high-growth potential companies traveling to Europe to access this capability. Demonstrating a process at scale is vital to reducing the technical risk associated with securing private investment. The lack of national infrastructure, compromises our companies' ability to raise investment, get products to market and create jobs in Scotland.**

IBioIC has been actively seeking support to address these three infrastructure gaps. The £20m+ [Net Zero Accelerator programme](#) aims to incorporate facilities and business support for new product development from design to industrial scale-up. The Falkirk Growth Deal Head of Terms were agreed in December 2021 and include £10m initial funding for a Bioeconomy Accelerator Pilot Plant as part of a Sustainable Chemicals Campus at Grangemouth. These are rapidly developing areas that need nurtured with government support to fast track the growth of a vibrant cluster of innovative businesses and anchor them in Scotland.

“ Scotland's world class expertise and facilities provide the nation with a competitive advantage in IB and green tech. ”

Ambition	Action
To develop affordable space for new start-ups to establish and grow their companies.	By learning from best practice internationally, build a business case for a dedicated Bioeconomy Accelerator space that meets the growing need for affordable lab and office space for biotechnology start-ups supported by technical and business advice, links to investors and access to talent.
To develop an integrated development route from genome assembly and strain engineering through to pilot plant scale, allowing companies to seamlessly transition between facilities.	To ensure delivery of the Net Zero Accelerator programme, which incorporates facilities for product development via cell engineering and bioprocess research and development through to initial scale-up, alongside business support.
To increase scale-up facility provision in Scotland enabling growing companies to demonstrate the viability of their processes at pilot scale.	To ensure delivery of a Bioeconomy Accelerator Pilot Plant, seeded by funding secured via the Falkirk Growth Deal, to enable companies to de-risk business plans and secure the significant investment needed to get to market.
Support the development of biotech enabled carbon utilisation to drive net zero ambitions.	Ensure integration of the Bioeconomy Accelerator Pilot Plant with the Carbon Dioxide Utilisation Centre at the Sustainable Chemicals Campus to enable renewables-powered biotechnology-based carbon capture to manufacture high value products.

Oceanium

Oceanium is developing and making seaweed-based products to benefit the health of people and planet. Creating a market for sustainably farmed seaweed, Oceanium hopes to generate systemic change in the food system and create jobs for rural coastal communities.



The Oban-based company is on a journey to “Kelp The World®” through driving positive change and turning the tide on traditional manufacturing in some of the world’s largest industries, such as cosmetics and food & drink. Reporting its targeted impacts against the UN’s Sustainable Development Goals (SDGs), Oceanium applies green

chemistry principles and a unique biorefinery approach to work towards zero waste and net zero production.

In 2021, Oceanium announced over €2 million in grant funding from the European Maritime and Fisheries Fund (EMFF) and closed their Seed II fundraising with investment from impact-led investors including the World Wildlife Fund. Oceanium is using the funding to support the scaling up of its

industry-leading biorefinery processing capabilities and will process well over 100 tonnes of seaweed in 2022.

Oceanium is a great example of a Scottish IB company with global reach and ambition.

www.oceanium.world



This is an exemplar of the following National Plan 2022 themes:



Fuel Change

Fuel Change is a social enterprise movement that taps into the potential of Scotland’s next generation to help fight the climate crisis. The not for profit organisation was launched in September 2020 and has empowered apprentices and graduates to develop innovative low carbon solutions to real issues currently being faced by industry.



Fuel Change is looking to build on the momentum of the 2021 COP 26 UN Climate Change Conference in Glasgow to create a movement from the ground up, led by the skills and energy of

young people in Scotland. Fuel change is passionate about collaboration and sharing ideas.

Through real low-carbon challenges set by key industry partners, Fuel Change’s ambition is to ensure Scotland’s next generation can become fully engaged in climate change by developing innovative but practical solutions to some of the world’s most pressing issues.

Fuel Change has already brought 500 young people together with businesses to develop low carbon solutions to real-life problems, including the recent Grangemouth Net Zero Challenge supported by INEOS. Teams work with mentors to come up with solutions to carbon issues set by businesses with topics ranging from sustainable manufacturing and plastics to heat, energy and the circular economy.

Working with 21 schools from across Scotland, Fuel Change is developing a truly integrated approach to what climate education could look like across the entirety of Scotland’s curriculum.

www.fuelchange.co.uk



This is an exemplar of the following National Plan 2022 themes:



ScotBio

ScotBio has a singular goal: to make natural ingredients, which are good for people and the planet, available to everyone.

SCOTBIO

Naturally Pioneering

The company is perhaps best known for its unique and sustainable food colourant, ScotBio Blue. The company makes products from spirulina, a type of algae, ensuring the products are natural, healthy and traceable. ScotBio has developed a patented, vessel-based process to respond to worldwide demand for products free of artificial

colours by providing manufacturers of FMCGs (fast moving consumer goods) with traceable, natural blue and green colourants and plant based protein.

Security of supply is critical in manufacturing, and ScotBio has found a sustainable way to secure its supply in an innovative and reliable way. Unlike producers who grow spirulina in outdoor ponds, ScotBio has an indoor production facility that is protected from the elements and operates to good manufacturing process (GMP) standards.

ScotBio's purpose-built manufacturing facility is located in the Scottish town of Lockerbie, while the company's headquarters is in Glasgow's BioCity.

During the Covid-19 pandemic, ScotBio explored how the company's advanced technical skills and production processes could be used for the creation and manufacture of treatments for current and future virus pandemics.

www.scotbio.com



This is an exemplar of the following National Plan 2022 themes:



IBioIC

The Industrial Biotechnology Innovation Centre (IBioIC) was established in 2014 to stimulate growth of the industrial biotechnology in Scotland. IBioIC is recognised as a European centre of excellence and connects world-leading industry with outstanding academic expertise and government to bring new IB processes and products to the global market. IBioIC is a key driver of Scotland's National Plan for Industrial Biotechnology.



IBioIC facilitates collaborations, provides scale-up capabilities, creates networks and develops skills and training provisions. IBioIC has more than 140

industry members, over 70% of which are SME or micro companies. To date, IBioIC has provided support for over 200 companies, forming collaborations with academia and other businesses, helping them on their innovation journey.

Since its creation, IBioIC has supported over 120 collaborative innovation

projects fostering academic-business partnership and co-funded by business. A total investment of £6.4 million has leveraged an additional £28.5 million from businesses, follow-on funding from other sources or partnering with other funding initiatives.

IBioIC has welcomed 369 students through its skills and training doors and has partnerships with 18 Universities and research institutes and four further education colleges across Scotland. In 2021 the IBioIC industry-ready PhD cohort reached 120, the MSc in Industrial Biotechnology including industry placement has graduated more than 200 students. IBioIC is a partner with Roslin Cell Therapies on one of three UK Advanced Therapies Skills Training Networks. IBioIC students are uniquely networked into the IBioIC community offering them a close connection to a wide and diverse industrial network.

www.ibioic.com



This is an exemplar of the following National Plan 2022 themes:



Celtic Renewables

Celtic Renewables’ patented low-carbon technology converts unwanted, low-value biological material into high-value, low-carbon sustainable chemicals and advanced biofuel.



The company has grown steadily since 2011 and has received multiple awards and accolades for its cleantech proposition including the “Most Innovative Biotech SME in Europe” award from the EU parliament – setting a high bar for the future of sustainable manufacturing.

Celtic Renewables has constructed Scotland’s first multi-million-pound biorefinery in Grangemouth, putting production at the heart of Scotland’s chemical cluster. The facility has the capacity to produce 1 million litres of sustainable biochemicals annually that will displace fossil-fuel equivalents across a broad range of markets from cosmetics to food.

Celtic Renewables recently completed a further successful and high-profile

crowd raise, focusing global media attention on Scotland’s biotech sector, with the company now having raised over £43m since its inception to bring the technology from university innovation to industrial operation.

With ambitious plans for full scale deployment in Scotland and around the world, the company is looking to penetrate a biochemicals market set to be worth over £40 bn by 2025. This work is already underway as Celtic Renewables has already signed its first major customer in the bio-solvents space with a strong pipeline of customer demand globally.

Celtic Renewables are playing a pivotal role in the transition to net zero and growing a sustainable bioeconomy.

www.celtic-renewables.com



This is an exemplar of the following National Plan 2022 themes:



Innovation



Sustainable manufacturing



Infrastructure

Closing Remarks



There has never been a more exciting time to be part of the revolution to transform how we approach manufacturing and sourcing of raw materials to create chemicals, develop new materials and products, produce novel foods and animal feed as well as new medicines.

This ambition is global in nature and Industrial Biotechnology (IB) holds the keys to a growing worldwide market. IBioIC provides an easy and innovative way to access the best of new thinking and de-risking new processes.

IBioIC and our members have already contributed to the substantial growth of IB in Scotland and beyond and this refreshed plan sets out the roadmap for our future ambitions for the growth and engagement with IB.

We will support the development of policy, by working with Government, the public, business and others, to underpin the reduction in use of fossil fuels in manufacturing to help meet Scotland’s target of Net Zero by 2045. We will accelerate the identification of new opportunities for business and the adoption of innovative IB technology and we will help create rewarding smart jobs and the skilled people to deliver them. IBioIC will help transform our ability to deliver sustainable economic growth and attract inward investment by building on our track record and reputation of delivery and partnership.

I hope that you, like me, are excited by our refreshed Industrial Biotechnology plan and that you will want to work with us to achieve our common goals of ensuring we have a safe, healthy and sustainable environment, the opportunity to drive the green economy and equip our workforce with the skills they need to deliver this. We at IBioIC look forward to working with you to make sure that you are part of the most important industrial revolution our planet has ever needed.

Professor Dame Anne Glover
Chair, IBioIC

This document has been prepared by IBioIC.

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