

National Plan for Industrial Biotechnology

Towards a Greener, Cleaner 2025

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FOREWORD

Industrial Biotechnology (IB) is already viewed at a global and EU level as a key sector with real growth potential. By 2025, robust estimates of the value of the global IB market range from £150 billion to £360 billion.

In 2009, the UK launched its Industrial Biotechnology strategy document IB2025 – Maximising Opportunities from Industrial Biotechnology in a Low Carbon Economy which outlined the UK's ambition for sustainable growth within the emerging bioeconomy.

Further strategic documents have since been published - both in the US and EU - underlining the growing global importance of Industrial Biotechnology in achieving sustainable economic growth across a range of sectors*.

IB offers us the opportunity for sustainable growth in the future and we must take this chance to ensure that Scotland is at the forefront of its development. The full scale of the impact IB could have on our everyday lives in the future is still being defined; however, it is clear that this field has the potential to enable society to live more sustainably and businesses to compete more effectively.

As you can use biotechnology to produce all the products we get from oil today, the potential is enormous. The transition from an oil based economy to a bio-based economy holds the potential to transform businesses, the market place, but also our world as a whole.



We welcome the development of the National Plan for Industrial Biotechnology. This will allow us to capitalise on our strengths and focus on the opportunities presented by Scotland's unique environment, heritage and business landscape. Through the delivery of this strategy we aim to support the transformation of many businesses in different sectors ranging from energy to textiles to food and drink.

We urge companies to find out more and to see what IB could potentially do for their business.

Fergus Ewing MSP,
Minister for Energy,
Enterprise and Tourism

Sandy Dobbie,
Chairman of
Chemical Sciences
Scotland

* (National Bioeconomy Blueprint, US White House, April 2012 and Innovating for Sustainable Growth: A Bioeconomy for Europe", European Commission, Feb 2012 respectively).

INTRODUCTION

Industrial Biotechnology

Industrial biotechnology (IB) is at the interface of chemical, life sciences and engineering and can be applied across a wide range of sectors including energy and food and drink.

It is defined as “the use of biological resources for producing and processing materials into desired intermediate and final products including energy and high value chemicals”.

As a multidisciplinary technology, IB is used to develop processes and products based on the use of cells (of microbial, plant or animal origin) or their components as biocatalysts.

Greater use of these bio-based products offers increased potential for cutting greenhouse gas emissions, while production processes which use less water and energy and generate less waste can make industry more sustainable and more competitive.

The National Plan for Industrial Biotechnology, delivered by the Scottish Industrial Biotechnology Development Group, aims to transform the competitiveness and sustainability of industries in Scotland by developing and applying IB within the emerging bioeconomy.

Chemical Sciences Scotland

Chemical Sciences Scotland is a unique partnership of industry – from petrochemicals to pharmaceuticals – with Scotland’s world renowned academic sector and government agencies. Its aim is to ensure the chemical sciences have a vibrant future, creating high value opportunities for skilled people and innovative companies.

Its main aim is to identify, develop and deliver projects that provide transformational opportunities for Scotland.

The Scottish Industrial Biotechnology Development Group

The SIBDG is a working group of Chemical Sciences Scotland, a cross sectoral collaboration between industry, academia, and the public sector.



“Modern biotechnology is one of the key technologies of the 21st century. Biotechnological processes, products and services play a role in almost all areas of our daily lives. IB is part of our growth strategy.”

Heinrich Hiesinger, CEO, ThyssenKrupp, one of the world’s largest steel manufacturers

OUR MISSION

Our mission is to grow industrial biotechnology related turnover in Scotland to £900m by 2025.

IB applications have the potential to transform many of Scotland's key sectors, deliver new innovation, inward investment and exporting opportunities and contribute to Scotland's transition to a low carbon economy.

Scotland currently has 43 companies employing over 1,100 FTEs with IB already contributing £189m in turnover and £61m in GVA to the Scottish economy. When Scotland's heritage in engineering is combined with its existing academic and industrial strengths in the related sectors of chemical and life sciences, it is clear there is huge potential in this country for the development and successful application of IB.

Over the next 1-5 years The National Plan for Industrial Biotechnology aims to:

- increase awareness of IB as a transformational tool
- increase company adoption of IB via company growth and improved turnover
- address skills requirements through a programme of targeted training and development
- encourage collaboration with overseas partners

Longer term, establishing a Scottish-based Biorefinery/Biochemicals facility (or facilities) will create economic benefits via new employment and ultimately play an enabling role in helping Scotland to build on its potential in IB.

“Our mission is to grow industrial biotechnology related turnover in Scotland to £900m by 2025”

	Key Stats 2013	Targets for 2025
Companies actively involved in IB	43	200
Estimated turnover	£189m	£900m
Direct employees	1,103	→2,500
GVA Contribution	£61m	→£250m

Impact of Industrial Biotechnology in Scotland to 2025

SCOTLAND'S STRENGTHS

Scotland already has many of the building blocks required for success in industrial biotechnology.

Leadership: the creation of an industry-led Scottish Industrial Biotechnology Development Group (SIBDG) and the establishment of leadership groups across chemical sciences, life sciences and energy have been instrumental in establishing Scotland's IB credentials.

Academic Excellence: the international reputation of academic research along with the success of the Scottish Research pooling initiatives in chemicals (ScotCHEM), life sciences (SULSA), energy (ETP) and Food and Drink (Interface Food and Drink Innovation) demonstrate our high levels of expertise.

Leading Companies: industry leaders such as FujiFilm, DSM, GlaxoSmithKline, Dupont, DOW and Syngenta have existing operations in Scotland across fine, commodity and specialty chemicals as well as pharmaceuticals while Scottish operators such as Ingenza, Calachem and Equateq (now part of BASF) can also provide an opportunity for scale-up and the development of a wide variety of products.

Carbon Reduction: Scotland's world leading carbon reduction targets and the commitment shown to IB by its most carbon intensive sectors as a transformational opportunity both provide a strong competitive advantage.

Geography and natural resources: our compact geography and abundant natural resources are clear benefits and also encourage collaboration, a key IB requirement.



New Market Development	Access to new markets
	Innovative new products
	Marketing advantage (“Green”)
Sustainability	Reduced GHG emissions
	Manufacturing efficiencies
	Cost reductions
	Energy savings
	Water savings
Innovation	Product Quality
	Innovative new products & Innovative new processes
	Product differentiation
	Longevity of competitiveness and profitability through protected manufacturing processes

Industrial Benefits of IB

“The National Plan for Industrial Biotechnology aims to transform the competitiveness and sustainability of industries in Scotland by developing and applying IB within the emerging bioeconomy”.

SCOTLAND'S CHALLENGES

Scotland faces a series of challenges in maximising its development of IB.

These include:

Industry awareness: the low levels of company adoption of IB are reflected in current industry turnover of £189m, just 4.7% of the £4bn UK IB turnover or 2.1 % of the £9bn chemical sector turnover.

R&D investment: while levels of industry investment in R&D are relatively low, Scotland's IB research base benefits from a strong academic sector.

Skills Shortages: IB is reliant on a combination of life sciences, chemical sciences and engineering skills. The provision of relevant cross-disciplinary training will be a priority.

Legislative issues: positive engagement with government by industry leaders will be essential in terms of incentivising the application of IB.

Commercialisation: as with other emerging technologies, IB must overcome barriers to attracting equity investment and resistance of businesses to adopting new technologies.

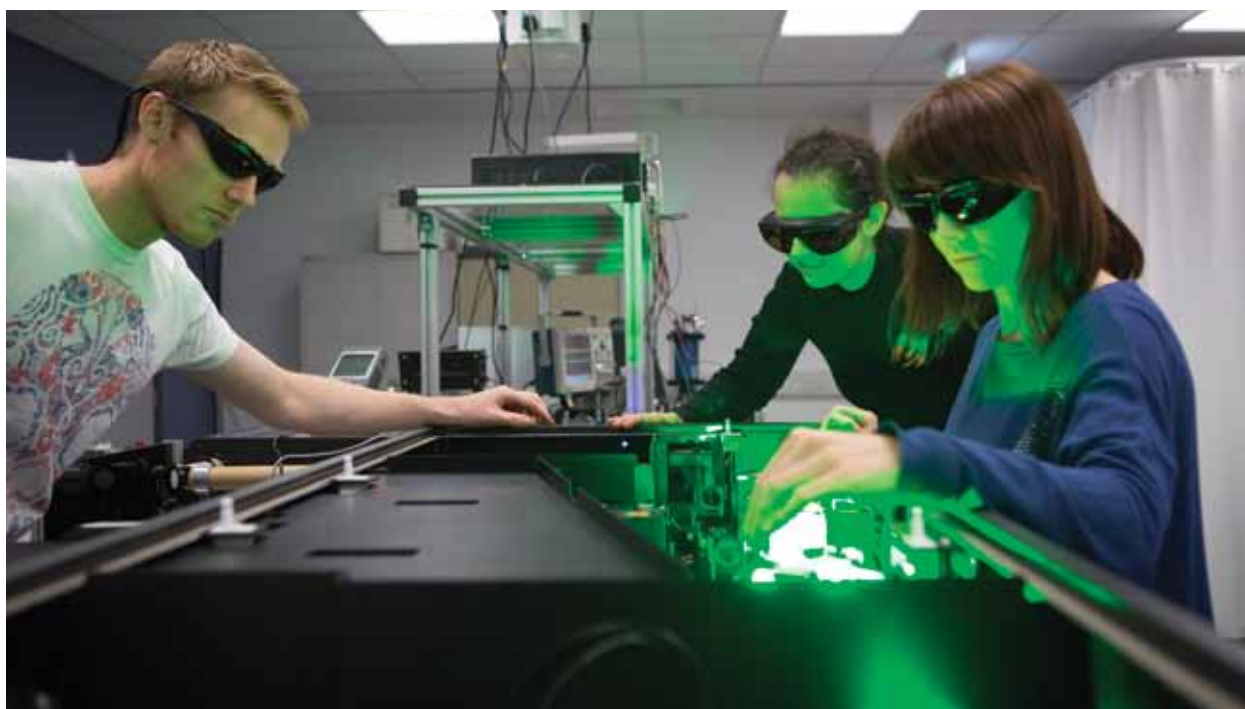
Facilities: Scotland currently has no test, demo or scale-up facilities, limiting the opportunity for companies to develop and validate commercial scale production processes.

Feedstocks: The availability and security of supply of suitable feedstocks will impact on the success of any Scottish Biorefinery/Biochemicals facility.

These should also be considered against the global background of

- Increasing global population
- Rapid depletion of resources
- Increasing environmental pressures
- Climate change

The overall challenge is to increase industry adoption of IB to increase competitiveness, sustainability and innovation against the backdrop of these testing global economic conditions.



SCOTLAND'S FOCUS FOR GROWTH

The National Plan for Industrial Biotechnology will be delivered under the four key themes identified by the Scottish Industrial Biotechnology Development Group.

- Industry Engagement
- Biorefinery/Biochemicals
- Network of Innovation Centres
- Skills

Individual subgroups have been established for each key theme, with an overall focus on transforming the competitiveness and sustainability of multiple industries in Scotland through the development and application of IB within the emerging bioeconomy.

Each subgroup has identified initial activities which are outlined in the following pages.

Together, these work streams will provide a platform from which to engage more organisations within Scotland through targeted interventions and programmes of activities.

Each of these key themes is explained in more detail in the following pages.

“The focus is on transforming the competitiveness and sustainability of multiple industries in Scotland”



INDUSTRY ENGAGEMENT

The growth of bio-based products, coupled with production processes which use less water and energy and generate less waste, can make industry more sustainable and more competitive. In addition, the creation of new non-food markets for crops, together with the emergence of alternative income sources for farmers, can give Scotland's rural areas a new lease of life.

Our objective is to create an awareness of IB, its applications and potential benefits and increase engagement and uptake in relevant commercial organisations across all sectors.

Activity

Existing work delivered through the UK Technology Strategy Board and the Knowledge Transfer Networks (KTNs) is aimed at ensuring that UK industry remains a vibrant player and maintains its growth profile.

To promote awareness of IB and its benefits to companies a model for engaging with industry will be developed to raise awareness of the benefits of applying IB in businesses across all relevant sectors.

Further activity will include the creation of a register of IB companies in Scotland. There are currently around 120 companies on this register ranging from those already actively applying IB to those who have the potential to use IB.

The initial phase of this work was completed in March 2012 following the delivery of a register of companies with a justification for their inclusion along with an economic contribution from their IB activities.

We will aim to

- **ensure organisations have access to IB information to inform decision making**
- **develop a programme of company engagement to raise awareness**
- **facilitate partnership working and ensure organisation are aware of collaboration opportunities**
- **facilitate access to funding and investment**

“Our objective is to create an awareness of IB, its applications and potential benefits and increase engagement and uptake in relevant commercial organisations across all sectors.”

BIOREFINERY/BIOCHEMICALS

A Biorefinery is a facility which integrates biomass conversion processes and equipment to produce power, heat, value-added chemicals and products as well as fuels from biomass.

There is currently a worldwide push to develop technologies and infrastructure for biorefineries. Europe, however, is falling behind in these developments due to fragmented R&D activities and the relatively low levels of state funding and resources for large demonstration facilities.

Our objective is to understand the opportunity and identify the barriers to the realisation of a Scottish-based Biorefinery/Biochemicals and consider which parties need to be involved to make this happen.

Activity

A Biorefinery/Biochemicals /biochemical facility would serve as the cornerstone for sustainable manufacturing in Scotland.

It will be essential to understand and identify the barriers to the realisation of a Scottish-based Biorefinery and consider which parties need to be involved to make this happen. The development and implementation of a roadmap towards a Scottish Biorefinery will also crystallise the level of interest in IB in Scotland.

There is a great deal of biorefining expertise across Scotland encompassing research into brewing and the potential for marine biomass, molecular and microbiology and the development of cost effective conversion technologies of feedstocks into high value chemicals, biofuels and other renewable products.

In the medium term, establishing a Biorefinery/Biochemicals facility(ies) in Scotland will, on its own, offer economic benefits, both tangible and intangible by, for example, creating new jobs.

Across the supply chain, there are other areas where there is potential for economic impact. The development of effective biomass supply chains, including resource development, supply and logistics is critical to the development of second generation biorefineries.

Scotland has the potential to generate significant quantities of biomass feedstock through existing industries such as forestry and via the development and growth of dedicated crops on marginal land unsuitable for crops or, in the longer term, micro and macroalgae based feedstocks.

We will aim to

- **clarify the availability of feedstocks available to Scotland**
- **engage the entire potential Biorefinery/ Biochemicals value chain**
- **define the barriers around regulation and legislation**
- **understand the market access for the products**
- **deliver a roadmap towards a Biorefinery/ Biochemicals facility in Scotland**
- **ensure adequate provision and access to R&D scale test / demo and scale up infrastructure**

“Our objective is to understand the opportunity and identify the barriers to the realisation of a Scottish-based Biorefinery/Biochemicals and consider which parties need to be involved to make this happen.”

NETWORK OF INNOVATION CENTRES

The Chemistry Innovation Knowledge Transfer Network (CIKTN) has been tasked with developing an approach on how a Network of Innovation Centres for IB should operate. Their vision is to create a world leading centre for enabling and promoting the commercialisation of IB across a range of sectors important to the UK economy.

The centre will establish new mechanisms for IB commercialisation, as identified in the 2009 Innovation and Growth Team report (IB-2025), enhancing the ability of companies to compete in the potential £360 billion global market.

Our objective is to create a network of collaborative Innovation Centres to ensure Scotland is positioned as a leading centre for IB industry and academic excellence and to provide access to relevant expertise and information for companies.

“Our objective is to create a network of collaborative Innovation Centres to ensure Scotland is positioned as a leading centre for IB industry and academic excellence and to provide access to relevant expertise and information for companies.”

Activity

Our vision, aligned with that of the UK strategy, is to create “a world leading centre for enabling and promoting the commercialisation of IB across a range of sectors important to the UK economy.”

The aim is to build on Scotland’s unique strengths in IB and use these to promote commercialisation, collaboration and training opportunities through the development of a network of collaborative innovation centres including a specific IB ‘hub’.

We will aim to

- **link Scottish academic research base with business**
- **deliver a single point of entry for industry relevant IB activities**
- **build multinational linkages and collaborations and leverage project funding through research councils, Technology Strategy Board and Horizon 2020**
- **ensure investment propositions are leveraged through industry/academic partnerships**

SKILLS

The transition to a bioeconomy will be a key factor in creating long-term economic growth, energy sufficiency and environmental sustainability as well as supporting advances in health and medication.

Biotechnology employers have identified a significant lack of skills provision as a barrier, something which must be addressed as quickly as possible to assist them in the challenges they face in a competitive environment.

Our objective is to ensure that full knowledge of job, career, and learning opportunities exists across all areas of IB and to ensure training opportunities are developed which meet current and future needs in all areas of IB.

Activity

Skills Development Scotland (SDS) is already implementing skills surveys across both life and chemical sciences and, in parallel with this activity, there is a need to identify skills gaps and issues relevant to IB.

The Skills Topic and sub-groups of Chemical Sciences Scotland and Life Sciences Scotland will collaboratively develop skills programmes and activities relevant to this plan with delivery partners including the National Skills Academy for the Process Industries (NSAPI), the Sector Skills Council (COGENT) and Skills Development Scotland (SDS).

The provision of a range of short courses alongside vocational training and mentoring will be required and could be managed by Skills Development Scotland in partnership with sector skills councils. In addition, there will be a requirement to work closely with the proposed network of innovation centres.

We will aim to

- **enhance Scotland's training portfolio for IB skills**
- **delivery of appropriate Skills Investment Plans for Life Sciences, Chemical Sciences and Engineering**
- **development of IB appropriate skills and training activities based on the 3 x Skills Investment Plans**

“Our objective is to ensure that full knowledge of job, career, and learning opportunities exists across all areas of IB and to ensure training opportunities are developed which meet current and future needs in all areas of IB.”

UNDERPINNING ACTIVITIES

In order to achieve the aims of this Plan, consideration should also be given to a number of other important underpinning activities.

Marketing and communications - to support levels of awareness and understanding. The benefits and opportunities presented by IB must be communicated clearly and consistently to a broad range of stakeholders including industry, academia, policy makers and the general public.

Investment - to ensure access to funding. If the IB sector in Scotland is to develop in line with the Plan's objectives it will be important for potential sources of funding to be identified.

Internationalisation - inward investment, collaborations and exporting. Offering encouragement and support for inward investment and exporting activities as well as fostering international collaborations will further assist IB's development.

Company Growth - to support companies to transition to IB alternatives, providing support for companies who wish to implement IB solutions as part of their growth ambitions.

Innovation - to provide specialist advice on IB opportunities. Ensure that the wider community of specialist advisors is able to assist companies when implementing IB solutions.

Cross-sector engagement - work across all industries to ensure that all sectors have equal access to the benefits that IB can deliver.



KEY MILESTONES

A series of short and long-term milestones have been identified which will be used to measure the progress of this Plan.

These are as follows:

By 2015

- **Increase** to 50 the number of companies involved in IB
- **Establish** a Scottish Innovation Centre for Industrial Biotechnology
- **Complete** a skills and training audit and develop at least 2 IB training programmes
- **Achieve** IB related turnover of £200m or more
- **Articulation** of the opportunity for a Biorefinery/ Biochemicals facility (or facilities) in Scotland

By 2020

- **Increase** the number of companies involved in IB to 80
- **Establish** at least one major global industry collaboration with the Scottish Innovation Centre for Industrial Biotechnology
- **Secure** at least one other Innovation Centre activity in Scotland
- **Reassess** the relevance of training programmes and revise where appropriate
- **Achieve** IB-related turnover of £400m or more



By 2025

- **Increase** the number of companies involved in IB to 200
- **Establish** a partial Biorefinery/Biochemicals facility (or facilities)
- **Extend** the range of industries applying IB into food and drink, textiles, forestry and energy
- **Achieve** IB-related turnover of £900m or more



CONCLUSION

While the development of industrial biotechnology in Scotland is at a relatively early stage, there are enormous opportunities to deliver lasting benefit to the Scottish economy by maximising the use of this emerging technology across a range of key industries.

This National Plan for Industrial Biotechnology results from extensive consultation with our businesses, academic and research institutions as well as the Scottish and UK governments and their agencies.

This National Plan for Industrial Biotechnology outlines how we can make best use of Scotland's existing strengths in chemical, life sciences and engineering and how we can take advantage of the country's academic and research expertise while also identifying important activities which will help us and our partners meet our objectives for IB in Scotland.

Initial actions have been outlined within this Plan however we expect this to be a living document, enabling SIBDG to respond to new opportunities as they arise.

We need all stakeholders across private, public and academic sectors to work in partnership and to align their investments and activities towards the delivery of this Plan. In achieving this, we can ensure that industrial biotechnology will deliver maximum benefits to companies and society and to secure a more sustainable future for our industries.

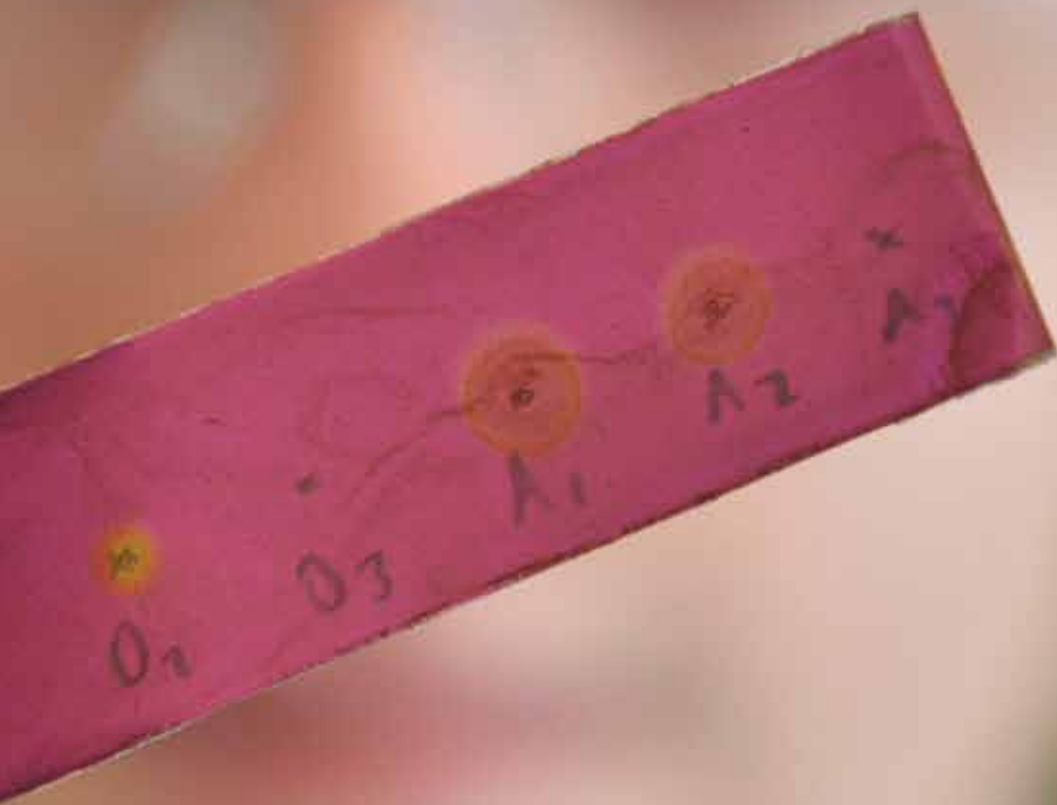
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