HM Government

Growing the Bioeconomy

Improving lives and strengthening our economy: A national bioeconomy strategy to 2030

INDUSTRIAL STRATEGY

Foreword

We live in an age of unprecedented demand on our global resources. This strategy will ensure that the UK can build a world-class bioeconomy, removing our reliance on finite fossil resources whilst increasing productivity across all our towns, cities and communities.

A strong and vibrant bioeconomy harnesses the power of bioscience and biotechnology, transforming the way we address challenges in food, chemicals, materials, energy and fuel production, health and the environment. The potential benefits are significant, as we develop low carbon bio-based products and processes that will improve our daily lives.

The UK is already benefiting from its world-class bioscience base. Working across industrial sectors and bringing together government, businesses and the research community, we will deliver an approach that is truly greater than the sum of its parts to help underpin our modern Industrial Strategy.

This strategy sows the seeds to grow a world-class bioeconomy, building on the UK's strengths to develop solutions that are economically and environmentally sustainable.

This will not only increase productivity but will also enable clean growth across the nation.

The bioeconomy has its roots in rural and coastal communities, industrial clusters and knowledge centres in all parts of the UK. The alliance of open access biorefinery centres in Aberystwyth, Glasgow, Redcar and York is a good example, as it provides businesses and researchers with regional focal points for innovation and the commercialisation of new products and processes.

The Clean Growth Strategy has already set out our plans to build on the country's outstanding green credentials as a leader in reducing emissions, whilst the Industrial Strategy provides a platform for stimulating growth and prosperity, increasing earning power and creating and supporting thousands of British jobs.

Growing our bioeconomy will ensure that the UK becomes an inviting and vibrant place to invest and do business, supporting innovation and stimulating economic growth. We will become a global leader in developing, manufacturing, using and exporting bio-based solutions, strengthening the UK economy and moving us towards a low carbon future. This is an opportunity we cannot afford to miss.

Richard Harrington

Richard Harrington
Parliamentary Under Secretary of State, Minister for Business and Industry

Industry Foreword

Making the UK a Global Biotech Partner of Choice.

As representatives of key organisations supporting the development of the bioeconomy we have come together to champion and provide strong industry leadership for the UK bioeconomy which is currently worth £220bn GVA, contributing over 5 million UK jobs.

Our joint strategy with the UK Government sets out a clear UK vision. The creation of highly skilled jobs; using cutting edge research; raising innovation and manufacturing capacity investment; increasing exports, and providing opportunities for regional growth through new value and supply chains.

Our world-leading UK industrial biotechnology and synthetic biology research, innovation and infrastructure will provide a unique platform for growth which connects businesses and industries in developing and using green, bio-based technologies to create a more sustainable future for all.

Our strategy sets out a plan for how this unique platform for growth can be harnessed in the bioeconomy to stimulate, connect and enhance business and Government activity across industries.

This will provide an unparalleled opportunity to deliver greater than the sum of parts growth and productivity, across the whole of the UK, which would not otherwise be possible.

Timing is critical; setting a bioeconomy vision now and then driving a fully supported strategy and action plan will maximise and unlock further value by linking to wider goals and actions such as those within the Life Sciences Strategy, the Chemistry Council Strategy, the UK Industrial Strategy and Clean Growth Strategy.

This connectivity will drive UK global competitiveness in emerging markets and key industries, stimulating new investment and helping to increase our domestic resilience. A key part of the action plan will be to work with the UK Government to develop and deliver a bioeconomy sector deal.

Our joint strategy and action plan are a significant opportunity to differentiate the UK from the rest of Europe and other countries through distinctively supportive policy, regulation and fiscal measures.

This will make the UK even more attractive as a centre for both local and foreign investment across the breadth of the bioeconomy. The rate of growth in the UK bioeconomy is already outpacing OECD GDP growth; support for this strategy will accelerate that growth driving the UK bioeconomy to double in size within the next 10-15 years.

The benefits to UK citizens that will come from living in a world-leading bioeconomy are significant. High-value, skilled jobs will give the UK a competitive advantage in creating, manufacturing and advancing bio-based solutions that are transforming people's lives. This will range from healthier, more sustainable and affordable foods due to smarter, more productive agricultural systems; to better medicines; sustainable fuels and cheaper materials, all whilst providing a cleaner environment for all.

There has never been a better time or stronger foundation upon which to build and sustain a world-leading bioeconomy in the UK. Now is the time to commit to this vision.

Steve Bagshaw
CEO, Fujifilm Diosynth Biotechnologies (Industrial Biotechnology Leadership Forum)

Judith Batchelar OBE
Director of Brand, Sainsbury's (Food and Drink Sector Council)

Lionel Clarke OBE
(Synthetic Biology Leadership Council)

Harry Swan
CEO, Thomas Swan & Co Ltd (Innovation lead - Chemistry Council)

Andy Evans
AstraZeneca Site Manager, Macclesfield (Medicines Manufacturing Industry Partnership)

Contents

Executive Summary

Overview

This strategy is a collective approach from government, industry and the research community to transform the UK economy through the power of bioscience and biotechnology.

What is the bioeconomy?

The bioeconomy represents the economic potential of harnessing the power of bioscience, using renewable biological resources to replace fossil resources in innovative products, processes and services. The bioeconomy in the UK in 2014 has been estimated to have contributed to £220bn of output across the UK economy, supporting 5.2m jobs[1].

Building a world-class bioeconomy will transform our economy by removing our dependence on finite fossil resources. Bioscience and biotechnology has the potential to create new solutions that are economically and environmentally sustainable as well as resource-efficient. These solutions will help to tackle global challenges and create opportunities in agri-food, chemicals, materials, energy and fuel production, health and the environment.

Bioeconomy strategy consortium

Government, industry and the research community have been working together to realise a transformation in the bioeconomy. Members of the consortium include:

- Food and Drink Sector Council
- Biotechnology and Biological Sciences Research Council (BBSRC)*
- Chemistry Council
- Department for Business, Energy and Industrial Strategy (BEIS)
- Department for International Trade
- Industrial Biotechnology Leadership Forum
- Innovate UK*
- Knowledge Transfer Network
- Medicines Manufacturing Industry Partnership
- Synthetic Biology Leadership Council

* Now part of UK Research and Innovation

Global Challenges

There is unprecedented demand on global resources. The world's population is growing by 83 million a year[2], meaning an extra one billion people on the planet by 2030.

People are living longer and are expecting greater mobility, improved products and better services as technology develops. We cannot rely on finite fossil resources to meet these demands. We have a responsibility to protect our environment, tackle the effects of climate change and improve our air quality. It is critical that we harness existing knowledge, skills and experience in the UK to make better use of global natural resources. Our modern Industrial Strategy has already set out the fundamental importance of these issues, and established four Grand Challenges to put the UK at the forefront of the industries of the future, including Clean Growth.

Global Opportunities

As set out in our Clean Growth Strategy, the UK has been at the forefront of encouraging the world to move towards clean growth. We are determined to play a leading role in providing the technologies, innovations, goods and services of this future. We set a Clean Growth Grand Challenge in our Industrial Strategy to maximise the opportunities for UK industry from the global shift to a low carbon resource efficient economy.

The UK already benefits from its world class bioscience base. By developing this we can boost national productivity and address key challenges in food, chemicals, materials, energy production, health and the environment. This includes:

- **Creating new forms of clean energy** and new routes to high-value industrial chemicals
- **Producing smarter, cheaper materials** such as bio-based plastics and composites for everyday items as part of a more circular, low-carbon economy
- **Reducing plastic waste and pollution** by developing a new generation of advanced and environmentally sustainable plastics, such as bio-based and biodegradable packaging and bags (whilst avoiding microplastic pollution)
- Providing **sustainable, healthy, affordable and nutritious food** for all
- Increasing the **productivity, sustainability and resilience** of our agriculture and forestry
- **Manufacturing medicines of the future** and making existing ones more efficiently

Global challenges and research frontiers are shifting rapidly. To take full advantage of the opportunities this presents, and set ourselves in a world leading position, the UK must aim to be transformative.

Examples of the bioeconomy at work

- Clean energy and transport fuels from waste and industrial by-products
- A more secure and resilient food supply with enhanced agricultural productivity
- Bio-based plastics and chemicals that preserve our natural environment
- Using microbes instead of chemicals to create medicines or cosmetics
- Strong, lightweight materials for the automotive and aerospace industries
- Using plants to grow vaccines to quickly tackle disease epidemics

Global Leadership on Plastics

Our Modern Industrial Strategy establishes the UK's ambition to be the world's most innovative economy. One example of how we are taking action on this is through our global leadership on tackling plastics waste:

- Up to £60m to transform the plastics economy through the Industrial Strategy Challenge Fund, making it more sustainable, efficient and productive.
- Support for research and development of biodegradable plastics through the Industrial Strategy Challenge Fund, such as the development of biodegradable plastic packaging and bags (whilst avoiding microplastic pollution).
- £20m to develop more sustainable approaches to plastics through the Plastics Research Innovation Fund, which is already supporting projects like Skipping Rocks Lab, with their sauce sachets made from seaweed that biodegrade as fast as a piece of fruit.
- The Commonwealth Marine Plastics Research and Innovation Framework, with £25m of UK government investment bringing together governments, industry and researchers to develop new solutions to marine plastics waste and pollution.
- £20m for research and development into new, smarter, more sustainable packaging as well as boosting plastics recycling and reducing litter and waste.

Case Study: GSK and Veolia

GSK and Veolia are currently working with the Biorenewable Development Centre to look at a range of alternative materials to manufacture glucose from, such as waste from processing high starch foods like bread or potatoes. If successful at scale, this could provide a valuable resource for the production of Augmentin, a penicillin antibiotic which has sales forecasts of over £1bn per year by 2018. **Info: biorenewables.org**

Case Study: OXITEC

Insecticide sprays are toxic to the environment but have to be applied to all mosquito breeding grounds to combat the spread of malaria. OXITEC have developed an alternative, inserting a self-limiting gene sequence into male insects athat limits reproduction. Trials show this eradicates 90% of mosquitos compared to 50% at best through insecticide spraying. The CDC estimates the direct costs of malaria to be at least $12bn (over £9bn) per year. **Info: oxitec.com**

Case Study: Virgin Atlantic and LanzaTech

Virgin Atlantic have been working with LanzaTech to pioneer technology that captures and recycles carbon-rich industrial waste gases from steel mills into jet fuel. October 2018 saw the first commercial flight using this sustainable aviation fuel, which has the potential to achieve over 70% lower carbon emissions compared to conventional fuels. Following a UK government grant through the 'Future Fuels for Flight and Freight' competition they are looking to build commercial scale jet fuel plants in Britain. **Info: virgin.com**

Our Vision for 2030

Our Vision is that in 2030 the UK is a global leader in developing, manufacturing, using and exporting bio-based solutions. Our thriving bioeconomy is an inviting and vibrant place to invest and do business, supporting innovation and stimulating economic growth. Sectors within the bioeconomy command trust, improve lives, strengthen the UK economy and move the UK towards a low carbon future.

Strategic Goals

For the first time the UK has adopted a bioeconomy strategy that creates cross cutting benefits across an existing network of related policies, practices, standards and legislation. Where actions to enable and support development of the bioeconomy will be consistent with broader priorities, such as delivering clean air, clean growth and increased productivity. To achieve an approach that works for everyone, government and industry have worked together to agree a long term vision for the bioeconomy, underpinned by four strategic goals:

- Capitalise on our world-class research, development and innovation base to grow the bioeconomy
- Maximise productivity and potential from existing UK bioeconomy assets
- Deliver real, measurable benefits for the UK economy
- Create the right societal and market conditions to allow innovative bio-based products and services to thrive

Achieving these goals will deliver clean growth, increased productivity and economic prosperity. Progress will be assessed by monitoring the impacts of the actions set out in this strategy as well as overall growth of the UK bioeconomy.

Delivering Change

We will achieve our goals by working together to meet the needs of society in health and well-being, food, energy, materials and chemicals. We will engage with a wide range of organisations covering the length and breadth of the UK to support this transformation, from our research councils and universities, through to regional and national government agencies and industrial leaders. All will have a role to play in enabling this transformation.

By working together under a shared strategy, we will support growth and generate greater economic returns through faster-to-market technologies and the successful commercialisation of ideas.

Introduction

Overview

The bioeconomy represents the economic potential of harnessing the power of bioscience. A thriving bioeconomy produces innovative products, processes and services that rely on renewable biological resources instead of fossil fuel alternatives.

A bioeconomy for everyone

The bioeconomy works across all industrial sectors – from agriculture and medicine to manufacturing and energy. It contributes to all four of the Industrial Strategy's Grand Challenges: supporting clean growth through low carbon alternatives to traditional materials, energy and fuels: fusing expertise in bioscience with AI and the data economy to transform production techniques; manufacturing the medicines of the future to help meet the needs of an ageing society; and developing advanced fuels and lightweight materials that will be part of the future of mobility.

An innovative bio-based economy offers significant opportunities for the development of a more circular economy and the optimal use of resources to meet the needs of modern society in terms of health and well-being, the environment, food, energy, materials and chemicals.

A Vision for 2030

Our Vision is that in 2030 the UK is a global leader in developing, manufacturing, using and exporting bio-based solutions. Our thriving bioeconomy is an inviting and vibrant place to invest and do business, supporting innovation and stimulating economic growth. Sectors within the bioeconomy command trust, improve lives, strengthen the UK economy and move the UK towards a low carbon future.

Mission

The project consortium shares in a mission to achieve the following:

- Provide a supportive policy environment in which businesses, developers and researchers can responsibly realise the full potential of the bioeconomy to develop and deliver of bio-based solutions to every day challenges.
- Support industry-led collaborative research and development to bring new businesses to the marketplace, driving clean growth through novel bio-based materials, processes and fuels.

- Ensure companies across the UK can thrive in a growing bioeconomy, with increased productivity, new high-value jobs, increased exports and investment, and more sustainable use of our resources.
- Set out the mechanisms needed to build a world leading bioeconomy, as part of our modern Industrial Strategy.

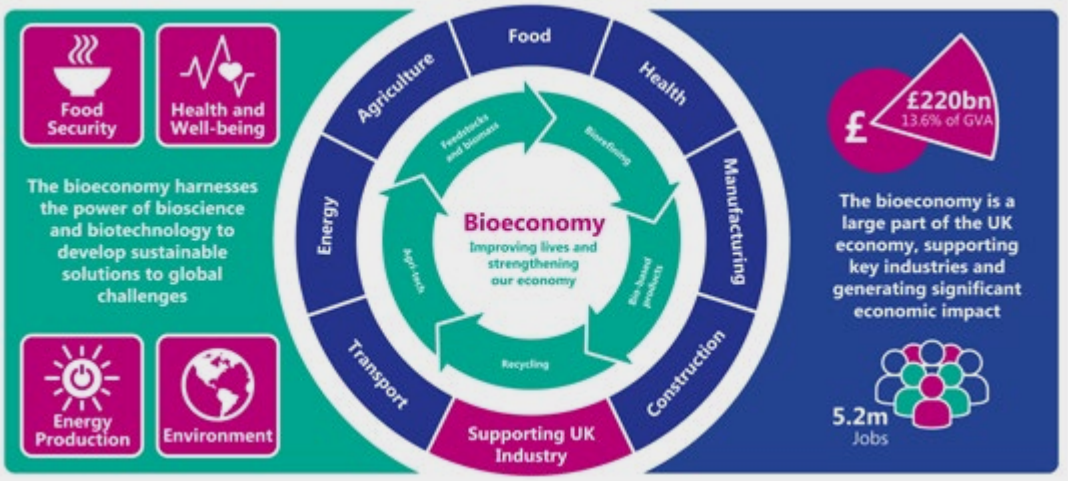
Global challenges and research frontiers are shifting rapidly. The UK must aim to be agile and responsive, maximising potential to be the leading nation in this field, so as take full advantage of the opportunities presented here.

Goals

We have set out four high level goals, which are reflected in the actions of this strategy.

1. **Capitalising on our world class R&D:** We will continue to advance our world class research, development and innovation base, leveraging greater investment to turn our cutting edge ideas into commercial success in the global marketplace.
2. **Maximising productivity:** We will maximise the potential of our bioeconomy assets right across the UK, making the most of our knowledge, facilities and people to increase productivity from our existing renewable biological resources,

A bioeconomy for everyone



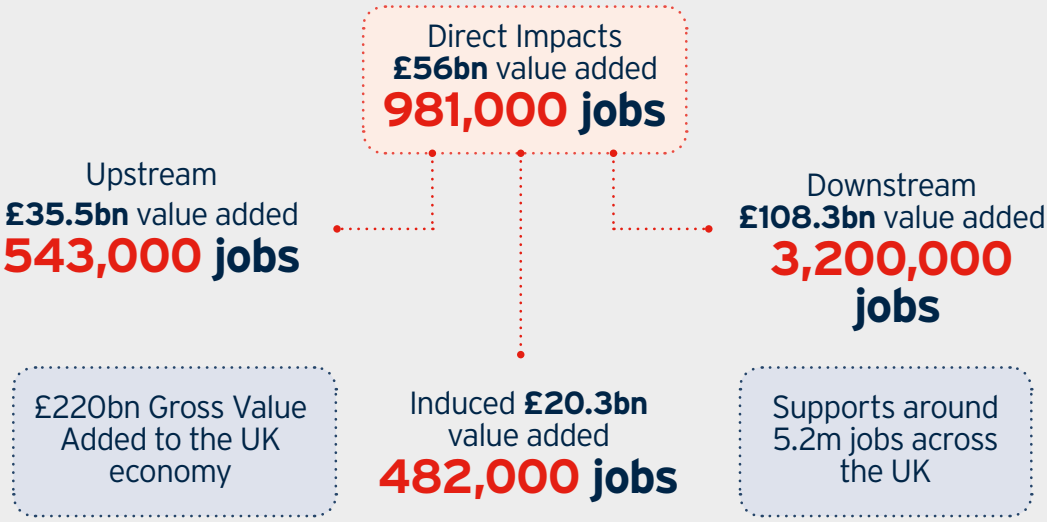
A bioeconomy for everyone **Bringing sectors together** **Scale of the opportunity**

3. **Delivering benefits:** We will support Industry sectors to ensure that this strategy delivers real, measurable benefits for the UK, creating jobs, increasing productivity and doubling the size of the impact of the bioeconomy to £440bn by 2030.

4. **Creating the right market conditions:** We will create the right national and international market conditions to allow innovative bio-based products and services to thrive, raising public interest, increasing skills in the workplace and sales to the market.

Gross value added and employment from the bioeconomy in the UK, 2014

The provision of bio-based feedstocks as well as other required inputs such as machinery, power and financial services represent what the 'transformative bioeconomy' demands as inputs from other industries, and are estimated to be worth almost £36bn in value added to the UK economy. Using the products of the bioeconomy to make other products or deliver services is estimated to be worth over £108bn in value added.



Source: Capital Economics, Evidencing the Bioeconomy (2016)

Challenge for the Future

This strategy signals the start of a transformation. We aim to create the right supportive environment in the UK to help double the size of the impact of the bioeconomy from £220bn in 2014 to £440bn by 2030.

Scale of opportunity

The bioeconomy is already growing rapidly and is delivering great value to the UK. In the BEIS and BBSRC report 'Evidencing the UK Bioeconomy', the existing bioeconomy was estimated to contribute £220bn Gross Value Added to the UK (see previous page). Within the bioeconomy, there is huge global potential for companies to grow across all sectors (see insert, right). However, industry feedback suggests other European countries and the USA are offering preferred investment environments to allow start-ups to thrive.

The UK is sixth in the world for exports of goods and services, but as our Export Strategy sets out, we can do more to achieve our full exporting potential.

For example – by 2030, the UK waste processing and materials recovery market is forecast to grow to £67bn, with an export value of £19bn.

With initiatives such as the UK Plastics Pact setting ambitious targets for all plastics to be reusable, recyclable or compostable by 2025, a strong innovation-based supply chain can create a thriving circular bioeconomy to help us realise this potential.

Our modern Industrial Strategy sets out our aim to maximise UK businesses' share of the global markets as they are transformed by the shift to clean growth and make our country one of the best places in the world to develop and sell clean technologies.

This strategy signals the start of a transformation. Our aim is to create the right supportive environment to help double the size of the impact of the UK bioeconomy to £440bn by 2030.

Here we set out the potential, our ambition for growth and the areas where key actions will make a critical difference to the growth of the bioeconomy.

Scale of Opportunity

- The global market for biorefineries is around £350bn and set to rise to almost £550bn by 2021.

- *Research and Markets, 'Biorefinery Products: Global Markets' (2017)*

- Biotechnology market size was valued at over £250bn in 2015 and is expected to reach nearly £600bn by 2024.

- *Global Market Insights, 'Biotechnology Market Size By Technology' (2016)*

Industry Leadership

"Work by the IBLF suggests annual turnover in the UK IB sector was £1.8bn in 2010 and could rise to £12bn by 2025. By taking action now we can build a long term platform for growth that will transform our economy."

Steve Bagshaw – Chair, Industrial Biotechnology Leadership Forum

"Growth associated with synthetic biology is expected to be substantially more rapid than within established sectors. This growth rate translates to a ten-fold increase between now and 2030."

Lionel Clarke – Chair, Synthetic Biology Leadership Council

Our Approach

Our Bioeconomy Strategy sets out a collective approach from government, industry and the research community to transform the UK economy through the power of bioscience and biotechnology.

Bringing Government and Industry Together

This strategy presents a landmark statement by government and industry regarding the potential benefits a thriving bioeconomy can offer to the UK economy. To achieve a transformation of the UK bioeconomy, change will need to be delivered in a coordinated way by a range of committed stakeholders.

Policy, regulations and guidance can help overcome barriers and create the right market conditions for growth. Funding is needed to maintain and grow our world class research and innovation landscape. Private sector investment and the commercialisation of innovative products to the market are essential to bring forward new highly skilled jobs and retain the current skills base.

By bringing the public and private sector together we can build a comprehensive picture of the strategic actions needed to deliver a transformation of the UK bioeconomy.

By bringing together different government departments and agencies with research councils, academia and industry, changes can be made to bring economic growth, increased productivity, greater exports and environmental benefits to all regions across the UK.

Bringing Sectors Together

By its nature the bioeconomy is cross cutting. It operates across different industrial sectors and connects a wide range of disciplines. It draws together industrial biotechnology and synthetic biology, aquaculture, agriculture and food technology, medicines manufacturing and chemicals.

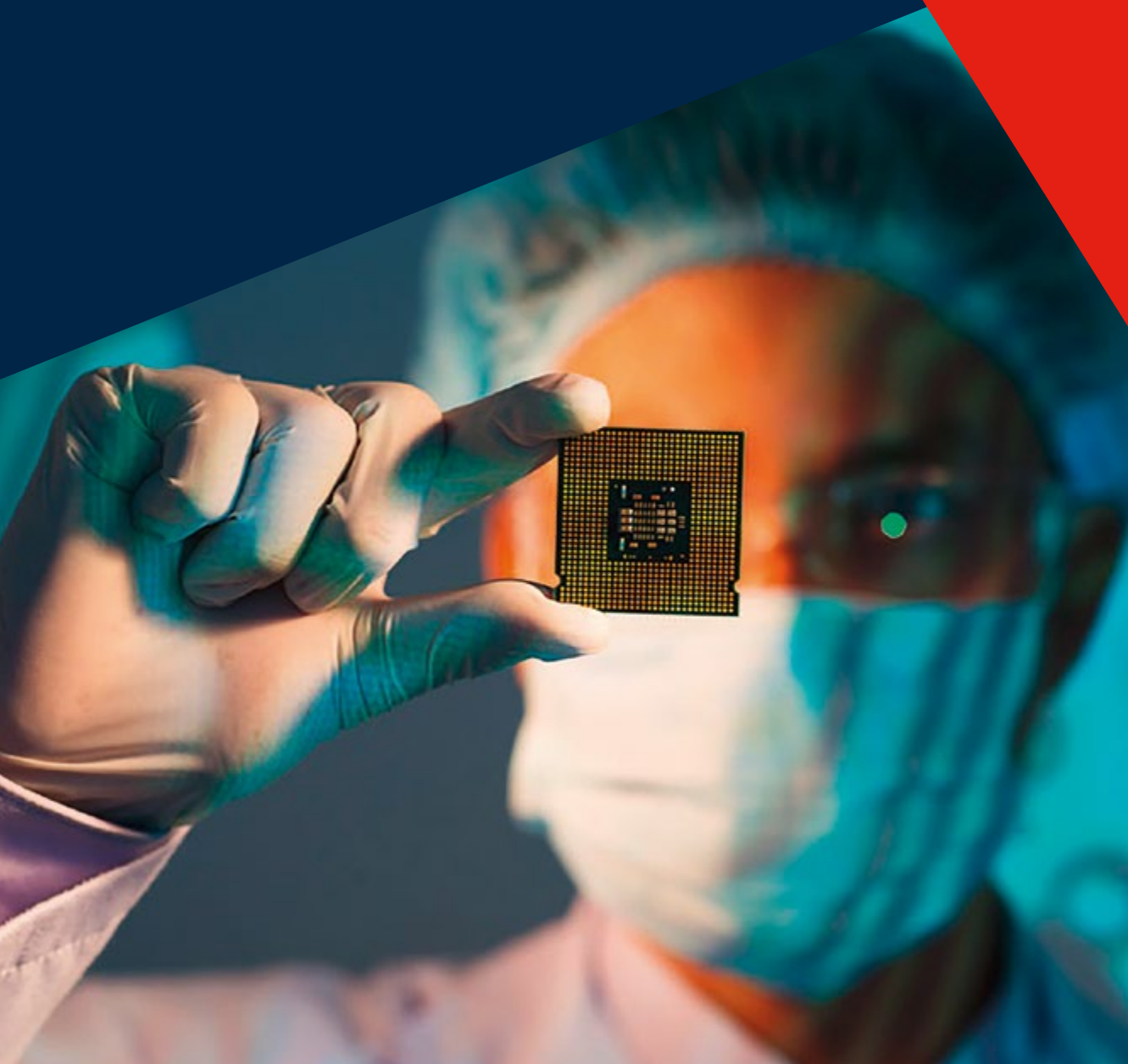
It is inclusive of those looking to make the most of the opportunities provided by our natural renewable resources, as well as reducing and even adding to the value of our waste materials. A national strategy is therefore needed to coordinate activities and set out an appropriate framework for growth.

Case Study: iBioIC

- The **Industrial Biotechnology Innovation Centre** (IBioIC) in Glasgow brings together industry, academia and government for collaborative IB projects. Their membership perfectly illustrates the broad and diverse nature of the bioeconomy, including:
- Member sectors including chemical sciences, life sciences, instrumentation & measurement, engineering, materials science, food & drink, waste and energy.
- 100 members including 17 multi-nationals, 42 SMEs, 9 start-ups and 5 university spin-outs.
- Initial £10m from Scottish Funding Council helped leverage more than £50m in funding, including over £8m from industrial partners.

Info: ibioic.com

Ideas



Overview

The UK has a great strength in its research, development and innovation capability and is at the cutting edge in game-changing fields such as synthetic biology and industrial biotechnology.

Capitalising on our great ideas

The UK enjoys a world class research and innovation community which must be maintained, and the continued advancement of this cutting-edge research underpins our ambitions for a thriving UK bioeconomy. Support from UK research councils, innovation bodies and the private sector has created centres of research expertise, new facilities, hubs and networks to bring industry and academia together, helping to bring many new and innovative products to the market.

Support for Innovation

If we are to continue this success we must support different disciplines working together, using this to unlock their full potential and helping to solve challenges at all stages of research and development across the bioeconomy.

The establishment of UK Research and Innovation brings together the seven Research Councils, Innovate UK and Research England as one organisation, to provide a strong, single voice for UK research and innovation at home and abroad.

Investment in the highest-quality research and innovation across the UK will support multidisciplinary and interdisciplinary areas such as the bioeconomy, fostering a collaborative environment for universities, researchers and businesses.

Case Study: Johnson Matthey

Glucaric acid is used to make adipic acid, an ingredient found in many everyday products such as detergents and cleaners. Conventionally derived from fossil based sources, Johnson Matthey have developed a bio-based alternative that could make a significant contribution to decarbonising production of every day commodities and products. The global market for adipic acid is forecast to reach around £5.6bn by 2019. **Info: jmprotech.com**

This will help attract funding from new sources, develop the talent pipeline and help ensure that UK researchers and innovators enjoy the world's best infrastructure for bringing forward game changing ideas.

The Industrial Strategy commits investment to many innovation areas relevant to the bioeconomy. The Industrial Strategy Challenge Fund has been established to help identify and develop UK industries that are fit for the future, driving progress in technologies where the UK can build on existing areas of industrial and research strength.

Case Study – IB Catalyst

The Industrial Biotechnology (IB) Catalyst helped accelerate the commercialisation of industrial biotechnology-derived products and processes. Key features:

- £76m awarded between 2014 and 2016
- Support for businesses and researchers
- Over 300 applications received
- Nearly 60% of partners were SMEs

Feedback from industry suggests it was highly effective in the translation of research to move towards the commercialisation of new products. **Info: bbsrc.ac.uk**

Case Study: Swansea University

The vine weevil is a serious pest of the £1bn UK soft fruits industry, which can significantly reduce crop yields. Swansea University have developed a bio-based alternative to conventional pesticides (called a 'biocide') that is produced by fungi. It can target and kill specific pests like the vine weevil without harming other creatures. **Info: swansea.ac.uk**

The Industrial Strategy Challenge Fund is part of an additional £4.7bn funding for research and development over the next four years, which includes £1bn for a range of innovation areas linked to the bioeconomy such as healthcare and medicine, robotics and artificial intelligence and manufacturing and materials of the future. Further to this, up to £60m has been committed to producing smart sustainable plastic packaging that can help the transition to a more circular economy. This will also be co-funded by private sector investment.

The National Productivity and Investment Fund[3] will also build a pipeline of high-skilled research talent including PhD places to directly help strengthen collaboration between business and academia. The scheme will support industrial partnerships and new fellowships for early and mid-career researchers, providing valuable resources to support growth across multiple industry sectors.

Challenge for the Future

We need to strengthen the way in which research is translated into commercial success in the UK. We need to move more quickly, identifying industry needs and recognising technologies that will be truly game changing.

To accelerate the commercialisation of ideas not only do we need to support research, but we also need to ensure that the right capabilities and facilities are in place to drive innovation though the feasibility stage to commercial demonstration and beyond. This will help de-risk private sector investment in new technologies and allow products to get to the marketplace more quickly.

Bringing our research community together with industry will create a fertile environment for growth. By matching research and innovation with entrepreneurship and commercial acumen we can bring forward more new, innovative products and processes, and give them a greater chance of success. Industrial biotechnology is a leading example of this, where creation of the BBSRC NIBBs coupled with investments in the IB Catalyst has been instrumental in establishing a thriving industrial biotechnology community.

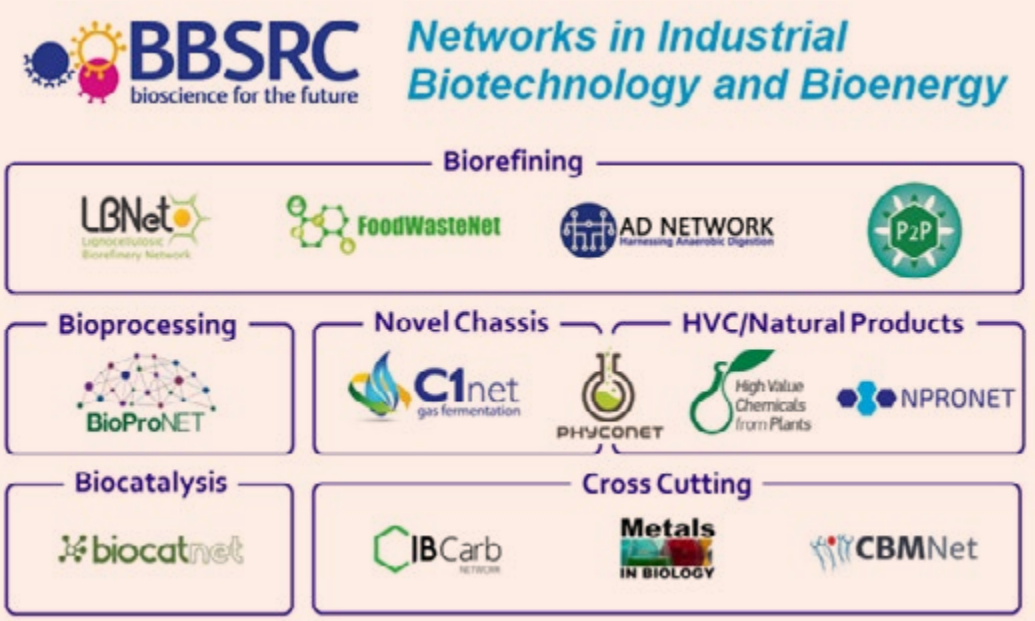
The NIBB has brought together industry and academia with great success, with 800 companies and 3,300 academics amongst their membership. BBSRC's Annual Report (2017) shows that £8.2m of funding had been committed as of January 2017, attracting £1.2m in private-sector investment. Building on this success by replicating across sectors will accelerate the innovation needed to solve global challenges through the bioeconomy.

Combining this industrial biotechnology expertise with world-leading synthetic biology capability, which has been advanced through the UK's £300m Synbio for Growth Programme, will provide us with the platform from which to build a world-leading bioeconomy.

Case Study – BBSRC Networks in Industrial Biotechnology and Bioenergy

The Networks in Industrial Biotechnology and Bioenergy (NIBBs) launched in 2013. They have resulted in a robust community of academic and business members with a pipeline of projects at various stages of translation that will deliver key benefits across the bioeconomy.

BBSRC have recently announced funding for a second phase of networks. **Info: bbsrc.ac.uk**



Our Approach

We will continue to advance our world class research, development and innovation base, leveraging greater investment to turn our cutting edge ideas into commercial success in the global marketplace.

Actions for Change

1. UK Research and Innovation will work with industry to maximise bioeconomy-based investment in UK research and innovation to bring new products to market. This action will look at the existing finance and support available for different sectors and product development stages, and how industry demand for new technologies, products or feedstock can influence priorities for existing and future research and innovation funding.

2. Industry and academia will work together to make best use of assets to drive innovation programmes and investment in the UK. This action looks to increase cooperation and delivery potential between industry and academia across the full range of technology readiness levels. This will include the identification of UK strengths in the bioeconomy which can be further developed as well as a clear communications and delivery strategy that works across sectors. Quantifying the additional capacity or productivity gained by working across borders or across disciplines will allow us to better assess the impact of a growing bioeconomy.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

People

Overview

The need for STEM skills

The Industrial Strategy has already established that nearly half of businesses report a shortage of STEM (Science, Technology, Engineering and Mathematics) graduates as being a key factor in being unable to recruit appropriate staff. The number of STEM undergraduates has been increasing over the last few years, but there remains unmet demand from employers. We must ensure the higher education sector is able to meet this need.

The Industrial Strategy White Paper announced a number of commitments in this area, including:

- Establishing a technical education system that rivals the best in the world, to stand alongside our world-class higher education system
- Investing an additional £406m in education and skills, including maths, digital and technical education, helping to address the shortage of STEM skills
- Creating a new National Retraining Scheme that supports people to re-skill, beginning with a £64m investment for digital and construction training

Working across disciplines

The bioeconomy brings together disciplines such as biology, chemistry, engineering and other specialties to break new ground with novel products and processes.

We need to ensure we help facilitate this cross-cutting way of working, which requires a combination of skills from different scientific disciplines in order to consider a problem from a particular viewpoint ('multidisciplinary') as well as using a variety of skills to get a big picture view using ('interdisciplinary').

Communication across disciplines is therefore a critical part of helping new ideas develop and grow.

Case Study: SynbiCITE

Each year about twenty emerging leaders working in diverse areas of biotechnology are selected to participate in the SynbiCITE LEAP (Leadership Excellence Accelerator Programme). LEAP looks to foster the next generation of leaders in synthetic biology by providing individuals with new tools and networks essential to achieving their visions for advancements in the sector. **Info: synbicite.com**

Challenge for the Future

Maintaining and improving the highly skilled bioeconomy workforce will be even more critical as we exit the European Union and look to meet the opportunities and challenges that lie ahead.

World class expertise

The UK is recognised for having a world-leading knowledge base which acts as a strong foundation for the bioeconomy. For example, UK research is responsible for 11% of all citations for biological science publications – second only to the US.

Our academic institutions and close industrial partnerships enable us to work across sectors, transferring learning and technology to accelerate the development of innovation and new business.

There is however a pressing need to maintain and improve the highly skilled bioeconomy workforce and ensure the best talent can be attracted to the UK.

As the bioeconomy operates across a wide variety of industrial sectors, each have their own particular skills needs. There are though some high-level challenges that are applicable on a cross-sector basis. There is a current and growing need for appropriately trained skilled technicians, as well as a greater influx of STEM graduates into academic and industrial roles.

To help translate cutting edge ideas into commercial success, innovators need to develop – or have access to – entrepreneurial, financial and communication skills. This support needs to be continuous and targeted.

With increased opportunity comes the need for a highly-skilled workforce. From trained technicians and informaticians, to school leavers and postdoctoral researchers – by collaborating across sectors we can present exciting career paths with considerable development opportunities capable of attracting the brightest minds.

The different industries and sectors within the bioeconomy have their own specific skills needs, but a common issue raised is the role of technicians and technical staff, and the importance of their associated vocational training and continuous professional development. It has been predicted that between 2015 and 2020 there will be a need for up to 73,000 new technicians in order to meet new demand and replace retiring workers[4].

Our Approach

Actions for Change

3. Industry will work with government, academia and further education bodies to ensure the UK has a workforce with the right skill set to enable growth. This will identify the skills needs of employers within the bioeconomy and develop targeted actions across the employment cycle: from continued support for STEM career choices in schools, through tailored higher level bioeconomy apprenticeships, to the promotion of in-work training and up-skilling of the existing workforce.

4. As previously set out in the Industrial Strategy, government will invest in skills to support growth and opportunity across the country. These measures will include actions to address the shortage of STEM skills and establish a world class technical education system. Other measures, as outlined in the Industrial Strategy, will include the creation of a new National Retraining Scheme, tackling the regional disparities in education and skill levels, and ensuring that the apprenticeship levy works effectively and flexibly for industry, and supports productivity across the country.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

Infrastructure

Overview

The UK already has a prosperous bioeconomy, but there is significant opportunity for clean growth if we can fully harness our intellectual, material and skills-based assets.

Existing Infrastructure

There is existing infrastructure, trade and investment in place to support development within the bioeconomy, which is already having a positive impact on the UK economy. This includes physical and knowledge-based infrastructure as well as the availability and best use of our natural resources.

For example, we have a network of four open access biorefinery centres (see insert below) as well as recent investment[5] to establish a Medicines Manufacturing Innovation Centre which will accelerate the adoption of new manufacturing technologies.

There are also four Centres for Agricultural Innovation covering agri-metrics, crop science, livestock and precision agriculture, supporting wide scale adoption of innovation and technology, developing skills and capability in the food and farming supply chain. And networks such as the BBSRC NIBBs and the Knowledge Transfer Network provide platforms for industry and academia to exchange information and knowledge on topics across the bioeconomy.

Case Study: BioPilotsUK

BioPilotsUK is a collaboration of four open-access biorefining centres across England, Scotland and Wales that recognises the importance of partnerships to develop UK bio-based value chains. They de-risk the commercialisation of bio-based products and processes by trialling new technologies to ensure partners are investing in the right technologies for their business. **Info: BioPilotsUK.com**

BioPilotsUK

Natural Resources

The opportunity to provide locally sourced biomass resources to the market is limited due to the size and nature of agricultural and forest land in the UK, with competing demands for its use across energy, fuel, chemical and material sectors. However, forest cover has more than doubled over the last 100 years and softwood production has increased.

There is potential for more growth, helping to ensure wood processing and bioenergy businesses have access to sufficient feedstocks and encouraging new entrants to invest in biorefining and liquid fuel production facilities.

Government has already committed to working with industry to increase the amount of UK timber used in construction, and advanced materials such as cross laminated timber can help lock-in carbon in our homes and buildings. Understanding resource flows and creating national and international supply chains for new businesses is critical for growth of the bioeconomy.

Challenge for the Future

New opportunities have arisen within the bioeconomy to tackle challenges facing society and industry in the UK and beyond.

Realising our Potential

To realise the full potential of the UK bioeconomy we need to understand more about our existing infrastructure, sharing that knowledge and understanding widely. Efficient use of resources is critical to ongoing success and achieving clean growth. We therefore need to know what and where our potential bio-resources are, how they can be harnessed and where the expertise is to facilitate transformation.

By building up a complete picture of our assets we can understand how and where they can be best utilised and support investment cases for bio based applications, taking into account the need to ensure that the environment is protected.

A healthy bioeconomy relies on abundant, appropriate feedstocks that are used efficiently. Increasing resource productivity is essential if we are to maintain the supply for our existing bioenergy market as well as support a growing, high value, bio-based industry for chemicals and materials. We now have an opportunity to transform the UK's biorefining capabilities and expertise, to increase productivity across the bioeconomy. Effective biorefineries will ensure increased productivity from our natural resources whilst maximising value from waste streams.

Investment in UK capability and capacity in biorefining demonstrator technologies can provide the necessary services to transform a range of bio wastes to fuel, high value chemicals, pharmaceuticals and materials, in support of the ambition to double the size of the impact of the bioeconomy to £440bn by 2030.

This will facilitate a step-change in the UK's ability to translate our world class research and development work into the successful commercialisation of innovative bio-based products and services.

As science and technology advances, new opportunities have arisen within the bioeconomy to tackle challenges facing society and industry in the UK and beyond. One such opportunity is the potential to convert underutilised unavoidable wastes into high-value products. As an alternative to virgin materials, harnessing wastes and residues will provide sustainable renewable resources for the bioeconomy.

Using waste-derived feedstocks to help produce the materials, chemicals, fuels and energy required to support modern lifestyles not only presents an economic opportunity for the UK, but could provide a low carbon alternative to traditional activities based on petrochemicals, virgin materials or finite resources.

Our Approach

We will maximise the potential of our bioeconomy assets right across the UK, making the most of our knowledge, facilities and people to increase productivity from our existing renewable biological resources.

Actions for Change

5. Government will explore the benefits of a market intelligence tool and whether that could support evidence-based decision making in resources allocation. This would look at various potential high value uses of existing natural resources, showing the relative value that can be derived from different feedstocks such as food waste, industrial by-products and other forms of biomass while ensuring the natural environment is protected and enhanced. This will build on existing work and would take into consideration social, economic and environmental factors such as market prices, local availability, and greenhouse gas impacts.

Actions for Change

6. Government will look to utilise assets to their full potential, accelerating progress so that the UK is a place where maximum value is extracted from sustainable resources at all stages of use, including minimising the creation of waste. The new Resources and Waste Strategy will set out how we work towards our ambition of zero avoidable waste by 2050. It will seek to maximise resource productivity, reduce waste in our resource systems and promote well-functioning markets for secondary materials and incentivise producers to design better products. This action will necessitate continued work with local authorities and the waste industry, as well as the sustainable forestry industry.

   New supply and value chains will need to be developed where resources are captured, treated and used in the best way possible. It is envisaged that this action would include communications and tools that can help improve both the minimisation of waste and the maximisation of value from unavoidable waste, including collection services, recycling and labelling and separation technology.

7. Industry will work with government to deliver increased public and private sector investment in the bioeconomy, by developing robust business models, delivering demonstration and pilot plants and reducing perceived investment risk.

   We need to work with existing centres of expertise and with proven financial mechanisms to exploit near market propositions; robust business case information is needed to support investment in bioeconomy projects and increase exposure of opportunities to investment audiences. This action will look to develop and replicate existing successful centres of expertise across UK regions and deliver pilot scale demonstration projects to provide the evidence needed to reduce investment risk at the commercialisation stage.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

Business Environment

Overview

The strategic importance of the bioeconomy is enormous. By fostering an environment that allows the bioeconomy to thrive we will create new skilled jobs, increase investment and deliver value right across the UK

A successful growing UK bioeconomy will create skilled jobs, deliver value through regions and places, secure global private investment and export deals, and fully capitalise on our world class innovation and research.

The bioeconomy operates in a complex and extensive regulatory landscape. Regulatory instruments that could impact on this area cover anything from health and safety to product design and specification, from environmental protection to renewable energy and fuels, and from intellectual property to finance and trade. There are therefore a variety of policy instruments, guidelines and incentives in place that impact upon the bioeconomy.

While there may be some understanding and awareness of the more familiar parts of the bioeconomy, such as energy from biomass, the concept is not well-known amongst the general public.

One in eight people state they have some knowledge of the bioeconomy, but despite this limited understanding, perceptions of the benefits are overwhelmingly positive once some basic information has been provided (see box below)

Case Study – BioPreferred® Program

The U.S. Department of Agriculture (USDA) BioPreferred® Program illustrates how a federal procurement programme can stimulate the market place.

The most recent report, in 2016, shows that the growing bio-based products industry contributes almost $400bn (around £330bn) and more than 4m jobs to the American economy.

Info:biopreferred.gov

Case Study – Public perceptions of the bioeconomy

In 2017 BEIS and BBSRC commissioned research involving a representative sample of 1,000 consumers to gauge perceptions of the bioeconomy. Key findings include:

- With no information provided, 1 in 8 people stated they have at least a little knowledge of the bioeconomy.
- Almost all (94%) of those with some prior knowledge about the bioeconomy felt it was important to the UK
- When told more about the bioeconomy, most participants (87%) thought it was fairly or very important to the UK.

More detail can be found in the Government Response to the Bioeconomy Call for Evidence, published in parallel to this strategy. **Info: gov.uk**

Challenge for the Future

Our Industrial Strategy aims to make Britain the best place to start and grow a business, and a global draw for innovators. Our Bioeconomy Strategy will deliver this for the sector.

The right regulatory environment

To create, operate and deliver new technologies and products into the market place we need to have the right regulatory landscape in place. We need to ensure new technologies and products are welcomed and trusted by the public and we need a workforce with the right skills to translate our world leading bioscience into economic activity.

In this area, the complex policy environment means that parts of the existing regulatory framework may not be optimal for the development of the bioeconomy. Many regulations will have been established for purposes outside of the bioeconomy, or for the use of more established industrial sectors that do not work across such a range of innovative practices.

To succeed and grow it is vital that regulators, investors and the wider public have confidence in the products, processes and services provided by the bioeconomy. Business and academics must operate transparently and responsibly in order to command public trust, with an open and honest dialogue between stakeholders and the public. Our aspiration is to build a wide base of support for the power of the bioeconomy to improve lives, strengthen our economy and tackle global challenges.

We must identify the areas where standards and regulations can make a positive difference to the bioeconomy, to stimulate the marketplace and grow new supply chains. By providing the right support, we can help innovators and start-ups get a foothold in the market. And by engaging from the classroom to the workplace we can build up the workforce needed to put the UK at the top of the global bioeconomy.

Case Study – Synthetic biology start-ups success

A recent SynbiCITE survey has shown that since 2000, the number of start-ups in the synthetic biology sector has doubled every five years.

- Between 2000 and 2016 the UK produced almost 150 start-ups in the synthetic biology sector.
- **Since 2010, in the UK these start-ups have raised over £620m of investment in new products**
- This includes £56m in public funds which leveraged more than ten times that from private investors

Info: ktn-uk.co.uk

Our Approach

We will create the right national and international market conditions to allow novel bio-based products and services to thrive, raising public awareness, increasing skills in the workplace and sales to the market.

Actions for Change

8. UK Research and Innovation will support business and academia to operate transparently and responsibly in a way which commands public trust, and to communicate the benefits of new bio-based products and processes openly and effectively.

This action will look at ways to increase understanding and awareness of new products, ensuring communications effectively set out the social, environmental and economic benefits of moving to a bio-based economy.

9. Government will identify and understand opportunities for growth in the bioeconomy. This includes the barriers to introducing or growing new products as well as the actions and processes that enable rapid development and deployment of new technologies. Through trade promotion, export finance and future trade policy activities government will help ensure businesses in the bioeconomy have the support to grow and compete globally.

This action will cover a range of issues such as intellectual property practices; policy, regulation and industry guidance on waste; the impact of bio-based procurement and standards for bio-based plastics and other bio-materials. As part of this, government will work with UK Research and Innovation and industry to seek evidence on the demand, benefits and implications (for example the impact on recycling streams) of a standard for bio-based and biodegradable plastics.areas to address the regulatory landscape that impacts on the bioeconomy.

Actions for Change

10. Government will work across policy areas to ensure that the right regulatory landscape is in place to allow the bioeconomy to thrive. The Clean Growth Strategy, Industrial Strategy, 25 Year Environment Plan and upcoming Resources and Waste Strategy position the UK as a potential world-leader in terms of resource efficiency, resource productivity and increasing competitiveness. Policies supporting clean electricity, renewable heat and renewable transport fuels interact with the bioeconomy. It will be essential to work across government policy.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

Places

Overview

The bioeconomy has its roots in rural and coastal communities, industrial clusters and knowledge centres in all parts of the UK.

Benefits right across the UK

Driving clean growth across the whole of the UK is a key theme of Government's Industrial Strategy. Disparities in economic performance between different parts of the UK are evident, but there is considerable potential for cities and towns outside of London and the southeast to close the productivity gap.

A thriving bioeconomy means more jobs, greater productivity and increased GVA for the UK. It also means reduced reliance on fossil fuels and making significant improvements to health, wellbeing and the environment.

It is important to note that these benefits will not just be limited to the traditional growth areas around London and the south east.

The strength of the bioeconomy comes from its decentralised nature and its reach into coastal, rural and urban communities right across the UK.

For example, the Austrian firm Egger has invested £400million in a state of the art panel board mill, employing 600 people in Hexham, Northumberland. Benefits will therefore need to be observed on a local level in order to fully appreciate the impact of a growing bioeconomy on our towns, cities and regions.

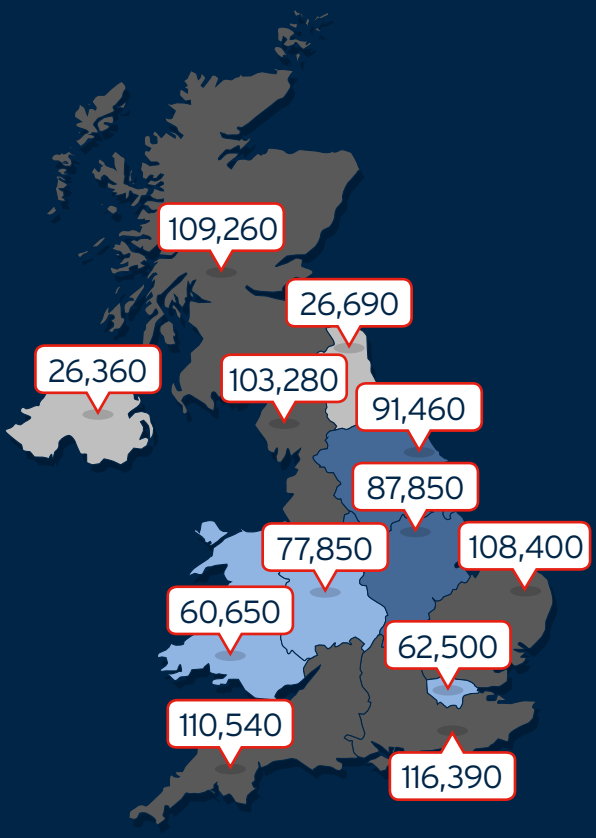
Previous studies (below) show that the bioeconomy is extremely well-distributed across the UK to drive growth and productivity and increase highly skilled jobs.

Gross value added from direct activities by the bioeconomy in the UK, 2014 (£ million)

UK Total: £56,000

- > £4,001
- £3,001 - £4,000
- £2,001 - £2,000
- £1,001 - £2,000
- < £1,000

Employment supported by direct activities by the bioeconomy in in the UK, 2014 (persons)



UK Total: 981,230

- > 80,001
- 60,001 - 80,000
- 40,001 - 60,000
- 20,001 - 40,000
- < 20,000

Source: Capital Economics, Evidencing the Bioeconomy (2016)

Centres of Expertise

The UK has centres of biorefining expertise from Aberystwyth to Edinburgh, marine bioeconomy expertise from Plymouth in the south to Oban in the north, thriving industries in Teesside and knowledge centres in York and Glasgow.

Work to identify and capitalise on regional expertise in scientific disciplines is being delivered through the Department for Business, Energy & Industrial Strategy's Science and Innovation Audit (SIA) programme. In 2017 a report was commissioned on the Bioeconomy of the North of England, which sets out an ambition to double the size of the transformative bioeconomy in the North of England from £12.5bn GVA to £25bn by 2030.

The North of England is projected to contribute £25 billion GVA to the UK economy is by 2030, with 11 LEPs in the North of England including aspects of the bioeconomy in their strategic economic plans.

Also in 2017, the SIA 'Enabling Technologies in Scotland's Central Belt' looked at the potential for high value manufacturing and highlighted industrial biotechnology as one of the enabling technologies to be developed in the region.

The third wave of SIAs was announced at the end of 2017, and includes 'Maximising the Marine Economy of the Highlands & Islands', which will focus on aquaculture, wave and tidal energy and marine biotechnology.

Case Study – Regional Support

Yorkshire is an important centre for the UK's bioeconomy. BioVale is a regional innovation cluster focusing on value from bio-wastes and advanced biorefining. With over 250 members, most of which are SMEs, BioVale promotes networking, research and development, bio-based supply chains, investment and trade.

Info: biovale.org

Challenge for the Future

Our cities, towns and rural areas have competitive advantages that will be essential to shaping our economic future.

A bioeconomy for everyone

Growing and exploiting the UK bioeconomy gives us the opportunity to deliver societal and economic value by promoting health and wellbeing for an ageing population, and delivering productivity and growth.

A thriving bioeconomy brings high value jobs into coastal, rural and urban communities right across the country. Mapping this expertise and bringing the right people together will be crucial to delivering a coordinated strategy that works for the whole country.

International Collaboration

An ambitious plan to double the size of the bioeconomy will require cooperation beyond our borders.

In order to achieve growth at scale international partnerships can help to balance our ability to deliver advanced technical solutions with increased access to sustainable biomass resources. A proactive approach to mutually beneficial partnerships and linked bioeconomies could help lead the UK way in establishing effective operating standards in an international marketplace.

Case Study: Advanced Plasma Power

Swindon-based Advanced Plasma Power have been developing ground breaking gasification technology since 2008. Their £27m facility, which is close to completion, will convert 10,000 tonnes of household waste per annum into 1,500 tonnes of renewable transport fuel. The world-first plant was made possible by an £11m grant from the Department for Transport's Advanced Biofuel Demonstration Competition. **Info: advancedplasmapower.com**

Our Approach

We will build on our strengths and learn from our successes to support prosperous communities throughout the UK.

Actions for Change

11. Government will work with the research and academic communities to initiate a system that identifies where the key UK bioeconomy assets can be found, including actual and potential interrelationships. This will allow us to identify gaps that need to be addressed to maximise productivity.

This action will look at existing finance, innovation and delivery expertise in both the academic and industrial sectors, identifying gaps where they exist. Options for delivery will be explored, including long term ownership and maintenance of the system.

12. As previously set out in the Industrial Strategy, Government will agree Local Industrial Strategies that build on local strengths and deliver on economic opportunities.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

Conclusion

Overview

We will become a global leader in developing, manufacturing, using and exporting bio-based solutions, strengthening the UK economy and moving us towards a low carbon future. This is an opportunity we cannot afford to miss.

Transforming people's lives

Our population is growing faster than ever, we are living longer lives, our climate is ever-changing and resources are increasingly hard to secure. Progress can come with unintended consequences, with the plastics waste littering our oceans being the most visible example of this. Actions matter. If we do not tackle the issues we collectively face, the world will be a poorer place to live and future generations will suffer. We have a responsibility to address pressing global problems and leave a positive and sustainable legacy.

A thriving UK bioeconomy will help us provide the solutions that are needed to deliver enormous gains in UK productivity and prosperity. The benefits to UK citizens cannot be overstated; high-value solutions based on bioscience and biotechnology will transform people's lives with better medicines, cheaper or more effective materials, healthier sustainable foods and a cleaner environment.

Our world class synthetic biology and industrial biotechnology expertise is creating new businesses and solutions which in turn support and enable the transformation across the bioeconomy.

Growing our agri-food sector, improving our medicines manufacturing capability, developing our chemical industry and increasingly supporting the development of new materials and fuels for our aviation and automotive sectors will make significant progress towards doubling the size of the impact of the UK bioeconomy to £440bn by 2030.

Case Study: Grand Challenges

As part of the Industrial Strategy four 'Grand Challenges' (below) have been set out to put the UK at the forefront of the industries of the future. Organisations within the UK bioeconomy are ideally placed to respond to many elements of these challenges, particularly in terms of maximising the advantages for UK industry from the global shift to clean growth. To respond to the Grand Challenges, business, academia, civil society and the government must work together, bringing their expertise and entrepreneurial spirit, to drive us all towards success. This strategy ensures that the right framework is in place to facilitate such a collaborative response.

AI & Data Economy

We will put the UK at the forefront of the artificial intelligence and data revolution

Clean Growth

We will maximise the advantages for UK industry from the global shift to clean growth

Future of Mobility

We will become a world leader in the way people, goods and services move

Ageing Society

We will harness the power of innovation to help meet the needs of an ageing society

Delivering Benefits

This strategy represents the opportunity for government and industry to work together to create the right environment for the bioeconomy to thrive. Measuring and demonstrating what the bioeconomy can deliver will encourage increased investment throughout the UK and create highly skilled jobs across sectors.

The 2016 report 'Evidencing the Bioeconomy' provided landmark research to evidence the potential of the bioeconomy and the £220bn contribution it makes to the UK economy. This covers a diverse range of sectors, from life sciences and agriculture to energy and materials, it is not a simple process to monitor and evaluate impact.

The development of this strategy has brought together key groups including industry leadership councils and other bodies representing agri-food technology, chemistry, industrial biotechnology, medicines manufacturing and synthetic biology. These groups have worked alongside government departments, research councils and innovation bodies across the whole of the UK to ensure this bioeconomy strategy works for everyone.

Delivering this strategy will therefore involve continued input from across the bioeconomy, and to monitor and evaluate the impact of this strategy we will need to maintain and grow these partnerships.

A Platform for Growth

This strategy marks the start of a transformation, providing a lasting platform for open dialogue between researchers, innovators, industrialists and policy makers.

Forecast bioeconomy growth

- The Global biorefineries market is set to grow from around £350bn to £550bn by 2021[6].
- The annual turnover of the UK industrial biotechnology and bioenergy sectors was £2.9bn in 2013/14 and was forecast to increase to £8.6bn by 2035[7].
- The global market for bioplastics is expected to grow from £13bn in 2017 to over £33bn by 2022[8]
- The global market for agricultural biotechnology is set to grow from £22bn in 2016 to £40bn by 2022[9]
- Production of sustainable aviation fuels in UK could be worth £265m GVA in 2030, with 4,400 jobs[10]
- A recent Zero Waste Scotland report[11] showed an estimated £500-800m could be generated for Scotland's economy by using food and drink by-products alone, that may otherwise go to waste.

This platform will facilitate the actions needed to drive innovation, bring new products to market and establish the UK as a global leader in developing, manufacturing, using and exporting bio-based solutions.

It will create the right supportive environment to make the UK an inviting and vibrant place to invest and do business, supporting innovation and stimulating economic growth. It will ensure that sectors within the bioeconomy command trust, improve lives, strengthen the UK economy and move the UK towards a low carbon future.

Our main metrics for measuring success will look at increases in GVA, jobs and productivity.

Additional metrics will also be observed to monitor progress towards more specific actions and deliverables. By actively monitoring and reporting on the progress of individual actions we will be able to build up a complete picture of the benefits a thriving bioeconomy brings to the UK.

Delivering Actions for Change

Following publication of this strategy, the next phase will be for the existing bioeconomy strategy consortium to develop an appropriate delivery mechanism to realise the actions set out in this strategy. This will require continued coordination across government, industry, academia and the research community.

For the purpose of this strategy a lead coordinator has been assigned to each of the high-level actions, although we anticipate cooperation across organisations to deliver on these commitments. These groups are broadly categorised as follows:

- **Government:** Actions may involve coordination across central government departments, the devolved administrations of Scotland, Wales and Northern Ireland as well as local or regional authorities.
- **UK Research and Innovation:** includes the seven Research Councils and Innovate UK. In this context we have also used the term to include the Knowledge Transfer Network (set up by Innovate UK in 2014) and academic institutions.
- **Industry:** includes industry bodies and leadership councils as well as individual companies that operate within the bioeconomy and the feedstock supply chain.

A critical step in realising the actions set out in this strategy will be to establish a governance group which will include representatives from government, industry and the research community. This will be created to support, monitor and evaluate the delivery of the bioeconomy strategy and related activities.

The new governance group will set out further details on delivery of the strategic actions required to:

- **Support the development of technology platforms such as synthetic biology and industrial biotechnology; and**
- **Provide an appropriate regulatory framework to support the growth of the bioeconomy.**

With these measures in place, the UK will be ideally positioned to become a global leader in developing, manufacturing, using and exporting bio-based solutions.

Boosting the Bioeconomy

We have already started delivering on the intent of this strategy through support for clean growth and related innovation:

- Launching Green GB Week in October 2018, to raise awareness of clean growth in the UK and how businesses and the public can help to tackle climate change.
- Supporting research and innovation in sustainable plastics with the £20m Plastics Research Innovation Fund.
- Strengthening UK science and business innovation with £1.1bn invested through the Industrial Strategy Challenge Fund including up to £60m for Smart Sustainable Plastics Packaging and co-funded by private sector investment.
- Investing £100m in low carbon industrial innovation to ensure we modernise our industries and accelerate the shift to low carbon transport

Our Approach

We will ensure that this strategy delivers real, measurable benefits for the UK, creating jobs, increasing productivity and doubling the size of the impact of the bioeconomy to £440bn by 2030.

Actions for Change

13. A governance group will be created to support, monitor and evaluate the delivery of the bioeconomy strategy and related activities.

Industry leaders will need to work with representatives from government, research and innovation bodies to provide leadership and guidance in the delivery stage of this strategy. A clear and transparent approach to implementing actions will involve a continuation of the collaborative approach adopted in the development of this strategy.

14. Government will facilitate continued dialogue with stakeholders on bioeconomy issues through a stakeholder engagement platform.

Developments in the sectors that contribute to the bioeconomy are fast and transformative. Continued engagement will be needed to ensure the strategy remains fit for purpose and an agile approach can be adopted. Ongoing dialogues are needed across industry sectors and with the regions and devolved administrations across the UK.

15. The governance group will establish a set of key bioeconomy metrics, including economic, environmental and societal impact, which can be monitored and reported on a regional level across the UK.

A delivery plan will be established, setting out the detailed actions and tasks needed to grow the bioeconomy. A detailed assessment will be undertaken to evaluate the potential benefits of the actions set out in this strategy. This will be set out alongside the delivery plan, to ensure appropriate ownership and scrutiny of actions.

Delivery of the actions set out in this strategy is likely to involve bodies such as local / regional authorities, Local Enterprise Partnerships and the Devolved Administrations.

Note: for definition of action owners, see Delivering Actions for Change section of the Conclusion.

References

1 BEIS / BBSRC (2016), Evidencing the Bioeconomy: http://www.bbsrc.ac.uk/documents/1607-evidencing-the-bioeconomy-report/

2 United Nations (2017): https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

3 BBSRC (2017): www.bbsrc.ac.uk/funding/filter/npif-industrial-challenges-skills-schools/

4 Science Industry Partnership supported by Cogent Skills (2016): Science Industry Partnership Skills Strategy 2025

5 Innovate UK (2017): https://www.gov.uk/government/publications/establishing-a-uk-medicines-manufacturing-innovation-centre/establishing-a-uk-medicines-manufacturing-innovation-centre

6 Research and Markets, Biorefinery Products (2017)

7 BBSRC, Biotech Britain (2015): www.bbsrc.ac.uk/ documents/capital-economics-biotech-britain-july-2015/

8 Research and Markets, Global Bioplastics Market Forecasts (2017)

9 Research and Markets, Agricultural Biotechnology: Emerging Technologies and Global Markets (2017)

10 Sustainable Aviation, Sustainable Fuels UK Roadmap (2015): www.sustainableaviation.co.uk

11 Zero Waste Scotland (2017): www.zerowastescotland.org.uk

This publication is available from: www.gov.uk/beis

Contact us if you have any enquiries about this publication, including requests for alternative formats, at: enquiries@beis.gov.uk