Feature

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Five recommendations to kick-start bioeconomy innovation in the UK

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The UK's bioeconomy has the potential to be world leading. However, political, economic, and social barriers are holding back innovation in this sector. Key interventions are needed to allow bioeconomic innovation to flourish. Caitlin Burns and Adrian Higson of the NNFCC The Bioeconomy Consultants, and Edward Hodgson of Aberystwyth University, make five recommendations to help the UK catch up with global competitors and stimulate investment in innovative bioeconomy. © 2016 Society of Chemical Industry and John Wiley & Sons, Ltd

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Introduction to UK bioeconomy

The world faces many challenges in the near future, increased competition for limited natural resources (including fossil fuels), a growing population, and climate change that will impact agricultural production systems.

A transition is needed towards a more efficient, sustainable, and integrated management of biological resources, agriculture, and processing systems that can produce more food, fiber, and bio-based products, with fewer inputs, fewer emissions, and less environmental impact.[1] A more innovative bioeconomy as described in the UK's bioeconomy white paper.

Recent estimates value the UK bioeconomy at £153–180 billion in gross value-added (GVA) terms, generating over 4 million jobs, and is the fourth biggest bioeconomy in Europe, after Germany, France, and Italy. However, there is large potential for growth through innovation. The Chemistry Growth Partnership estimated the economy would benefit £8 billion by 2030 by switching chemical feedstocks to biomass, and grow £4–12 billion per year if smart industrial biotechnology were adopted.

The UK has a strong and lengthy track record in science and innovation. With the exception of biopharmaceuticals, however, it has been slower to take up and support bioeconomy innovation, compared to other leading countries such as the USA, Brazil, France, Italy, Germany and Scandinavian countries.

Recommendations

This feature reviews the current status of UK bioeconomy innovation, highlighting barriers and making recommendations to enhance growth and competitiveness. We focus on the production of bio-based products, biofuels, and the development of industrial biotechnology (IB), as key areas of innovation.

There are policies in place to support innovation in the bioeconomy, many described in the Governments white paper *Building a High Value Bioeconomy: Opportunities from Waste*.

However, innovation systems are often characterized by their flaws. To identify barriers, a wide range of studies and consultations were reviewed, including the Biohorizons EU survey of bioeconomy barriers.[2] The full review is on the NNFCC website (http://www.nnfcc.co.uk/).

The following themes became apparent as necessary to lift barriers for UK bioeconomy innovation:

- Provide continuity of policy to give investors confidence in the bioeconomy
- Attract large companies to developing bioeconomy innovation clusters

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- Demonstration of innovative technology
- Use Public Procurement to develop markets for bio-based products
- Raise public awareness and understanding of bio-based products

Continuity of policy

Continuity of policy and investor confidence are commonly cited as barriers to UK bioeconomy development. These concepts are linked, as long-term policy stability can lead to greater confidence in industry, and less need for government incentives.

Policymakers appear to be interacting with industry and third sector organizations, through government working groups including the IB Leadership Forum, and have implemented many policy recommendations, which have benefitted the industry.

However, the government departments responsible for supporting bioeconomy development – the Department of Energy and Climate Change (DECC), the Department for the Environment, Food, and Rural Affairs (Defra), and the Department for Business Innovation & Skills (BIS) – all face significant cuts, which makes the future of R&D, facilities, and business support less certain. BIS has already announced plans to privatise the Green Investment Bank, the main financial instrument for green infrastructure. In the bioenergy and biofuels sectors, there is uncertainty after changes to a number of renewable energy policies, including changes to biofuel and renewable heat incentive criteria; grandfathering policies; and an uncertain budget for bioenergy Contracts for Difference.

Many regions, including the EU, the USA, and countries such as Germany, Finland, Spain, the Netherlands, and Belgium (Flanders), have developed bioeconomy strategies. These documents set out a long-term and cross-sectorial vision of the sustainable use of biomass resources and bioeconomy innovation, to boost the economy, create jobs, benefit the environment, and reduce the reliance on fossil fuels and imports.

- The development of a bioeconomy strategy would clarify the UK's long-term vision to provide confidence to investors, and a plan for the sustainable and innovative management of the nation's renewable bioresources.
- The creation of an advisory body, similar to the bioeconomy council in Germany, would ensure delivery of the strategy and co-ordinate development across sectors.

Together, the bioeconomy strategy and body could provide much needed confidence to investors in bioeconomy innovation and manufacturing in the UK.

Otherwise, continued unstable policy will further damage confidence, and diminish investment in the UK in favor of countries where advanced bioeconomies are already flourishing or where governments have a longer-term vision and offer more support, such as China and the USA.

Attract large innovative companies to bioeconomy clusters

The world's leading bioeconomy nations, including the USA, Japan, and Germany, have large and innovative chemical industries. Today, the UK focus has been on technology development and the production of biopharmaceuticals. Less attention has been paid to the production of speciality and commodity chemicals. Small and medium-sized enterprises (SMEs) and large industry cite the fragmented and small nature of the UK IB sector – which is mainly made up of SMEs – as the main obstacle to growth.[3] In addition, the number of IB spinout companies from universities has been surprisingly small, due to lack of industry skills, know-how, and investment.[4]

- To address some of these issues, efforts should focus on attracting large innovative bioeconomy companies to the UK. These large companies would attract and train a stable skilled workforce, and invest in pioneering facilities. This would in turn develop industry know-how to benefit the wider bioeconomy and improve industry confidence stimulating further investment.

Clustering is also a popular way to encourage growth, where companies pool geographically to a sufficient mass to attract a more stable and skilled workforce. For example, biotech clusters are very important for growth in Germany and France. There is no obvious innovation cluster in the UK for biorefining, IB, or bio-based products, equivalent to the booming bio-medical hubs in Cambridge, Oxford, and London. However, there are places where clusters could be developing and encouraged, centered on important institutes.

For example, the North East has the Centre for Process Industry facilities for R&D and scale up; the North East Processing Industry Cluster organization to facilitate collaboration and networking; and many chemical, biotechnology, pharmaceuticals, bioresources, and energy companies, and a large biofuels manufacturer (Ensus). There is a potential bioeconomy hub forming in Yorkshire, associated with BioVale (aiming to develop the cluster),

the Biorenewables Development Centre facilities to scale up bio-based products, and large biofuel (Vivergo), bioenergy (Drax), and bio-chemical (Croda) companies. Other potentials include: an IB hub in Scotland around IBiolC and the established chemical industry, and a biorefining cluster in Wales supported by the BEACON project.

Bioeconomy clusters could provide access to a range of services important for developing companies, including:

- Shared pilot and demonstration facilities to scale up ideas
- Innovation grants for technology development
- Links to business support and connection services
- Reduced costs for start-up companies
- Joint public-private investment in technology development, strategically important to the UK
- Facilitated contacts between UK SMEs and multinational companies to benefit from industry know-how and skills
- Facilitated links to high-quality science/technology researchers and expertise

However, if no large companies are present to support SMEs, it will be much harder for them to find the skills, finance, and staff to establish themselves and subsequently grow.

Demonstration of innovative technology

Demonstration is an essential tool to accelerate the development of a new technology and build investor confidence. The UK has a strong knowledge base and there has been a recent emphasis on increasing impact from research spending, which has boosted academic publications and patents. Together with increased spending on R&D facilities and tax breaks for R&D and patented products, this has led to a surge in SME activity. However, the budget for science research has fallen to the lowest in the G8 which will impact academic and SME activity. In addition, start-up companies need to demonstrate technology to get investment, but often find financing scale-up projects a barrier.

NNFCC analyzed the need for investment in IB facilities in the UK,[5] and concluded that, overall, the UK is currently well served in accessible pilot equipment and competence, and is competitive with other EU states. However, investment was recommended in a number of emerging technologies (C1 fermentation and high-value products from microalgae), and to continue in specific established sectors (biorefining and cellulosic fermentation) to strengthen UK capability.

To bridge the gap from lab and pilot scale to commercialization, larger-scale demonstrators are important to show that new products are technically and economically feasible. For example, the Bio-Based Industries Joint Undertaking funds demonstration and flagship projects across Europe. The UK's Advanced Biofuels Demonstration Competition has provided an important boost to biofuel development, as we are behind many nations in the development of advanced processes using wastes, by-products, or agricultural residues. However, these demonstrators won't be operational until 2018, and only concern biofuel production.

- Continued support for academic and applied R&D is needed to retain the UK's world-leading status of knowledge and innovation.
- Targeted support for pilot and large-scale demonstration of technologies in which the UK has established strengths and target emerging markets is needed to ensure UK innovation translates into commercial success.

These measures would show the innovation system is thriving, making the UK an attractive location to invest in technology development and manufacturing innovative bio-based products, and perpetuate growth. Otherwise, manufacturers and investors will continue to be led away from the UK, in favor of countries where policies are more supportive of bioeconomy development.

Targeted public procurement of sustainable bio-based products

New technologies often face large barriers when entering markets, such as a lack of demand and awareness of new products and services, and high initial costs which lower competitiveness against established markets, such as the fossil fuel industry. Government intervention is often necessary to help new technologies overcome these financial obstacles and increase demand for innovative products. The UK government aims to stimulate private investment for innovative and low-carbon companies with incentives, regulation, and tax breaks, to help meet national and EU targets for climate change reduction, and to boost economic growth and job creation.

Green public procurement focusing on bio-based products could have great power to boost the industry, and stimulate market demand by using the massive spending power of the UK public sector, of £238 billion per year. However, EU and UK Green Public Procurement targets and standards are currently voluntary, and there is no

direct reference to 'bio-based' in these schemes, only a focus on recyclability and non-toxicity among other non-bio-specific properties.[6]

The message from stakeholders is that market pull measures are working for bioenergy. However, the government is underutilizing its purchasing power through public procurement to drive market demand for bio-based products.

- Targets for bio-based products in public procurement strategies (such as in Greening the Government, and the EU Green Public Procurement programme), would drive markets of bio-based products directly, and improve awareness of bio-based products, further driving markets and improving the environmental impact of the public sector.

To not use the power of the public purse would be an enormous opportunity missed to deliver policy goals.

Public awareness and acceptance of bio-based products

Understanding public opinion and working towards social acceptance is one of the key challenges faced by any developing innovation, in order to prevent a public backlash that could damage progress. Issues surrounding advanced bioeconomy cause a lot of debate, including ethical issues with biotechnology, land use and sustainability of feedstocks and resources, and trust of government and scientists.

There are organizations and initiatives working to gain public acceptance of bio-based products and biotechnology, including the Biotechnology and Biological Sciences Research Council (BBSRC) and the Royal Society, supporting science communication; Nuffield Council stimulating debate on bioethics; trade organizations raising awareness of economic benefits; and government working groups for strategic coordination, including the IB Leadership Forum and the Synthetic Biology Leadership Council. However, recent consultations and media reports show that public perception is still a major barrier to bioeconomy innovation.[4,7,8]

To gain public acceptance of bio-based products and the IB sector, there needs to be:

- Clearer benefits relayed to consumers, to put risk and benefit in perspective
- Stronger regulation, to improve public trust and ethical application of new technology
- Greater transparency and more genuine public engagement, in science and government, to shape development and improve acceptance of new innovations

If new technologies are not regulated appropriately and accepted by the public, there is likely to be subsequent over-regulation and major set-backs for commercializing new technology, similar to the controversy over genetically modified (GM) crops, which has resulted in more than half of EU countries attempting to ban them in growth in 2015, including Scotland, Wales, and Northern Ireland.

Conclusions

The UK has great potential to be a world-leading center of bioeconomy innovation, with an already strong research base; many cutting-edge companies; and active support from funding bodies, network, and policymakers. However, there are still barriers which are slowing down innovation, mainly to do with continuity of policy, skills, finance, and public awareness and acceptance of bio-based technologies.

To allow the UK innovation system to flourish, a government bioeconomy strategy needs to be developed, aligning cross-sector stakeholder consultation and evidence, and action needs to follow. We recommend continuing and increasing support for R&D, facilities, clustering, and networking activities; expanding renewable energy support schemes to bio-based products; and bridging finance gaps with innovation awards and tax breaks. In addition, bio-based products should be included in public procurement guidelines, joint public-private investment in strategically important demonstrators supported through joint public-private investment, an emphasis placed on attracting large innovative companies into the UK, and a greater focus placed on public engagement and achieving wider public consensus and support.

The UK has the opportunity to capitalize on the economic opportunities presented by the growing global bioeconomy and with the right action and support, the country could be at the forefront of bioeconomy innovation.

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