



INDUSTRIAL BIOTECHNOLOGY IN THE UNITED KINGDOM

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INTRODUCTION

The UK is as a significant player in industrial biotechnology. Building on its life sciences strengths and productive healthcare biotechnology industry, the UK has established good conditions for industrial biotechnology to reinforce the biotech sector. The UK Government has recognised the tremendous potential of industrial biotechnology as both a means of making UK manufacturing industries more competitive and as a way of reducing emissions and environmental pollution. Today, progressive governmental support, innovative institutes and companies and powerful collaborations are supporting the discovery and development of new industrial biotech processes and bio-products.²

² <http://www.ukinvest.gov.uk/United-Kingdom/10441/en-GB.html?page=1>

RESEARCH AND INNOVATION

Modern industrial biotechnology is a relatively new discipline, with major areas of knowledge still to be explored. Public support to research as well as the establishment of pilot and demonstration facilities to scale-up individual processes will therefore help in the development of a European bio-based economy.

A. Public research funding

The UK Department for Business Enterprise and Regulatory Reform³ (BERR) is member as a partner of the European Research Area – Industrial Biotechnology⁴ (ERA-net IB).

The BERR Technology Programme's⁵ – Technology Strategy Board⁶ published 2 calls to date on bio-based products and processes.

Defra⁷, in conjunction with the BBSRC, has a programme devoted to renewable materials that will provide grant-aid to private sector-led collaborative research into non-food crops.

The **Business Resource Efficiency and Waste⁸ (BREW) programme** is offered via Defra and provides funds to support business in improving its resource efficiency, including waste minimisation and diversion from landfill. The funding is distributed over three years with £43 million for 2005/06, £95 million for 2006/07 and £146 million for 2007/08.

The Biotechnology and Biological Sciences Research Council⁹ (BBSRC), sponsored through the UK Government's Office of Science and Innovation, is the leading funding agency for academic research and training in the biosciences. The BBSRC invests £336 million a year in scientists working in universities and in eight research institutes as well as in the promotion of knowledge transfer, industrial collaboration, business start-ups and IP protection.

The Responsive mode and initiatives Programme of the BBSRC supports several initiatives and research projects for the period 200-2010. It is mainly funding universities and public research institutes. In 2008, 239 projects were supported.

IBTI - integrated biorefining technologies initiative¹⁰ is a product development partnership led by Bioscience for Business KTN¹¹ and consisting of leading industries, government departments and research councils. The research club is being led by the UK's main public funder of bioscience research – the Biotechnology and Biological Sciences Research Council (BBSRC). BBSRC will be working with the Bioscience for Business Knowledge Transfer Network and the founder company members of the IBTI Club: Biocaldol, BP Biofuels UK, British Sugar, Croda, Danisco A/S Genencor, Green Biologics, AHDB-HGCA, KWS UK, Syngenta and TMO Renewables.

IBTI activities will be:

- Activity 1: A strategic research programme (BBSRC Industry Research Club) - An industry-guided research programme with bi-annual dissemination meetings to ensure members are informed of research outputs. This forum will provide opportunities for early engagement with UK academics to establish close working relationships for future collaborative ventures.

³ <http://www.berr.gov.uk/>

⁴ <http://www.era-ib.net/>

⁵ <http://www.berr.gov.uk/dius/innovation/technologystrategyboard/tsb/technologyprogramme/programme/page11697.html>

⁶ The Technology Strategy Board is an executive non-departmental public body (NDPB), established by the Government in 2007 and sponsored by the Department for Innovation, Universities and Skills (DIUS), <http://www.innovateuk.org>

⁷ www.defra.gov.uk

⁸ <http://www.defra.gov.uk/environment/business/support/>

⁹ <http://www.bbsrc.ac.uk>

¹⁰ http://ktn.globalwatchonline.com/epicentric_portal/site/bfb/menuitem.ecb64364566d6990043ae2c68380e1a0/

¹¹ www.biosciencektn.com

- Activity 2: Demonstration Projects - Industry and government departments will fund demonstration projects as proof-of-concept. Projects will vary in size and extent of private/public investment according to the specific needs of individual companies/consortia.
- Activity 3: A facilitated network - The IBTI Industrial Strategy Board is an influential group of experts with knowledge across the entire biorefining supply chain. Importantly, this includes both the energy and non-energy sectors to ensure commercial potential is maximised through the integrated production of bioenergy, biochemical and biomaterial products.

The Technology Programme¹² of the Department for Business Enterprise and Regulatory Reform covers seven key technology areas in Bio and Healthcare, ICT, Photonics and Electronics, Materials, Emerging Energy, Sustainable Consumption and Production, Design Engineering and Advanced Manufacturing. It is mainly supporting private companies in their development process.

SusChem United Kingdom is the national platform that links the UK with the European Technology Platform for Sustainable Chemistry¹³. It is an alliance of six partner organisations¹⁴ with an interest in sustainable chemistry, working together to support industry and academia in providing the chemistry-based solutions that will contribute to a sustained quality of life. Launched in June 2008, SusChem United Kingdom focuses on areas where innovation in chemistry, engineering and related sciences can bring about major advances in sustainability through the design, manufacture, formulation, packaging and distribution of products and through new and improved processes.

B. Pilot and demonstration plants

i. pilot plants

a) Open to all

Wilton, Redcar

National Industrial Biotechnology Facility (NIBF), Wilton, Redcar	
General, products, feedstocks	Industrially focused service within the Centre for Process Innovation (CPI). Owned and operated by CPI the NIBF is available for producing microbial proteins and enzymes and cells for biocatalysis and for biotransformations at pilot scale. Downstream chemical processing will allow recovery of low molecular weight metabolites and polymers (e.g. DNA) for non-clinical use.
Services	<p><i><u>Bio processing facilities available for use include:</u></i></p> <ul style="list-style-type: none"> • 2 x 1000 litre fermentors • Development labs to 10 litre scale • Dedicated 50 litre solvent facility and integrated chemical processing capability • Marine fermentation capability • Online PAT to provide real-time fermentation information as it happens • Plug and play DSP • Novel bioreactor design, build and optimisation • Consultancy services and process packages <p><i><u>Chemical processing</u></i></p>

¹² <http://www.berr.gov.uk/dius/innovation/technologystrategyboard/tsb/technologyprogramme/index.html>

¹³ www.suschem.org

¹⁴ Royal Society of Chemistry, Society of Chemical Industries, Chemical Industries Association, Institute of Chemical Engineers, Bioscience for Business KTN, Chemistry Innovation KTN

	<p>CPI provide a range of services from small consultation projects to full pilot plant design, build, operation and optimisation. Products available to trial and test include notably:</p> <ul style="list-style-type: none"> • Structured reactor • Micro Reactor technology • Spinning disk reactor • COBR • Pilot plant design and build • Process consultation and optimisation • Full process package/front end engineering design • Continuous crystallisation technology • A full kilo lab capability <p>And a developing integrated demonstrator with flexible plug'n'play options</p>
Financing	
Contact	<p>Ms Sophie Walton (BSc) Business Manager – Advanced Processing</p> <p>T: +44 (0)1642 447 278</p> <p>M: +44 (0)7770 331838</p> <p>E: sophie.walton@uk-cpi.com</p> <p>W: http://www.uk-cpi.com/</p>

b) Restricted

Wissington, Norfolk

British Sugar plc – Bioethanol plant, Wissington¹⁵	
General, products, feedstocks	<p><u>Bioethanol plant:</u> UK's first bioethanol plant. Its capacity is 70m litres (55,000 tonnes) of bioethanol and biobutanol a year, using sugar beet as a feedstock. The plant started bioethanol production in September 2007.</p> <p><u>Sugar beet refining:</u> The Wissington sugar factory situated represents an excellent example of a biorefinery, processes up to 3 million tonnes of beet every year. Main products are white crystal sugar, liquid sugars and screened speciality sugars. About 140,000 tonnes of feed pellets are also produced each campaign. The factory also produces betaine, a valuable animal feed supplement. Over 100,000 tonnes of LimeX70 is produced each campaign and sold to farmers to correct acidity, add some nutrients, and improve the structure of the soil. More than 35,000 tonnes of conditioned Topsoil is sold, mainly to the landscaping industry. The factory provides its own electricity and exports up to 50Mw to the national supply network from a 50Mw gas turbine and a 30Mw steam turbine. The combined heat and power (CHP) plant also provides heat and carbon dioxide to the adjacent horticulture business, which produces tomatoes under 11ha of glass.</p>
Services	
Financing	
Contact	http://www.britishsugar.co.uk/RVE0ecabedd4f8646afbb62e00fc6dfe23d...aspx

¹⁵ British Sugar's Wissington Plant in Norfolk includes a recently added bioethanol production facility which is an early example of a biorefinery. Approximately 40% of the UK's total sugar beet crop is grown within a 50-mile radius of the plant. Sugar is made by slicing up the beet root, steeping them in hot water and treating the liquor with lime and CO₂. After filtration, the resulting liquid is concentrated by evaporation. The bioethanol plant siphons off surplus syrup, yeast is added, and an 8% ethanol brew is subsequently concentrated by distillation to produce 50,000 tonnes of pure ethanol per annum, which is sold to be blended with petrol. All of the by-products are reused; soil and stones washed off the roots are recycled as growing medium and aggregate; chalk from the purification process is sold as soil improver; and vegetable solids and protein residues are dried for animal feed. A gas fired CHP plant provides steam for both sugar and bioethanol production, CO₂ and low temperature heat is used to grow tomatoes in adjacent greenhouses, and up to 35MW of electricity is exported to the national grid. A complex process of life-cycle analysis has shown that British Sugar's bioethanol "saves 60% of the fossil CO₂ released per unit of energy by burning conventional petrol" (Lightowlers 2008).

ii. demonstration plants

The main organisations in the UK developing biorefinery demonstration facilities represent private enterprises. Attention has currently focused on biorefinery facilities for the production of biofuels, including bioethanol and biodiesel. Those facilities have currently been financed through the private sector.

Associated British Foods/BP/DuPont	
General, products, feedstocks	Associated British Foods have recently reached an agreement with BP and DuPont on an investment to build a world-scale biofuel plant in the UK. The bioethanol-biobutanol plant, in which BP and ABF subsidiary British Sugar would each hold 45 per cent with DuPont owning the remaining 10 per cent, will be built on BP's existing chemicals site at Saltend, Hull. The plant will produce bioethanol from wheat with an annual capacity of 420m litres (330,000 tonnes) per year and will be built at a cost of £200m at BP's chemicals site at Saltend, Hull. The plant is planned to come on stream in late 2009 and will initially produce bioethanol, but the partners will look at the feasibility of converting to biobutanol once the technology is available. The BP site in Hull has also been selected as the preferred location for a planned biobutanol demonstration plant, funded and owned equally by BP and DuPont which could produce around 20,000 litres of biobutanol a year from a wide variety of feedstocks.
Services	
Financing	The bioethanol plant will be built at a cost of £200 million. BP and ABF subsidiary British Sugar would each hold 45 per cent with DuPont owning the remaining 10 per cent. The European Investment Bank (EIB) is providing £60m of the finance for the plant to ABF at an attractive interest rate. It will be funded and owned equally by BP and DuPont
Contact	http://www2.dupont.com/Media_Center/en_US/daily_news/february/article20080215.html

II. POLICY

Public authorities can promote the quick take-up of industrial biotechnology innovations by implementing a number of “instruments” or policy initiatives. This can be the improvement of the regulatory framework; the integration of specification for bio-based products in public procurement; the establishment of standardisation, labelling and certification schemes to overcome perceived uncertainty about product properties and weak market transparency; the development of financial instruments and supports to increase investments into research, technology development and innovation as well as the elaboration of communication and information campaign to communicate the benefits of bio-based products to users.

A. Policies and regulations

No policies are in place at present although some discussions have taken place as mentioned in the White Paper “ Innovation Nation”¹⁶ (March 2008) and in the UK Life Science marketing strategy¹⁷ launched in November 2007.

In 2004, DEFRA¹⁸ and DTI (now BERR¹⁹) published a “**A strategy for non-food crops and uses - creating value from renewable materials**”²⁰. The Strategy action plan covers areas such as tackling climate change, funding more scientific research and increasing the use of sustainable products.

In November 2006 the Strategy Project Board published its report²¹ on the delivery of the first two years of the Strategy and in May 2007, the Government responded²² to this two years evaluation by refocusing the action plan for developing the strategy up to the end of 2009. The Government noted that Bioenergy has seen most progress over the last two years. He noted that to achieve a low carbon economy, the development of biorefineries to provide a sustainable manufacturing base for energy, fuels, biomaterials and chemicals is central.

The DTI (now BERR) established in October 2004 the **Biomass Task Force** with the challenge ‘to assist Government and the biomass industry in optimising the contribution of biomass energy to renewable energy targets and to sustainable farming and forestry and rural economy objectives’.

The Task Force concluded that biomass – in its diverse forms – has potential for contributing strongly to our renewable energy and climate change objectives, and that much of this potential is currently unrealised. Biomass cannot solve all of the issues facing us, for energy or for farming. But its contribution can be very significant and in this response we set out our plans for moving forward towards optimum use of this resource.

In 2006, the Government responded to the task force²³. The response provided further detail on how the United Kingdom intends biomass to contribute to renewable development. The Government asked the Task Force to concentrate on the use of biomass for heat and electricity generation, while taking account of biofuels for transport and other non food uses of crops in so far as cross-cutting issues arose.

BERR has facilitated an Innovation and Growth Team on Industrial Biotechnology (IB-IGT)²⁴ that is industry led project formed to produce a collective view from the UK chemical and bioscience industries on the challenges of Industrial biotechnology. This was formed in 2007 and will report

¹⁶ www.dius.gov.uk/publications/scienceinnovation.pdf

¹⁷ <https://www.uktradeinvest.gov.uk/ukti/fileDownload/LifeScienceStrategyLaunchPublication.pdf?cid=411429>

¹⁸ <http://www.defra.gov.uk>

¹⁹ <http://www.berr.gov.uk>

²⁰ <http://www.defra.gov.uk/farm/crops/industrial/pdf/nfc-strategy.pdf#search=%22%22nfc%22%20%22non%20food%20crops%22%22>

²¹ <http://www.defra.gov.uk/farm/crops/industrial/pdf/nfc-progress-0611.pdf>

²² <http://www.defra.gov.uk/environment/climatechange/uk/energy/renewablefuel/pdf/nonfoodstrat-2yearreview.pdf>

²³ <http://www.berr.gov.uk/files/file28197.pdf>

²⁴ www.berr.gov.uk/whatwedo/sectors/biotech/IBIGT/page44395.html

Q2 09 with advice on finance, procurement, labeling, LCA and policy issues relating to industrial biotechnology. This report will advise government policy in the UK.

B. Public procurement

There are no specific guidelines on bio-based products in public procurement. Ad hoc – some examples of renewable products have been incorporated into public procurement contracts.

C. Standardisation, labelling and certification

Support the EU wide ecolabel rather than National scheme.

D. Access to finance

Links to some sources of information about support and funding for Bioscience companies is available here: <http://www.berr.gov.uk/sectors/biotech/support/page10221.html>

Finance and Investment will be a workstream for BERR's recently launched Industrial Biotechnology Innovation and Growth Team (IB-IGT)²⁵ due to report in quarter 2 2009.

Knowledge Transfer Networks (KTN)²⁶ promote collaboration between research, industry and technology organisations to broaden and accelerate industry driven knowledge transfer from scientific expertise into the end-user markets through a range of activities facilitating the entire chain.

The Bioscience for Business KTN²⁷ is the UK's knowledge transfer network (KTN) in making sustainable use of renewable bio-resources.. The Bioscience for Business KTN operates across white, green and blue biotechnology and is designed to meet the challenge of integrating rapid developments in the biosciences with the necessary equipment and process advances, including biocatalytic manufacturing processes to achieve industrial excellence.

E. Communication

NNFCC are developing a communications strategy for non-food crops to provide information to the consumer to influence behaviour and support beneficial choices and to industry on new commercial opportunities.

Bioscience to Business KTN is promoting a number of events and "webinars" to raise awareness and to bring together researchers and commercial bodies. The Chemistry Innovation KTN is also working to promote IB in collaboration with BfB.

²⁵ <http://www.berr.gov.uk/whatwedo/sectors/chemicals/ibigt/page44395.html>

²⁶ www.ktnetworks.co.uk

²⁷ www.biosciencektn.com