

Third biotech generation targets industrial growth and sustainability

As the 21st century progresses the third biotechnology generation – industrial biotechnology – is set to establish itself at the core of a competitive and sustainable UK economy. Here, Dr Martin Anthony of the Department of Trade and Industry's Bioscience Unit, outlines the main drivers and on-going progress being made towards the development of a European and UK policy framework.

Just as the pharmaceutical industry and agriculture have been transformed by biotechnology, observers are predicting even greater impact across other industrial sectors. By 2010, growing demand for novel bio-based tools and products may result in an estimated global output from industrial biotechnology of €1,500 billion (outpacing pharma-biotech output by €680 billion) and could account for one-fifth of the world's chemical output by value^{1,2}.

Industrial biotechnology uses living cells like moulds, yeasts or bacteria, as well as enzymes to improve manufacturing and product quality. There is growing evidence, at both international and domestic levels, that these enabling technologies have significant performance benefits compared to conventional options – including increased conversion efficiency, product purity, lowered energy consumption and reduced waste generation – and that their application provides new solutions to old industrial problems that are cleaner, less polluting and less energy intensive.

Increasingly, policy developers (OECD and EU) are recognising that industrial applications of biotechnology can deliver strategic solutions to the twin challenges of competitiveness and sustainability at every stage of the manufacturing process from raw materials through to end-of-pipe and clean-up (see inside front cover).

Industrial biotech – the international perspective

Policy decisions within the major industrial economies are moving towards greater adoption of industrial biotechnology. Japan, for example, is seeking to derive 30 per cent of its chemical production from the bio route while the US has already adopted a “bio-energy initiative” to accelerate the development of biotechnologies.

The US is, however, more cautious over in-process applications and American commentators have suggested that Europe may well be more farsighted here. Ambitious environmental targets within Europe are also providing added impetus, encouraging further innovation and adoption in this area.

European developments

Europe is a major player in the world's industrial biotech sector boasting 1,500 new biotech companies based on life sciences R&D, and has a 70 per cent share of the world enzyme industry with major developers and adopters in key industries such as the chemicals sector. Over the last three years there has been increased public and private sector investment and growth in the number of national support mechanisms. Commentators have, however, pointed to the need for a “European industrial biotechnology initiative” to build sufficient critical mass to face the challenges ahead. Included here is the need to improve the co-ordination of research and the fiscal and regulatory environments that would promote the uptake of industrial biotechnologies across different sectors.

The UK is helping lead developments within Europe to improve investment, partnering, and promotion of industrial biotechnology. Increasingly, Europe is recognising the significant potential for industrial biotechnology to contribute to the Lisbon, Barcelona and Gothenburg objectives for promoting economic growth and employment. For example, the European Commission's recently published *Environmental Technology Action Plan* stresses the importance of industrial biotechnologies for the sustainable development of our society, and it may well feature in the next EU R&D Framework Programme (FP7).

EuropaBio (the European Association for Bioindustries³) together with trade bodies for sectors such as chemicals, paper and pulp and textiles recommended that the EU form a strategic alliance to define a European approach for industrial biotechnology and establish a stakeholder-led European Technology Platform.

In response to this vision July 2004 saw the EC announce⁴ the setting up of an industry led Technology Platform on sustainable chemistry bringing together leading chemical industries with the new emerging biotechnology sector. This new Technology Platform is an initiative by CEFIC, the European Chemical Industry Council, and EuropaBio. It is a multi-stakeholder forum and is designed to develop a European strategic research agenda and carry out joint research projects. Sitting below this overarching platform is a technology sub-platform or “pillar” devoted to industrial biotechnology. Over the coming months the respective stakeholder communities involved will be developing a detailed vision and action plan for industrial biotechnology across Europe.

Also playing to the industrial biotechnology agenda is the recently launched European Plant Genomics and Biotechnology Platform⁵ whose overall policy objective includes the move towards a zero waste, emission neutral bio-based economy where biomaterials such as fine chemicals and pharmaceuticals will be produced from renewable, plant based materials, reducing greenhouse emissions and waste.

UK developments

To inform deliberations on future UK policy direction and to help guide strategic UK investment, including support under the Department of Trade and Industry's Technology Programme, the Bioscience Unit established an Industrial

Biotechnology Task Force (IBTF) in December 2003 to develop a 2015 vision. The focus is on bio-based industrial tools and products; acknowledging, but not duplicating DTI/DEFRA work on non-food crops. Its aim is to scope the technical and commercial opportunities, identify barriers to success and advise on measures to promote greater collaboration and growth. A report, setting out a 2015 vision for UK industrial biotechnology with suggested actions, will be published in early December 2004.

The UK – Europe's bioscience leader

The UK is an ideal place for business to reap the benefits of industrial biotechnology. Accounting for just under half of all European biotechnology companies, the UK bioscience sector is the largest in Europe and placed second globally behind the USA.

Supportive economic and political conditions, coupled with a world-class science base and a well-established industrial supply base, provide an enviable platform for industrial biotechnology R&D and commercialisation.

Relevant emerging science areas where the UK is thought to be particularly strong include extremophiles, high-throughput screening, isotopes for industrial applications (potentially five years ahead of the US), microbial solutions, plant-based solutions, physics-based biotechnology and bioremediation (particularly metal remediation and nuclear waste treatment).

The UK also has internationally recognised centres of expertise, such as the National Non-Food Crop Centre (www.nnfcc.co.uk), and technology transfer mechanisms typified by three relevant Faraday Partnerships⁶ – including the UK Centre of Excellence for Biocatalysis (www.pro-bio-faraday.com) – Biotechnology Exploitation Platforms⁷ to exploit publicly funded bioscience

research in bioremediation [Beacon Bio BEP] and bio-based environmental technologies [EnVision BEP], and the Centre for Novel Agricultural Products (www.cnap.org.uk) exploring the potential of industrial products from plants.

Strong links between research and the domestic supplier base and export active companies of over 100 specialist companies⁸, have contributed to the strong penetration of industrial biotechnology with practical inroads made in biomaterials, enzyme production, biosensors, biocleaning, surface coating, product authentication, waste management and remediation technology arenas.

However, many of these are SMEs and lack the critical mass to expand and take full advantage of the opportunities presented without a framework of support.

UK Government Actions

Regarded by other EU countries as an exemplar, UK Government actions have stimulated this sector for several years. The DTI's Bioscience Unit has, for example, raised awareness of the benefits of industrial biotechnology and encouraged commercial application of novel biotechnologies since 1994 through its Biotechnology Means Business and BIO-WISE (www.dti.gov.uk/biowise) programmes while collaborative R&D has been supported through LINK

programmes.

Independent research has indicated that UK companies across a wide range of industrial sectors made savings in excess of £350 million between 1995 and 2001 as a result of incorporating industrial biotechnology into their business model, many of those received support directly from BIO-WISE. In particular, the BIO-WISE "Demonstrator projects", funded by the DTI, formed an important component of the programme, helping to disseminate the benefits of biotechnology in real working industrial settings.

Current commercially viable Demonstrator Projects include the recycling of metals from scrap computers and mobile phones, use of glowing bacteria to test contaminated land, replacing toxic coatings with seaweed extract to prevent metal corrosion and handheld biosensors that detect pathogens in sewage and ammonia in water.

Passing on best practice in this way has encouraged the continued expansion of industrial biotechnology in the UK and is helping our manufacturing sectors sustainably reduce cost, boost product quality, and cost-effectively comply with environmental legislation (see text box).

For further information visit www.dti.gov.uk/biowise.

BIO-WISE Demonstrator Projects have helped industry comply with existing environmental legislation:

A demonstration of Biopolymer Conversion coatings for the prevention of corrosion (*End of Vehicle Life Directive*)

Bio-electrochemical technology for the recovery of precious metals from electronic scrap metal (*Restriction of Hazardous Substances in Electrical and Electronic Equipment (ROHS) Directive and Waste Electrical and Electronic Equipment (WEEE) Directive*)

Field testing and evaluation of Rapid On-site Toxicity Audit System (ROTAS™) (*Landfill Directive*)

Sensor technology for rapid environmental ammonia monitoring (STREAM) (*Water Framework Directive*)

¹ EU Life Sciences and Biotechnology: 'A Strategy for Europe' (2002).

² Uptake of White Biotechnology by the Chemical Industry (2001), McKinsey analysis.

³ Relevant EuropaBio position papers and profiles on industrial biotechnology can be found at: <http://www.europabio.org>

⁴ For further details see EuropaBio's press release <http://www.europabio.org/PRWB.htm>.

⁵ For further information see EuropaBio's press release <http://www.europabio.org/PRGB.htm>.

⁶ Faraday Partnerships are alliances of organisations and institutions dedicated to the improvement of the competitiveness of UK Industry through the research, development, transfer and exploitation of new and improved science and technology.

⁷ Biotechnology Exploitation Platforms are consortia that aim to create new opportunities for the exploitation of the intellectual property arising from publicly funded bioscience research in the UK through the capture and protection of IP, and the creation of new and viable IP portfolios.

⁸ Companies whose core business (i.e. first or secondary product/service) is industrial and environmental biotechnology according to the BIO-WISE Suppliers Survey and database.