Industrial (White) Biotechnology

An Effective Route to Increase EU Innovation and Sustainable Growth

POSITION DOCUMENT ON
INDUSTRIAL BIOTECHNOLOGY
IN EUROPE AND THE NETHERLANDS

Unlimited. DSM

INTRODUCTION

Industrial (or white) biotechnology, the use of biotechnology in industrial processes, is a subject which is rapidly gaining priority on the agendas of those in industry, politics, academia and NGOs. Why? Because white biotechnology offers enormous opportunities, not just for the economy, but equally to our environment and to our society. Recent studies from McKinsey and the Öko-Institute, as well as reports from the OECD, demonstrate the need to pay serious attention to building a European strategy for white biotechnology jointly among industry, politicians and scientists.

The USA is moving fast in this field. The current US administration has adopted the stimulation of white/industrial biotechnology as part of its governmental programme and allocated a substantial budget to draft a “road map” to facilitate the development and implementation of the use of this form of biotechnology. We should not simply copy the US policy. Instead, Europe and individual Member States should use the rich potential that this continent offers in terms of knowledge, industrial activities and academic research institutes.

EuropaBio, the EU Industrial Association of Biotechnology, urges all white biotechnology stakeholders to jointly discuss the benefits of applying white/industrial biotechnology in Europe. We would like to see us identify and action some concrete steps towards making the use of white biotechnology really happen on a large scale.

In this paper, you will find our initial recommendations, both for the Netherlands and for Europe as a whole. To realise the proposed steps, political support at national and EU levels will be very important. It would be very welcome if the Dutch government were to use the Dutch EU Presidency in the second half of 2004 to draw up an action plan, and to present that to Europe. We would hope to see white/industrial biotechnology programmes being secured within the existing EU Framework Programme 6 and in the new Programme 7.

White biotechnology offers the rare opportunity to create a triple win for People, Planet and Profit. Let’s not pass up this promising development for Europe, from which both our own and future generations can benefit.

Feike Sijbesma
Member, Managing Board, DSM

EXECUTIVE SUMMARY

Industrial biotechnology, also known as white or environmental biotechnology, is the application of nature's toolset to the production of bio-based chemicals, materials and fuels.

Current practice in industrial biotechnology demonstrates that the social (People), environmental (Planet) and economic (Profit) benefits of bio-based processes go hand in hand. Substantial reductions of 17-65% greenhouse gas emissions could be realized, and a more profound shift towards bio-based chemicals could potentially account for up to 20% of the global Kyoto target. The potential economic value of industrial biotechnology for the chemical industry alone is estimated to be € 11-22 billion per annum by 2010. As white biotechnology is making the industry more sustainable, it is expected that benefits will also been seen across a range of critical society-based areas.

The Netherlands has a long tradition in biotechnology. Dutch-based life sciences companies have an overall yearly turnover of more than € 49 billion, invest € 950 million in research and development every year and employ 255,000 people. A substantial part of these life-sciences activities are devoted directly or indirectly to industrial biotechnology. The Netherlands has the infrastructure and potential to become a leading player in industrial biotechnology. To further boost the developments in the Netherlands, it is proposed to pursue the following recommendations, among others, during the Dutch Presidency of the EU, which will take place from 1st July to 31 December 2004:

For The Netherlands the following priority setting is proposed for industrial biotechnology: focus on bio-based chemicals, and secondly on biomaterials, and finally on biofuels.

In line with these strategic choices, the Dutch Government should take concrete steps to fully support a Dutch taskforce in order to:

- create a vision and roadmap on industrial biotechnology for The Netherlands underpinning the strategic choices in white biotechnology;
- benchmark The Netherlands with other OECD countries on the development of a bio-based economy;
- propose special R&D programmes in order to fill the gaps in the industrial biotechnology R&D portfolio (e.g. systems biology, biomaterials);
- select and launch two or three demonstration projects;
- create a top Dutch institute on industrial biotechnology based on, or as a follow up of the existing industrial biotech R&D initiatives, which should operate as a European centre of excellence for science and education; and
- facilitate stakeholders dialogue by promoting public awareness and support for industrial biotechnology.

In addition to these measures, it is proposed to create substantial (tax) incentives for all (new) start-ups, including those initiatives in white biotechnology, based on measures taken in France, Belgium or the UK.

Europe has considerable assets in the field of industrial biotechnology: for instance 70% of the world enzyme industry is European and a high level of knowledge in the field of food technology and fine chemistry is located in Europe. Moreover, there is a strong political and public sentiment to improve industrial sustainability in Europe (Gothenburg objectives) and the objective to become the most competitive and dynamic knowledge-based economy in the world by 2010 (Lisbon strategy). For Europe the following recommendations are made:

It is proposed that during the Dutch Presidency of the EU The Netherlands actively participates in the EU technology platform on sustainable chemistry, where industrial biotechnology forms an integral but independent part.

The main tasks of this technology platform would be to:

- define a European industrial biotechnology vision and road map on industrial biotechnology;
- conduct a benchmark between Europe and the US and Japan on the development of bio-based economy;
- secure an industrial biotechnology programme within the EU Framework Programme band 7;
- establish public-private-partnerships, whereby some of the Dutch initiatives can serve as a model;
- launch selected demonstrations and information programmes to increase public awareness and support in white biotechnology;
- create a transparent and supportive regulatory framework;
- implement (tax) incentives for start-ups based on the French, Belgium or UK example, and;
- encourage competitive price for sugars within the EU.

White biotechnology has a lot to offer to our society, it is our challenge to develop and exploit that on time!

OBJECTIVE

The aim of this position paper is to outline the importance of industrial biotechnology for the Dutch and European society as well as its economy, and to propose concrete recommendations to boost the further development within the Netherlands and the European Union, among others, during the Dutch Presidency of the EU which will take place from 1st July to 31st December 2004.

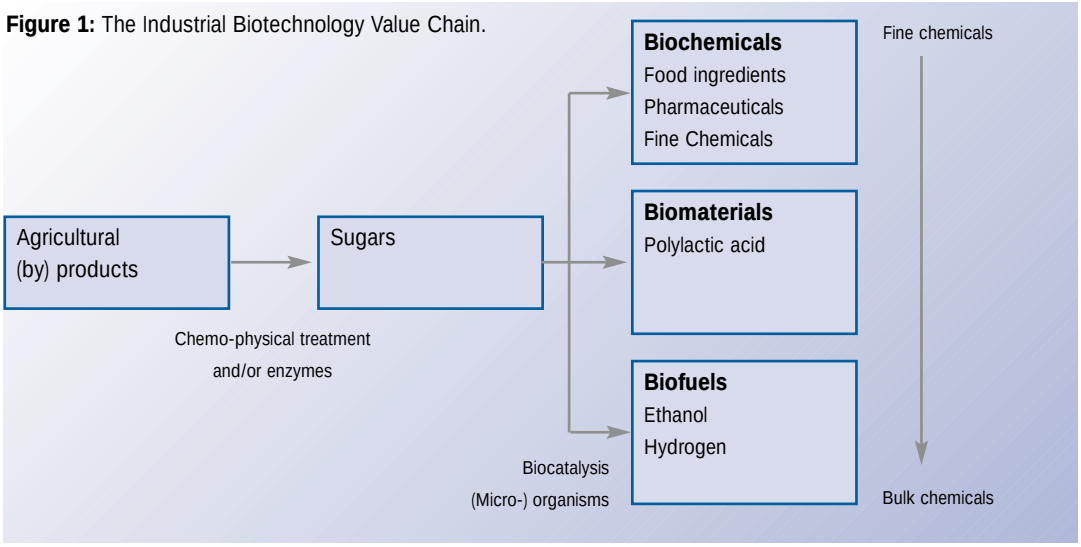
WHAT IS INDUSTRIAL BIOTECHNOLOGY?

Industrial biotechnology, also known as white or even environmental biotechnology, is the modern use and application of biotechnology for the sustainable production of biochemicals, biomaterials and biofuels from renewable resources, using living cells and/or their enzymes. This results generally in cleaner processes with minimum waste generation and energy use (see Figure 1 below).

Industrial biotechnology can be differentiated from pharmaceutical (red) biotechnology or agricultural (green) biotechnology. “Red” biotechnology is confined to the healthcare sector, whereas “green” biotechnology is applied to the agro-food sector.

Industrial biotechnology is mainly based on fermentation technology and biocatalysis. In a contained environment, genetically modified or non-GM micro-organisms (e.g. yeast, fungi and bacteria) or cell lines from animal or human origin, are cultivated in closed bioreactors to produce a variety of goods. Likewise enzymes, which are derived from these (micro-) organisms, are applied to catalyse a conversion in order to generate the desired products.

Figure 1: The Industrial Biotechnology Value Chain.



Activities and opportunities in this field are rapidly growing due to recent breakthroughs in genomics, molecular genetics, metabolic engineering, and catalysis. Promises are becoming reality and cells can now be used as tiny micro-factories, which can be optimised with respect to productivity, safety and minimal environmental load.

Figure 1 shows the industrial biotechnology value chain. Raw materials, including crops and organic byproducts from agricultural sources and households, are converted into sugars, which can be readily converted by tailor-made (micro-)organisms into the desired products. Typical products include enzymes, vitamins, flavours and fine chemicals such as chiral building blocks for the pharmaceutical industry. Traditionally, The Netherlands has a strong foothold in this value chain, given the presence of many important and international players in the agribusiness, food and chemical industry.

Today, the prime focus of the Dutch industry lies in the second part of the value chain, namely the fermentative and/or enzymatic production of biochemicals. This is the part where most value can be created.

The United States and Japan are Europe's major competitors in the field of industrial biotechnology. The US is strongly supporting industrial biotechnology[1] and is spending nearly ten times as much as Europe on research in this field[2]. Also China and other emerging countries are very fast developing in this field.

In the US, large R&D programmes are in place to convert complex (waste) biomass into sugars. Also the second part of the value chain is covered with emphasis on biofuels and biomaterials and to a lesser extent on biochemicals. The US 2020 vision[1] is structured around a coherent strategy aimed at becoming less energy dependent. Whilst the orientation of the Japanese industry is not completely clear, most activities seem to be targeted towards the second part of the value chain (see Appendix). Several R&D programmes are in place and several new activities are planned.

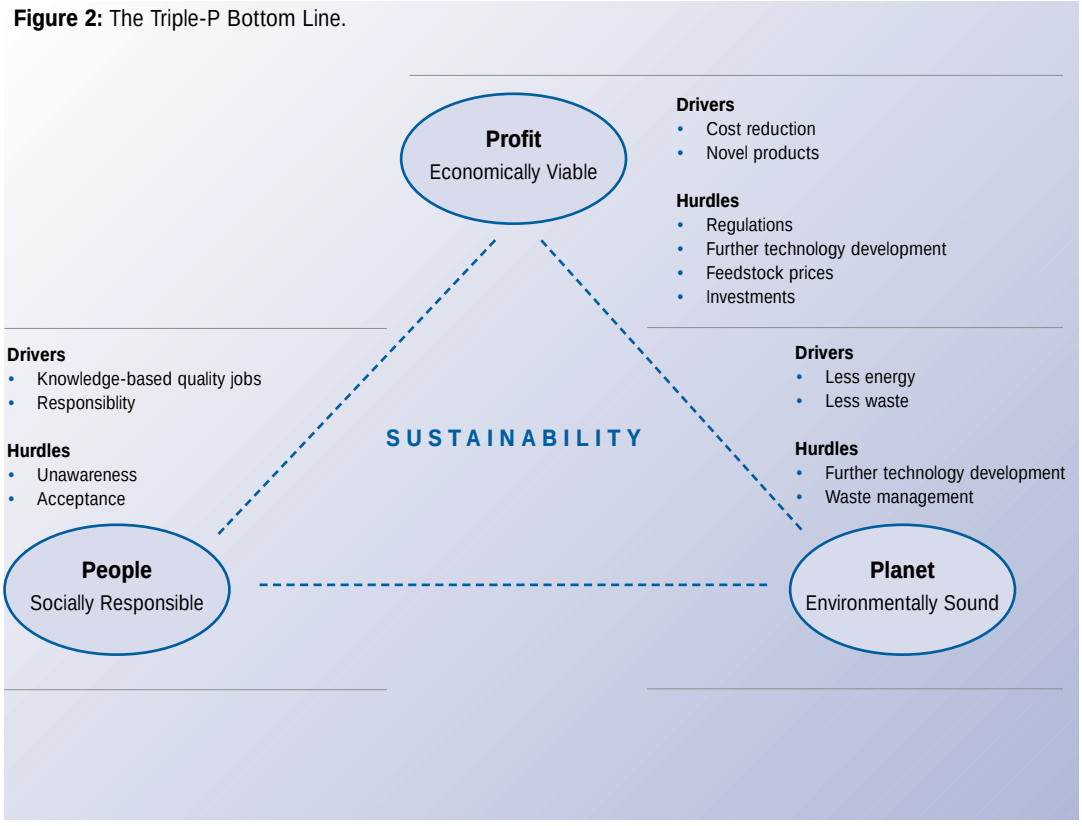
The European Union distinguishes itself by a fragmented approach across the different Member States (see Appendix). Every country has its own programmes and initiatives, with little or no EU-level coordination and no visibility in the EU Framework Programme 6.

WHAT ARE THE BENEFITS OF INDUSTRIAL BIOTECHNOLOGY?

Recently, a number of leading companies operating in industrial biotechnology, including DSM, Cargill Dow, Dupont, BASF, Novozymes and Genencor, in cooperation with the European and US biotechnology industry associations (EuropaBio and BIO) and the reputed and independent German Öko Institut, conducted an assessment of the potential impact of white biotechnology[3].

Detailed case studies were combined with a market analysis by McKinsey & Company to estimate the impact on the three elements of sustainable development: People, Planet and Profit (see Figure 2 below). The results confirmed an earlier study by **the OECD that the social, environmental and economic benefits of industrial biotechnology go hand-in-hand**[4]. If all stakeholders cooperate in a self-reinforcing cycle, industrial biotechnology could create new employment, while reducing the impact on the environment and even creating economic value.

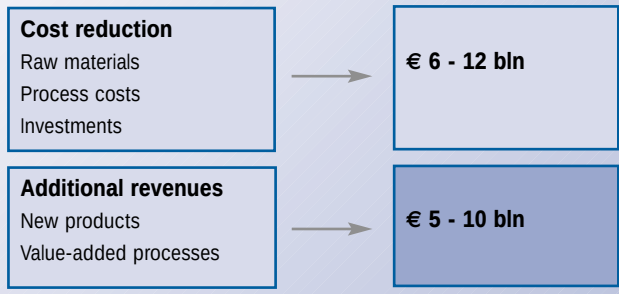
Figure 2: The Triple-P Bottom Line.



PROFIT: ECONOMIC BENEFITS

McKinsey & Company[3] estimate that biotechnology could be applied in the production of 10 to 20% of all chemicals sold by 2010, starting from the current level of about 5%. Whilst different chemical markets introduce and use biotechnology at different rates, the McKinsey study indicates that the greatest impact of industrial biotechnology will be on the fine chemical segment, where up to 60% of products may use biotechnology by 2010. McKinsey estimates that between € 11 and € 22 billion additional added value could be created by the chemical industry alone in 2010, through cost reduction and the introduction of novel products. The economic impact of industrial biotechnology will, however, depend on the feedstock prices, technology developments and the policy framework as well as on the overall demand.

Figure 3: The Impact of Industrial Biotechnology on the Economy.
McKinsey estimate of annual added value by the global chemical industry[3].



Starting with the chemical industry, white biotechnology will make inroads into a number of other industries. For example, enzymes will transform production processes in the pulp and paper industry and new polymers will find multiple applications in the automotive and consumer industries. Given the strength and presence of the Dutch biotech industry, it should be possible to capture a substantial share of this potential. According to the Dutch Ministry of Economic Affairs, The Netherlands should be able to generate at least around €50 million extra economic value per year[5].

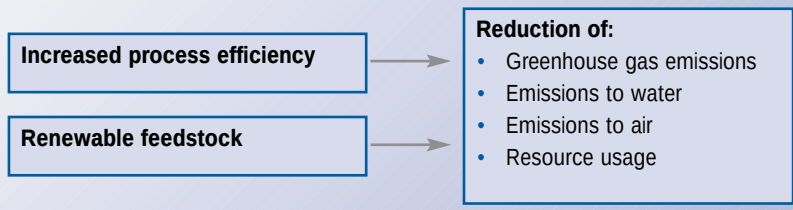
As industrial biotechnology moves from fine chemicals into the segment of commodities and eventually into bulk products, feedstock prices are becoming even a more important issue. The current price levels of renewable feedstocks for the fermentation industry exceed the prices of feedstocks used by the bulk and petrochemical industry. Moreover, current EU agricultural trade policy measures maintain the price of sugar at a level, which is higher than the world market prices. At present sugar costs € 596 euros per tonne in the EU, three times more than the world market price set at € 198 per tonne. Even further price reduction is necessary to allow the large-scale implementation of industrial biotechnology by developing cheaper processes to convert complex waste biomass as bagasse, cornstover and lignocellulose to simple feedstock as glucose, xylose and other sugars.

PLANET: ENVIRONMENTAL BENEFITS

Industrial biotechnology is not an "end-of-the-pipe" cleaning technology: it is a key tool in the development of sustainable production processes. As case studies have shown[3], industrial biotechnology has a substantial potential to reduce environmental impact: air and water pollution could be reduced, energy use lowered, fewer raw materials needed, and waste could be diminished or substituted by bio-degradable materials.

An environmental indicator that is relevant for all case studies on a global scale is greenhouse gas emissions. In their study, McKinsey & Company[3] estimate that the application of industrial biotechnology in the chemical industry could considerably reduce global greenhouse gas emissions by 2010. According to McKinsey there is sufficient agricultural byproducts in the world to satisfy at least 40% of the current demand for bulk chemicals. The shift to bio-based feedstock alone could potentially account for up to 20% of the global Kyoto target. This positions industrial biotechnology amongst the key technologies that can help to address global warming, one of the world's most pressing environmental challenges. Cleaner industrial biotechnology processes could thus enable countries to meet the Kyoto objectives in terms of carbon dioxide emissions.

Figure 4: The impact of industrial biotechnology on the environment.



Industrial biotechnology has a dual impact: it increases process efficiency and enables the use of renewable feedstock. This entails a reduction of greenhouse gas emissions such as CO_2, emissions to water, emissions to air and resource usage. The case studies performed by the Öko Institut[3] have shown that reductions of 17 to 65% can be achieved for both fine chemicals and commodity chemicals. Even higher reductions have been estimated for future challenges, such as the bulk production of polyethylene from renewable resources.

During the fermentative production of biochemicals, biomaterials or biofuels, waste is generated in the form of microbial mass, which has to be disposed of once the product has been recovered. Typically, the microbial mass is inactivated by, for instance, a heat treatment and subsequently the mass can be incinerated or used as cattle feed or fertiliser (preferred in case of non-GM microorganisms having a GRAS status (generally recognised as safe)).

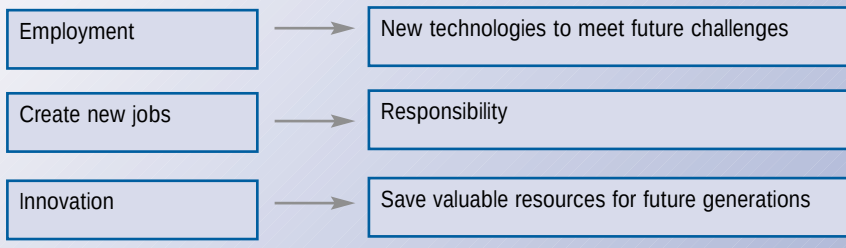
Currently, the Dutch Ministry for Spatial Planning, Housing and the Environment (VROM) is conducting a life-cycle analysis and risk-assessment of several Dutch case studies to shape its policy with respect to industrial biotechnology.

PEOPLE: BENEFITS FOR SOCIETY

As industrial biotechnology makes industry more sustainable, it is expected that the benefits will be seen across a range of critical society-based areas: job retention/creation, development of new technology platforms, and the reduction of society's dependence on valuable fossil resources, thereby conserving them for future generations.

Industrial biotechnology can stimulate high-level education and research by providing highly qualified employment and by developing R&D initiatives such as the Kluyver Centre and B-BASIC (see Appendix for details and further examples).

Figure 5: The impact of industrial biotechnology on society.



The Dutch Life Science Industry provides direct employment to more than 6,000 people in research and development alone[5]. In addition to creating new and highly qualified jobs, industrial biotechnology can rebuild the industry by gradually replacing existing processes with a low technological level by highly specialised production processes and shifting to entirely new products. This will help to counter the unacceptable drain of highly qualified workers from Europe.

However, industrial biotechnology cannot achieve its full potential without a coordinated effort on the part of all stakeholders. As a first step, a dialogue amongst stakeholders needs to be started to share the facts and information as well as to discuss the opportunities, including the concerns related to this technology. Important stakeholders range from industry (fine chemicals, pharmaceutics, textile and leather, paper and pulp industry, recycling industry) to academia and public institutions. Stakeholders also include NGOs, the financial community, suppliers and industry users and observers from institutions such as the OECD. Currently, such stakeholder meetings are being organised in several Member States and at the European level.

CURRENT OBSTACLES TO THE DEVELOPMENT OF INDUSTRIAL BIOTECHNOLOGY

In Europe the rapid development of white biotechnology is hampered by a number of important obstacles. Key issues, which need to be addressed are:

- Development of a long-term strategy;
- Stimulating key technological capabilities;
- Setting favourable economical and regulatory framework conditions;
- Encourage competitive biological feedstock prices;
- Public awareness and acceptance.

Other countries have made considerable progress in addressing and breaking down these hurdles. In the US, for example, representatives from different governmental bodies, industry, agriculture, and academia worked together on a project called 'vision 2020' with the aim to boost industrial biotechnology usage over the next decade[1]. Large R&D programmes are in place to develop improved and (much) cheaper enzymes for the conversion of agricultural (by)products into sugars (see figure 1). To compete successfully with the non-renewable - petro-based - bulk production processes, sugar prices need to be reduced further to about half of the current world market price. Likewise programmes are being started up to improve the next step in the industrial biotechnology value chain, the optimal conversion of sugars into valuable products by (micro-)organisms.

Finally, the Dutch government and the European Commission could help to build broad public support for white biotechnology by increasing the awareness of its benefits along the three pillars of sustainability: Society, environment and economy (Triple P, see figure 2).

THE IMPORTANCE OF INDUSTRIAL BIOTECHNOLOGY FOR THE NETHERLANDS

The Netherlands has a long history and reputation in both traditional and modern biotechnology[a]. The traditional industrial biotechnology includes the production of consumer goods such as food and beverages. The Netherlands also has a well-established presence in modern industrial biotechnology, especially in the production of business-to-business biochemicals such as enzymes, antibiotics, food acids, flavours and other food ingredients. The overall sales of the Dutch fermentation industry amount to approximately 10 billion euros for 2003[6].

According to the Dutch Ministry of Economic Affairs, Dutch-based life sciences companies have an overall yearly turnover of more than € 49 billion, invest € 950 million in research and development every year and employ 255,000 people[5]. A substantial part of these life-sciences activities are devoted directly or indirectly to white biotechnology.

Although The Netherlands is an important world player in the production of high-performance synthetic polymers[b] relatively little attention is being paid to the development of bio-based polymers. By combining our excellent R&D capabilities in synthetic polymers, as bundled in the Dutch Polymer Institute, with our strength in fermentation and biotechnology, a very strong biomaterials endeavour could be envisaged.

Besides biochemicals and biomaterials, industrial biotechnology also enables the production of bioethanol from renewable resources such as glucose (see Figure 1 above). Dutch companies[c] are involved in the production of bioethanol. Bioethanol can efficiently replace products issued from the petrochemical industry. The European Union has agreed on a new objective: 5.75 % of all the fuel consumed by atmospheric engines should be biofuel. At present, the level is 0.3%. To meet this ambitious, but feasible objective, 9.3 million tons of bioethanol will have to be produced or imported per year by 2010.

Public-private partnerships between industry, academia and institutes, such as the Kluyver Centre for Genomics of Industrial Fermentation and B-BASIC (Bio-based Sustainable Industrial Chemistry) have recently been set up (see Appendix) to further strengthen the Dutch R&D infrastructure in white biotechnology.

These initiatives are efficiently promoting pre-competitive research around themes of mutual interest. The prime focus of the Kluyver Centre is to optimise the microbial workhorses of the Dutch fermentation industry (e.g. baker's yeast, *Aspergillus niger* and lactic acid bacteria) by using genomic tools. Complementary to the Kluyver Centre is the recently approved B-BASIC initiative, which focuses on product and process development.

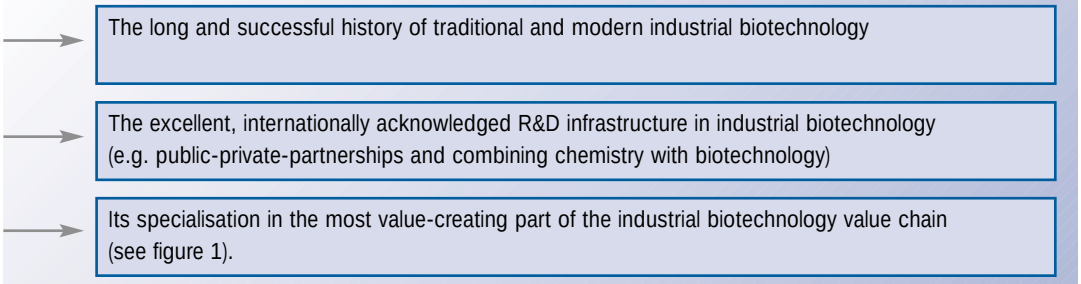
a Important Dutch players in the field of biotechnology include Unilever, Heineken, Grolsch, Bavaria, Campina, Friesland Coberco Dairy Foods, Cosun, CSM, Avebe, DSM, AKZO Nobel, etc.

b For example, DSM and AKZO Nobel;

c Mainly Shell and Nedalco

B-BASIC is part of the NWO programme Advanced Catalytic Technologies for Sustainability (ACTS), which also supports projects that combine chemistry and biocatalysis, thereby building on one of our key R&D assets.

Figure 6: The three main assets of the Dutch industrial biotech.



Despite these activities some serious gaps in our knowledge base need to be bridged to fully capture the Dutch white biotech potential. A typical area, which urgently needs attention, is systems biology to completely understand and control microbial productivity. Furthermore, our efforts in biomaterials need to be increased substantially to keep pace with, and eventually outperform, the bio-based polymer initiatives in the US. To that end, a joined initiative of two of our public-private-partnerships (e.g., Dutch Polymer Institute and B-BASIC) would be highly recommended. Last but not least, demonstration projects could be started, where all relevant stakeholders are involved, with the aim to demonstrate the triple P benefits.

Recently, a Dutch taskforce for industrial biotechnology has been set up to create a consistent vision, coordinate our efforts and facilitate stakeholder dialogue. The taskforce is composed of representatives from the Dutch Ministry of Economic affairs, the Kluyver Centre, B-BASIC, DSM and The Netherlands Genomics Initiative (NROG). Other parties will be invited to join when required. The ambition of the taskforce is to create a leading Dutch institute for industrial biotechnology, which is based on existing partnerships and which will be acknowledged as a world-leading centre of excellence for science and education.

At present about 13 start-up companies are directly or indirectly involved in white biotechnology[7]. Further growth of existing as well as the creation of new ventures could be stimulated by appropriate tax incentives as recently introduced in France[8], Belgium[8] and the UK[9].

The Dutch authorities will soon be in a position where they can promote measures in favour of industrial biotechnology at the European level. Indeed, the Presidency of the Council is a privileged position to launch and support initiatives. Industrial biotechnology is a field in which major achievements can be reached for the food ingredients and chemical industry, with immediate results. The Dutch Presidency during their tenure between 1st July and 31st December 2004 should ensure that industrial biotechnology has the appropriate place on the European agenda.

WHAT SHOULD THE NETHERLANDS DO?

The Netherlands has the infrastructure and potential to become a leading player in the field of industrial biotechnology, a strategic, knowledge-intensive field offering real economic, environmental and social benefits.

The main drivers for the Dutch industrial biotechnology are competitiveness (e.g., economic growth, high-quality jobs) and sustainability (e.g. less energy usage and waste production). These drivers differ from, for example, the US, which aims at reducing its energy dependency and at maintaining a high level of employment in agricultural areas.

For The Netherlands the following priority setting is proposed for industrial biotechnology:

- biochemicals: build on current strength in (bio)pharmaceuticals, fine chemicals and food ingredients;
- biomaterials: start up joint projects between B-BASIC and the Dutch Polymer Institute;
- biofuels: focus on the production of bioethanol, either in The Netherlands from domestic waste, or from abroad, where cheap raw materials are available (e.g. Brazil).

In line with these strategic choices, the Dutch Government should take concrete steps to fully support the Dutch taskforce in order to:

- create a vision and roadmap on industrial biotechnology for The Netherlands underpinning the strategic choices in white biotechnology;
- benchmark The Netherlands with other OECD countries on the development of a bio-based economy;
- propose special R&D programmes in order to fill the gaps in the industrial biotechnology R&D portfolio (e.g. systems biology, biomaterials);
- select and launch two or three demonstration projects;
- create a top Dutch institute on industrial biotechnology based on, or as a follow up of the existing industrial biotech R&D initiatives, which should operate as a European centre of excellence for science and education; and
- facilitate stakeholders dialogue by promoting public awareness and support for industrial biotechnology.

In addition to these measures, it is proposed to create substantial (tax) incentives for all (new) start-ups, including those initiatives in white biotechnology, based on one of the following measures:

- The French Young Innovative Company (YIC)[8] status, which includes uncapped exemption of local business tax, exemption of social costs for employees involved in R&D for the first eight years, income tax exemption for the first three profitable years and 50% (or €100,000) relief of income tax for the following two years; and
- The UK's new fund vehicle, called Enterprise Capital Fund, based on the US Small Business Innovation Company (SBIC) model[9]. The main objective is to enable these Enterprise Capital Funds to use "soft" government loans to leverage private capital and bridge the equity gap between business angels and private equity houses.

THE IMPORTANCE OF INDUSTRIAL BIOTECHNOLOGY FOR THE EUROPEAN UNION

Europe has considerable assets in the field of industrial biotechnology: for instance 70% of the world enzyme industry is European and a high level of knowledge in the field of food technology and fine chemistry is located in Europe. Moreover, there is a strong political and public sentiment to improve industrial sustainability in Europe (Gothenburg objectives[10]) and the objective to become the most competitive and dynamic knowledge-based economy in the world by 2010 (Lisbon strategy[11]).

Europe, however, invests less in R&D (1.9% of GDP in 2000 and even less after enlargement given that accessing countries have an average R&D level of 0.7%) than the US (2.7 % in 2000) and Japan (3% in 2000)[2,11], and suffers from fragmented R&D funding and infrastructure. In the remaining six years, all Member States will have to take major steps to reach the Lisbon target of 3% by 2010.

A relatively new and helpful instrument to bringing Europe to the forefront of selected technology areas is a technology platform. A technology platform is a strategic, demand-driven initiative, aimed at bringing together all interested stakeholders to address major economic, technological or societal challenges. The European Commission has already scheduled the launch of three technology platforms, respectively for hydrogen and fuel cells, photovoltaics and water supply and sanitation technologies.

The setting up of a technology platform on sustainable chemistry, which would include industrial biotechnology, is currently being discussed. To facilitate this process, The Netherlands and Belgium[12] have already organised themselves by installing a taskforce/platform on industrial biotechnology.

WHAT SHOULD THE EU DO?

Industrial biotechnology is a promising sector, strategic and vital for European industry and the European economy. In addition to economic growth, the creation of highly qualified jobs and a reduced environmental load, the European Union can benefit from industrial biotechnology in terms of energy and farmland use.

The EU seems to cover the entire value-chain of industrial biotechnology (see Figure 1 above). However, to fully capture Europe's potential a strategic vision and coordination is urgently needed. Clear choices must be made as to which particular areas of industrial biotechnology are to be supported (e.g., the production of sugars from biomass, biochemicals, biomaterials, and/or biofuels).

It is proposed that during the Dutch Presidency of the EU The Netherlands actively participates in the EU technology platform on sustainable chemistry, where industrial biotechnology forms an integral but independent part.

The main tasks of this technology platform would be to:

- define a European industrial biotechnology vision and road map on industrial biotechnology;
- conduct a benchmark between Europe and the US and Japan on the development of bio-based economy;
- secure an industrial biotechnology programme within the EU Framework Programme 7;
- establish public-private-partnerships, whereby some of the Dutch initiatives can serve as a model;
- launch selected demonstrations and information programmes to increase public awareness and support in white biotechnology;
- create a transparent and supportive regulatory framework;
- implement (tax) incentives for start-ups based on the French, Belgium or UK example, and;
- encourage competitive price for sugars within the EU.

Concrete and immediate action is now required to meet the challenges and seize the opportunities of industrial biotechnology.

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MEMBER STATES AND INTERNATIONAL ACTIVITIES IN INDUSTRIAL BIOTECHNOLOGY

UNITED STATES OF AMERICA

The US Department of Agriculture (USDA) has demonstrated its support for biotechnology by adopting a new procurement regulation (www.usda.gov/procurement/policy/agar.html).

Federal Agencies will give priority to bio-based products that have been approved. In 2000, Congress passed the Biobased Research and Development Act1. This legislation created an interagency board to coordinate federal programs promoting the use of biobased industrial products. It also authorized € 40 million a year over five years to be used for research and development on enzyme and biomass technologies. The 2002 Farm Bill allocated € 60 million over six years to fund research, development and demonstration projects under the 2000 Biomass Research and Development Act. The legislation established a governing board co-chaired by the USDA and the US Department of Energy, with a joint R&D budget of € 186 million for biobased products and bioenergy in 2001. (Information: http://www.nrel.gov/biomass/projects.html)

BELGIUM

The Belgian Government has recently decided to create an interdisciplinary platform for industrial biotechnology (http://www.ifrro.org/papers/opening_speech_f_moerman.pdf). Its role will mainly consist in facilitating cooperation and interaction between the various disciplines and stakeholders. In particular, it will aim at a fruitful cooperation between industry and the academic and political worlds. This platform should produce a long-term vision and concrete strategies for the integration of sustainable technology into society.

THE NETHERLANDS

B-BASIC is a nation-wide, public-private-partnership between academia, institutes and industry to develop new production routes using renewable feedstocks and biobased catalysts such as microorganisms and enzymes. B-BASIC is a national Dutch consortium, operating as an independent programme in NWO-ACTS. It is an extension of existing cooperations between TU Delft (coordination), Groningen University, Leiden University, TNO-MEP and A&F, as well as a consortium of large and small industries including DSM, AKZO Nobel, Shell and Paques.
The programme contains four application areas, covering the bulk and fine chemicals sector, as well as performance materials and novel feedstocks & recycling. B-BASIC will also provide an advanced training center to foster the education of future generations of

life scientists and engineers. Currently, the consortium has the ambition to invest approximately € 55 million into its research programme during the period of 2004-2009 of which € 25 million has been received from the BSIK provisions of the Dutch Government (Information: www.b-basic.nl).
The Kluyver Centre for Genomics of Industrial Fermentation is a consortium made up of Delft University of Technology, Wageningen University and Research Centre, Leiden University, Nijmegen University, Utrecht University, TNO, Wageningen Centre for Food Sciences and NIZO food research.
It employs microbial genomics to improve microorganisms for use in industrial fermentation processes. Fermentation is used in the production, from renewable feedstocks, of food products and ingredients, beverages, pharmaceutical compounds, nutraceuticals, and fine and bulk chemicals. Each research programme focuses on one of the industrial workhorses: yeast, fungi, lactic acid bacteria, and pseudomonas. In addition there is an integrated 'genomics tools' programme, which includes, among others, bioinformatics.
It is the ambition of the Kluyver Centre for Genomics of Industrial Fermentation to become world leading in functional genomics research on industrial microorganisms and their application in fermentation processes. The Kluyver center has an overall budget of over € 55 million for five years. (http://www.kluyvercentre.nl/). The Centre has established an industrial platform, which enables direct association of the Dutch fermentation industries with its research programmes, aiming at effective technology transfer and valorization. Close cooperation with industry will help to focus the Centre's pre-competitive research portfolio to the long-term requirements of the fermentation industry.
Advanced Catalytic Technology for Sustainability (ACTS) is the Dutch platform for pre-competitive research in catalysis and related disciplines. In ACTS major parties from industry, academia and government co-operate. It is the mission of ACTS to embody the aspiration of these partners to initiate and support the development of new technological concepts for the sustainable production of materials and energy carriers. Through its activities, ACTS will contribute to the sustainable economic growth and to the knowledge infrastructure in The Netherlands, and attract young talent to a career in science and technology. The main programmes of the ACTS are the integration of biosynthesis and organic synthesis, sustainable hydrogen and ASPECT (Advanced Sustainable Processes by Engaging Catalytic Technologies)
http://www.nwo.nl/nwohome.nsf/pages/NWOP_5B7B9S.

AUSTRIA

Technologie Impulse Gesellschaft (TIG) is a research and technology-funding agency. TIG sets up and promotes competence centres, thus improving the interaction between the business sector and research, which, in turn, enables research excellence on an international and competitive level. Under the umbrella of TIG, the Kplus programme aims to build up long-term cooperative initiatives between public and private research at an advanced level. The Kplus programme manages an overall research volume of € 400 million for seven years (1998-2004), of which a part is dedicated to white biotechnology.

To date, there are 18 Kplus centres, which have already started their activities in various different areas. This means that top-level research is being conducted together with some 270 partners from the business sector and 150 from the research sector. For instance, the Austrian Bio-energy Centre brings together expertise from numerous areas of research such as biomass composting, biomass gasification, process development, chemistry and environmental science. Research is conducted in the field of alternative energy sources. The main emphasis of their work lies in the generation of energy using biomass (www.tig.or.at).

UNITED KINGDOM

The Pro-Bio Faraday partnership (www.pro-bio-faraday.com) seeks to maximise commercial benefits from biotechnology and has identified three core themes: (1) discovering and developing new biocatalysts; (2) developing integrated production processes and (3) designing and modelling new and improved biotransformation processes. In the UK, a Faraday partnership is an alliance of organisations and institutions which can include research and technology organisations, universities, professional institutes, trade associations and firms, co-operating in research, development, transfer and exploitation of new and improved science and technology.

Bio-Wise (www.biowise.org.uk) is a major UK government programme funded by the Department of Trade and Industry. The main objective of this programme is to support the development of biotechnology by providing information and advice. The € 4.5 million available budget has been committed to a total of 21 innovative collaborative demonstration projects within UK industry.

GERMANY

BioProduktion is a programme funded by the German Ministry of Education and Research. It promotes partnerships in the field of industrial biotechnology and provides funds when necessary. Through the Biotechnology framework programme, the German Government has planned to invest more than € 800 million in biotechnology research over the 2001-2005 period, of which – a still unknown part – will be devoted to white biotechnology.

THE BALTIC REGION

The Baltic 21 Institute for Sustainable Industry (www.baltic21institute.org) was established to catalyse the work in this field in the industrial sector in the Baltic region. The purpose is to extend co-operation on research and development and transfer of knowledge and technology. This initiative improves the network of research institutes, universities, environmental engineering businesses and governmental actors. The network allows actors of the field to search for business partners, funding opportunities and other relevant information.

JAPAN

Several programmes have been initiated by the Japanese Government to develop industrial biotechnology. These programmes respectively aim at developing the technological infrastructure for industrial bioprocesses, evolutionary molecular engineering, biomolecular synthesis technology using glycoclusters, structural genomics and informatics and biocatalysis. The overall budget allocated to these industrial biotechnology programmes was, as far as we could gather, about € 55 million in 2001. There are, however, indications that in recent years the budgets for industrial biotech related activities have increased substantially.