BE-Basic Annual report 2011

BE-Basic

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Floor van der Hilst/Janske van Eijk – p.18
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We thank all scientists and parties involved for their cooperation

March 2012

Contents

Foreword

Dear Reader,

We are proud and honoured to present to you the public version of the 1st Annual Report of BE-Basic, a public-private partnership around Biobased Ecologicaly-BAlanced Sustainable Industrial Chemistry, coordinated by TU Delft involving 27 parties from leading Dutch and international industries, SMEs, universities and knowledge institutes. BE-Basic aims to accelerate the development of a biobased economy in the Netherlands in a globalizing world. BE-Basic is firmly positioned at the forefront of industrial and environmental biotechnology.

BE-Basic's activities range from investigating and advancing key scientific fields such as synthetic biology and metagenomics, developing new biological and bioprocess technologies, and deepening our understanding in the sustainability of integral biobased systems and society to create and help commercialise new innovations to accelerate the transition to a biobased economy.

The BE-Basic consortium started in 2010 with an initial budget of 120 million Euro with 60 million Euro support of the Ministry of Economic Affairs, Agriculture & Innovation for the period 2010-2015 and an equal investment from our partners. In the reporting period 2010-2011, BE-Basic and its partners have leveraged this initial investment and have grown by approximately 25% in budget and activities. BE-Basic has become a dominant player in the international biobased arena and plans to increasingly and positively impact this field.

Highlights are presented of the initial programs of our Research and Innovation Flagships. But BE-Basic operates in a globalising world. We realise that a transition to a biobased economy requires joint developments with our partners worldwide in two ways: (1) adding value to the vast amounts of international (imported or locally produced) biomass residues and (2) co-investing internationally while exporting "NL-inside" biotechnology. Therefore, we are extremely happy to present collaborations with several major International players in Brazil, Malaysia, Vietnam, USA, as well as with the German CLIB2021 consortium.

BE-Basic is ready to contribute positively to a radical change towards a sustainable biobased economy, while protecting our environment and improving safety and health of mankind.
This 1st Annual Report will share our initial contributions. ◀

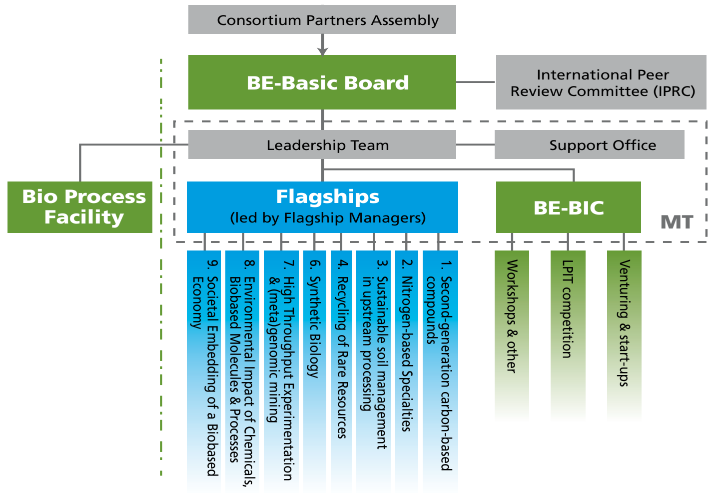
The BE-Basic Leadership Team,
Bram Brouwer and Luuk van der Wielen

Governance, Research & Innovation

Governance

The BE-Basic governance structure is depicted below, including an executive Leadership Team and Support Office, a coordinating Board and Consortium Panel Assembly, and an International Peer Review Committee. The Research and Innovation programme of BE-Basic consists of 8 R&D based Flagships, contributing to the major parts of the biobased value chain which is further specified below. The Innovation part involves a BE-Basic Innovation Center to support innovation, entrepreneurship, and new start-ups, and the Bio Process Pilot Facility (BPF), a separate legal entity to enable semi-industrial piloting of biobased production processes.

BE-Basic is a public-private partnership (PPP) governing a large scale Research & Innovation Programme. This cooperation requires a clear governance structure which is illustrated below.



Research & Innovation Programme

Our mission is to develop industrial biobased solutions for a sustainable society. The BE-Basic R&D programme focuses on fundamental and applied sciences in the field of industrial and environmental biotechnology, and builds on earlier work done in the successful research programs B-Basic and Ecogenomics. The following Flagships are defined, each addressing a major scientific, industrial and/or socio-economic challenges:

Carbon-based compounds

The research in this Flagship focuses on the conversion of first and second generation lignocellulosic materials and other biobased feedstocks - such as glycerol, alcohols, acids and furanics- including their contaminants into relevant products.

Nitrogen-based Specialties

The focus of this Flagship is on the design and optimisation of pathways for the production of unnatural compounds that can be used as pharmaceuticals or as building blocks for materials. In addition, this Flagship includes high throughput bio-pharmaceutical process development toward the optimisation of protein production.

Sustainable Soil management in Upstream Processing

This Flagship focuses on sustainability aspects and issues like nutrient cycling, soil quality, health and safety while producing and retrieving second-generation biobased agricultural materials.

Recycling of Rare Resources

This Flagship will aim at recovery and reuse of valuable nutrients and other materials from waste streams for biobased applications.

Synthetic Biology

The focus of this Flagship is on design and optimisation of novel pathways to desired products is complimented by unique cell membrane engineering aiming for efficient product export and improved robustness of the production organisms.

High-Throughput Experimentation and (meta)genomic mining

This Flagship develops and applies high-throughput approaches and tools to explore and mine the metagenome, genetic material that comes directly from environmental samples. In addition, this Flagship aims to engineer and screen for enzymes and other products with improved properties.

Environmental Impact of Chemicals, Biobased molecules and Processes

This Flagship focuses on the environmental and human safety issues arising from the transition and implementation of a biobased economy, as compared to existing industrial activities.

Societal Embedding of a Biobased Economy

The mission of this Flagship is to optimise the societal embedding of the products and processes developed by BE-Basic, including identification of socio-economic aspects and sustainability issues, development of adequate monitoring systems and of effective and efficient education, communication programmes.

second-generation lactic acid on the way

FS1 Second-generation carbon-based compounds

One of the major aims of the BE-Basic programme is to determine which non-food feedstocks suitable for the production of biobased chemicals are available, wherever in the world they are. In flagship 1, the production of lactic acid from renewable raw materials will be studied as an example of this approach.

In the near future, Purac – a leading company in natural food preservation and biobased building blocks & chemicals – wants to derive its fermentable sugars for lactic acid production from non-food sources, such as agricultural waste streams, if it can be done in a cost-effective and sustainable way.
"We currently produce lactic acid from food-grade sugars, the so-called first-generation feedstock. But we want to develop a process in which we can use sugars derived from agricultural residues, the second-generation feedstock." says Corjan van den Berg, scientist at Purac. Lactic acid and its derivatives are traditionally used as food ingredients and for certain pharmaceutical, cosmetics and technical applications. "We're scaling our activities especially in the plastics and chemical market."

Van den Berg's colleague Peter Baets continued: "The plastics market is very large. For the production of bioplastics, you need a large extra volume of lactic acid, and consequently sugar as feedstock. We can't permit ourselves to use such large volumes of food-grade sugars because that could interfere with the availability of food for human consumption. Remember the tortilla crisis in Mexico a few years ago? That was a result of an increasing demand for corn starch for biofuel."

Choosing the feedstock

The starting point is the determination of available non-food feedstocks that are suitable for producing lactic acid. Van den Berg: "You can think of empty palm fruits, residues from sugarcane or coffee beans, and even potato peelings. It's potentially suitable as long as it's a non-food agricultural residue that contains enough hemi-cellulose and can be converted into fermentable sugars."

According to Baets, there are more than a hundred kinds of waste streams in the world that are potentially of interest, considering their volume. "We can't try them all, so we'll have to make a considered selection on the basis of economic, technical and sustainability related criteria. Not every material is available the whole year, though. And some waste materials already have valuable applications. Many aspects play a role in this issue – which might be even more complex than we think."

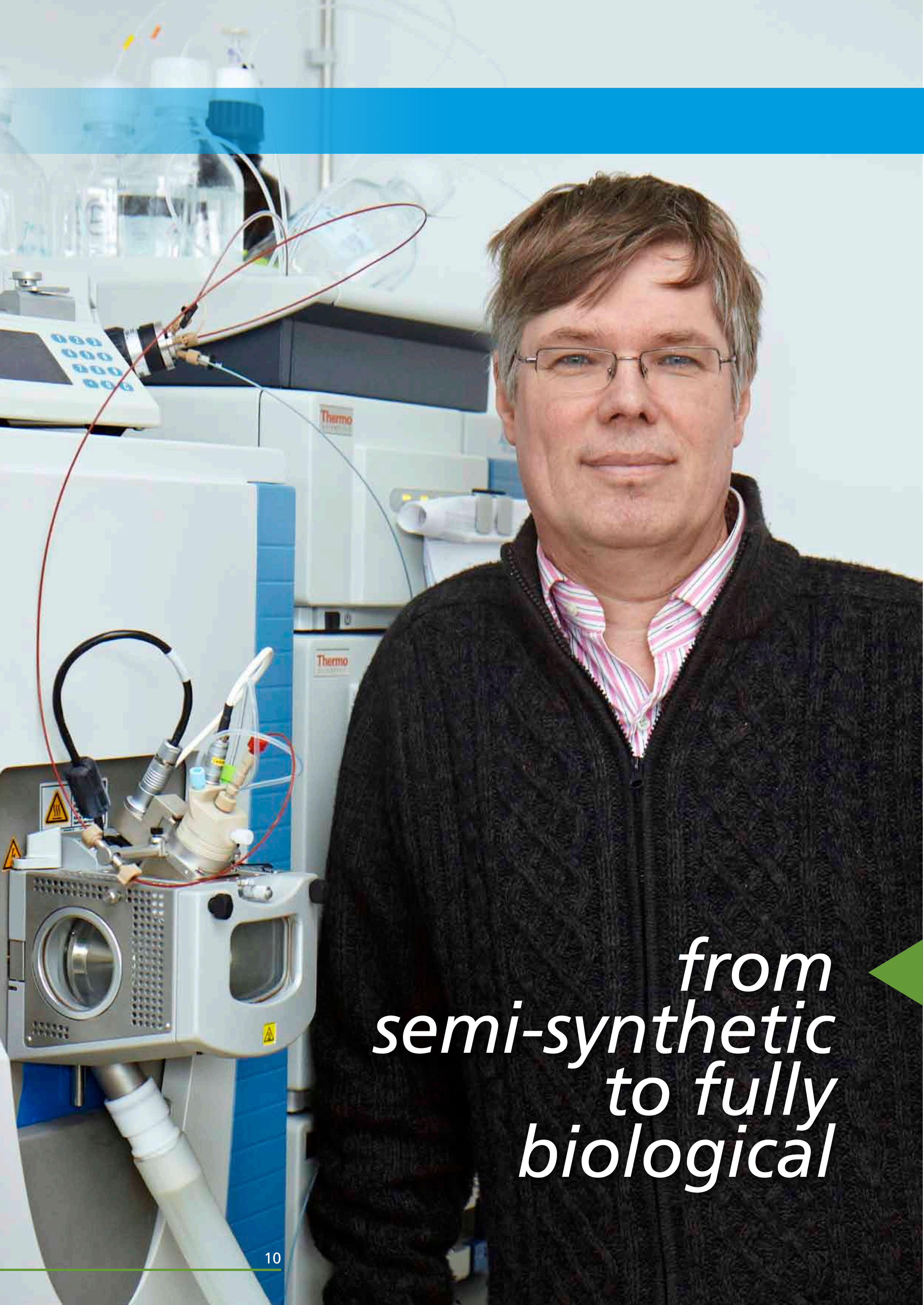
Another major issue is how to release the fermentable sugars from these feedstocks. Every waste stream might need a specific pre-treatment. Van den Berg: "It's possible that to use empty palm fruits, you'll need totally different techniques than when you use potato peelings." Pre-treatment leads to the release of not only sugars but also inhibitory or toxic components. "These components can affect the micro-organism that produces lactic acid later in the process. We're therefore going to test several waste streams in more detail."

All in-house

For this project, Baets and Van den Berg are collaborating with various academic groups that specialize in microbiology, food chemistry, bioprocess engineering and food & biobased research. Van den Berg: "Together with other industrial partners in the BE-Basic project, we have all the expertise in-house to oversee the whole production process, from pre-treatment right through to the final purification of the lactic acid."

All the data that are generated by the project partners will undergo a lifecycle analysis (LCA). An LCA establishes the impact of every process step on, for example, greenhouse gas emissions and other important parameters. Van den Berg: "An LCA will give us more insight into whether our production process will be sustainable and whether we're on the right track."

The end result will be a design on paper that describes the production process of lactic acid from non-food feedstocks. Baets: "The design will be validated on both the lab and the pilot scale, so we'll have generated sufficient data by 2015 to target an industrial installation. But whether it really is going to happen depends on many factors." ◀



from semi-synthetic to fully biological

Designing novel pathways for the production of pharmaceuticals and biochemicals using advanced engineered micro-organisms: that is the major challenge for the next years of BE-Basic's Flagship 2 programme which covers nitrogen-based specialities. "This is high risk research, but if we succeed it will also have a high impact."

"We are working on nitrogen-based compounds, for example proteins and pharmaceuticals. These are mostly specialities, some of which are only produced in small amounts but which have high added value, the opposite of the carbon-based compounds of Flagship 1 that are mostly bulk commodities," says Prof. Arnold Driessen of the University of Groningen and Director of the Groningen Biomolecular Sciences and Biotechnology Institute. "What we have in common is that we work in close collaboration with Dutch industry. Our scientists do part of their work at the companies and part at the university."

The consortium focuses on three major themes. The first of these concerns improving the protocols for the purification of proteins by studying practical cases from industry. "Developing an effective purification method is a time-consuming process. We are going to speed that process up by miniaturization and the automation of test protocols. This enables us to screen a wide variety of conditions which delivers reliable predictions for optimal conditions for the purification process at a larger production scale," Driessen explains. "This enabling technology means the industry can bring its products to the market faster."

Reprogramming pathways

There is a need for antibiotics that are not already naturally made by micro-organisms. The second research theme focuses on the production of these kinds of antibiotics with the aid of micro-organisms. "We are looking at antibiotics for which a semi-synthetic route already exists. A part of the production process is biological via fermentation, another part is done chemically. What we want to reach is a fully biosynthetic process," says Driessen.

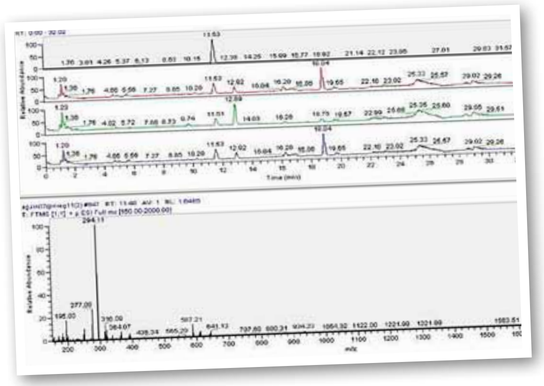
Making these compounds demands extensive reprogramming of the micro-organism. The problem is that the enzymes needed to take over the chemical steps do not yet exist. "Therefore we have to reprogram the antibiotic production pathways completely by designing new enzymes that catalyse the conversion steps we require. This is a major challenge", says Driessen. "It is high risk research, but if we succeed it will also have a high impact. We are confident that it will be possible at the end."

The organisms that he and his colleagues are working on are closely related to the organisms that are used in an industrial setting. "You get what you ask for," according to Driessen. "When you focus on a certain model organism you eventually get a working process in that particular organism. You can compare this to the development of drugs against cancer. Being able to fight cancer in a mouse using a certain drug does not mean that you can treat cancer in humans. There is still a large step to make. This is why we are working close to the real production micro-organism, to make the transition easy at the valorisation step."

Unnatural compounds

The third theme is still in a pilot phase and concerns the biological production of chemical compounds for biomaterial from renewable sources. At present these compounds are made of fossil fuels. "In our specific case we are working on an unnatural compound. The biological processes for synthesising these compounds are not known, so we have to start almost from scratch. This requires a huge amount of work compared with some of the carbon-based compounds, such as bio-ethanol, for which the biological production pathways exist in nature."

Another challenge is that material applications require bulk amounts of the intended chemical which therefore has to be produced in large quantities. This means a very efficient process is needed to overcome the low margins on profit in bulk commodities. "We are still in the enzyme design and enzyme discovery process and are now working on a proof of principle. But if we succeed, we will open a drawer full of possibilities for similar components that can be produced this way."



creating efficient cell factories

Synthetic biology is a new approach to improving the performance of industrial micro-organisms on a larger scale by designing and building in new functionalities. Flagship 6 of BE-Basic will focus in the coming years on increasing the production and excretion of compounds and improving the cell robustness through membrane engineering.

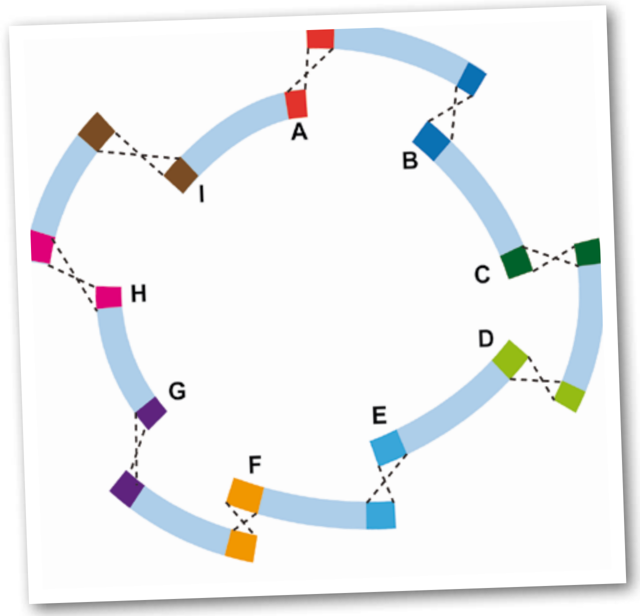
Prof. Bert Poolman of the University of Groningen: "Within the Synthetic Biology Flagship, we aim to improve some of today's most important production organisms – namely the yeast *Saccharomyces cerevisiae* and the bacterium *Escherichia coli* – so that they are better equipped to produce all sorts of compounds." Synthetic biology is especially suited to reprogram metabolic pathways and give the cell new functionalities. "We can build on existing knowledge of the cell machinery of these two production organisms, so there's a good chance that we can be successful and take large steps forward in building efficient cell factories." Scientists from the universities of Groningen, Delft, Wageningen and Utrecht together with their industrial project partner DSM are collaborating on the engineering of metabolic pathways for amino acid production and the performance of membrane functions.

Membrane mysteries

A major part of the programme is dedicated to the cell membrane (the outer shell of a cell), primarily in order to get it to excrete more of the substances the cell produces. Poolman: "You could say that biological cells are designed to take up substances from their surroundings, but not to excrete their products. For a more efficient production we have to persuade them to excrete solutes by, for instance, reversing the transport reactions." In the coming years, Poolman's research group will focus on this, while Delft scientists try to improve the production of amino acids inside the cell. Most products that are of interest for a biobased economy – such as alcohols for biofuels, or fatty acids – are toxic to cells because they dissolve well in the cell membrane. Poolman: "In practice, this means that the cell membrane is disrupted, and that is usually detrimental to the cell factory. But if you can change the membrane properties in such a way that the products hardly dissolve, you will have gained a lot. For instance, butanol at a concentration lower than 1% is already lethal to *E. coli*, but there are cells that can tolerate much higher concentrations. We aim to find out how they do this and we will evolve *E. coli* to become more tolerant to this type of solvent."

Making robust cells

One approach is a computational method. Cell membranes are exposed to a large library of different compounds to determine the basis of their toxic effect. Poolman: "Then we determine whether the toxic effect can be reduced by changing the lipid composition of the membrane. If you find that a certain lipid composition performs better in the computer, then you have a lead for making the corresponding changes in the cell." This requires the insertion and expression of the genes for the corresponding pathways into *E. coli*. This approach will be a joint effort by research groups at Groningen and Wageningen. "Groups in Utrecht that are experienced in lipid analysis and engineering will find out what the differences are in evolved industrial strains, and use this information to rationally engineer the membrane system. We hope that a comparative study with different strains will provide a clue as to why these organisms can cope with toxic cell products." Most of the technologies that the consortium is going to develop will be generic. Poolman: "Our first goal is to make cells that are more robust; the actual application can be added later. For now, the proof-of-principle is the most important."



new robust enzymes for bioplastic production

Nature will be the main hunting ground for Isabel Arends and her research team in their efforts to uncover novel enzymes with very special properties. These new enzymes must be capable of producing bio building blocks for bioplastics. "With enzyme technology we can even make bioproducts that are water resistant and durable."

Today's production of building blocks for plastics is based on fossil fuels and chemical processes. "These building blocks can be produced in a more environmentally friendly way by using bio-ethanol as a starting compound, in combination with enzymes," says Isabel Arends, professor in Biocatalysis and Organic Chemistry at the Delft University of Technology. AkzoNobel, the industrial project partner for this BE-Basic project and a market player in the production of monomers for plastics, stands behind this idea.

That enzymes can endure much tougher conditions than micro-organisms is often the main consideration in opting for enzymatic processes, as in the pre-treatment of cellulosic feedstocks, for example. Enzymes are also more easy to condition and train so that they can cope with extreme conditions such as the presence of organic solvents, high salt levels or high temperatures. "That's why you can make the same building blocks by using enzymes instead of via chemical pathways. The true advantage is that enzymes allow us to perform the process in an atom-efficient way. "Our goal is to develop novel enzymes that convert bio-ethanol into building blocks for durable bulk plastics."

Promising places

Nature is a good source in which to look for these novel enzymes. Postdoc Özlem Erol-Hollmann has already taken samples from many different locations, ranging from the North Sea and the harbour of Rotterdam to the Botanical Gardens at Delft and Texel. "The most promising places to take sample from are the places were micro-organism are exposed to some form of stress," says Arends. In industrial and salty environments the bacteria are already trained to cope with more extreme conditions and have developed specialized enzymes to survive. "In these locations we have a good chance of finding something really new; the dream of every researcher. Finding new enzymes also gives us the opportunity to build up new intellectual property. That is a big advantage over existing enzymes, which are protected by patents."

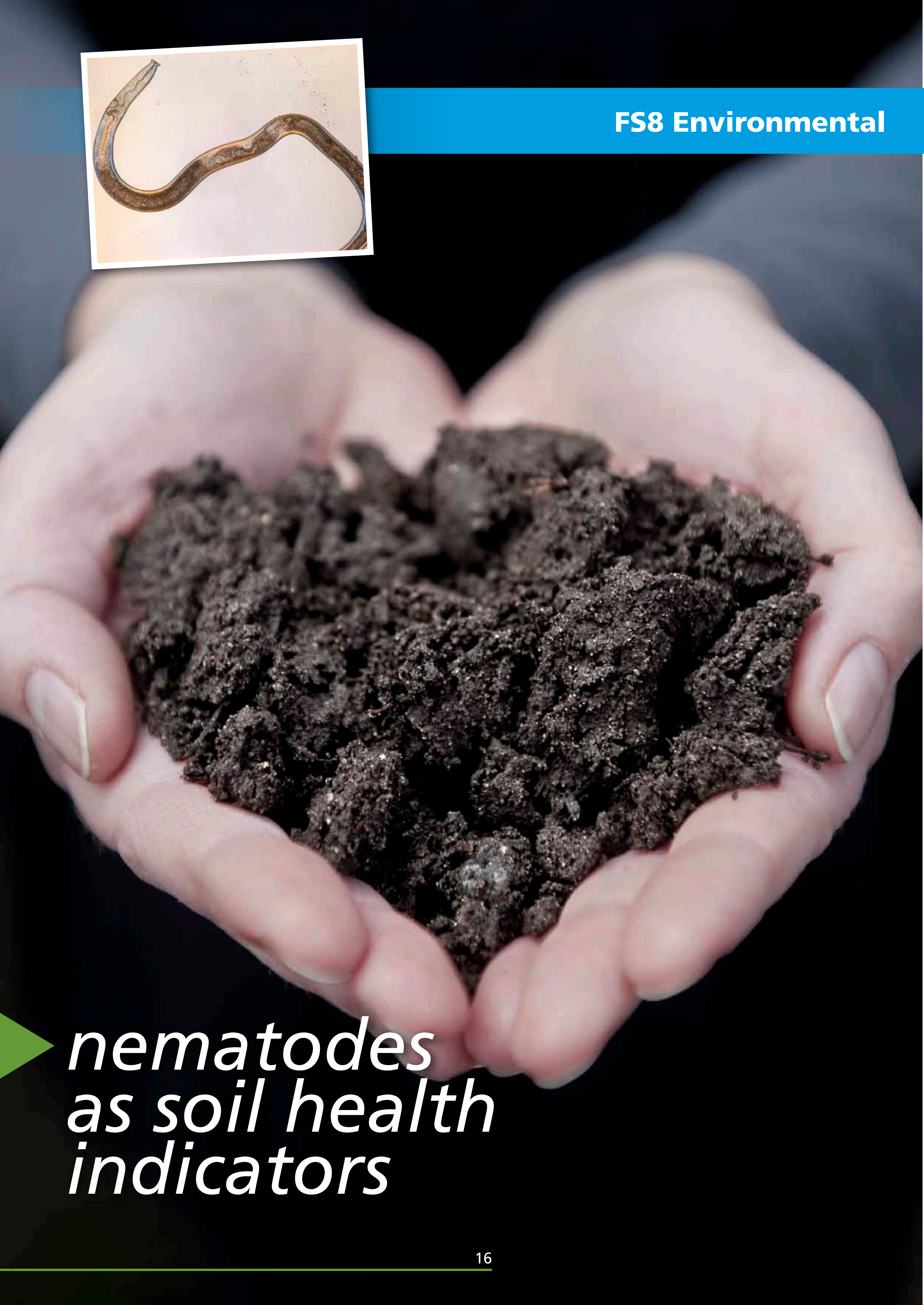
The scientists got an initial idea of what such an enzyme would look like in theory from the literature. With the corresponding DNA-code they developed a kind of probe that they could use to search for enzyme variants in the total DNA pool found in their soil and water samples. "We call it 'DNA-mining'. Once we find the DNA that codes for enzyme variants, we can produce that enzyme in the lab using molecular biological techniques and test whether it is able to convert bio-ethanol," Arends explains.

Screening for activity

The screening assays designed to test the newly found enzymes in terms of activity are developed by postdoc Dr. Marina Faiella. "Together we are looking at more than a thousand enzymatic variations, which all have to be tested. Therefore we are developing high-throughput screening methods based on a colour reaction that indicates whether an enzyme is displaying the required activity. We want to be able to screen ninety-six variants at the same time." This is still a qualitative method. The second step of the screening will be a thorough quantitative analysis of the conversion with more advanced analytical equipment.

For this high-throughput screening (HTS) work the department of Biotechnology has arranged a specially dedicated lab in Delft. "Our HTS-lab has the safety level ML II, which is necessary for working with metagenomes from environmental samples. Because the samples must not leave the lab space, we have also our screening robot, plate readers and chromatograph inside."

Research in Delft is in full swing and Arends's group is ready to discover the first enzymes.
"If we succeed, AkzoNobel will have a blueprint for an entirely new and sustainable process based on bio-ethanol and enzymes. It will be green, clean, and waste free."



nematodes as soil health indicators

Hans Helder is working on a novel tool to monitor the impact of biobased activities on soil and water environments. A key role is reserved for microscopic worms, the nematodes. These play an important role in soil health and are an indicator of the soil condition necessary for sustainable land use.

"Suppose you want to grow sugar cane on a massive scale, how can you show the impact that this has on the soil condition" says associate professor Dr Hans Helder of the Laboratory of Nematology of Wageningen University. "You need a reliable and affordable tool to monitor the ecological condition of the soil."

That is easier said than done. Soil is one of the most bio-diverse environments on our planet, with bacteria, fungi and nematodes being among the main inhabitants. "Since you cannot measure the whole biodiversity of every soil sample, you have to search for a group of organisms that reflect the biological condition of the soil," says Helder. Nematodes, microscopically tiny worms in the soil, are the perfect candidate for this. Nematodes as a group show a range of feeding habits, and are therefore present in every level of the soil food web. "They not only reflect their own condition, but also the condition of their food sources. If agronomic practices negatively affect soil fungi, an impact will be observed on one of more groups of fungi-eating nematodes. As a group, nematodes are an accurate indicator of the biological soil condition."

Largest nematode DNA databank

There was one big challenge which had to be tackled first. All nematodes look alike. Only well-trained technicians and specialists are able to see the difference under the microscope, which has been the standard method of analysis up to now. "A time consuming job and not easy to scale up," explains Helder. "Fortunately, the molecular diversity among nematodes is high. So we started looking at their DNA barcode. Over the years we screened all major North West European nematode families and built a databank that contains now over 2,500 species. This is currently the largest database of its kind worldwide."

This knowledge resulted in the development of sensitive quantitative assays for the detection of plant parasitic nematodes for the agricultural sector. Together with Renske Landeweert from the agricultural service laboratory BLGG AgroXpertus, Helder recently founded ClearDetections, a start-up company that is about to launch a number of nematode detection kits on the market.

Monitoring natural fluctuations

For BE-Basic he is going to characterize natural fluctuations in nematode communities. Helder: "Since soil life differs over the seasons and different soil types harbour different nematode communities, we will be monitoring three different Dutch soil types throughout the seasons for three years." The soil types - marine clay, river clay and sandy soils - have been selected from the RIVM BISQ (Biological Indicator for Soil Quality) network on the basis of their optimal ecological stability.

Within three years the BE-Basic partners in this project, Wageningen University, RIVM, BLGG AgroXpertus and Bioclear, will have generated an extensive nematode DNA database that gives insight in the band width ("seasonal fluctuations") of individual nematodes within the community, the so-called normal operation ranges. "A combination of the monitoring tool and a database of natural fluctuations will allow us to carefully monitor the impact of human activities on the ecological condition of local soil and water environments," says Helder. "Any type of agricultural activity is bound to have an impact on soil life. This is perfectly acceptable as long as these changes are reversible, and as long as no major soil functions are disrupted. These processes can be monitored with our tool kit for community analysis."

The use of this tool is not limited to the Netherlands. Just like bacteria and fungi, nematodes can be found literally everywhere on Earth. Helder: "Research has revealed that soil nematodes show very little biogeography above genus level. So this tool developed in the Netherlands can also be used in other countries where BE-Basic is active, such as Brazil or Malaysia."

biomass production with a sustainability certificate

Over the past ten years criteria for sustainability have been drawn up on a national and international level. But how these criteria are going to be measured and monitored is the main question Floor van der Hilst and her colleagues will be studying in the coming years. The first case study focuses on Brazil's feedstock production for fuel, feed, fibre and chemicals.

"What you see happening now is that many companies are starting up feedstock production but lack good information to help them determine whether their activities are sustainable and profitable. So two years later they discover that things are not working as expected. A waste of time and money," says Dr. Floor van der Hilst of the Copernicus Institute for Sustainable Development and Innovation in Utrecht. "That can be avoided by carrying out a good assessment beforehand. This is also important for governments, for the implementation of policies and land use planning and for certification mechanisms to verify the level of sustainability." Together with four PhD students and the research institute LEI, Van der Hilst is going to focus on the sustainability of feedstock production and utilisation. "To run a biobased economy an enormous amount of biomass is needed. These feedstocks must be produced somewhere. How much land is potentially available? How can we monitor the process and ensure that it will happen in a sustainable way? That are the main objectives of our project," she explains.

Sustainable criteria with regional aspects

What qualifies as sustainable has been a point of discussion. To solve this, different sets of sustainability criteria have been formulated on national and international levels. One of the major criteria is greenhouse gas emissions. "Other factors are competition with other land uses, impact on water, soil and biodiversity and social-economic aspects, to include the impact on the local population," says Van der Hilst. "Therefore we are going to take a perspective that is spatial, in time and regional. That means that we look where land is available for biomass production and if that will be the case in the future. That depends on specific regional conditions which may change over time."

In Mozambique, for example, there is an increase in the population and an increase in the consumption per head of the population. So the total food demand is increasing and, consequently, so is land use for food production. On the other hand, production is so inefficient that they can make considerable gains by taking some steps forward in terms of technology. "One possible outcome is that there is more land available for biomass production. In the Ukraine the population is decreasing and the land is now mainly used for agriculture. There a totally different dynamic is going on," Van der Hilst explains. "The next thing to look at is the impact on the environment and if it is possible to make it profitable."

First case study Brazil

In order to create a uniformly applicable certification method that incorporates regional and spatial aspects, Van der Hilst is going to study different areas in more detail. The first area is in Brazil with which BE-Basic has a collaborative framework for joint projects. Floor and her colleagues will carry out their study in collaboration with the Bio-ethanol Science and Technology Centre (CTBE). "Brazil is a key player in bio-ethanol production from sugar cane and still expanding, which makes it an ideal region to start with. We are now working hard on contacting partners to collect information about the land use change dynamics." From both sides there is much enthusiasm for collaboration, she noticed. "We need information and for them it is interesting to let foreigners take a look behind the scenes. You can say yourself that your bio-ethanol is sustainable, but it is more credible when others say that for you."

Other regions on her list are Eastern Europe, Africa, South America, and Asia in general. Collaboration is ongoing with all these regions. "It is important to collect different case studies so as to end up with a standardised assessment procedure for evaluating sustainability, which can be used everywhere," Van der Hilst says. "It will also be possible to make an analysis beforehand to decide which is the best region for biomass production. In that way you can even identify go or no-go areas."

innovation in the biobased valley

BE-BIC is the Business and Innovation Centre which stimulates and supports all innovation activities within the BE-Basic research program. Its specific tasks include stimulating entrepreneurship amongst scientist, creating new start-ups and promoting research in existing and new companies to get products onto the market. "We support entrepreneurial scientist all the way from invention to start-up."

"It all starts on the work floor, where young scientist do their research," says Prof. Bram Brouwer, director of BE-Basic and responsible for BE-BIC. "We try to bring it to their attention that there is more they can do with research than acquiring a PhD degree. For this purpose we are going to organise special master classes."
In small groups PhD-students are going to sit around the table to identify the best opportunities for innovation within their research project. "To encourage their enthusiasm we shall give examples of others who have done this before," Brouwer says. "Secondly, the project leader has indicated in his project proposal what he thinks are the innovation possibilities. We are going to confront the young scientist with these opportunities and ask them to think of ways to pursue these and about what the end result will be: is it a product, a patent, a method, or can it be a start-up company?"

Role models and challenges

The innovation workshops were organised to provide more inspiration. Last October the first BE-Basic innovation workshop Challenges and Opportunities for SMEs took place. Several SMEs and start-ups within the BE-Basic consortium presented their business cases, and shared their experiences of founding a company and being part of the BE-Basic consortium. "They act as role models for the would-be entrepreneurs," says Brouwer. "We also give very practical help to those starting up a company, such as finding a place in an incubator that can deliver basic infrastructure. Of course there are the legal, fiscal and financial aspects. For most scientist these aspects form the largest bottleneck for making that step to entrepreneurship." And that is exactly where BE-BIC can be of assistance.

In an initial survey conducted within the flagships, Brouwer noticed that there are already 7 to 8 good ideas for an activity or company that are up to the challenge of competing in what is called a 'venture challenge'. "In the journey from invention to product there are a few things you need to consider, for example: who will be your first customer? Ignoring this is a classic pitfall. If nobody wants your product it all is a waste of time and money. So exploring your potential market is essential." In a venture challenge the participants learn to develop business plans and hold elevator pitches. The idea that wins the pitch and those with high potential receive funding for a feasibility study.

Biobased value chain

When a feasible concept has been developed, there is still a long way ahead. The product has to be validated, certificated, accepted internationally and produced on a larger scale. That requires an investment from outside, from bankers or investors. "As a consortium we support these start-ups with some funding to minimise the risks. But our budget is limited. For additional funding we are trying to get a group of investors together," says Brouwer. "When the moment comes that they actually launch a company, we still don't let them go. They can become a new party within the BE-Basic consortium, so they can make another step forward."
Companies within BE-Basic and the wider field of the biobased economy work in value chains, starting with biowaste or agro-based feed stocks, via refinery, fermentation, semi-finished products right up to the end products. All these steps cannot be done by one company alone. "You need different companies in a chain, therefore we also try to stimulate new start-ups to be focussed on the gaps that we see. So when the whole process starts running it provides security for the future for suppliers and buyers in the chain. That greatly reduces the chance of producing something that others don't need."
Brouwer has noticed that investors are also convinced of the powerful potential of this biobased valley concept. ◀

center of bioprocessing expertise and technology

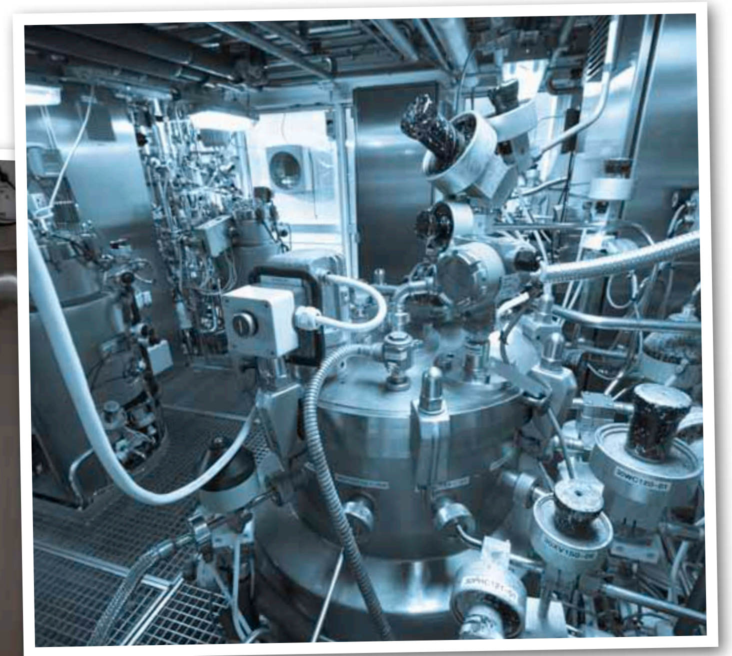
Biobased economy
Finite supplies of fossil fuels and raw materials, climate change issues and peak oil prices urge our society to learn using renewable resources such as plant materials or agricultural waste for the production of chemicals, materials, products and fuels. By (re)using such biobased resources we move towards a Biobased economy based on sustainable production processes.

Research and development
However, scaling novel production processes up from laboratory scale to a larger, industrial scale currently presents a major bottleneck. The need for complex equipment to investigate scale-up issues slows down scientific as well as commercial progress. This is why the research consortium BE-Basic has initiated a unique multi-purpose facility where companies, universities and knowledge institutions can experiment and learn how sustainable production processes respond to larger scales and how they can be scaled up.

Modules
The facility has a modular setup. Users themselves select the process to be investigated from the available modules, ranging from various methods of biomass pre-treatment, fermentation, recycling and purification to third-generation bioprocesses. As such, the facility is flexible and geared towards the needs of researchers from universities, knowledge institutions and industries, large and small, from the chemical industry to equipment manufacturing.

Center of expertise and technology
Located in Delft, the Netherlands, the facility will be a center of bioprocessing expertise and technology. Training opportunities will be available for students,researchers and technologists from all over the world. Both its scale and its open nature make it unique, and make the region a pioneer in the development of the biobased economy.

Cooperation
The Bioprocess Pilot Facility is planned to be funded by TU Delft, other universities, companies such as Purac and DSM, the European Union, the Dutch Ministries of Agriculture, Nature & Food Quality and Economic Affairs, the Province of South Holland and the Municipalities of Rotterdam, Delft and The Hague. The proposed grants will comply with European Union competition rules and procedures, in particular the rules on State aid. The public authorities involved will follow all necessary procedures.



International cooperation

The strong international focus of BE-Basic is reflected by the membership of the consortium of several leading institutions in the EU: Imperial College from the UK and Karlsruhe University of Technology and Technische Universität Dortmund from Germany. Moreover BE-Basic puts its international focus into practice through strategic partnerships in a selected number of countries: Brazil, Malaysia, the U.S.A. and Vietnam.

USA

Amyris has joined the BE-Basic consortium as a new partner in 2011. Amyris is applying an industrial synthetic biology platform to provide high-performing alternatives to petroleum-sourced fuels and chemicals. With the partnership of Amyris, BE-Basic actively expanded its activities in the USA.

Besides the co-operation with Amyris, BE-Basic has teamed-up with the Energy Biosciences Institute (EBI) at Berkeley and the Oak Ridge National Laboratory (ORNL) as its USA partners for their excellence in research and opportunities for BE-Basic partners. EBI and ORNL are leading in programs for bioenergy and biorenewables research.

Brazil

Brazil is one of the largest players in the biobased field through their extensive experience in ethanol extraction from sugarcane. In particular the State of Sao Paolo is largely investing in research in the field of bio-energy, biofuels and bio-chemicals. Their focus and quality in applied research, make cooperation with Brazilian partners an added value for BE-Basic.

Cooperation agreements were or are being signed with BE-Basic's three initial partners;

- FAPESP - São Paulo Research Foundation
- CTBE - Brazilian Bioethanol Science and Technology Laboratory
- Unicamp - University of Campinas

The first call for proposals within the framework of the FAPESP/ BIOEN programme was launched in October 2011. The total budget of this call and of two future calls within the FAPESP/ BIOEN Programme is around $ 6 million. As a result of the October 2011 call, the granted projects will kick-off in 2012. Prior to this, several junior design trainee (PDEng's) started working on joint exploratory projects.

First preparations started with the aim to set up a Brazilian hub of TU Delft and BE-Basic in Campinas in 2012. This will be the center for joint R&D projects, will give access to Brazilian pilot facilities and test fields, and will offer relevant educational programs and courses to the Brazilian academic and industry community and offers access to TUD design capabilities and (PDEng) programs.

Malaysia

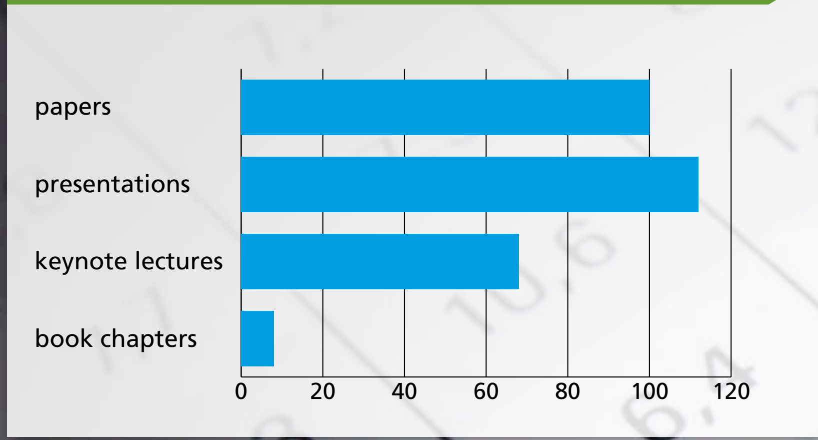
BE-Basic has an interest in collaboration with biomass producing countries to both co-develop and transfer technology and to increase the sustainability performance, contributing to the development of a biobased society in general.

Malaysia annually produces 80 million tonnes palm biomass, which is presently used at modest economic and climate benefits. Palm biomass contains substantial amounts of valuable proteins, phytochemicals and nutrients that originate from the fertilizer used in the plantations. BE-Basic developed collaborations to better and sustainably utilize the biomass which resulted in April 2011 in an agreement with the Unit Inovasi Khas (UNIK) of the Prime Ministers Office. The agreement involved the carrying out of a Macro-economic Study and the establishment of the Oil Palm Biomass Center (OPBC) in Malaysia. A series of workshops lead to a Business Plan for OPBC focusing on the use of palm waste as a raw material for the chemical industry in an economically effective and sustainable way, maintaining and improving soil quality and productivity. The official signing of the Memorandum of Understanding of the OPBC will take place on March 22, 2012, in the presence of the Malaysian Prime Minister. OPBC is a Malaysian public-private partnership in which BE-Basic and several partners of BE-Basic will participate.

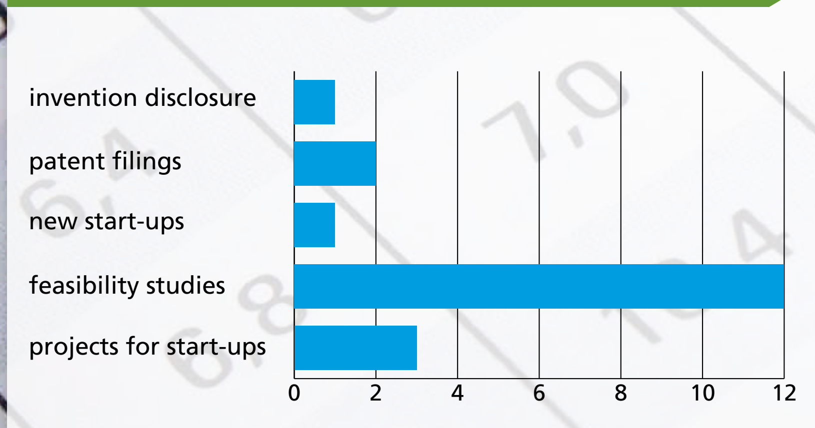
Vietnam

Recently an Letter of Intent was signed between BE-Basic and the Vietnamese Academy of Science & Technology (VAST). The aim of the Letter of Intent is to develop a 4 Million Euro program focussed on exploring novel enzymes and bio-functional activities from microbial, marine and plant species, using functional metagenomics mining technologies.

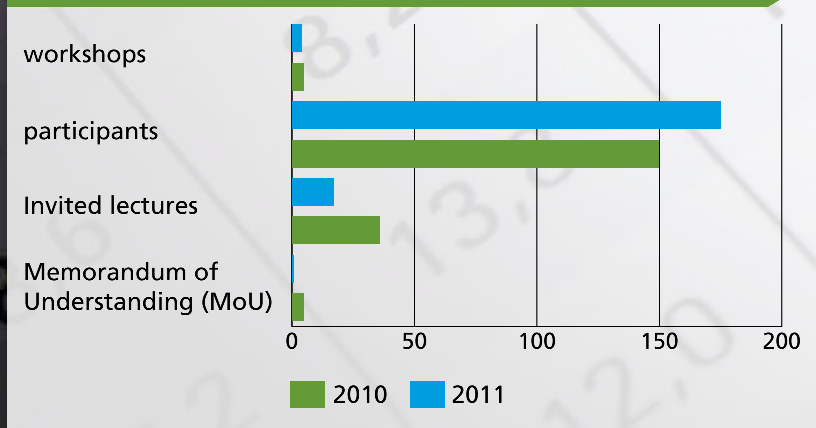
Scientific Output 2010-2011



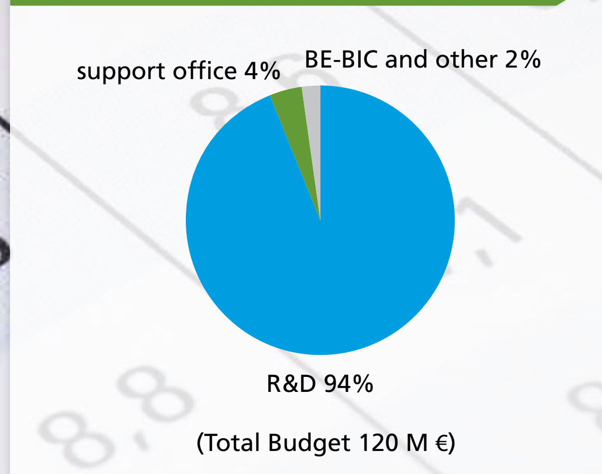
Valorization output 2010-2011



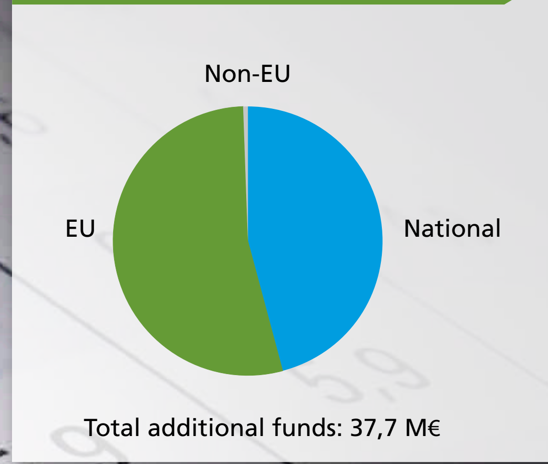
International activities 2010-2011



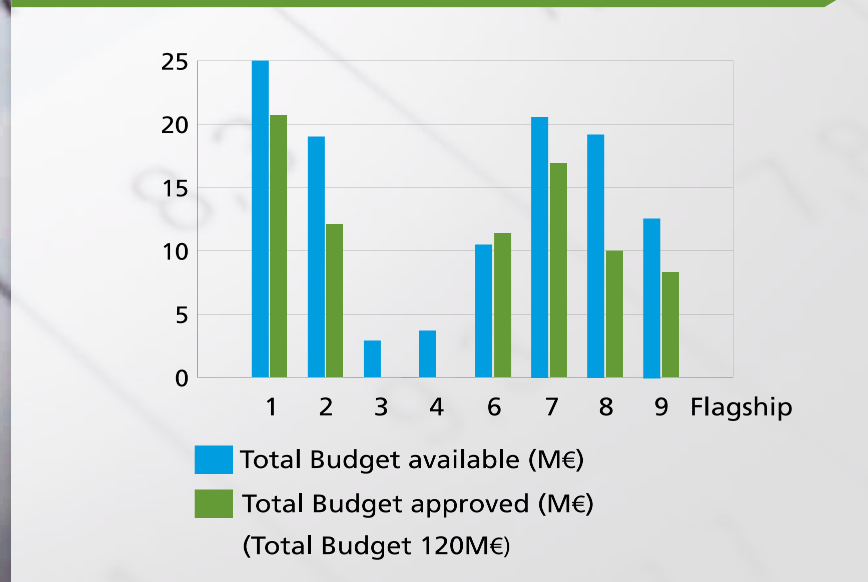
Distribution of BE-Basic funds



Newly acquired projects in 2010-2011



Total available and approved budget per Flagship per end 2011



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BE-Basic beyond Dutch borders

What started as a biobased research programme on industrial biotechnology has become an integral approach that includes most aspects of the biobased value chain. BE-Basic is now ready to take the next step. "Our ambition is to grow and consolidate as leading European Institution."

The BE-Basic R&D programme is the result of a thorough analysis of what a biobased economy could mean for the Netherlands. "If you base it on the current technology and use biomass to generate electricity, you see a slightly positive effect, in the form of several billions of Euros added to the gross domestic product. But you add only modest value to the economy and the environment," says Prof Luuk van der Wielen of the Delft University of Technology and Director of BE-Basic. He summarises the conclusions of a macro-economic impact study: "The study shows us that we need a high added-value product portfolio, in which the necessary power generation is balanced with the co-production of fuels, chemical compounds and materials, in order to make a real difference."

Integral approach

BE-Basic's R&D programme was created with the aim of contributing to the greater part of the biobased value chain; from the conversion and fermentation of second-generation feedstocks to product purification and sustainability studies. Van der Wielen: "The industrial biotechnology component remains substantial but our environmental biotechnology component is reaching the same magnitude. For example through projects aimed at analysing, monitoring and improving soil and water quality as well as nutrient recycling."

The agro-forestry sector is the only area in which BE-Basic is not directly involved, although it is of essential importance since it is at the beginning of the value chain "The availability of sustainable biomass in the Netherlands and the countries around us is limited, in comparison with industrial needs. It is clear that Dutch biobased industry will mostly depend on sustainable biomass (derivates) imports or co-investments (with "BE-Basic Inside" technology) abroad, something the petrochemical sector has always done. That is why we have been focusing for many years now on creating connections with the large crop-producing countries, such as Brazil for bagasse, and more recently Malaysia for palm residues and Vietnam for other tropical crops."

Global player

BE-Basic's integral biobased approach is highly appreciated by the industry, knowledge institutions and national governments, according to Van der Wielen. "Within the Netherlands we have gained a good reputation among national and international industries. Our German neighbours see BE-Basic as a textbook example of a global player. We have been welcome in Brazil since 2004 and we have developed substantial collaborative relationships there with partners including the Bioenergy Program of the State of Sao Paulo (BIOEN), the federal Bioenergy Center (CTBE) and various key universities. In Malaysia we were invited by the government to help establish a large programme similar to BE-Basic, intended to increase social, environmental and economic sustainability of the palm (biomass) sector, which is called the Oil Palm Biomass Center (OPBC). And very recently, we signed a collaborative agreement with the Vietnamese Academy of Science and Technology (VAST) to explore metagenomics for soil and water remediation and help achieve progress in industrial biotechnology for domestic feedstocks."

One-Stop-Shop

At this moment, BE-Basic is focusing on the further roll out of R&D programmes. The implementation of the Bioprocess Pilot Facility in Delft for scale-up research also plays a pivotal role. "This national facility forms part of our asset base for accelerating the implementation of a biobased economy," Van der Wielen says. "With the planned merger of the Kluyver Center for Genomics of Industrial Fermentation and BE-Basic we will strengthen our fundamental genomics capabilities." The merger of the Kluyver Center with BE-Basic will combine scale with the quality of all leading scientists and industries to become a key European and global One-Stop-Shop for Industrial and Environmental Biotechnology, from fundamental science to industry-level piloting.

Van der Wielen is also striving to consolidate the foreign activities, with an emphasis on the European roll out, and on international collaborations with Brazil, USA, Malaysia and Vietnam. "In Brazil, we plan to establish a support office for joint programmes, and in Malaysia we are working on the further development of the OPBC. We are becoming a bit too large for the Netherlands alone, in terms of the required capacity but also the influx of international industries. Our ambition is to grow and become a European Institution, and to further strengthen our position as a global player."

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