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PHILIPPE MENGAL: KICK START THE BIO-ECONOMY

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EDITORIAL

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BACK TO COAL

Over the last few months, social media, websites and newspapers have been full of the presidential elections in the USA. Just as with Brexit, the 'underdog' of the media decided the argument. That is, at least, if possible recounts of the votes do not lead to a different judgement.
Should Trump take up office, one of the key questions is: what will The Donald do with climate change and how are his policies geared towards this?
Trump initially expressed an extremely negative opinion about climate change and even labelled it an initiative of the Chinese government to restrict the competitiveness of the American manufacturing industry. Trump also tweeted about the coal that would revitalise the economy in Virginia. His decision to put Harold Hamm, a billionaire from the oil and gas sector, on the shortlist for the position of Energy Secretary seems to be more significant. This would point at renewed attempts to get fossil energy back at the top of the agenda: a step back from policy set in motion earlier under Obama to promote the development and exploitation of renewable energy.
In the meantime, Trump has backed down slightly by stating that the influence of humans on climate change has been proven, just not the extent to which. So it remains a guessing game as to what the president-elect really thinks - but the signs are not favourable.
The question is whether the USA would be able to turn the renewable tide. In the USA, the separate states also have considerable influence. Thus around 30 states drew up their own standards for generating part of the electricity supply from renewables. It is also conceivable that protests will increase from parts of the population and civil society, as is happening now with the Keystone pipeline.
On the international stage there is serious doubt whether Trump's course will affect the policy of other nations. China, responsible for 30 percent of the worldwide CO_2 emissions, is dispensing with coal to an increasing extent and is also making a greater effort regarding renewable energy and chemistry. The industrial biotechnology sector in China will grow 20 percent in the coming years. The government plays a crucial role in this, not only through policy-making, but also in research and development. Perhaps China - first the 'wrongdoer' in global warming - can set a good example for the USA?

GREEN CHEMISTRY CAMPUS IS SCALING UP

For five years, the Green Chemistry Campus in Bergen op Zoom (the Netherlands) is offering a comprehensive solution for innovative biobased entrepreneurs that operate at the interface of agro and chemistry. To extend this success, companies, local authorities and the province of Noord-Brabant are joining forces with new investments, new partnerships and a new director.

Signing the agreement to further strengthen Green Chemistry Campus: Annemarie Vrijenhoek - De Vries (municipality of Bergen op Zoom & N.V. Indumij), Bert Pauli (province of Noord-Brabant), Peter van den Dorpel (Green Chemistry Campus), Leon Kalle (SABIC) and Henk Rosman (N.V. REWIN West-Brabant).

Companies like Nettenergy, Millvision, NNRGY Crops and the Shared Research Center Biorizon of VITO, TNO and ECN have achieved positive results at the Campus over the last five years. For biobased entrepreneurs and research programmes there are four key ingredients: access to raw materials, facilities, market access and financing. Based on the experience that has been gained in these last five years and interviews with entrepreneurs, government and education, the Campus is expanding its range, for example a demo hall and dedicated access along with additional accommodation and laboratory space in the longer term.

Chemelot

More intensive collaboration with the other top locations in the Biobased Delta will enable entrepreneurs located in one of these locations to also benefit from the facilities of the other locations. Such as the research and pilot facilities, a communal location for demos, start-ups and small-scale production activities and accommodation options for production companies at Nieuw Prinsenland in Dinteloord. Also the collaboration with Chemelot (material development) is being intensified. This complements the focus of the Campus: the utilisation of sugars from agricultural waste in green building blocks for high-performance materials, chemicals and coatings.
Finally, Green Chemistry Campus has appointed a new director. In the past five years Paul Nijskens, former director of REWIN, has been at the helm of the Campus. He is now passing on this role to Peter van den Dorpel who earned his spurs in the industry in positions such as managing director of Europa at General Electric. Van den Dorpel: 'The Campus has everything required to become a leading international hub for green chemistry. I am really looking forward to working with the companies and the team at the Campus to make this a reality!'

Leaf and Novozymes work on biomass-to-sugarconversion

Leaf Resources announced a collaboration with Novozymes, the world's largest producer of industrial enzymes, to further increase the yields and efficiency associated with Leaf Resources' innovative biomass conversion technology.

Leaf Resources' patented biomass pretreatment process, Glycell, is a high-yield route to clean, economical cellulosic sugars, derived from agricultural waste, woody biomass or corn stover. This technology operates at low temperature and pressure, and uses crude glycerin as a recyclable reagent.
As part of the collaboration, Novozymes will use its expertise in biotechnology to customize its broad portfolio of enzymes to the aforementioned process. 'The goal of the collaboration is to design a highly tailored enzyme package that allows the Glycell process to achieve superior performance, quality, and reliability for the production of high-value renewable chemicals', Leaf says.

AMIBM-LABS OFFICIALLY OPENED

At the beginning of December, the Aachen-Maastricht Institute for Biobased Materials (AMIBM) has opened its 1500 m² of new laboratories at the Brightlands Chemelot Campus in Sittard/Geleen, the Netherlands.

Within AMIBM, Maastricht University (UM), RWTH Aachen and Fraunhofer work together in a unique partnership. The institute presented new facilities and initiatives, such as the 'bi-component wet spinning line' for the development of medical fibres, which is the only one of its kind in the world.
The Brightlands Chemelot Campus is the place for triple helix cooperation in the field of new materials. More than 50 employees from the three cooperating partners are working on the development of innovative and sustainable materials, such as materials constructed with the waste from mechanically peeled shrimp, using the help of deep-sea bacteria. 'People from around the world are applying to work with us. Working towards a non-petrol based economy in this dynamic location really appeals to people,' says managing director Richard Ramakers.

Global bioplastics award for biobased Mars-wrapper

The Dutch potatostarch processor Rodenburg Polymers and the US-based global food corporation Mars as well as the innovative film producer Taghleef Industries (Ti) have won this year's Global Bioplastics Award for their development of a new film packaging for food products.

The international jury found it an outstanding example of research to develop a complex packaging fulfilling demanding requirements. The prize was awarded to the winning companies on November 29th, 2016 during the 11th European Bioplastics Conference in Berlin, Germany.
Calling it a very 'cool product' deserving of the recognition, and an awesome example of team spirit, Michael Thielen, Publisher of bioplastics MAGAZINE presented the 3D-printed trophy.
In an acceptance speech that he kept brief and to the point, Thijs Rodenburg, CEO of Rodenburg Biopolymers, said to be 'surprised that we won.' In a single breath, he went on to say: 'But I think what's important is that a big brand stood up and used bioplastics. It's perfect and it's a big step!'

AGENDA

JANUARY 26th -27th

IBioIC'S 3rd Annual Conference, Glasgow

IBioIC's annual conference is fast becoming the main 'go to' event for the biotech industry in Scotland. Attracting over 400 biobased professionals, academics and students from across the UK and Europe in 2016, this two day event aims to explore the potential for the industrial biotechnology's current and future activities in Scotland and further afield, whilst providing delegates with networking opportunities to drive new collaborations. Key highlights of the conference will include: plenary sessions around biorefining, policy, challenges and barriers, themed parallel tracks focussed around Impact, Technical and Innovation and a networking conference dinner with awards ceremony and guest speakers.

MARCH 16th

1st IWA Conference on Algal Technologies for Wastewater Treatment and Resource Recovery, Delft

The aim of this event is to gather scientists, 'algaeneers' and (bio-)technologists to exchange the latest knowledge on the application of algae for wastewater treatment and resource recovery. Wastewater treatment using algae was already introduced more than 50 years ago. Quite recently, algae have regained interest as raw materials for products such as biofuels, food supplements or green pharmaceuticals alongside wastewater treatment. Wastewater engineers using algae can benefit from knowledge coming from the use of algae to make products of higher added value. Likewise, wastewater can be considered as a cheap source of nutrients and inorganic carbon is promising for the production of algae-based commodities. Thus, microalgae technologies can be rather helpful to closing resource cycles whilst producing valuable biomass.

MAY 12th

Applied Biobased Materials Conference, Geleen

The Aachen-Maastricht Institute for Biobased Materials (AMIBM) will host its second international conference on Applied Biobased Materials (ABC conference) on Brightlands Chemelot Campus in Sittard-Geleen. During the conference, consecutive sessions by international key-note speakers will offer guidance along the value-chain, giving the opportunity to discuss latest research developments and future perspectives of applying biobased materials.

NEWS

REVERDIA TOPS HOT 40

Reverdia has been awarded the number one spot in this year's '40 Hottest Emerging Companies in the Advanced Bioeconomy'. The ranking is an important industry endorsement of innovation and achievement in bio-based chemicals and materials.

This recognition builds upon a successful year for Reverdia. It has launched partnerships with Protea Chemicals, Xinhuarun and Wageningen University. The company won 'Bio-Based Chemical Partnership of the Year' at the WBM Bio Business Awards. In addition, Mäder launched a range of innovative paints based on Reverdia's Biosuccinium.
'Achieving first place in the Hot 40 is a phenomenal honour and we would like to thank everyone who helped get us here', said Marcel Lubben, President of Reverdia. 'This prize spotlights Reverdia's industry leadership in the global bioeconomy. We will continue to enable biomaterials with our Biosuccinium-offering and grow the market together with brand owners and producers.'

Joint-venture Total and Corbion

French petrochemical company Total and Corbion are joining forces to develop bioplastics by creating a 50/50 joint venture to produce and market polylactic (PLA) polymers.

The new company will be based in the Netherlands and will launch operations in the 1st quarter of 2017, subject to regulatory approvals. The two partners plan to build a world-class PLA polymerization plant with a capacity of 75,000 tons per year at Corbion's site in Thailand. The plant already has a lactide (PLA monomer) production unit that will become part of the joint venture. Corbion will supply the lactic acid necessary for the production of the PLA and the lactide.
'I'm very pleased with this joint venture, which aims to become a major player in the growing bioplastics market. This investment is consistent with our One Total ambition of expanding in biofuels and bioplastics, in addition to our more traditional oil- and gas-based products', commented Bernard Pinatel, President of Total Refining & Chemicals.

ENOUGH TALK, NOW ACTION!

Jalila Essaïdi reached the world press with a so-called bulletproof skin, a project that is being continued as a medical application. With another concept, textile based on manure, she is currently also attracting attention. 'I am all for action; there are more than enough talking shops in the Netherlands.'

Text Lucien Joppen
Images Ruud Balk, Cleo Goossens, Jalila Essaïdi

Jalila Essaïdi: 'I know that in Europe we are not that keen on these technologies, but the fact is that they are out there and we need to do something with them.'

The bulletproof skin in action.

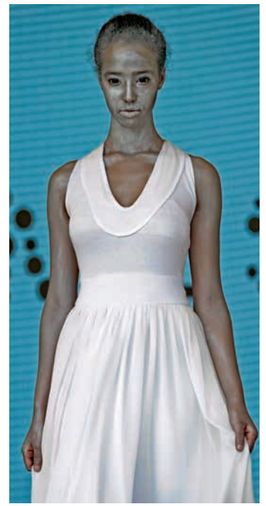
Jalila is an exponent of BioArt, an art movement in which artists and/or enthusiastic 'amateur biotechnologists', as she calls them, work with organisms. The term BioArt was first used by Eduardo Kac in 1997 in his artwork Time Capsule. BioArtists usually work with organisms on a cellular level, such as human cell material or organic materials such as manure. The transformation of nature by human hands is a key theme in BioArt. The artists do not so much take up a position as confront people with the manipulability of nature. Apart from making a statement, Jalila, who graduated from Fontys Hogeschool in Tilburg in Art, also wants to make business from BioArt.

Jalila, what attracts you in nature and, more specifically, in the influence of technology on nature?

'As a child I already had a tendency to bring little creatures and plants home with me and dissect them. I have always retained this fascination for nature. While I was studying I came into contact with BioArt. That idea appealed to me and still does. Biotechnology's role in and influence on our society, and on nature, is already large and will only grow in the coming decades. Take genetic modification of crops or the development of medicines and medical applications, such as cultivating animal cells for human applications.'

Genetic modification, cell cultures. Is BioArt welcomed with open arms?

'There is criticism against BioArt, from PETA (editor's note: People for the Ethical Treatment of Animals), for instance, because of the use of transgenic organisms. This involves putting a foreign gene in an animal's DNA - it can happen naturally but also in the laboratory - so that they obtain certain properties and can also pass them on. The textbook example from science is Herman the bull. His female offspring produce certain medicinal proteins in their milk. Genetic modification is already used on a large scale in crops such as wheat. I know that in Europe we are not that keen on these technologies, but the fact is that they are out there and we need to do something with them. The point is that science goes immeasurably faster than the public debate and political decision-making. So we will have to discuss the pros and cons of biotechnology, with artists playing a catalyst role. Personally, I see myself as unbiased. I am not affiliated with particular organisations or companies.'



A dress made from Mestic. The material is biodegradable and its life span can be adjusted, according to the application.

But you are involved in a few business projects that were your own idea, aren't you?

'That is right. I have a few patents on the project of the human bulletproof skin and I've set up a separate company, Inspidere, for activities based on the principle underlying the skin. I was pointed in the right direction for that idea by Randy Lewis, who has bred transgenic goats so that they produce specific proteins in their milk. These proteins in turn form the basis for spider silk. That brings this material within the reach of industrial applications. Spider silk, the threads of the spider web, is an enormously strong and tough material. It is five times stronger than steel and three times tougher than Kevlar, a material that forms the basis for bulletproof vests. The production process for spider silk does not harm nature and no chemicals are released, as opposed to the production of the above inorganic materials. The only 'but' is that the 'spider production process' cannot be scaled up. Spiders are territorial and cannibalistic, and, moreover, they only produce minor quantities. Enough for a web, but not enough for an industrial or semi-industrial application.'

In the meantime you have developed a prototype for a bulletproof skin, together with a number of parties, including the University of Utah and the Netherlands Forensic Institute. How did you get these parties to go along with you?

'Simply by picking up the telephone and convincing the right people of my idea. And don't forget the preparation. I had read up in depth beforehand in many fields of expertise. Not to specialise in a particular domain, but to get a hang of the jargon. It is important for all parties to speak the same language. In the end we managed to reinforce a part of a human skin (editor's note: originating from cosmetic surgery) with "armour plating" of spider silk so that it could receive a .22LR bullet fired at a relatively slow speed. For that matter, it was not my objective to create a skin that would be real armour in the long term. It is more that I wanted to show how far we have to go to believe we are safe. Over the years we have taken all kinds of safety measures to protect ourselves from all kinds of things, but the feeling of not being safe continues to gnaw at us.'

Not real skin then, but a prospect of other applications?

'Definitely. Right now we are working on variations that might be able to serve as "living plasters" for burns and/or bedsores. The American army also showed some interest. I organised a public debate on the question of whether it should get a military application. The consensus was that it was better to take the medical path. To be honest, if I had been business-like, I would have sold the patent. It takes at least 10 years to get a medical application on the market, with in-vitro testing, animal testing and human testing. And then you have to see whether it really works and whether it is permitted by the authorities.'

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COLUMN

BIOBASED: FROM NICHE TO NORM

I was a guest speaker at the EU conference 'The Role of the Regions in the European BioEconomy' in Bratislava on 17 October. It is striking that this is far from ordinary fare for many participants. That is why Europe takes it to the next level. The biobased/circular economy has changed from niche to norm in the whole of Europe.

There are more than enough figures: consultancy firm McKinsey & Company estimates that by around 2030 the circular economy will provide Europe with a boost of 900 billion euros. This raises the competitiveness of the European regions. EuropaBio has calculated that industrial biotechnology will supply between 900,000 and 1,500,000 jobs by 2030. With less input, but more output.

Poland has surged ahead in the past few months. On 6 October this country translated its efforts into the 'Łódź Declaration of Bioregions'. Other Central and Eastern European regions, following a hesitant start, are trying to become forerunners in the circular economy. Regions play the leading role in this. According to the approach of 'Smart Specialisation', Europe is helping them to make headway fast. This surge, also called the 'Stairway to Excellence', is made possible partly through the Regional Development Fund. Not only in our country The Netherlands: 15 percent may be spent on procuring expertise or collective investment with other regions in the European Union. Exchanges between companies, students and employees can be financed this way. The first steps are being taken now. Do you want to take part?

There is also much discussion about the public profile of the biobased products in the regions. The bio economy merits more publicity. If the consumer does not know that he or she can buy biobased products, the bio economy will remain a niche. In Bratislava a veritable catwalk of practical applications was presented. 'Be good and tell it' applies here too. If Europe gives specific support for this, across country boundaries, biobased will go from niche to norm.

Lambert van Nistelrooij
CDA Euro MP, Rapporteur BioBased Industries.

It looks like another project, Mestic, will be on the market faster. How did this idea come about?

'It came to me during a visit to the provincial hall in 's-Hertogenbosch, where the manure problem was on the agenda. The solutions were also reviewed, and it was noticeable that they were mainly energy applications. This triggered me to investigate whether "we" could use manure as raw material for high-grade materials. In this case, too, it was a matter of approaching the right parties, talking with dairy farmers, the sector, that is, ZLTO (Dutch organisation of farmers, ed.), and other relevant partners. It started with an inventory of what cow manure contains and then seeing whether these components could be processed into specific materials. Different applications emerged, including vanilla. We would get problems with that under the Dutch Commodities Act, which is why non-food applications were the most obvious. Now the fixed fraction of cow manure is rich in cellulose, a raw material that can be converted into cellulose acetate via the Mestic method (editor's note: designed by Jalila, patent pending). With respect to this method: a chemical step on the farmer's property already affects the composition of the various fractions. This is followed by a mechanical and chemical separation, after which the cellulose is pulped to "dissolving grade pulp". Various roads lead to Rome from here: paper, regenerated cellulose (fibres) or acetylation into cellulose acetate. Threads can be spun from cellulose acetate (and from dissolving cellulose), twined and woven into textile. With this material, called Mestic, a dress has been designed, among other items. This collection is now on a world tour of museums and suchlike.'

What are the critical success factors of Mestic? Can it compete with synthetic varieties like nylon or polyester?

'We still have to overcome a number of obstacles that are certainly not insurmountable. One of them is the quality of the raw material: the cellulose content is determined to a large extent by the feeding regime. Farmers will therefore have to make a change. This results in lower milk production, but it does create milk with a higher protein content. Difficult, you might think. But they earn money for that through the cellulose from the cow poo. Something they previously had to pay for themselves. As far as supply is concerned, pure volume, there are no problems I can foresee. We are now going to scale up the processing - the process from manure to textile - in a factory that can process 100,000 m3 of manure a year. I am currently talking with a number of investors. ZLTO also sees opportunities in Mestic. And as far as the market is concerned: yes, there are alternatives to Mestic and there are also other raw materials (pulp, wood, etc), that can form the basis for the production of cellulose acetate. The point is that we do need to find a solution for the manure and that Mestic can be part of a solution. Of course, price-wise it will have to be able to compete with current materials. This will only be possible if we scale up to larger volumes.' ●

Jalila Essaïdi (1980) studied Art and Art History in Tilburg, after which she studied BioArt at the University of Leiden. Essaïdi works as an artist, entrepreneur and facilitator for other artists and designers. To that aim she set up Stichting BioArt Laboratories on Strijp S in Eindhoven. Other artists and/or students can work out their BioArt concepts in depth at the former Philips site. Of course they can make use of the facilities (laboratories, etc) and of the network and business network of BioArt Laboratories.

SUIKER UNIE: ADDED VALUE IN CHEMICAL ROUTE

Suiker Unie has been biobased since the Dutch sugar processing cooperative has been established at the end of the nineteenth century. The company not only processes sugar beets to consumer end products, but it also transforms side streams into products for feed and non-food purposes. Towards the chemical industry, the company also identifies opportunities.

Text Lucien Joppen **Image** Suiker Unie

By the end of 2014 and last year, the consultancy firm Deloitte published two studies that highlighted the possibilities for the Dutch-grown sugar beet in the biobased economy in north western Europe. Factors such as yield per hectare and room for improvement in terms of yield, ensure that the sugar beet can compete with other sugars, such as cane sugar from Asia or Brazil.

Especially the availability (volume) of sugar beet production and other biomass streams that enter the deep sea harbours in the southwestern part of the Netherlands are usp's for this particular region.

SPECIAL BEET

Suiker Unie, part of Royal Cosun, is the spider in this web. As mentioned before, the biobased economy - or better said the biorefinery principle - has been part of its DNA since its establishment. Frank van Noord, director of R&D at Suiker Unie: 'We want to use each and every valuable component of the sugar beet in a sustainable manner. The crops itself is very well suited for this approach. The most important aspect is that it is low on lignin, compared with other crops. Therefore, the individual components can be separated with relative ease. For example, arabinose, fibers that can replace nanoplastics in detergents or galacturonic acid as a building block for polymer production. The possibilities are endless.'

COSUN INNOVATION CENTER

Endless possibilities indeed, but Suiker Unie doesn't have all the necessary expertise to explore these routes. 'We can only succeed if we cooperate with the chemical industry. Only then commercially viable biobased chemicals or materials will be developed. Suiker Unie also cooperates within the Royal Cosun holding, for example with its sister company, Cosun Biobased Products. A good example is the project Pulp2Value which explores new biorefinery routes for sugar beet pulp.

In short, Suiker Unie sees future growth in connecting and cooperating with other organisations. Processes which we will able to facilitate in a better way via the brand new Cosun Innovation Center which will be opened in the summer of 2017.' ●

AVIATION WANTS TO REDUCE CO_2 EMISSIONS

BIOKEROSENE THE ONLY OPTION FOR NOW

Just like every beginning market, biokerosene has to contend with 'the establishment'. Higher prices, technologies under development and small supply. There are positive signals that indicate a larger demand, which can then be matched with increased production and lower fuel prices.

Text Lucien Joppen **Images** Shutterstock

That demand will have to mainly come from the aviation industry, that is, airplane manufacturers and airlines. The good news is that these parties have made commitments in the past few years to allow more biokerosene to enter.

This year the 191 companies that are united in the ICAO (International Civil Aviation Organisation) made the agreement to achieve CO_2-neutral growth as of 2020 and to reduce the total CO_2 emissions by 50 percent in 2050, compared with 2005.

'The drivers behind this development are compound,' says Misha Valk of SkyNRG, a major chain player in biojet fuel. 'Airlines want to reduce their CO_2 footprint in order to lower their share in global warming. They have a number of tools they can use for this purpose, such as reducing the weight of the aircraft, flying more efficient routes, or adhering to flight protocols that require less fuel. But these are merely optimisation drives with which the sector will not achieve its ambitious targets. Road transport has alternatives, such as electricity or hydrogen, that will not be implemented for aviation in the next few decades, say until 2060. The development and use cycles of passenger airplanes are too long for that. In the end, biofuels are the only option for aviation to accomplish net CO_2 emission reduction.'

STABLE PRICE

A second motive, according to Valk, is the availability and price stability of aviation fuel in the medium term. Fuels are the most important operational cost item. The kerosene prices are currently relatively low, but low oil prices are no guarantee against severe price fluctuations. At the end of 2014 the kerosene price in the USA rose by more than 9 percent within a month, while the oil price in that period actually dropped by 4 percent. The reason: an unexpected rising demand from a strengthening market.

Airlines thus gain if there is greater supply from non-fossil and comparatively cheap feedstocks. The focus is almost exclusively on second-generation biomass, according to Valk. 'In the past, other parties used biojet fuels based on edible feedstocks such as palm oil, but they quickly came under attack from NGOs: there is a relationship between palm oil and the deforestation of rainforest. Airlines have therefore expressed their preference for feedstocks that do not directly compete with the production and consumption of foodstuffs.'

FOUR ROUTES APPROVED

In the meantime, a number of routes are now available that have been approved by the ASTM, American Society for Testing and Materials, based on various feedstocks and different technologies. The biokerosenes from these processes have to be added in varying ratios - between 10 and 50 percent.

Four routes have been approved: Fischer-Tropsch, HEFA (hydroprocessed esters and fatty acids), Alcohol-to-jet (ATJ) and Synthesized Iso-Paraffins (SIP). With the Fischer-Tropsch process, carbon-rich feedstock is converted into synthesis gas (syngas) and then catalytically into kerosene or biokerosene. Alcohol-to-jet is a process based on sugars - first or second generation from cellulose - via an alcohol intermediate to biokerosene. The American company Gevo has developed this process (see box Alaska Airlines). The ASTM has approved the biokerosene, but scaling up still needs to take place. SIP, developed by Amyris, is based on the fermentation of second-generation sugars to hydrocarbons which are then converted into biokerosene through a thermochemical process.

HEFA THE FURTHEST

HEFA is by far the technology that has come the furthest and that is already in semi-industrial production (editor's note: 40 Ktonnes per year by the American AltAir Fuels). Around 90 percent of all flights with biokerosene made since the first flight in 2011 have been based on HEFA. In this process, vegetable or animal fats/oils - such as used cooking oil - are converted into biojet fuels or other biofuels such as biodiesel.

Air France-KLM is one of the airlines that flies on a mixture of kerosene and HEFA kerosene on one of its routes: returning to Amsterdam Schiphol from LAX in Los Angeles. 'The fuel for our flights from Los Angeles contains 30 percent biokerosene,' according to an Air France-KLM spokesperson. 'Translated to all flights from LAX and the more than 8,000-tonne reduction that is planned, in the next three years we will fly using an average of 6 percent biofuel.'

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- The international aviation industry produces approximately 2 percent of all CO_2 emissions on earth.
- Of all transport movements, aviation takes up 12 percent of the CO_2 emissions; road transport is responsible for the lion's share with 74%.
- The aviation industry uses up more than 250,000,000 tonnes of kerosene per year.
- The global annual production of biokerosene will amount to approximately 40,000 tonnes in 2017.

Sources: IATA/SkyNRG

HOUSEHOLD WASTE

As mentioned, the aviation industry is targeting feedstocks that compete as little as possible with the production and consumption of foodstuffs and that are also attractive price-wise. Used oils and fats from the food chain may be good for converting into biokerosene with a high blend ratio (50 percent), but they are comparatively expensive - and scarce - because they can also be used for other applications, such as feed.

That is why various consortia and/or companies are scrutinising different feedstocks, such as inedible crops like camelina or the 'veteran' jatropha. In addition, these plants grow in areas that are not suitable for agriculture, so that no cannibalisation occurs. Other likely candidates are crops containing cellulose from forestry or the primary sector and household waste. Thus the American company Fulcrum produces biojet fuel by gasifying household waste into syngas and converting it via the Fischer-Tropsch process into a synthetic crude oil. This can then be converted into biokerosene or other biofuels.

Valk: 'If there are several suitable feedstocks, this plays into the sector's hand. Not only as far as price is concerned, but also regarding availability at the airports. Production and processing would ideally take place locally, so that biomass and biokerosene are transported as little as possible.'

SIMPLY FLY LESS

Using biokerosene to reduce the airline's CO_2 footprint does not go down well with all parties. For example, in response to the first KLM flight on used cooking oil in 2011, Milieudefensie (Friends of the Earth Netherlands) argued that inedible crops such as jatropha also take up agricultural land. The group also has doubts about the feasibility of the endeavour to significantly reduce CO_2 emissions via biokerosene. 'Even just to satisfy the requirements of the European airline industry in 2020, an "extra Belgium" would be needed for the agricultural land.'

According to Milieudefensie, there is only one effective measure: fly less. The NGO recommends the train or high-speed train for distances shorter than 500 kilometres within Europe.

NO INFRASTRUCTURE MODIFICATIONS

In view of the ambitions of the aviation sector to reduce its CO_2 footprint drastically (among other things by adding biokerosene), the market for biojet fuel will undoubtedly have to grow. The technologies for converting low-grade biomass into biokerosene are on their way. If the production capacity is expanded, price levels will also move closer to those of fossil kerosene. 'Five years ago the difference was still a factor of 15, while now it is around 2 to 3,' according to Valk. 'That is still a significant difference, but the gap is getting smaller. There are no two ways about it: aviation wants biokerosene, but at a price level that is comparable with fossil jet fuel.'

According to Valk, the price difference can be partly blamed on inefficient supply chains. It is essential for the supply to use existing infrastructure for fossil kerosene such as pipelines. If not, the operational costs will be considerably higher. This year Oslo was the first airport in the world where biokerosene blends became available 'on tap'. 'They managed this without drastic modifications. Many stakeholders, airports, airlines and managers of the 'fuel farms' at airports do not realise this entirely yet. Part of our task is to remove this barrier.'

BRIDGING THE PRICE DIFFERENCE

Governments could also lend a helping hand to bridge the price difference, for example by establishing a blend obligation. But this is not the case. At the same time it is also a threat, because the biokerosene manufacturers can use their technologies to produce other biofuels such as biodiesel, for which there is a guaranteed market. This would mean that the R&D and scaling up would shift more towards transport fuels, away from biokerosene.

So the push really has to come from the market. SkyNRG, as a downstream player, sees it partly as its task to help airlines to compensate the price difference. One way it does this is by acquiring corporate clients, ABN AMRO-bank for example. These companies pay slightly more for their tickets and through that, help develop the market. It is a nice gesture, but most air travellers are private persons. Shouldn't they be prepared to pay more for a 'low-CO_2' flight?

According to Air France-KLM, recent customer surveys show that travellers believe that renewable energy is important and that the airline could pay more attention to the matter of biofuels. The question is whether travellers would also want to pay a surcharge. In the current market, where many carriers try to bluff each other with prices, this could be a bridge too far for the time being. ●

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ALASKA AIRLINES

On 14 November 2016 the first commercial flight took place that was powered by 30 percent alcohol-to-jet fuel based on second-generation sugars. The manufacturer of the biokerosene is Gevo, which converts the sugars into isobutanol and then into ATJ. Alaska Airlines had the honour, on a scheduled flight from Seattle to Washington D.C. According to Gevo, cellulosic biojet fuel has the future, in view of scaling up, availability of biomass and the roll-out to diverse locations in the world.

BE-BASIC: FOCUS ON INTERNATIONAL DIMENSION

BE-Basic is setting its sights more and more on the international aspects of the biobased economy. It is the next logical step in a development that started more than ten years ago, according to chairman of the board Luuk van der Wielen.

Text Harm Ikink

'At the time we started as B-Basic with research on how you could convert biomass into promising products. But that is not enough, of course. With the transition to BE-Basic in 2010, the focus switched to the implementation of sustainable biobased solutions in society. This has a major international dimension that we now target explicitly.'

One of the basic principles, according to Van der Wielen, is that the biobased economy starts with the feedstock. 'If, for example, you look at the energy needs and the scale of the chemical industry, then you see that the Netherlands is already far too small to meet the demand itself. That is why we are looking at raw materials internationally.'

In addition, BE-Basic has had an international character right from the start. 'Whether you talk about big industry, the multinationals, small and medium-sized enterprises or the academic partners, they all move in a global network. So it is only logical that you look for business opportunities along those lines.'

BIG-C

Inevitably some focus has to be applied when the whole world is the playing field. Van der Wielen: 'We are too small to be everywhere at once. Nor can you make a difference in all regions.' BE-Basic determined where it could make a difference, by using the SCOPE reports that map out the global opportunities and threats for sustainable development. SCOPE (*Scientific Committee on Problems of the Environment*) is a global network of scientists affiliated with UNESCO and UNEP. BE-Basic participates in this network.

With a chemical cluster that stretches through the entire Rhine-Scheldt Delta, it seems obvious to implement projects together with parties from Belgium (Flanders) and Germany (North Rhine-Westphalia). That is why BIG-C, the *BIO-Innovation Growth mega-Cluster*, was established in 2014 together with the neighbouring countries. The emphasis in this breeding ground for international biobased innovation and valorisation is on bio-aromatics, C1 chemistry and fuels for aviation, shipping and heavy road traffic.

NEW ENZYMES

Another focal point is Brazil, which has a considerable biobased industry. BE-Basic has had an office there in Campinas for years and is involved in the Agropolo public-private consortium that wants to accelerate the development of the bio economy. 'The focus is shifting from the production of sustainable end products to the use of residual flows. With BE-Basic we can make a major contribution to this and it provides opportunities to our partners,' according to Van der Wielen.

In Asia, BE-Basic especially has a strong presence in Vietnam. There the attention is focused on the processing of rice hulls, the husk of the rice grain. This is still often incinerated as waste, but has the potential for an important feedstock. 'Technically it is difficult to use for fuels and chemicals, so there is a big challenge there,' says Van der Wielen. The choice for Vietnam is also motivated by the unique biodiversity in that country. This offers opportunities for discovering new unknown enzymes, which can open up new conversion routes as biocatalysts. BE-Basic is collaborating on this with the Vietnamese Academy of Science and Technology.

OPPORTUNITIES OVERSEAS

All these projects across the border might raise questions. After all, BE-Basic is partly financed under the top sector policy (via the Top Consortia for Knowledge and Innovation, TKIs). This concerns support aimed at boosting the Dutch economy. Luuk van der Wielen explains: 'It is a fallacy to think that this means concentrating on Dutch projects only. On the contrary, we would be using those funds poorly if we did not make any use at all of the leverage effect of the international perspective. The opportunities for the Netherlands are not necessarily only found on Dutch soil! For a successful commercial roll-out of new technology, you definitely need to look beyond borders. That is why we offer our industrial partners, small and large, the possibility of gathering clout on a global level. Furthermore, a large part of the Dutch capital flows goes overseas. Worldwide, the Netherlands is one of the largest investors. So it is no more than logical that we also go down that path, as far as the biobased economy is concerned.' ●

DEMAND FOR BIOBASED APPLICATIONS MUST GROW

Aaik Rodenburg (Rodenburg Biopolymers): 'Through the Biobased Delta-network we have met companies with whom we cooperate.'

The growth and innovation of the biobased economy in the Netherlands is receiving a significant contribution from 100 to 150 SME businesses, knowledge institutions and local governments in the Biobased Delta. The first tangible biobased products and applications are a fact and the demand for them is growing. For the Biobased Delta this ushers in a new phase.

Text Kelly van Bragt **Images** Hemcell, REWIN

The Biobased Delta, a public-private organisation in the south west of the Netherlands, has a twofold agenda. The large-scale transition programmes such as Biorizon, Sugar Delta and Redefinery attract a great deal of attention. On the other hand, you have smaller-scale bottom-up initiatives and small and medium-sized enterprises (SMEs) in the Biobased Delta. Peter Bijkerk, Business Developer at Impuls Zeeland: 'We see a number of SMEs with huge potential, but the biobased economy is only at the start now.' The Biobased Delta is therefore concentrating on supporting SMEs through valorisation programmes from the regions.

Dennis van der Pas, Business Developer at REWIN West Brabant, sees the benefit of stronger business development in the SME: 'After all, providing stimulus to the SME led to the first tangible products.' Henk Vooijs, Business Developer at Innovation Quarter South Holland, adds: 'We also see developments that come more from the knowledge corner. What about the extract library, a unique collection of more than 2,200 plant extracts? Knowledge institutions are seeking contact with businesses increasingly often so that specific applications can be developed.'

CONNECTING WITH THE BUSINESS SECTOR

It is difficult to estimate exactly how many businesses are a part of the Biobased Delta and which product group has the strongest representation. 'On the one hand we see the establishment of new businesses that are centred on a biobased product, while on the other hand, other businesses develop a biobased line alongside their conventional product line,' says Bijkerk.

Developments in the 'Delta' range widely and are incorporated in SME clusters. Local SMEs work jointly with educational and government partners on applications in one of the many clusters, which include natural fibres, coatings and biopolymers, and on bringing the innovation to the market. Jan Noordegraaf, general director of Synbra Technology BV in Etten-Leur and established SME entrepreneur in the Biobased Delta, is optimistic. 'The expansion of Avans University of Applied Sciences with the Biopolymer Application Center (BAC) seems to tie in well with the needs of the local business community. So we support this development wholeheartedly.' Since 1957 Synbra Technology has been occupied with the production of 'expandable polystyrene' and in 2007 started the production of BioFoam, the world's first biobased foam that has received a Cradle-to-Cradle certificate.

SMES

The Biobased Delta can, and, according to Van der Pas, must, contribute to encouraging the SME in various ways. Van der Pas believes that an initial role lies in promoting the research infrastructure, such as laboratories, application centres and testing facilities, where SME entrepreneurs can test on a small scale whether things work or not. 'Physical spaces and facilities have to be made available in the current phase for testing so that a proof of concept can be supplied for the products we have now.'

Henk Vooijs concurs with the importance of an extra boost for SMEs during the proof-of-concept phase: 'Investment fund UNIIQ is helping businesses in South Holland by offering them seed capital to bridge the riskiest phase from concept to successful company.'

DE-RISKING

Then again, there are opportunities for the Biobased Delta to strengthen SMEs by 'de-risking' business cases. Thus HemCell BV has also covered its patents, entered into partnerships with chain partners (injection moulding, extrusion, production automation, etcetera) and carried out a good market analysis and feasibility studies. HemCell produces various biobased plastics from palm fibres, such as the Hemcell+50PLA, which is 100% biodegradable outdoors. Nico Osse: 'We have put a good product on the market, price-wise and performance-wise. That is the only way for it to be attractive for other parties to co-finance.' Support from Impuls Zeeland three years ago led to HemCell BV finding funding via the programme InnoGo!. Osse: 'I was pleased we could carry out some of the research using this funding. But the total investment is much larger. I searched for innovative investment solutions as well and had success.'

TEMPORARY VAT EXEMPTION

The government wants to procure biobased products increasingly often, so that it can fulfil the role of launching customer. The Province of Zeeland has anchored biobased procurement as a spearhead in its procurement policy. Calls for tender value the use of biobased products. Examples of implementation include bamboo clothing, biobased tree anchors and a biobased scooter.

Van der Pas: 'It is important to enter into a dialogue with regional governments about how they can stimulate the local economy, instead of obtaining the products more cheaply from abroad. This is an essential step towards getting production to a satisfactory level and on a sufficiently large scale so that Dutch businesses can stand on their own feet.'

Bringing public parties and businesses together can also help in the permit process, finding the right location, financing and other factors for a successful business. Jan Noordegraaf >>

thinks that many businesses do not yet dare take the step to biobased: 'They are afraid of the typical "beginner's problems" for which they can be held to account and that entail high costs. This step is taken much faster overseas.' He believes it would help if the government for example offered a temporary VAT exemption for biobased and recycling.

EFFECT IN RETROSPECT

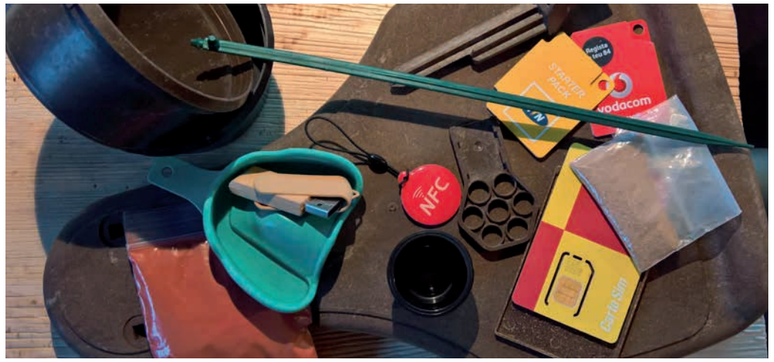
The Biobased Delta must furthermore continue to encourage the 'meet-and-match' activities such as the Biobased Delta Business Development Day (see box) to stimulate the cooperation between businesses, knowledge institutions and government, according to Van der Pas.

Aaik Rodenburg: 'Through subsidy processes and network meetings, among other things, we became acquainted with new partners from the Biobased Delta, with which we now cooperate intensively. You usually only see the effect of this kind of business event in retrospect.'

Rodenburg Biopolymers BV has been in Oosterhout since 2003 and produces biobased raw materials for plastics. 'The creation of the Biobased Delta is an added value for our profile in the region.' Rodenburg Biopolymers also collaborates to a great extent with knowledge institutions both from the region and outside the region. According to Van der Pas, this is not an exception: 'We see that universities like the Wageningen University & Research (WUR) mainly affiliate themselves with large-scale transition programmes, while knowledge institutions like the HZ University of Applied Sciences and the Center of Expertise Biobased Economy of Avans University of Applied Sciences tend to concentrate more on applications and collaborations with SMEs.'

GROWING INTEREST

One of the greatest hurdles businesses had to tackle in the emerging biobased economy was the lack of awareness in the market. 'The market was totally unaware of the toxicological effects of packaging materials for food and suchlike,' says Marco Duijvelaar from Green-4Print in Halsteren, which produces sustainable non-toxic ink and other materials for the packaging industry. They were the first business in this product category in the world to receive Cradle-to-Cradle certification for this. 'The idea that ink can be sustainable is a philosophy embedded in the DNA of our company identity. Sharing knowledge and creating awareness form a major component of the concept,' says Duijvelaar. Aaik Rodenburg does observe a slow change in mentality. 'From 2003, little by little people started being more open to the idea of biobased products, but it only really gained a life of its own in 2007. As of last year, chain partners have also been coming to us every so often with questions.'



The product portfolio of Hemcell.

FUTURE-PROOF

So the biobased market is growing steadily. How do the established SMEs guarantee themselves a spot in the future biobased economy? Aaik Rodenburg: 'Rodenburg Biopolymers only makes raw materials, but we actively try to keep up with the market. We are working hard on closing the entire chain.' At Green4Print, too, there is a proactive attempt to develop new markets and achieve breakthroughs. Duijvelaar: 'One example is "flexo inks" on foil packaging and print ink for newspapers. Our ambition is also to look for sustainable alternatives for glues, paper, plastics and other packaging materials in collaboration with chain partners and to make the entire chain more sustainable.'

Besides innovation in products, Ferry Samuels also devotes time to innovation in marketing and sales to make his business, Eco-Point, future-proof. Eco-Point, also from Halsteren, develops and produces environmentally friendly cleaning and maintenance products for various sectors. 'So many new sales channels have opened up through the Internet. We are looking for possibilities to make better use of social media and other channels to sell our products B2B.'

INVOLVING THE CONSUMER

According to Van der Pas, biobased is a branch of sport that by definition goes beyond all sectors. 'It once started in the Biobased Delta as an amalgamation of the agricultural and chemical sectors, but applications and products are applicable in several markets and sectors and that is what we see happening now.'

It is becoming increasingly important to provide a low threshold for the market to become involved in the biobased economy, as this creates new perspectives. One example of this is the Dutch Design Week, where the number of biobased products was represented strongly last month. It is a smart idea to display tangible biobased products and involve the normal citizen in this process of growing awareness, a thought Ferry Samuels also shares: 'Currently we are in the pop-up store in Bergen op Zoom with our cleaning and maintenance products. It is wonderful to see which products are already being made. Now it is a matter of everyone embracing the success together and seriously getting to work to replace the petrochemical sector by biobased.' ●

This article has been written in cooperation with Biobased Delta.

BIOBASED DELTA BUSINESS DEVELOPMENT DAY

Many old and new faces, 172 participants from the Netherlands and overseas, attended the 7th Biobased Delta Business Development Day. The day was held on 29 September in the Markiezenhof in Bergen op Zoom. Topics such as business development, financing and internationalisation received ample attention during the meetings, presentations, pitches and at the information market. Businesses from the Biobased Delta had the opportunity to showcase their company and to network. Dennis van der Pas: 'The participants welcomed the day very positively. I think we have to continue to push these kinds of initiatives to get the right partners to find each other and speed up innovation.'

OFFICIAL OPENING OF CENTER COURT

'MAJOR MILESTONE AT BRIGHTLANDS CHEMELOT'

'Development of a campus on the Chemelot grounds (editor's note: Brightlands Chemelot Campus) went faster than we originally thought. We reached a major milestone with the opening of the Center Court in mid November, but this is certainly not the only one.'

Text Lucien Joppen **Image** Agro&Chemie

Emmo Meijer, standard bearer for Source B among other things, was involved in paving the way for an open innovative campus on the DSM grounds in Geleen around the turn of the century.

'At the time I was working as Research Manager at DSM. DSM decided to divest itself of certain activities in the short to medium term. This meant that other parties would set up on the premises and would also want to use the facilities, such as R&D laboratories. This became a reality when the polymer business was sold to Sabic in 2002. The coming of this "odd man out" signified a change in mentality at the same time. It was no longer purely DSM, but a site where other businesses could establish themselves. That is also why the name was changed earlier from DSM Research to Chemelot.'

DIFFERENT DYNAMICS

More and more businesses set up at Chemelot by taking over DSM activities, but newcomers also arrived, such as Sappi and Avantium, or spin-offs of DSM like Isobionics and Yparex. There are now more than 50 businesses.

Meijer: 'In a relatively short period, a completely new ecosystem has arisen, which certainly brings a dynamics with it that is totally different to just one multinational with its own company culture. The profile at Chemelot is diverse, with Dutch and international businesses targeting divergent markets. There is one important common denominator: high-quality sustainable chemistry and (biomedical) materials.'

HEART OF BRIGHTLANDS

Activity alone is not enough for an open innovation campus, according to Meijer. 'Educational and research institutes and new activity are preferably under the same roof. This in turn leads to intensive interaction, which makes the campus model unique. You need knowledge workers, students and R&D people at the companies to achieve this. These interactions really come into their own if they are concentrated at a specific location. You can see this in Eindhoven, at the High Tech Campus where the Strip forms the dynamic heart. That is the role we also envisage with the Center Court.'

BRIGHTLANDS MATERIALS CENTER

The latter building is not the only 'catalyst' for innovation as far as smart, sustainable materials are concerned. Brightlands Materials Center opened its doors last year. This new knowledge centre, targeting the development of polymer materials, is a place where businesses and knowledge and research institutes work together closely. The budget for the next five years: 45 million euros.

The Multipurpose Pilot Plant, opened at the start of 2016, is another initiative in which businesses (Sappi, Avantium and Technoforce), research institutes and the government have combined forces. The planned expansion of the campus to the north is also important. 'It will allow us to facilitate start-ups that want to scale up or expand.'

ON TARGET

It would not have been possible to develop the campus if the Province had not participated, according to Meijer. 'You can only realise a campus development in a triple helix: the business sector, knowledge and research institutes, and the government. The province of Limburg not only contributed in word to the realisation of Brightlands Chemelot Campus, but most definitely also in deed. That is how we have managed, together with the existing Industrial Park, to be on target for our ambition: the most competitive chemical and sustainable materials site in Western Europe in 2025.' ●

This article has been written in cooperation with Source B.

GFBIOCHEMICALS

DEEPER INTO THE CHAIN

GFBiochemicals made a forward integration step at the start of this year through its acquisition of Segetis. The levulinic acid manufacturer wants to operate closer to the market to incorporate specific derived chemicals in existing applications, such as detergents.

Text Lucien Joppen **Image** GFBiochemicals

Super-concentrated detergents, made possible by levulinic acid.

GFBiochemicals is a company of Italian origin, with a 1,200-tonne production facility in Caserta and plants at Brightlands Chemelot Campus in Geleen, in the south of the Netherlands and, since the takeover of Segetis, also in the USA (Minnesota). There is a small team in Geleen which includes R&D manager Rudy Parton. Together with several DSM colleagues, he came to GFBiochemicals in 2014.

'The company worked on a direct route from C6 sugars to levulinic acid from 2008 to 2014. It used the Biofine process under licence for that purpose. But GFBiochemicals could not get this technology operational in Caserta. At the time we analysed the process in Caserta and made changes to the hardware and the process conditions and added new equipment. The major drawbacks were in the reactor technology and the purification of the levulinic acid.'

DIRECT CONVERSION

These drawbacks have since been 'massaged away', according to Parton. 'In the Caserta factory, say on TRL7 level, we now produce levulinic acid based on soft wood with yields that are similar to those of bio-ethanol. The advantage of our technology is that we are the only company in the world that can run on raw materials (C6 sugars) that contain cellulose. There are manufacturers (editor's note: in China) that produce levulinic acid based on C5 sugars. We convert the cellulose in the biomass directly into levulinic acid. Because we are flexible with feedstock, we are also in a good position as far as availability is concerned. In due course, once we have the new plant, we also want to look at waste wood. It is a feedstock with even more attractive sustainability, but it can introduce complications to the process.'

GROWTH FROM DERIVATIVES

Levulinic acid and bio-ethanol have similar business cases, according to Parton. The point is that bio-ethanol is a product that is subsidised, while levulinic acid - as a fine chemical - has to manage in the market without external assistance.

The market for levulinic acid is currently fluctuating between 2,000 and 3,000 tonnes per year. Uses include the knitting of resins, as a means to combat microbial growth in foodstuffs and as a flavouring (butterscotch).

Parton: 'It is a small market and completely inadequate to facilitate the further scaling up of levulinic acid. Let me put it this way: I did not move to GFBiochemicals with my colleagues from DSM to produce 5,000 tonnes a year. Our target on the horizon is a factory of around 50 Ktonnes in 2022. We want to make the interim step in 2017 with a 10-Ktonne plant for levulinic acid. Now, a capacity of 10,000 tonnes for a world market of 3,000 tonnes is indeed very large. That is why we also want to build a 10-Ktonne plant for ketals (from levulinic acid) and a similar plant for other derivatives.'

SUPER-CONCENTRATED DETERGENT

It is precisely the derivatives from the ketals and levulinic acid that are interesting for GFBiochemicals to expand the market volume for levulinic acid and thus escape from a niche market, according to Parton. 'That is also the reason for buying up Segetis. They have developed technology based on ketals from levulinic acid and, more importantly, developed applications with brand owners for existing markets. For instance, they have developed a detergent with a concentration eight times greater than the standard. This degree of concentration is possible thanks to the solvent based on ketals from levulinic acid. It is more effective than other solvents because it acts as a coupling agent. It links different constituents together better. What's more, the solvent is biobased. Depending on the type of ketal based on levulinic acid, it can break up into perfectly harmless components such as glycerol, ethanol and levulinic acid. In environmental terms that also makes it a better solution than many fossil solvents.'

POTENTIAL IN VOLUME MARKETS

GFBiochemicals has other derivatives in its sights, apart from the derivatives of ketals. In view of the broad scope of levulinic acid, the company cannot aim at all possibilities, according to Parton. 'We have selected three derivatives - gamma valerolactone, methyl butanediol en methyltetrahydrofuran - that can be used as environmentally friendly solvents and/or intermediate products for nylons, among other things. Gamma valerolactone (GVL), for example, can be used as a solvent, but also as an intermediate coupling for monomers for large-scale industrial polymers. In the medium to long term, if the production volume increases, GVL has the potential to serve as a monomer for polyesters and nylons or specific acrylates. That's when you start talking about significant markets with large volumes.'

PRODUCT MIX

The route from levulinic acid to the above chemicals has been proven on a laboratory scale. The purpose of the Horizon project GreenSolRes, in which GFBiochemicals participates, is to deliver an 'engineering blueprint' for a 10-Ktonne plant that will produce the three chemicals and applications (solvents, resin). 'The process will deliver the three end products in any case. This is positive, because we do not expect that we can dispose of 10 Ktonnes of a specific chemical immediately. So we are going to produce a mix of the three products, adjusting the ratio according to the market demand. Eventually there should be a plant in 2021-2023 with a capacity of approximately 10 Ktonnes per year. It will be linked to the 50-Ktonne levulinic acid plant that is planned at the same time and that will supply the raw material for these derivatives, but also for the other production locations where the other derivatives are produced, such as the ketals. Where these facilities will be built? That is one thing we still don't know.' ●

This article has been written in cooperation with Source B.

Levulinic acid is a Dutch invention. In 1840 professor G.J. Mulder produced levulinic acid by heating fructose with hydrochloric acid. The name levulinic was derived from levulose, an old name for fructose. Between 1925 and 1950, Quaker Oats in particular raised the production of levulinic acid to demonstration scale. The emergence of inexpensive oil in the nineteen fifties precluded large-scale industrial production of levulinic acid based on biomass. A cheaper fossil route was developed. DSM, among other companies, produced this product in Linz, Austria. At the end of the nineteen nineties, production dried up because the route had become too expensive and only a small-scale three-step route based on furfural was left in existence. Biobased levulinic acid came back into the picture in this century, partly due to the Department of Energy report about promising biobased chemicals (including levulinic acid) and the previously mentioned Biofine process. Since then, levulinic acid has been back with a vengeance. Multinationals like Dupont and Shell have registered various patents for several applications - Shell for biofuels, for instance - based on levulinic acid.

‘VALUE EXTRACTION FROM ENTIRE BIOMASS FLOWS’

It is running at full speed: the laboratory facility of the semi-industrial biorefinery with supercritical CO2 technology in the Zernike Advanced Processing facility of the Hanze University of Applied Sciences Groningen. ‘I expect the entire system to be ready by March next year. Then we can first isolate the high-grade components from various biomass flows on a semi-industrial scale, and after that extract value from the other material flows.’

Text Adriaan van Hooijdonk **Image** Hanzehogeschool Groningen

Rob van Haren, lector in Transition Bio Economy at the Hanze University of Applied Sciences Groningen, is currently working on a special semi-industrial biorefinery with supercritical CO_2 technologies. The system, according to Van Haren unique in the European research world, consists of several components. ‘During the preparatory treatment in the supercritical extruder, we first extract the fatty components from the biomass. We use CO_2 as a carrier instead of water. This way we reduce the biomass flow at the same time so we can go faster from the batch process to a continuous process,’ he explains.

‘The extractor then plays an essential part in extracting the highest-quality components from the biomass, such as components with a pharmaceutical effect. Furthermore, we have two large ten-litre stainless steel reactor vessels connected in series, as well as a four-metre fractionating column. The heat exchangers, the process control systems and the supercritical CO_2 spray dryers complete the system.’

LIBBIO PROJECT

The semi-industrial biorefinery was built in the first instance for the European Horizon 2020 project LIBBIO. In this project, Van Haren and other parties are investigating the possibility of getting an entirely new biomass flow going in Europe, based on the Andean Lupin plant. This lupin variety grows excellently on poor soils because it produces its own fertilisers. And since the most fertile soils are already in use, expansion is only possible by using less productive soils. According to Van Haren, lupins are the ideal choice. Moreover, they contain high-quality proteins and high-grade oil. A business case similar to that for the cultivation and processing of soya can be developed with this.

Van Haren is also targeting other biomass flows. ‘For instance, we are also collaborating with Hillebrands Laboratorium and Hoekstra New Food Business on the extraction of lutein from the Tagetes flower, better known as marigold. Lutein is a powerful carotenoid that is used to prevent retinal degeneration, among other things,’ he explains. ‘We are also working on the extraction of genistein from the plant dyer’s broom; this is a phytosterol that is effective against cancer, among other things.’

The most important goal in each project is to first isolate the high-grade components on a semi-industrial scale, and after that extract value from the other material flows, stresses Van Haren. The biorefinery cascading principle is central to this. It means that Van Haren extracts value from all components in the biomass and there is no waste. ‘This approach ties in seamlessly with the plans of the European Commission to create a circular economy in Europe.’

DIFFERENT YIELD

The processing capacity of the system depends on the speed and effect of the extraction process and the composition of the biomass flow, according to Van Haren. ‘In principle we can process hundreds of kilos of biomass per day, but the yield will differ. Take the lupin bean, which contains forty percent protein. If we put one hundred kilos in the system, we get forty kilos of protein out of it.’

Van Haren emphasises that extraction and fractionating are techniques that have long proven themselves in the past thirty years. ‘What is new is that we are building a semi-industrial system here that combines the opening up with extraction. We also have software to calculate the total cost price of the process. This means we are not only able to calculate the technical feasibility of the process, but also its economic feasibility.’

GREEN PREMIUM

The processes take place under mild process conditions, at temperatures below 70 degrees Celsius, and without the use of solvents (based on fossil raw materials). So it concerns a fully green extraction process in which Van Haren uses only bio-ethanol and water as cosolvents.

He believes that the semi-industrial biorefinery can easily compete with fossil raw material-based systems as far as cost and functionality are concerned. ‘The supercritical CO_2 processes are expensive in principle, but you have to compare them with the alternatives. Those are processes based on hexane, often polluting, toxic not only for humans but also for the environment,’ he specifies. ‘What is more important? As a company do you transfer the environmental costs to society, or do you include the environmental costs in your product by putting a premium product on the market?’

In Van Haren’s opinion, consumers increasingly want pure, natural products and are also prepared to pay more for them. ‘From biomass subsidiary flows from the food and process industries we can now extract particularly interesting and valuable components. And in such a way that the original raw material flow remains intact.’ ●

Rob van Haren: ‘What is more important? Do you transfer environmental costs to society or do you include these costs into the consumer price?’

COLLABORATING WITH COMPANIES IN THE CHAIN

In the project, Van Haren works together with a number of companies in the chain. Thus the potato processor Avebe is interested in supercritical CO_2 processes for separating in an effective way. This not only increases the yield, but also requires less energy and solvents. In addition, parties such as Syncom and the Ofichem Groep are interested in the industrial production of pharmaceuticals and nutraceuticals. ‘This morning I was in discussion with a party that wants to extract astaxanthin from shrimp shells, a natural pigment that can be used to give salmon a pink colour, for example. In brief: there is more than enough interest from companies in the chain,’ notes Van Haren. He also works closely together with professor Witkamp from the Delft University of Technology, one of the originators of the supercritical CO_2 technology in Europe, on the further optimisation of the extraction processes, including deep eutectic solvents (NADES).

REMOVING MINERAL OILS

Van Haren is also working on the development of a process that uses supercritical CO_2 technology to remove residue of mineral oils from used packaging of foodstuffs. The European Commission indicated in early October that more research into this is required. Thus a Euro MP of the Dutch CDA party (Christian Democrats), Annie Schreijer-Pierik, declared that ‘nobody is keen to ingest ink from old newspapers in their pasta or rice.’ Van Haren’s first attempts on a laboratory scale were successful in removing the residue with supercritical CO_2. He is now working on the optimisation of the process.

'KICKSTART THE BIO-ECONOMY'

'The global paradigm shift from oil-based towards bio-based materials represents a unique opportunity for Europe to kick start a world-leading competitive bioeconomy, having significant economic, environmental and societal benefits for the continent.' The Bio-Based Industries Joint Undertaking plays a pivotal role in this transition. Agro&Chemistry interviewed Executive Director Philippe Mengal about the recent past and future challenges ahead.

Text Lucien Joppen **Images** BBI JU

At Bratislava Bio-economy Conference in October, BBI JU presented the potential for the bio-based industries in a range of everyday biobased products in a walking exhibition. From dandelion tyres to dresses made from milk fibres, bio-degradable compostable shopping bags to high performance bio-ethanol.

Mr. Mengal, what is your role within BBI JU and has this organisation developed the way it should?

'Well, I have been in office as from October 2015. My first objectives were to establish the organisation, recruit the team and implement tools, methodologies and processes, organise and promote the BBI JU and its second call for proposal and ensure the management of the project portfolio. It was successfully done and today BBI JU is already delivering its first results. It is playing a key role as the catalyst for the development of a sustainable bio-based industry in Europe. It is considered to be one of the most forward looking initiatives under Horizon 2020 and aims to achieve the highest leveraging of public funds of all the EU Joint Undertakings.'

What are the specific objectives of BBI JU?

'To develop sustainable and competitive biobased industries in Europe, based on advanced biorefineries that source their biomass sustainably. The specific objectives are: first to demonstrate new technologies to fill the gap in existing value chains with concrete and well identified applications and markets; furthermore to develop business models integrating all economic actors along the value chain and - finally - set up flagship biorefinery plants at a commercial scale in order to keep the investments in biorefineries in EU and contribute directly to the deployment of the biobased industries.'

Is the public-privatepartnership model instrumental in realizing the aforementioned goals?

'BBI essentially is about de-risking investment, enabling joint financial commitment and setting up jointly defined programmes by pooling resources from public and private sectors into a common platform. It is a question of alignment of resources, objectives and strategies. What was missing was the critical mass at European level in terms of scale of activity, excellence and potential for innovation. The sector is fragmented because it is not well organised, with organisations and companies that are not used to collaborate across industries and geographical regions. Most industrial sectors were used to working in silos. Fragmentation is also linked to geographical issues, such as location of feedstock which may not be centralised or potential biorefinery facilities which are not connected to an adequate supply chain or close to the end user of the finished biobased products after transformation.'

Will Europe be able to compete with other continents in establishing a mature biobased industry that is competitive in terms of R&D and industrial scale production? Will BBI JU contribute to this aim?

'First of all, PPP's are not exclusively a European affair. Other continents also employ similar strategies, such as North America. It is more important to focus on our strengths than on our weaknesses. Europe has always been excellent in developing sciences and technologies in different sectors and especially in biobased industries. We have world leading companies in key technologies of industrial biotechnology. But when we look at the investment performed in large scale biorefineries corresponding to the full scale deployment of biobased production, Europe was late in the global race compare to North America, Brazil or China. These big countries have extensive biomass resources and benefit from R&D-investment programmes and a strong political will for the bioeconomy. For instance, Barack Obama declared during his second mandate that the bioeconomy is a major engine for American innovation and economic growth. Brazil clearly claims that it intends to become the worldwide number one in the bioeconomy. Europe has the potential to compete for this 'crown' but we - public and private enterprises - have to cooperate through sectors in order to establish commercial value chains on our continent. By doing this, Europe should be back in the race for becoming the strongest biobased industry and even become a leader in certain areas and value chains.'

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In terms of geographical representation, is the BBI JU truly a pan-European initiative or are certain countries or regions better represented than others?

'As to be expected with a new programme, take up rates have been higher with some Member States and Associated Countries who were already in positions to take advantage of the programme's early Calls. The BBI JU, as a pan-European programme, is inclusive and engages with Member States, regions and areas that have massive potential for developing the biobased industries. The objective now is to widen the participation of countries, regions and stakeholders in the BBI JU-programme to leverage the EU's full potential. European regions and cities will play an increasingly important role in implementing the bioeconomy as they come to understand the opportunities for developing a local bioeconomy. When regions support initiatives with a strong regional bioeconomy policy, they enable innovation to occur by bringing industry and research institutions together. Regions can foster the necessary support and infrastructure needed to capitalise on local natural resources, regional strength and capabilities.'

The first BBI JU-projects have been launched in 2015. Can you mention any successes already or is it too early a day?

'No, far from it. There are examples of some new bioplastics, biolubricants and cosmetic ingredients. For the near future - 2020 - we set the bar high: ten new biobased value chains, five new building blocks based on biomass of European origin, fifty new biobased materials developed (TRL3), validated (TRL 4-5) or demonstrated (TRL 6-7-8) with BBI-projects. Furthermore, thirty new demonstrated 'consumer' products based on biobased chemicals and materials should be launched by then. For the time being, our main challenge for 2017 will be to run the organisation at full speed with a project portfolio multiplied by four, accounting for more than on-going 60 projects. Most important will be the call 2017 for which the topics will be public by the end of 2016. The call will be open in April 2017 with an Open InfoDay in Brussels on the 28th of April 2017. At the beginning of next year the revised SIRA (Strategic Innovation and Research Agenda) will be published. It will provide BBI JU with the direction for topics in our next three years Calls for proposals. As an industry-led programme, the new SIRA will look forward into areas which industry sees potential for including the so called blue (aquatic biomass) bioeconomy and brown (waste) bioeconomy.' ●

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