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ABOUT BUSINESS IN THE **BIOBASED** ECONOMY

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SPORTS & OUTDOOR:
MATERIAL INNOVATION KEY

STORA ENSO LAUNCHES
MULCH PAPER

BBI OPENS
THIRD CALL

ROQUETTE'S AMBITIONS
IN NON-FOOD

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MAY 2016

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EDITORIAL

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TECHNOLOGY

At the Eco-Bio 2016 Congress which took place at the beginning of March, the key note speaker, DSM CTO Marcel Wubbolts, inaugurated the ball with a plea for science and technology. Logical, Eco-Bio is an event with a strong scientific slant, although its focus is to unite ecology AND economics. With the objective of working on a sustainable, prosperous economy that has a minimum impact on our planet and its inhabitants.
This will be difficult enough considering the prognosticated global warming. We will have to pull out all the stops in order to keep this warming below 2 degrees. Technology plays a crucial role in this, says Wubbolts.
'The ambitious goals will not be met without cutting edge technology. We will also have to develop new business models.' One of the arguments advanced by Wubbolts was linking the technological (blue) cycle to the natural (green) cycle, while slowly but surely replacing the finite raw materials by renewable equivalents.
Developing new technology is one thing, but it will have to be accepted by the industry and, eventually, by the consumer as well. That is not always a walk in the park, for example the resistance that put pressure on genetic modification in the past and still does. We must beware of so-called merchants of doubt who benefit from discrediting science, stated Wubbolts. For that reason DSM has set up the sciencecanchangetheworld.org website in order to put science and scientists (the unsung heroes) in the spotlight. A good initiative, but not enough, says Wubbolts. The sector, meaning chemistry/biotechnology/agrofood, will have to tell inspiring tales, not to polish up its image, but also to show, on the basis of facts, that it is part of the solution.
The importance of proper, solid science for companies, governments and other stakeholders to base their policy and investments on is evident. Unfortunately the scientific discourse is not always kept unbiased, according to Luuk van der Wielen (BE-Basic) and co-chairman of Eco-Bio-2016. 'Those (editor's note: scientists) who operate in the sensitive area between private and public domain are assessed on this position and not on content. I find that difficult to deal with', according to van der Wielen.
To put it briefly, science will have to prove itself to the outside as well as internally. However, it will always be sensitive to criticism from colleague scientists or charlatans from the outside. This is normal and shouldn't be a problem, at the condition that the battle is waged openly and above board, based on hard facts. That would already be quite some progress.

BIOMASS PRETREATMENT: CLEAN AND EFFICIENT METHODS

Pretreatment is one of the most expensive and crucial steps in the bio-economy. Therefore it is important to develop more efficient and 'cleaner' methods in order to facilitate business development based on biomass.

Solange Mussatto, Invited Assistant Professor at the Bioprocess Engineering Group at the Delft University of Technology, is specialist in the area of biomass conversion. Recently she published a book on "Biomass Fractionation Technologies for a Lignocellulosic Feedstock Based Biorefinery", which provides the state-of-the-art in this area by covering the most important topics related to biomass pretreatment.
'Pretreatment is an essential step in the overall process for biomass conversion to biobased products. In order to achieve an efficient utilization of biomass and to develop economical, robust, and reliable processes for a biorefinery, an effective pretreatment technology is essential', Mussatto says.

Big 3

'To be attractive, pretreatment must be cost-effective by minimizing heat, power, and chemical requirements, avoiding the degradation of sugars (since this negatively impacts the fermentation step) and generating fewer waste. Momentarily, only three methods are being used on a commercial scale: steam explosion, dilute acid and alkaline pretreatment. These methods are effective but also have disadvantages in terms of costs, as pretreatment step is the most costly step in a biomass biorefinery. Apart from the 'big 3', more than 20 other pretreatment methods have been studied with the purpose of developing technologies less energy-intensive and less dependent on the use of chemicals. One of these options is hydrothermal pretreatment, using relatively moderate temperatures and high-pressure, but without chemical agents. Other interesting method is based on the use of CO_2 under high-pressure conditions, which results in an inexpensive acid, clean and easy to recover after use by depressurization. These cleaner methods have to be scaled up in order to assess their true potential in terms of economics.'

Long term policies needed to promote biomass use

Unorthodox steps and long term policy making are needed to fully use the potential of biomass for energy and materials purposes, according Stientje van Veldhoven, MEP for the Dutch political party D66.

Van Veldhoven spoke briefly at the presentation of the Macroeconomic Outlook report at the ECO-BIO 2016-conference, which has been produced by LEI (Landbouw Economisch Instituut/Agri-economical Institute) and BE-Basic and funded by the TKI BBE. 'In Paris, at the COP 21, the groundwork has been laid. This however is only the beginning. In order to reach the ambitious targets in terms of CO_2-emissions and global warming, long term policies need to be put in place. Otherwise, these objectives won't be met.'
In the report 4 scenario's are being described, with the so-called globalhightech-scenario having the highest impact (on climate change, economy) and a regionallowtech having the lowest impact.

Lower mitigation costs

According to Hans van Meijl (LEI), one of the authors of the outlook, the first scenario would be the way to go. 'Opting for this scenario would also imply less CO_2-mitigation costs. Compared to the regionallowtech-scenario this would mean 40 per cent less (in 2030). Also, the impact on economic development in the globalhightech-scenario will be higher. In our estimation the added GDP for the Netherlands will be 1 billion euro's in 2030.'
Van Meijl stated that there are several uncertainties in the scenario-planning. 'The oil price, policy making and technology development are crucial factors. Momentarily, the oil price is hovering around the 30 dollar-mark. However, in 2030 the IEA estimates this to be around 90 dollar per barrel.'

'Natural fibers are the future'

Viscose is being manufactured on an industrial scale since the beginning of the 20th century. The feedstock for this material is cellulose from wood pulp. In the 1930's, the textile industry switched to polyester fibers. Biobased fibers, however, still have a future.

That's what Friedrich Weninger, chairman of the Man Made Fiber Institute and manager of the Lenzing Group, claimed during the Applied Biobased Materials Conference van AMIBM in Maastricht, the Netherlands (29th of April).
One of the reasons the textile industry changed to polyester was that the manufacturing process of biobased fibers was complicated and costly. Lenzing, however, stuck to the production of 'botanic' fibers and is currently world market leader with a turn over of 2 billion euro per annum. The market is growing at a double digit rate, due to strong demand from China which is making a switch from cotton to viscose as the first crops needs far more land and water, stated Weninger.

LIGNIN-FIRST APPROACH

The valorisation of lignin is crucial in making lignocellulosic biorefining economically viable. Unfortunately, in conventional processes, such as Kraft pulping, the lignin is hard to convert into intermediates and end products because of unwanted components.

Roberto Rinaldi (Imperial College) presented at Eco-Bio 2016, held in Rotterdam, parts of his research conducted in Germany and England. 'In terms of mass and energy (content) lignin is an important macromolecule. It has the reputation of being 'difficult' which isn't true. The complexity added to native lignin is due to the processing – Kraft pulping – of lignocellulosic biomass.'
The model of obtaining lignin therefore has to change, Rinaldi said. The idea is to 'mine' lignin first, not as a byproduct but as a main product. Through catalytic hydrogen transfer reactions, a new biorefining method results in the isolation of depolymerized lignin, a non-pyrolytic lignin bio-oil, in addition to pulps that are amenable to enzymatic hydrolysis. The oil doesn't contain any acid species, just fenols, is stable in storage up until two years and relatively easy to convert into other end products. According to Rinaldi, there is a downside to the process, namely the production of CO_2, which in some way needs to be mitigated.

AGENDA

MAY 24TH AND 25TH
4th World PLA Congress

PLA is one of the bioplastics with the largest market significance. Blending PLA with other bioplastics as well as mixing it with natural fibres such as flax, hemp or kenaf broadens the range of applications even more. That's why bioplastics MAGAZINE is now organizing the 4th PLA World Congress, to be held in Munich, Germany.

MAY 26TH 2016
Knowledge for Growth

FlandersBio is organizing the 12th edition of its annual life sciences convention Knowledge for Growth in Ghent, Belgium. Knowledge for Growth is Europe's leading regional biotech and life sciences convention attended by more than 1.100 participants from life sciences companies and organisations. The convention features an elaborate program with four high-level plenary talks by visionary speakers, 30+ keynote lectures from leading companies and academics, a dedicated pharma track and hands-on workshops, networking opportunities, a conference exhibition where over 90 companies present their activities and a poster area.

JUNE 1ST AND 2ND 2016
Chemspec 2016

Chemspec Europe 2016, held in Basel Switzerland, is the international exhibition for fine and specialty chemicals. For purchasers and agents looking for specific products or bespoke solutions, the event is the ideal marketplace to meet with manufacturers, suppliers and distributors of fine and specialty chemicals. Beside exhibition stands of leading manufacturers and distributors from all over the world, visitors will be able to attend a series of top-class conferences and workshops. The free conferences provide first-hand research results; numerous networking opportunities foster exchange with industry experts.

JUNE 6TH - JUNE 9TH 2016
24th Biomass Conference and Exhibition

One of the world's leading R&D-conferences, combined with an international exhibition, an international meeting point for biomass experts from research, development and from industry, with presentations dedicated to biomass, addressing the latest technologies, the policy framework, and the medium and long-term strategies and potentials. Location: Amsterdam.

NEWS

FRANCE AND THE NETHERLANDS JOIN FORCES TO DEVELOP BIOECONOMY

The leading French and Dutch public-private biobased innovation clusters have joined forces to develop a sustainable bioeconomy.

This collaboration will help both countries to benefit optimally from available resources and facilities, to help reach the agreed reduction of Green House Gasses at COP21 as well as economic growth. The Memorandum of Understanding between Toulouse White Biotechnology (TWB) and BE-Basic Foundation was signed by their presidents on Monday 7 March 2016 during the first day of the international ECO-BIO conference at the World Trade Center in Rotterdam.
Development, testing and demonstration of new biobased value chains requires resources and facilities, often larger than a single company or institution can handle. Professional partnerships, especially between public and private organisations can substantially increase the rate of development and implementation by sharing resources, costs, facilities and thereby risk. BE-Basic and TWB are such professional national-level public-private partnerships that connect each 40 to 50 companies and research institutes in The Netherlands and France respectively. Both have proven track record of boosting innovation and creating new industries in the field of biorenewables production.

Opportunity

Pierre Monsan, Founding Director of TWB: 'Joining forces with BE-Basic is a fantastic opportunity for TWB as we share the same vision of pragmatism and efficiency to promote the best level of science and training of student as well as to develop successful applications in the fields of environmental and industrial biotechnology.'
Connecting people, facilities and other resources at a larger scale generates new opportunities for technology implementation and investment. The current partnership, formalised via the MoU that has been signed, will provide a formal and ambitious basis for this. Luuk van der Wielen, President of BE-Basic says: 'Our colleagues in Toulouse and France in general have developed a high level of competence in environmental and industrial biotechnology, and have been successful to create sustainable solutions for chemicals and fuels industries. Therefore, TWB is a perfect match for BE-Basic and its partners.'

From left to right: Luuk van der Wielen, Pierre Monsan and Bram Brouwer

ECO-BIO 2016 CONFERENCE

CHALLENGES ON THREE FRONTS

The use of biomass for biofuels, chemicals and polymers production is instrumental in reaching CO_2-emission targets (COP 21, Paris 2015). It also makes sense from an economic point of view in the long term. However, there are economical, societal and technological challenges which need to be solved for a definitive break through.

Text Lucien Joppen

During the ECO-BIO-conference, which took place from March 6 to 9th in Rotterdam, this became apparent. Marcel Wubbolts, chief technology officer at DSM, stressed the importance of using biomass in reducing greenhouse gas emissions and slowing down global warming. 'Given the increase of the world population and the rise of the middle classes in emerging economies, we need to develop renewable energy, not only wind and solar, but also biomass for energy and chemicals/materials. At DSM we have developed several biobased materials which offer unique selling points in terms of functionality and environmental footprint.'

FIRM POLICIES

Products that are able to offer other functionalities, do not necessarily compete on price with fossil-based products. Unfortunately, producers of one-on-one replacements, so-called drop-in's, experience difficult times with crude oil prices hovering around the 30-40 dollar mark.
Therefore, incentives need to be put in place to level the playing field, such as carbon taxing or fiscal measures. 'Firm policies need to be put in place over a longer period of time', according to a speaker at the conference.
If not, CO_2-reduction targets will not be met, which will lead to ecological problems and substantial costs in mitigating the effects of climate change. Furthermore, it will result in a set back in reviving local economies, which are highly dependent on local biomass.

THE RISE OF ADVANCED BIOFUELS

Unfortunately, biomass was barely mentioned at the COP21 in Paris, in contrast to wind and solar. Carlos Henrique de Brito Cruz, scientific officer of FAPESP (Brazil), stressed - in accordance with Wubbolts - that all three are needed. 'The energy share of biomass worldwide is hovering around the 10 per cent mark, most of it being first generation biomass, such as sugar cane. Currently, the share of advanced - second generation - biofuels is relatively low. However, this share is expected to rise to 70 per cent of the total biomass volume for energy purposes in 2035.'
The shift towards biofuels from non-edible biomass will also impact the sustainability discussion. According to De Brito Cruz, the use of second generation biomass does not exclude discussions regarding sustainability issues, such as water and land use, land rights and so on. 'We need to develop crops which are less dependent on water and that have higher yields.'

NEW BUSINESS MODELS

Creating new value chains, redefining value. The transition towards a biobased economy requires more than just developing and marketing products, Wubbolts says. 'In essence it is about connecting the renewable (biological) cycle with the non-renewable (technological) cycle, in which renewables increasingly compensate for losses in the technological cycle.'

PRETREATMENT VITAL STEP

In the development of a value chain based on second generation biomass, fundamental research and technology development are needed to create economically viable processes. Pretreatment of this biomass is a crucial step, says Solange Mussatto, Invited Assistant Professor at the Bioprocess Engineering Group at the Delft University of Technology. 'Only three methods are in use at an industrial scale. These are effective but also energy-intensive, require the use of chemicals and are having adverse effects (for example fouling) on the output.' Milder pretreatment methods are needed. According to Mussatto, there are 20 alternative technologies which are still in the development stage.
Finally, the valorization of lignin - apart from the extraction of sugars for further fermentation processes - is a key factor. For the time being, lignin is mainly being used for energy purposes. Ultimately, optimized pretreatment steps would facilitate higher value applications such as biofuels and biochemicals. ●

SPORTS AND OUTDOOR SECTOR

MATERIAL INNOVATION POWERFUL WEAPON

The sports shoes and sportswear market is extremely competitive. Unknown players -like Under Armour- can become giants in no time at all. Besides marketing, an important weapon in the fight for market share is product and material innovation, with biobased options entering the picture more and more.

Text Lucien Joppen **Images** Patagonia, Shutterstock

The prevailing market definition of sportswear and sports footwear is wider. Analysts often include clothing and footwear for outdoor activities (sailing, surfing, etcetera) and clothing 'inspired' by sport activities. Market analyst Catalyst observes that these markets overlap each other more and more. The boundary between sportswear and leisure wear in particular is blurring increasingly, especially thanks to the growing numbers of sportswomen.

Catalyst sees a promising future for this market. 'Consumers are increasingly choosing an active lifestyle, and this is also being encouraged by their employers and other organisations,' according to the M&A update of Catalyst from 2014. 'As mentioned earlier, we also observe that the importance of female consumers is growing, which leads to market expansion (in volume and value).'

Product and material innovation is one of the things driving that value appreciation. Consumers are better informed about products and materials with improved functionality such as lower weight and better breathing fabric, and they are more receptive to them.'

LIGHTER, STRONGER, MORE SUSTAINABLE

Material innovation is a hot topic in the sector. It is not just the 'big' players which are looking for lighter, stronger, better breathing, moisture-resistant and 'more sustainable' materials; the smaller players are also interested. A brief enquiry among the large brand owners shows that they want to make their business more sustainable. That applies to the production methods (less energy, water, chemicals, etcetera) but most certainly also to their products.

'We are using more sustainable raw materials, such as biobased materials, polymers and elastomers, to an increasing extent. We then use them in combination with synthetic fibres, foam, rubber or textile,' according to a spokesperson of Adidas. 'What we're talking about is PLA, biobased polyamides, biobased thermoplastic polyurethane and materials such as viscose, Lyocell and Modal.'

These hybrid materials - a combination of recycled plastics (including polyester) and biobased components (plastics and/or textile) - are then used in the production of sports shoes and sportswear. Adidas claims that it aims at using these materials and material combinations more and more, to replace virgin fossil-fuel-based plastics. 'The aim is to reduce our environmental footprint, but this does have to be validated,' according to the spokesperson. 'If we use biomass, it must come from sustainable sources. That means things like no pesticides, a low water footprint and no competition with food consumption.'

PHASE-OUT

Adidas wants to increase its efforts in recycling, biobased materials and more efficient design (fewer (types of) materials per product). In addition, it wants to phase out certain materials and/or chemicals as much as possible, such as PVC, polyethylene chloride and phthalates (inks).

Adidas does use leather, mostly in its footwear lines. The company argues that it ensures that this leather does not come from endangered animal species. The tanning process, however, is not really 'clean'. That is why an alternative (biobased) would be welcome. At the University of Delaware, the department of Prof. Richard Wool is working on a biobased substitute; Nike and Puma, among others, have already expressed interest. It is as yet unclear whether this has already resulted in a tangible product. The two companies are unwilling or unable to answer this question.

Besides a substitute for leather - still under development - there are numerous tangible products on the market already. Thus DSM supplies Ecopaxx, a biobased polyamide, to the French manufacturer of outdoor apparel, Salomon. Salomon processes Ecopaxx in the soles of the Salomon X hiking boot line. 'We had the soles tested for two years by mountain guides, athletes and rescue teams,' according to the French company. 'We were already using it in snowboard fasteners, and were convinced that this lightweight material would also be suitable for this application.'

WINNING COMBINATION

The spokesperson of the French manufacturer said it already: lightweight. Manufacturers choose (partly) biobased materials particularly also for their material properties. Weight, and through that (the feeling of) speed, are selling points the industry can use to strike a chord with professional and amateur sportspeople. Four years ago Nike launched the GS (Green Speed) model, manufactured partly on the basis of thermoplastic polyurethane. 'The GS is the lightest and fastest football boot we have deve-

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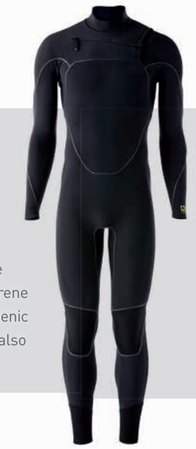
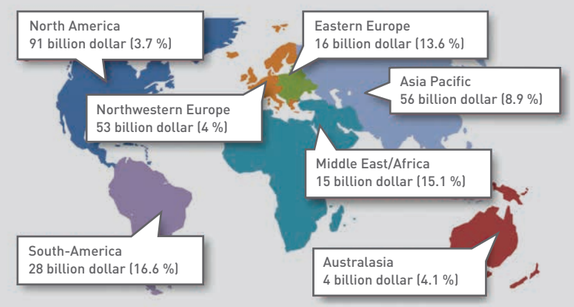
GETTING RID OF THE BADDIES

Phasing out 'baddies' and replacing them by raw materials which are cleaner because of their sourcing and processing is a major driving force in the sports and outdoor sector. Thus Patagonia will introduce a wetsuit in the autumn in which neoprene, a synthetic rubber, is replaced by Yulex, a latex-free rubber produced from a desert plant. The production of neoprene uses the vulcanisation accelerator ethylene thiourea, a carcinogenic substance. In the meantime, neoprene manufacturers are also working on cleaner and safer production methods.



GROWTH MARKET

In 2013 the total market amounted to approximately 263 billion dollars (Euromonitor, 2013), and the growth was higher (1.8 percentage points) than that of the generic clothing market, in comparison with 2012. The Euromonitor predicts a CAGR of 7.5 percent for the coming years (up to and including 2017). In terms of sales volume the most important markets are North America, Asia Pacific and Europe. South America, Asia Pacific and Eastern Europe stand out as far as growth potential is concerned. North America and Europe are the 'underperformers'.



Source: Euromonitor 2013 (estimated turn over)

PEF SHIRT

Nike introduced football shirts during the World Cup which were produced entirely from recycled PET. The next step is to add (partly) biobased components such as PEF, from which yarn can be spun on conventional machines (polyester production). The PEF fibres can also be coloured without any problems. 'The first PEF shirt is an important step in the commercialisation of PEF,' according to Tom van Aken. The Avantium CEO argues that the material is more sustainable than fossil-fuel-based materials and offers functional advantages (barrier properties).

loped thus far,' according to Andy Caine, Global Design Director at Nike. 'When you combine high-end performance with a low environmental footprint in a shoe, you have a winning combination.' For that matter, it is debatable whether Nike has found the winning combination. Headquarters was unwilling to react to our questions about the sales figures for this line. Certain models, such as the Neymar edition from 2012, are offered for sale on the Internet for 700 dollars. So it is vintage.

PUMA EVOSPEED

Apart from weight, another important functionality is moisture resistance, without loss of breathing properties. These properties are particularly important for sportswear and outdoor clothing.
Puma's evoSpeed shirt has a biobased water-repellent finish, in which the so-called dryCELL technology ensures that perspiration is diverted directly to the outside. According to Puma that not only feels better, but it also provides for a longer shirt life because the perspiration affects the textile less.
This effect - drawing the perspiration through and out of the clothing - is called moisture wicking. A biobased polyamide, Terryl (Cathay Biotech), is already available on the market. It has superior performance in the area of absorbance and wicking, according to the manufacturer. Terryl has been positioned mainly as an alternative to nylon.

'MILK SHIRT'

Another aspect related to perspiration is the odour of sportswear. Various companies are working in this area on biobased antibacterial coatings and/or materials which are intended to fight the growth of micro organisms. The German startup Qmilk has developed a 100% natural textile based on casein, a milk protein. The compostable substance has antibacterial properties, according to Qmilk. A different route is to add antibacterial properties through the finishes or coatings. In the Bio-AmiCoFitex project (Centexbel), biocides from the foods industry, including chitosan, are used in biobased coatings based on water (soya polymers, PLA). The choice for biobased or renewable polymers and biocides from the food sector is driven mainly by the factors of increasing sustainability, the environment and public health.

ROBUST SUPPLY CHAIN

It should be clear that the sports and outdoor industry is looking for more sustainable materials which have a better environmental footprint and functionality score than customary (fossil-fuel-based) materials, or at least similar. Unfortunately, this cannot be quantified, so the percentage of renewable raw materials which is used in the sector - biobased and/or recycled - is not known.
For these materials to break through properly, some hurdles still need to be overcome. 'Developing and sourcing biobased polymers and yarns which have similar or even better properties than fossil-fuel-based materials is no sinecure,' according to the spokesperson of Adidas. 'If the materials are already on the market, it is a matter of building a robust supply chain, so that a sufficient supply of a stable, homogenous quality is ensured.'

NO IRRESPONSIBLE USE

Another issue to which Adidas attaches value, and the sector too in a general sense, is the provenance of the biomass. As the German multinational pointed out earlier, the biomass must originate from sustainable sources: a low environmental and water footprint, no competition with food crops or threat to vulnerable ecosystems. Adidas is certainly not the only player to emphasise this. Various designers and clothing producers such as Stella McCartney, H&M and Patagonia, have sided together behind the Fashion Loved by Forest initiative. This campaign warns about the irresponsible use of raw materials from forestry.
Second generation biomass is therefore preferred, but it must come from demonstrably sustainable sources. 'We encourage the use of residual flows from the agricultural and/or food industry,' according to Adidas. 'We are also extremely interested in third generation biomass, for example based on algae or waste gases.' ●

COMPETITION ON PRICE NO PROBLEM

SYNGIP: ISOBUTENE FROM SYNGAS

It is roughly a matter of two to three years when bacteria will be able to convert syngas into the valuable chemical isobutene on an industrial scale. Syngip, established in 2014, has developed a particular strain that is able to do the job. More work, however, is needed to optimize its output.

Text Lucien Joppen **Image** Syngip

Syngip is the brainchild of Bernhard Guentner and a continuation of Guentner's PhD-thesis at the Fraunhofer Institute in Germany. 'The idea was to find artificial, metabolic pathways for carboxydotrophic bacteria to manufacture certain chemicals from waste gases, such as isoprene or isobutene. In nature these bacteria do not perform these tasks. They have to be genetically engineered or 'trained' to produce these chemicals, preferably in the most efficient way.' By incorporating genetic material from other organisms such as enzymes from yeasts, Syngip is able to produce and further optimize these strains. For now, the company has identified isobutene, isoprene, butadiene and propylene as targets. 'The latter three are in the early development stage, while isobutene is in a more advanced stage, with titers which are approaching industry standards.'

LARGE MARKET

These titers should be higher than 100 grams pure product per liter reactor volume, Guentner says. Syngip is getting there with isobutene, but more work in the lab is needed to perfect the specific strain. Also, the process needs to be scaled up. 'Bacterial fermentation of syngas (CO and/or CO_2, H_2) is already taking place on an industrial scale (by Lanzatech, ethanol). Having said that, we need to experience in a 10 to 100-litre pilot setting if the process works. Momentarily, we are cooperating with a Belgian and a Swiss company and investigating the possibility of setting up a pilot plant together.'

Guentner, born and raised in Germany, opened office on Chemelot Campus in 2015. Why his move to the Netherlands? 'I am living in the Netherlands, in Vaals, just on the border. When I was looking for office/labspace, Chemelot Campus is the nearest and the best option because of the technical, legal and support infrastructure. Furthermore, it is easier and more attractive, compared to my home country, to start up a business in the Netherlands.' On the photo, one of Guentners colleagues

Ethanol fermentation from syngas is a trick the industry has already mastered, Guentner says. The production of isobutene would be more profitable, given the price level and the sheer market volume. 'It's a global market of around 30 billion dollars annually. Isobutene is being used in various products, such as an intermediate in the production of various products, such as rubber or MTBE (methyl tert-butyl ether), a fuel additive which raises the octane level (to prevent engine knocking, red.).'

NO PROBLEM

In order to compete with petroleum-based isobutene, the syngas-based isobutene needs to be price-competitive. 'Even with record-low price levels even under 30 dollars per barrel crude oil, this won't be problematic', Guentner says. 'However, we don't know what the situation will be in two to three years. I expect that the oil price will fluctuate between 30 to 50 dollars per barrel. The price level of our isobutene will be roughly 100 euro per tonne (roughly ten times cheaper than fossil-based isobutene, ed.). Admittedly, this is a rough guess as the optimisation of the strain is still an ongoing process and upscaling needs to take place. There will be definitely a price advantage in terms of feedstock costs as ours are negative. These are gases which we need to get rid of. Furthermore, the production process will be cost-friendly as the end product is gaseous, which means that it is relatively easy to purify, compared to liquid solutions. All in all, we have a technology nobody in the industry has. Everybody can ferment ethanol, but we are - as far as I know - the only company to ferment isobutene from syngas.' ●

This article was created in collaboration with Source B.

ALTERNATIVE FOR PE-FILMS

STORA ENSO LAUNCHES MULCH PAPER

Mulch films have been around for decades. For the last ten to fifteen years, the primary sector is increasingly making use of this practice because of its positive effects. However, there are also negative costs and detrimental environmental effects as the fossil-based plastic has to be removed. Biodegradable, pulp based materials could prove to be a worthy alternative. This year, Stora Enso will launch its biodegradable mulch paper on the market.

Text Lucien Joppen **Images** Stora Enso

At the moment, plastic mulch films, mostly made from PE, are used increasingly in vegetable, berry and fruit production. Mulches prevent weed growth (and thus limit the use of pesticides), soil erosion and control the temperature and moisture of the soil.
Due to its beneficial functionalities in agri- and horticulture, sales of plastic mulch films have been increasing (see graphic). Most of this material has to be collected before the harvest. Because of soil contaminated plastic mulch, recycling or burning for energy purposes is not an option. Landfilling therefore remains. Not the best solution in terms of the environment, but still better than ploughing the plastic into the soil, a practice by which some farmers aim to save money. Ultimately, these practices reduce soil fertility and endanger local wild life.

LOW MARKET SHARE

In most EU-countries, collecting and disposing of plastic mulch film is a labour-intensive and expensive task. Therefore, a biodegradable mulch would not only offer environmental, but also economic benefits.

A BRIEF HISTORY OF MULCHING

Use of reel paper for mulching started in early 30´s. The use remained limited and practically died down as low cost plastic mulches became available for the farmers in late 50´s. The use of these materials remained quite low for decades until rapid growth of use started in 80´s. During 2000-2007, annual world demand of plastic mulch films increased from 0,54 million tons to 1.4 million tons. Most of the mulch films are used in Asia (70 per cent), followed by Europe (13 per cent). Each year, roughly 80.000 km^2 of agricultural lands are covered with plastic mulch films. If this area would be covered by paper mulch, this would require 4,8 to 8,0 million tonnes each year, comparable with the total paper and board production in Finland.

For the time being, however, the market share of biodegradable products is relatively low, estimated to be lower than 10 per cent of the total volume. This is partly due to the higher price level, 2 to 3 times more expensive, but also partly because these have been mainly developed for small scale, say hobby farming in which these products have to be applied manually.
Stora Enso - on the other hand - has developed a mulch paper which can applied mechanically and is therefore suitable for commercial farming purposes, according to the company.

HURDLES

Carl-Mikael Tåg, Team leader Product Development at Stora Enso: 'We wanted to develop a product not only for a niche market, but for a large market. This meant we had to overcome several hurdles in order to make our mulch paper work in daily farming practices. One issue is the strength and the elasticity of the mulch paper. Most machinery in agriculture has been developed to lay down PE on the soil. Therefore, the settings of the machinery needed to be adjusted in order to avoid ripping of the paper. Last but not least, the preparation of the soil, ploughing in order to make the top surface soft, makes a huge difference.'
According to Tåg, the material is fully biodegradable and based on mechanically refined virgin wood fiber. The coating consists mainly of natural source pigments which are enriching the soil, and a water based dispersion as binder to protect the paper.

BALANCING ACT

Apart from the stability of the mulch paper, the biodegradability proved to be a huge challenge. Quite understandably, as the stability has to be maintained to a certain level, after which the breaking down process should start. 'It is a tough balancing act', Tåg says. 'We have managed to develop our mulch paper which breaks down between 4 to 12 weeks. The key to this transitory process is the fibre mixture while a slow biodegradation is achieved with papers made from mechanical pulp fibres (GW, PGW, TMP) or chemimechanical pulp fibres (CTMP).'
With surface treatment it is also possible to steer the breaking down process. 'Apart from the product variable, there are natural variables, such as heat, moisture, acidity of the soil, which determine the stability and the biodegradability of mulch paper', Tåg adds. 'We have tested various compositions of the mulch paper across Europe, for example in Spain and in Finland, as we wanted to develop a product which is suitable for different climate conditions and/or crops.'

POSITIVE RESPONSE

In the spring this year, Stora Enso will roll out its mulch paper in Europe, further tests will be held in Asia, the biggest market for this type of product. Tåg is optimistic about the market response. 'Farmers in general are very interested and willing to adapt their farming practices to suit our product. Yes, our product has a price premium, but we also have investigated the bandwidth we have, compared to PE. In certain markets, for example in Finland, the costs of removal and disposal are relatively high. By saving on these expenses, our mulch paper offers significant cost advantages.' ●

'IT IS A TOUGH BALANCING ACT. WE HAVE MANAGED TO DEVELOP OUR MULCH PAPER WHICH BREAKS DOWN BETWEEN 4 TO 12 WEEKS.'

Peter Janssen grows zucchini and pumpkins on his 50 hectare farm in the province of Limburg in the Netherlands. Janssen previously used PE-foil to protect his zucchini against weed and to keep the plants warm. 'In the meantime I have switched to PLA-foil, mainly because of reduced costs after usage. Why did I participate in the test with mulch paper? Because I want to be ahead of the competition. The idea of paper appeals to me, as it sounds more environmental-friendly than foil. Mulch paper roughly has the same performance on the field than PLA. The only aspects that needed improvement, was the mechanically laying of the material and the decomposition time. From what I understand, these parameters have been improved by the manufacturer.'

GRONINGEN-DRENTHE CLUSTERS GREENING CHEMICAL SECTOR

The provinces of Groningen and Drenthe want to provide more practical assistance to the development of the biobased economy. An extra stimulus for this endeavour is the European Commission's designation of the above area as a model region for greening the chemical sector and making it more sustainable.

Text Aribert Guiking

The two provinces have a great deal to offer when it comes to 'greening' chemical production. This is not just the umpteenth promotional slogan for the northern provinces, but a recommendation by the European Commission which designated Groningen-Drenthe last January as one of the six model regions in Europe. That positive assessment does not directly entail funding from Brussels to the north, but it does ensure a high profile and it is a stimulus for showing the existing chemical sector that there are opportunities for making the sector future-proof; opportunities also identified by external parties.

GETTING THE STAKEHOLDERS TOGETHER

Errit Bekkering, business development manager at Greenlincs, points out the chemical cluster in Delfzijl and the polymer, biopolymer and natural fibre cluster around Emmen, as well as the many agrifood players in the provinces of Groningen and Drenthe. 'Potato and sugar beet are available in abundance here, as well as the corresponding processing companies and their suppliers.' Greenlincs is a cluster organisation comprised of the above provinces and the Northern Development Association (NOM). Greenlincs was formed to bring businesses, knowledge institutes and governments together and act as a facilitator. For example, it can bring parties together and assist in defining projects and cooperation. Government subsidies sometimes play a part in this.

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> BOTH PROVINCIES HAVE GREAT POTENTIAL IN 'GREENING' CHEMICAL PRODUCTION

Bekkering believes that it is important to maintain a certain focus and he mentions four key areas: the sugar beet and potato industry mentioned above, various chemical activities around Delfzijl, the development of biopolymers and composites around Emmen and lastly, the 'protein store' in Friesland. The last point does not come directly under 'greening the chemical sector and making it more sustainable' mentioned above, but it does fit in the wider context of the biobased economy in the northern provinces. (Also see the Reactions of Provincial Executive members box.)

FOUR KEY AREAS

The four key areas are the elaboration of the Noord4Bio report which was published mid-2015. It examined the opportunities for the biobased economy in Northern Netherlands and concluded that those opportunities do exist. The presence of sea ports, the existing chemical and plastics companies and the presence of raw materials from crop production and livestock farming form the basis for this. The University of Groningen, Hanze University of Applied Sciences, Van Hall Larenstein University of Applied Sciences and Stenden University of Applied Sciences are knowledge institutes which can play a part in this specific greening endeavour. They have joined forces under the name Bio-Economy Region Northern Netherlands (BERNN). Besides this Dutch region, the report also refers to the cross-border character which is essential to greening, and names the German border region Weser Ems explicitly in this context.

BUSINESS COMMUNITY HAS THE DRIVE

Greenlincs wants to get the various parties together to assist them in capitalising on the opportunities mentioned above. Linking up with existing developments can be helpful in this context. For instance, AkzoNobel has a large factory in Delfzijl and the company wants to present itself (internationally) as a model of sustainable business practice. This drive from an individual company and the idea of greening the chemical sector in the region link up together wonderfully, according to Bekkering. He also refers to large cooperatives such as Cosun and Avebe which focus on sugar and starch respectively. The two feedstocks can be used for food applications but also for biobased products. SME businesses are also hard at work in their own markets, creating a position for themselves in the biobased economy. This is nice, but Bekkering still sees a gap between plans, implementation and subsequent commercial success. He believes that the planning process is an important step, because businesses will play it safe when it comes to substantial investments. 'That is why it can take a little while before the first spadeful of earth is turned.' ●

This article was created in collaboration with Greenlincs.

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Source: Greenlincs

Patrick Brouns and **Henk Brink** are Provincial Executive members of Groningen and Drenthe respectively and they both have economy in their portfolios. Together they want to share some information about their policies, their plans and the possibilities in the northern provinces for taking action with developments towards a bio-based economy, whereby the chemical sector forms the starting point.

What is the significance of the designation as a model region for greening the chemical sector and making it more sustainable?

Henk Brink
'It means that as provinces we are on the right track and it also honours the efforts made in this area. For that matter, not just through our own actions. It is a combined action between the governments, knowledge institutes and last but not least, the business community. This does not mean that we have a chieved our goal. Greening the chemical sector is a long-term process and requires continual attention. A long-term view and corresponding policy on the biobased economy level are therefore also required.'

To what extent does the interprovincial cooperation play a part in raising the biobased economy in Northern Netherlands to a higher level?

Patrick Brouns
'The biobased economy is not bound to one single sector. Agriculture, the chemical sector and the manufacturing industry all play a part in this. Provincial boundaries are furthermore only artificial and the business community looks over the borders literally and figuratively. Cross-border cooperation is therefore pure necessity. Our provinces will jointly have to create the right investment climate in which the regional biobased activities can flourish.'

To what extent will or can Friesland participate?

Brink and Brouns
'There are joint processes on the biobased economy level which involve all three provinces, such as the northern cluster organisation Greenlincs. But direct participation of Friesland in the 'model regions' process is less self-evident, because the starting point is the greening of the chemical sector. In both Drenthe and Groningen there is a substantial chemical cluster, which is not present in Friesland.'

FOUR PILOT PLANTS UNDER ONE ROOF

The brand-new Multipurpose Pilot Plant (MPP) at Brightlands Chemelot Campus will open its doors at the start of this year. The unique thing about the MPP is that it is not the only pilot facility. Separate pilot plants of Sappi, Avantium and Technoforce are also housed under the same roof.

Text Lucien Joppen **Images** Brightlands Chemelot Campus, Flowid, Technoforce

Artist impression of the MPP

The idea to combine these facilities and put them together in one building is actually a no-brainer,' according to Bart van As, business development manager Biobased at Brightlands Chemelot Campus. 'The parties - the above companies and the operator of the MPP (Chemelot Research Facilities, eds.) - do not have to invest as much because they share the costs of infrastructure, pipelines and cables, exhaust systems etcetera. If each of these parties had to build their own pilot plant themselves, the costs would end up considerably higher.'

'WE HAVE A UNIQUE PROPOSITION WITH MPP.'

The InSciTe programme (also see Agro & Chemie number 4, 2015) will take up two thirds of the capacity in the MPP. The remaining space is available for businesses which want to take the step from proof of principle to pilot production and/or which want to generate sufficient product for performing further tests.

CLASSIC CHEMISTRY

The MPP concentrates on scaling up biobased chemicals, but it is geared towards classic chemistry, emphasises Van As. 'We have a unique proposition with the MPP. The pilot plants in Ghent and Delft are oriented more towards pretreatment and fermentation. We do not deal with fibres, but with catalytic-chemical and thermochemical conversions. The volumes involved vary from 50 to 500 kg per day.'

The 500 m2 of the MPP contain four so-called skids, systems which can be moved in their entirety to another location. Companies can reserve these skids for specific time blocks. 'These are usually periods of at least two and no more than six weeks, but we are quite flexible about this,' according to Van As.

The four skids have been set up for specific processes. Thus Flowid has a scaled-up version of its spinning disc reactor, renamed Spinpro, in the MPP. The company uses the setup for its own R&D, but it also makes it available to third parties. Flowid also participates in the InSciTe programme.

From left to right: Jeoffrey van den Berg with a predecessor of the SpinPro Reactor, the old pilot plant of Technoforce and the production site of Sappi in Maastricht.

GREATER THROUGHPUT

Jeoffrey van den Berg, director of Flowid, has high expectations of the Spinpro reactor. 'We can achieve considerably higher throughput - approximately 1 litre per second - than with its predecessor. This allows us to generate sufficient output in a short time which other companies can then use for testing.'

Van den Berg was asked whether Flowid would also cooperate with the other companies in the pilot plant. He responded: 'Currently there is nothing on paper, but I can imagine that our activities and Technoforce's knowledge of downstream processing can tie in with each other.'

The latter company produces physical separation equipment, including distillation, drying and crystallisation equipment, for various industries such as (fine) chemicals, biobased pharmaceutical and foods. The Indian corporation had a pilot plant at Chemelot for 3.5 years, but over time it outgrew its accommodation. Now the staff have room to manoeuvre again in the MPP. In addition, the company has purchased brand-new equipment.

WIDER SPECTRUM

Ben Bovendeerd, director Technology & Business at Technoforce, considers himself lucky that he registered in time for a place in the MPP. 'We were also given the opportunity to design the layout of our space as we saw fit. We can also offer a wider spectrum of physical separation techniques. We have added two 'plug flow' crystallisers (at laboratory and pilot plant scale), a conical stripper and an annular centrifugal extractor to the current equipment.'

Bovendeerd sees an important role in store for physical separation techniques, for example to purify biomass flows as much as possible. 'Biomass contains water and all kinds of contaminating components which have to be removed to make the next step possible. In the end the intended component must have a purity level of 99+ percent.'

HIGH-QUALITY NANOCELLULOSE

Paper manufacturer Sappi is building a pilot plant at the Brightlands Chemelot Campus for scaling up a new, energy-saving process to produce high-quality nanocellulose.

R&D director Math Jennekens: 'This will enable us to reduce the energy consumption substantially. That is what we are going to investigate in the pilot plant. Everything is possible in the laboratory, I always say, but if you want to scale up, you have to consider CAPEX and OPEX. And then it's the question of whether we will achieve the intended energy savings and whether we can recover the process chemicals fully. Also not insignificant: will we get sufficient nanocellulose in the desired quality from the pipeline and is the drying process efficient? The plus point of Brightlands Chemelot Campus in a general sense and the shared pilot plant facility more specifically is that there are enough experts in (pilot) processing who can support us. With advanced analysis equipment, our own or that of third parties on site, we can examine the process in greater depth for better troubleshooting.' ●

This article was created in collaboration with Source B.

BBI OPENS THIRD CALL

The Bio-Based Industries (BBI) Joint Undertaking (JU) recently publicized its third call, with room for three flagships in the realm of valorisation of sidestreams from the food industry and the development of new plastics or chemical building blocks.

Text Lucien Joppen **Images** Shutterstock, BIC

The food industry in general is interested in 'doing more' with sidestreams of food production. In terms of volume, the potential is there. Around 100 Mt of food waste and residues are generated every year in the EU.

Dirk Carrez: 'Sustainability is key, especially in Europe and the US. Therefore, crops that do not compete with food - also in terms of land use - come into play.'

With the BBI-program entering its third year, the momentum is clearly visible, according to Dirk Carrez, executive director of the Biobased Industries Consortium, a conglomerate of roughly 70 companies and 150 research institutions. BIC together with the EU are funding the BBI JU: up until 2020 1 billion euro will be funded by the EC to which the industry will add 2.7 billion euro. The partnership mobilizes investment in innovative facilities and processes that manufacture high-quality biobased products as well as in biorefining research and demonstration projects.

This money will be invested in five value chains: the route from lignocellulosic feedstock to advanced biofuels, biobased chemicals and biomaterials, next generation forest-based value chains, next generation agro-based value chains, new value chains from (organic) waste and integrated energy, pulp and chemicals biorefineries.

NEW VALUE CHAINS

According to Carrez, the real added value of BBI is bringing different sectors and industries together. 'This leads to the creation of new value chains, with different partners working together within a single project. With this 2016 Call, new areas were introduced such as research topics using algae and other aquatic biomass, demo projects focusing on industrial crop varieties and novel sources of biomass such as municipal solid waste or flagship actions addressing waste-streams and by-products from the food processing industry.'

SUSTAINABLE FEEDSTOCK

From the first two calls various projects have been set into the motion, once they had been approved by the BBI-board. Some examples are First2run and Provides. The first project, headed by Novamont, is directed at next generation agro-value chains. Carrez: 'The industry is interested in biomass as a feedstock but sustainability is key, especially in Europe and the US. Therefore, crops that do not compete with food - also in terms of land use - come into play. In this project, the technological, economic and environmental sustainability at an industrial scale of the processing of underutilized oil crops (i.e. cardoon) is investigated. These crops contain bio-monomers and esters that will be further transformed into bioproducts, such as biolubricants, cosmetics and bioplastics.'

Provides is aimed at forestry-value chains, to be more precise to develop deep eutectic solvents that are able to separate lignin, hemicellulose and cellulose under mild conditions. The advantages: less chemicals, lower processing costs and a better quality end product.

SIDESTREAMS FROM THE FOOD INDUSTRY

For the third call the emphasis - in terms of flagship projects - is on new chemical building blocks or plastics and sidestreams from the foodindustry. Carrez: 'This call has just opened, so it is too early to disclose anything about the proposals as many have yet to come in. What I can say is that the food industry in general has expressed great interest in this subject, which doesn't surprise me. It is a mature sector that handles vast amounts of biomass, both edible and non-edible.'

Around 100 Mt of food waste and residues from food processing industry are generated every year in the EU, of which around 38 per cent at the processing stage. These plant- or animal-based waste streams or by-products are currently either unusable or underused. Hence the economical and ecological to explore higher valorisations of these sidestreams at an industrial scale.

SME'S ON TOP

Carrez states that the BBI JU, three years after the start, has gained momentum in the EU. 'The BIC had 30 members in 2013, at the moment more than 200 public and private partners have joined the initiative. In terms of company participation, SME's have the upper hand. As an example, the share of SMEs in the total number of participants in proposals retained for funding is 37 per cent. These enterprises are mostly directed at technology development or the development of new, innovative products.'

There is also more interest from biobased (regional) clusters throughout Europe. In the beginning, the clusters in Northwest-Europe, the UK, Belgium, France, Germany, the Netherlands, were more involved. 'Now we see that biobased clusters in other parts of Europe are getting on board. Finally, other industry sectors, see the aforementioned food production industry, have become interested in the possibilities the bioeconomy has to offer.' ●

‘WHAT EXACTLY ARE WE WAITING FOR?’

‘A LOT PASSES THROUGH OUR HANDS AND THAT’S A GOOD THING TOO, BECAUSE YOU DON’T JUST FIND SOMETHING OVERNIGHT ABOUT WHICH YOU THINK: “THAT WORKS WELL ENOUGH, LET’S POLISH UP THAT ONE.”’

As New Biobased Building Blocks group leader at Maastricht University, Stefaan de Wildeman is involved in projects of InSciTe as well as AMIBM, which seem to be leading quickly to promising building blocks. According to the endowed professor, businesses are needed which dare to invest their heart and soul to actually develop those building blocks further into applications and products.

Text Richard Bezemer **Images** Jonathan Vos

Stefaan de Wildeman (41) is aware more than anybody of the disastrous environmental impact of the current generation of fossil fuel-based plastics and is truly concerned by this. This urgency to effect a reversal, also on a public level, is one of the reasons he switched more than two years ago from the business sector to science, from DSM to Maastricht University. A funny coincidence is that his New Biobased Building Blocks group at the Brightlands Chemelot Campus is located at exactly the same place where he did his work as Senior Scientist Biobased Building Blocks for DSM.

How do you experience your first years as a researcher after working eleven years for a multinational?

‘Life here is freer; no corporate structures surrounding you. I come in in the morning with an idea and by the evening that idea can already be starting to walk, so to speak. Currently I have a team of five people: three PhDs and two technicians. Every two weeks we manage to arrive at the first grams of a new building block and we can immediately attempt to make polymer materials with those new building blocks. A lot passes through our hands and that’s a good thing too, because you don’t just find something overnight about which you think: “That works well enough, let’s polish up that one.”’

What building blocks are you aiming at?

‘In the two years of our existence, the project we have worked the longest on is a collaboration with Cosun. We want to make new polymers with sugar derivatives. I can’t say precisely which ones they are, because we are still in the process of covering the IP. A second PhD candidate has been working for six months on a Horizon 2020 project, Robox, which involves making new building blocks with biocatalysis, in order to make polymer materials from them. The third PhD candidate, who has just started, is working on the first InSciTe project and concentrating on C5 and C6 sugars. Two more PhD positions have been promised, one for another InSciTe project, this time involving lignin, and the other one for an AMIBM project.’

Chemelot InSciTe, AMIBM: the ecosystem for stimulating biobased research is starting to prove fruitful?

‘That is certainly the case, although I would have liked to start the projects much earlier. But in the six months we have been at work in InSciTe, I can already see the advantages of this combination of expertise from the business sector and knowledge institutes. There are manifest advantages for both sides. In this case, DSM is able to provide guidance in all kinds of academic investigations, and to do some scouting. And the universities (Maastricht University and Eindhoven University of Technology, eds.) get first-hand verification: what is relevant for later industrialisation and what is not relevant? In that capacity InSciTe functions as a valorisation centre as well. There are a number of projects in which you know almost certainly that you will end up with applications. If you work in that direction, you can also drag along the more fundamental work in that positive spirit. InSciTe focuses on high pressure, high temperature reactions and it has a lovely pilot facility at the Brightlands Chemelot Campus which will shortly be put into use. It is wonderful that you can, or actually have to, make a direct connection from the laboratory where you make the first grams to the way we are going to manage to do it in a pilot plant. You don’t sit in a laboratory doing something you know in advance you can never scale up; that is what is forbidden in InSciTe!’

‘It is very easy to say, for example, that the fossil-fuel realm of the plastics will never change, that there is only room for drop-ins and it will go no further than that. I refuse to accept that, not only because it is necessary, but also because I believe in it.’

Do you have the same experience with AMIBM?

‘AMIBM (Aachen Maastricht Institute for Biobased Materials, eds.) has a slightly lighter and broader feel about it. It is more a varied collection of professors who approach the matter from their different institutes, with at the front of the chain people who know everything about cloning genes in plants for instance. But they have little idea what applications will look like with the partners at the end of the chain, from textile fibres to plastics for heart valves. With our biochemical and chemical knowledge and colleagues who have enormous knowledge about the chemistry and physics of polymers, we sit in between them and can build a bridge between the front and the end of the chain. The great thing about our work in this construction is that the building blocks necessary for this are more or less hidden in chemical trees, the synthetic connections which can be made between all those molecules. In that tree-thinking - which is really my thing - you unravel what comes from where, what we could still make and what that could be used for. What kind of function could that building block suddenly have in a fibre or another end product?’

Hidden, so those new building blocks already exist?

‘In my inaugural lecture I already claimed that, and I still stand behind that statement. We do not really need inventions to get biobased going. There is an awful lot all around us, more than a century of chemistry. Have a good look around you, select the right things, make a useful combination of them, let chemistry loose on them and make materials from them. Avantium is >a

COLUMN

BIO-BASED ECONOMY, NO PLACE FOR IP BATTLES

In my previous post I called for an equal playing field for bio-based players vis-a-vis fossil-based incumbents. In short: (i) stop subsidizing fossil-based fuels and chemicals and (ii) put a price on carbon. Essentially, two of the most important conditions that our emerging biobased industry needs to move from niche to mainstream.

What we certainly don't need, is biobased players fighting each other over IP. At this moment in time where oil dropped below $30/barrel, we need all of our energy to develop meaningful products with customer benefits that go beyond green. We need to demonstrate together with our customers and partners that biobased products are meaningful innovations and that our renewable value chains will reduce overall system costs even in a "$30/barrel world".

In that environment, it is important to team up. Team up with biomass suppliers, biopolymer companies, compounders and brand owners. Co-develop but also co-commercialize. Changing value chains from fossil-based to biobased is a tremendous effort and requires multiple competencies that no company has all in-house.

But this goes further than collaboration through the value chain. This is also about working with industry peers. For our industry to thrive, multiple strong players are needed. Customers don't want to find themselves depending on one or two (emerging) companies. They want to have security of supply and always want to have a choice.

It is in this spirit of working towards a common goal that Reverdia signed a deal with BioAmber. Both companies are active in bio-succinic acid. Both companies use a yeast-based fermentation manufacturing technology. And yet Reverdia agreed to provide a non-assert agreement to BioAmber on certain intellectual property conditions of Reverdia's Biosuccinium™ technology.

On top of that, the non-assert agreement provides comfort to both BioAmber and Reverdia to continue the implementation of their respective businesses using their own unique, proprietary yeast-based technologies.

I am firm believer in Open Innovation. In my time at DSM I have practiced this approach in many different ways. At Reverdia, we launched our licensing strategy in October 2014 to complement sales of Biosuccinium™ from our plant in Cassano. At Reverdia, we will continue practicing open innovation throughout the value chain because we believe the bio-based economy needs collaborators. Not companies that hold each other hostage over IP.

Marcel Lubben
Reverdia

good example of this. The literature already described furandicarboxylic acid 115 years ago. Then it stayed quiet for 107 years, until one morning CEO Tom van Aken and his team said: "This has potential, let's have a go at making a product with it." That decision in itself gets that dynamic going that you need to make it a success.'

Plenty of ideas, not enough businesses?

'Exactly: our culture does not have enough of the pragmatism of the Chinese and the daring of the Americans. We still prefer to play it safe in large businesses or big institutes. It is very easy to say, for example, that the fossil-fuel realm of the plastics will never change, that there is only room for drop-ins and it will go no further than that. I refuse to accept that, not only because it is necessary, but also because I believe in it.'

Does that also apply to the research you are currently involved in?

'The projects in InSciTe as well as AMIBM have huge potential. The same applies to the research we are doing with Cosun. But if you wait a whole PhD cycle - say four or five years - for something to happen with a building block, then often the following question arises: "What exactly are we waiting for?"' ●

STEFAAN DE WILDEMAN

2013 – to date Group leader New Biobased Building Blocks at Maastricht University
2010 – 2013 Senior Scientist Biobased Building Blocks at DSM
2002 – 2009 (Associate) Scientist Biocatalysis at DSM
1998 – 2002 Doctoral research at Ghent University and Jena: discovery of a new dehalorespiratory bacterium, and upscaling for groundwater purification
1993 – 1998 Master in Applied Biological Sciences at Catholic University of Leuven

WILLEM-ALEXANDER AND MAXIMA VISIT BIOBASED DELTA

‘ON THE BOTTOM LINE, IT IS ABOUT EMPLOYMENT’

The visit of King Willem-Alexander and Queen Maxima to the Western region of the province of Noord-Brabant felt very much like King’s Day. There was indeed a very good atmosphere on 16 February. There were flags waving, music ringing out and the orange sun was shining. But the visit also had a serious side. The Royal couple gathered information about the economic resilience of a region under stress and discussed matters with the stakeholders in Biobased Delta.

Text Edwin van Gastel **Image** Erik van der Burgt

‘West Brabant is having a hard time of it,’ according to Willem Sederel, chairman of Biobased Delta. ‘Just take the impact of the mass lay-off at Philip Morris. And there are more businesses experiencing hard times. I believe firmly in the manufacturing industry. But we must have fundamental renewal in order to guarantee our prosperity and welfare for the future. Innovation and the transition to a new economic foundation are highly important. That is what we stand for with Biobased Delta.’

DEPTH

Sederel got together with Bert Pauli, member of the Brabant Provincial Executive for Economy, Petra Koenders from the Avans University of Applied Sciences, Leon Joore from Millvision, Albert Markusse from Suiker Unie and Marc Jamin from SABIC for a good discussion with the Royal couple. Everyone was pleasantly surprised; it was not just a perfunctory exercise.

‘At this level you can quickly end up talking about general issues such as sustainability and the energy transition,’ according to Sederel. ‘But now we talked for more than twenty minutes about a very specific theme: the biobased economy. The King and Queen had been very well informed and they asked the right questions. We were really able to discuss matters in-depth and demonstrate how we are involved as government, business sector, knowledge institutes and education and show the developments we strive for. We showed how we contribute to strengthening the economy and the choices we make in doing so. We discussed our supraregional agenda for the long term, our focus on research into new applications for sugar molecules, our regional agenda in which clusters of SME businesses are able to commercialise research quickly, chances, threats, successes and challenges.’

PERSEVERANCE

Albert Markusse, CEO of Suiker Unie, looks back on the discussion with considerable pleasure. ‘We were able to present ourselves very well as a network organisation, as a collective which makes a huge combined effort to provide added value on the cutting edge of agribusiness and the chemical sector. We clarified the opportunities, but were also able to show where we stand after a decade of cooperation, and why developments sometimes proceed more slowly than anticipated. Research and technological innovation always take a lot of time, definitely if you want to do something really new. Besides, it is the large and small businesses which ultimately have to fulfil this, with new, successful products. Unfortunately they have had a considerable crisis to deal with in the past few years. Now that is behind us, but the low oil prices are throwing a spanner in the works. It is a matter of perseverance, but that there is a wonderful future for biobased is a certainty. At Cosun and Suiker Unie we are making great efforts in that direction, by establishing specific partnerships and targeting extra production of sugars and semi-finished products as raw material for new products. We are also concentrating on research into increasing the value of residual products and by-products in new applications. That is why we are investing heavily in a new Cosun innovation centre and pilot plant at Nieuw Prinsenland.’

> ‘WE MUST HAVE FUNDAMENTAL RENEWAL IN ORDER TO GUARANTEE OUR PROSPERITY AND WELFARE FOR THE FUTURE.’

POWER

Leon Joore, director of Millvision, an SME company which develops recipes and prototypes based on natural fibre technology for paper, board and composites, is close to the market. ‘For us it’s about pressing ahead and being active. We have enjoyed increasing success in this, for example with our piles made from mown grass which are used for waterway bank reinforcement. What is better than a practical application to bring a theme like biobased to life? That is why I arranged a few products on the table for the Royal couple, such as a 100% biobased plant pot. The plant pot is made from fibres from capsicum and tomato stalks which are cultivated locally and from plastic from starch produced by Rodenburg Polymers in Oosterhout and Bato Plastics in Zevenbergen. The pot goes into the ground with plant and all. It is fully decomposable and is used by plant grower Boot & Co Nurseries in Zundert. This makes it completely local-for-local. It demonstrates our innovative power and the value we add. On the bottom line, biobased investment is the way to employment.’

SEAWEED

Before King Willem-Alexander and Queen Maxima started the discussions with the delegation from Biobased Delta, they were introduced to several primary schoolchildren who showed how plastic can be made from potatoes. Avans art student Eva Leenen also displayed her interactive sensory wall which is made from two kinds of seaweed. Its frame, made of polylactic acid based on potato starch, becomes visible when visitors touch the seaweed.

‘These kinds of examples bring biobased to life, also for the Royal couple,’ says Petra Koenders, director of the Centre of Expertise Biobased Economy, a joint venture between Avans University of Applied Sciences and HZ University of Applied Sciences. ‘It is extremely important to inspire each other, transfer knowledge, look beyond boundaries and cooperate with each other. And with these kinds of transition processes you are also talking by definition about the education of a new generation. That is a challenge which Avans is taking up with specific education and practice-oriented research, but also with the development of learning material packages for primary schools and the stimulation of exciting cross-overs with non-technical courses. Our approach is very broad, we work on this all together. We have a lot of energy and belief in the future. And we were able to make that absolutely clear to King Willem-Alexander and Queen Maxima.’ ●

This article was created in collaboration with Biobased Delta.

BIOBASED STUDIO

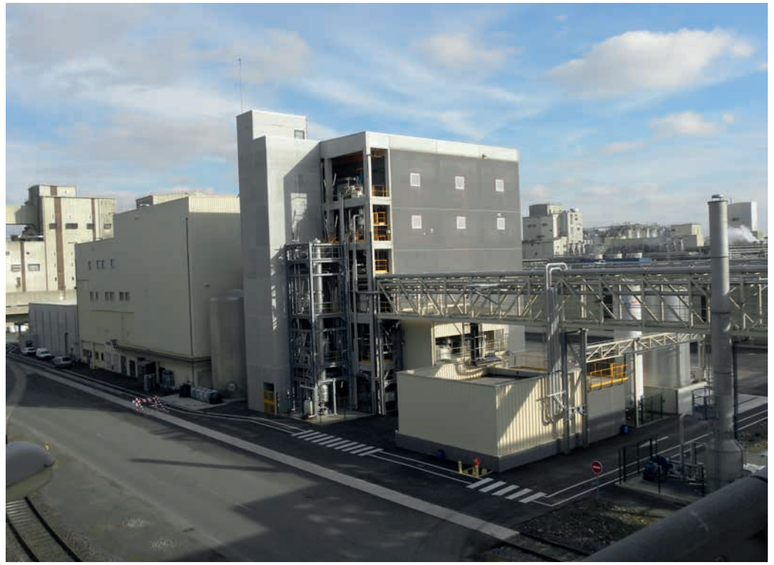
The royal visit programme also included the Biobased Studio in the hall of the Markiezenhof town palace in Bergen op Zoom. Here the Royal couple were introduced to the Biobased Collection: dozens of products which are the result of a decade of innovation on the cutting edge of agro and chemical. ‘The collection was thought up by 33 businesses and consists of waste bags, dishwashing liquid, plates, construction felt, composite stone and tree anchors, among other things. It is a wonderful illustration of what we have achieved together over the past years,’ according to Marc Jamin, director Government Relations & Public Affairs Europe for SABIC. ‘The research performed by large companies such as ours is generally not very visible due to its fundamental nature and the long development time. The products we have gathered show a number of beautiful results at a single glance. We have surely inspired the Royal couple with them as well.’

The biobased collection can be viewed at three locations: the Center of Expertise Biobased Economy in Breda, the Centre for Innovative Craftsmanship and the Green Chemistry Campus in Bergen op Zoom. It is also available online at www.coebbe.nl/biobased-collectie.

BIOPOLYCARBONATE WITH PROMISING FUTURE

In Lestrem, Northern France, Roquette has its largest production site. In total, the French-based company processes roughly 8 million tonnes of corn and wheat per year, resulting in 6 million tonnes of starch and starch derivatives. Mostly for human consumption, but the non-food applicationpart is growing. An interesting product in this respect is isosorbide.

Text Lucien Joppen **Images** Roquette



A significant part of the above tonnage is being processed in Lestrem, a non-assuming village in the north of France. Not only is this factory the largest of its kind in Europe, it also turns out the world's most diversified range of products, the company claims.

Again, these end or half products are used in foods, feed, farma and other nutritional products. Roughly 80 per cent of Roquette's turn over (3,1 billion euro per annum) is generated by these applications. The other 20 per cent are non-food applications in the chemical/industrial domain.

One of these interesting applications is isosorbide. Roquette has been producing this chemical compound for years, mostly for applications in pharma. However, the company also saw possibilities for isosorbide as a component for superior polymers/materials. The origin for isosorbide is glucose, a byproduct from starch processing. Roquette transforms glucose into sorbitol by adding hydrogen and subsequently removing the water molecules from the sorbitol molecules by adding sulfuric acid. The end product is isosorbide at a 98 per cent purity, which is insufficient for polymer production purposes. Roquette further purifies this product to a 99,5 per cent grade. The step is clearly visible: the 98 percent product is yellowish, the 99,5-one is like water.

SMART PHONE SCREEN

Isosorbide for material purposes has various routes.

It can be added to PET to make PEIT, by which the 'i' (isosorbide) ensures better performance in terms of heat and mechanical resistance and optical properties. Reycling of PEIT in PET-streams is possible, says Roquette. However, this end-of-life discussion is not top of the agenda in the industry. First and foremost, the performance characteristics count.

This is also the case with isosorbide-based materials replacing polycarbonate, for example in touch screens of consumer electronics. Roquette and Mitsibishu have developed Durabio, a biopolycarbonate which is being used by Sharp Electronics in of its smart phone models. Durabio has superior qualities, for example in UV-resistance, optical performance, surface hardness, compared to PC. An added bonus is that biopolycarbonate does not need bisfenol-A as an additive, which makes it attractive as a food packaging (no fears of migration, ed.).

Other possibilities/routes are the use of isosorbide as a platform chemical for divinylether, epoxy resins or isocyanates or as a PU-replacement in products such as shoes, skates or ski goggles.

MARKET ESTIMATES BLURRY

In 2013, Roquette officially opened its current isosorbide plant in Lestrem: production capacity 20.000 tonnes per annum. The company previously built a smaller plant in 2007 (1000 tonnes per annum) and a larger one in 2011 (5000 tonnes per annum).

At the moment, the combined capacity of the largest and the mid-sized plant is 25 kTon. When asked how big the world wide isosorbide-market (the high purity grade, ed.) is, Roquette-officials are hesitant. It would be fair to say that this market does not exceed the 25 kTon-mark, given the fact that Roquette is the only supplier that is able to purify on a larger scale. The company also does not want to disclose price levels, as compared to fossil-based plastics. Admittedly, its performance characteristics could warrant a certain premium, it only depends on how big the 'gap' is. ●

'ROUGHLY 80 PER CENT OF THE COMPANY'S TURNOVER IS GENERATED BY FOOD, FEED AND PHARMA. THE OTHER 20 PER CENT ARE NON-FOOD APPLICATIONS.'

IFMAS

In Northern France, to be precise in Lille, a public/private partnership has been established to stimulate innovation in the bio-economy. IFMAS (Institut Français des Matériaux Agro-Sourcés) has been active for 2 years and is running on a budget of roughly 50 million euros until 2019. Roquette is one of the partners and a big contributor to the R&D-budget. Other partners are INRA, Matikem, the University of Lille, Mäder and Mines Douai.

The focus of IFMAS is on feedstocks which are common to North-Western Europe, such as cereals. Given Roquette influence, R&D-efforts are based on starch and functional molecules and /or engineered polymers derived from starch. These halfproducts would be suitable for various applications in sectors such as paints, coatings, construction, medical and electronics.

According to a representative of IFMAS, sugars from food products or woody biomass will be on the R&D-agenda at a later stage.

NEW GENERATION OF MORE SUSTAINABLE MEMBRANES

The 'Biobased Materials' department at Maastricht University and chemical producer SABIC are starting joint postdoctoral research into the development of a new generation of membranes. These will be made partly with renewable polymers for sustainable applications, for example, in water filter systems.

Text Vincent Hentzepeter **Image** Source B

Rob Duchateau, Chief Scientist at SABIC Europe: 'Our company is big in polymers. We want to concentrate more on new applications, especially the high-value applications, a market with high margins.'

In her laboratory at the Chemelot campus in Geleen, Katrien Bernaerts, Assistant Professor Biobased Materials, Polymer Chemistry, talks about this project which will take place in the next two years. The research is funded by a project grant from the Netherlands Organisation for Scientific Research.
The core of the project is making membranes more sustainable. Membranes are partially permeable partitions between two liquids which stop chemical flows from mixing together. The solvent can pass through the semi-permeable barrier easily, while the dissolved substance cannot do this or only with difficulty.

SPECIFIC PROPERTIES

Membranes can be made from synthetic polymers. 'Their source consists of fossil feedstocks. Oil is a finite raw material. In view of the increasing shortage of oil in the medium term, our research group has been concentrating on biobased alternatives since it was established three years ago. In this case, we are carrying out that research in collaboration with the industrial sector, since SABIC is also interested in developing 'green' membranes. They are used on a large scale in water purification plants, for example, where they remove bacteriological and chemical contamination,' according to Bernaerts. 'The great thing about this collaboration is that we do the research side - building biobased polymers into membranes - while SABIC concentrates on the applications. So they do the translation to applicability and commercial feasibility.'
The university has a well-equipped laboratory at its disposal for the research. 'If there is any equipment for this project which we don't have ourselves, like a Scanning Electron Microscope, we can turn to SABIC. The intended product consists of conventional synthetic polymers, the material with which SABIC made its name, and biobased polymers. Their composition allows us to give specific properties to the membrane.'

HIGH-VALUE APPLICATIONS

Rob Duchateau, Chief Scientist at SABIC Europe, is the direct point of contact for this project for the postdoctoral researcher. 'Our postdoctoral candidate will work closely together with him. That is easy, since we are only one floor away from each other here at Chemelot. Remember that the real application tests will also take place at SABIC. This research location is ideal for this kind of cooperation.'
We asked Duchateau why this research is so interesting for SABIC. 'Our company is big in polymers. We want to concentrate more on new applications, especially the high-value applications, a market with high margins. For that purpose you need to come up with innovations which are competitive in the market. We are able to initiate this research and build up knowledge together with the university. That means SABIC can contribute to solving major problems in this world. One example is safeguarding clean drinking water through proper water purification. The applications of biopolymers in membranes and their reuse are also in line with our environmental objectives.'

GREEN STAMP

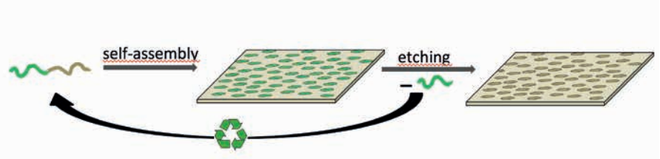
During the production of the membrane, which consists initially of conventional and biobased polymers, the biobased part is removed. You end up with the desired porous microstructure with nanopores. 'The diagram (see figure, eds.) gives a good impression of this. The continuous phase is the synthetic polymer which must provide the mechanical strength. That part remains intact. The green 'balls' are biobased polymers which we remove and which can be recycled. That is the green stamp in this research.'
The goal is to make polymer membranes which have controllable properties. The new block copolymers to be made must arrange themselves in order on nanoscale to provide optimum membrane operation. 'That is the crux and we have to come up with that process in the next two years. When the block copolymer is etched, all kinds of nanopores arise. You want to be in control of that. In this project we will deliver the proof of concept that it is possible, and this can be used in applications later.' ●

This article was created in collaboration with Source B.

COPOLYMERS

When two compounds are mixed to form a polymer together, a copolymer is created. Besides the random form (random copolymer, AAABABBABBBABAABA) and the alternating form (alternating copolymer, ABABABABABABAB), there is also a block copolymer in which blocks of the two monomers alternate with each other. For the monomers A and B, that will be AAAAAABBBBBB, for example.

Source: Wikipedia



The selective degradation/removal of biobased copolymers creates (nano) pores in the membranes. The renewable components can be reused.

CORBION OPENS BRAND NEW LAB

Corbion, a leading food ingredients and biobased chemicals company, has recently opened its advanced R&D and applications laboratory in Gorinchem, the Netherlands. According to the company, the new facility will be pivotal to the continued delivery of world-class and ground-breaking food ingredient and biochemical products and services to customers across the globe.

Text Lucien Joppen **Images** Corbion

Home to over 150 technical specialists, the laboratory focuses on the conception and development of new biobased products based on lactic acid or lactides, comprehensive application development work and testing and trials. 'State-of-the-art equipment and a highly experienced team now enable Corbion to offer customers more collaborative NPD services, faster development times and exhaustive testing and trialling under conditions that mimic their specific manufacturing environments', a spokesman for Corbion says.
With an unprecedented range of production and analytical equipment in a purpose-built 3500 square metre facility, Corbion can now innovate faster, manufacture flexibly for rapid sample provision or testing and dramatically boost its efficiency and responsiveness to customers.

COATINGS

In addition to its work in the food industry, Corbion's new research center is geared towards developing biochemical solutions that improve

the sustainability and performance of industrial products such as coatings and adhesives, chemicals, home and personal care, pharmaceuticals and animal nutrition. 'Customers will benefit from first rate pilot plant and scale-up facilities and extensive analytical equipment. Developments in the area of adhesives include PURALACT® B3, which can be incorporated into polymers to produce safe, high performance, fully compostable, hot melt adhesives for cases and cartons. The new laboratory will also build on Corbion's successful PURASOLV® esters destined for the agrochemical and electronics markets.'

MYTH

Coatings and paints for indoor and outdoor purposes is a promising market for Corbion. The company is developing recipes for these products based on lactides, which in turn are incorporated into alkyd paints.
Armin Michel, senior technical marketing manager: 'Alkyd paints with solvents contain VOC's (volatile organic compounds) which are damaging to human health. In some countries, these alkyd paints aren't allowed to be used indoors by law. Therefore, there is a market need for 'healthier' formulations with a comparable performance. We can develop these formulations for our clients.'
According to Michel, there is myth that (part) biobased materials cannot compete with fossil-based products performance-wise. 'On the contrary, in terms of gloss and hardness our coatings perform equally well. The bonus is that the gloss will sustain longer and that yellowing (of white colour) occurs in a later stage.' ●

TOOL AND APP FOR BETTER BUSINESS

The Province of Zeeland, leader when it comes to biobased procurement, organised a meeting together with CoEBBE and Tebodin at the start of this year to bring buyers and 'biobased businesses' together: 'Biobased procurement: this is how you do it!' Key element of the meeting was the development of an app and a benchmark tool which will help connect supply and demand better.

Text Mariska van Dalen

Mr Van der Maas, member of the Provincial Executive, launched an animated film to open the meeting. The straightforward 90-second film showed what biobased products are and why the Province of Zeeland is stimulating biobased procurement. There are roughly three reasons why the public sector should stimulate the development of biobased products. To start with, it is ultimately better from an environmental point of view. Secondly, biobased business strengthens the local economy. Lastly, the practical experience of the Province has shown that biobased products can contribute added value thanks to their extra functionality, such as biodegradability. This is good news, since buyers not only look at the price, but also the life span and maintenance.

DIFFICULT TO ASSESS

Biobased procurement may be inspiring, but it does form a challenge for the parties involved, as the real-life stories show. It is difficult for buyers to find the information. Even the powerful Google often fails to provide an answer. And when they do find information, buyers find it difficult to assess. In addition, wholesalers often do not know what biobased is, and even the sellers of manufacturing companies do not always know what biobased means. Suppliers often declare that their products satisfy the five indicators (see box). It is important that the information is validated by an independent party. Only then can buyers select products which have added value relative to the petroleum-based options.

The five indicators:

1. Percentage of renewable ingredients with respect to the total quantity of the fossil ingredients.
2. Improvement of the functionality and technical performance of the product due to biobased ingredients with respect to the fossil ingredients.
3. Extent to which the CO_2 footprint improves with respect to the fossil products.
4. Insight into the costs/revenue during the life cycle of the product (TCO calculation in accordance with European Procurement Directive 2014/24/EU).
5. Insight into the end of the period of application (including compostability, biodegradability, reusability via calculation in accordance with 'Cradle to Cradle Standard Version 3.1').

BIOBASED PROCUREMENT APP

That's why the Province of Zeeland has developed several tools to bring buyers and suppliers together. The Biobased procurement app (GoBiobased) was developed to help find the available information fast. With a simple press of the button it can be used to share the above animated film, the research and the Biobased collection of the CoEBBE with market parties.

Currently I am developing an interactive benchmark tool which will show how biobased products score on the five indicators with respect to petroleum-based products and visualise the added value (compared with fossil counterparts). The app will give you updates on the developments.

BENCHMARK FOR ASPHALT

With this tool, buyers can invite suppliers to complete a questionnaire which will be validated by independent experts. The benchmark links the scores of the biobased products with the procurement categories used by governments and allows the simple generation of an overview. Thus far ten products have been validated and a benchmark has been developed for the asphalt product group. The advantage of the tool is that buyers do not have to reinvent the wheel every time and do not lose as much time on market research. For biobased businesses it is a great portal to respond actively to demands from the market and bring their products into view. This makes it more tangible and easier to start doing it, according to Ben de Reu, member of the Provincial Executive (Province of Zeeland, Biobased Economy portfolio). ●

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