Walking Exhibition

Bio-based Economy made in Europe

Bioeconomy Conference Bratislava
17 October 2016

BIO-BASED INDUSTRIES
Public-Private Partnership

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Foreword

The bio-based industries in everyday life are not something we need to look into the future to f nd. In fact, the everyday items in this exhibition show how innovative bio-based materials are already being developed and tested for consumers. Through innovative advanced technology and processes, bio-based products are already part of our daily lives.

The research, development and deployment of new uses of biomass offers us a real alternative to petrochemicals in providing energy to heat and light our homes, as well as in producing a vast array of plastics, lubricants, paints and a host of industrial chemicals. And for Europe this is great news!

Europe has always been good at developing the science and technologies behind the scenes but when it came to producing things on a commercial scale, historically the investment went elsewhere. Here at the Bio-Based Industries Joint Undertaking (BBI JU), we aim to speed up the shift of investment to Europe by showing how it can be an attractive place for industry to base its bio-based activities. Of course, we need the right conditions for bio-based companies to stay and invest.

What better way than for European citizens to insist on home-grown and produced bio-based products like the ones on show here. One of the objectives of the BBI JU initiative is to help Europe wake up to the potential of bio-based materials, second-generation bio-fuel and other bio-chemicals, which can reliably replace our dependence on petroleum-based fossil fuels. Why are the bio-based industries important? Using biological material called biomass to produce energy or advanced materials can be a sustainable alternative to fossil fuels. Biomass includes raw material from animals, vegetables or microorganisms and is creating value from underutilised residues and useable waste from other industrial or agricultural processes.

This exhibition illustrates a few of the impressive new ideas coming from the smart use of non-edible biomass.

Philippe Mengal,
Executive Director of BBI JU

The Bio-Based Industries Joint Undertaking

The Bio-Based Industries Joint Undertaking (BBI JU) is a €3.7 billion public-private partnership between the European Commission and the Bio-based Industries Consortium (BIC), established to provide the impetus for bio-based sectors to find new ways of collaborating, through the creation of new strategies and objectives. It implements a research and innovation programme through its open calls for proposals which operates under Horizon 2020.

Ambition & Vision

It is dedicated to realising the European bioeconomy potential, turning biological residues and wastes into greener everyday products through innovative technologies and biorefineries, which are at the heart of the bioeconomy: this includes connecting key sectors, creating new value chains, and producing a range of innovative bio-based products to ultimately form a new bio-based community and economy in Europe. Facilitating the development of new, bio-based products and markets based on smart and efficient use of resources, industries are offered the opportunity to diversify their revenue streams.

The BBI could enable European companies to be more competitive in the global bioeconomy race with the US, China, and Brazil. Reducing the import of oil-based raw materials, as well as foreign biomass, also benefits the efforts to meet the EU's climate change targets, leading to greener, sustainable, more environmentally-friendly growth. All in all, a bioeconomy is better for Europe, better for its citizens, and better for keeping industry engaged and actively investing in novel bio-based 'grown and made in Europe' technologies and innovation.

Fact box

Bio-based Industries expected impact:

- **Help diversify and increase farmers' incomes by 40%**
- **Develop existing value chains and build new ones to revitalise rural environments**
- **Support a new generation of bio-based materials and composites produced in biorefineries**
- **Create a competitive bio-based infrastructure in Europe**
- **Boost job creation, 80% of which will be in rural and underdeveloped areas**
- **Facilitate Europe's target to replace at least 30% of its oil-based chemicals and materials with bio-based and biodegradable ones by 2030**
- **Facilitate Europe's target to meet 25% of Europe's transport energy needs with advanced biofuels by 2030**

The Bioeconomy:

What is it?

The bioeconomy is made up of those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals, and micro-organisms – to produce food, materials, and energy.

It is an essential alternative to our present fossil-based economy which is dependent on the planet's limited supply of non-renewable resources, such as petroleum and coal.

Bioeconomy is hailed as the next wave in our economic development and should provide major opportunities for innovation, jobs, and growth to help re-industrialize Europe. Instead of using non-renewable resources, such as petroleum and coal, plant material, and municipal and livestock waste – biomass – can be converted into electricity, fuels, plastics, and the basic components of chemical processes.

The bioeconomy offers great opportunities and solutions

Biomass, like plant material and municipal and livestock waste, is converted into electricity, fuels, plastics, and basic building blocks for chemical processes. Many materials made from petrochemicals can be replaced with materials made from biomass. Sometimes, small alterations of naturally occurring substances can produce useful alternatives to commonly used products, such as trash or packing bags.

Cups, forks, spoons, knives, plates, food storage containers, T-shirts, and pillows are some examples of products that can be made from biomass, including waste and residues.

These products can be made so that they are biodegradable and compostable. It is hoped that the production and use of these bio-products and materials will reduce the amount of biodegradable waste and materials going to landfills.

The bioeconomy offers great opportunities and solutions to an increasing number of major societal, environmental, and economic challenges, including climate change mitigation, energy and food security, and resource efficiency.

> *"Europe is committed to excelling in smart, inclusive, and sustainable growth. Mobilizing investment to make new markets is key. Europe's commitment to building the world's leading bioeconomy by 2020 remains critical to achieve growth, fight climate change, contribute to the circular economy and the investment goals of the Juncker Commission."*
>
> John Bell, Director of the Bioeconomy Directorate at the EU Commission Directorate-General for Research and Innovation.

What's next?

The European Commission is devoting resources to better study the overall biomass available in Europe and its uses, and to assess the efficiency of the bio-based solutions through life-cycle analyses.

The Commission will review the strategy and its associated action plan over the course of 2016 – 2017. It will assess how the bioeconomy can deliver on the current EU and international policy agenda, including sustainability and climate change, highlighting the link between bioeconomy and circular economy.

Walking exhibition

The Bratislava walking exhibition is an innovative and engaging way to show how everyday objects can have bio-based ingredients, and that the application of bio-based technologies offers new opportunities for developing the bioeconomy in Europe. This unique, vanguard exhibition presents more than 20 different bio-based products from more than a dozen companies, displaying current, concrete realisations of the bioeconomy. Bio-based products are evidence of the bioeconomy, and it is important to communicate the benefits of these products to all stakeholders along the value chain, including producers, distributors, users, consumers, public authorities, and NGOs. As environmental awareness grows, the demand for products from sustainable manufacturing processes, including bio-based products, is also likely to increase and, with it, the need to raise awareness and broaden knowledge about these innovative products.

The walking exhibition was developed against this background. Its objective is to show that the bioeconomy is more than a policy. It proposes concrete solutions to major societal, environmental and economic challenges. European industry has adopted some of these solutions and found new, innovative and resource-efficient ways of developing services and goods, thus contributing to develop an industrial economy that is low carbon, high value and locally sourced. The EU, national, regional, and local governments, industries, indi-

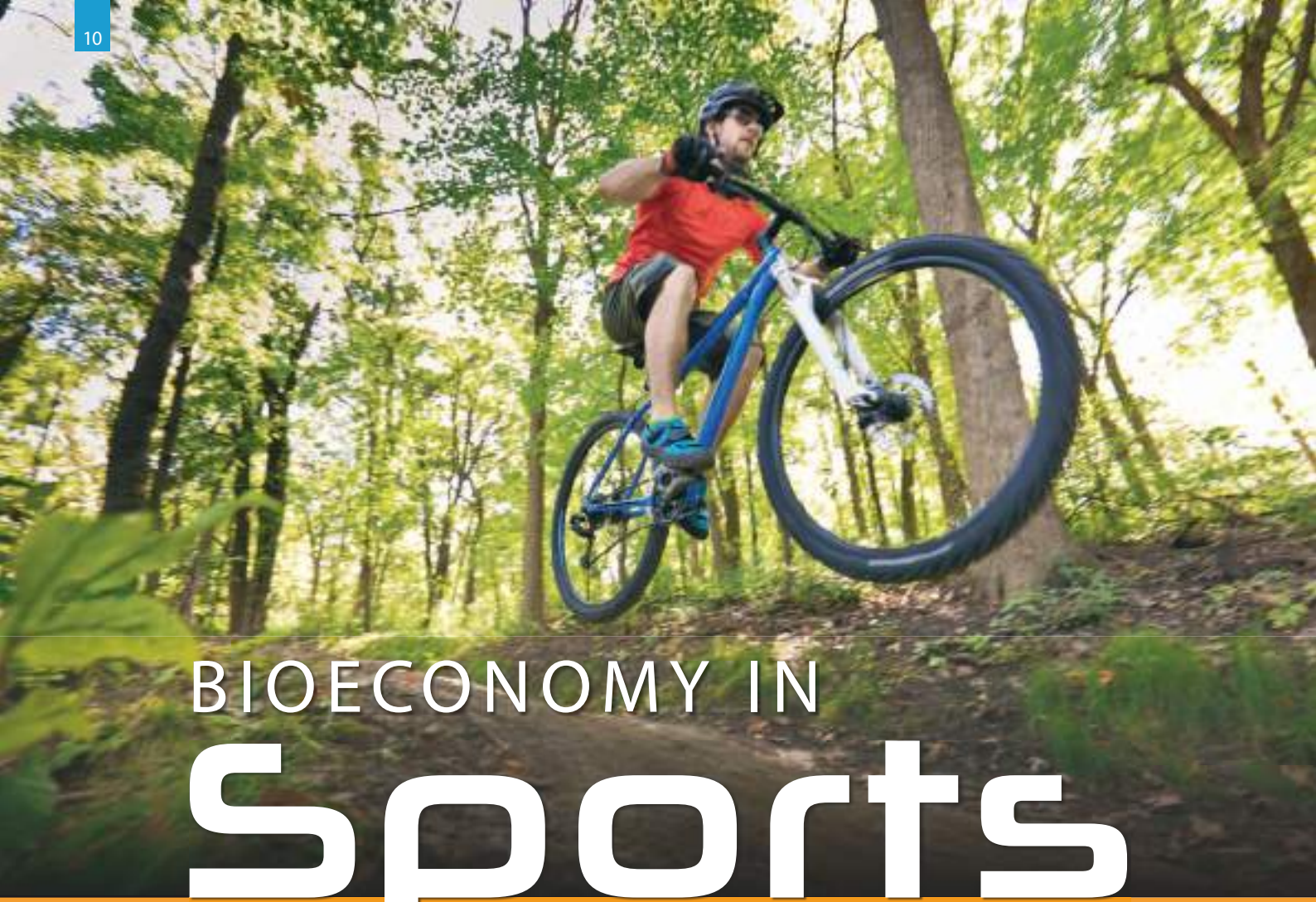
vidual companies, workers, and consumers will all need to contribute to the changes the bioeconomy and these bio-based products offer. We are very proud to share this unique show with you, an exhibition conceived to guide you through new, wondrous solutions for renewable raw materials and waste – clothes made of milk that cannot be used for consumption, cups made of used coffee waste, bikes made of flax fibres, dandelion flowers turned into tyres…

Someone dreamt it. We live it.

About the Bioeconomy Conference

17 October 2016 Bratislava, Slovakia

The 'walking exhibition' is part of 'The role of the Regions in the Bioeconomy' conference, organised by the Slovak Presidency of the Council of the European Union and supported by the European Commission. The conference intends to highlight good practices and initiatives for regional development in the bioeconomy, paying particular attention to micro-, macro-regional and national aspects. It serves as a platform to exchange good practises that will serve to foster the deployment of the bioeconomy in regions particularly those of Central and Eastern European countries.



BIOECONOMY IN Sports

Bio-based products in the sports sector demonstrate that an eco-friendly production process doesn't comprise on performance or design. Be it trainers or shirts, bikes or skateboards, there are already lots of different types of applications 'made in Europe' available globally. The natural resources used range from wood, flax and starch biomass to castor oil and sugar beet pulp.

SKATEBOARD

Turning agricultural waste such as sugar beet pulp into high-valued products: that's the aim of the BBI JU funded project Pulp2Value. Together, the researchers from science and industry developed an innovative, lightweight material as a bio-based alternative to glass fibre-reinforced composites. This can be used for components of skateboards, amongst others.

High-value product from agricultural waste

With some 13 million tonnes produced annually in Europe, sugar beet pulp is a major residual stream from the sugar beet industry. Currently, it is valorised as low value feed or as green gas. Together with colleagues from companies such as Royal Cosun and Orineo, researchers from the Netherlands at the University of Wageningen have now developed a method that converts the agricultural waste into a highly valued product. By fractioning the beet pulp into cellulose microfibres, they create a bio-based, functional additive that helps to create an eco-friendly composite material, that additionally supports improved mechanical damping properties. For this reason, the microfibre-based composite is suitable as lightweight material for diverse application fields, be it for the production of components for sports equipment, such as skateboards or for use in the automotive or aviation sector.

Better ecological footprint

Compared to traditional composites based on glass and carbon, the microcellulose fibres made from sugar beet pulp save energy in the production process and over the course of product lifetime, offering advantages in end of life solutions and, thus, leaving a much better ecological footprint than current lightweight materials. In the prototype for the skateboard, almost half of the new material consists of the bio-based component.

BBI JU project: Pulp2Value

Sugar beet mircofibres are in the focus of the 'Pulp2Value' consortium. Led by agro-industrial cooperative Royal Cosun, the four-year project is a collective venture of seven partners collaborating within the scope of the Bio-Based Industries Joint Undertaking (BBI JU). Pulp2value aims to demonstrate an integrated and cost-effective cascading biorefinery system and to produce value chains for microcellulosic fibres and other products using side streams from the agro-food industry. The main applications for the microcellulosic fibres are as rheology modifier and in fibre reinforced composites. The project partner Orineo is working on both of these applications in the development of flooring (composites, Touch of Nature) and bio-based adhesives (rheology modifier). Pulp2value has a total budget of €11.5 million with €6.6 million coming from the BBI JU.

TREKKING SHOES

Replacing oil-based, high-performance plastics with a bio-based and sustainable alternative is one of the major goals of the chemical industry. Dutch company DSM has developed a polyamide that is made from tropical castor beans that don't compete with the food production. One of the applications is as a building block in the material for the high performance sole in mountaineering shoes.

Green alternative to oil-based polymers

Once upon a time, plastics were perceived as oil-hungry, unsustainable materials. Meanwhile, there are green alternatives with the same properties on the market – among them a bio-based polyamide called EcoPaXX that was developed by the Dutch chemical company DSM. Up to 70% of the material is made from castor beans (*Ricinus communis*) oil. This is a non-food crop and is, therefore, a suitable replacement for oil-based polymers without compromising in material performance. EcoPaXX offers properties such as chemical resistance and low moisture absorption, combined with a very high melting point and a high crystallization rate. Similar to its oil-based counterparts, the bioplastic can be used in several application fields. The French sporting goods producer Salomon used this material for the edging along the sole of these mountaineering shoes, amongst others.

Carbon neutral from cradle to gate

For applications in the consumer sector, the flexibility and impact resilience of EcoPaXX makes it ideal for all kinds of dynamically loaded applications, whether it's sports shoes, ski and snowboard bindings, or stiffeners and fasteners. The material also has a suitable surface for painting, which is needed for applications where aesthetics can make all the difference. Additionally, the amount of carbon dioxide emitted during the production of EcoPaXX is offset by the amount absorbed in plant growth, and, in particular, by castor beans. That's why EcoPaXX is certified 100% carbon neutral from cradle to gate and helps to establish sustainable processes in the sporting goods industry.

BIKE

Until now, using European wood as a green starting base for a multi-layer, composite material is still a niche approach in the construction industry. The German company Lignotubes wants to change this. It has developed resource-saving, lightweight hollow tubes made from beech and other European woods to serve as bio-based replacements for aluminium or carbon. One of the application fields is that of bicycle production.

Construction material made from European wood

In the construction industry, materials such as aluminium, stainless steel, carbon, or plastics are the most used materials. However, in Europe, there are sufficient amounts of European woods that could be an alternative resource for a more eco-friendly approach. German inventors at Dresden-based startup Lignotube Technologies fill this gap and aim at establishing a bio-based alternative in the market. By using European wood, such as beech combined with an innovative processing technology as a starting point for a robust and lightweight construction material. At Dresden Technical University the process engineers developed a resource-saving procedure for lightweight hollow tubes called lignotubes. In 2013, the spin-off was founded to offer the new multi-layer composite material of wood veneers to the market.

Highly ef cient raw-material use

The individual layers of veneer are glued crosswise so that the new material offers many different possibilities for structure, texture, and colour. According to the company, engineered wood has also caught up in terms of strength and processability. Additionally, this wood is combinable with other common construction materials, making them suitable for different application fields in the construction area. The first product is a designer bicycle built by using a Lignotubes frame. Due to this special technology, the new material also helps to save more raw materials and weight, compared to a solid, wooden frame. The company attaches importance to a highly efficient production process, so that a minimal amount of real wood is used. Nevertheless, the thin-walled tubes are as robust as needed.

CYCLING HELMET

With the help of innovative technologies, the forest-based industry in Northern Europe delivers new bio-based materials for several industrial applications. In a prototype project, Swedish researchers and designers created a bicycle helmet made completely from forest products. One of the components is a renewable and bio-degradable foam based on nanocellulose produced from wood pulp.

Green alternative to plastic foam

In Sweden, forests are planted and harvested continuously, so the country has the resources to support the commercial need for wood-based materials. A group of researchers from the KTH Royal Institute of Technology and the Stockholm University worked together at the Wallenberg Wood Science Center and developed a renewable and biodegradable alternative to plastic foams. Cellufoam is a low density, highly porous material consisting of nanocellulose that is produced from wood pulp, using a green, solvent-free process. Because of its strong mechanical properties, cellufoam is suitable for use in lightweight construction, packaging materials, and absorbent products and the material is commercialised by the startup Cellutech, founded in 2012.

The potential of wood cellulose

The prototype was designed and constructed by the designer Rasmus Malbert, who used cellulosic materials in different applications: wood veneer for the outer shell, durable paper for the straps, and cellufoam for the inside cushioning. The bicycle helmet from cellufoam brings renewable and bio-degradable foam materials closer to commercialisation.

T-SHIRT

Dutch company Avantium has developed a 100% bio-based polyester by turning carbohydrates into chemical building blocks. The bio-polyester can be melted down and turned into thin fibers for spinning and weaving using the same technology used to make polyester clothing. T-shirts are one of the most versatile products.

Bioplastic as a green alternative to polyester

Since 2011, Dutch company Avantium has been a leader in the production of a 100% bio-based plastic material called polyethylene furanoate, or PEF. In comparison to other bioplastics, PEF is 100% derived from commercially available, bio-based feedstock, such as sugar and starch crops. With the help of its YXY technology, the biomass sugars are converted into the building block for PEF polyester. In terms of thermal properties, PEF is widely considered attractive, due to its superior ability to withstand heat and processability at lower temperatures. As a next step, Avantium is looking at ways to move towards commercialised processes which use non-food starches and sugars in future.

Textile industry market as an important recycling outlet

The PEF fibre spinning and fabric weaving and dyeing was performed by the Institute of Textile Technology at German RWTH Aachen University, using conventional polyester processing technology and equipment. The textiles industry is an important recycling outlet. PEF T-shirts made from 100% bio-based and recycled material would be the next step in sustainability, reducing dependence on petroleum and further decreasing the carbon footprint. Avantium is currently working with brand owners and the recycling industry to establish a PEF to PEF recycling infrastructure in the future. Additionally, the company is developing processes based on feedstock from second-generation, non-food crops to ensure that the technology is fully compatible to these new feedstocks.

TENNIS RAQUET

Flax is a common European plant that only needs a litte water. French company Lineo has developed flax fibre as a bio-based composite material for sports goods like this tennis raquets, offering better performance and diverse use for this fibrous European staple.

A complementary fibre with new properties

Flax is an old, cultivated European plant that is grown today primarily in Russia, Belgium, the Netherlands, and France. However, flax is enjoying increasing popularity as a renewable resource. With 81,300 hectares of fibre flax cultivated in 2014, Europe is responsible for 80% of the global production. One of the best known applications is as linen in the textile industry. The French company Lineo uses flax fibres – in combination with a resin – as a bio-based structural component for hybrid, composite material. The flax fibres are incorporated into the frame making it lighter, and with a higher performance as it absorbs shocks. The flax fibre can be considered a complementary fibre to glass or carbon, which can bring new properties to sporting goods such as tennis raquets. It's a good example of advanced applications providing enhanced performance in the end product. Thanks to the vibration-damping effect, a flax content of 8% to 25% provides effective results that reduce the risk of tennis elbow.

Better for environment

The use of flax for advanced applications brings benefits for the environment. While growing, flax does not require irrigation and as little to no fertilizers or pesticides. Very little energy is needed to process flax. The plants are also carbon neutral. In other words, they absorb the same amount of carbon dioxide that they produce. During the transformation from stem to fibres, mainly organic wastes are generated, and these can be used to produce electricity or make ecological products. Additionally, flax fibres are 100% bio-degradable.

T-SHIRT

The chemical industry increasingly offers innovative chemical building blocks. One example is German company BASF, which has intermediates based on renewable resources, such as Polytetrahydrofuran (PolyTHF), commercially available. PolyTHF is used primarily to make elastic spandex fibres for a variety of textiles.

Intermediates based on renewable resources

Chemical intermediates are used, for example, as starting materials for coatings, plastics, pharmaceuticals, textiles, detergents, and crop protectants. German chemical company BASF is among the largest providers of PolyTHF globally, which is particularly interesting with regards to textiles such as underwear, outerwear, sportswear, and swimsuits. For some years, the chemical industry has been looking for more sustainable processes. That's why BASF started collaborating with biochemical company Genomatica. The California-based firm has delivered the industry's first commercial, bio-based process for the high-volume intermediate chemical 1,4-butanediol (BDO), from which other intermediates such as PolyTHF are derived. Based on a license agreement, BASF is now allowed to produce sugar-based BDO, of up to 75,000 tons per year, in a world-scale production facility.

Alternatives to petrochemical building blocks

Sugars from plants, such as maize, are used as natural, raw material, among other applications. According to both companies the quality of this renewable BDO is comparable to petrochemical-based BDO. This lays the groundwork to deliver new market opportunities to business partners in the textiles, plastics, and automotive industry, and through them, to end-users of everyday products in different areas of application.

BIOECONOMY IN Mechanics

The need to cut carbon emissions and make vehicles more fuel and cost efficient has never been greater. High performing advanced bio-based materials now offer a broad range of properties ranging from low creep and outstanding mechanical performance to high-heat resistance. Environmentally-friendly materials can replace traditional ones and European companies are at the forefront of these advances.

CAR TYRE

What can you do with a dandelion? They are weeds for most people. In the right sort of quantity, dandelions are an alternative source for a raw material in high demand: natural rubber, the fundamental ingredient in products, such as car tyres. Up until now, the European rubber industry has been dependent on fluctuating Asian supplies or synthetic rubber. Today, producers have developed the first prototypes of dandelion tyres.

Modest plant as a new rubber provider

Natural rubber from European dandelions? If you process the sap from the roots you can make a bio-based polymer that mimics rubber form the rubber plant. The dandelions are grown in Europe. This cuts down the cost and environmental footprint and uses less energy to make than synthetic rubber. The resulting tyre has low rolling resistance, lower fuel consumption and tyres can be used in both summer and winter seasons. 85% of the environmental impact of a tyre comes from the rolling resistance, so improving this, significantly reduces the impact. Using dandelion rubber as the basic raw material replaces petroleum-based synthetic rubber. And, dandelion production fits in crop rotation systems and reduces the dependence on the rubber tree production system which is responsible for decrease biodiversity and waste water disposal, amongst other things. It also lowers the risk associated with rubber tree monocultures.

Enough for commercial use

Dandelion farming and processing into a natural rubber means that new supply chains will be created, offering all those involved added value, from seed production right through to end production. There is no dandelion or natural rubber production in Europe presently which means new jobs will be created. Added to that, dandelion can be farmed in the north, northwestern, and northeastern part of Europe and on marginal or under-utilised land not used for food production. This innovative application for an everyday plant has been the focus of the EU-PEARLS consortium, supported by the European Commission's 7th research and innovation Framework Programme. Partners include KeyGene (who extract and process the rubber from dandelions), Apollo Vredestein (a tyre manufacturer), Wageningen University (looking for advanced extraction technologies and use of by-products for food and bioplastics for inulin by-product).

BIOETHANOL FUEL

In the BBI JU funded project BIOSKOH, eleven partners from seven European countries aim to establish the largest second generation biorefinery in Europe. While bioethanol produced from food crops is already on the market, its production from non-food biomass opens up huge opportunities for enhancing sustainability and ultimately making bioethanol affordable as a fuel.

Largest second generation biorefinery in Europe

The BBI JU funded BIOSKOH project is setting up the largest second-generation biorefinery in Europe. It will be built on a brownfield site in the eastern part of the Slovak Republic, demonstrating a first of its kind, full-scale commercial plant. As a first step, it will produce 55 kton of cellulosic ethanol per year for EU bio-fuel mandates. Aside from biofuel, bioethanol can be used for a range of products such as for the bioethylene production.

Making bioethanol sustainable and competitive

The BIOSKOH project will demonstrate new technology for second generation biorefineries for Europe. Developing brownfield sites and new value chains is one way the BIOSKOH project will demonstrate that second generation bioethanol can be produced at a lower and economically viable price within the current market context with the additional potential for further cost reduction. .The flagship research project is based on four Innovation Stepping Stones: superior biorefinery technology, a brownfield approach, improving regional infrastructure and creating jobs, industrial symbiosis and energy autonomy, abundant, secure and sustainable biomass. BIOSKOH will also explore emerging bio-based materials, such as lignin by-products created during the process.

BBI JU project: BIOSKOH

The BIOSKOH project will pave the way for a second generation European circular bioeconomy by showcasing how a number of innovation stepping stones can realise a breakthrough in techno-economic viability of lignocellulosic biorefineries. Partners include the full value chain starting from land owners and feedstock producers, supply chain experts, technology providers such as Biochemtex, Novozymes and Lesaffre, as well as an agronomical research partner, to set-up a new biomass value chain exploiting large amounts of currently unused crop residues, and developing newly grown dedicated crops on marginal land, as such revitalising the regional economy. The BIOSKOH project has a BBI JU contribution of around €21m.

ENGINE COVER

The automotive industry has a high demand for robust polymers in different application areas. Increasingly, manufacturers are asking for bio-based alternatives to fossil-based materials. Dutch chemical company DSM is an example of large industry moving the bioeconomy forwards in Europe.

Green alternative for car components

Car engine components have to withstand extreme conditions like high temperatures. That's why the automotive sector is one of the largest users of plastics. Advanced thermoplastics, resins and fibres are transforming the automotive industry. Today, there are green alternatives with the same properties on the market – among them a bio-based polyamide called EcoPaXX that was developed by Dutch chemical company DSM. Up to 70% of this chemical building block is made from castor bean oil. The tropical plant is a non-food crop and so is a suitable replacement for oil-based polymers without compromising material performance. EcoPaXX offers properties, such as a good surface appearance, high termal resistance up to 230 °C, high mechanical properties and dimensional stability. Additionally, the material is of a significantly lower weight of up to 9% and demonstrates considerably reduced water absoption.

Reducing CO_2 footprint

German car manufacturer Mercedes Benz already uses the bioplastic for its engine covers in the series production for its A-Class, demonstrating that the material is just as effective as crude, oil-based polyamides. In terms of environmental impact, the new material is much more beneficial. Compared to the conventional plastic products, the bio-based plastic engine cover is reducing the CO_2 footprint of the production process, down to a total of 40%.

OIL & LUBRICANTS

Producing high-value chemicals or biolubricants with low input oilseed plants such as thistles is what BBI JU funded consortium First2Run is currently doing in its reconditioned biorefinery in Sardina, Italy. Coordinated by Italian producer Novamont, the partners from science and industry will revitalise the local rural economy and put marginal lands to use adding value for local farmers.

Thistles as sustainable raw material

The project will show how using arid, marginal wasteland and a reconditioned petro-chemical refinery to process thistles can deliver low-impact, bio-based vegetable oils. Cardoon was selected as the most fitting, underutilised crop for the production of bio-based monomers. A dryland farming crop, cardoon naturally grows in areas that are normally unsuitable for traditional crops and produces high yields without irrigation. Using advanced processes, the Cardoon seeds go through a unique low impact oxidative cleavage process that will deliver more than 30 kton per year of Azelaic and Pelargonic acid and other co-products such as Glycerol.

Establishing a circular economy infrastructure

There is potential for added value from using the products for several other applications, including energy, animal feed, and chemical production for the by-products of the bio-based processes. The project's biorefinery model can be considered an example of a system economy and a starting point from which supporting actions to further sustainable innovations could be successfully implemented. Standardisation, certification, and dissemination activities will also help to support the market penetration of the produced, bio-based products.

BBI JU project: First2Run

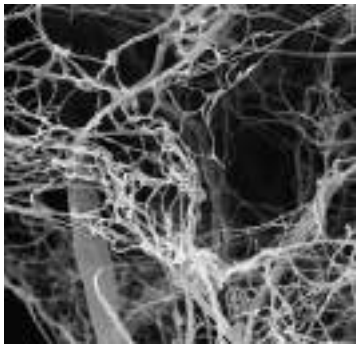
The First2Run project aims at demonstrating the technological, economical and environmental sustainability at the industrial scale of a first-of-its-kind value chain, where low input and underutilised oil crops (i.e. cardoon), grown in arid and/or marginal lands not in competition with food or feed, are exploited for the extraction of vegetable oils to be further converted into bio-monomers (mainly pelargonic and azelaic acids) as building blocks for high, added-value bioproducts, biolubricants, cosmetics, bioplastics, and additives through the integration of chemical and biotechnological processes. The consortium is coordinated by Novamont. Further partners are SIP in the UK, SoliQz in the Netherlands, Biophil in Slovakia, Matrìca in Italy, and the University of Bologna in Italy. The BBI JU contribution for the project is €17m.

BIOECONOMY IN Building & Decorating

The use of bio-based building materials may reduce emissions and contribute to sustainability. Many applications in construction are relatively new but these materials offer an opportunity to exploit nature's properties to give better performance. In the comfort of your home, innovation comes from nature - wood, plants and grass are the building materials for the future.

PAINTS

Until now, most additives in exterior paints were based on synthetic polymers, sourced, primarly, from oil. Within the BBI-funded project Exilva, Norwegian biorefinery specialist Borregaard has developed Microfibrillated Cellulose (MFC) as a natural paint additive. In doing so, it not only improves the CO_2 footprint of the product, but also strengthens the anti-cracking properties of paints.



World's first commercial plant for microfibrils

By using wood as a raw material, the Exilva project produces environmentally friendly and sustainable biochemicals, biomaterials and biofuel that can replace oil-based products. The fibres in the wood are converted into advanced grades of specialty cellulose for products in the construction and oil industries, and for the production of foodstuffs, cosmetics, hygiene products, paints and much more. Textiles such as viscose and rayon are wood-based and can be good alternatives to synthetic fabrics or cotton. The field of Microfibrillated Cellulose (MFC) has existed since the early 1980s. However, research has been confined to small laboratories and pilot plants, due to constraints in technology and production feasibility. Norwegian biorefinery specialist Borregaard has developed its proprietary technology, Exilva, that helps to provide high quality MFC for several applications. Supported by BBI JU funding, the experiences from a pilot plant are now scaled up to a viable commercial plant.

Better performance from paints

The nanocelluse material Exilva MFC has a unique set of characteristics, including plasticity, stablisation, texture modification, and water retention. As a component in paints, this material is able to change the flow behaviour, so that the final product offers improved, anti-cracking resistance, better functionalities in colder conditions, as well as an improved resistance against syneresis (phase separation) and settling. In addition, by using Exilva MFC, paint producers can also reduce the CO_2 footprint of the end-user paint and advance its sustainability profile.

BBI JU project: Exilva

The objectives of the Exilva project, coordinated by Norwegian biorefinery specialist Borregard, stretches over the entire value chain, bringing together six partners from industry and academia in five European countries, among them Unilever from UK and CHIMAR from Greece. By constructing and running the world's first MFC plant, the partners want to secure both environmental and economic incentives for advanced market segments, so that European industries have the tools to produce more sustainable products. A major scope of the project is to successful transfer of technologies from the pilot plant to the flagship plant and the attainment of a stable production output of at least 1,000 tons of MFC per year of sufficient quality. The project has a BBI JU contribution of €27m.

PAINTS

Usually sidestreams from the sugar producing industry are used as low-grade cattle feed. The Scottish start-up company CelluComp is turning root vegetables into a new bio-material, which can be used to lock moisture into any additive, from paints to cosmetics.

Turning waste into high-value additive

Curran – which is Gaelic for carrot – is a material made from nano-cellulose fibres of root vegetables. Its raw material base is waste streams produced by the food industry. Currently, the main feedstock is sugar beet pulp. The Scotland-based, material science company CelluComp has developed curran as a bio-based high-value additive for paints, coatings or cosmetics. While the exact method of production is secret, nanofibres are extracted from the vegetables and then combined with high-tech resins. The paste can be moulded into different shapes. It is manufactured at low temperatures and pressures, using a green chemistry production process that maximises energy efficiency. Leftovers of the process, such as carbohydrates and proteins, can be further utilised as animal feed or – by extracting further high value compounds – as commodity chemicals or biofuels.

Eco-friendly component for paints

Because the discarded products such as carrots or sugar beets would otherwise be thrown away, there is no direct competition with food crops for scarce land. The manufacturing of curran leads to a lower carbon footprint, as it uses waste and less water, requires fewer chemicals, and does not emit toxic gases. CelluComp aims at exploring the new bio-additive as an eco-friendly alternative component for the paintings and coatings industry.

TERRACE FLOORING

German company Biowert has built a 'grass factory' to exploit meadow grass as a sustainable resource for a natural-fibre composite material that is used for construction products. The biorefinery follows an ef cient closed-loop recycling process, so that neither waste water nor waste products are generated.

Natural-fibre composite based on grass

Biowert terrace flooring is made from an environment-friendly natural-fibre composite. The so-called AgriPlast[BW] material contains 25% recycled plastics and 75% cellulose that stems from meadow grass in the Hessien Odenwald in Germany. To exploit this resource, the company has established its own biorefinery concept, called 'grass factory'. Local farmers harvest and supply fresh meadow grass and process it into silage, during which the meadow grass undergoes fermentation. This is a natural process that prepares the grass for processing. In a next step, the cellulose fibres are separated and dried – very carefully, only using water and heat, both obtained from the closed-loop recycling process. The fibres are then mixed with recycled plastic or biodegradable plastic and processed into the natural-fibre composite AgriPlast[BW], which functions as an alternative to petroleum-.based polymers for terrace profiles.

Biorefinery with a no-waste concept

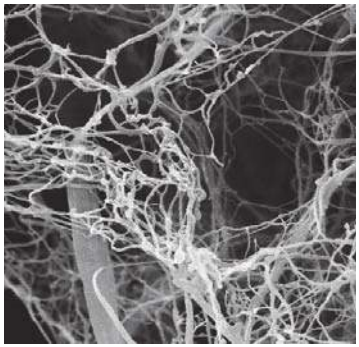
Thanks to the innovative mounting system (Biowert clip), the non-slip barefoot boards are especially easy to install. The Biowert terrace profiles (as well as any other product made from AgriPlast[BW]) can run up to four recycling cycles with no diminishing of technical performance. At the end of life, the material could be exploited thermically. In addition, the factory is not dependent on external energy. The grass slurry from the separation process feeds the biogas reactor together with other organic waste, like leftovers. Within this circular economy approach, the biorefinery actually uses no energy, but generates it. Furthermore, waste heat is utilised directly in the plant – including for fibre drying – and water from this process is treated and completey re-used. At the end, only the natural fertilizer AgriFer[BW] remains as leftover, which is then spread onto the fields in the surrounding area.

BIOECONOMY IN Personal care

Consumers today want products which are high performing and which are environmentally-friendly and sustainably produced. Bio-based ingredients are already found in many everyday personal care products like conditioners, face creams and cosmetics.

FACE CREAM

Bio-based ingredients are not a novelty in the personal care industry. They have been around and used extensively to slow down aging and improve skin condition. Innovation now lies in the use of cellulose fibres as the next generation of personal care products. The BBI-JU funded project Exilva aims at building a commercial production plant for cellulose microfibrils that could be the next generation of natural enhancer for personal care systems.



Microfibrils as natural performance enhancer

Cellulose fibres are built up of fibril bundles, which consist of smaller elements called microfibrils. Through a fibrillation process, the cellulose fibres are converted into a three dimensional network of microfibrils with an ultra-high surface area. These microfibrils are called Microfibrillated Cellulose (MFC). Norwegian biorefinery specialist Borregaard has developed a technology to produce MFC in commercially relevant amounts. Within the BBI-funded project Exilva, the construction and running of the world's first commercial MFC plant is planned for the end of 2016. One aim is to establish MFC as a next generation of natural performance enhancers for personal care systems, such as face creams. In tests, the Exilva MFC shows the ability to reduce wrinkles and improve the sensory characteristics of oil-in-water creams. At the same time it helps to reduce the CO_2 footprint of production processes.

Perfect combination of soluble and insoluble characteristics

These micro fibres which come from sustainability sourced wood give the end products many additional characteristics. By adding it to cosmetics, it provides a 'soft focus' or matt effect on the skin. It has anti-wrinkle effects in the short term. And it gives an improved spray effect and stabilises cosmetic formulations. It can be used in sun-sprays, body-lotions, facial creams and more. It's easier to use and more easily absorbed.

BBI-JU project: Exilva

The objectives of the Exilva project, coordinated by Norwegian biorefinery specialist Borregard, stretches over the entire value chain, bringing together six partners from industry and academia in five European countries, among them Unilever from UK and CHIMAR from Greece. By constructing and running the world's first MFC plant, the partners want to secure both environmental and economic incentives for advanced market segments, so that European industries have the tools to produce more sustainable products. A major scope of the project is to successful transfer of technologies from the pilot plant to the flagship plant and the attainment of a stable production output of at least 1,000 tons of MFC per year of sufficient quality. The project has a BBI JU contribution of around €27m.

DRESS

A cooperation between the forest and the textile industry started in Finland some years ago. The result is an innovative, eco-friendly technology that converts wood into textiles, presenting a green alternative to less sustainable fibres such as water-intensive cotton or polyester.

Sustainable alternative to cotton fibres

Forests and tree plantations act as carbon sinks combatting climate change. At the same time, globalisation and population growth rapidly increased the demand for textile fibres. However, this cannot be met by increasing the production of cotton, due to the large land area required for farming and the amount of water needed for irrigation. Therefore, sustainable man-made fibres are needed to substitute existing resources. In Finland, researchers from Aalto University and the University of Helsinki have developed the Ioncell technology. The process has proved to be especially suitable for the recycling of cellulose waste, which is a by-product in the forest industry. Hence, this allows the manufacture of textile fibres of the highest quality even from low quality waste. One of the biggest benefits of the Ioncell production process is its low energy consumption.

New process of textile recycling

The Finnish technology is able to separate the cellulose fraction from blends with polyester, while preserving the macromolecular structure of polyester for further use. This offers new potentials in recycling of already used textile fibres, as waste cotton can transform into high-quality, luxury fibres. The research on the recovery and purification of ionic liquid is currently ongoing. The so-called Ioncell-F fibres feel soft and are strong, even when wet. According to the researchers involved, the new fibre properties are equal or better than present viscose and Tencel® fibres. Together with the designer Tuula Pöyhönen, some prototype clothes were made for Marimekko's fashion show in Helsinki in 2014. The raw material used for this production is dissolving pulp provided by Stora Enso. This pulp stems from certified forests. Because of their high tenacity, Ioncell-F fibres are also promising for technical applications, e.g. for composites.

LIPSTICK

Consumers these days are looking for products which perform well and provide an alternative to traditional petrol-based chemicals and additives. Italian manufacturer Novamont coordinates the BBI JU funded project First2Run to provide a sustainable, raw material based on thistles, which can be used as an additive in lipsticks, among others.

Building a sustainable value chain

Underutilised oil crops, such as thistles, could offer a sustainable solution as a natural resource in a circular economy. That's why manufacturers try to establish an efficient infrastructure to exploit commercially relevant components from these plants, as raw material for diverse applications fields, such as cosmetics, among other sectors. Coordinated by Italian producer Novamont, the BBI JU funded consortium First2Run will build a first-of-its-kind value chain that uses not only low input oil crops such as thistles for raw material, but also all by-products of the process. In a first step, vegetable oils will be extracted and converted with biotechnological processes into bio-monomers, to serve as building blocks for high-added value products, such as ingredients for lipsticks or other cosmetic products.

No competition with food production

By-products of the process are valorised for energy, animal feed, and added value chemicals productions, in order to increase the sustainability of the value chain. The advantage of the First2Run approach is the use of modest plants grown in arid or marginal lands that are not competing with food production. In addition, the consortium aims to revitalise former industrial plants to establish new business fields and jobs in the circular economy at a regional level.

BBI JU project: First2Run

The First2Run project aims to demonstrate the technological, economical and environmental sustainability at an industrial scale of a first-of-its-kind value chain, where low input and underutilised oil crops (i.e. cardoon) grown in arid and/or marginal lands not in competition with food or feed, are exploited for the extraction of vegetable oils to be further converted into bio-monomers (mainly pelargonic and azelaic acids) as building blocks for high-added value bioproducts, biolubricants, cosmetics, bioplastics, and additives through the integration of chemical and biotechnological processes. The consortium is coordinated by Novamont. Further partners are SIP in the UK, SoliQz in the Netherlands, Biophil in Slovakia, Matrica in Italy, and the University of Bologna in Italy. The BBI JU contribution for the project is €17m.

DRESS

Spinning milk protein casein into fibres is an old technique from the 1930s. It worked but it used a lot of chemicals and water. Now a German company established an eco-friendly production process to turn milk waste into silky fibres, providing the basis for modern textiles with advanced performance properties.

Turning milk waste into textiles

Milk is a popular food product, but not all milk proteins are actually used. Every year, millions of tonnes of milk are accrued, which cannot be used for consumption. In Germany alone, around 1.9 million t of milk are lost to the food industry. For instance, if milk has gone sour, it cannot be sold anymore and would otherwise go to waste. Qmilch uses the milk protein casein for the production of textile fibres and clothing. These are silky to the touch, naturally antibacterial, and easily dyed. The casein is extracted from dried milk powder and then heated up in a type of meat-mincing machine with other natural ingredients. The fibre comes out in strands and is then spun into yarn on a spinning machine. It takes about 6 litres of milk to produce an entire dress. Even some auto companies have looked into using the fibre for car upholstery.

Eco-friendly production process

The T-shirt fabric made from high concentrations of the milk protein casein is the first man-made fibre produced entirely without chemicals. The production of the organic fibre is carried out in line with the Global Organic Textile (GOT) standard: compared to the conventional wet spinning process, significantly fewer resources are consumed. No chemical additives are added, and the fibre is tested for harmful substances. Due to its anti-bacterial qualities, the milk fibre can also be used in medicine and makeup.

FACE CREAM

The biodiverstiy of plants is a useful resource for cosmetics ingredients. Under European Commission Framework Programme 7 the AGROCOS project partner Greek company Korres explored the anti-aging properties of plants and herbs from the hotspots around the globe. One of the most interesting and perhaps surprising was chestnut leaves.

Natural cosmetics proven by clinical research

AGROCOS focused on the cosmetic properties of a number of plants, aiming to find actives with interesting anti-aging properties in plants from six hotspots of the worlds' richest areas for plant biodiversity. One of these hotspots is the Mediterranean basin. More than 3,600 extracts were studied, and Korres has found that one of the most interesting extracts was stemming from the chestnut leaves of the Arcadian chestnut trees. The clinical researchers in the project could demonstrate, that sweet chestnut has anti-oxidant properties and protects against free radicals, the main cause of wrinkles. This may be explained by a number of compounds found in the leaves of the sweet chestnut – including rutin, quercetrin, apigenin, kaempferol, and many others. Many of these antioxidant compounds are also found in the shell, which provides an interesting opportunity to recycle waste from the food industry.

Sustainable and ethical exploitation of natural ingredients

Korres has set up contracts with local farmers, who pick and select the leaves from the chestnut forests, so creating new jobs for the local community. The leaves were left to decompose but are now adding value to the local rural economy and providing a rich source of active ingredients for these high-end personal care products. There is a social side to this enterprise - the aim is not to compete, but to support the farmers and their unions, as well as the community bodies.

Coffee time...

Transform old coffee into new products: That is the idea of German company Kaffeeform. The Berlin startup manufactuers cups and saucers created from used coffe grounds. Each cup is made from 60 grams of coffee grounds, the equivalent of eight cups of Espresso. The coffee grounds are collected from local coffee stores in Berlin and dried, packed, and shipped by disabled people employed in a sheltered workshop.

The recycled material consists not only of coffee grounds, but also of plant fibres, cellulose, and a resin made of biopolymers. The company uses an injection moulding procedure to manufacture the goods. The resulting products are stable and washable.

BBI ongoing projects

ACRONYM	PROJECT TITLE	BBI JU CONTRIBUTION	STARTING DATE
AgriMax	Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications	€ 12 488 230	Oct. 16
BioCannDo	Bioeconomy Awareness and Discourse Project	€ 998 345	Oct. 16
BIOCOM	Increase public awareness of bio-based products and applications supporting the growth of the European bioeconomy	€ 965 750	Oct. 16
BIOFOREVER	BIO-based products from FORestry via Economically Viable European Routes	€ 9 937 998	Sept. 16
BIOrescue	Enhanced bioconversion of agricultural residues through cascading use	€ 2 635 140	Sept. 16
BIOSKOH	BIOSKOH's Innovation Stepping Stones for a novel European Second Generation BioEconomy	€ 21 568 195	June 16
Carbosurf	New processes for the fermentative production of glycolipid biosurfactants and sialylated carbohydrates	€ 2 730 605	Aug. 15
DEMETER	Demonstrating more efficient enzyme production to increase biogas yields	€ 4 629 586	Aug. 16
EFFORTE	Efficient forestry by precision planning and management for sustainable environment and cost-competitive bio-based industry	€ 2 230 221	Sept. 16
EnzOx2	New enzymatic oxidation/ oxyfunctionalization technologies for added value bio-based products	€ 3 000 000	Nov. 16
EXILVA	Flagship demonstration of an integrated plant towards large scale supply and market assessment of Microfibrillated cellulose	€ 27 433 610	May 16

ACRONYM	PROJECT TITLE	BBI JU CONTRIBUTION	STARTING DATE
FIRST2RUN	Flagship demonstration of an integrated biorefinery for dry crops sustainable exploitation towards bio-based materials production	€ 16 995 882	July 15
FRESH	FRESH - Fully bio based and bio degradable ready meal packaging	€ 5 636 813	Oct. 16
Funguschain	Valorisation of mushroom agrowastes to obtain high value products	€ 5 700 547	Nov. 16
Greenlighy	Cost effective lignin-based carbon fibres for innovative light-weight applications	€ 1 299 164	July 15
GreenProtein	Revalorisation of vegetable processing industry remnants into high-value functional proteins and other food ingredients	€ 4 246 122	Sept. 16
GreenSolRes	Demonstration of solvent and resin production from lignocellulosic biomass via the platform chemical levulinic acid	€ 7 451 945	Sept. 16
HYPERBIOCOAT	High performance biomass extracted functional hybrid polymer coatings for food, cosmetic and medical device packaging	€ 4 617 423	Sept. 16
InDIRECT	Direct and indirect biorefinery technologies for conversion of organic side-streams into multiple marketable products	€ 1 347 947	Nov. 16
LIBBIO	Lupinus mutabilis for Increased Biomass from marginal lands and value for BIOrefineries	€ 4 923 750	Oct. 16
LIBRE	Lignin Based Carbon Fibres for Composites	€ 4 919 060	Nov. 16
LIGNOFLAG	Commercial flagship plant for bio-ethanol production involving a bio-based value chain built on lignocellulosic feedstock	€ 24 739 430	June 15
LIPES	Life Integrated Process for the Enzymatic Splitting of triglycerides	€ 4 448 374	Sept. 16

ACRONYM	PROJECT TITLE	BBI JU CONTRIBUTION	STARTING DATE
MACRO CASCADE	MACRO CASCADE – Cascading Marine Macroalgal Biorefinery	€ 4 156 356	Oct. 16
NeoCel	Novel processes for sustainable cellulose-based materials	€ 2 441 612	Sept. 16
NewFert	Nutrient recovery from bio-based Waste for Fertilizer production	€ 1 209 520	July 15
PROMINENT	Protein Mining of Cereal side-streams Exploring Novel Technological Concepts	€ 1 685 006	July 15
PROVIDES	PROcesses for Value added fibres by Innovative Deep Eutectic Solvents	€ 1 079 551	July 15
Pulp2Value	Processing Underutilized Low value sugar beet Pulp into VALUE added products	€ 6 589 180	July 15
PULPACKTION	Optimised moulded pulp for renewable packaging solutions	€ 8 303 374	Oct. 16
SmartLi	Smart Technologies for the Conversion of Industrial Lignins into Sustainable Materials	€ 1 481 258	July 15
STAR4BBI	Standards and Regulations for the Bio-based Industry	€ 995 880	Sept. 16
TECH4EFFECT	Techniques and Technologies for Effective Wood Procurement	€ 4 999 902	Oct. 16
US4GREENCHEM	Combined Ultrasonic and Enzyme treatment of Lignocellulosic Feedstock as Substrate for Sugar Based Biotechnological Applications	€ 3 457 602	July 15
ValChem	Value added Chemical building blocks and lignin from wood	€ 13 125 941	Nov. 15
Zelcor	Zero Waste Ligno-Cellulosic Biorefineries by Integrated Lignin Valorisation	€ 5 256 993	Oct. 16

Table of bio-based products

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