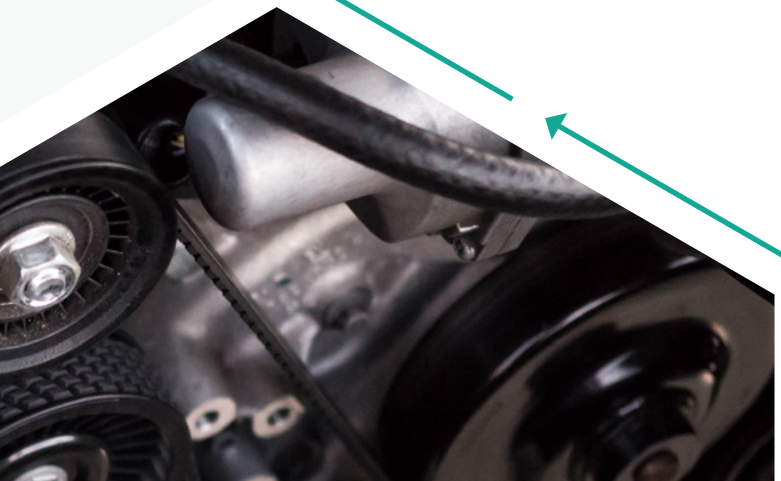
UNLOCKING THE POTENTIAL OF THE BIOECONOMY

BIO4 PRODUCTS
Creating sustainable resources for process industry



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Bio4Products is an EU-funded Innovation Action which answered the call for 'Industrial technologies for the valorisation of European bio-resources into high added value process streams' (SPIRE-03-2016).

Between 2016 and 2021, seven partners worked together towards the common goal of creating sustainable resources for process industry.

Click on the graphic to find out more about each part of the project.

TOWARDS A SUSTAINABLE BIO-BASED ECONOMY

2020 was a crossover point in human history. For the first time, man-made materials – buildings, objects, infrastructure - outweigh the mass of all living organisms.

Our use of natural resources is unsustainable: to continue this way will soon need 3 planets. So, we urgently need new ways of producing and consuming that respect the ecological boundaries of planet Earth.

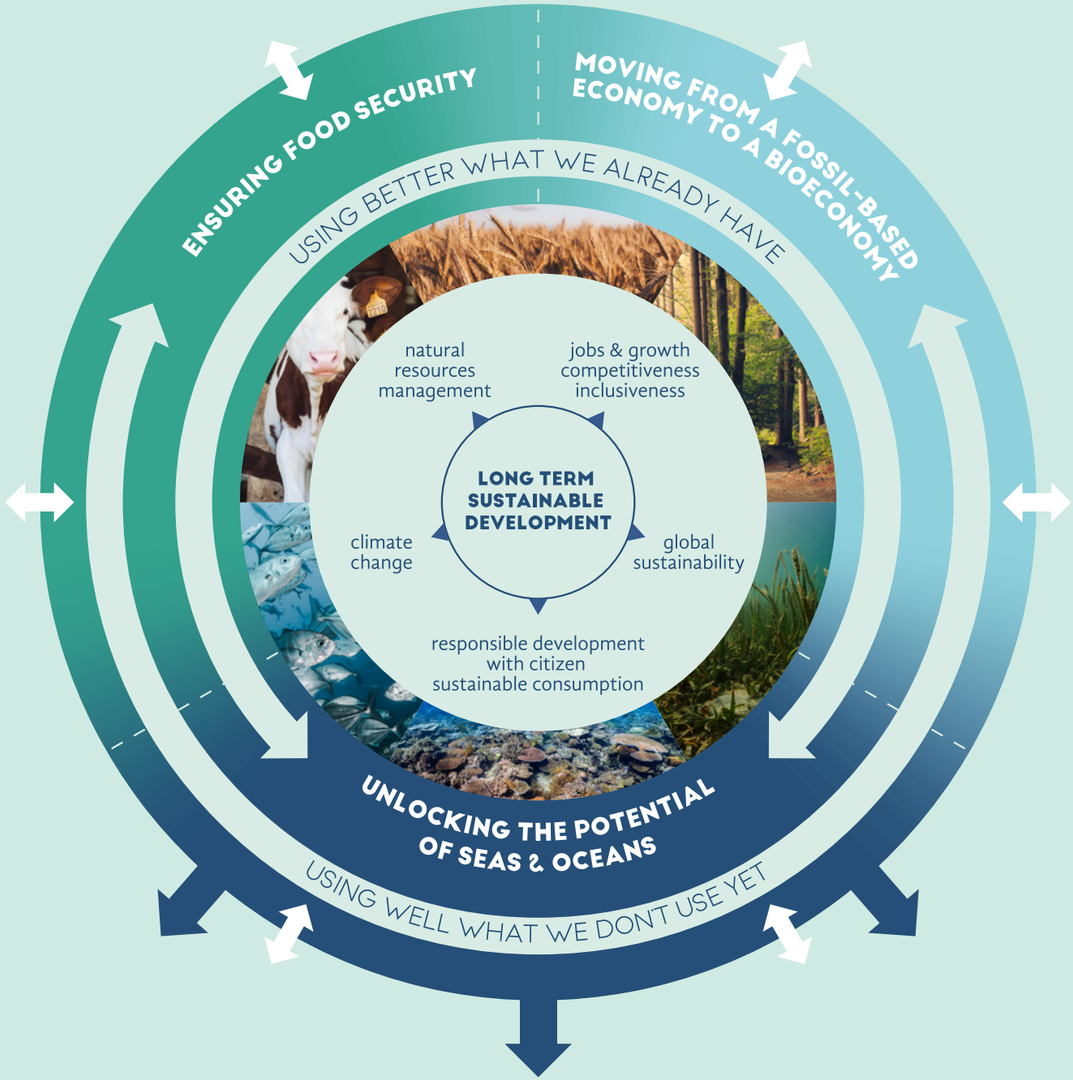
The replacement of fossil resources by renewable resources in the production of fuels and chemicals is a key part of the solution. To succeed, this transition to a 'bioeconomy' requires new industrial processes which can efficiently convert biomass into safe and sustainable bio-based products.

The Bio4Products project has contributed to this transition, successfully demonstrating the feasibility of a novel biorefinery technology based on fast pyrolysis, which can efficiently convert a range of solid biomass into sustainable bio-based products.

5 GOALS OF THE **EU BIOECONOMY STRATEGY**

- ensure food and nutrition security
- manage natural resources sustainably
- reduce dependence on non-renewable, unsustainable resources
- limit and adapt to climate change
- strengthen European competitiveness and create jobs

The EU Bioeconomy Strategy contributes to the European Green Deal, as well as industrial, circular economy and clean energy innovation strategies. It is represented visually on the opposite page.



SUSTAINABLE FEEDSTOCK SELECTION

For any bio-based project, identifying the right feedstock strategy is key. One of the first steps to make the project viable is to secure a continuous and long-term supply of biomass, ensuring the plant runs efficiently and without interruptions. The cost and sustainability of the chosen biomass are equally crucial.

Within the Bio4Products project Capax Biobased Development evaluated the overall availability and quality of suitable biomass feedstocks. They first researched the total availability of selected biomass feedstocks in EU member states, focusing on lignocellulosic by-products and residues.

Going a step further, a study was conducted into the composition and processability of different biomass feedstocks, to find the most suitable for producing bio-based products via fast pyrolysis conversion. Of the 10 feedstocks studied, sunflower seed husks and poplar wood slabs came out on top.

AMANDA KOZLO / CAPAX BIOBASED DEVELOPMENT

"We came up with a term 'virtual plant location' to identify the feedstock needs of a pyrolysis plant in a specific region/location. This allowed us to assess all parameters like availability, distance and accessibility in detail. We considered a couple of extra types of feedstocks for the project as we were getting inspired. At the end of the day we evaluated all of the Europe and selected four main regions and specific sites with a high potential.

A project like Bio4Products contributes to a more circular and greener Europe. Even if it takes many, many, steps, I truly believe that this project contributed to a better understanding of how to get there."

VIRTUAL PYROLYSIS PLANT LOCATIONS

Bergen op Zoom, The Netherlands.
Feedstock: Poplar (Short Rotation Coppice and phytoremediated poplar)

Marne region, France.
Multi-feedstock: Wheat straw, Flax shives, Forestry chips (hardwood), Poplar wood slabs (sawmill residues)

South Karelia region, Finland.
Feedstock: Forestry residues (softwood)

Moldova region, Romania.
Feedstock: Sunflower husks

FIND OUT MORE

Choosing the right biomass feedstock strategy (webinar)
Virtual Pyrolysis Plant Locations: Availability and quality of biomass at four potential sites (report)
Chemical composition of ten biomass feedstocks and their suitability for conversion by fast pyrolysis (report)

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FIRST-OF-A-KIND BIOREFINERY

Thermo-chemical fractionation is an innovative two-step conversion process to transform different bio-resources into raw-materials for renewable chemicals and products. In this approach, a short thermal treatment at elevated temperature (fast pyrolysis) is followed by a low temperature fractionation of the mineral free, liquid product (fast pyrolysis bio-oil) that keeps the key chemical functionalities intact in separate, depolymerised fractions.

Following previous testing at bench scale, within the Bio4Products project BTG Biomass Technology Group designed, constructed and commissioned a pilot fractionation unit with a throughput capacity of 3 tonnes per day of fast pyrolysis bio-oil – a ten-fold scale-up of the bench-scale unit. The properties of the fractions obtained with the pilot plant are very similar to those produced in the bench-scale unit. The main products are:

- **Pyrolytic lignin:** A raw material suitable for the production of various resins as a replacement for fossil phenol.
- **Pyrolytic sugars:** A raw material suitable for the production of furan based resins and formulations to modify/engineer wood.
- **Extractives:** A raw material for specialty chemicals (analogous to "pine chemicals").

BERT VAN DE BELD / BTG BIOMASS TECHNOLOGY GROUP

"Our major achievement in Bio4Products has been the upscaling from lab scale to a full-scale fractionation pilot plant. Importantly we also proved the fractions we make are sustainable, complying with all relevant sustainability criteria. On top of this we were also able to show that we can apply this fractionation process to pyrolysis oil originating from different types of biomass, which is important for the further deployment of the technology.

Looking to the future, now we have shown the feasibility of the fractionation plant, its likely we will look to commercialise it through our sister company BTG Bioliquids. They can then offer fractionation as an add-on to the fast pyrolysis plants currently being marketed."

FIND OUT MORE

Developing a pyrolysis based biorefinery (webinar)
Thermo-chemical fractionation (TCF) of lignocellulosic biomass (slides)
Pilot plant for extracting bio-based chemicals and materials from pyrolysis oil (factsheet)

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NEW PRODUCTS FROM LIGNIN

Lignin, a basic component of almost any plant that grows, is a promising renewable resource for Europe's process industry.

In the framework of Bio4Products, Bakelite Synthetics, a global leader for phenolic speciality resins, succeeded in partially replacing fossil phenol with lignin in resins. Together with their customers, Bakelite Synthetics developed several different products using the resins, including insulating foams, moulding compounds and wood-based applications.

The insulation foams are the most advanced in terms of product development. Testing showed these bio-based foams have improved material properties compared to those using conventional resins, including better fire performance and compression strength.

MELIKE BAYRAM / BAKELITE SYNTHETICS

"Within Bio4Products we were able to go from basic research to actual products in their end applications. Phenolic resin is an intermediate product, and we were able to work with actual customers outside of the project who incorporated these green resins in their products.

If we manage to execute everything with our customers, we could introduce a game-changer with regard to the insulation foam, potentially triggering a real change in the European market. There is no other phenolic resin for this type of application that introduces this bio-feedstock in the formulation; being the first would be a huge benefit for us."

FIND OUT MORE

New products from lignin (video)
Bio-based products from fast pyrolysis oil (webinar)
Resins and moulding compounds from lignin (slides)

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BAKELITE SYNTHETICS

WORLD-FIRST PILOT PLANT

The beating heart of the Bio4Products project is the pilot plant built by BTG Biomass Technology at their premises in Enschede, The Netherlands. This first of a kind thermo-chemical fractionation plant represents an important step towards the commercialisation of a fast pyrolysis based biorefinery. More on pages 8 and 9.

POLYMERS, RESINS AND ADHESIVES FROM PYROLYTIC SUGARS

TransFurans Chemicals (TFC) is the pioneer in Furfural chemicals. For the past 45 years they have been producing basic chemicals from renewable raw materials (biomass).

Within Bio4Products they have looked into utilising pyrolytic sugars in the production of PFA based resins. These have applications in heavy industry and modification/engineering of wood used in various applications.

Combining the pyrolytic sugar fraction with polyfurfuryl alcohol resins TFC also prepared wood modification formulations, which have been utilised by Foreco, also within the project (see more on next page). The companies have a joint pilot plant for wood impregnation at Foreco's premises in the Netherlands.

HANS HOYDONCKX / TRANSFURANS CHEMICALS

"The molecules and fractions that were offered to us in the project were completely new and we've been able to show that they can be converted into polymers, resins and adhesives and be integrated in a chemical manufacturing process.

In Bio4Products we've clearly demonstrated the high potential for wood modification, making lots of nice products, but in the long term I'm convinced there will be many more applications."

FIND OUT MORE

Bio-based products from fast pyrolysis oil (webinar)
Sustainable chemicals from renewable raw materials (factsheet)

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TFC
BIOMASS BASED CHEMICALS

WOOD MODIFIED WITH WOOD

New wood preservatives are in high demand as companies look for sustainable alternatives to creosote, a toxic chemical, and imported tropical hardwood, which can contribute to deforestation.

Within Bio4Products, Dutch timber company Foreco developed a sustainable alternative: Faunawood. Faunawood uses European pinewood impregnated with a resin formulation developed by TFC. After impregnation, the poles are dried and cured, fixing the resin in the wood.

The result is a durable, strong wood pole, suitable for various applications. The impregnation ensures the product is not damaged by wood rotting fungi and termites for at least 25 years.

Because the resins are made of wood residues, an old Faunawood pole can be used as input for future products: a 100% circular solution.

ADAM TURI / FORECO

"The whole idea of the Bio4Products project was to use more renewable materials and we actually achieved the goal to make them more sustainable. We had the idea and dream to use wood in a circular way and I think we achieved that. We learned that the technology is possible and this idea of 'cradle to cradle' is a feasible option. We will continue to innovate and develop other segments of this innovation in the future.

The timber industry is very traditional and stakeholders - though not all of them! - are generally resistant to change. So, I think the timber industry should have more focus on marketing and product development to prepare the consumer to understand these products and their positive features."

FIND OUT MORE

Bio-based products from fast pyrolysis oil (webinar)
FaunaWood - wood modified with wood, a circular alternative to creosote (video)
Life Cycle Assessment on a Biorefinery Approach to Pyrolysis Oil for Wood Modification Treatment (Report)

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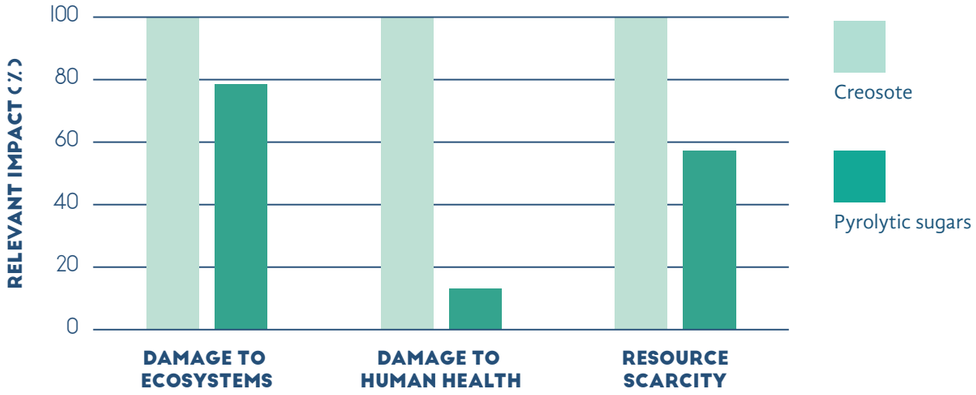
FORECO houtproducten

SUSTAINABILITY OF THE VALUE CHAINS

The main ambition of Bio4Products is to create 'sustainable resources for process industry'. But how do we know if the products are really sustainable or not?

To answer this BTG Biomass Technology Group's Consultancy department conducted a large-scale study into the environmental impacts of the four products. The Life Cycle Assessment (LCA) involved an analysis of 17 different impacts clustered around three end points: damage to human health, damage to ecosystems and damage to resources.

The results prove that all value chains show significant Greenhouse Gas (GHG) savings and overall low environmental impacts. The 'Faunawood' modified wood product, for example, was found to contribute 82% less greenhouse gas emissions compared to fossil-based creosotes. Due to lower its toxicity it is also more than 7 times less damaging to human health.



JURJEN SPEKREIJSE / BTG BIOMASS TECHNOLOGY GROUP

"This is the first time that we conducted such a large-scale LCA on multiple products and product flows. We had four different biomass streams and four different products so it's quite a lot of value chains that you have to go through!

For BTG the exercise has been really important because we want to make sure that products from pyrolysis oil are safe for society, and there is no question of burden-shifting or greenwashing. Sometimes a person can look at a product and say 'oh, this is very green' not knowing that the producer deals with waste in a horrible way. By doing an LCA we consider all the environmental impacts and can really make sure we offer a more sustainable product compared to the fossil fuel alternatives. As an outcome of Bio4Products, this is a really important one."

FIND OUT MORE

Life Cycle Assessment on a Biorefinery Approach to Pyrolysis Oil for Wood Modification Treatment (Report)
Sustainability and lifecycle assessment of pyrolysis oil production and applications (Report)
How sustainable is 'bio-based' anyway? (Webinar)

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MARKET PERSPECTIVES

For Bio4Products to have the desired impact on the process industry the value chains demonstrated in the project will need be scaled up in the years to come. For this to happen requires more than just technical feasibility, but also economic viability and a sound business case.

Sustainable energy consultancy company E4tech was charged with investigating this during the project. Their work had two main focuses. The first was to develop a cash-flow model and risk assessment for upscaling the fast pyrolysis biorefinery. The models included a sensitivity analysis of various scenarios which can be used as a basis for future analysis for a first of a kind commercial plant.

The second activity carried out by E4tech was a market assessment for the four end products. This helped the industrial partners to understand the size of their target markets - and potential new markets.

PRAGNA KIRI / E4TECH

"Working really closely with the partners has been very valuable, helping us and them to understand the technical, regulatory and environmental barriers that need to be overcome in the years ahead.

A competitive analysis to help partners understand their strategic positioning in the market has been really useful as well, and, going forward, can help them to prioritise their next steps in developing their business plans. There are many markets where these products could be applicable and where industries are looking to replace fossil-based products with bio-based products.

Taking part in Bio4Products has particularly helped us to expand our knowledge around bio-based products and the pyrolysis platform, which has informed our other activities such as the Biorefinery Outlook and RoadToBio projects."

FIND OUT MORE

Emerging biorefinery technologies and pathways to deployment (webinar)
Biorefinery pathways and outlook for deployment (project)
Roadmap for the Chemical Industry in Europe towards a Bioeconomy (project)

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Strategy | Energy | Sustainability

The present booklet introduces the main outcomes of the Bio4Products project which ran from September 2016 to June 2021. The project received funding from the SPIRE Public Private Partnership within the European Union's Horizon 2020 research and innovation programme, under Grant Agreement N° 723070. Further information about the project can be found via the project website and the EU research results portal Cordis.

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IMAGE SOURCES

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