The Bio-based Industries

VISION

Accelerating innovation and market uptake of bio-based products

A PUBLIC-PRIVATE PARTNERSHIP ON BIO-BASED INDUSTRIES

July 2012
The European Public-Private Partnership on Bio-based Industries

Investing in new and sustainable ways to organise our economy

Translating the EU’s R&D potential into new bio-based products and markets

Enabling rural development and re-industrialisation

Connecting farmers and foresters to consumers with locally sourced and produced goods/products

Accelerating the transition towards smart and efficient use of resources

Strengthening European competitiveness in the global bio-based economy race

Laying down the foundations of the post-petroleum society

For more information visit our website www.biconsortium.eu or email us at info@biconsortium.eu

Disclaimer

This document reflects the potential, ambitions and vision of the founding members of the Bio-based Industries Consortium (BIC) in July 2012, and forms the basis of the Bio-based Industries initiative together with the European Commission strategy ‘A Bioeconomy for Europe’. References to figures, budgets, public and private contributions, statistics are those that were official in July 2012. Changes may have occurred since with, for instance, the EU legislative process on the proposal for a Council Regulation establishing the Bio-Based Industries Joint Undertaking.
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We envisage a bio-based economy founded on locally sourced and produced plant and waste-derived materials, chemicals, fuels, food and feed.

At the heart of this vision are biorefineries which will gradually replace oil refineries by using renewable resources in place of fossil fuels. In doing so, biorefineries will play an important part in spurring growth and drive the effort to reindustrialise Europe.

To accelerate innovation and to boost market uptake and public awareness of bio-based products, a European Public-Private Partnership (PPP) for bio-based industries is needed.

Putting the European Commission’s strategy “A Bioeconomy for Europe” into practice, the objectives of the PPP are to foster “radical innovation”, from R&D and deployment to market pull, to deliver bio-based products superior, or at least comparable to, non-bio-based products in terms of price, performance, availability, and sustainability.

This global paradigm shift from oil-based towards bio-based materials represents a unique opportunity for Europe to kick-start a world-leading competitive bioeconomy with significant economic, environmental and societal benefits. It will build on existing EU strengths and resources, embracing technological and scientific excellence and creating new and novel partnerships between hitherto unconnected industries. Supplementing food production, the conversion of biomass into bioproducts will likewise present a chance for the EU27 agricultural and forestry sectors to diversify revenues and revitalise rural areas.

Emerging global trends show that leading economies are seizing on the bioeconomy too. The US and China have declared the bioeconomy a priority, putting in place ambitious bioeconomy policies and investments in biorefineries. Nevertheless, the EU, with its strong agricultural, agro-food and forest-based sectors and world-leading companies in the plant breeding, biotech, renewable energy and chemical/biochemical industries, is technologically poised to spearhead the development of a bio-based economy with a global market value of €200bn by 2020.

Whilst the European industry is already making significant investments in biorefineries, there remain critical technological, political and commercial challenges to be overcome before any large-scale commercialisation can succeed and innovative solutions brought to the market. Some of these barriers relate to the nascent and fragmented nature of emerging bio-based industries as well as incoherent policy frameworks.
Yet the most fundamental challenge which remains is to build new value chains and improve the economics of production through upscaling and industrialisation.

For now, steep financial first-mover-risks hold back further developments for Europe as a "chicken-or-egg" dilemma prevails: The EU will not reap the benefits of its scientific and technological expertise in the bioeconomy without investment in large-scale biorefineries. Yet, investments will not be made in biorefineries without support for biomass value chains via farmers, foresters and waste management authorities - and vice versa.

The interdependency and complex value chains across a wide range of products and sectors calls for a coherent and coordinated EU approach. However, another rationale for an EU led PPP is evident: most of the barriers/challenges to kick-start a bio-based economy – from sustainable biomass supply to market pull via targets, product standardisation and green public procurement schemes – are not adequately addressed at national level but rest firmly on Community-level regulation, i.e. the Common Agricultural Policy, environmental regulations and the single market.

Focus of the Bio-Based Industries PPP:

• **Feedstock:** foster a sustainable biomass supply with increased productivity and building new value chains;

• **Biorefineries:** optimise efficient processing through R&D and upscaling at large-scale demo/flagship biorefineries;

• **Markets, products and policies:** develop markets for bio-based products and optimising policy frameworks.

The Bio-Based Industries PPP will pool Member State expertise and form an umbrella for national strategies and projects. Also, it will enable national and regional clusters to flourish and provide crucial support to national initiatives, being inclusive and open to all players in the bioeconomy. In this respect, SMEs play a critical role as the future bioeconomy will be a cluster of local and regional installations, catering to global industries for global markets.

Companies involved in the preparation of the PPP - the “Founding Members”- estimated that during the period 2014-2020 they will invest more than €2.8bn in collaborative research, development and deployment of bio-based technologies, provided conducive policy frameworks are in place. In addition, the PPP will further leverage and facilitate access to additional funding from other companies and funding sources such as national agencies, research institutions, private foundations or venture capital firms. This is expected to at least double the initial investment of the Founding Members.

Bio-based Industries Vision

In 2030 the European bio-based economy will be flourishing, with biorefineries playing a key role in the reindustrialisation of rural Europe. Based on demands of a more conscious and resource-efficient society and market, versatile biomass supply chains will feed full-scale, integrated biorefineries and sustainably process biomass into a spectrum of marketable products and energy.
Bio-based Industries Objectives 2030

- Reindustrialise Europe by creating a new rural infrastructure of biorefineries;
- Diversify farmer's income and provide them with additional margins by up to 40% by using available residues;
- Enable 30% of overall chemical production to become bio-based. For high added value chemicals and polymers (specialties and fine chemicals), the proportion is more than 50%, while less than 10% of bulk commodity chemicals are derived from renewable feedstocks;
- Supply 25% of Europe's transport energy needs by sustainable advanced biofuels;
- Support the European market for bio-based fibre and polymers such as viscose, carbon fibres, nano-cellulose derivatives and bioplastics to grow rapidly. Traditional fibre products such as paper remain 100% bio-based to create more value out of the same resources;
- Realise a new generation of bio-based materials and composites produced in biorefineries, allowing the production of better-performing components for industries including automotive, construction and packaging.

The Bio-Based Industries Public-Private Partnership answers three main European challenges to the creation of a bio-based economy in 2030. It aims to keep Europe in the fast-growing global bio-based economy race, by creating new untraditional partnerships and innovative value chains, and bringing competitive solutions to the market.

This ambition will be achieved through a coherent set of actions that aim to remove the economic, competitive, technological and societal barriers to the realisation of the PPP’s objectives: actions that build innovative competitive bio-based value chains, contributing to a competitive, innovative and sustainable Europe, and that decouple European economic growth from resource use while leading the transition towards a post-petroleum society.

1.1 PPP initiative backed by a committed consortium

A group of more than 30 leading companies and clusters from current and future bio-based sectors, across Europe, has taken the initiative to develop a joint vision on how to reach a substantial bio-based economy. The cooperation and exchange between chemical, pulp and paper, food, sugar, starch, energy and biofuel companies promises to be extremely fruitful and holds great potential. The industry-led initiative builds on work done under the seventh EU framework programme for research, member states’ national bio-based economy policies and national clusters’ activities. Research organisations and academics are joining the work to be done. The key term for success is the joint multi-sectoral approach, learning from each other and working together.

The founding partners have committed to invest above €2.8 billion in research and innovation efforts between 2014 and 2020, if the right framework conditions can be developed. Demonstration and flagship plants play a key role. This industry commitment will be leveraged to multiply the monetary commitment when additional partners join, national strategies come into force and research programmes bring in the scientific, academic and research communities. The aim of the PPP is to have this investment matched by an equal amount of public funding. Furthermore, the development of value chains and industries resulting from the initial investments will generate at least €5 for each public euro spent.

As a first step, €1 million will be made available by the private sector to develop the PPP initiative and the subsequent research agendas further. A central coordinator will start activities soon and funds will be made available for studies to further strengthen the economic impact assessment.

The PPP is supported by the following established European Technology Platforms: Suschem, Plants for the Future, the Forest-based Sector Technology Platform, European Technology Platform FoodforLife, European Biofuels Technology Platform, Manufacture, and European sector organisations such as COPA COGECA,
CEPI, EuropaBio, European Seed Association, ERRMA, European Bioplastics, FoodDrinkEurope, and CEFIC. It will align with the activities of the European Industrial Bio Energy Initiative. It will reinforce national and regional clusters working on the bio-based economy. It aims to be inclusive and open to all players in the bio-based economy.

SMEs play a crucial role in this respect – as the future bio-based economy will be a cluster of local and regional installations, catering to global industries for global markets.

1.2 Strategic objectives

In the future bio-based economy biorefineries play a central role. Versatile biomass supply chains will feed full-scale, highly efficient, integrated and sustainable industries, processing biomass into a spectrum of marketable products and energy. New innovative value chains will have grown on the interface of the different traditional sectors that have succeeded in combining their key strengths to create the critical mass to attract investors, policy makers and young talent. These value chains will provide European industry with a competitive edge in the global market.

By optimising land use and complementing food production, the Bio-Based Industries Public-Private Partnership aims at ‘producing more using less’ meaning optimizing the value creation from the resources and closing loops. The PPP is based on a cascaded approach, driven by the need to create added value, prevailing market demands and promoting the most efficient use of biomass.

In more detail, the PPP objectives are to:

Address the Investment challenge to keep Europe in the global bioeconomy race

Overcoming the barrier of investment risk in the piloting and demonstration phases in order to prove the viability of the new value chain. The PPP will especially stimulate the development and building of pilots and demonstration/flagship plants in operation by 2020.

• Provide a long-term innovation agenda ensuring upfront commitment on investments;

• Reverse current trends of attracting investments in regions outside Europe. It will leverage and facilitate additional funding sources like national agencies, private foundations or venture capital firms.
Address the Innovation challenge
A number of additional obstacles remain to be overcome in bridging the gap from research to marketable innovation of bio-based products. These include the need to:

• Embrace the challenge of the gradual change from oil-based feedstock to renewable bio-based feedstock;
• Support projects covering whole value chains from plants to products, linking industries involved in biomass supply, biorefineries and product innovation;
• Focus on actual realisation of new value chains: implementing and integrating all technologies and concepts required, while identifying necessary strategic research topics for the development of game-changing technologies for the medium and longer-term;
• Create ‘unconventional partnerships’, bringing together several traditionally separate industry sectors and disciplines as well as different parts of the biomass-to-products value chains;
• Create an institutional PPP functioning as a European platform specifically addressing the general challenges the bio-based economy faces, including communication, policy support, facilitating consumer and market demands and harmonising sustainability topics.

Address the Integration challenge and build the value chains

• Foster a sustainable biomass supply and build new value chains: Improving output from agriculture, agro-food and forestry in a sustainable and foreseeable manner for feeding an increasing population and producing bio-based products with a view to valorising local resources; building logistics & infrastructure for more competitive transport of various feedstock/biomass to the new biorefineries;
• Optimise efficient processing: biorefineries as the core processing operations linking biomass supply to market demand, while promoting the most efficient use of biomass;
• Develop markets, products and policies: Many well-known brand owners have stressed their ambitions to replace their packaging materials with bio-based materials. The PPP aims to develop and deliver those products and at the same time speed up the creation of new markets and new products.

Achieving the full potential of the bio-based economy requires swift and concerted action by the industry across the whole value chain, closing the gap between scientific feasibility and industrial applications and enhancing strategic cooperation between sectors: the PPP embraces the integrated value chain approach, linking industries involved in biomass supply (breeding and plant production, forestry, valorisation of waste, farming), in biorefineries (transport, storage, separation, isolation) and in product innovation (biochemical, biomaterials, advanced biofuels, food & feed ingredients).

5 Based on the Joint Technology Initiative provision of the Treaty (Art 187 TFEU)
6 See chapter 7 for more information on the structure
OBJECTIVE:
Diversify farmer’s income and provide them with additional margins by up to 40% by using available residues

2. ANSWERING EUROPE’S BIO-BASED CHALLENGES

A sustainable growth of the bio-based economy requires a dedicated approach addressing specific common challenges on communication, policy and sustainability, while integrating cooperation between stakeholders over different disciplines and value chains. This integrated PPP approach is needed to tackle the most important challenges.

Keeping Europe in the global race
Europe is technologically well positioned to spearhead the development of a new bio-based economy, with strong agricultural, agro-food and forestry sectors and world-leading companies in the plant breeding, biotech and chemical/biochemical, engineering and energy industries. Although EU industry has already started to make significant investments in biorefineries – e.g. in France, Germany, Finland, Netherlands, Denmark, Italy, Spain – this has so far been done in a fragmented manner. Europe needs to maintain its competitive edge by consolidating and capitalising its prominent knowledge base and creating the necessary framework conditions for industry to increase its investments in Europe. The Bio-Based Industries PPP is set to become a hub for Member States which have already in place bioeconomy strategies and also for those which still do not have one in order to promote coherent programmes at national and regional levels in line with the objectives of the European Commission.

Improve the competitiveness of bio-based products
The most pressing challenge for all bio-based industries is to improve the economics of production through upscaling and industrialisation in order to bring competitive solutions to the market. This is as much an innovation challenge as an investment challenge. “Radical innovation” to bring R&D towards deployment and market pull is needed to deliver bio-based products superior or at least comparable to non bio-based products in terms of price, performance and availability and environmental benefits.

- Continue research and innovation on technologies & processes which are not yet developed or proven at demonstration/commercial scale;
- Establish economically competitive production at scale;
- Remove sector barriers, and create new value chains from farms, forests, agro-food and pulp industry to consumers in a cradle to cradle approach.

Accelerate building of the value chains
Diverse technical, strategic and commercial challenges have to be addressed in parallel in order to ensure a smooth transition and a lasting success. Companies which today do not engage in joint business activities need to come together in untraditional partnerships and cooperate on:

- Research and innovation on the three challenging parts in the value chain: fostering a sustainable biomass supply; optimising efficient biorefineries; and developing markets and products;
- Encouraging optimal integration within existing industrial infrastructures of agro-food, pulp/paper, chemical and energy companies as well as local agricultural practices and logistics;
- Promoting a global vision with local benefits: Biorefineries close to the raw materials and to customers minimizing transport and promoting recycling. Centralising integrated biorefineries to improve process efficiency and benefit from economy of scale and industrial symbiosis and trading of bio-based products in the global market.
Enable 30% of overall chemical production to become bio-based.

For high added value chemicals and polymers (specialties and fine chemicals), the proportion is more than 50%, while less than 10% of bulk commodity chemicals are derived from renewable feedstocks.
3. STRONG ADDED VALUE OF ACTING AT EU LEVEL

The multi-sectoral approach in the Bio-Based Industries PPP will combine the strengths of industries, regions and countries which each on their own would not be able to enable the transition from oil & gas to a bio-based sustainable future.

Highly forested countries and agricultural regions will be linked to industrial centres in Europe. Core to the bio-based economy is the development of integrated value chains, which combine new sources of income for farmers and foresters, develop bio-based industries, create new products, and fulfil the sustainability requirements that need to be met. We envisage an EU-wide network of regional and local biorefineries that add value to available residues and renewable raw materials, create jobs that did not exist before in local, regional and rural settings, and transform sustainable biomass into chemical intermediates and consumer & industrial products that support the competitiveness of European Industries worldwide.

The PPP aims to create a new EU raw material base, reducing dependence on other regions, increasing resource efficiency, and creating value and jobs to the EU economy. Due to the regional character of the bio-based economy and biomass value chains, it will provide opportunities in all four corners of the EU, in all member states.

The EU approach has a distinct added value, complementing and bringing together national approaches. The EU mandates on the Common Agricultural Policy and the EU Horizon 2020 programme that combines knowledge and expertise from member states with the technologies available in other member states and the value chains in the different EU regions add up to a much larger effort than single projects alone. The PPP projects will therefore where possible be combined with national projects and structural and regional funds to achieve a multiplier effect.

This approach will enable Europe to play to its strengths making it more competitive in the worldwide market and better placed to export key technologies and products to lead the transition to a post-petroleum society.
OBJECTIVE:
Supply 25% of Europe’s transport energy needs by sustainable advanced biofuels
Biorefineries offer the opportunity to revitalise rural Europe by creating a new manufacturing base, linking R&D activities to local/regional production.

Standing at the forefront of a new era, the enormous potential of the bio-based economy can only be envisaged for the moment. Nevertheless what is already manifest is its **significant revenue and job creation potential** along the entire biomass value chain in Europe and globally.

The turnover and employment of the European primary and processing bio-based sectors (see table 1 below) will increase by at least 10%, resulting in 3 million extra jobs and an €80bn increase in turnover.

A number of independent studies corroborate the bio-based Economy’s economical potential:

- The World Economic Forum has estimated the global revenue potential of the entire biomass value chain to be more than €200bn by 2020.8
- According to Bloomberg New Energy Finance (BNEF), if 10% of cellulosic ethanol was used in gasoline cars in Europe by 2030, the revenue potential would be €78bn and 170,000 jobs would be created.9
- 10% more forest biomass can be mobilised by 2030:10 Based on the current employment and turnover figures for the forest and pulp and paper sectors, this would lead to an additional revenue creation of €35bn and 350,000 extra jobs.
- The total value of the European seed market is €7bn, with approximately 7,200 companies employing over 50,000 people. The necessary growth in biomass production will increase the turnover and employment of the seed sector by 10%, resulting in 5,000 extra jobs.
- The EU27 agricultural and forestry sectors will be able diversify their revenues and reinvigorate rural communities. According to BNEF, using only 17.5% of the EU27 residue resource for producing advanced biofuels has the potential to diversify farmers’ revenue and provide them with additional margins by up to 40%.11 BNEF also claims that using only 17.5% of the EU27 residue resource for producing advanced biofuels has the potential to displace between 52% to 62% of the EU27’s forecast fossil gasoline consumption by 2020, reducing the bill of EU oil imports by some €20bn to €24bn.
### Table 1. Key figures on bio-based industries in Europe

<table>
<thead>
<tr>
<th>Sector</th>
<th>Products</th>
<th>Employment</th>
<th>Turnover in EU</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOREST</strong></td>
<td>340 Mton paper</td>
<td>16 million forest owners</td>
<td>€550-600 billion (EU-25)</td>
<td>• Europe accounts for 25-30% of world production of forest-based products</td>
</tr>
<tr>
<td></td>
<td>405 Mm³ sawn goods</td>
<td>3-4 million industrial jobs</td>
<td>8% of GVA in manufacturing industry</td>
<td>• Industrial jobs to large extent in rural areas and SMEs</td>
</tr>
<tr>
<td></td>
<td>200 Mm³ wood-based panels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AGRICULTURE</strong></td>
<td>12.2 million (2009)</td>
<td>5.5% of total EU employment</td>
<td>€168 billion (2009) accounted for 1.6% of the total GVA</td>
<td>Economy of sector in EU undergoing restructuring, due to productivity gains for labour and capital, and decline in relative prices</td>
</tr>
<tr>
<td><strong>STARCH</strong></td>
<td>21 million tonnes/year raw materials</td>
<td>15,500</td>
<td>€7.5 billion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65% food/ 35% non-food use (incl. Feed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUGAR</strong></td>
<td>19-20 million tonnes</td>
<td>28,000 employees and 161,000 beet growers</td>
<td>€14 billion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2% for non-food (fuel, feed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIOFUELS</strong></td>
<td>12 Mtoe (2009) – EU27</td>
<td>150,000</td>
<td>€ 6 billion</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td><strong>CHEMICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIOPLASTICS</strong></td>
<td>196 kton (2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIOLUBRICANTS</strong></td>
<td>137,000 tonne</td>
<td></td>
<td></td>
<td>Forecast production in 2020 with supportive EU measures 420,000 tonne</td>
</tr>
<tr>
<td><strong>BIOCHEMICALS</strong></td>
<td>150,000 (incl. bioplastics)</td>
<td></td>
<td>€50 billion</td>
<td>Largely based on starch, sugar and vegetable oil</td>
</tr>
<tr>
<td><strong>ENZYMES</strong></td>
<td>5,000</td>
<td></td>
<td>€0.8 billion, 64% of global production</td>
<td></td>
</tr>
</tbody>
</table>

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8 The World Economic Forum, “The future of industrial biorefineries”, 2010
9 Bloomberg New Energy Finance, “Moving towards a next generation ethanol economy”, 2012
13 European Bioplastics
15 European Biolubricant Market (Frost and Sullivan) Forecast for Europe to 2013
Thanks to the capturing of CO₂ through photosynthesis the production and use of bio-based materials in the chemical and sectors using renewable raw materials contributes to the mitigation of climate change, improves soil quality and fosters rural revitalisation.

The PPP aims to:

**Reduce the impact on the environment**

Value chains will be based on sustainable biomass production and good forest management practices that contribute to the maintenance of biodiversity and ecosystems. New business concepts forged between forest owners, societies, and the processing industry can balance the demand for biodiversity, recreation, carbon sinks, soil and water protection and water production. Biomass production can even be designed in such a way that pollutants in the soil are collected and removed. Moreover, the use of bio-based products may present many advantages (e.g. biolubricants), and may raise citizen awareness on separate collection of organic waste (e.g. bio-plastics).

**Help mitigate climate change**

With sustainable management, biomass production systems represent a significant carbon sink. With carbon stored in growing biomass, it is also possible to store carbon in bio-based products such as bio-plastics, paper products and construction wood. Such storage is enhanced by proper recycling systems. Afforestation, soil protection and fertility improvement further increase the carbon storage capacity of forests and agricultural land. Bio-based raw materials are the only substitute for fossil fuels for chemicals and materials and are also, in the short term, the only widely-available substitute for oil in transport. The use of advanced biofuels would cut greenhouse house gas emissions by a minimum of 80% compared to fossil fuels. In addition, substitution of other energy intensive materials, such as aluminium and concrete, might also significantly reduce carbon emissions. Industrial biotechnology represents an important group of energy efficient conversion technologies with full climate change mitigation potential ranging between 1bn and 2.5bn tons CO₂ equivalent per year by 2030. Also bio-based materials such as biofiller, used as a substitute for non bio-based alternatives in tyres, can contribute to reduce rolling resistance by 30%, consumption of fuels by cars by 5%, and CO₂ emission by 5%.

**Foster regional competitiveness**

The biorefineries which are currently under construction in several member states severely hit by the current economic crisis are often located in disused and derelict plants and in areas seriously hit by high levels of unemployment. Those reconversion processes are proving to be a key tool to restore regional competitiveness by valorising local territorial resources through innovation. The aim is to increase the value of local territorial resources in synergies with local biodiversity by building operational plants and biorefineries within the EU – and not outside it. This will ensure a greater number of jobs and growth opportunities for all EU citizens.

**Contribute to food security**

Complementing food production by using non-edible biomass for biorefineries will deliver new food and feed ingredients and contribute to global protein availability. The creation of new markets for bio-based products increases the versatility of biomass use and industrial outlets. This will stabilise markets and improve revenues from agriculture and forestry. The increased production in bio-based products implies more feedstuff to the livestock sector where the EU is currently highly dependent on imports (e.g. DDGS from ethanol production, rapeseed meal from oilseed production).
OBJECTIVE:
Support the European market for bio-based fibre and polymers such as viscose, carbon fibres, nano-cellulose derivatives and bioplastics to grow rapidly.

Traditional fibre products such as paper remain 100% bio-based to create more value out of the same resources.
The Bio-Based Industries PPP covers the entire value chain from biomass feedstock cultivation and harvesting / mobilisation to manufacturing of new products and their market penetration. Each step of the value chain faces specific innovation challenges. Projects in the PPP, especially large flagship projects, will consider the whole value chain, placing particular emphasis on certain innovation challenges; more specific research projects will address specific technological barriers.

Integrated bio-based value chains
As the starting point of the bio-based economy, feedstock availability is crucial for the feasibility and economic viability of every value chain. The European agricultural and forestry sectors already have production potential to ensure supplies of food and non-food materials. **The major challenge is achieving an optimal integration of food, feed, bio-based products, fuel and energy production.** The PPP’s objective is to meet the increasing demands for bio-based raw materials sustainably without increasing pressure on natural resources and biodiversity.

**New business models: agriculture, environment and society**

By diversifying outlets for agricultural and forest renewable materials, the bio-based economy can contribute to the creation of a higher, or at least more stable, revenue for both farmers and forest owners, thereby establishing a financial incentive to grow and/or mobilise more biomass. Several solutions will be considered and demonstrated in the PPP:

- Moving from being solely suppliers of raw material to producers performing primary processing, thus capturing more value from biomass;
- Developing new business models to create financial incentives for the farmers and forest owners to produce or mobilise more biomass, demonstrating value creation (economic, environmental and social) at the production/mobilisation stage.

**Sustainable management practices**

The aim is to ensure long-term production of renewable resources in synergy with local territorial specificities and to find an optimum balance between productivity and environmental impact of production and residues mobilisation, so that local societal and economic development can be boosted. Several solutions can be considered and demonstrated in the PPP:

- Adapt forestry and agricultural management practices, considering water and nutrient cycles, soil quality and fertility, crop rotation, ecological services and impact of climate change;
- Develop closed loop systems by utilising recovered minerals and organic matter as fertilisers to improve plant yield and soil quality whilst reducing waste and environmental impact.

**Mobilising an increasing supply**

To achieve optimal biomass supply from agriculture for a variety of products, it is essential to improve plant yield per production unit in a sustainable manner – in short, “producing more and better”. Innovations in plant breeding and good agricultural practice, as well as improved mobilisation of side-streams are major contributors to reaching this goal. The key challenges to mobilisation are the seasonality of most agricultural products and the need for biorefineries to operate all year round to reduce operating costs. In addition, mobilising new biomass requires sufficient economic incentives, and should maintain or improve the environmental sustainability of the production.
Several solutions can be considered and demonstrated in the PPP:

- Plant breeding is critical to ensure higher and stable productivity and sustainability of biomass production; adapt crops to climate change effects and soil conditions; improve feedstock quality and develop dedicated and specialised varieties for biorefinery-targeted applications and end-uses, facilitating the total use of biomass;

- Mobilise currently unused biomass and residues from forests, while maintaining other important functions of woodlands, through improved harvesting technologies and collecting systems and developing a full and steady supply of biomass from scattered forest holdings.

- Identify the potential of existing residue streams (forestry/agro-/horticultural, agroindustrial and consumer residues) and develop or improve their sustainable mobilisation;

- Improved logistics and storage to provide a continuous supply of feedstock, minimise transport costs and guarantee intermediate product quality and availability. Implement innovative technologies and methods to reduce post-harvesting losses in the chain;

- Improved collection, sorting and processing systems for recycled bio-based products.

The Bioeconomy focuses on the use of renewable resources as the major input source for materials, chemicals, food and feed ingredients, and energy and fuels. The bio-based economy offers great opportunities through:

- maximising the value (economic, social and environmental) creation from renewable resources including residues and side-streams (cascading use of biomass),

- encouraging the reuse and recycling of products (cascading use of products),

- aiming towards zero waste generation by developing sustainability management practices and closed loop cycles wherever possible.

Renewable resources of the bio-based economy - plant and animal-based raw materials:

- Agricultural crops (wheat, rapeseed, sugar beets, grass, potatoes, corn, sunflower, lupine, carduus, carthamus brassicaceae...)

- Dedicated ligno-cellulosic / fibre crops (Arundo donax, miscanthus, flax, short rotation copices, ...)

- Dedicated non-edible oil crops (castor, safflower, cambe, calendula, ...)

- Wood, recovered paper and side-streams from forestry, landscape, nature conservation (wood, heath, reed, ...)

- Agricultural residues, partly now being left on the land (beet leaves, grass, straw, ditch cuttings, ...)

- By-streams from horticulture (green house and open-air cultivation)

- Animal side-streams (manure, offal, ...)

- Industrial side-streams:
  - Agro-industrial side-streams, partly now utilised as feed (beer fines, DDGS, beet pulp, potato pulp, potato peelings, dregs of oil, vinasses...); and other pre-consumer side-streams (olive pits, orange peelings, etc.) and waste streams

- Residues from the wood industry / saw mills and other bio-based processes (paper sludge ...)

- By-streams from biorefineries (digestate, ...)

- Process and waste water

- Post-consumer residues (food wastes and other organic waste, sewage sludge, ...)

- New promising biomass sources, with short time to market (e.g. marine biomass)
Efficient bio-based value chains require integrated concepts that utilise all components of the biomass. Biomass needs a refining process that separates complex materials into different valuable components, which then undergo further processing. These biorefinery concepts include the application of advanced separation and conversion processes and biorefineries are based on the principle of cascading use of biomass, driven by the need to create added value, prevailing market demands and promoting the most efficient use of biomass.

In order to enter a commercial stage, the technologies have to be demonstrated on a large scale to verify their feasibility, model their integration into more complex industrial systems and optimise resources use. Scale and level of integration in value chains will vary according to the feedstock, the integration into existing industries or biomass production, and the production of specialty or bulk products.

Primary conversion: Refining of biomass into its valuable components
Primary biorefinery processes aim to obtain the optimal added value from biomass, providing the downstream industries with constant quality and competitively priced bio-based products and building blocks. Primary processing can include one or more of the following steps: cost-efficient preparation of harvested material; cost-efficient fractionation and separation of materials into their basic components; and isolation of specific higher value components in pure forms.

Several solutions will be developed and demonstrated in the PPP:

- Improving existing primary conversion processes (agro-food, pulp and paper) to minimise residues and obtain higher value;
- Robust industrial processes to produce stable quality outputs from variable feedstock quality or mixed streams; lower energy requirements of mechanical processing, and hydrolyse lignocellulose into fermentable sugars;
- Technologies to mildly extract or separate components while preserving their functionalities and minimising the degradation of other components to enable their further valorisation;
- Process intensification - to improve efficiency and allow for smaller-scale, more readily distributed, processing technology;
- Recovery of nutrients (closing the cycle) and proteins (e.g. for feed and food);
- Valorisation of process and waste water: isolation of valuable components from diluted streams.

Secondary conversion: Valorisation of intermediates and products
Individual bio-based components will be further converted and valorised into value-added specialty and platform chemicals, materials, food and feed ingredients, valuable fibres, as well as liquid and gaseous energy carriers. The main challenge is the development of cost and resource-efficient processes for each new product or intermediate and their subsequent integration into complex industrial systems to optimise value and reduce environmental impact (emissions, water use, energy, etc.).

Main technologies include biotechnology, chemical and physical processes and multiple combinations thereof. As example biotechnology, chemo-catalytic and thermo-chemical technologies can be used to achieve the best result in a given industrial setting. For the same product, different feedstock, technical paths or technologies might be used. A critical step, which can represent a large part of the process costs and energy, is the purification of intermediate products or downstream processing. The specific technological challenges will be detailed in the Research and Innovation Roadmap. Cooperation is foreseen with related initiatives that focus on the development of further technologies.

The following themes are of specific interest to be developed and demonstrated in the PPP:

- Developing routes for value extraction from all three major components of lignocellulosic biomass, incl. conversion technologies for lignin for materials and chemical building blocks (bio-based aromatics);
- Development of building blocks optimally utilising the oxygen contained in the molecules;
- Synthesis of new monomers for bio-based polymers with new functionalities.
Focusing on market-driven innovation, the PPP seeks to unleash demand for new bio-based products and solutions as a catalyst for growth and value creation in Europe. In this context, the PPP fully endorses and advocates the implementation of recommendations provided by the European Commission’s Lead Market Initiative for Bio-Based Products.

Many well-known brand owners have stressed their ambitions to replace their packaging materials with bio-based alternatives. The PPP aims to develop and deliver those products and at the same time speed up the creation of new markets and new products. Market-driven research should aim at creating products and opening new markets, and it is essential that bio-based products reach at least the same level of quality as their fossil-based counterparts and have a lower environmental impact. New bio-based materials with equal or superior levels of performance will be developed.

Rather than just mimicking properties of fossil-based products, bio-based products should aim for specific functionalities, taking full advantage of the native properties of biomass and its components. In line with the current trend of major consumer companies to invest in bio-based alternatives to achieve their sustainability goals, the PPP will build on existing demand and will also encourage market push measure (See Annex 3).

Product design should focus on the properties of bio-based products, where possible using natural formulations to achieve desired performance. This will be achieved in close cooperation with stakeholders both upstream (biomass suppliers) and downstream (converters) in the value chain.

The gap between building blocks and final products will be addressed by performing studies on how different bio-based materials and building blocks fit in different applications and value chains in order to establish more uses and markets for the various intermediates and products. This approach will be coupled with a ‘cradle to cradle’ approach, taking into account the whole value chain, including recycling. The following themes are of specific interest for development and demonstration:
6. PRIORITY RESEARCH & INNOVATION AREAS

Technologies
- Polymisation processes for new bio-based monomers;
- Conversion technologies, including chemistry and biotechnology;
- Fractionation and extraction technologies to preserve structure and activities of macromolecules of natural polymers. Advanced functionalisation technologies;
- Biopolymer processing into products (films, fibres, packaging, automotive, agriculture).

Products and materials
- New (chemical) building blocks and bio-based alternatives for existing polymers
- New functional bio-based materials and products: e.g. bioplastics, biocomposites, materials based on lignin, starch, (nano) cellulose or carbon fibres
- Materials based on oils and fats from plants and animals e.g. biolubricants, biosurfactants, biosolvents
- New high-value products, in some cases directly extracted from plants
- Biofuels from waste, residues and lignocellulosic materials
- Identify and create downstream applications for biomaterials
- Standardisation of bio-based products

Policies
The Bio-Based Industries PPP will be the key enabler for implementing the European Commission’s strategy and action plan, “Innovating for Sustainable Growth: a Bioeconomy for Europe” It will also contribute to the implementation of several European policies and existing EU actions, deliverables and recommendations (i.e. Lead Market Initiatives for Bio Based Products) which will help to increase coherence of market pull measures for bio-based products across member states: Green Public Procurement, Standardisation, Mandates, Tax Incentives for sustainable bio-based product categories, setting indicative or binding targets for certain bio-based product categories where they contribute to achieving the objectives of existing and future EU sustainability policies.

In this context, the Partnership will incorporate a feedback mechanism on several cross-sectoral policies of relevance for the industry (from supply to market pull measures) in order to respond to EU recommendations and action plans and to help inform the development of new regulation. Another important contribution is that the PPP will act as a hub for those Member States which already have in place bioeconomy strategies as well as those which still do not have one in order to promote and steer coherent programmes at national and regional levels in line with the objectives of the European Commission.

The creation of a permanent policy desk within the initiative will also contribute to an improved and more informed dialogue between public and private bio-based economy actors and to the sharing of best practices of ad hoc measures between Member States and the EU.
OBJECTIVE:
Reindustrialise Europe by creating a new rural infrastructure of biorefineries
7. BUILDING AN ORGANISATION THAT FITS CHALLENGES

7.1 Introduction
To realise the PPP’s vision for Biomass for Growth, an organisation will be built that addresses the common challenges and synergistic opportunities among the stakeholders:

• Providing a single voice for the bio-based industries in Europe;
• Gathering expertise and promoting engagement between industries and sectors;
• Focusing on cross-sectorial cooperation;
• Ensuring a market demand approach;
• Involving industry, researchers and academia at European and national level;
• Addressing common topics: policy support, consumer and market demands and sustainability;
• Ensuring contribution to the implementation of recommendations from the Lead Market Initiative on bio-based Products (Annex 3);
• Involving public authorities and civil society from an early stage;
• Installing a dedicated structure ensuring SME involvement;
• Communicating on the benefits of the bio-based economy;
• Developing multiple annual strategic roadmaps.
7.2 The Bio-Based Industries PPP Institute

The joint public-private governance of the PPP is illustrated below, with the different roles described.

Joint Undertaking
The role of the Joint Undertaking (which is a public Commission body to be established) is to implement the multi-annual roadmap, publish an annual Work Programme with Calls for Proposals; organise the selection process or proposals; conduct project contract negotiations, project follow-up and financial reporting, and be responsible for maintaining the auditing and reporting standards applicable for public funding. The Governing Board of the Joint Undertaking takes the final decision on the annual Work Programmes as well as the funding decision for the accepted PPP projects.

The Industry Grouping governance
General Assembly represents the Members of the Industry Grouping. The General Assembly selects the members of the Steering Board, proposes representatives to the Joint Undertaking Governing Board and takes decisions on the Multi-Annual Roadmaps and Annual Call topics.

Steering Board represents the members and communicates with the European Commission. The elected representatives of the Steering Board also represent the private stakeholders on the Governing Board of the Joint Undertaking. In order to strengthen the representation of SMEs, one seat on the Steering Board is dedicated to SMEs.
Working groups and Advisory Groups will be set up on a temporary basis or become permanent. Their roles will range from preparing reports to drafting the Multi-Annual Roadmap. Working Groups can also include non-member organisations or individual experts depending on competence and representation needed.

In order to strengthen the integration throughout the whole value chain and between traditional industry sectors and scientific disciplines, three permanent working groups are foreseen:

• Responsible use of Raw Materials, which looks at questions related to primary and recycled biomass mobilisation, as well as biomass sustainability.

• Creating Industrial Leadership, in charge of demonstration and upscaling, resource efficiency, competitive production technologies, production logistics, etc.

• Fulfilling Consumer needs and markets, responsible for new markets and innovative product design, eco-design concepts, etc.

Special SME support

Although big industries are key partners in the PPP, a substantial part of the transition to a bio-based economy will be initiated and/or developed by innovative starters and SME. These SME are essential in offering and developing specific services, technologies, equipment and instruments, both in enhancing developments at big industries as well as in standalone projects or local cooperation. In addition, innovative SME capture the potential of new technologies extremely fast, thus pushing the bioeconomy as a whole. This PPP will develop supportive measures for SME concerning critical issues such as financing, market information and forecasts, legal obstacles and international partnering. SME representation will take place through the different clusters participating in the PPP, but also through individual membership of the PPP. The PPP will ensure that innovative SME will be an integral part of the PPP execution by having a visible and easy accessible SME portal, easy access to market information and financing instruments dedicated to SME. Furthermore, it is envisaged that a significant number of PPP funded projects will include a minimum of SME involvement.

Intellectual Property protection

In order to accelerate the unfolding of the bioeconomy, spreading new and improved technologies into the industry is crucial. The PPP governance will set up rules to ensure rapid and broad dissemination of R&D results beyond direct project partners – e.g. by general rules for licensing IP. Blocking IP will not be accepted.

The PPP Projects

Projects funded under the Bio-Based Industries PPP will:

• be led and co-funded by an industrial partner or a consortium of industrial partners;

• encourage the participation of SMEs;

• include research organisations as partners supporting the value chain development by supplying required expertise, research facilities and technological innovations.
7.3 Position in the field
With a focus on realising competitive bio-based value chains, the Bio-Based Industries PPP will implement and integrate all technologies and concepts required and provide feedback on measures and policies required to facilitate practical realisation. This requires optimal alignment, cooperation and exchange with related initiatives.

European Innovation Partnerships (EIPs) aim to address weaknesses in the European research and innovation system, which might prevent the entry of innovations into the market. They provide a working interface between practice, science, policy makers, advisors, and other stakeholders at EU, national and regional level. Three candidate EIPs are of relevance to the Bio-Based Industries PPP: Sustainable Agriculture, Raw Material and Water Efficiency.

The SPIrE PPP aims to better understand and develop the role of the process industry in resource & energy efficiency.

- The Bio-Based Industries PPP supports the SPIRE PPP and its stakeholders by developing renewable value chains, bringing together the critical stakeholders to ensure an infrastructure from field to the output from biorefineries.
- The SPIRE PPP supports the Bio-Based Industries PPP and its stakeholders by developing energy and resource efficient processes (both fossil and bio-based) and prepares the current process and manufacturing industry for feeding in bio-based building processes and blocks.

EIBI supports demonstration or reference plants for innovative bioenergy value chains which are not yet commercially available (thus excluding existing biofuels and heat & power technologies) and which could be deployed on a large scale. The Bio-Based Industries PPP will develop competitive biorefineries optimising the creation of economic, social and environmental values, including energy conversion from waste streams.

The Factories of the Future PPP increases the technological base of European manufacturing through the development and integration of enabling technologies. Synergies with the Bio-Based Industries PPP are related to sustainable manufacturing tools, methodologies and processes for cost-efficiently shaping, handling and assembling products composed of complex and novel materials.

The Green Cars Initiative develops sustainable transport methods, including research on greening combustion engines, biomethane use, logistics and transport systems. Synergies with the Bio-Based Industries PPP lie in realisation of value chains providing sustainable advanced biofuels for transport.

The Energy-efficient buildings PPP (EeB) aims at promoting green technologies and the development of energy-efficient systems and materials in new and renovated buildings aiming to reduce their energy consumption and $\text{CO}_2$ emissions. The Bio-Based Industries PPP develops value chains delivering sustainable bio-based building materials to support the EeB objectives.
OBJECTIVE:
Realise a new generation of bio-based materials and composites
Produced in biorefineries, allowing the production of better-performing components for industries including automotive, construction and packaging.
APPENDIX
Overview of founding partners
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Overview of founding partners

Associates