



“Accelerating  
innovation and  
market uptake  
of biobased  
products”

# Biobased for Growth

A PUBLIC-PRIVATE PARTNERSHIP ON BIOBASED INDUSTRIES



# Table of content

1	Introduction	6
	1.1 PPP initiative backed by a committed consortium	6
	1.2 Strategic objectives	7
2	Answering Europe's biobased challenges	9
3	Strong added value of acting at EU level	10
4	Economic analysis – current state of play and analysis of economic impact	11
5	Broader socio-economic impact analysis	13
6	Priority research & innovation areas	15
	6.1 Fostering a sustainable biomass supply	16
	6.2 Biorefineries: Optimising efficient processing	18
	6.3 Developing markets, products and policies	21
7	An organisation is built that fits the challenges	23
	7.1 Introduction	23
	7.2 The biobased PPP Institute	24
	7.3 Position in the field	27
Annex 1	An Overview of founding partners companies	29
Annex 2	Research and technological challenges	31
Annex 3	Biomass supply – overview of today's practice	36
Annex 4	Lead Market Initiative - priority recommendations	39
Annex 5	Policy Feedback mechanism	41

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# Executive summary

**Our vision** is that of a competitive, innovative and sustainable Europe: leading the transition towards a post-petroleum society while decoupling economic growth from resource depletion and environmental impact. We envisage a biobased 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 biobased products, a European Public-Private Partnership (PPP) for biobased 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 biobased products superior, or at least comparable to, non-biobased products in terms of price, performance, availability, and sustainability.

This global paradigm shift from oil-based towards biobased 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 it the bioeconomy a priority putting in place ambitious bioeconomy policies<sup>1</sup> and investments in biorefineries. Nevertheless, the EU, with its strong agricultural, agro-food and forestry 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 biobased economy with a **global market value of €200bn** by 2020<sup>2</sup>.

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 biobased 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**.

<sup>1</sup> In February 2012, President Obama issued a Presidential Memorandum outlining steps to take greater advantage of the BioPreferred Program and significantly increase federal procurement of biobased products. In April 2012, the Obama administration launched the « National Bioeconomy Blueprint ». Also, China's new 12th FYP prioritises biorefineries.

<sup>2</sup> The World Economic Forum, «The Future of Industrial Biorefineries», 2010

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 biobased 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 biobased 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 biobased products and optimising policy frameworks.

The biobased 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 biobased 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.

### Biobased Industry Vision

In 2030 the European biobased 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**.

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### Biobased Industry Objectives 2030:<sup>3</sup>

- 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<sup>4</sup>;
- Enable 30% of overall chemical production to become biobased. 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 biobased fibre and polymers such as viscose, carbon fibres, nano-cellulose derivatives and bioplastics to grow rapidly. Traditional fibre products such as paper remain 100% biobased to create more value out of the same resources;
- Realise a new generation of biobased materials and composites produced in biorefineries, allowing the production of better-performing components for industries including automotive, construction and packaging.

<sup>3</sup> Based on Star Colibri Vision for 2030, [www.star-colibri.eu/files/files/vision-web.pdf](http://www.star-colibri.eu/files/files/vision-web.pdf)

<sup>4</sup> Bloomberg New Energy Finance, "Bioproducts: diversifying farmers' income", 2011

# 1. Introduction

**The biobased Public-Private Partnership answers three main European challenges to the creation of a biobased Economy in 2030. It aims to keep Europe in the fast-growing global biobased 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 biobased 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 biobased sectors, across Europe, has taken the initiative to develop a joint vision on how to reach a substantial biobased 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 biobased 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.

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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, Manufuture, 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 biobased economy. It aims to be inclusive and open to all players in the biobased economy. SMEs play a crucial role in this respect – as the future biobased economy will be a cluster of local and regional installations, catering to global industries for global markets.

## 1.2 Strategic objectives

In the future biobased 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 biobased 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 biobased products. These include the need to:

- Embrace the challenge of the gradual change from oil-based feedstock to renewable biobased 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<sup>5</sup>** functioning as a European platform specifically addressing the general challenges the biobased economy faces<sup>6</sup>, including communication, policy support, facilitating consumer and market demands and harmonising sustainability topics.

<sup>5</sup> Based on the Joint Technology Initiative provision of the Treaty (Art.187 TFEU)

<sup>6</sup> See chapter 7 for more information on the structure

Investment

Innovation

## 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 biobased 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<sup>7</sup> have stressed their ambitions to replace their packaging materials with biobased 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 biobased 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).

<sup>7</sup> e.g. P&G: [www.pg.com/en\\_US/downloads/sustainability/reports/PG\\_2011\\_Sustainability\\_Overview.pdf](http://www.pg.com/en_US/downloads/sustainability/reports/PG_2011_Sustainability_Overview.pdf), Unilever: [www.unilever.com/sustainable-living/](http://www.unilever.com/sustainable-living/)



# Answering Europe's

## 2. biobased challenges

A sustainable growth of the biobased 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.

### Investment

#### Keeping Europe in the global race

Europe is technologically well positioned to spearhead the development of a new biobased 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 biobased 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.

### Innovation

#### Improve the competitiveness of biobased products

The most pressing challenge for all biobased 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 biobased products superior or at least comparable to non biobased 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.

### Integration

#### 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 biobased products in the global market.

# Strong added value of

## 3. acting at EU level

The multi-sectoral approach in the biobased 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 biobased sustainable future. Highly forested countries and agricultural regions will be linked to industrial centres in Europe. Core to the biobased economy is the development of integrated value chains, which combine new sources of income for farmers and foresters, develop biobased 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 biobased 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.

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# Economic analysis – State of play and analysis 4. of economic impact

Europe has solid agricultural, agro-food and forestry sectors and world-leading companies in the plant breeding, biotech and chemical/biochemical, engineering and energy biotech industries. All those sectors create a strong European basis, economic and technological, to harness the potential of a biobased economy and create long-term growth and jobs in Europe. 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 biobased 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 biobased sectors (see table 1 below) will increase by at least 10%, resulting in 3 million extra jobs and an €80 bn increase in turnover.

A number of independent studies corroborate the biobased Economy's economical potential:

- The World Economic Forum has estimated the global revenue potential of the entire biomass value chain to be more than €200 bn by 2020.<sup>8</sup>
- 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 €78 bn and 170,000 jobs would be created.<sup>9</sup>
- 10% more forest biomass can be mobilised by 2030<sup>10</sup>. 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 €35 bn and 350,000 extra jobs.
- The total value of the European seed market is €7 bn, 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%.<sup>11</sup> BNEF also claims that using only 17.5% of the EU 27 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 €20 bn to €24 bn.

<sup>8</sup> The World Economic Forum, "The future of industrial biorefineries", 2010

<sup>9</sup> Bloomberg New Energy Finance, "Moving towards a next generation ethanol economy", 2012

<sup>10</sup> Star Colibri, [www.star-colibri.eu/files/files/vision-web.pdf](http://www.star-colibri.eu/files/files/vision-web.pdf)

<sup>11</sup> Bloomberg New Energy Finance, "Bioproducts: diversifying farmers' income", 2011

Table 1. Key figures on biobased industries in Europe <sup>12,13,14</sup>

Sector	Products	Employment	Turnover in EU	Remarks
<b>FOREST</b>	340 Mton paper 405 Mm <sup>3</sup> sawn goods 200 Mm <sup>3</sup> wood-based panels	16 million forest owners 3-4 million industrial jobs	€550-600 billion (EU-25) 8% of GVA in manufacturing industry	<ul style="list-style-type: none"> <li>Europe accounts for 25-30% of world production of forest-based products</li> <li>Industrial jobs to large extent in rural areas and SMEs</li> </ul>
<b>AGRICULTURE</b>		12.2 million (2009) 5.5% of total EU employment	€168 billion (2009) - accounted for 1.6% of the total GVA	Economy of sector in EU undergoing restructuring, due to productivity gains for labour and capital, and decline in relative prices
<b>STARCH</b>	21 million tonnes/year raw materials 65% food/ 35% non-food use (incl. Feed)	15,500	€7.5 billion	
<b>SUGAR</b>	19-20 million tonnes 2% for non-food (fuel, feed)	28,000 employees and 161,000 beet growers	€14 billion	
<b>BIOFUELS</b>	12 Mtoe (2009) – EU27	150,000	€ 6 billion	
<b>CHEMICALS</b>				
<b>Bioplastics <sup>13</sup></b>	196 kton (2011)			
<b>Biolubricants <sup>15</sup></b>	137,000 tonne			Forecast production in 2020 with supportive EU measures 420,000 tonne
<b>Biochemicals</b>		150,000 (incl. bioplastics)	€50 billion	Largely based on starch, sugar and vegetable oil
<b>Enzymes</b>		5,000	€ 0.8 billion, 64% of global production	

<sup>12</sup> Star Colibri, [www.star-colibri.eu/files/files/vision-web.pdf](http://www.star-colibri.eu/files/files/vision-web.pdf)

<sup>13</sup> European Bioplastics

<sup>14</sup> European Commission, “Innovating for Sustainable Growth: a Bioeconomy for Europe”, 13 February 2012

<sup>15</sup> European Biolubricant Market (Frost and Sullivan) Forecast for Europe to 2013

# Broader socio-economic

## 5. impact analysis

Thanks to the capturing of CO<sub>2</sub> through photosynthesis the production and use of biobased 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 biobased 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 biobased 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. Biobased 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<sup>16</sup>. Industrial biotechnology represents an important group of energy efficient conversion technologies with full climate change mitigation potential ranging between 1bn and 2.5bn tons CO<sub>2</sub> equivalent per year by 2030<sup>17</sup>. Also biobased materials such as biofiller, used as a substitute for non biobased alternatives in tyres, can contribute to reduce rolling resistance by 30%, consumption of fuels by cars by 5%, and CO<sub>2</sub> emission by 5%.<sup>18</sup>

### 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.

<sup>16</sup> See e.g. Sathre R. and O'Connor J. (2010), A synthesis of research on wood products and greenhouse gas impacts, 2nd edition, Vancouver, B. C. FP Innovations, 117p. (Technical Report No. TR-19R).

<sup>17</sup> WWF "Industrial Biotechnology: More than green fuel in a dirty economy", 2009

<sup>18</sup> European Commission DG Environment LIFE and resource efficiency: Decoupling growth from resource use, May 2011

### 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 biobased 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 biobased 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).

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# Priority research & innovation areas

The biobased 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.





## 6.1 Fostering a sustainable biomass supply

As the starting point of the biobased 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, biobased products, fuel and energy production.*** The PPP's objective is to meet the increasing demands for biobased 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 biobased 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.

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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, agro-industrial 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 biobased products.

The Bioeconomy<sup>19</sup> focuses on the use of renewable resources as the major input source for materials, chemicals, food and feed ingredients, and energy and fuels. The biobased 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.

<sup>19</sup> The bioeconomy encompasses the sustainable production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. (Source: European Commission, "Innovating for Sustainable Growth: a Bioeconomy for Europe", 13 February 2012)



### Renewable resources of the biobased 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)

## 6.2 Biorefineries: Optimising efficient processing

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.

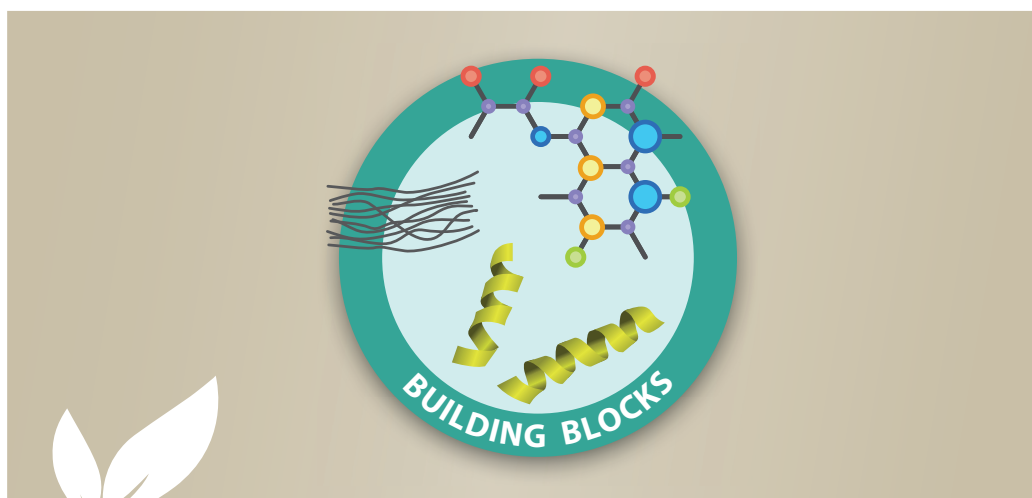
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### Primary conversion: Refining of biomass into its valuable components

Primary biorefinery processes aim to obtain the optimal added value from biomass, providing the downstream industries with constant quality and competitively priced biobased 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.



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### Secondary conversion: Valorisation of intermediates and products

Individual biobased 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 (biobased aromatics);
- Development of building blocks optimally utilising the oxygen contained in the molecules;
- Synthesis of new monomers for biobased polymers with new functionalities.



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## 6.3 Developing innovative products and accelerating market introduction

Focusing on market-driven innovation, the PPP seeks to unleash demand for new biobased 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 biobased 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 biobased products reach at least the same level of quality as their fossil-based counterparts and have a lower environmental impact. New biobased materials with equal or superior levels of performance will be developed.

Rather than just mimicking properties of fossil-based products, biobased 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 biobased 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 biobased 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 biobased 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:

### Technologies

- Polymerisation processes for new biobased 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).

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### Products and materials

- New (chemical) building blocks and biobased alternatives for existing polymers
- New functional biobased 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 ligno-cellulosic materials
- Identify and create downstream applications for biomaterials
- Standardisation of biobased products

### Policies

The biobased 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 biobased products across member states: Green Public Procurement, Standardisation, Mandates, Tax Incentives for sustainable biobased product categories, setting indicative or binding targets for certain biobased 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 biobased economy actors and to the sharing of best practices of ad hoc measures between Member States and the EU.**

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# An organisation is built 7. that fits the challenges

## 7.1 Introduction

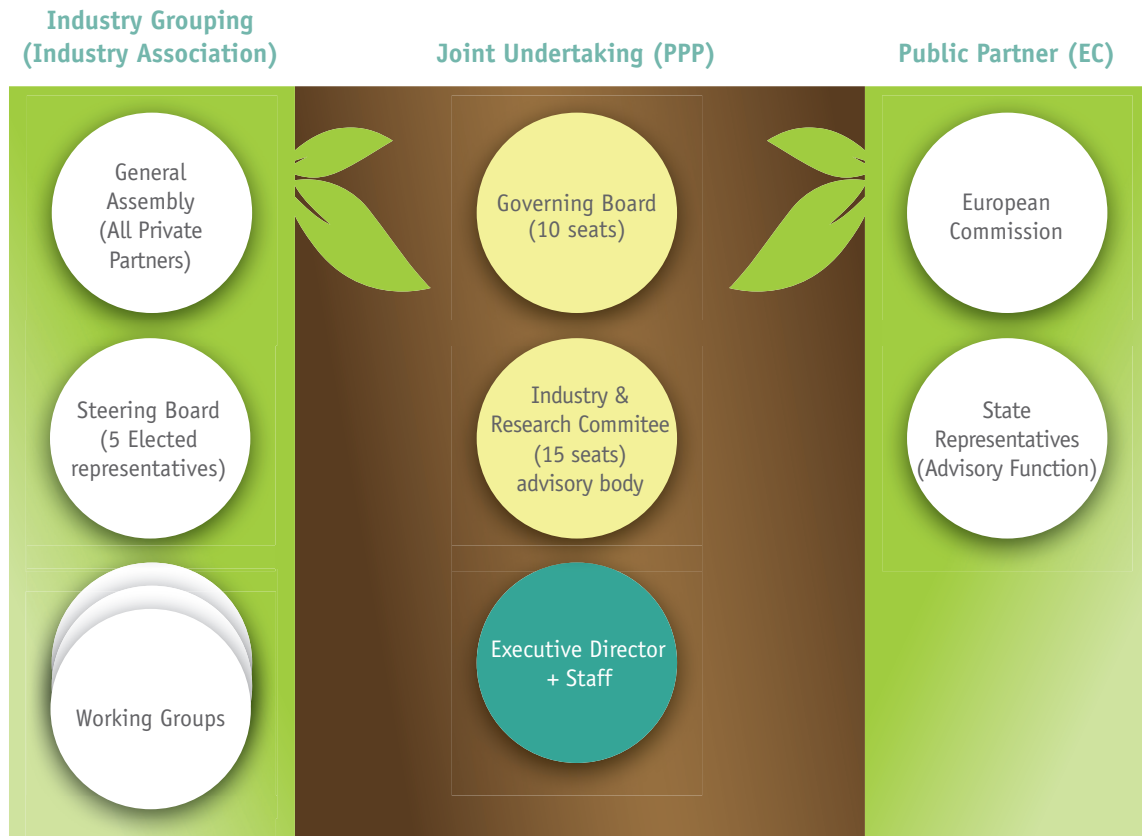
To realise the PPP's vision for Biomass for Growth, an organisation will be built that addresses the common challenges and synergistic opportunities among the stakeholders:

- Providing a single voice for the biobased 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 biobased 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 biobased economy;
- Developing multiple annual strategic roadmaps.

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## 7.2 The biobased 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 of 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.

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## 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.

## Additional functions of the Industry Grouping Secretariat

### Policy desk

In order to contribute to this harmonisation and reinforced policy and stakeholder interaction a permanent policy desk will be installed in the secretariat that will support PPP projects with policy and regulatory issues. The desk will advise on how to integrate and align their activities with relevant EU, national and regional biobased economy strategies, policies and regulations. It will also collaborate with policy makers and advisory groups. The Policy Desk will be a central contact point for the PPP to feedback results and studies from the projects, PPP experiences and success stories to European, national and regional decision-making bodies. It will formulate comprehensive recommendations to support interaction, strategic planning and implementation of biobased economy policies and strategies.

In particular, Policy Desk will interact, contribute and participate to the biobased economy interaction model proposed by the strategy “Innovating for sustainable growth: a Bioeconomy for Europe”, the Bioeconomy Panel, the regular Bioeconomy Stakeholders Conference, the Bioeconomy Observatory and the various hearings that will be organised.

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### Special SME support

Although big industries are key partners in the PPP, a substantial part of the transition to a biobased 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 biobased PPP will:

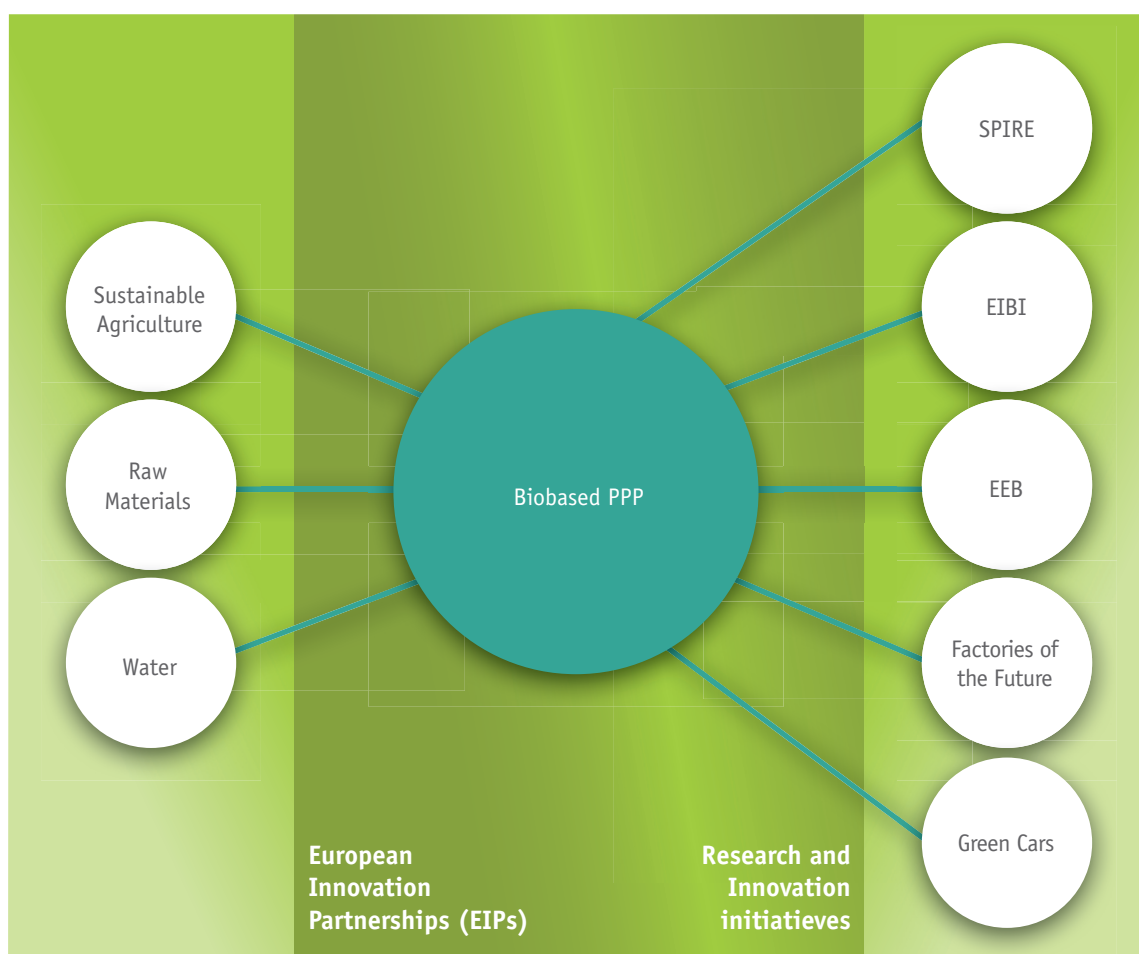
- be led and co-funded by an industrial partner or a consortium of industrial partners;
- encourage the participation of SMEs;
- include research organisations as partners supporting the value chain development by supplying required expertise, research facilities and technological innovations.

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### 7.3 Position in the field

With a focus on realising competitive biobased value chains, the biobased 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 biobased PPP: Sustainable Agriculture, Raw Material and Water Efficiency.



The **SPIRE PPP**<sup>20</sup> aims to better understand and develop the role of the process industry in resource & energy efficiency.

- The biobased 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 biobased PPP and its stakeholders by developing energy and resource efficient processes (both fossil and biobased) and prepares the current process and manufacturing industry for feeding in biobased building processes and blocks.

<sup>20</sup> Sustainable Process Industry through Resource and Energy Efficiency

**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 biobased 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 biobased 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 biobased 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 CO<sub>2</sub> emissions. The biobased PPP develops value chains delivering sustainable biobased building materials to support the EeB objectives.

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## Annex 1

# Overview of founding partners

**ABENGOA BIOENERGIA**



**Borregaard**

The Sustainable Biorefinery

**BILLERUD**



**CLEA** Technologies

**Cargill**



**Clariant**

Süd-Chemie AG  
a Clariant Group Company

the  
dutch  
biorefinery  
cluster

**DONG**  
energi

**CLIB**  
2021  
CLUSTER  
INDUSTRIELLE  
BIOTECHNOLOGIE



**HOLMEN**



**DSM**

BRIGHT SCIENCE. BRIGHTER LIVING.

**kemira**



COMPETITIVENESS CLUSTER  
INDUSTRIES & AGRO-RESSOURCES

**GFP**

Lebensbasis Pflanze



**Metsä**

**ard**  
L'INNOVATION VERTE

Subsidiary of:

**SICLAÉ**  
CRISTAL UNION

**Forestcluster**



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## Associations



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## Annex 2

# Research and technological challenges

### Feedstock: fostering a sustainable biomass supply

#### Business development

- Development of business models: How to create financial incentives for the farmers and forest owners to produce or mobilise more biomass and develop new crops / coppices, fitting in current crop and forest management systems.

#### Breeding

- Breeding crops with higher yet stable yields per production unit, in such a way that negative environmental impacts are minimized and social-economic benefits are maximized. High-yielding crops remain a priority for plant breeding research, in order to obtain sufficiently large volumes of biomass at competitive prices. In terms of research, this would mean:
  - Improving crop tolerance to adverse weather conditions (drought, heat, frost, flood, water ...) and extreme soil conditions (salinization), resistance to pests and pathogens, nitrogen use efficiency and competitiveness of minor crops (e.g. domestic protein crops);
  - Development of new breeding tools (molecular, phenotyping and bioinformatic) for a more rapid and precise crop improvement.
- Breeding varieties with in-built new traits e.g. creating higher added value products.
- Breeding to improve feedstock quality for biorefinery applications: develop dedicated and highly specialised varieties that meet targeted applications and end-uses, maximizing the value throughout the whole biobased value chain.
  - Improving the cascading use of crops by widening the scope of variety testing, to take into account not only the characteristics of the primary harvest material, but also of the residue;
  - Improving composition of (ligno)cellulose (e.g. more easily hydrolysable, lignin with less different bonds);
  - Improving varieties to deliver specific ingredients (e.g. fatty acids, more homogeneous lipid composition, starch or protein components).

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### Productivity increase and soil fertility

- Increase the yield and the productivity of land while minimizing environmental impacts;
- Microbial technologies to increase plant growth (Bioyield enhancement), increase phosphate and nitrogen uptake (Biofertility) and Biocontrol (e.g. biopesticides, bio-insecticides);
- Identifying the most appropriate energy crop cultivation systems taking into account nutrient balance, water use efficiency, soil tillage practices and management needs;
- Increase the availability and use of forestry biomass while meeting the wide range of other demands on woodland via their sustainable management;
- Increase the use of marginal and abandoned lands;
- Adaptation of the forestry and agricultural practices to climate change;
- Research on forest soil productivity and removal of organic matter related to collection of biomass (e.g. logging residues);
- Development and reuse of fertiliser concepts recovered from by-streams in biorefinery operations. Preferably leading to separate organic matter and minerals, leading to improved plant yield and soil quality whilst reducing waste and environmental impact;
- Optimisation of crop rotation;
- Precision farming: Improving data on soil quality, water, land use, new input management technologies (water, crop protection, animal husbandry techniques).

### Harvesting and mobilisation

- Innovative technologies of mobilisation /harvesting techniques in forests and improved methods for better uptake of harvesting residues (bark, stumps and branches) and maintenance of sustainability;
- Improve the wood mobilisation from small forest holdings and from early thinnings;
- Develop optimal logistics and intermediate storage to provide a continuous supply of feedstock, minimise transport costs and guarantee intermediate product quality and availability;
- Improved mobilisation of primary forestry/agro-/horticultural residues, secondary agro-industrial residues, and tertiary consumer residues, and the identification of their potential;
- Adjusting the existing primary conversion processes (agro-food, pulp and paper industry, ...) in such a way that process residues are both minimised and obtain higher value;
- Innovative technologies and improved methods for reducing post-harvesting losses in the chain;
- Improved collection, sorting and processing systems for recycled biobased products.

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## Biorefineries: optimising efficient processing

### Primary Conversion: refining of biomass into its valuable components

- Energy efficient preparation of harvested material (cleaning, homogenisation, liquefaction);
- Efficient fractionation and separation of the biomass into its basic components: such as lignin, cellulose, hemi-cellulose, minerals, oils and fatty acids, protein, starch, sugars and other carbohydrates);
- Isolation of specific higher value components in pure forms (e.g. lipids, molecules for specialty chemicals and pharmaceuticals, nutritional ingredients, pigments).
- Advanced technologies, demonstrated at credible scale, to mildly separate the pure components of biomass to maintain their natural functionalities;
- Development of efficient extraction and separation methods for the commercial exploitation of non-polymeric extractives;
- Development of large-scale robust mechanical processing methods, which have lower energy requirements;
- Process intensification - to improve efficiency and allow for smaller-scale, more readily distributed, processing technology;
- Nutrient recovery - closing the cycle for the inorganic components of biomass;
- Protein recovery from new raw materials and side-streams - to ensure future feed and food supply;
- Robust processes which produce stable output from variable feedstock quality;
- Maximize valorisation of pre-consumer recycling streams;
- Development of chemical or biological techniques, which allow individual components to be extracted or transformed without degradation of the other components;
- Valorisation of process and waste water: isolation of valuable components from diluted streams;
- Cellulose fibre fractionation systems that maximise application potential and value of each fibre;
- Develop an efficient and cost-effective technology for the hydrolysis of ligno-cellulosics to fermentable sugars. The method should avoid the generation of harmful or inhibiting chemicals. Microorganisms should be developed to be more resistant to inhibitory compounds that are generated in the process.

### Secondary conversion: Valorisation of intermediates and products

#### Bio-technological challenges

- Optimisation of industrial micro- and macro- organisms - performing under industrial conditions and from a diversified range of biomass;
- Increase in micro-organisms activity for the fermentation of novel biomolecules;
- Increase yield and productivity using synthetic biology, high-throughput experimentation, microbiology and large-scale fermentation technologies;
  - Develop water management systems for biocatalytic processes
  - Develop fermentation science specifically for biorefinery operations

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### Chemo-catalytical challenges

- Develop novel, stable and robust catalysts for conversion of oxygen-rich biomass-derived feedstocks that:
  - preferably work in aqueous environments
  - are able to perform reduction reactions
  - are bi- or even multifunctional
  - preserve natural functionalities and chirality
  - create more robust catalytic formulations to limit poisoning
- Main challenge is to adapt hydrocarbon-centred “petrochemical thinking” to oxygen-rich biomass-derived feedstocks)

### Thermo-chemical challenges

- Processing of biomass towards building blocks compatible with current infrastructure (e.g. torrefaction, pyrolysis)
  - robust conversion technologies;
  - optimisation of fluidised-bed and entrained flow gasification systems that can tap into existing synthesis gas conversion routes towards platform chemicals;
  - scale-up of new technologies

### Downstream processing

- Flexible separation and purification technologies for valuable compounds from complex matrices after conversion processes;
- Innovations with natural polymers or special ingredients from fresh biomass or side streams;
- Cellulose fibre fractionation systems that maximise application potential and value of the fibre.

### Scale-up and integration challenges

- Scale-up to demonstration scale of new technologies;
- Novel approaches by combining biotechnological, chemo-catalytical and thermo-chemical challenges;
- Process intensification of biobased conversion processes;
- Develop robust solutions addressing the impurities and compositional variations inherent to biomass;
- Developing routes where value can be extracted from all three major components of lignocellulosic biomass, incl. especially conversion technologies for lignin for materials and chemical building blocks (biobased aromatics);
- Develop building blocks optimally utilising the oxygen contained in the molecules;
- Synthesis of monomers from renewable sources and synthesis of biobased polymers with new functionalities. Integration of processes with advanced instrumentation and monitoring concepts to optimise production;
- Up-stream and Down-stream processing with a special focus on new separation and purification technologies.

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## Developing markets, products and policies

### Biobased building blocks and materials

- New (chemical) building blocks from renewable resources
- Biobased alternatives for existing polymers and innovative polymers from new biobased monomers
- New functional biobased materials and products: Smart, high added value, effective, healthy, sustainable and safe materials. All wood and plant polymers are of interest here.
- Materials based on lignin (and bio-aromatic) chemistry
- Materials based on biopolymers (such as starch, polyesters from vegetable oils and sugar)
- Biocomposites: biopolymers reinforced with natural fibres
- New high-value products (pharmaceuticals, cosmetics, chemical), in some cases directly extracted from plants
- Lignin-based carbon fibres and nano-cellulose fibres e.g. in clothing or composites
- Identify and create downstream applications for biomaterials
- Biofuel with improved and innovative technology and new biofuel in aviation
- Standardisation of biobased products (e.g. biolubricants, bioplastics, biosolvents, insulation panel with natural fibres)

### Technologies

- Polymerisation processes for new biobased monomers
- Fatty acids conversion technologies, including chemistry (metathesis, for example) and biotechnology (including microbial conversion of sugars to lipids/fatty acids)
- Fractionation and extraction technologies to preserve structure and activities of macromolecules of natural polymers. Develop expertise to characterise these molecules as well as conversion tools to add new functionalities
- Advanced functionalisation technologies for diverse applications
- Biopolymer processing into products (films, fibres, packaging, ...)

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## Annex 3

# Biomass supply – overview of today's practice

### Biomass from agriculture

#### Sustainability

In the EU-27, cross-compliance ensures that sustainable production in agriculture is monitored effectively. Cross-compliance is effective and sufficient to ensure that the criteria for water, air and soil protection are controlled. These standards of production are applied across Europe's 178 Mio. Ha and are much higher than other standards applied around the world.

#### Land productivity

The EU is cultivating less and less land. Since 2008, the total grain production area (cereals, oilseed and protein crops) has fallen by 1.6 million hectares. At the same time, the EU is cultivating more than 35 million ha outside the EU to feed its population. Several studies<sup>21</sup> show that the increase of crop productivity in the EU would significantly reduce net food imports. There is no conflict between the various food, feed and non-food outlets. Furthermore, the development of biorefineries in rural areas coupled with the use of marginal abandoned and non-irrigated land offers an opportunity to keep land for food production and create new value-added for the rural communities.

#### The main drivers: Starch – Sugar and Oilseed raw materials

Currently 30 million tonnes of EU cereals are used for industrial purposes, including 10 million tonnes of wheat, 9 million tonnes of barley and 8 million tonnes of maize. 30% of the oilseed produced is dedicated to biofuels, 10% to sugar production and 4% to cereals. Furthermore, increased production of biobased products in some cases implies more feedstuff to the livestock sector where the EU is currently highly dependent on imports:

- For every litre of bio-ethanol produced in the EU, 1 to 1.2 kg of by-product for use as animal feed is created. The production of the 16 million tonnes of bio-ethanol needed to replace 10% of transport fuel in the EU by 2020 will generate up to 21 million tonnes of animal feed, such as DDGS, substituting 6.6 million hectares' worth of soya from third countries.
- Between 2003 and 2008, rapeseed production increased from 12 million tonnes to 19 million tonnes, generating an additional 4 million tonnes of rapeseed meal. In the EU-27, the oilseed production potential is estimated at 39 million tonnes, i.e. an additional 7.3 million tonnes of meal. In total, this 11.3 million tonnes of additional meal would substitute 5.6 million hectares' worth of soya from third countries.

#### Natural fibres

For many years, the cultivation and primary processing of fibre flax has been a considerable asset for the European Union. The EU is an ideal area for fibre flax cultivation due to its suitable climate, well-adapted land and the expertise of its producers. The EU-27 is the world's primary producer of flax. At 90,000 to 120,000 ha, it has two thirds of the world's flax surface area. There are between 11,000 and 19,000 ha of hemp in the EU. There was an upwards trend in fibre production between 2001 and 2010.

<sup>21</sup> von Witzke, H. and S. Noleppa (2010), "EU agricultural production and trade: Can more efficiency prevent increasing "land-grabbing" outside of Europe?" Research Report, University of Piacenza  
European Environment Agency "How much bioenergy can Europe produce without harming the environment" – 2006  
"EEA estimated additional land availability from arable areas for EU22 to be from 19-25 Mio ha in 2030."



## Horticulture

Horticulture substrates, side-streams and bulbs can all be used as renewable energy sources as well as sources for higher added value components and materials. Flowers, nursery and ornamental plants can even be developed and produced in order to extract components for pharmaceuticals, biocides, perfumes, cosmetics.

## Plant breeding

Plant breeding has been critical to ensure the productivity and sustainability of agriculture. There have been huge investments in breeding research, especially from the private sector where companies invest on average 15% of their annual turnover on R&D. In the context of rapidly evolving agricultural practices and needs, research in plant breeding is underpinning these changes in order to “produce more from less”. As a result, several paths have been identified where dedicated breeding programmes can enhance biomass supply, both in terms of creating plants with sustainable and higher yields per production unit, as well as plant varieties with in-built new traits. Currently, breeding has a sound knowledge of first generation biomass (starch and sugar content, oil content and composition), and is piloting several projects on second generation biomass (lignocellulosic biomass, cell wall composition, oil content for energy use). There is still a vast area of research where breeding can make significant contributions. An important condition is that new crops fit in current crop rotation systems.

## Agricultural co-products and residues

Straw and pruning are agricultural co-products which have a market. In Europe, there is a potential of pruning of about 25.2 million tonnes annually. These co-products can be used for thermal and electrical energy and also hold a potential for conversion into advanced biofuels, but are also the main source of sugar for the production of biochemicals. Straw and other co-products like manure contribute to soil fertilisation and carbon maintenance. The use of agricultural residues and co-products in biorefining should be balanced with the need to maintain soil productivity at the current level in order not to compromise the future of sustainable agriculture and food production.

Furthermore processing of crops into food products and technical products create large by-streams, partly currently used as cattle feed (e.g. Beet pulp, beer fines), but partly still available for further processing into non-food products (e.g. dregs of oil and vinasses as residues from the first processing of olive oil and wine).

## Economical benefits from biorefineries

Returns on agricultural commodities have been falling for many decades, resulting in the stagnation of production yields and decline in production areas. The volatility of the agricultural commodities markets is increasing. The volatility in the input markets (energy, fertilisers, feedingstuffs) has also increased. Biorefining of agricultural products can contribute to this market volatility and helps to improve the return from the food and feed market.

Biorefining of agricultural products can improve efficiencies of land use as it represents a way of maximising the use of the outputs and inputs (land and agronomic). Unlike traditional markets where oilseeds or cereals may only have one end use, biorefining can produce multiple products from the same crop.

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## Biomass from forest

### Sustainability

Forests are the lungs of Europe, transforming CO<sub>2</sub> into oxygen, maintaining biodiversity whilst producing wood. Forests also host game, provide places of leisure and recreation and ensure clean water and air alongside other ecosystem services. All these functions and services are mutually compatible and must be seen as a whole.

European forests are already subject to sustainable management based upon criteria and indicators set by the Ministerial Conference on the Protection of Forests in Europe (MCPFE). The EU should support this process as a key reference point for the sustainable use of forest resources, also within the framework of renewable energy.

### Wood availability

There are 157 million ha of forest in the EU-27, of which 85% is available for wood<sup>22</sup> supply. Other wooded lands cover an additional 20 million ha. Forest Europe has estimated the total growing stock volume in the EU-27 to be ~24 billion m<sup>3</sup>, with an annual increment of (2010) ~620 million m<sup>3</sup> and an annual felling of (2010) ~469 million m<sup>3</sup>. Based on this annual harvest rate, there is normally 60% to 70%, or 150 million m<sup>3</sup>, of available wood which is unused every year. In the last 20 years, a total of 250 million m<sup>3</sup> has been added in to growing stock volume due to the expansion of the forest area and an increase in growing stocking levels.

The biomass potentials in 2030 are currently expressed in energy terms due to the recent focus studies on bioenergy or biofuels. Furthermore, all the studies are based on the estimated demand. The EUWood final report (2010)<sup>23</sup> estimated total biomass production from European woodland (2010) to be 1,277 billion m<sup>3</sup> including bark, of which 50% is stem wood and 50% logging residues, stumps and woody biomass from early thinning in young forest. The potential is, however, reduced to about 747 million m<sup>3</sup> by various environmental, technical and social constraints. After subtracting the wood used directly or processed to produce fiberboard and other materials, the EUWood report estimates that the remaining biomass has the energy potential of 2.56 EJ. The BEE<sup>24</sup> (Biomass Energy Europe) final report gives a similar estimate of 2.6 EJ for potential energy production from European forestry. The BEE figure takes account of stem wood, primary above-ground residues and primary stump wood. If secondary forestry residues are included, the potential energy content rises to 3.3 PJ.

Biomass production is not equally distributed across EU Member States. Five countries (Sweden, Germany, France, Finland and Italy) produce about 62% of the total. This is to a large extent due to the size of the countries, as well as the extent of their forestation.<sup>25</sup>

These reports show that in European forests there is a significant amount of biomass available from forested land. However, we can assume that the future production of biomass in Europe will be roughly based on the current land distribution with an increase in systems based on perennial species (e.g. woodland), the cultivation of which can have a number of positive impacts (e.g. increasing the water retention capacity of the soil and reducing erosion).

<sup>22</sup> State of Europe's Forests 2011. Status and Trends in Sustainable Forest Management in Europe. FAO, UN, UNECE and MCPFE.

<sup>23</sup> EUWood – Real potential for changes in growth and use of EU forests. Final report.

<sup>24</sup> Böttcher, H et al. 2010. BEE, D 6.1, Illustration Case for Europe, p. 21-50

<sup>25</sup> Verkerk, H, Lindner, M, Anttila, P. & Asikainen, A. 2010. The realistic supply of biomass from forests. P.56-79. In Mantau, U. et al. 2010: EUWood – Real potential for changes in growth and use of EU forests. Final report.



## Annex 4

# Lead Market Initiative – priority recommendations

*EU- LMI Advisory Group, 16. December 2011*

### 1. Access to feedstock

- Legislation and policies (agriculture, rural development, research, industrial policy, etc.) should be balanced between bio-energy and biobased products to allow access to sustainable renewable raw materials/ feedstock for industrial uses.
- Legislation and policies should promote the availability of renewable raw materials/ feedstocks in sufficient quantities at a suitable and guaranteed quality and at competitive prices.
- All programmes in Structural Funds and Rural Development, which are used to support and implement bio-energy and biofuels, should be opened to biobased products, and all criteria for funding should be handled equally.

### 2. Applied Research & Development & Innovation

- Continue to stimulate and enhance technological innovation and the development of technology.
- Increase public funding for demonstration projects via public-private partnerships. Increase public funding for demonstration projects and stimulate the construction of demonstrators via Public-Private Partnerships.
- Set up a specific “EU Innovation Fund” which could also serve to aid the transition of the results to full-scale implementation and to the marketplace.
- Develop incentives for the conversion of production plants and industrial processes into biobased ones, provided that they have proven to be sustainable and that applicable EU State Aid rules are respected.
- Develop incentives (taxation or state aid measures, grants) to support the development of new, sustainable biobased products’ production processes.

### 3. Access to markets

- Continue to develop and apply clear and unambiguous European and international standards. The standards help to verify claims about biobased products in the future (e.g. bio-degradability, bio-based content, recyclability, and sustainability).
- Consider setting indicative or binding targets for certain biobased product categories where they contribute to achieving the objectives of existing and future EU sustainability policies (such as climate change, resource efficiency, energy security, etc.). Study their market perspectives, possible mechanisms for implementation and their contribution to these sustainable goals.
- Allow Member States to grant tax incentives for sustainable biobased product categories.

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#### **Sector-specific markets:**

- Allow biobased plastic to enter all waste collection and recovery systems, including composting, recycling and energetic recovery (depending on the type of plastic and compliance with applicable standards). Biobased plastics certified compostable according to EN 13432 should gain unhindered access to bio-waste collection.
- Biobased construction materials (e.g. foams for insulation, composite material, mortar, and concrete made of vegetative aggregate particles) have now become sufficiently advanced to offer a real alternative. The Construction Products Directive should promote the specificities of biobased products. In addition, new and transparent standards showing the product capabilities are needed to help demonstrate that biobased materials comply with construction legislation.
- Study the possibility of mandating the use of biolubricants and hydraulic fluids in environmentally sensitive areas. This could be implemented e.g. via soil protection and water protection legislation.

#### **4. Public Procurement**

- Encourage contracting authorities in all EU Member States to give preference to biobased products in tender specifications. A requirement or a recommendation to give preference can be laid down in a national action plan adopted by the government. Preference should be given to biobased products unless the products are not readily available on the market, the products are available only at excessive cost, or the products do not have an acceptable performance.
- Develop a list of product groups and designated biobased products. The product groups and subgroups reflect the areas of application (e.g. building materials, furniture, cleaning products, lubricants, packaging). The designated biobased products reflect the individual products from each manufacturer respectively.

#### **5. Communications**

- Promote and use harmonised certification and labelling schemes for biobased products.
- Design and implement a communication strategy involving all partners in the value chain and all other stakeholders to achieve coherent messages on biobased products.

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# Annex 5

## Policy Feedback mechanism

The biobased PPP should ensure that Europe becomes the leading biobased society. Therefore, the PPP should report on the efficiency of different policy initiatives as to accomplishing the intended objectives. The activities of the PPP should also reinforce and, where possible, assist with the implementation of European, national and regional policies and regulations that will support this objective. Within this framework, ***the biobased PPP will contribute to the implementation of several European policies and existing EU actions, deliverables and recommendations*** which will help to create a pull for biobased products and create a more competitive Europe. ***It will also contribute to an improved and more informed dialogue between public and private biobased economy actors*** through the creation of a permanent Policy Officer as an interlocutor on behalf of the PPP with the Bioeconomy Observatory.

### Implementation of European policies

The European Union has defined three ambitions in its Europe 2020 Strategy for Growth, which are linked to biobased industries:

- Smart growth: developing an economy based on ***knowledge and innovation***
- Sustainable growth: promoting a ***more efficient, greener and more competitive economy***
- Inclusive growth: fostering a ***high-employment economy delivering social and territorial cohesion***

These ambitions are supported by several direct or indirect policies and strategies that will enhance and support the development and implementation of European based biobased industry:

#### Global policies

- Innovating for sustainable growth: a Bioeconomy for Europe
- Roadmap for a Resource Efficient Europe
- European Regional Development Fund Programme

#### Biomass supply policies

- European Innovation Partnership on Productive and Sustainable Agriculture
- Common Agricultural Policy
- Forestry Action Plan
- LULUCF, Land-Use, Land Use Change and Forestry

#### Research and Innovation policies

- Horizon 2020
- SET Plan (in particular EIBI)

#### Market support policies

- Lead Market Initiative on Bio-based Products
- Renewable Energy Directive

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Examples of ways in which projects funded by this PPP could contribute towards achieving policy objectives could include but will not be limited to:

- Projects are focused on actual realisation of biobased technologies in value chains. The construction of first-of-their-kind demonstration and flagship plants and the expansion and adjustment of existing facilities are key to overcoming the innovation valley of death and to boost sustainable economic growth throughout the value chain (Global policies);
- Projects providing the knowledge-base for sustainable intensification of primary production of biomass and improving the understanding of current, potential and future availability and demand of biomass across sectors, prioritising the most profitable exploitation of biomass, job creation, sustainability, soil fertility and climate mitigation potential (Biomass supply policies);
- Projects supporting the establishment of a network of diversified biorefineries across Europe, as well as the creation and networking of one or more clusters of integrated and diversified biorefineries in every Member State. Assist in the creation of supply chains and the necessary logistics for use of biomass and waste by the biorefinery networks and clusters (Biomass supply policies);
- Projects will support a balanced approach between bio-energy and biobased products access to sustainable renewable raw materials / feedstock for industrial uses (market support policies) and data gathered will contribute to developing tools to aggregate data on biomass and bio-waste availability and its use by the biobased industry, bio-energy and food sectors in order to contribute to the mapping of available resources in Europe;
- Projects will study the impact of use of biolubricants and hydraulic fluids in environmentally sensitive areas with a view to contributing to soil protection and water protection legislation through findings and data (market stimulation policies). Projects supporting the expansion of new markets by developing standards and standardised sustainability assessment methodologies (e.g using LCAs and LCT) for biobased products and supporting scale-up activities (Market support policies);
- Projects facilitating green public procurement for biobased products by developing labels, an initial European product information list and specific training for public procurers (Market support policies);
- Projects contributing to the long-term competitiveness of bioeconomy sectors by putting in place incentives and mutual learning mechanisms for improved resource efficiency (Global policies);
- Projects in cooperation with the farmers' community and highlight (and quantify) revenues generation from additional activities (eg. Valorisation of biowaste) (Biomass supply policies; Global policies);
- Projects on valorisation of biowaste from retailers and municipalities and communicate the benefits of separate collection of bio-waste to the local communities (Global policies);
- Projects identifying concrete points of intersection and cooperation with regional programmes to maximise synergies between EU and local regional development policies related to innovation in the field of biorefineries (Global policies);
- Projects will seek to elaborate and contribute to the setting-up of eco indicators by financing studies capable of delivering strong environmental social and economic benefits in the local areas in which they operate (Global approach).

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## EUROPEAN INITIATIVE



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