

Biobased and Renewable Industries for Development and Growth in Europe

Strategic Innovation and Research Agenda (SIRA)

BRIDGE PUBLIC-PRIVATE PARTNERSHIP



DISCLAIMER: This document reflects the ambitions and objectives of the members of the Biobased Industries Consortium (BIC) in March 2013, and is the basis for road mapping towards the BRIDGE calls for proposals. The BRIDGE SIRA will frequently be adjusted based on technology and market developments, results obtained and ambitions of new members entering the BIC.

1. EXECUTIVE SUMMARY

THE BIOBASED INDUSTRY VISION

The industry 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**.

In this vision, the Biobased Industries will optimize land use and food security through a sustainable, resource-efficient and largely waste-free utilisation of Europe's renewable raw materials for industrial processing into a wide array of biobased products:

- **Advanced transportation fuels¹**
- **Chemicals**
- **Materials**
- **Food ingredients and feed**
- **Energy**

In doing so, the Biobased Industry will play an important role in spurring **sustainable growth** and boosting Europe's competitiveness by re-industrialising and **revitalising rural areas**, thus providing tens of thousands of high-skilled research, development and production jobs over the next decade.

HOW TO REALISE THIS VISION?

At the heart of this vision, the **development of biobased value chains** will be accelerated. **New biomass supply chains** will be developed to feed new **integrated biorefineries while existing biorefineries will be brought to a new level**: to secure feedstock availability and flexibility throughout the year, with multiple inputs and multiple outputs. These developments will gradually complement and replace product streams from fossil oil and provide innovative new products and solutions and markets. The Biobased Industries play a critical role in the realisation of this vision and are already making significant investments in biorefineries.

However, critical technological, political and market challenges remain before full-scale commercialisation of the innovations can succeed and innovative solutions are brought to the market. Another fundamental challenge is the innovation "Valley of Death", from research to market. These challenges cannot be overcome by individual companies or the industry alone.

The competitiveness will be increased by reversing the currently seen trend of significant biobased economy investments in regions outside Europe where framework conditions appear to be more attractive. A long term research and innovation agenda jointly funded by public and private players can help address this challenge. This will be done by developing new value chains, de-risking investment in demonstration projects of innovative processes and in building first-of-its-kind flagship plants.

¹ Biofuel from waste, residue and non-food cellulosic material, RED Article 21(2). This means that any R&D, demonstration and flagships in the PPP dedicated to biofuel production will be based on waste, residue and non-food cellulosic feedstock.

² Flagship plants are the first units of value chains operating at an economically viable scale

BRIDGE PUBLIC PRIVATE PARTNERSHIP (PPP)

The PPP on Biobased Industries (BRIDGE PPP) is an integrated and fundamental tool under Horizon 2020 to realise the biobased industry vision. BRIDGE focuses on developing EU-based value chains and accelerating the transition to advanced feedstock for biorefineries: It will focus on:

- Building new value chains based on the development of sustainable biomass collection and supply systems with increased productivity, and improved utilisation of biomass feedstock (incl. co- and by-products), while unlocking utilisation and valorisation of waste and lignocellulosic biomass;
- Bringing existing value chains to new levels, through optimised uses of feedstock and industrial side-streams, and offering innovative added value products to the market, thus creating a market pull and reinforcing the competitiveness of EU agriculture and forest based industries;
- Bringing technology to maturity through research and innovation, and through upgrading and building demonstration and flagship biorefineries that will process the biomass into a range of innovative biobased products.

BRIDGE fully recognises that biomass is not an unlimited resource. It must be utilised intelligently, to ensure that additional uses of biomass do not compromise **the ability to produce food in sufficient quality and quantity**. By doing so, the PPP will ensure availability of a sustainable and secure supply of biomass **both for food and feed applications as well as for chemicals, materials, fuels and energy**.

To enable supply of additional and sufficient biomass for a biobased economy, it is critical to increase the productivity and output of biomass from European forest and agricultural land in a sustainable way and to unlock the potential of the residues and side-streams and waste. BRIDGE focuses on optimising utilisation of existing feedstock (forest and agricultural biomass) and the development of new feedstock supply chains (e.g. forest residues, agricultural lignocellulosic residues or dedicated crops), as well as industrial side streams and organic municipal waste. Providing new markets for biomass producers strengthens rural economies, and allows further development and investment in the production system. Albeit essential for the future of the biobased economy, the advanced feedstock supplies are still underdeveloped and require significant infrastructure for mobilization and logistics. The goal of BRIDGE is to address those issues by 2020 through research, demonstration of technologies and flagship projects to build efficient and cost competitive supply chains and transformation units.

COOPERATION TOWARDS NEW BIOBASED VALUE CHAINS AND MARKETS

All developments will occur in parallel and will lead to technology and competence transfer between sectors. In the short term existing value chains will drive the product development, in particular for added value products. Without biobased product market development at an early stage, there will be no market pull in Europe for the biobased economy and thus significant delay in its deployment. As new supply chains develop to 2020 and become economically viable, the biobased economy feedstock will increasingly come from lignocellulosic supply. The PPP builds upon the strong agricultural, agro-food, forestry and pulp & paper sectors and world-leading companies in the plant breeding, biotechnology, chemistry, energy and bioprocess engineering. It also capitalizes on the vast amount of R&D investments and results, both optimising and utilizing Europe's existing pilot and demonstration facilities, and realising the required leap forward towards advanced technologies utilizing waste and lignocellulosic feedstock. But not least, BRIDGE will leverage the combined and complementary knowledge and skills of academia, research organisations, SMEs³ and larger corporations to achieve its innovation objectives.

³ The primary mode of participation by SMEs in PPP activities is expected to be as regular industry actors

THE STRATEGIC INNOVATION AND RESEARCH AGENDA (SIRA)

The BRIDGE multi-annual SIRA translates the PPP ambitions into a coherent set of actions that will deliver tangible and increasingly ambitious results by 2020 and by 2030.

The SIRA includes a balanced combination of:

- Value chain demonstration projects aiming towards integration and deployment of technologies and R&D results into actual value chains and bringing technology close to commercial scale through upscaling in demonstration activities and flagship projects;
- R&D projects focused on filling the gaps in technological innovations: dedicated projects on the development of specific technologies and concepts needed to realise the value chains, and proving the principles in pilot installations;
- Supporting projects, addressing the cross-sectoral challenges and supporting the value chains to become reality.

The projects of the SIRA will be developed around 5 value chains, where specific deliverables will be demonstrated, ultimately leading to flagship projects.

1. From lignocellulosic feedstock to advanced biofuels, biobased chemicals and biomaterials: realising the feedstock and technology base for the next generation of fuels, chemicals and materials;
2. The next generation forest-based value chains: utilisation of the full potential of forestry biomass by improved mobilisation and realisation of new added value products and markets;
3. The next generation agro-based value chains: realising the highest sustainability and added value by improved agricultural production and new added value products and markets;
4. Emergence of new value chains from (organic) waste: From waste problems to economic opportunities by realising sustainable technologies to convert waste into valuable products;
5. The integrated energy, pulp and chemicals biorefineries: Realising sustainable bio-energy production, by backwards integration with biorefinery operations isolating higher added value components.

To have competitive biobased products in the market in 2020, each step of the value chains needs to be competitive: the feedstock supply, the processing, as well as the product(s) and market (both in term of price and environmental performance). BRIDGE focuses on developing, optimizing and demonstrating this competitiveness throughout the five value chains.

2. THE LONG-TERM STRATEGIC OBJECTIVES FOR THE BIOBASED ECONOMY

BRIDGE activities reflect clearly the ambitions of industrial partners to contribute to a sustainable society on the longer term. The PPP will **trigger** further developments leading to long-term benefits: new value chains and products initiated and demonstrated by BRIDGE will come into full deployment, biorefineries will be upgraded and new flagships will be built, new biobased developments will be triggered by the PPP activities, and dedicated policy measures will be put in place.

BRIDGE will achieve concrete and significant results by 2020, yet the greatest leverage effect and commercial deployment will be reached in the period from 2020 to 2030. Thus the strategic objectives of the Biobased Economy that will be stimulated and triggered by the PPP are evaluated over two periods⁴.

TABLE 1. OVERALL STRATEGIC OBJECTIVES FOR 2020 AND 2030

- The PPP activities will help to guarantee a secure and sustainable supply of lignocellulosic biomass (incl. waste) for European biorefineries through the development of integrated and sustainable agricultural and forestry value chains;
- There is a potential to better valorise agriculture land that currently is no longer under production or is currently not under optimal use. BRIDGE aims to contribute to put **15%** of this underutilized land back into production or at least be better utilized in 2020 (**35% by 2030**);
- Current EU biomass utilisation for food, feed and materials is **1100 Mton**. The amount of biomass used in the EU for energy and material uses is estimated to amount to **500 Mton**⁵. The PPP results will contribute to achieve **10%** increase in biomass supply in Europe by 2020 (**20% by 2030**) by increasing productivity and mobilization in sustainable manner while making best use of innovations in agriculture and forestry practices;
- Current unused by-products and wastes from various biobased sources (agriculture, forestry, waste water treatment, sludge, organic household waste, yard waste, food processing waste, debarking waste) amount to a total of 2.8 bn tons/year in the EU⁶. BRIDGE activities will stimulate the mobilisation and utilisation of these potential resources to be increased to **15%** of the total amount in 2020 (**25% in 2030**);
- BRIDGE results will contribute to maintain and further develop a competitive and knowledge intensive rural economy in Europe based on biorefineries resulting in new, higher and more diversified revenues to farmers and cooperatives and creating up to **400.000** new skilled jobs in 2020 (**700.000 by 2030**), of which more than **80%** will be in rural and today underdeveloped areas;

⁴ The qualitative and quantitative objectives in this table have been identified through intense discussions among all partners, and reflect business plans and expected investments. Unless otherwise stated the reference for the figures is the current situation in 2012.

⁵ Of this, approx. 400 Mton comes from forestry and other wood sources. In 2010, 229 Mton wood was used for materials, 173 Mton for energy (Mantau, U. et al. (2010), EUwood. Final report, 30. June 2010). In 2008, industry used some 18.6 million tonnes of biomass (excl. wood), and the total quantity of biomass (excl. wood) used for both materials and energy use amounted to over 98 million tonnes (Jossart, J.-M. (2009): Development of the bioenergy sector – future European demand factors, technological development and competition. EEA-JRC-UASE Workshop Biomass resource assessment for biofuels/bioenergy and competition with other biomass. Eberswalde, December 2009). No numbers exist for EU alone, but the worldwide harvested biomass in 2008 was 13 bn tons (forestal and agricultural). Of this, 73% was used for food and feed, 11% was wood for material use, 10% wood for energy use and only approx. 3 % each was renewable raw materials for material and energy use (Nova-Institut 2011, FAO 2011, Kausmann et al 2008).

⁶ IEA Bioenergy Task 37. See also: http://www.iea-biogass.net/_download/publi-task37/Potential%20of%20codigestion%20short%20Brosch221203.pdf, http://www.iea-biogass.net/_download/publi-task37/IEA-ABP-Brochure_en_2.pdf, http://www.iea-biogass.net/_download/publi-task37/Biogass%20upgrading.pdf, <http://www.biores.eu/docs/BIOGASFUNDAMENTALS/IEA-MSWAD.pdf>, http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/waste_generation_management_generation.

- The biomass available will be fully utilized and cycles will be closed. The PPP will contribute to protein isolation and valorisation from additional biomass processing, that will result in **15%** reduced import of protein (e.g. soy) for feed in Europe in 2020 (**50% by 2030**). Currently **2300 Mton** of phosphate and **2700 Mton** of potash are consumed in the EU, most of which (**estimated 90%**) are imported in the form of rock materials or processed rock (non-renewable resources) into the EU. Optimisation of soil fertility programmes including recovery and use of phosphate and potash, as triggered by the PPP activities, will lead to a **10%** reduced import of those components for fertilizers applied to feedstock production (**25% by 2030**);
- BRIDGE will contribute to and trigger industrial deployment of biobased chemicals, biomaterials and advanced biofuels, so that
 - o **20%** of the chemicals and materials production in Europe will be biobased by 2020 (**30% to 2030**); this is compared to the current situation 10% of chemicals and materials being biobased.
 - o By 2020 at least **2%**⁷ of Europe's transport energy demand will be met by sustainable advanced biofuels (**25% in 2030**, together with an overall 50% improved road transport system efficiency⁸); This is compared to the current situation of no advanced biofuels in European fuel mix.
 - o At least 5 first-of-its-kind flagship plants will be realised to optimise technology for biomass conversion and ensure price-competitiveness for a second wave of commercial production to kick-in from 2017.
- BRIDGE will realise a new generation of biobased materials and composites, allowing the production of better-performing components for application in several industries. With this the PPP contributes to the ambition that in 2020, the market supplied by biobased polymers and composites at comparable quality-price ratio compared to the fossil alternatives will be **5** times higher than today (**factor 10 in 2030**); increased consumer acceptance, concerted policy and labelling, awareness of biobased products as well as recycling and reuse will have an important contribution to the improved market penetration;
- Through its combined efforts the PPP will have a significant contribution to the European objective of achieving **20%** reduction in greenhouse gas emissions in 2020 (compared to 1990 levels);
- As a consequence of following the openness and excellence principles, BRIDGE intends to actively involve academia, research organisations, and SMEs⁹ such that at least **15%** of the Horizon 2020 funds allocated through the PPP goes to these actors. It is expected that significant additional industry funding will go to academia, RTOs and SMEs through their participation in industry-driven demonstration activities.

⁷ A 2% substitution of the transport fuels in 2020 with advanced ethanol would require 45 Mton of biomass

⁸ ERTRAC SRA 2010.

⁹ Should SMEs decide to participate in contract research. But it is expected that the primary mode of participation by SMEs in PPP activities will be as regular industry actors, which significantly increases the industrial SME participation.

3. THE OBJECTIVES AND ACTIVITIES OF BRIDGE PPP

The long-term strategic objectives will be achieved by the triggering of and leverage effects on the BRIDGE direct deliverables. This Chapter describes the BRIDGE activities, as well as the direct deliverables (the Key Performance Indicators - KPIs), which will be achieved if the right framework conditions can be developed.

TABLE 2. BRIDGE DIRECT DELIVERABLES 2020

- **36** new cross-sector interconnections in biobased economy clusters (new bridges creating cooperation between the 9 different sectors (see figure 3);
- **At least 10** new biobased value chains (new products and feedstock);
- Realising a total industrial investment of **2.8 bn Euro** by the PPP partners in research, development and innovation via R&D projects, realised demonstration and flagship projects: both by building of new operations and upgrading existing and abandoned industrial sites to be converted into biorefinery operations (reindustrialisation);
- **More than 200** cooperation projects through cross-industry clusters;
- The new biobased products resulting from BRIDGE will on average have an at least **50%** reduction on green house gas emission compared to their fossil alternatives;
- **10** new regional biorefinery clusters raised: biorefinery demonstrations, with regional biomass supply;
- **10** conversion of existing and unused facilities into biorefineries;
- At least **5** flagships resulting from BRIDGE producing new biobased materials, chemicals and fuels which have proven to become cost-competitive to the alternatives based on fossil resources (at least 1 per value chain).

BRIDGE aims at accelerating the building of biobased value chains, starting from sustainable feedstock production and mobilization towards the implementation and use of biobased materials and products (see Figure 1).

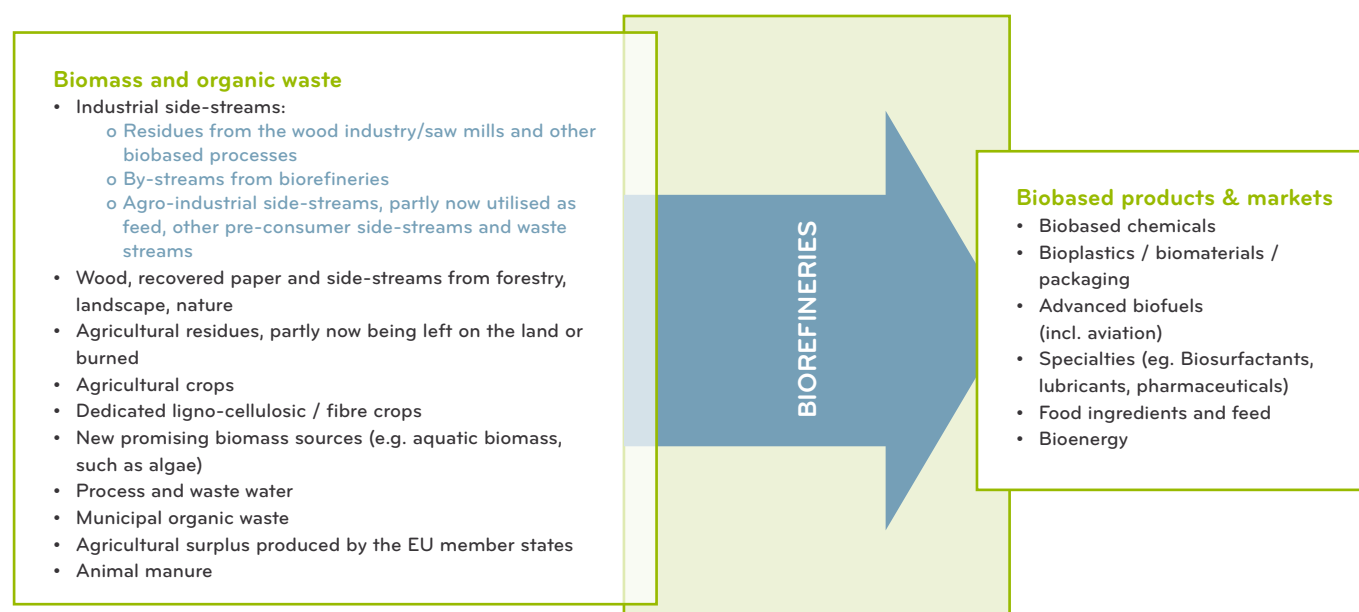


FIGURE 1. BIOBASED VALUE CHAINS ENVISIONED IN BRIDGE

3.1. BRIDGE ACTIVITIES IN THE PERIOD 2014-2020

A sustainable growth of the biobased economy requires a dedicated and balanced approach addressing specific common research and innovation challenges, while integrating and demonstrating cooperation between stakeholders over different disciplines and value chains. These key challenges have been grouped into three types of projects, as follows:

- **Value chain demonstration** projects aiming towards integration and deployment of technologies and R&D results into actual value chains and bringing technology close to commercial scale through upscaling in demonstration activities and flagship projects;
- **R&D projects** focused on filling the gaps in technological innovations: dedicated projects on the development of specific technologies and concepts needed to realise the value chains, and proving the principles in pilot installations;
- **Supporting projects**, addressing the cross-cutting challenges and supporting the value chains to become reality.

Projects in BRIDGE, especially the value chain demonstration and their resulting flagship projects, will consider the **whole value chain**. To have competitive biobased products in the market in 2020, each step of the value chain needs to be competitive: the feedstock supply, the processing and the product (both in term of price and performances).

Further details about the different types of projects are presented in the following chapters.

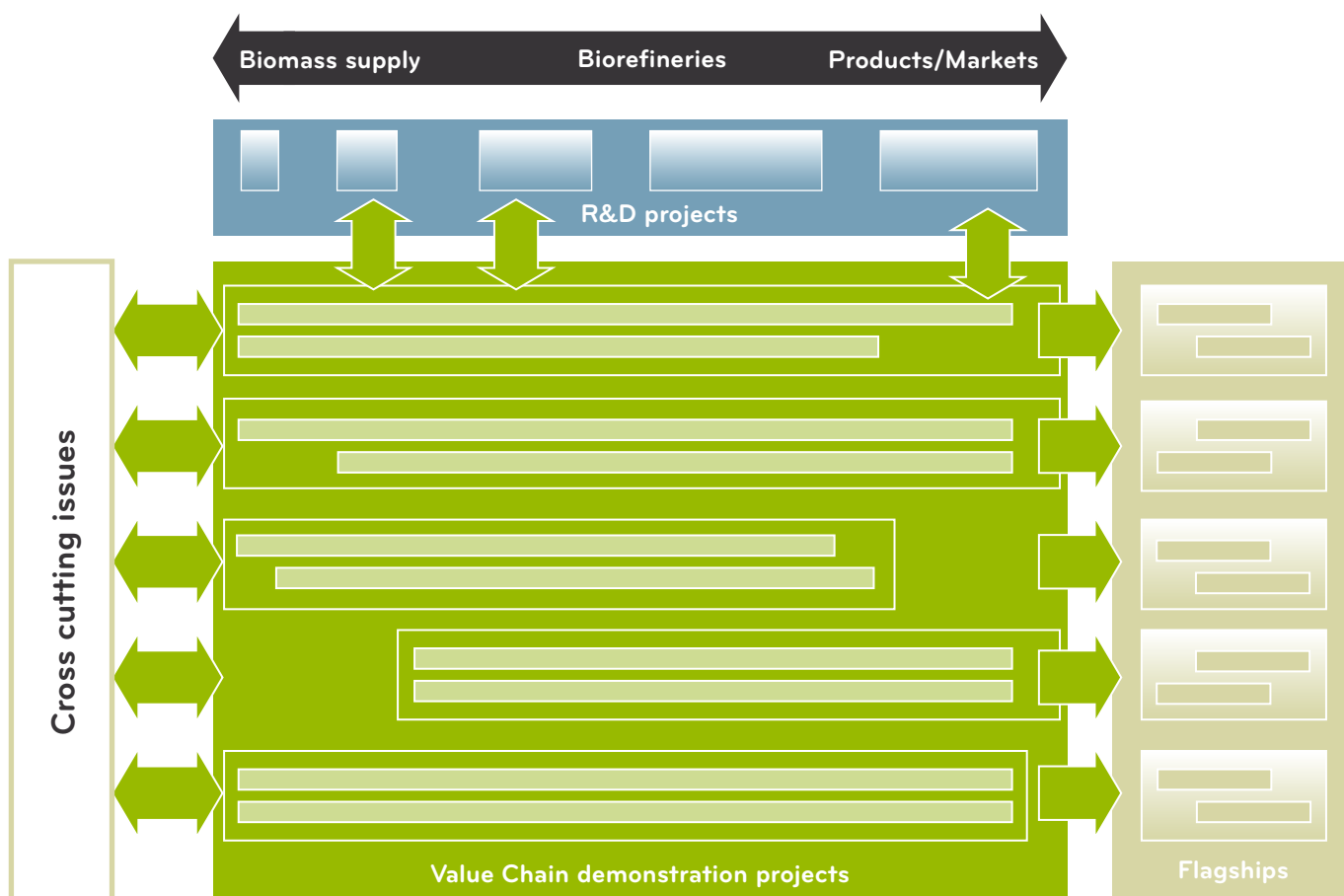


FIGURE 2. OVERVIEW OF BRIDGE PROJECTS

Value chain demonstration projects contain mainly demonstrator activities corresponding to Technology Readiness Level (TRL) levels 4 to 6. These activities are considered as being the last non-commercial step to demonstrate the performance and reliability of all critical steps in a value chain so that the first commercial unit can be designed and performance guaranteed from the outcome of the demo unit. Operation of such projects for the purpose of demonstration of the innovative technologies will either not generate any revenue or generate insufficient revenues to pay back capital costs and cover operating costs. The purpose of these value chain demonstration projects is to provide the backbone for subsequent flagships (demonstrator TRL 7-8 projects). The scale / maturity of demonstrators TRL 4-6 should be high enough to be able to prove technical, environmental and economical performance and provide enough data so that the technology can be realistically scaled-up to industrial size after successful operation of the demonstration.

Flagship projects mainly include Demonstrator activities corresponding to TRL levels 7-8. Flagships are the first units of value chains operating at an economically viable scale. Building and running such plants entails significantly higher costs and risks than demonstration plants because of the increased scale. They have significantly higher costs and higher risks than subsequent commercial plants which benefit from a learning curve and lower risks premium for the capital and loans funding the project.

R&D projects mainly include Research activities, which are focused on applied research to be performed based on R&D demands arising from the Value Chain demonstration projects. Applied research here refers to scientific study and research directed primarily towards a specific practical aim or objective (e.g. research that seeks for new technologies).

TABLE 3. DEFINITIONS OF THE INNOVATION AND RESEARCH PHASES¹⁰

¹⁰ Starting points are the definitions provided in the EIBI Implementation plan, as well as the TRL-definitions used by the Commission (Reference to Commission document on TRL levels). TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept; TRL 4: Technology validation in a laboratory environment; TRL 5: Technology validation in a relevant environment ; TRL 6: Technology demonstration in a relevant environment; TRL 7: Technology prototype demonstration in an operational environment ; TRL 8: Actual technology system completed and qualified through test and demonstration ; TRL 9: Actual technology system qualified through successful mission operations;

3.1.1 VALUE CHAIN DEMONSTRATION PROJECTS - ADDRESSING THE INTEGRATION CHALLENGE

The core of BRIDGE is the realisation of new untraditional partnerships. This aims for accelerating the building of biobased value chains by the cooperation throughout and across value chains. Value chains will be well integrated to existing infrastructure, demonstrated at suitable level and fully aligned with market demand and sustainable policies. Addressing these challenges through demonstration activities will prove the viability of the new value chains thus contributing to overcome investments barriers.

The demonstration activities in the value chain projects of BRIDGE aim to provide the final proof of technological and economic feasibility of a process or product manufacturing and the necessary supply chain before moving into a commercial phase. A demonstration activity allows, for instance, to scale-up a process to industrial or near-industrial scale. Each step of the process has previously been tested and validated individually on a pilot scale. The demonstration activities focus on proving how different sub-processes can be combined using equipment available at industrial scale. Research activities within the demonstration activities focus therefore mainly on optimization of flows and cost reduction. Those research activities could be for instance testing operational conditions that have been identified before at research and pilot scale to optimize productivity, or to reduce costs. The monitoring, data collection and analysis is critical during this phase. A demonstration also aims at fine tuning the process to ensure a reproducible and constant quality of the product(s).

Wherever possible the value chain demonstration projects will make use of the existing infrastructure and available demonstration facilities for the Biobased Economy (available at the PPP partners - industry and SMEs, or open shared facilities¹¹). For some of the new innovative value chains new and near-industrial scale facilities will be required. The developments in the demonstrated value chains will lead to investments in flagship plants.

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for **R&D Projects** (See 3.1.2).

Moreover, demonstrating the value chains will require non-technological, cross-cutting challenges to be solved. This will lead to calls for specific **Supporting Projects** on cross-cutting issues (See 3.1.3). The value chains demonstration projects will lead to investments in full-scale **Flagship projects**. Each value chain area will lead to at least one flagship project. These flagships projects will cover the full value chain. They will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures.

Five main innovative biobased **value chains** have been identified, in which demonstration projects will be carried out. These value chains are built on the ambitions of the existing sectors / industries (the 'pillars') that all have biobased ambitions, though from different perspectives. The current agro- and forest biobased sectors want to strengthen their competitiveness by increasing their product portfolio and maximise the use of scraps and residues. The waste-sector aims to achieve a valuable and sustainable solution for converting waste-streams into resources. And the chemicals, materials, fuels and energy sector have ambitions to transform their current fossil-based products into new sustainable biobased products with low environmental footprint aiming for consolidation of existing markets and creation of new ones.

BRIDGE will thus strengthen the sustainability and competitiveness of all biobased industries, by strengthening the innovation pillars. This increased innovation capacity will facilitate and accelerate the emergence of new sustainable value chains building on an innovative and economically strong infrastructure: effectively building the bridges towards new value chains (Figure 3).

¹¹ E.g. Leuna, Biobase Europe Ghent, BRI platform Reims, Bioprocess Pilot Facilities Delft, facilities at RTOs, as well as company-owned pilot and demonstration facilities



FIGURE 3. BRIDGING BETWEEN THE PILLARS – TOWARDS THE BIOBASED ECONOMY

Though starting from different feedstock and/or ambitions, all value chains aim to improve the biomass supply chains and to cooperate for the development and demonstration of new biobased chemicals, fuels, materials and products. Therefore common ambitions are set on achieving the supply chain and product deliverables:

TABLE 4. BRIDGE DIRECT DELIVERABLES 2020 - BIOMASS SUPPLY

- 5 to 10 new/innovative species varieties;
- 10% higher mobilisation of forest biomass by innovative technologies;
- 10% higher biomass yield by combining innovative cultivation methods with the regional most suitable crop rotation;
- Higher efficiency of fertilizer use (focus on N, P, K) by 15% increase of harvested biomass per unit of fertilizer;
- 15% increase in the water use efficiency by adapted crop rotations and management practices.

TABLE 5. BRIDGE DIRECT DELIVERABLES 2020 - BIOBASED PRODUCTS

- 5 new building blocks based on biomass of European origin validated at demonstration scale, further increasing to 10 in 2030;
- 10 functionalized chemicals and materials developed, with demonstration of their economic feasibility, lower environmental footprint and societal benefits;
- 5 successfully demonstrated concepts for valorisation of proteins from plant residues;
- 50 new biobased materials (eg. such as specialty fibres, plastics, composites and packaging solutions);
- 30 new demonstrated 'consumer' products based on biobased chemicals and materials;
- 5 new biodegradable, compostable or recyclable bio based products and materials for short life application.

VALUE CHAIN 1

From lignocellulosic feedstock to advanced biofuels, biobased chemicals and biomaterials: realising the feedstock and technology base for the next generation of fuels, chemicals and materials.

The projects within this value chain aim at realising sustainable and efficient cascaded value chains at scale to mobilise and convert lignocellulosic feedstock into cost-competitive advanced biofuels¹² and biobased chemicals and materials. This includes new/improved profitable lignocellulosic biomass sources with a higher efficiency in the production (fertilizer, water use, logistics) and/or improved digestibility in biorefineries. This will reduce industrial waste streams and improve the environmental impact, contributing to reducing the pressure on natural resources, the European dependency on imports and increasing the development of rural livelihood. Moreover, it focuses on creating a financial incentive and better revenues for farmers and forest owners to produce and mobilise more biomass at a competitive price. This value chain furthermore includes the demonstration of advanced technologies to hydrolyze and convert lignocellulosics in a sustainable and economic way into valuable chemical building blocks, materials, and advanced biofuels.

The value chain demonstration projects will achieve:

- Mobilizing an increasing supply by sustainably increasing productivity and mobilization of currently unused biomass and residues for agro and forest with special attention to SMEs and farmers/foresters
- Cost-efficient preparation of harvested material at farm level including suitable packaging and e.g. water extraction from the biomass to reduce transport volume and improved storage capability
- Improved logistics and storage to provide a continuous supply of feedstock
- Development and demonstration of new feedstock with higher sugar content (C6 and C5)
- Integration of lignocellulosic feedstock (e.g. agricultural residues) supply, transportation and storage into a complete biorefinery logistics concept to demonstrate economics of year-round operation
- Evaluate feedstock flexibility of lignocellulosic enzymatic conversion processes for European lignocellulosic biomasses (available agricultural residues, wood residues, energy crops) at demonstration scale
- Demonstration of cost-effective fractionation, separation and purification technologies for lignocellulosic biomass into its basic components, such as lignin, cellulose, hemi-cellulose, sugars and other carbohydrates
- Development and demonstration of low-cost integrated bioreactors in order to reduce the investment needed for the production of biofuels and biochemicals
- Separation and purification technologies for high quality (low cost) sugar streams for chemicals and fuels
- Development and testing of robust enzyme cocktails for (ligno-cellulosic) biomass conversion for improved performance and cost price reduction
- Demonstrate innovative biotechnological, biocatalytic and catalytic routes to obtain building blocks and chemicals from cellulosic sugars (C5 and C6), to convert ethanol into butanol, and to produce ethanol and butanol derivatives
- Production of biobased advanced fuels and materials via innovative advanced technologies
- Improving the overall conversion yield from the lignocellulosic feedstock into biochemicals and biofuels
- Demonstrate processes for transforming lignin into high(er) value products, such as hydrocarbons, biomolecules, aromatic platform chemicals, resins, additives, new materials and composites
- Demonstrate production of derivative products from ethanol and other fermentation products (e.g. ethylene, ethylene oxide, butanol derivatives, jet fuels)
- Demonstrate processes that decrease Capex and / or Opex and increase the overall process sustainability of processes based on lignocellulosic feedstock¹² biofuels include road transport fuel and aviation jet fuel
- Demonstrate the economics of combined production of biofuels and bio-based chemicals from lignocellulosic feedstock at large scale

- Demonstrate the added value of integration of existing chemical and catalytic conversion technologies into production processes based on lignocellulosic feedstock
- Polymerisation processes based on new biobased monomers, biopolymer processing into products (films, fibres, packaging, structural composites for e.g. automotive, agriculture) and demonstration of routes to replace specific fossil-based polymers
- Demonstration of new value chains leading to consumer products
- Increase consumer awareness on biobased products and biobased economy
- Identify and create market applications for new biobased products; diversification of markets of current biomass based products; networks and closer cooperation with downstream industries to better understand and serve industrial customers and consumers requirements
- Demonstrate industrial feasibility for new products

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for R&D Projects (see section 3.1.2 for the description behind the topics):

Moreover, demonstrating the value chains will require non-technological, cross-cutting challenges to be solved. This will lead to calls for specific Supporting Projects on cross-cutting issues (See 3.1.3).

R&D PROJECT TOPICS

1.1.1; 1.1.4; 1.2.1; 1.2.3; 1.2.4; 1.2.5; 1.2.6; 1.2.7; 2.1.1; 2.1.2; 2.1.3; 2.1.4; 2.2.1; 2.2.2; 2.2.4; 2.2.5; 3.1.2; 3.1.3; 3.1.4; 3.1.5; 3.1.8; 3.1.10; 3.1.12; 3.2.1; 3.3.1; 3.3.2; 3.3.3; 3.3.4; 3.3.5

The value chains demonstration projects will lead to investments in full-scale Flagship projects. This value chain will lead to at least flagship project. These flagships projects will cover the full value chain. They will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures. See below an example of one of the possible flagship projects to be realised within value chain nr 1.

VALUE CHAIN FLAGSHIP EXAMPLE

A flagship for advanced biofuels using 400.000 dry tons of straw could produce biofuels and biochemicals (ethanol, butanol, polyols, diols) and energy.

VALUE CHAIN 2

The next generation forest-based value chains: utilisation of the full potential of forestry biomass by improved mobilisation and realisation of new added-value products and markets.

Projects within this value chain are built on the current sustainable practice of forestry and its processing value chain (e.g. the pulp and paper industry). The ambition of this sector is to increase the product portfolio and to create new markets in addition to the current products. Technologies and applications will be developed based on their current raw materials and the residues and side streams.

This will be achieved by creating more added-value products from the current feedstock base: by increasing feedstock mobilisation (forest residues), and improved utilization of side and waste streams. For this, innovative and efficient technologies will be implemented, new innovative products developed and co-products, side-streams and residues valorised. This improves the competitiveness of the European forest-based value chains while reducing the pressure on biomass resources by producing more and better from less, and thus developing rural livelihood.

The biobased products from this value chain help to mitigate climate change by realising the replacement of fossil-based materials by biobased materials with a positive social impact and lower environmental footprint. This will fulfil market and consumer demand and create new markets by demonstrating routes and concepts for new and innovative materials into new products.

The value chain demonstration projects will achieve:

- Mobilizing an increasing supply by increasing productivity and mobilization of forest biomass and residues in sustainable manner while making best use of innovations in forestry practices
- Biostimulants that enhance forestry output increasing the nutrient use efficiency
- Innovative tree species that can provide biomass to the biorefinery with sustainable management practices
- Development and demonstration of cost-effective fractionation, separation and purification technologies for wood
- Development and demonstration of new functional biobased chemicals and materials from side streams and residues from forestry and pulp and paper mills (e.g. based on lignin, cellulose, or e.g. hemicelluloses)
- Demonstration of new processes (biological, chemical, and combination thereof) at scale, for added value products, and in particular their economic viability and environmental benefits
- Integration of new biobased additives and formulation for high performance products / in cooperation with converters, formulators and users
- Demonstration of new and more efficient production concepts for specialty and performance chemicals (e.g. biosurfactants, emulsifiers, pigments, lubricants, specialty polymers, additives, etc.)
- Develop adequate advanced recycling methods for bio-materials and residues (improved collection, sorting and processing)
- Replacement of petrochemical specialties / performance chemicals such as stabilizers, emulsifiers, chelants, surfactants, solvents, thickeners, lubricants, antioxidants, pigments, etc. with bio-based counterparts
- Develop and demonstrate new functional biobased materials: e.g. bioplastics, biocomposites, materials based on lignin, starch, (nano-)cellulose or carbon fibre: towards fit-for-purpose solutions for diverse industrial customers
- Formulation of new materials into end-user products and demonstration of new value chains leading to consumer products with higher bio-content, improved ecoefficiency and/or improved performance at the production and customer side (films, fibres, packaging, structural composites for e.g. automotive, construction)

- Application testing and demonstration of the industrial feasibility of new products
- Increase consumer awareness on biobased products and biobased economy
- Identify and create market applications for new biobased products; diversification of markets of current biomass based products; networks and closer cooperation with downstream industries to better understand and serve industrial customers and consumers requirements

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for **R&D Projects** (see section 3.1.2 for the description behind the topics):

R&D PROJECT TOPICS

1.1.1; 1.2.7; 1.2.8; 2.1.1; 2.1.2; 2.1.4; 2.2.1; 2.2.3; 2.2.4; 2.2.5; 3.1.1; 3.1.2; 3.1.3; 3.1.4; 3.1.5; 3.1.6; 3.1.8; 3.1.9; 3.1.11; 3.1.13; 3.1.15; 3.2.2; 3.2.3; 3.3.1; 3.3.2; 3.3.3; 3.3.4; 3.3.5

Moreover, demonstrating the value chains will require non-technological, cross-cutting challenges to be solved. This will lead to calls for specific **Supporting Projects** on cross-cutting issues (See 3.1.3).

The value chains demonstration projects will lead to investments in full-scale **Flagship projects**. This value chain will lead to at least one flagship project. This flagship project will cover the full value chain. They will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures. See below an example of one of the possible flagship projects to be realised within value chain nr 2.

VALUE CHAIN FLAGSHIP EXAMPLE

A flagship converting a pulp mill into a multiproduct forest-based biorefinery producing new biobased products. Production of innovative pulp fibres for textiles at a volume of 200.000 ton/y from wood, coproducing new biobased products, e.g. biocomposites and biopolymers at 20.000 ton/y.

VALUE CHAIN 3

The next generation agro-based value chains: realising the highest sustainability and added value by improved agricultural production and new added value products and markets.

Projects within this value chain build on the current sustainable practice of agriculture (incl. horticulture, and fertilizer companies) and its processing value chain (e.g. agro-food industry). The ambition of this sector is to increase and broaden the product portfolio and create new bio-based markets on top of the current products. Technologies and applications will be developed based on the current raw materials and increase the use of their residues and side streams. This strengthens the competitiveness of the existing value chains thereby securing the production of their primary products and increasing the added value of industry in rural environment.

This will be achieved by creating more added value products from the current feedstock base through increasing feedstock production and flexibility, improved utilization of side streams and mobilising residues. Moreover new and improved profitable crops with a higher efficiency in the production (regarding fertilizer and water use, logistics) will reduce industrial waste streams and improve the environmental impact. For the existing and new crops, innovative and efficient technologies for growing, harvesting and logistics will be implemented, new innovative products developed and co-products, side-streams and residues valorised. Moreover, for specific value chains an innovative range of inputs will become available enhancing agricultural productivity whilst not threatening the environment. New plant protection products (biocides, biocontrol, ...) and plant nutrition products (biostimulants, high -efficiency fertilizers) will be obtained under this value chain. This improves the competitiveness of the European agricultural value chains while reducing the pressure on biomass resources by improved utilisation of by-products and side streams. Moreover, it will create a more competitive European farming sector, thus especially developing rural areas.

The biobased products from this value chain help to mitigate climate change by realising the replacement of fossil-based materials by biobased materials with a positive social impact and lower environmental footprint. This will fulfil market and consumer demand and create new markets by demonstrating routes and concepts for new and innovative materials into new products.

The value chain demonstration projects will achieve:

- Mobilizing an increasing supply by increasing productivity and mobilization in sustainable manner while making best use of innovations in agriculture practices (eg. By improved soil structure and fertility, innovative crop and plant species)
- New plant species or varieties: Deliver specific ingredients for the new value chains (e.g. fatty acids, more homogeneous lipid composition, single and complex carbohydrates or protein components)
- Cost-efficient preparation of harvested material: introduction of innovative technologies and machinery that reduce pre & post-harvest losses and prepare the biomass in the best possible way
- Demonstration of technologies that recover minerals (such as phosphate) from agricultural, agro-industrial and dairy farming residues, convert them into fertilizers and prove new fertilizer concepts by eg. field trials
- Demonstration of valorisation concepts of co-products and side-streams (proteins, pulp, fibres) from agro-food industry towards higher added-value products including feed and food ingredients, including efficient and cost-effective fractionation, separation purification technologies to simplify biomass into its basic components, mildly extract or separate components while preserving their functionalities (eg. Functional proteins)
- Demonstration of production concepts that specifically use a combination of various biomass feedstocks thereby increasing the diversity and functionality of products
- Integration of new biobased additives and formulation for high performance products / in cooperation with converters, formulators and users

- Demonstration of new and more efficient production concepts for specialty and performance chemicals (e.g. biosurfactants, bioplastics, emulsifiers, pigments, lubricants, specialty polymers, additives, etc.)
- Replacement of fossil-based plasticizers and flame retardants with biobased (superior) alternatives
- Introduction of new biobased molecules: platform chemicals and polymers going towards 100% biobased solutions, providing alternatives and new solutions to fossil-based chemicals and materials, which should be competitive in the market place and demonstrate environmental benefits (through Life Cycle Assessment)
- Develop and demonstrate new functional biobased materials: e.g. bioplastics, biocomposites, materials based on lignin, starch, (nano-)cellulose or carbon fibre: towards fit-for-purpose solutions for diverse industrial customers
- Formulation of new functional biobased materials into end-user products and demonstration of new value chains leading to consumer products with higher bio-content, improved eco-efficiency and/or improved performance at the production and customer side (films, fibres, packaging, structural composites for e.g. automotive, construction, infrastructure)
- Application testing and demonstration of the industrial feasibility of new products
- Demonstration of new biodegradable, compostable or recyclable materials and products and development of adequate advanced recycling methods for bio-materials and residues (improved collection, sorting and processing)
- Establishing stronger links and better understanding of the needs (quality, performance) of downstream industries
- Increase consumer awareness on biobased products and biobased economy
- Identify and create market applications for new biobased products; diversification of markets of current biomass based products; networks and closer cooperation with downstream industries to better understand and serve industrial customers and consumers requirements

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for R&D Projects (see section 3.1.2 for the description behind the topics):

R&D PROJECT TOPICS

1.1.1; 1.1.2; 1.1.5; 1.1.6; 1.1.7; 1.2.7; 1.2.8; 1.2.2; 2.1.1; 2.1.2; 2.1.4; 2.1.5; 2.2.1; 2.2.2; 2.2.3; 2.2.4; 2.2.5; 3.1.1; 3.1.2; 3.1.3; 3.1.4; 3.1.5; 3.1.6; 3.1.8; 3.1.9; 3.1.11; 3.1.13; 3.1.15; 3.2.2; 3.2.3; 3.3.1; 3.3.2; 3.3.3; 3.3.4; 3.3.5

Moreover, demonstrating the value chains will require non-technological, cross-cutting challenges to be solved. This will lead to calls for specific **Supporting Projects** on cross-cutting issues (See 3.1.3).

The value chains demonstration projects will lead to investments in full-scale **Flagship projects**. This value chain will lead to at least one flagship project. This flagship project will cover the full value chain. They will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures. See below an example of one of the possible flagship projects to be realised within value chain nr 3.

VALUE CHAIN FLAGSHIP EXAMPLE

A flagship processing agricultural green or lignocellulosic residues (beet leaves, grass, ...) and surplus into 100.000 ton/y of proteins, and valuable chemicals and materials, like dicarboxylic acids.

VALUE CHAIN 4

Emergence of new value chains from (organic) waste: From waste problems to economic opportunities by realising sustainable technologies to convert waste into valuable products.

Projects within this value chain aim to develop and demonstrate value chains based on currently unused by-streams and waste from various biobased sources (agriculture, forestry, waste water treatment, sludge, organic household waste, yard waste, food processing waste, debarking waste). Realising cost competitive value chains producing added-value products will create solutions for the environmental problem of increasing waste flows (partly due to urbanisation), reducing pressure on virgin resources, and increasing the competitiveness of industry.

Energy, fuels and building blocks produced from this value chain help in mitigating climate change by realising the replacement of fossil-based solutions with alternatives with a positive social impact and lower environmental footprint.

The value chain demonstration projects will achieve:

- Cost-efficient preparation of heterogeneous waste material, e.g. through e.g. separation technologies for the biogenic part of municipal solid waste (MSW), or thermocatalytical processes (gasification, torrefaction or pyrolysis)
- Modification of the pretreatment conditions to make the cellulose from (MSW) accessible to the enzymes
- Adaptation of existing technologies to alternative feedstock, like the organic fraction of urban waste
- Development and demonstration of new enzymes that can hydrolyse the cellulose fraction of MSW to sugars with improved yield, from which biofuels, building blocks and bioproducts can be obtained using different biological and chemical routes
- Organic waste (agro-food residues and MSW) bioconversion to added value molecules using microorganisms and also higher organisms (e.g. insects)
- Development and demonstration of processes based on bark and other "wastes / sidestreams" from existing industrial uses of biomass as feedstock for high value biobased chemicals and biomolecules
- Implement adequate advanced recycling methods for bio-materials and residues (improved collection, sorting and processing)

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for **R&D Projects** (see section 3.1.2 for the description behind the topics):

R&D PROJECT TOPICS

2.2.1; 2.2.3; 2.2.4; 2.2.5; 3.1.3

Moreover, demonstrating the value chains will require non-technological, cross-cutting challenges to be solved. This will lead to calls for specific **Supporting Projects** on cross-cutting issues (See 3.1.3).

The value chains demonstration projects will lead to investments in full-scale **Flagship projects**. This value chain will lead to at least one flagship project. This flagship project will cover the full value chain. They will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures. See below an example of one of the possible flagship projects to be realised within value chain nr 4.

VALUE CHAIN FLAGSHIP EXAMPLE

A flagship that Converts 400 000 tons of straw, 650,000 tons of manure and 50.000 tons of municipal solid waste into 73 million litres of bioethanol and about 99 million cubic meters of biogas (of which 76 million cubic metres of biogas will be upgraded and fed into the natural gas grid). In addition, district heating for approx. 10-20 000 households and electricity equivalent to 15-25,000 households' consumption will be produced.

VALUE CHAIN 5

The integrated energy, pulp and chemicals biorefineries: Realising sustainable bio-energy production, by backwards integration with biorefinery operations isolating higher added value components.

New value chains will be demonstrated that improve the sustainability and economics of bio-energy production by conversion / integration into biorefinery operations: creating a spectrum of added-value products from the feedstock in addition to bio-energy. This will decrease the pressure on biomass resources and increase industries competitiveness.

New chemicals, biofuels and materials from this value chain help mitigating climate change by realising the replacement of fossil-based materials by biobased materials with a positive social impact and lower environmental footprint. This will fulfil market and consumer demand and create new markets by demonstrating routes and concepts for new and innovative materials into new products.

The value chain demonstration projects will achieve:

- Primary processing of biomass at farm level including suitable packaging and e.g. water extraction from the biomass to reduce transport volume and improved storage capability (e.g. by Torrefaction, pyrolysis, shredding, etc.)
- Integrating the production of bio-products and advanced bio-energy carriers in a smart way (smart use, maximise carbon and energy yield from biomass)
- Demonstrate processes for more efficient use of lignin: transformation into high(er) value hydrocarbons polymers, aromatics and performance chemicals before energetic use
- Densify the energy content of the initial feedstock through several pre-treatment processes, e.g. torrefaction pelletization and pyrolysis oil production
- Implementation of conversion technologies allowing for the use of heterogeneous biomass while ensuring high efficiency and low environmental impact
- Turning solid residues (bottom ash, fly ash) into valuable products, a.o. taking advantage of their mineral properties for plant nutrition
- Integrating technological results from other value chains into the integrated bio-energy concept

The value chain demonstration projects will also reveal technological challenges that need more extensive R&D. These specific technological challenges are the basis of the calls for **R&D Projects** (see section 3.1.2 for the description behind the topics):

R&D PROJECT TOPICS

1.1.4; 2.2.1; 2.2.3; 2.2.4; 2.2.5; 3.1.3

The value chains demonstration projects will lead to investments in full-scale **Flagship projects**. This value chain will lead to at least one flagship project. This flagship project will cover the full value chain. It will include programmes realising feedstock supply, ensuring the market uptake, and integrating in the existing rural and industrial infrastructures. See below an example of a possible flagship project to be realised within value chain nr 5.

VALUE CHAIN FLAGSHIP EXAMPLE

A flagship for the conversion of an energy plant that currently co-fires 1.000.000 ton/y of biomass for energy production, into an integrated biorefinery, producing 400.000 ton/y cellulose fibres & chemicals next to bio-energy.

3.1.2 THE R&D PROJECTS (ADDRESSING THE INNOVATION CHALLENGE)

While value chains can be built partly on already developed research results and successful pilot trials, the demonstration projects will still require substantial research and development before the whole value chain can be moved to the demonstration level.

Calls for R&D projects (including specifically SME targeted projects) will address the specific research and innovation challenges arising from the value chain demonstration activities. This will generate the necessary enabling knowledge and technologies to build and reinforce the new value chains from biomass to biorefineries and markets/products. Research and innovation activities addressing the innovation challenge will be centred around the three parts of the value chain: biomass supply, biorefineries and products & markets. The table on the next pages shows an indication of possible research areas and their timing. However, **calls will only address those topics that arise from encountered challenges** in the value chains to be demonstrated and realised. Calls will therefore be made **more specific** based on the value chains to be realized. Some (hypothetical) examples of topics becoming more specific:

- "Development of concepts for reuse of fertilizer recovered from by-streams in biorefinery operations" (1.1.2) might become a specific call on "Development of an economical process for the isolation of pure phosphate from process water arising from the value chain that processes Irish nature grass into proteins for fish feed and specific functional food ingredients" and / or "Development of an effective fertilizer application for the phosphate recovered from process water arising from the value chain that processes Irish nature grass into proteins for fish feed and specific functional food ingredients"
- "Efficient and cost-effective fractionation and separation technologies to simplify biomass into its basic components" (2.1.1) might become "Development of a sustainable and cost-efficient technology to separate wheat straw from Denmark into its pure components cellulose, hemicellulose and lignin, within the specifications given by the further conversion of those components into pure sugars, cellulose for paper, benzene and furans"

TABLE 6. THE INNOVATION CHALLENGE - MAIN RESEARCH AREAS SUPPORTING THE VALUE CHAINS

1. Fostering a sustainable biomass supply to feed both existing and new value chains				
1.1	Increase biomass production by improving agriculture practices	Short 2014-15	Medium 2016-17	Long 2018-20
1.1.1	Development of higher efficiency in cultivation systems to increase yield, availability and use of forestry and agricultural biomass (in particular residues, co- and by-products) while meeting the range of other demands on arable and woodland. Reducing feedstock production costs under sustainable production methods with added value for the complete production chain and demonstrating of value creation (economic, environmental and social) at the production/mobilisation stage;			
1.1.2	Development of concepts for reuse of fertilizer recovered from by-streams in biorefinery operations. Preferably leading to a separation of organic matter and minerals, helping to improve plant yields and soil quality and reducing waste and environmental impact of biorefineries;			
1.1.3	Identifying the most appropriate crop cultivation systems to increase biomass production for specific value chains taking into account climate change, crop rotational effects, resistance to biotic and abiotic stresses, nutrient and carbon balance, water use efficiency, soil tillage practices and management needs;			
1.1.4	Development of pre-transformation techniques at harvest and/or storage, in particular focusing on cost-effective concentration systems to facilitate transport and/or storage;			
1.1.5	Development of agronomic solutions to maintain soil structure and fertility, reducing erosion, putting into value arable land and maximizing water use efficiency for specific areas in order to supply the biomass production for dedicated new fuels, chemicals and materials value chains;			

		Short 2014-15	Medium 2016-17	Long 2018-20
1.1.6	Precision farming: improving soil quality, water, land use, new input management technologies (water, crop protection, animal husbandry techniques, sensor technology) for specific areas in order to increase the biomass supply for dedicated new value chains;			
1.1.7	Develop regional closed loop systems in biorefinery clusters and hubs: study the use and impact of spreading safe and nutrient-rich process water from biorefineries onto fields on soil quality and productivity.			

1.2 Mobilising an increasing supply

1.2.1	New plant species or varieties: Improving composition of lignocellulose or other components for the use of plants as source of renewable materials to be used in specific value chains (e.g. more easily hydrolysable, lower lignin content, lignin with less stable bonds);			
1.2.2	New plant species or varieties: Deliver specific ingredients (e.g. fatty acids, more homogeneous lipid composition, single and complex carbohydrates or protein components);			
1.2.3	New plant species or varieties: Create a list of biomass genotypes (e.g., poplar, willow, miscanthus, reed canary grass) to be grown for specific new value chains;			
1.2.4	Mobilisation of currently unused biomass and residues from agriculture and forest through precision equipment for harvesting and collection, while maintaining other important functions of woodland and crop land;			
1.2.5	Storage: Develop technologies to improve biomass storage properties and to improve feedstock quality;			
1.2.6	Logistics: Improved logistics and storage to provide a continuous supply of feedstock to specific value chains, minimise transport costs, exploitation of transport as process stage and guarantee intermediate product quality and availability;			
1.2.7	Planning and managing integrated logistics chains at local and regional scale to achieve the maximum supply potential required for the value chains (also combining different transport types: road, railways and waterways);			
1.2.8	Recycling: Develop adequate advanced recycling methods for bio-materials and residues (improved collection, sorting and processing);			

2. Optimising efficient processing through R&D and pilot biorefineries

2.1	Primary conversion processes	Short 2014-15	Medium 2016-17	Long 2018-20
2.1.1	Efficient and cost-effective fractionation and separation technologies to simplify biomass into its basic components, such as lignin, cellulose, hemi-cellulose, minerals, oils and fatty acids, protein, starch, sugars and other carbohydrates;			
2.1.2	Innovations in existing primary processes (agro-food, pulp and paper) to minimise residues and obtain higher value;			
2.1.3	Advanced technologies to mildly extract or separate components while preserving their functionalities and minimising the degradation of other components to enable their further valorisation;			
2.1.4	Cost-efficient preparation of harvested material;			
2.1.5	Ensuring flexibility on size of biorefineries while at the same time remaining price-competitive Combining low investment costs with large regional stakeholder commitment improving market deployment with the specific advantages of local/regional processing;			

2.2 Secondary conversion processes		Short 2014-15	Medium 2016-17	Long 2018-20
2.2.1	Bio-technological;			
2.2.2	Chemo-catalytical;			
2.2.3	Thermo-chemical processes;			
2.2.4	Hybrid & consolidated processes;			
2.2.5	Downstream processes;			
3. Developing innovative products & accelerating market-pull for biobased products and fuels				
3.1 New materials & products (incl. conversion and functionalization technologies)		Short 2014-15	Medium 2016-17	Long 2018-20
3.1.1	Materials based on lignin (and bio-aromatic) chemistry;			
3.1.2	Biobased alternatives for existing polymers and innovative polymers from new biobased monomers;			
3.1.3	Advanced biofuels and bioenergy carriers from waste, residues, lignocellulosic materials and other new promising biomass sources;			
3.1.4	New (chemical) building blocks from renewable resources;			
3.1.5	New functional biobased materials and products: e.g. bioplastics, biocomposites, materials based on lignin, starch, (nano-)cellulose or carbon fibres;			
3.1.6	Materials based on cellulosic and hemicellulosic fibres and fibre/polymer composites;			
3.1.7	Lignin-based carbon fibres and nano-cellulose fibres;			
3.1.8	New packaging solutions derived from biobased materials;			
3.1.9	Materials based on biopolymers (such as starch, polyesters from vegetable oils and sugar, chitin);			
3.1.10	Biomass based oleochemistry: fatty acids conversion technologies, including chemistry (metathesis, for example) and biotechnology (including microbial conversion of sugars to lipids/ fatty acids, cutin and suberin conversions);			
3.1.11	New advanced fertilizers;			
3.1.12	New high-value products (pharmaceuticals, cosmetics, chemical), in some cases directly extracted from plants;			
3.1.13	New hygiene products derived from biobased solutions;			
3.1.14	Materials based on oils and fats from plants and animals e.g. biolubricants, biosurfactants, biosolvents;			
3.1.15	Recyclability concepts for biomaterials;			

3.2 Conversion and functionalisation technologies		Short 2014-15	Medium 2016-17	Long 2018-20
3.2.1	Functionalisation and conversion technologies, including chemical catalysis, mechanical, thermal and biotechnology processes towards functionalised chemicals and products;			
3.2.2	Fractionation and extraction technologies to preserve structure and activities of macromolecules of natural polymers. Advanced functionalisation technologies;			
3.2.3	Biopolymer processing into products (films, fibres, packaging, structural composites for e.g. automotive, agriculture);			
3.2.4	Polymerisation processes based on new biobased monomers;			
3.3 New applications and market development		Short 2014-15	Medium 2016-17	Long 2018-20
3.3.1	Connect market demand with biobased opportunities: combine required techno-economical specifications with opportunities of new biobased chemicals and materials;			
3.3.2	Increase consumer awareness on biobased products and biobased economy;			
3.3.3	Identify and create market applications for new biobased products; diversification of markets of current biomass based products; networks and closer cooperation with downstream industries to better understand and serve industrial customers and consumers requirements;			
3.3.4	Demonstrate industrial feasibility for new products;			
3.3.5	Create combinations and synergies between fossil and biobased materials;			

3.1.3 SUPPORTING PROJECTS (ADDRESSING THE SOCIETAL CHALLENGES)

Demonstrating the value chains will require non-technological cross-cutting challenges to be solved. Some of those will be solved in the value chain demonstration projects and R&D projects, or on the programme level in the Joint Undertaking. Others will lead to calls for specific Supporting Projects on cross-cutting issues. Supporting projects will thus enable the value chains to face the many critical elements related to cross-disciplinary approaches. These practices and tools can either address market, legal aspects, technology, quality or any other aspect. Cross-cutting issues include cross-sectoral and critical elements which connect the different steps of the value chains, the different levels of innovation as well as the different stakeholders involved from the private and the public sector.

The Supporting Projects in BRIDGE will take into account the following cross-cutting issues:

- **Clustering and networking:** Clusters are networks of stakeholders in the bioeconomy, which transcend regions and value chains. They will be essential to develop new value chains and support the development of new processes and materials by connecting different partners: research, technology development, operators/producers and consumers. Some value chains aim to create and strengthen optimally integrated areas of rural and industrial biobased activities (Biobased 'hubs'), and create and strengthen clusters which connect value chains and linking regional agriculture, industry and research networks. Activities might also involve the demonstration of systems of new integrated cascaded biorefinery approaches or systems of industrial ecology and symbiosis: combined residue processing, bio-energy production, heat integration and valorisation, re-use of water and (organic) nutrients, analyse energy streams to discover what processes / companies could fit together, etc. Studies might include feasibility studies regarding the optimal locations for biorefineries and suitable unused facilities for conversion to biorefineries;
- **SME engagement:** SMEs are expected to play an important role in building the European bio-based industries. They will be active throughout the whole PPP, in R&D and demonstration projects. In addition, BRIDGE will develop supportive measures for SMEs concerning critical issues such as financing, market information and forecasts, legal obstacles and international partnering. Moreover it is planned that SMEs pay a reduced membership fee to the PPP¹³;
- **Standards and regulations:** While developing new biobased products, the BRIDGE projects will contribute to the development of standards working closely together with CEN¹⁴. Specific questions might arise from the value chain demonstration for analysing the relationship between the development of standards and regulations and the markets for bio-based products and bio-fuels and identify societal demands and unmet market needs. This includes the development of a common language over the entire value chain(s);
- **Feed-stock sustainability and LCA:** Specific value chains might require the assessment of methodologies for addressing sustainability criteria facilitating all projects, including a sustainability and economic feasibility evaluation over the whole value chain, and the environmental footprint of the resulting product.

Cross-cutting issues to be covered in the individual projects and by the overall Joint Undertaking concern increasing awareness and support for the activities of BRIDGE. Actions will include proactive communication, dissemination and outreach, educational activities and monitoring the impact on the European biobased economy.

¹³ A defined in the BIC statutes, its Internal Rules and the Biobased Industries PPP Governance document.

¹⁴ European Committee for Standardization (Comité Européen de Normalisation)

3.2 MONITORING THE PROGRESS AND IMPACT

Fast implementation and performance feedback are key issues of BRIDGE. Overarching strategic objectives towards the Biobased Economy that will be triggered by the PPP activities and results have been identified in Table 1 (Chapter 2), covering the whole value chain as well as cross-cutting areas. Looking at the ambition and the high level strategic objectives of BRIDGE, the effectiveness and throughput will be the most suitable aspects for monitoring the success of the initiative.

The PPP is a chain of links: input, throughput, output, outcome, impact. Each of these links is taken into account in monitoring to assess and evaluate:

- **Efficiency**, in terms of relationship input/output;
- **Effectiveness**, in terms of relationship input/outcome and impact;
- **Throughput**, in terms of relationship between output, outcome and impact.

It is proposed to implement all validated technologies or processes at pilot scale within demonstration projects and in some cases flagships allowing the assessment of the programme progress with the help of an appropriate set of KPIs. Three levels of quantitative and qualitative Key Performance Indicators have been identified (see Figure 4).

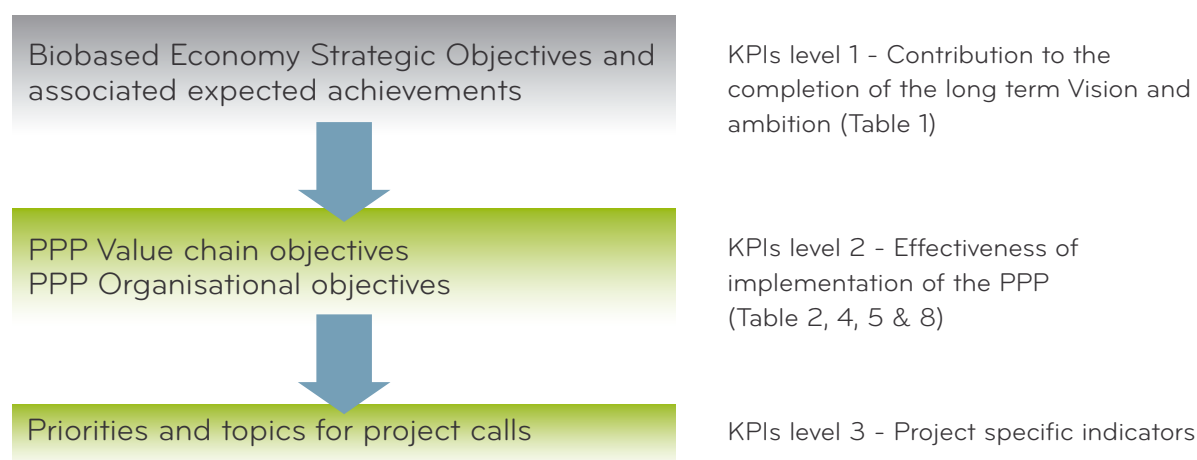


FIGURE 4. THE DIFFERENT LEVELS OF KPIS

In particular:

- KPIs "Level 1" address the contribution to accomplishment of the overall strategic objectives of the Biobased Economy associated with the Vision 2030 (outcome and impact). Although the PPP results and activities will be crucial triggers for these objectives, these objectives will not be direct results of the PPP;
- KPIs "Level 2" aim at monitoring the progress of BRIDGE and measuring how the specific research and innovation targets defined by 2020 are met (output and outcome);
- KPIs "Level 3" allow monitoring the success of each project to be funded under BRIDGE.

KPI level 3 will be defined by each project as ad-hoc KPIs attuned to KPI level 2.

EFFICIENCY OF BRIDGE

For the sake of monitoring progress and implementation of BRIDGE, the direct quantitative objectives could be used as KPIs Level 2 to monitor the progress of the programme (see Tables 2, 4, 5 and 8). A limited selection from these objectives is made as key specific objectives. These objectives are directly linked to a set of key performance indicators (kpi's), to be measured and monitored during the progress of the PPP, and to be used to steer the PPP activities accordingly. See table 8 and 9 on the next pages.

The monitoring at this level will be a task of the programme management. Frequent monitoring gives insight in the efficiency of the programme. During the execution of the programme these KPIs will be evaluated on their effectiveness, in order to be able to change and complete the monitoring of the programme when needed.

These kpi's will be complemented with operational objectives on the PPP performance to be monitored continuously:

- Overall percentage % of industry investments (cash + in-kind) in the total PPP organisation and projects;
- A well balanced SME involvement in BRIDGE organisation and projects, in line with Horizon 2020;
- Involvement of RTOs / Academia (i.e. targeted amount of finances flowing to RTOs / Academia);
- Balance between R&D, demonstration and supporting projects;
- Addressing the societal challenges (i.e. including some cross-cutting issues in demonstration projects);
- Follow-up on R&D results: % of PPP R&D results brought into demonstration projects;
- How well do the projects realised address the variety of topics in the SIRA in a balanced way (e.g. variety in feedstock, in products, in processes, etc.);
- A geographically balanced distribution of projects across member states (in all projects, and especially large demonstrators).

TABLE 7. PPP KEY OBJECTIVES

- **36** new cross-sector interconnections in biobased economy clusters (new bridges creating cooperation between the **9** different sectors)
- **At least 10** new biobased value chains (new products and feedstock)
- **More than 200** cooperation projects through cross-industry clusters
- **5** new building blocks based on biomass of European origin validated at demonstration scale, further increasing to **10** in 2030
- **50** new biobased materials (eg. such as specialty fibres, plastics, composites and packaging solutions)
- **30** new demonstrated 'consumer' products based on biobased chemicals and materials
- At least **5** flagships resulting from BRIDGE producing new biobased materials, chemicals and fuels which have proven to become cost-competitive to the alternatives based on fossil resources (at least 1 per value chain)

EFFECTIVITY OF BRIDGE

To get insight in the effectiveness of the programme, i.e. answering the question 'are we doing the right things?', a monitoring for the KPIs at Level 1 (Table 1) has to be set-up. This is a task of the programme management, but might be supported by a Supporting Project within the PPP, that will run throughout the execution of the programme.

KPI level 3 will be defined by each project. This can be done by setting monitoring criteria in the call for proposal and/or by demanding the determination of KPIs in the Description of Work of the projects. The KPIs Level 3 have to be attuned to KPI level 2 and 1. Ensuring the KPIs Level 3 are well attuned is the responsibility of the programme management of BRIDGE. The project manager is responsible for monitoring the progress of the project and has to deliver data for KPIs Level 1 and 2 when needed.

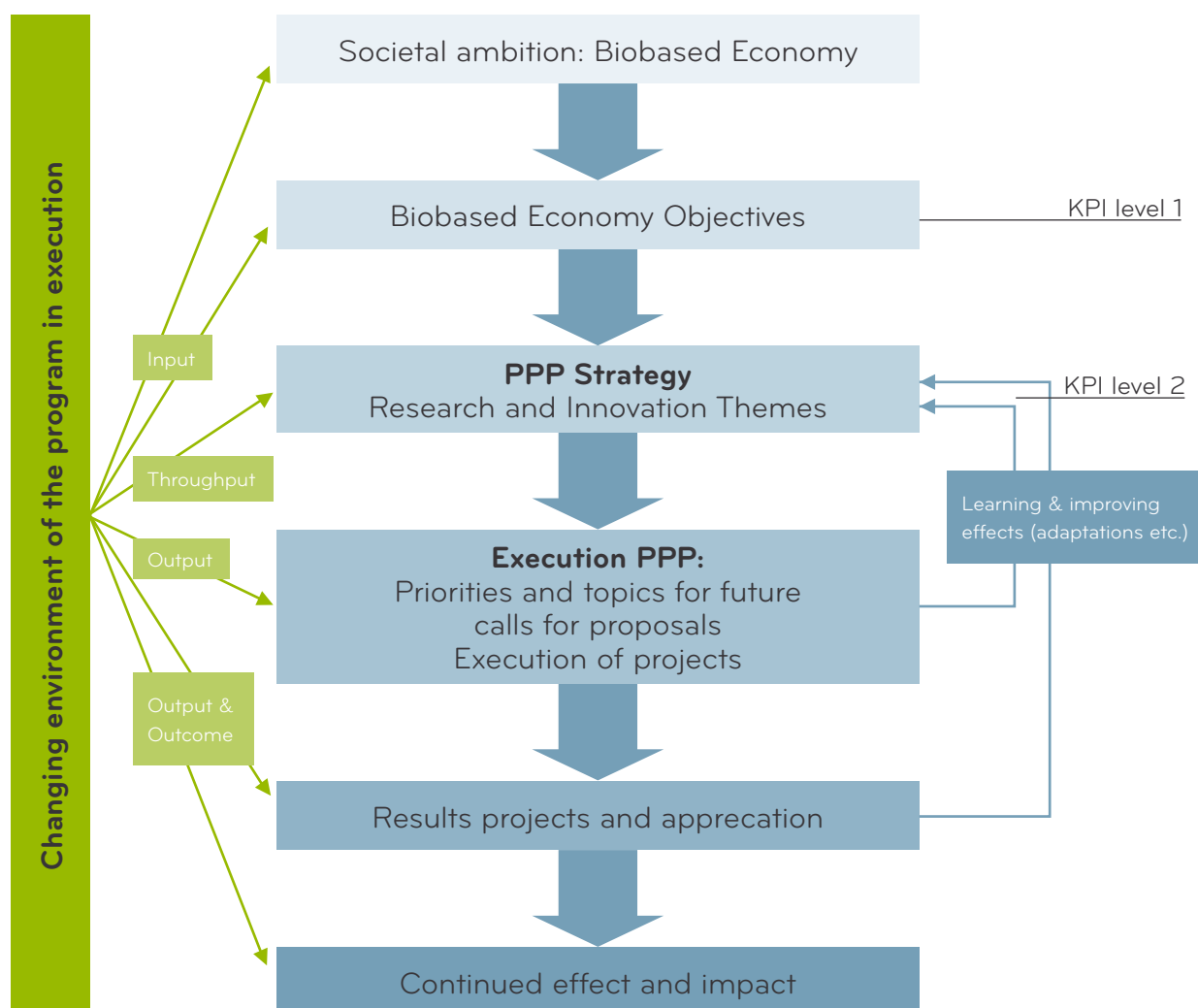


FIGURE 5. PROPOSED APPROACH TO MONITOR BRIDGE

Monitoring of these key specific objectives and kpi's will be performed according to the overall logic of figure 5.

TABLE 8. PPP KEY SPECIFIC OBJECTIVES + KPI'S FOR MONITORING AND ASSESSING THE PROGRESS OF THE BIOBASED INDUSTRIES PPP

1	Objective	36 new cross-sector interconnections in biobased economy clusters (new bridges creating cooperation between the 9 different sectors);			
	KPI	# of new cross-sector interconnections in BRIDGE projects	31-12-'16	31-12-'18	31-12-'20
	How to analyze	Amount of innovative cooperation's started in BRIDGE value chain demonstration projects: When companies from different sectors start to cooperate on building new value chains, while these companies have not been active in the same value chain before / did not cooperate in business before (or did cooperate but in a totally different field).			
2	Objective	At least 10 new biobased value chains (new products and feedstock);			
	KPI	New biobased value chains realised	31-12-'16	31-12-'18	31-12-'20
	How to analyze	Amount of completely new value chains (from raw material to product) developed in BRIDGE projects: New innovative products or existing products that have not been produced from the biobased feedstock before. The new value chains are proven in the PPP projects to be economically viable, and to fulfil all relevant sustainability criteria. Each of the value chains have elaborated business cases and plans for commercialisation (if not already scaled up to flagship projects - see objective 7).			
3	Objective	More than 200 cooperation projects through cross-industry clusters;			
	KPI	General progress of BRIDGE	31-12-'16	31-12-'18	31-12-'20
	How to analyze	Amount of cooperation projects started (value chain demonstrations and R&D).			
4	Objective	5 new building blocks based on biomass of European origin validated at demonstration scale, further increasing to 10 in 2030;			
	KPI	Amount of new biobased building blocks	31-12-'16	31-12-'18	31-12-'20
	How to analyze	New building blocks developed and demonstrated by BRIDGE projects. New biobased building blocks are chemical building blocks that are currently made from fossil sources and have not (successfully) been made from biomass on (pre)commercial scale before, or are new building blocks that could replace the current fossil based ones. The new building blocks are proven in the PPP projects to fulfil a clear market demand and its technical requirements, to be economically viable and to fulfil all relevant sustainability criteria.			
5	Objective	50 new biobased materials (eg. such as specialty fibres, plastics, composites and packaging solutions);			
	KPI	Amount of new biobased materials	31-12-'16	31-12-'18	31-12-'20
	How to analyze	New biobased materials developed and demonstrated by BRIDGE projects. The biobased materials that replace current materials have proven to have an equal or overall better sustainability (by LCA, replacing fossil based, improved material efficiency, reduced GHG emission, biodegradability, recyclability or other improved effects during use or reuse). The biobased materials have proven in the PPP projects to fulfil a clear market demand and its technical requirements, to be economically viable and to fulfil all relevant sustainability criteria.			

6	Objective	30 new demonstrated 'consumer' products based on biobased chemicals and materials;			
	KPI	Amount of new biobased 'consumer' products	31-12-'16 5	31-12-'18 15	31-12-'20 30
	How to analyze	New biobased products and applications developed and demonstrated by BRIDGE projects. The biobased products (materials, fuels, chemicals successfully converted into to 'consumer' products) will have an overall better sustainability than its current alternative (by LCA, replacing fossil based, improved material efficiency, reduced GHG emission, biodegradability, recyclability or other improved effects during use or reuse). The biobased products have proven in the PPP projects to fulfil a clear market demand and its technical requirements, to be economically viable and to fulfil all relevant sustainability criteria.			
7	Objective	At least 5 flagships resulting from BRIDGE producing new biobased materials, chemicals and fuels which have proven to become cost-competitive to the alternatives based on fossil resources (at least 1 per value chain);			
	KPI	Bring PPP results into practice	31-12-'16 1	31-12-'18 2	31-12-'20 5
	How to analyze	Amount of flagship projects started based on BRIDGE demonstration projects.			

3.3 CALL PROCEDURE

BRIDGE supports research and innovation activities following open and competitive calls for proposals, independent evaluation, and the agreement for each selected project of a Grant Agreement and a Consortium Agreement.

SUBMISSION AND EVALUATION PROCEDURE

Applications to the Joint Undertaking for financial support will be made following open competitive calls for proposals. The evaluation, selection and award procedures will be described in details in a specific document "Rules for submission of proposals, and the related evaluation, selection and award procedures". Evaluation will be performed on the basis of Excellence. The evaluation criteria (including weights and thresholds) and sub-criteria together defining 'Excellence', and the eligibility, selection and award criteria, for the different funding schemes will be based on Horizon2020 guidelines and described in a dedicated chapter in each Annual Implementation Plan and call, titled "Evaluation criteria and procedures".

Proposals will not be evaluated anonymously. Ranked lists of proposals will be established for each main area. Proposals from different topics, within the same area, with equal overall scores will be prioritized according to the overall Joint Undertaking Annual Implementation Plan coverage. Proposals for the same topic with equal overall scores will be prioritised according to their scores for the S/T Quality criterion. If they are still equal, they will be prioritised according to their scores for the Impact criterion. A reserve list will be constituted if there is a sufficient number of good quality proposals, which will be taken into consideration if budget becomes available.

CONSORTIUM AGREEMENT

The legal entities wishing to participate in a project shall form a consortium and appoint one of its members to act as its coordinator. As a general rule, the coordinator of a demonstration project should come from the Industry Grouping (members of the Biobased Industry Consortium - BIC) or become member of BIC (before project application). For R&D and Supporting Projects the coordinator can be an Associate member to the BIC (e.g. RTO, university, industry association, ...), however supported and steered by one or more members of BIC that together defined and support the specific call topic, based on the value chain project under development. Any exception to this rule will have to be justified. The IPR rules of BRIDGE will be described in a separate document.

GRANT AGREEMENT AND FORMS OF GRANTS

The Consortium Agreement (between the partners) has to be agreed and signed before the signature of the Grant Agreement (between consortium and BRIDGE).

BRIDGE financial contribution will be given as a grant to the beneficiaries. The contribution will depend on the funding scheme, activity, nature of the beneficiary and type of cost. The reimbursement rules will be specified in detail in the call for proposals.

The Grant Agreement will:

- Govern the relationship between the consortium and BRIDGE;
- Provide appropriate provisions for the implementation of the RTD activities and support actions;
- Ensure that appropriate financial arrangements and rules are in place relating to the intellectual property rights policy (to be further detailed in the Consortium Agreement);
- Projects shall be supported by a financial contribution from BRIDGE and through in-kind and/or cash contributions from the legal entities participating in the activities.

REQUIREMENTS FOR PARTICIPATION

Participation in projects shall be open to all legal entities and international organisations once the minimum conditions have been satisfied. The minimum conditions for projects funded by BRIDGE are (cfr. Horizon 2020 rules):

- at least three legal entities must participate, each of which must be established in a Member State or Associated country;
- The partners should come from at least 3 different Member States;
- All three legal entities must be independent of each other as defined in Chapter 1, Article 7 of the Rules of Participation of Horizon 2020.

BRIDGE will ensure that innovative SMEs 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, including special SME-calls for technology development.

Details on the calls procedure of BRIDGE (programming and implementation) are described in a separate document.

4. STAKEHOLDER INVOLVEMENT

A group of 40 leading companies and clusters from current and future biobased sectors, across Europe, together developed this underlying Strategic Innovation and Research Agenda. The cooperation and exchange across a broad range of sectors such as chemical, pulp and paper, agro-food, biofuel and energy companies and well as technology providers (e.g. biotechnology) is exceptional and promises to be extremely fruitful and holds great potential. Partners cover all the key phases of a general biobased value chain, as well as nearly all countries in the EU. SMEs are well involved and integrated in the PPP partnership. Research organisations and academics are joining and supporting the research and demonstration priorities.

4.1 INDUSTRIAL PARTNERS IN BRIDGE

4.1.1 THE INDUSTRY GROUPING

Currently 41 industrial partners (large enterprises, SMEs and clusters) contribute financially and in-kind to the founding of the PPP (see figure 6). The industrial partners have grouped themselves into a legal entity (BIC AISBL), with a General Assembly and a balanced representation of the relevant industrial sectors.



FIGURE 6. THE BIC INDUSTRIAL MEMBERS (LARGE ENTERPRISES, SME, CLUSTERS)

The industrial partners are supported and advised by their European Associations (figure 7).



FIGURE 7. EUROPEAN ASSOCIATIONS CONTRIBUTING TO BRIDGE

4.1.2 SME PARTICIPATION

A substantial part of the transition to a biobased economy will be initiated and/or developed by innovative starters and SMEs. These SMEs are essential in offering and developing specific services, technologies, equipment and instruments, both in enhancing developments at large enterprises as well as in stand-alone projects or local cooperation. In addition, innovative SMEs 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 BRIDGE, but also through individual membership of BIC. Already among the current partner consortium, SMEs are already well involved, either directly or via clusters.

Direct SME partners

Currently 5 SMEs are direct members in BIC:

- [IUCT](#) (a high-tech company for industrial technological innovation aimed at developing, implementing and promoting new technologies in the chemical, pharmaceutical, and environmental fields)
- [CLEA Technologies](#) (core competencies in the development of green, sustainable biocatalytic processes and a proprietary technology for enzyme immobilization as Cross-Linked Enzyme Aggregates (CLEAs))
- [Biobase Europe Pilot Plant](#) (open innovation pilot and demo facilities for the biobased economy)
- [Direvo – Engineering Biomass](#) (develops and implements biology-based solutions for partners and customers in the fast growing biomass conversion market)
- [Biorefinery Process Facilities](#) (open innovation pilot and demo facilities for the biobased economy)
- [BIONET Ingenieria](#) (provides equipment and engineering for biotech, chemical, food and pharma industries)

SMEs in Clusters

Many SMEs are currently involved via four cluster-members in BIC: IAR, GFP, DBC and CLIB2021.

GFP – German Federation of Private Plant Breeders

A cluster of 60 German plant breeders of which 2/3 is SME

IAR (“Industries et Agro-ressources”) cluster, France

90 SMEs represented and, in particular, the companies:

- [Deinove](#) (microbiological technologies for lignocellulose conversion into biofuels and chemicals)
- [YNSECT](#) (novel molecules from biomass using insects)
- [Omega Cat System](#) (novel catalysts and solutions in the field of olefin metathesis)
- [Maguin](#) (novel extraction process using pulsed electric fields)
- [Alderys](#) (disruptive synthesis for the production of chemical compounds by micro-organisms)

Dutch Biorefinery Cluster (DBC)

- Via the association of Dutch paper and board mills: 2 SME specialty paper mills
- Coldenhove Papier
- Meerssen Papier
- Via the Product Board Arable Products
- Several SMEs converting arable biomass to food and materials
- Via the Product Board Horticultural Products
- Several SMEs converting arable biomass to food and materials

Biobased Innovations

- Involvement of SMEs is arranged on project bases. Two projects active (biobased innovations & biofunctionals). Active SMEs
 - 5 SMEs in biobased innovations (advisory, fermentation, agrofood, biobased cleaning)
 - 13 SMEs in biofunctionals (biogas, textile, advisory, agrofood, biomaterials, technology, packaging, filtration, paper, 1 torrefaction)

CLIB2021 Cluster Industrial Biotechnology, Germany

26 PPP-relevant SME members from Germany, EU27 and other countries represented, in particular 5 companies.

- SME are active in a variety of biotech sectors (see figure 8):
 - Technology development/services (enzyme/strain development and optimisation, bioproducts, fermentation/reaction technology, purification, downstream processing, process optimisation, pilot plant/pilot services, biofuels, analytics)
 - Biomass processing
 - Biomaterials
 - Policy/market analysis

<p>Tech development, enzymes/strain development and optimisation, bioproducts</p> <ul style="list-style-type: none"> • ARTES Biotechnology GmbH • Autodisplay Biotech GmbH • c-LEcta GmbH • Dyadic Nederland BV (NL) • DIREVO Industrial Biotechnology GmbH (<i>also individual member of the Biobased PPP</i>) • Senzyme GmbH • BUTALCO GmbH • BIRD Engineering BV (NL) • Emcid Biotech GmbH • evocatal GmbH • SeSaM-Biotech GmbH • Phytowelt GreenTechnologies GmbH (specialisation on plants) 	<p>Tech development: pilot plant/pilot services</p> <ul style="list-style-type: none"> • Bio Base Europe Pilot Plant (BE) (<i>also individual member of the Biobased PPP</i>) Tech development/services: purification, downstream processing, process optimisation • instrAction GmbH • Insilico Biotechnology AG • Schaumann BioEnergy GmbH • BIRD Engineering BV (NL) <p>Policy/market analysis</p> <ul style="list-style-type: none"> • nova-Institut GmbH 	<p>Biomass logistics/processing</p> <ul style="list-style-type: none"> • Camelina Sativa Projekt GmbH <p>Biomaterials</p> <ul style="list-style-type: none"> • Emery Oleochemicals GmbH • Mitsui & Co Deutschland GmbH • SpecialChem SA (FR, marketing/innovation services) • Solutex (ES) <p>Tech development/services: Analytics</p> <ul style="list-style-type: none"> • AQura GmbH • B&S Analytik GmbH • Taros Chemicals <p>Tech development: biofuels</p> <ul style="list-style-type: none"> • Greasoline GmbH
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FIGURE 8. SMES IN CLIB2021

BRIDGE will have a clear direct impact on SMEs' competitiveness. European SMEs offer a wide range of biobased products, processes and technologies in different stages of development. For example, in Spain it is estimated that 95 bioprocesses, 91 bioproducts (49 of which are advanced biofuels) and 53 biobased technologies are currently being developed by biobased companies, most of which are SMEs¹⁵. However most of the SMEs do not have a product or a process ready for demonstration and still require substantial research work to be carried out.



FIGURE 9. POSITIONING OF SMES ALONG THE INNOVATION CHAIN

The Biobased Industries PPP will contribute to bringing these products and processes led by SMEs to the market, which will significantly contribute to fulfilling the 2030 objectives associated with the PPP's ambitions. SMEs can also provide valuable support to large industrial players with technical assistance and support, often in tight cooperation with RTOs. They are experts in high technological solutions and are technology developers. Bioreactor design, process optimization, new biocatalyst for biomass processing, are some examples of areas where SMEs are deeply involved. These technologies and expertise could be instrumental for the implementation and deployment of demonstration projects.

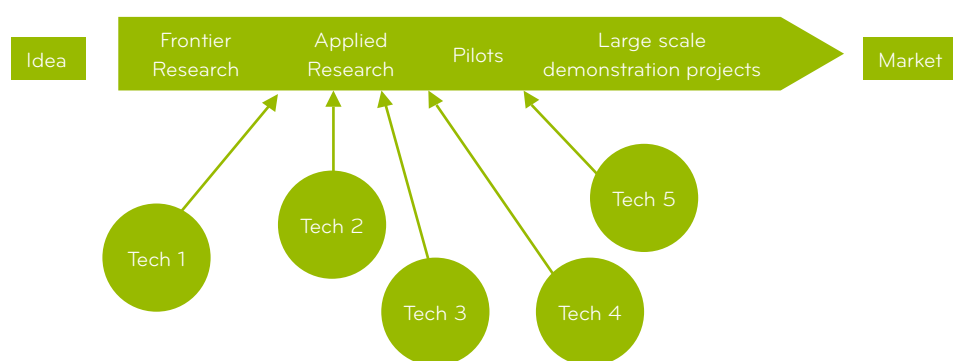


FIGURE 10. POTENTIAL CONTRIBUTION OF SMES ALONG THE INNOVATION CHAIN

The industrial interest of this type of SME will be to develop a new product, process or services to be licensed or used by larger players in traditional and new value chains. BRIDGE, with a strong presence of SMEs, will become a platform for the most effective exploitation of the available resources to have new technologies going to the market. This will result in a greater number of new innovative products on the market.

BRIDGE 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, including special SME-calls for technology development.

¹⁵ Data collected from the Industrial Biotechnology of ASEBIO, ASEBIO report 2011

4.1.3 BIOMASS PRODUCTION

Sustainable biomass supply is an essential part of biomass value chains. This includes the increased production and mobilisation of existing biomass (forestry and agriculture), as well as the development of new dedicated crops. PPP partners investing in this part of the value chain are:

Plant breeders

- Federation of German Private Plant Breeders (60 plant breeders)
- Via Dutch Biorefinery Cluster
 - Productboard Arable farming
 - Productboard Horticulture

Fertilizer companies

- Fertiberia

Farmers / Farmers associations / Farmers cooperatives

- Nordzucker (16,000 beet growers as biomass suppliers, all shareholders are farmers)
- Südzucker (56% share holders are farmers – beet growers cooperative)
- Via Dutch Biorefinery Cluster
 - FrieslandCampina (cooperative of dairy farmers)
 - Cosun (cooperative of beet growers)
 - Avebe (cooperative of potato growers)
 - Productboard Arable farming
 - Productboard Horticulture
- Via IAR:
 - Tereos (cooperative, 12 000 farmers as shareholders)
 - Sofiproteol (leading player in the French vegetable oil and protein industry with agricultural shareholders)
- Via ARD:
 - Cristal Union, 9500 farmers involved as cooperators
 - Vivescia, the main cooperation of Siclae, has 12.000 farmers also cooperators

Forest cooperatives

- Holmen: 60% of their wood consumption is from own forest: 1Mha
- Metsä Group (Metsäliitto Osuuskunta): cooperative of 125.000 Finnish forest owners
- SCA: Europe largest private forest owner – 50% of own wood consumption: 2.5 Mha
- Södra (cooperative) has a total of 36,000 forest properties and 51,000 people as members
- UPM: own forests in EU area 0,9 Mha – 16 % of annual wood consumption originate from own forests and plantations

4.1.4 PARTICIPATION ACROSS EUROPE

The current PPP members cover whole Europe with their businesses. Except for Malta, production and conversion activities are in all EU member states. Especially in terms of contributing to an EU wide supply of sustainable biomass, the potential of the EU12 is substantial. Agricultural and forestry production levels are relatively low and leave significant room for progress. The Bloomberg New Energy Finance study estimates the potential of agricultural & forestry residues & municipal waste across the EU27 and concluded that 25.4 % of the total EU potential is located in the EU12, with Poland ranking in 5th position overall in the EU. For reasons of efficiency, biorefineries need to be close to the biomass sources.

The EU12 could not only benefit from being purely biomass suppliers, thus creating additional income opportunities for farmers and foresters, but even more so in terms of establishing the required industrial conversion/biorefinery capacities. This approach would allow addressing difficulties of the EU12 to identify a sufficient number of economically viable projects that can “absorb” the resources available to them in rural development funds. The concept of “Smart Specialisation” in this regard would allow EU12 Member States to build on their individual strengths, e.g. in terms of agriculture and forestry and in terms of fermentation know-how, giving priority to related investments in R&D&I. DG REGIO in cooperation with DG RTD and other services is currently preparing a “Practical Guide for Managing Authorities”, assisting managing authorities (MAs) in integrating green growth into the regional research and innovation strategies for smart specialisation, thus making optimal use of the EU Structural Funds to address issues of sustainable energy, eco-innovation and eco-system and nature protection.

Independent from or as a follow-up to BRIDGE, the development of a network of biorefineries in EU12 Member States can provide an excellent opportunity to leverage the necessary structural funds under the EU Cohesion Policy, creating new sources of employment and economic growth.

In addition, PPP information and brokerage events will need to be organised in cooperation with the industry, specifically focusing on the EU12.

Therefore, BRIDGE will also stimulate demonstration activities at the production locations in EU-12 countries.

Below an overview is given from the production facilities of the current BIC members:

- Billerud: Lithuania
- Borregaard: Czech Republic
- Cargill: Poland
- Clariant: Czech Republic, Poland
- Holmen: Estonia
- Metsä Group: Poland, Slovak Republic, Estonia
- Mondi: Slovakia (2x), Czech Republic (5x), Bulgaria (1x), Poland (11x), Hungary (3x)
- Nordzucker: Lithuania, Poland, Slovak Republic, Czech Republic
- Roquette: Bulgaria, Estonia, Romania
- SCA: Poland, Slovak Republic
- Smurfit Kappa: Poland, Czech Republic, Slovakia, Romania, Latvia, Lithuania
- Stora Enso: Estonia, Hungary, Latvia, Lithuania and Poland
- Südzucker: Poland, Hungary, Romania, Slovak Republic, Czech Republic
- Tereos (via IAR): 5 plants in Czech Republic
- Siclae (via ARD), via its subsidiaries: Hungary, Romania and Poland
- Sofiproteol (via IAR): Romania
- UPM: Poland, Estonia
- Unilever: Czech Republic, Romania

In order to benefit from scientific and technological expertise from institutes and academia from all over Europe, BRIDGE will cooperate with the relevant ERA NETs. Results of ERA NETs will be incorporated and implemented in BRIDGE and the PPP will advise on their research topics. Moreover, involved industrial partners in ERA NETs will be stimulated to become partners in BRIDGE.

In the ERA-NET ERA-IB (industrial biotechnology) partners and observers from 15 different countries joined forces to reduce fragmentation of national research efforts, and to encourage academics and industrial researchers to work together. The fact that member states such as Romania, Croatia and Poland are also participating, illustrates the growing interest of the Eastern European countries. Some of the clusters in BRIDGE have strong ties to academic institutions in EU-12 countries (e.g. CLIB2021 with Poland and the Slovak Republic).

4.1.5 PARTICIPATION RESEARCH ORGANISATIONS

Research organizations, consisting of Research and Technology Organisations (RTO) and universities, play an important role in the implementation of the European Framework Programme for Research & Technology Development¹⁶. They also have an essential role in BRIDGE, through supporting the demonstration activities by executing research and development required to realize the vision of the Joint Undertaking. They furthermore contribute by evaluating and disseminating the scientific achievements as described in the annual activity reports and advise in setting the R&D agenda and Annual Implementation Plans.

A large network consisting of over 200 representatives of research organizations from different European member states expressed their interest in the SIRA (see Appendix 1). In their combined response to the prioritization of the SIRA research topics, it was shown that the research organizations have a quite similar prioritization of the research topics as the industrial partners.

4.1.6 REGIONS

Many regions in Europe have already developed a regional strategy for the biobased economy, and several have set up local clusters and PPPs. Also the Committee of the Regions (CoR) recently emphasized the important role of public-private partnerships (PPPs) in accelerating the transition towards a bioeconomy¹⁷. More specifically, the CoR suggested that advanced regions in the bioeconomy field should be supported in taking the steps required by bioeconomy value chains and in connecting to other less advanced regions, and believes that this approach leads to an effective use of resources, while fostering cohesion.

Through the "Smart Specialisation Strategy" the European Commission encourages national and regional authorities across Europe to draw up research and innovation strategies for smart specialisation, so that the EU's Structural Funds can be used more efficiently. Synergies between different EU, national and regional policies, as well as public and private investments, can be increased.

The Biobased Industries PPP is a key enabler in this respect since several of the regional clusters participate. BRIDGE will contribute to the creation of the "bridge" between Horizon 2020 and Structural Funds since it will trigger the participation of the regions in planning actions and measures well aligned with the intrinsic capabilities of each local areas.

¹⁶ Research and Technology Organisations in the Evolving European Research Area – A status report with Policy Recommendations by EARTO

¹⁷ Conference 'Partnering for the Bioeconomy in European Regions', 12 October 2012, Brussels

5. THE EU ADDED VALUE

In February 2012, the European Commission has adopted a strategy and action plan "Innovating for Sustainable Growth: a Bio-economy for Europe2" to shift the European economy towards greater and more sustainable use of renewable resources. This bio-economy strategy is part of the Europe 2020 flagship initiatives "Innovation Union" and "A Resource Efficient Europe". The goal is a more innovative and low-emissions economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection. This PPP is part of the implementation of this strategy.

5.1 ADDED VALUE OF ACTION AT EU LEVEL AND OF PUBLIC INTERVENTION USING EU RESEARCH FUNDS

The multi-sectoral approach in the biobased PPP will combine the strengths of industries, regions and EU countries enabling the transition from oil & gas to a biobased sustainable economy. Neither single stakeholders nor individual member states will reach the required critical mass on their own, justifying the clear added value of tackling these ambitions on a EU27 scale. Highly forested countries and highly productive agricultural regions will be linked to industrial centres in Europe to generate new value propositions through the development of integrated value chains.

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. BRIDGE projects will therefore, where possible, be combined with national projects and structural and regional funds to achieve a multiplier effect.

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. In this context, BRIDGE will report on policy feedback on several cross-sectoral policies of relevance for the industry (from supply to market pull measures).

A clear EU added value for the Biobased Industries PPP is its key enabling role 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. the 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. 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 stakeholders.

Tackling these challenges in a cooperation between industry and the European Commission within the framework BRIDGE is justified by:

- **the research needed which is so complex that no single company or public research institution can perform it alone,**
- **the absence of an agreed long-term budget plan and strategic technical and market objectives to encourage industry and the research community to commit more of their own resources will slow down the pace of innovation,**

- the sub-optimal allocation of funds leaving **gaps and overlaps in a fragmented research coverage**, when member states do not align their funding,
- an **insufficient volume of funds for an integrated and continuous programme** covering fundamental research, applied research and EU-level demonstration and flagship activities,
- the fact that the **value chains are dispersed across different countries and sectors** which restricts the exchange and pooling of knowledge and experience.

This summarizes the clear European added value in having BRIDGE as a EU wide long term research and demonstration programme to allow large industrial companies and SMEs, including those in the new Member States, to collaborate between themselves and with European RTOs, universities, national governmental organisations and NGOs, working towards shared short, medium and long-term objectives across value chains.

5.2 ADDITIONALITY TO EXISTING ACTIVITIES

This SIRA aims at providing research and innovation priorities for the period 2014-2020 with the ultimate goal of accelerating the pace of innovation towards a sustainable biobased economy.

In this framework, there are three components of additionality:

- **Input Additionality:** collaborative Research and Innovation activities around an industry-led programme in close dialogue with different EC services could not be launched without public support, at first due to the current economic and financial challenge, but also because of the specific nature of the sectors involved and their complex value chains.
- **Process Additionality:** the innovation process is managed and implemented in a more efficient way due to the value chain approach, well aligned with the Horizon 2020 objectives.
- **Output Additionality:** the partners have drawn pathways to meet the 2030 vision, whatever economic scenarios may be faced by investors. This means a European roadmap towards demonstration and flagship projects and the tests of various business models and associated value propositions. It brings direct benefits to the participants and to the represented sectors and industries, showing that the barriers towards a sustainable biobased economy are not insurmountable.

Synergy, optimal alignment, cooperation and exchange with all main running initiatives in EU, is required to facilitate practical realisation. We will actively work with, for example, the following EU initiatives to deliver the objectives described in this document:

- **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: Agricultural Productivity and Sustainability, Raw Materials and Water Efficiency.
- **EIBI (European Industrial Bioenergy Initiative)** supports the demonstration of reference plants for innovative bioenergy value chains which are not yet commercially available (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, thus contributing important developments to the EIBI. In turn, the EIBI's demonstration of successful bioenergy value chains could be valuable for the integrated biorefineries which are the goal of the Biobased PPP.
- **EERA (European Energy Research Alliance)** is a co-operation between the major European RTOs advising the EC on necessary bioenergy-related fundamental and applied research to achieve the policy goals defined in the SET-Plan.

- The **PPPs running under the Recovery Plan**, in particular **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 PPP** develops sustainable transport methods, including research on greening combustion engines, biomethane use, logistics and transport systems. Synergies with the biobased PPP lie in the realisation of value chains providing sustainable advanced biofuels for transport. The **Energy-efficient Buildings (EeB) PPP** 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 CO2 emissions. The biobased PPP develops value chains which could deliver sustainable biobased building materials to support the EeB PPP objectives.
- The **SPIRE PPP**, also developed under Horizon 2020, 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 sustainable value chains, bringing together the critical stakeholders to ensure an infrastructure from field to the output from biorefineries. The SPIRE PPP strengthens 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. Biobased Industries PPP, together with the Bio PPP, has identified docking points between the two PPPs to ensure mutual support and complementarity.

An overview of complementarities and synergies is provided in the following picture.

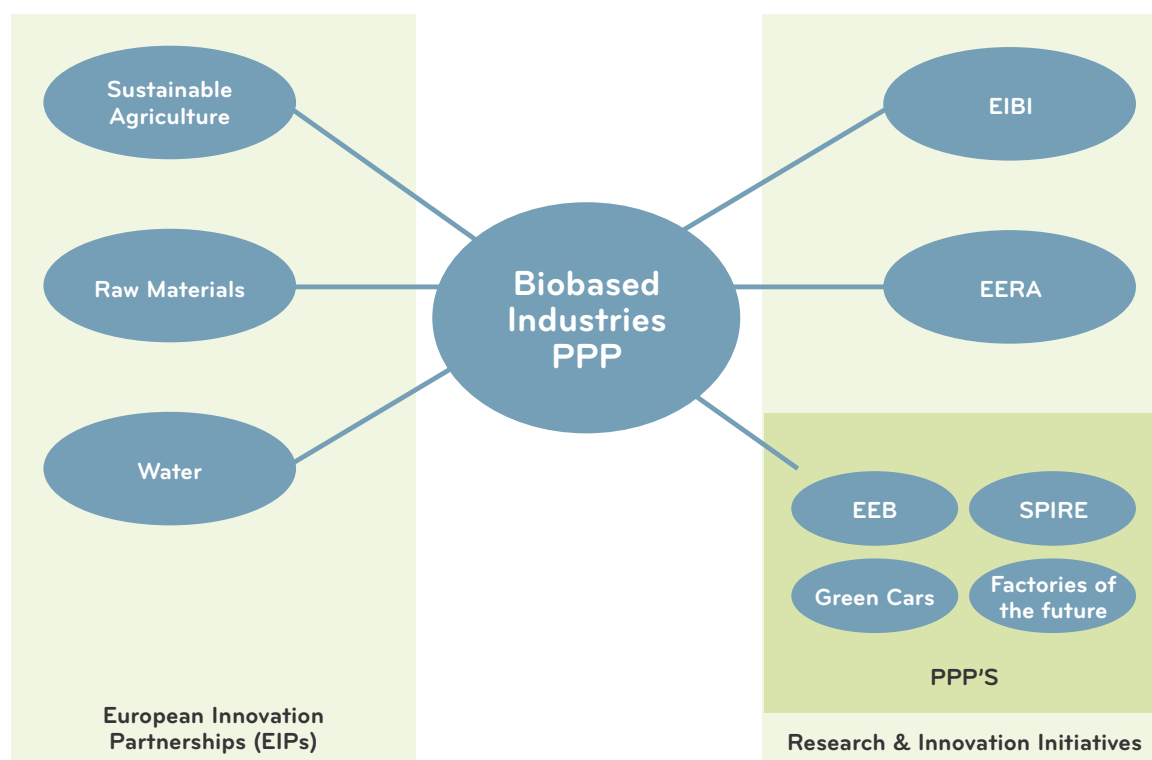


FIGURE 11. COMPLEMENTARITY AND SYNERGY OF BIOBASED PPP WITH MAIN EU INITIATIVES

The intended biobased PPP is fully complementary and synergetic to the Lead market initiatives and its recommendations, aiming at:

- Continuing to stimulate and enhance technological innovation and the development and application of technology;
- Increasing public funding for demonstration projects via public-private partnerships.
- Increasing public funding for demonstration projects and stimulating the construction of demonstrators via Public-Private Partnerships;
- Setting 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;
- Developing 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;
- Developing incentives (taxation or state aid measures, grants) to support the development of new, sustainable biobased products' production processes.

Ultimately, this SIRA builds heavily on the findings of the previous CSA projects BECOTEPS¹⁸ and Star-COLIBRI¹⁹. In particular the industrial stakeholders have further elaborated their findings and aligned them with the overall vision towards 2030, based on the integrated value chain approach.

¹⁸ [http:// www.becoteps.org](http://www.becoteps.org)

¹⁹ <http://www.star-colibri.eu>

6. FINANCIALS

The founding partners together 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. These framework conditions include € 1 billion from the Horizon 2020 budget of the European Commission to be used for the cofundable part of the BRIDGE projects, following Horizon2020 rules.

In Figure 13 an overview of in which topics and kind of projects this total of €3.8 billion is planned to be invested. This prioritisation is based on the ambitions of the BIC members in March 2013. A regular review will be performed on both the topics and budget distribution, based on obtained results and updated ambitions of the industrial partners (at least every 2 years).



FIGURES 12. SHOW THE FUNDING PRIORITISATION OF THE HORIZON2020 CO-FUNDABLE PART OF THE BRIDGE PROJECTS (WHICH COVERS HORIZON2020 CO-FUNDING AS WELL AS INDUSTRY INVESTMENTS (IN CASH AND IN-KIND)). THIS FINANCIAL PRIORITISATION IS BASED ON THE AMBITIONS OF THE BIC MEMBERS, WHERE THE DISTRIBUTION OF THE FUNDING OVER THE KIND OF PROJECTS AND VALUE CHAINS IS WEIGHTED BASED ON THE INTENDED INVESTMENTS OF THE PARTNERS.

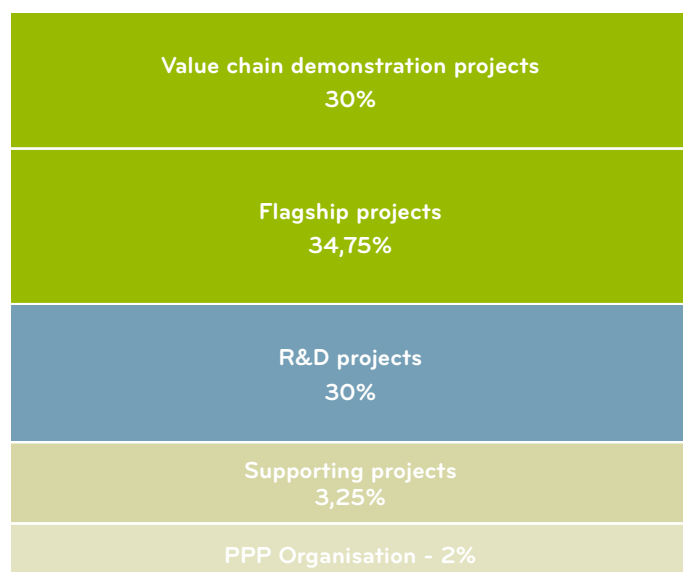


FIGURE 13. DISTRIBUTION OF FUNDING OVER RESEARCH, DEMONSTRATION AND SUPPORTING PROJECTS

Demonstration projects 64,75%	Value Chain 1: From lignocellulosic feedstock to advanced biofuels, biobased chemicals and biomaterials: realising the feedstock and technology base for the next generation of fuels, chemicals and materials.	48%
	Value Chain 2: The next generation forest-based value chains: utilisation of the full potential of forestry biomass by improved mobilisation and realisation of new added value products and markets.	15%
	Value Chain 3: The next generation agro-based value chains: realising the highest sustainability and added value by improved agricultural production and new added value products and materials.	15%
	Value Chain 4: Emergence of new value chains from (organic) waste: From waste problems to economic opportunities by realising sustainable technologies to convert waste into valuable products.	15%
	Value Chain 5: The integrated energy, pulp and chemicals biorefineries: Realising sustainable bio-energy production, by backwards integration with biorefinery operations isolating higher added value components.	7%

FIGURE 14. DISTRIBUTION OF FUNDING OVER THE VALUE CHAIN DEMONSTRATORS

R&D projects 30%	Biomass supply	15%
	Biorefineries	60%
	Products & Materials	25%

FIGURE 15. DISTRIBUTION OF FUNDING OVER THE R&D PROJECTS²⁰

²⁰ These numbers reflect the ambitions and objectives of the members of the Biobased Industries Consortium (BIC) in March 2013. The numbers will be adjusted based on technology and market developments, results obtained and ambitions of new members entering the BIC.

BIOMASS SUPPLY

Many partners representing the 'biorefinery-sector' as well as the 'bio-products and bio-fuels' part of the chain recognize that the 'biomass supply' is an important area to invest more resources in. This stresses the importance for either increasing the involvement of partners active in the biomass supply chain, or stimulating research, development and demonstration via other funds.

Enable to realise the objectives on increasing the biomass supply, BRIDGE will actively cooperate with the EIP Agricultural Productivity and Sustainability to align on the relevant R&D and demonstration topics. Only by a strong cooperation with the agricultural and forestry sectors, a sustainable and secure supply of biomass for the production of biochemicals, bio-based materials can be secured, in harmony with food and feed applications.

OTHER FUNDING FOR DEMONSTRATION AND FLAGSHIP PROJECTS

Demonstration and flagship activities are a key output of BRIDGE. This is an area where significant public co-investments will be deployed jointly with large investments by industry to firstly implement their technologies on the market. Demonstration and flagship activities in BRIDGE include both smaller demonstrators (TRL 4-6) and bigger demonstrators (TRL 7-8) - see Table 3, the latter however not being fully eligible under Horizon2020. Thus, these developments require a close synergy between research and innovation grants available through H2020 on one side and cohesion and structural funds as well as debt facilities and risk finance instruments by EIB on the other side. The involvement of the EIB can act as a catalyst, encouraging other banks, financial institutions and the private sector to participate in an investment. Eventually EIB loans can be combined with EU grants depending on the scope and definition of the individual project fully in line with the overall ambition of the Innovation Union and H2020.

Structural Funds may complement local financial needs in terms of deployment of technologies, processes and products. Within the structural funds there are also regional development funds (cohesion funds for regional development); they will be addressed for instance for improved logistics, roads, required education, help SMEs to start-up. Within the integrated approach targeted by BRIDGE also the second pillar of the CAP is considered, which provides funds for rural development, in particular to help farmers to place investments that benefit the rural development. These should also be addressed for biobased economy related themes, for instance machinery to mobilise the residues, improve storage at the farms, etc.

Details on the finances and funding rules within BRIDGE are described in a separate document.

APPENDIX 1. RESEARCH ORGANISATIONS AND UNIVERSITIES THAT HAVE EXPRESSED INTEREST AND SUPPORT TO THE DEVELOPMENT OF BRIDGE, THE BIOBASED INDUSTRIES PPP

Aalborg University	Denmark	Polish Academy of Sciences	Poland
Ainia, Technological Centre	Spain	PTS	Germany
Aitiip	Spain	SINTEF	Norway
Ascamm	Spain	SP	Sweden
Aula Dei Spain	Spain	Swerea	Sweden
Austrian Centre of Industrial Biotechnology (ACIB)	Austria	Tecnia	Spain
Cartif Technology Centre	Spain	Tekniker	Spain
Cener	Spain	TNO	Netherlands
Centre Technique du Papier (CTP)	France	TU Delft	Netherlands
Cetenma	Spain	TU Munich	Germany
Cidaut	Spain	Univeristy of Vigo	Spain
Ciemat	Spain	Universidad Politecnica de Madrid	Spain
CIRCE	Spain	Università di Bologna	Italy
CSIC	Spain	University of Barcelona	Spain
ENEA	Italy	University of Freiburg	Germany
Forschungszentrum Jülich	Germany	University of Girona, Lequia	Spain
Fraunhofer	Germany	University of Hohenheim	Germany
IdealFood	Spain	University of Kaiserslautern	Germany
IFP ENERGIES NOUVELLES	France	University of León	Spain
Inbiotec	Spain	University of Lleida	Spain
INIA	Spain	University of Naples "Federico II"	Italy
Innovhub SSI	Italy	University of OULU	Finland
Innventia	Sweden	University of Valladolid	Spain
INRA	France	University of Zaragoza	Spain
IRTA	Spain	Vito	Belgium
Itacyl	Spain	VTT	Finland
James Hutton Institute	UK	WageningenUR	Netherlands
KTH	Sweden		
Leitat	Spain		
Materia Nova	Belgium		
Metla, Finnish Forest Research Institute	Finland		