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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Proposal for a
COUNCIL REGULATION

on the Bio-Based Industries Joint Undertaking

{COM(2013) 496 final}
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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Background to the development of the proposal

The Communication outlining the European Bioeconomy[1] Strategy, adopted on 13 February 2012[2] proposes the creation of a Public-Private Partnership (PPP) for bio-based industries ("Bio-based PPP") as part of its Action Plan. The Communication promoting a stronger European industry for growth and economic recovery adopted on 10 October 2012[3] reiterates the importance of setting up a Bio-based PPP in the form of a Joint Technology Initiative (JTI) in the context of the EU's industrial policy. In addition to defining the Bio-based PPP as a priority action point, both Communications are committed to ensuring a coherent policy environment and fostering markets for innovative bio-based products, creating a favourable environment for the rapid deployment of the results arising from such a PPP.

Bio-based industries can make a significant contribution to the smart, sustainable and inclusive growth objectives of the Europe 2020 Strategy, and its flagship initiatives "Innovation Union", "A Resource Efficient Europe" and "An Industrial Policy for the Globalisation Era". This has been recognised in several recent policy initiatives, such as the European Innovation Partnership for Agricultural Productivity and Sustainability[4] and the proposal for rural development under the revision of the Common Agricultural Policy (CAP)[5], the Smart Specialisation Strategy for Member States and Regions[6] and the proposal for the 7th Environmental Action Programme[7]. The Committee of the Regions (CoR) has also underlined the important role of bio-based products and a bio-based society in Europe in its opinion on the European Bioeconomy Strategy end of November 2012[8].

PPPs have been identified as instruments to address societal challenges and strengthen European competitiveness in the Communication on partnering in research and

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1 Note: A glossary providing a definition of bioeconomy and other technical terms is provided under Annex 1
2 COM(2012) 60
3 COM(2012) 582
4 COM(2012) 79
5 COM(2011) 627
6 DG REGIO (2012) Connecting Smart and Sustainable Growth through Smart Specialisation: A practical guide for ERDF managing authorities
7 COM(2012) 710
8 CDR1112-2012

innovation (R&I)[9]. They leverage additional private investments and have to be seen as a measure to enhance growth and create jobs. Criteria for the establishment of such PPPs in the area of R&I have been included under Article 19 of the proposal for Horizon 2020, the Framework Programme for Research and Innovation for the period 2014-2020[10].

An industry group backing the proposal for a Bio-based PPP has been active since end of February 2012 and is grouped in the Biobased Industry Consortium (BIC). The BIC includes representatives from different industrial sectors (including pulp and paper, biofuels, chemicals, sugar and starch, biotechnology) as well as several trade associations (e.g. the association of European Farmers and Farmer associations COPA-COGECA) and regional or national cluster organisations, a more detailed description of the BIC is provided under Annex 2. The group delivered a vision document in May 2012[11]. It also prepared the Strategic Innovation and Research Agenda (SIRA) for the PPP in close interaction with research organisations across Europe that is included in Annex 3.

The proposed Bio-based PPP has been included in the Commission Work Programme for 2013[12].

1.2. Organisation and timing

This ex-ante Impact Assessment was prepared by DG RTD. It was supported by the Commission Inter-Service Group (ISG) created in June 2012, which included DGs AGRI, BUDG, COMP, CNECT, EMPL, ENER, ENTR, ENV, ESTAT, HR, JRC, MARKT, MOVE, SANCO, SG and the Legal Service. Meetings have been held for all major steps in the development of the Bio-based PPP initiative on 28 June 2012, 20 July 2012, 20 September 2012, 22 November 2012 and 12 December 2012.

During the last ISG meeting of 12 December 2012, a range of questions was discussed relating to the leverage of the proposed Bio-based PPP, the use of structural funds and links to Member States' and Regional activities, links to Bioeconomy Panel and Observatory, PPP funding mechanisms and risk awareness and mitigation of external factors. A good collaboration was established between DGs RTD and REGIO in the context of the Bioeconomy Strategy implementation, during which bio-based industries were extensively discussed, at bilateral meetings on 9 December 2012, 19 July 2012 and on 15 March 2013.

1.3. Consultation and expertise

A wide range of sources were consulted in preparation of this Impact Assessment:

- A public consultation on the proposed Bio-based PPP took place from 21 September to 14 December 2012[13] and received 638 valid responses. 64.6% of responses came from the private sector, 24.6% from academia, 8.8% from the public sector and 2% from NGOs. Responses were received from 19 out of 27 Member States, with most replies coming from Poland, followed by the Netherlands, Germany, Spain, France, Belgium, Sweden, Finland, Italy, Austria,

9 COM(2011) 572

10 COM(2011) 809

11 Biobased for Growth – A public-private partnership on biobased industries http://www.biobasedeconomy.nl/wp-content/uploads/2012/07/Bio-Based-Industries-PPP-Vision-doc.pdf

12 DG RTD (2012) Roadmap for a Joint Technology Initiative in the field of Bio-based industries http://ec.europa.eu/governance/impact/planned_ia/docs/2013_rtd_007_biobased_industries_en.pdf

13 Public Consultation on "Bio-based industries, towards a public-private partnership under Horizon 2020?" http://ec.europa.eu/research/consultations/bio_based_h2020/consultation_en.htm

the UK, Romania, the Czech Republic, Portugal, Denmark, Ireland, Hungary, Greece and Slovakia. Almost all respondents (94.3%) called for EU intervention and 86.9% viewed a PPP as the most appropriate mechanism to implement the R&I programme for bio-based industries under Horizon 2020, and considered that it would have positive socio-economic impacts. Other key messages were the need to strengthen EU innovation, to improve competitiveness and to formulate clear intervention objectives for bio-based industries. The results of the consultation were presented and discussed at a stakeholder event on 9 January 2013 attended by 162 people and are addressed in the present Impact Assessment. The full report of the online public consultation is attached in Annex 4. A printed version is planned for June 2013.

- The proposed Bio-based PPP implements a part of the European Bioeconomy Strategy. Thus, the outcome of the public consultation[14] and a preparatory impact assessment[15] of the Strategy were also taken into account for this Impact Assessment.
- Several events organised in the framework of the Bioeconomy Strategy implementation allowed for regular and broad-based contacts with stakeholders during the preparation of the Impact Assessment[16]. This included the conference "Partnering for the Bioeconomy in European Regions" of 12 October 2012, co-organised by DG RTD and the CoR. During the conference, information on a possible Bio-based PPP was provided and examples of regional activities highlighted possible benefits of bioeconomy partnerships. During this event, DG REGIO specifically informed about the Smart Specialisation Strategy, being part of the rural development policy of the EU. It proposed focusing investments on the bioeconomy where appropriate.
- Several studies conducted in connection with the bioeconomy, bio-based products and biofuels were consulted. These are referenced throughout this document.
- A group of ten external reviewers with expertise relevant to the different parts of the bio-based industries value chain was brought in to assist DG RTD with collecting and analysing the above data and preparing the Impact Assessment.

1.4. Results of the Impact Assessment Board consultation

Following the opinion of the Impact Assessment Board, the present Impact Assessment was revised as follows: 1) Section 1 "Procedural issues and consultation of interested parties" was complemented with information on the interactions with relevant DGs; 2) Section 2 "Problem definition" was re-structured and strengthened substantially to explain the intervention logic based on Horizon 2020 and the European Bioeconomy Strategy, underlining how a new Bio-based PPP provides the logical extension of and builds on lessons learnt from past research and development (R&D) activities at European, national and regional level; 3) Section 3 "Objectives" was revised to clarify further the objectives of the Bio-based PPP, in particular in the wider policy context; 4)

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14 Public consultation “Bio-based economy for Europe: state of play and future potential” from 22 February to 2 May 2011 http://ec.europa.eu/research/consultations/bioeconomy/consultation_en.htm

15 SWD(2012) 11

16 Conference “Partnering for the Bioeconomy in European Regions” co-organised by DG RTD and the Committee of the Regions (CoR) on 12 October 2012 at the CoR, Brussels Belgium

Section 4 "Policy options" was revised to include more detailed information on the policy options; 5) Section 5 "Assessment of impacts" was strengthened with information linking the impacts better to the technological and innovation challenges and problem drivers; 6) Section 6 "Comparing the options and selecting the preferred option" was revised to clarify the weighting of the options in terms of cost effectiveness and efficiency; 7) Section 7 "Evaluation and monitoring" was revised to describe in more detail the criteria and methodology used to monitor the Bio-based PPP implementation.

2. PROBLEM DEFINITION

2.1. Bio-based industries in Europe

Bio-based industries[17] are at the heart of the European Bioeconomy Strategy and one of the main elements of the Communication for a stronger European industry for growth and economic recovery in line with the objective of the Europe 2020 Strategy.

In the past decade, a growing number of established European processing industries (e.g. chemical, pulp and paper, and sugar and starch industries) have explored moving partially or entirely towards innovative bio-based products and biofuels in response to climbing oil prices, increasing global competition in traditional markets and stricter environmental and energy efficiency targets. This trend has given rise to the nascent sector of bio-based industries that is defined by the use of innovative technologies to convert renewable biological resources into innovative bio-based products and biofuels, which can replace existing goods or open completely new markets.

Despite an increasing number of different market players supporting the development of bio-based industries, the sector has been struggling in setting up its value chains due to the wide range of players to be involved, many of which have not worked together before, and to several market failures. Overcoming these issues is all the more important as bio-based industries are facing several technological and innovation challenges, which are best addressed as part of a value chain approach.

The value chain can be roughly sub-divided into three parts, as indicated in Figure 1:

- **Biomass production (upstream)** – Raw material has to be sourced in a sustainable manner, for example by collecting residues from the agriculture and forestry sectors or biodegradable wastes;
- **Biomass processing/conversion** – Two processing steps are usually distinguished, the pre-treatment of the biomass and its conversion into bio-based intermediates and products or biofuels. These two steps can be carried out by the same industry or by different industries. Processing industries include the sugar and starch industry, the chemical and pulp and paper industry, etc.
- **Bio-based markets (downstream)** – The output from the processing industry can be a final product, e.g. in the case of biofuels, or may have to be further transformed into a final product by another industry or consumer brand, e.g. bio-based fine and specialty chemicals for the pharmaceutical or cosmetic industry.

[17] Note: A glossary providing a definition of bio-based industries and other technical terms is provided under Annex 1

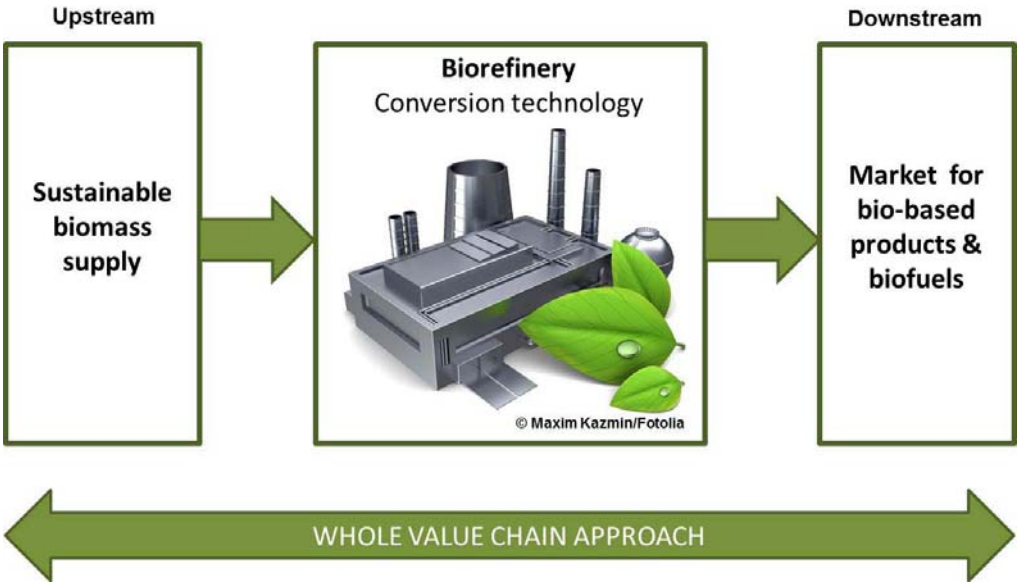

Figure 1: The value chain of bio-based industries

More detailed information on the market players required to constitute the value chains of bio-based industries is provided in Annex 2.

2.2. Bio-based industries as a source of green growth

2.2.1. The environmental potential of bio-based industries

The European economy is heavily dependent on fossil resources as source of carbon for energy and products[18]. Reducing this dependence is paramount in view of the increasing depletion of fossil resources and their impact on climate change. It is critical for Europe to meet its climate change and energy efficiency targets by 2020 and to move towards a competitive low carbon economy in 2050[19]. To achieve this, our industries and our society need to become more resource efficient and expand the use of renewable biological resources as possible substitutes for fossil ones. The need to do "more with less" and to succeed in "living well, within the limits of our planet" is anchored in recent policy initiatives, such as the European Bioeconomy Strategy, the Roadmap for a Resource Efficient Europe and the proposal for the 7th Environmental Action Programme to 2020.

The industrial sector is the third largest user of fossil oil after transport and households. At present, only about 10% of chemical products are derived from renewable resources[20][21]. While it is unlikely that fossil resources can be entirely substituted by renewable ones in the production of chemicals, fuels and other products, increasing the percentage of renewable inputs in these industries can have a tremendous impact on reducing fossil resource dependence. Replacing petro-chemical refineries by biorefineries can significantly contribute to mitigating climate change. Estimates show that the conversion of bio-based wastes into bio-based materials alone could reduce emissions by up to 633 million tonnes of CO_2[22]. The EU's total greenhouse gas (GHG) emissions stood

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18 DG ENER (2011) Key Figures – Market Observatory for Energy –June 2011

19 COM(2011) 112

20 McKinsey (2009) White Biotech

21 OECD (2009) The bioeconomy to 2030: Designing a Policy Agenda

22 WWF (2009) Biotechnology could cut C02 sharply, help build green economy http://wwf.panda.org/?174201/Biotechnology-could-cut-C02-sharply-help-build-green-economy

at 4,614.5 million tonnes of CO_2-equivalents in 2009[23]. As easily extractable high-quality fossil oil is increasingly scarce, more cost-intensive alternatives are becoming competitive. The calculation of the "energy return on investment" (EROI) for different fuels shows, that certain conventional biofuels (e.g. bioethanol from sugarcane and biodiesel from soy) can already compete with some fossil fuels (e.g. tar sands, heavy oil from California) on the basis of their EROI today due to advances in technology and innovation in the last twenty years[24].

By focusing on advanced biorefineries that rely on non-edible biomass as a feedstock, European bio-based industries respond to the concerns about the sustainable management of Europe's limited natural resources, indirect land use change (ILUC) and food security, also see Box 1. On-going work to further improve the sustainability of agricultural and forestry practices, and to develop standards and sustainability criteria for bio-based products will contribute to meeting the EU's policy objectives on biodiversity and ecosystems[25].

Bio-based processes can also make production processes more resource efficient and environmentally friendly. It is considered that the use of industrial biotechnology in various production processes already today avoids the creation of 33 million tonnes of CO_2 per year (excluding bioethanol). The full climate mitigation potential of industrial biotechnology is estimated to range between 1 billion and 2.5 billion tonnes CO_2 equivalent per year by 2030, which is more than Germany's total reported emissions in 1990[26].

Several bio-based consumer products can also make a direct contribution to mitigating climate change, such as detergents with new cold water enzymes, which can reduce washing temperatures from 40°C to 30°C. By washing laundry at 30°C rather than 40°C or 60°C, 32 million tonnes of CO_2 could be saved in the US and Europe alone – this corresponds to the emissions of 8 million cars[27].

Box 1: "Conventional" versus "Advanced" biorefineries – How concerns about food security and indirect land use change (ILUC) are being addressed in Europe

In order to reduce the dependence of their economies on fossil carbon, the US, Brazil, the EU and other parts of the world have introduced ambitious biofuel targets in the last decade. The increasing demand for renewable biological resources (biomass) as carbon sources for industrial and energy purposes has given rise to concerns about the impact these uses may have on food security, scarce natural resources and the environment in Europe and third countries, in particular with regard to ILUC.

In the light of these concerns, the EU has reviewed its strategy since 2010 by applying approaches based on life-cycle analyses that taken into account issues, such as food security, environmental protection and sustainability, when developing bio-based industries. In contrast to many of its global competitors, who continue to draw heavily on food crops to kick-start their "conventional" biorefineries, the EU is addressing these concerns by gradually shifting the feedstock base of these industries to non-edible biomass between now and 2020 by investing in "advanced" biorefineries. This is also

23 Eurostat (2011) Climate change statistics http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Climate_change_statistics

24 Inman, M. (2013) The true cost of fossil fuels, Scientific American, April 2013

25 COM(2011) 244

26 WWF (2009) Industrial Biotechnology: More than green fuel in a dirty economy

27 OECD (2011) Industrial Biotechnology and Climate Change: Opportunities and Challenges

clearly illustrated by two recent EU policy initiatives – the European Bioeconomy Strategy and the proposal[28] for a revision of the Renewable Energy[29] and Fuel Quality Directives[30].

"Conventional"/"first-generation" biorefineries

The conversion of edible parts of food crops into biofuels or bio-based products is technologically fairly easy. Sugars and starch from these crops can be transformed into bioethanol through fermentation processes similar to those used for the production of beer or wine. Vegetable oils can be converted into biodiesel through processes similar to those used by the petro-chemical industry for the production of plastics. Since the technology used in these processes is already well-established and accessible, the resulting products and processes are being referred to as "conventional" or "first-generation".

"Advanced"/"second-generation" biorefineries

Transforming non-edible parts of plants (e.g. wood, agricultural and forestry residues) and biodegradable wastes is more challenging. This biomass, also referred to as ligno-cellulosic material, is usually heterogeneous and contains a mix of different types of complex biomolecules (i.e. cellulose, hemi-cellulose and lignin). The technology required for the transformation of ligno-cellulosic material is more advanced and still under development, the resulting products and processes are therefore called "advanced" or "second-generation".

In the long-term, the aim will be to replace carbon from renewable biological resources, as used in first- and second generation biorefineries, by carbon from atmospheric CO_2 using microalgae. The development of such advanced "third-generation" technology is however still at a very early stage.

2.2.2. The socio-economic potential of bio-based industries

Bio-based industries are a cornerstone of the bioeconomy in generating growth and jobs. Although bio-based products and biofuels currently only represent about 3% of the € 2 trillion in annual turnover and 1% of the 22 million jobs generated by the European bioeconomy today, bio-based industries are expected to grow more rapidly and substantially than more traditional bioeconomy sectors[3132]. The potential of bio-based industries for generating growth and jobs has also been highlighted in the updated Industrial Policy, the EIP for Agricultural Productivity and Sustainability and the proposal for rural development under the revision of the CAP.

Estimates from different sources consider that:

- The global revenue potential of the entire biomass value chain for biorefineries could exceed € 200 billion by 2020[33];
- The share of bio-based processes in all chemical production is likely to increase from less than 2% in 2005 to 25% in 2025[34], and could reach 30% in Europe by

28 COM(2012) 595
29 Directive 2009/28/EC
30 Directive 2009/30/EC
31 OECD (2009) The bioeconomy to 2030: Designing a Policy Agenda
32 Festel, G. (2011) Presentation at the 4th Annual European Forum for Industrial Biotechnology & The Biobased Economy, Amsterdam, 20 October 2011
33 WEF (2010) The future of Industrial Biorefineries

2030 (>50% for high added value chemicals and polymers, less than 10% of bulk commodity chemicals)[35];

- The volume growth of EU bio-based chemical products (including bio-plastics, bio-lubricants, bio-solvents, bio-surfactants and chemical feedstock) will be at 5.3% per year up to 2020, resulting in a market worth € 40 billion and 90,000 jobs within the bio-chemical industry alone[36];
- Up to 75 billion litres of bioethanol could be sustainably produced at a competitive cost by 2020, which would represent about € 15 billion in additional revenue for the agricultural sector[37];
- The development for 2nd generation bioethanol in the EU by 2020 could lead to almost 950 biorefineries generating more than € 32 billion in annual revenue and 933 000 jobs (total man years from 2010 to 2020)[38].

2.3. The national and regional potential of bio-based industries

Given the diversity of Member States and Regions in terms of geography, natural and technological resources, and infrastructure, developing bio-based industries and their value chains opens interesting opportunities for transnational and transregional cooperation within Europe, especially in bringing together partners from primary production and processing industries. Biorefineries need to be close to their feedstock sources to be economically viable.

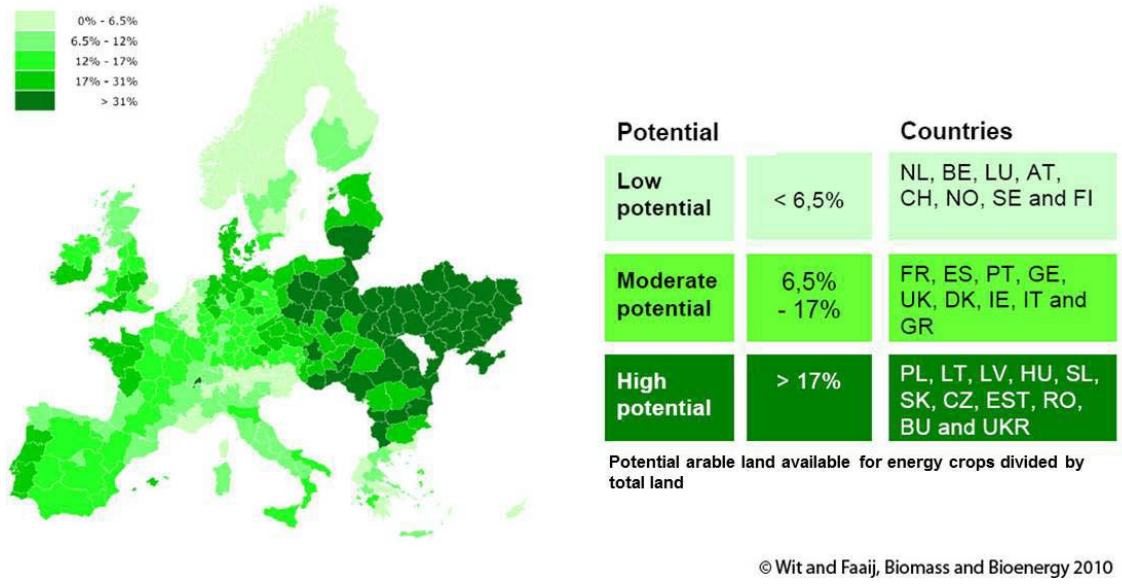

Figure 2: Indicative spatial biomass potential for energy crops in Europe[39]

The use of biorefinery processes is typically most advanced in Member States and Regions that already have a strong chemical, biofuels, biotechnological or pulp and paper

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34 OECD (2009) The bioeconomy to 2030: Designing a Policy Agenda

35 Star-COLIBRI (2011) Joint European Biorefinery Vision for 2030

36 COM(2012) 582

37 Bloomberg New Energy Finance (2010) Next-generation ethanol and biochemicals: What's in it for Europe

38 Bloomberg New Energy Finance (2010) Next-generation ethanol and biochemicals: What's in it for Europe

39 Wit and Faaij (2010) Biomass and Bioenergy

industry, where they either complement or build on existing activities. Most of these industries are situated in Austria, Belgium, France, Germany, Italy, the Netherlands, Spain the UK and Scandinavia. While several of these Member States dispose of sufficient feedstock in the form of agricultural and forestry residues or waste for demonstration activities and small- to medium-scale flagship biorefinery plants, large-scale flagship biorefinery plants and deployment will need to rely strongly on cooperation with new Member States. As indicated in Figure 2, these have biomass resources that can still be better exploited by further improving agricultural practices. When considering the setting up of biorefineries, the regional biomass potential and its existing uses will however need to be carefully assessed (e.g. through life-cycle assessments (LCAs)), as well as potential impacts of these activities on biodiversity and ecosystem.

Bio-based industries in Europe will have to invest in transnational and transregional cooperation in order to reach the necessary economy of scale to be successful. Although early investments into the development of bio-based industries are likely to benefit regions that already have some bio-based industries or similar infrastructures in place today, investments will increasingly shift to regions with substantial biomass resources, as the technology reaches sufficient maturity for full deployment as of 2020, see Figure 3 and Box 2. Bio-based industries thus can offer a win-win situation for all interested Member States and Regions.

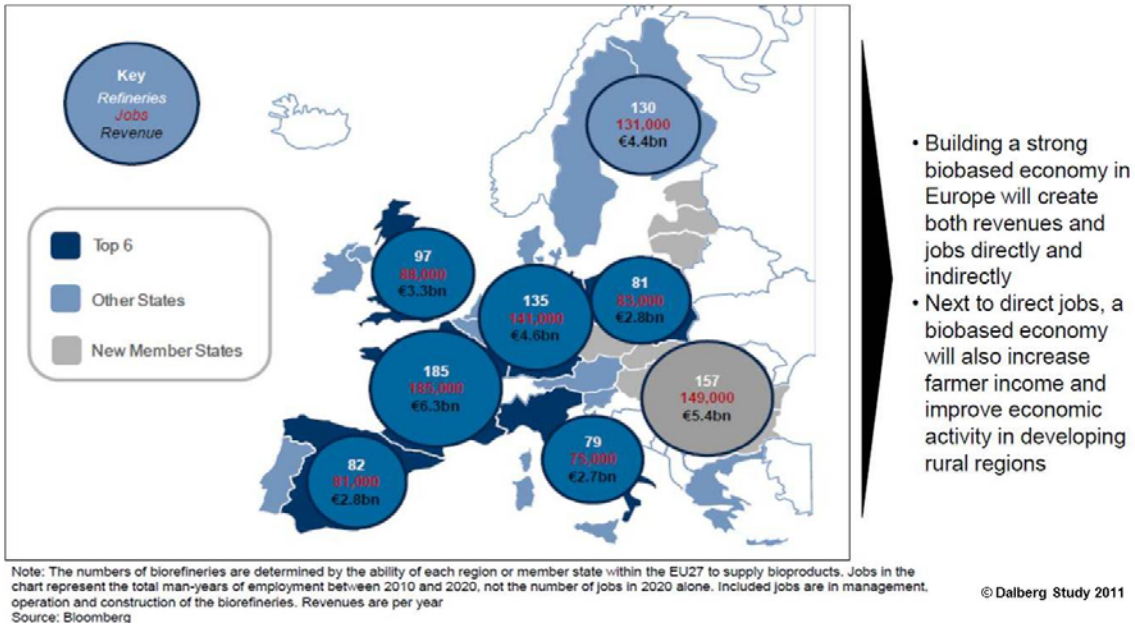

Figure 3: Potential socio-economic impact of 2nd generation ethanol on EU in 2020[40]

The potential of the bio-based industries, as part of the bioeconomy, to generate economic growth and jobs and assist with the compliance with environmental policy objectives at a local and regional level has also been recognised by the CoR. Regional and local authorities have been encouraged to include the bioeconomy in their Smart Specialisation Strategies[41] from 2014 to 2020 and rural development activities in order to exploit this potential and provide support to the development of these industries through Structural Funds, see Section 2.7 for more details.

40 Bloomberg New Energy Finance (2010) Next-generation ethanol and biochemicals: What's in it for Europe

41 DG REGIO (2012) Smart Specialisation Guide on smart and sustainable growth

Box 2: The current use of biomass for industrial and energy purposes

It is estimated that the total amount of biomass used in the EU for energy and industrial material uses today lies at about 470 million tonnes, including imported biomass[42]. The majority of this biomass (400 million tonnes) comes from forestry, of which 230 million tonnes are used for wood working and the pulp and paper industries, and 170 million tonnes for energy (heat and power)[43]. The amount of biomass from agriculture transformed into industrial materials and energy is estimated at 70 million tonnes. The majority of agricultural biomass (> 90%) goes to food and feed.

The availability of additional biomass for uses beyond the current levels of conversion into bio-based products was confirmed by studies from the European Environmental Agency, the International Energy Agency and several research projects funded by the EU. In order to ascertain the long-term sustainability of EU biomass supply to bio-based industries, due account needs however to be given to potential environmental considerations, such as the level of agricultural residues that can be collected without negatively affecting soil fertility and/or biodiversity, or potential effects on the water retention of soils concerned. These and other environmental factors need to be assessed as part of the decision-making process. Annex 5 to this Impact Assessment provides a more detailed insight into this issue.

2.4. International competition

The US, Brazil and China are aggressively advancing the development of commercial-scale biorefineries through policy targets and incentives, with a strong focus on conventional biofuel. Russia, India, Thailand and Malaysia are following suit. Generous government support schemes for large scale demonstrators and first-of-a-kind industrial plants have motivated several European companies to carry out the up-scaling of their technology to commercial scale in these countries[44]. Some of these countries are also increasingly investing in advanced biofuels: about $ 1.4 billion of select public funding was allocated to the development of advanced biofuels in the US in 2011[45].

Compared to the US, which promotes the commercialisation of bio-based products through its BioPreferred Program[46], the European market also suffers from a relative absence of incentives at the product level. However, the product portfolio of a biorefinery needs to be adjusted to the local economic situation, e.g. in terms of feedstock, local and global demand.

Many European companies move abroad to be closer to cheaper feedstock, e.g. sugarcane in Brazil, microalgae in Australia, seaweed in Chile and South Korea, sugarcane and jatropha in India, and a mix of biomass in South East Asia[47]. The increasing exploitation of shale gas for energy and industrial purposes, in particular in the US and Canada, may also have an impact on the price and availability of biomass in these countries

The EU cannot compete with these countries in terms of biomass volume prices, and is likely to have to rely on imports for bulk applications. Its technology base do however

42 Contributed by M. Carus, member of the independent expert group of this Impact Assessment

43 Mantau, U. (2012) Wood Flows in Europe

44 Futuris (2012) Supporting the set-up of industrial demonstrators in Europe - Position paper

45 Burill & Company (2012) Biotech 2012: Innovating in the New Austerity; Burill & Company's 26th Annual Report on the Life Science Industry

46 USDA BioPreferred Program www.biopreferred.gov

47 Burill & Company (2012) Biotech 2012: Innovating in the New Austerity; Burill & Company's 26th Annual Report on the Life Science Industry

allow its bio-based industries to compete if they concentrate on producing high added value bio-based products and biofuels from Europe's limited resources. It is therefore important for Europe to establish reliable biomass supply chains and to optimise the use of this valuable resource to remain competitive.

The EU's focus on advanced biorefineries gives other countries the first-mover advantage and critical mass in conventional biorefineries, in particular for biofuel production. This also provides them with a stepping stone for the development of bio-based products and advanced biorefineries. In order to remain competitive, the EU will need to leapfrog its competitors in terms of technology development, and establish reliable supply chains for biomass.

2.5. Technological and innovation challenges of bio-based industries in Europe

In order to fulfil the potential of bio-based industries and ensure their competitiveness in global markets, a number of hurdles need to be overcome. These include four technological and innovation challenges that arise from the strong emphasis of Europe on advanced biorefineries. Since these complex and inter-connected challenges need to be addressed in a coherent and integrated way, adopting a value chain approach is likely to be the most cost-effective and efficient, given the dispersion of market players.

2.5.1. Accessing sufficient sustainable feedstock

The potential for large contributions in terms of socio-economic benefit and GHG savings from bio-based industries requires that production infrastructure will be developed in the EU and that a substantial share of the biomass can be locally obtained. It is therefore essential that biomass is sourced in Europe in a sustainable way, e.g. by using LCA approaches that take into account issues, such as the loss of biodiversity, the damage to ecosystems, ILUC or negative effects on food security. Attention will also have to be given to other industries that may rely on the use of biomass.

Actions to be taken include assessing the sustainability of integrating new solutions for residue removal in current farming or industrial practices (e.g. preserving soil fertility), developing new dedicated industrial crops that are optimised in terms of yield and quality, as well as sustainable farming practices that take into account fertiliser and water use. At a smaller scale, sustainable solutions to efficiently grow non-edible crops on polluted or marginal land will be explored with a view to make the best use of land that does not contribute to food/feed production.

Supply chains for residues from agriculture and forestry, waste streams and dedicated industrial crops will need to be put in place to overcome the lack of reliable and cost-competitive feedstock. This will require the development of logistics and storage solutions to ensure quality and availability of the feedstock, as well as the reduction of losses along the supply chain.

Addressing this challenge will require the establishment of new collaborations between market players from primary production and processing industries, ideally by building value chains for the main feedstocks in Europe.

2.5.2. Developing efficient conversion processes for advanced biorefineries

Processes for the conversion of feedstock derived from edible parts of food crops are already well-established for the use in conventional biorefineries, as their feedstock is usually homogenous and composed of single type biomolecules (e.g. sugar, starch or vegetable oils) that are easy to transform. For the feedstock targeted by advanced

biorefineries, efficient conversion processes are lacking, as they are usually quite heterogeneous in terms of quality and composition, with a mix of different types of complex biomolecules (mainly so-called ligno-cellulosic material[48]).

As a consequence, new processes need to be developed to separate, pre-treat and convert these feedstocks into bio-based products and biofuels. A wide range of radically different technological options (e.g. enzyme-based versus thermo-chemical processes) will need to be taken forward simultaneously in a strong and multi-facetted research effort to enhance process efficiency and optimise yields. Only when economic competitiveness is reached, will new processes be commercially deployed and start achieving further efficiency gains through economies of scale.

A major contribution to breaking barriers to economic competitiveness of bio-based processes can come from technologies enabling smart use of biomass. This implies that biomass is being used to make multiple products in a process cascade that combines high added value applications (e.g. high value ingredients) with production of lower added value products (e.g. biofuels), but also opportunities for re-using and recycling products. Smart use solutions require reinforcing research cooperation along the value chain and across sectors. With sustainability as a guiding principle, they can substantially optimise the use of biomass as a resource and maximise the derived value.

Addressing this challenge will require better interaction between market players from the processing industries with other players along the value chains, in particular with biomass producers to fine-tune the feedstocks and end-users to identify market demand for different bio-based goods.

2.5.3. Demonstrating and deploying advanced biorefineries

It took more than 100 years to develop the current (petro-)chemical industry, with its system of family trees of platform chemicals. In order to compete with these industries, innovation efforts of bio-based industries need to be bundled and biorefinery development needs to be accelerated by promoting the rapid up-scaling from lab-scale research to pilot and demonstration scale. To achieve this, fragmentation needs to be overcome and cross-sectorial industrial synergies need to be identified and exploited.

Technological breakthroughs are required to upgrade existing bio-based industries (e.g. pulp and paper mills, biofuels, starch, chemical, etc.) into integrated biorefineries (i.e. multi-feedstock, multi-product) and to develop new and scalable integrated biorefinery models (e.g. ligno-cellulosic material, green grass). Significant investments in up-scaling technology and infrastructure are needed to assess the relative merits of radically different technology options and to identify winning option(s).

Addressing this challenge will require better interaction between market players from the processing industries, as well as end-users.

2.5.4. Supporting demand-side actions for the uptake of bio-based products

R&I efforts will play an important role in removing obstacles to and promoting the uptake of bio-based products in consumer markets and green procurement. The successful uptake of new bio-based products and biofuels depends on customer

[48] Note: The term ligno-cellulosic refers to the fact that this type of biomass contains cellulose and lignin as the main types of biomolecules. Cellulose – like starch - is made up of a chain of sugar molecules, but is more difficult to break down in its basic constituents – in part because it is embedded in a matrix of lignin which is difficult to remove.

acceptance. Sustainability criteria, LCA approaches, standards, labelling and certification systems have to be developed to allow product prices to appropriately reflect externalities and assist consumers in making informed product choices, e.g. based on data on the benefits of these products over the full product life-cycle from cradle to grave.

Several demand-side actions are supported by recent policy initiatives, such as the European Bioeconomy Strategy, the updated Industrial Policy that builds on the Lead Market Initiative for Bio-based Products[49], the EIP for Agricultural Productivity and Sustainability and the proposal for rural development under the revision of the CAP, and the Smart Specialisation Strategy. R&I efforts involving actors along the whole chain (including end-users, consumer organisations, NGOs, policy-makers, etc) will play an important role in implementing these policies and designing effective new policies.

Addressing this challenge will interaction between market players along the entire value chain, i.e. biomass producers, processing industries and end-users, as the success of bio-based industries will strongly depend on the environmental performance of their outputs.

2.6. Underlying problem drivers

A number of market failures are causing lack of investment in R&I activities necessary to overcome the four technological and innovation challenges and the creation of new value chains for bio-based industries.

2.6.1. High risk and cost of demonstration and deployment

"The development of the bio-based economy is at an early and high risk stage, and no single industry or company is capable of managing this phase of its development independently"[50].

By gradually shifting the emphasis from conventional to advanced biorefineries due to sustainability and food security considerations, the EU makes it difficult for its companies to build critical mass and "first mover advantage" based on massive deployment of conventional technologies. They face an additional challenge in breaking the technological and economic barriers related to the development of advanced biorefineries compared to their international competitors.

The need to move directly to the development of advanced biorefineries also further exacerbates the lack of significant levels of public support for demonstration and first-of-a-kind investments in Europe. Companies considering expanding their activities in bio-based industries in Europe therefore face a very high degree of risk when investing in these technologies, especially SMEs.

Demonstration and flagship plants for biorefineries come at an elevated cost, in particular in terms of infrastructure (between € 5-100 million and € 50-1000 million respectively[51]). Essential parameters, such as market development, evolution of the price of fossil resources, policy (e.g. public support levels for biofuels and biomaterials), can have a significant impact on the return on investment and present a substantial degree of uncertainty. As a consequence, it is difficult to attract large private investors before proof of concept at demonstration scale.

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49 DG ENTR (2009) Taking Bio-based from Promise to the Market – A report from the Ad-hoc Advisory Group for Bio-based Products in the framework of the European Commission's Lead Market Initiative

50 WEF (2010) The Future of Industrial Biorefineries

51 Dalberg (2011) Biorefinery Feasibility Study

2.6.2. Knowledge spill-overs

Many successful biorefinery technologies will eventually be deployed at a large scale and in multiple locations. While certain technologies can be protected and commercially exploited on a broad scale (e.g. patenting of novel enzymes), many innovations (e.g. organisation of an effective biomass supply chain) are inherently difficult to protect. The benefit of the results will thus flow to society at large ("spill-overs").

With many key players in the bio-based industries being relatively small, few companies can expect to fully "internalise" the benefits of their research, i.e. convert the results in income streams to the exclusive benefit of their company. As a consequence, the private sector is likely to allocate fewer resources to this type of R&I activities, resulting in lower than optimal research spending levels.

2.6.3. Nascent and fragmented industrial sector

Mobilising the necessary R&I resources is difficult for a nascent and fragmented industrial sector, such as bio-based industries, because it is difficult for it to get the necessary visibility. Although many industrial sectors have a stake in activities contributing to their development, there are currently hardly any major players that have a large and fully dedicated R&I budget for the development of bio-based processes and products.

A comparison of R&I budgets of leading companies in industrial biotechnology, pharmaceutical biotechnology and plant biotechnology shows that the company with the highest research and development (R&D) budget in industrial biotechnology spends about five times less than the largest player in agricultural biotechnology and almost two orders of magnitude less than the largest pharma player[52]. R&D budgets for industrial biotechnology are also significantly smaller than those of large international players in the (petro-)chemical industry[53].

Furthermore, the sourcing of sufficient quality biomass on the supply side and the need to support demand-side activities through the development of standards, labels and sustainability criteria, requires collaboration beyond the processing industries. Key players along the value chain are often located in different Member States.

2.6.4. Transaction cost

The development of successful value chains for bio-based industries requires the involvement of different players, ranging from primary producers, biorefineries to industrial users and consumer brands. However, working together in complex multi-party R&I collaboration models implies many research interfaces and high transactions costs for the companies involved. The issue is aggravated by the strong need for non-traditional R&I collaborations, i.e. bringing together parties that have not worked together closely in the past or involving parties with no tradition of conducting in-house R&I, e.g. when determining sustainability criteria for production processes and products.

A partial and frequent response to this issue is the use of joint-venture models, even by larger companies. A growing number of European bio-based companies are involved in joint-venture type collaborations. However, there seems to be a trend to establish these joint-ventures with non-EU companies and to transfer the construction of new production

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52 OECD (2009) The Bioeconomy to 2030: Designing a Policy Agenda

53 CEFIC (2012) The European chemical industry in worldwide perspective Facts and Figures 2012

plants outside of Europe mainly due to easier access to finance (subsidies and loans) for demonstration and first-of-a-kind production facilities.

2.6.5. Policy framework

Bio-based industries and their value chains are subject to a wide range of established and emerging policy areas at EU, national and regional level, leading to a complex and sometimes fragmented policy environment. Although most of these policies are favourable to the development of these new industries, the targets and incentives they formulate are often not as strong as those of comparable policies in other countries (e.g. the US has introduced clear target volume for bioethanol by 2022, while the EU speaks of a 10% target for renewable energies in transport), also see Section 2.4. Furthermore, there has been an increasing sense of uncertainty due to a strong public opinion on the food versus fuel debate and ILUC.

2.6.1. Uncertainty around resource availability

Lack of reliable data on the availability of and demand for sustainable biomass in Europe for industrial and energy purposes is hampering solid forecasting of a realistic scope and scale for bio-based industries. This makes it difficult to fully assess the return on investment in terms of environmental, economic and social impact.

2.7. Need for EU intervention

Horizon 2020 foresees activities supporting the development of bio-based industries under two pillars "Societal Challenges" and "Leadership in Enabling and Industrial Technologies", see Section 5 for more details. It thus ensures the continuance of the activities carried out under the Seventh Framework Programme for Research and Technological Development (FP7) which started in 2007 and is ending in 2013. Horizon 2020 provides the right framework to facilitate the kind of cross-border, cross-sector, interdisciplinary research and innovation effort required to address the technological and innovation challenges and mitigate the market failures bio-based industries are facing.

In particular, Horizon 2020 will provide increased funding for innovation activities in order to achieve higher Technology Readiness Levels (TRLs) than FP7, see Annex 6. However, this will not be sufficient to overcome important weaknesses, such as lack of access to state-of-the-art demonstration plants and of collaboration between stakeholders along value and supply chains. The programme does not offer the tools to create the critical mass, see Box 3, and to address the risk involved in moving to higher TRLs. These require costly demonstration, flagship and first-of-its-kind biorefinery plants. The implementation of innovation activities at high TRL levels (4 to 8) requires strong involvement levels of industry which are typically not achievable under Collaborative Research as experience under FP7 has shown, even with increased investment in innovation activities under Horizon 2020. This is why the European Bioeconomy Strategy and the updated Industry Policy have been calling for a PPP on Bio-based Industries.

A large majority of participants in the online public consultation on the Bio-based PPP proposal (94.3%) were favourable to an EU level intervention and confirmed that there are four major areas requiring immediate action in terms of R&I: a) Achieving the required level of investment into R&I activities; b) Ensuring EU wide cooperation between all stakeholders along value chains; c) Providing improved policy coherence; and d) Promoting non-traditional partnerships (e.g. transnational, cross-sectorial). It also found that a value chain approach, e.g. in a PPP, would allow to address these challenges

in the most cost-effective and efficient way given the current dispersion of the market players required to tackle them.

Box 3: Critical mass for the creation of bio-based value chains

Bio-based industries are a very promising nascent sector, which will however have to overcome several technological and innovation challenges and market failures to be successful. Addressing these in the most efficient and effective manner requires bringing together all the key market players, many of which have not worked together in the past, which has the added benefit of creating ownership and ensuring better harmonisation and standardisation in the setting up of the sector.

Critical mass in this context is defined by a combination of framework conditions that allow for:

- Bringing together all industry players along the value chain;
- Formulating a long-term, industry-driven, consensus-based strategic innovation and research agenda (SIRA);
- Raising private and public resources commensurate with the ambition or the SIRA (leverage effect);
- Implementing this SIRA through cross-border, cross-sector, interdisciplinary research; and
- Going beyond R&D into standard setting.

Consultation of stakeholders suggests the critical mass for achieving this implies the:

- Securing of sufficient and reliable feedstock supply that is sustainably sourced, e.g. by involving:
  - At least 50% of the biggest forest-based industry companies;
  - A significant part of the agro-food industry (since 99% of these are SMEs, a 50:50 balance between big industry and SMEs should be targeted);
- Leveraging private investment into research activities from bio-based processing industries to a similar level than that from the pharmaceutical industry.
- Ensuring access to and investment into infrastructure for up-scaling.
- Representation of all Member States as appropriate based on their bioeconomy potential.
- Developing five value chains based on the key feedstocks available in Europe.

The BIC already includes many of the key players in this area, see Annex 2, and is reaching out to those who are not yet involved.

2.7.1. European added value

Several Member States and associated countries have developed bioeconomy strategies and initiatives that support the development of bio-based industries, see Annex 7. However, while some Member States have mature national bioeconomy strategies (e.g. Germany, the Netherlands, Sweden and Denmark), others are still developing their strategies (e.g. France and Italy) or only have regional initiatives (e.g. Belgium). The

strategies and initiatives typically reflect the geography, natural and technological resources, and infrastructure of a Member State or Region.

Many bioeconomy initiatives build on close cooperation between the public and the private sector and support the development of bio-based industries at a national or regional level. In particular bioeconomy clusters are often set up in the form of PPPs, such as the clusters IAR in France, Wagralim in Belgium, CLIB 2021 in Germany and BE-BASIC in the Netherlands. Several of these initiatives have also recognised the importance of cross-border collaboration, as illustrated by the partnering between IAR and Wagralim, or CLIB 2021 and BE-BASIC.

Although these collaborations between clusters look promising at first sight, they are often affected by differences in funding levels and financing rules in and a notion of competition between the Member States and Regions. It is therefore challenging for such transnational collaboration to achieve the necessary economy of scales to establish competitive bio-based industries value chains. Many national/regional clusters are more likely to be involved in collaborations with partners in third countries with more favourable framework conditions and incentives, such as Brazil, Malaysia, US and Canada. An example of a bioeconomy cluster deploying its technology abroad is provided in Annex 8.

The success of regional bioeconomy clusters in mobilising relevant players at regional level shows that PPPs are a good instrument to promote the development of bio-based industries value chains. The hurdles they encounter when trying to deploy their potential beyond the regional level in Europe despite an increasingly favourable policy environment confirms the need for an initiative at EU level that provides them with the necessary strategic framework and critical mass to overcome these limitations.

2.7.2. Lessons learnt – Collaborative research under FP7

The EU has funded a wide range of projects contributing to the advancement of bio-based industries under its Framework Programmes for Research and Technological Development (FPs) in the past decades, notably under the FP7 Specific Programme on "Cooperation". Theme 2 "Food, Agriculture and Fisheries, Biotechnology" is currently financing 100 "Collaborative Research Projects" (CPs) and "Cooperation and Support Action" (CSAs) in the Activity "Biotechnologies" with an EU contribution of about € 400 million. These have improved the knowledge- and technology base on a wide range of areas, namely:

- ***Novel sources of biomass and bioproducts and aquaculture*** – Projects under this area focus on improving our understanding of the genetics of plants and other organisms in support of breeding and the development of cell factories, as well as deliver feedstocks and precursors to bio-based industries, fostering the optimisation of biomass for industrial purposes;
- ***Marine and fresh-water biotechnology (blue biotechnology)*** – Projects under this area aim to exploit the potential of marine and fresh-water resources (e.g. new enzymes) for use in industrial applications;
- ***Industrial biotechnology: novel high added-value bio-products and bio-processes*** – Projects under this area aim to develop and apply industrial biotechnology for the production of high added value products, and explore novel bio-based fine and specialty chemicals (e.g. food additives, pharmaceuticals);

- ***Biorefinery*** – Projects under this area use industrial biotechnology to convert a range of different biomass sources into bulk bio-based products (e.g. biochemical and biopolymers;
- ***Environmental biotechnology*** – Projects under this area develop biotechnological solutions for preventing and cleaning pollution, and bioremediation of polluted land (e.g. near mining sites) and water (e.g. waste water, oil spills);
- ***Emerging trends in biotechnology*** – Projects under this area aim to advance biotechnology as a tool or Key Enabling Technology by developing systems biology, synthetic biology, bioinformatics etc.

CPs typically have TRLs from 2 to 5. As a consequence, only about 8% of the EU contribution under this Activity went to demonstration activities. High SME participation rates were achieved in certain targeted calls (up to 30% of the EU contribution in call FP7-KBBE-2012-6), but large industry participation was rather limited. While total industry participation (as share of EU contribution) peaked at 35 % in the 2012 call, it was on average between 15 and 20% during FP7 so far.

Given the multidisciplinary nature of biorefineries, DG RTD in 2009 organised a Joint Call on biorefineries involving four Themes of the Cooperation Programme (Theme 2, Theme 4 "Nanosciences, Nanotechnologies, Materials and New Production Technologies, Theme 5 "Energy", and Theme 6 "Environment"). Three flagship CPs (BIOCORE EUROBIOREF and SUPRABIO) and one CSA (Star-COLIBRI) were selected with a total EU contribution of about € 50 million. The Call revealed the existence of a large research and industrial community committed to taking biorefineries forward.

The three CPs are on-going and developing multi-product biorefineries. The substantial budget dedicated to demonstration activities (TRLs 4-8) in all three shows on one hand, that there are a number of biorefinery technologies and concepts ready to be scaled up from the lab, on the other hand, that more support is needed for up-scaling activities. This was confirmed by the results of Star-COLIBRI, which aimed to overcome fragmentation and promote cross-fertilisation in the area of biorefinery research. The project ended in 2011. One of the main conclusions from its reports is that Europe could be a world-leading, competitive bio-based economy by 2030, provided that European bio-based industries utilise biomass in an efficient and flexible manner and focus strongly on value added products.

The results from Star-COLIBRI and the experience of the past years shows that Europe has a strong research base in the area of bio-based industries, but also that there is a demand for projects with higher TRLs at EU level. While FP7 projects in the area of biotechnology are contributing to advancing the knowledge and technology base for bio-based industries in Europe in many areas, their impact is lessened by the fact that their findings often only cover small and very different parts of the technological and innovation challenges the sector is facing (e.g. developing standards for certain bio-based products, discovering new enzymes for a specific type of feedstock), see Section 2.5. They are thus difficult to connect and integrate with each other, especially given the dispersion of the market players, and may thus not always provide the most cost-effective and efficient solution.

More support is needed to take the results from this research to higher TRLs in view of bridging the "valley of death" for innovations. This is why a working group has been put in place to identify how TRLs can be integrated in Horizon 2020 and how activities "close to the market" should be defined.

Although SME participation has improved under FP7, it is considered that this was not sufficient to strengthen innovation content and that more attention should be given to quality of participation and constructive engagement[54]. The limited participation of large industry is also seen as a hurdle to be tackled given their critical role in bringing new technologies and products closer to the market.

2.7.3. Lessons learnt – PPPs on research and innovation under FP7

There is no precedent for a PPP on Bio-based Industries under FP7. As a new initiative, it will have to base itself on the lessons learnt from existing PPPs under FP7 (contractual PPPs and Joint Technology Initiatives (JTIs)).

PPPs are an innovative way of implementing EU R&I policy. An assessment of PPPs under FP7[55] showed that they can play a significant role in mitigating market failures that are hindering R&I activities necessary for the resolution of technological challenges. In particular the stable and long-term framework of JTIs through the development of strategic R&I agendas succeeds in bringing together key stakeholders from relevant industrial sectors (almost 30% of call participants in all JTIs were SMEs) and to leverage significant private investment (€ 1 EU contribution was matched by about € 1.5 in private investment for all JTIs taken together).

PPPs under Horizon 2020 will differ from those created under FP7 by the possible extension of their range of activities to demonstration and deployment. They will also address several recommendations formulated for future PPPs:

- The PPP needs to be open to new participants during its implementation;
- The commitment from industry needs to be stronger;
- A stronger focus is needed on generating measurable output and innovation;
- The structures and instruments used for implementation need to become simpler and less bureaucratic[56], e.g.:
    - Reduced administrative costs for participants;
    - Faster processes for the selection proposals and the management of grants;
    - Decreased financial error rate.

A more detailed description of the two PPP types is provided under Section 4.

2.7.4. Conclusions

Certain funding mechanisms applied at EU and regional level – in particular large and integrated biorefinery projects and regional bioeconomy clusters – are a first step in the right direction in that they apply a value chain approach to R&I, support demonstration and deployment activities, and encourage transnational collaboration. However, the existing initiatives have not succeeded in reaching the critical mass required to overcome

54 DG RTD Expert Group (2010) Interim Evaluation of the Seventh Framework Programme

55 COM(2011) 572

56 DG RTD Expert Group (2010) Interim Evaluation of the Seventh Framework Programme

fragmentation and create integrated bio-based industry value chains in Europe. The impact of these funding mechanisms could have been even better if they had been part of an integrated long-term strategic vision for bio-based industries in Europe that gives more support to demonstration and deployment activities.

A Bio-based PPP Industries will give a strong political signal at EU level. It provides a stable long-term framework that allows for strategic programming with industry. This will be critical in leveraging and securing long-term investments from the private sector, in particular for demonstration and deployment activities. The prospect of a possible new Bio-based PPP brought together a group of companies and several regional initiatives and clusters in the Biobased Industries Consortium (BIC), also see Annex 2. This demonstrates that many actors "in the field" endorse the need for decisive EU action beyond the foreseen Collaborative Research under Horizon 2020. The relevance and timeliness of such an initiative is also supported by the strong response to the Public Consultation on a Bio-based PPP, which received 673 replies, and the fact that 94.5% (strongly) agreed with the need for EU intervention.

In addition to leveraging private investments from industry, a Bio-based PPP will also provide a unique framework to facilitate synergies between different financing mechanisms and instruments at EU level to support converging policy objectives. These synergies will increase the scope and scale of policy-driven actions, in particular in combining R&I with demonstration and deployment activities. Funding mechanisms and instruments include Horizon 2020, Structural Funds[57], European Investment Bank (EIB)[58]. Contributions from Member States could also be associated to these activities.

In relation to possible contingencies with EU competition on State Aids[59] it has to be considered that State Aid rules for risk finance aim at facilitating public support to fill the "equity gap" for new market entrant. State Aid modernisation will extend those rules beyond pure equity instruments, in order to avoid the "valley of death" effect between the start-up phase and the first revenue streams.

State Aid policy also allows for R&D&I support. Since 2007 more than 200 schemes for R&D&I have been approved upon notification and an even larger number authorised on the basis of the block-exemption regulation. State Aid modernisation aims to direct public spending towards areas of growth. Today Member States allocate 46% of public aid towards competitiveness-enhancing objectives (such as innovation, research and development, environment, energy saving, risk capital, training). A further 26% corresponds to aid aiming at reducing disparities between regions.

3. OBJECTIVES

3.1. Description of objectives

The PPP on Bio-based Industries is supported by research and innovation activities under two pillars "Societal Challenges" and "Leadership in Enabling and Industrial Technologies", see Section 5 for more detailed information. The general and specific objectives formulated for the PPP below are in line with the objectives of the respective parts of Horizon 2020.

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57 Pending of approval of Article 55 of the General Regulation of Structural Funds

58 Financing instruments: Horizon 2020 – grants, Structural Funds – Smart Specialisation Strategies, rural development, European Investment Bank (EIB) – loans, Risk Sharing Finance Facility (RSFF)

59 DG COMP Seminar on State Aids January 2013

3.1.1. General objective

Bio-based industries can significantly contribute to achieving smart, sustainable and inclusive growth in Europe by 2020 and making the transition towards a low-carbon economy by 2050. Biorefineries can reduce the dependence of the European economy on fossil resources and contribute to the EU's climate change and energy targets, as they rely on biomass and more resource efficient and sustainable processes for the production of bio-based products and biofuels.

The strong growth potential of bio-based industries can lead to significant economic growth and job creation by 2020 and beyond, if Europe succeeds in maintaining and enhancing its competitiveness in this area. The development of biorefineries and their supply chains offer new sources of revenue for rural areas.

Based on the above and Section 2, the general objective of the proposed PPP is to contribute to a more resource efficient and sustainable low-carbon economy and to increasing economic growth and employment, in particular in rural areas, by developing sustainable and competitive bio-based industries in Europe, based on advanced biorefineries that source their biomass sustainably.

3.1.2. Specific objectives

In order to achieve the overall objective, the proposed PPP will assist bio-based industries in addressing the technological and innovation challenges and overcoming the market failures that are currently hindering them, as described in Section 2. The specific objectives are to:

- Demonstrate technologies that enable new chemical building blocks, new materials, and new consumer products from European biomass and which replace the need for fossil based inputs;
- Develop business models that integrate economic actors along the whole value chain from supply of biomass to biorefinery plants to consumers of bio-based materials, chemicals and fuels, including through creating new cross-sector interconnections and supporting cross-industry clusters; and
- Set up flagship biorefinery plants that deploy the technologies and business models for bio-based materials, chemicals and fuels and demonstrate cost and performance improvements to levels that are competitive with fossil based alternatives.

The specific objectives, see Figure 4 and Annex 9 for more detailed information, have been elaborated based on the technological and innovation challenges and in consultation with the BIC (>40 companies, several trade associations and ETPs), Research and Technology Organisations (RTOs), universities and SMEs. Since some aspects of the proposed activities will also be supported under other parts of Horizon 2020 and PPPs (e.g. SPIRE), docking points for cross-cutting activities will be defined to avoid duplication.

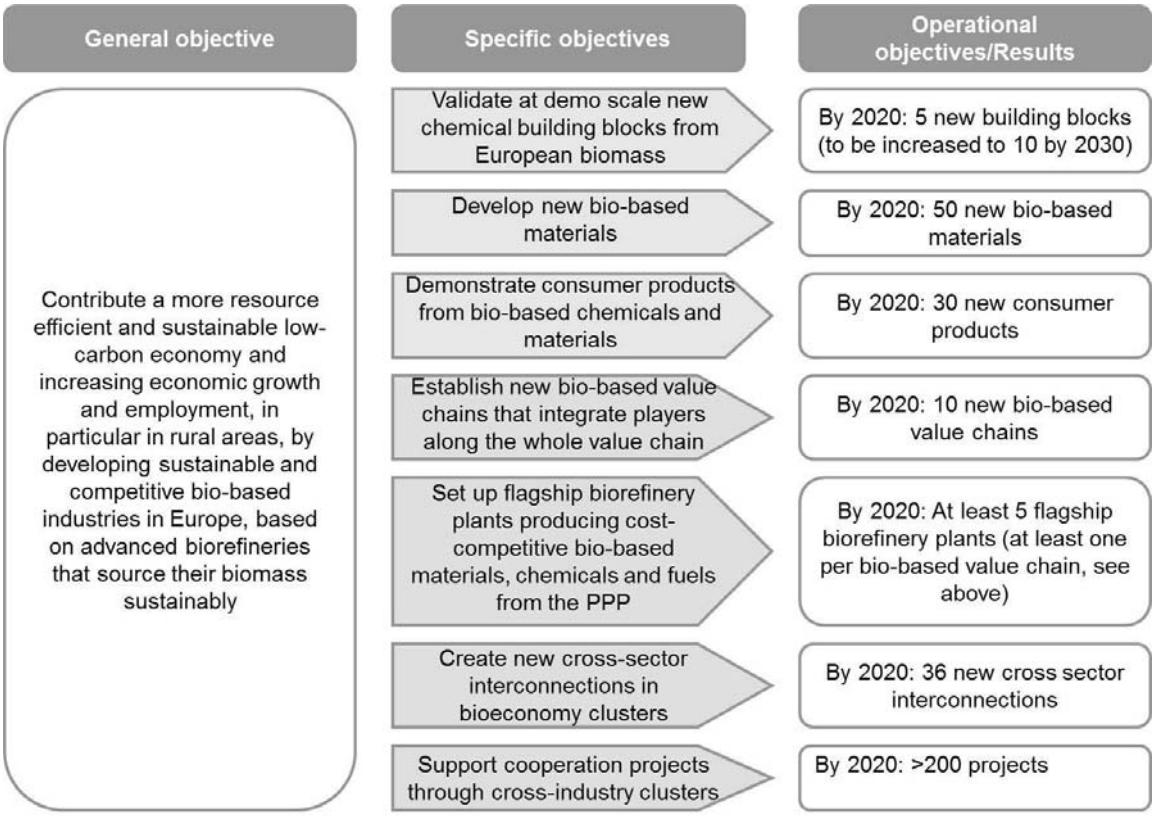


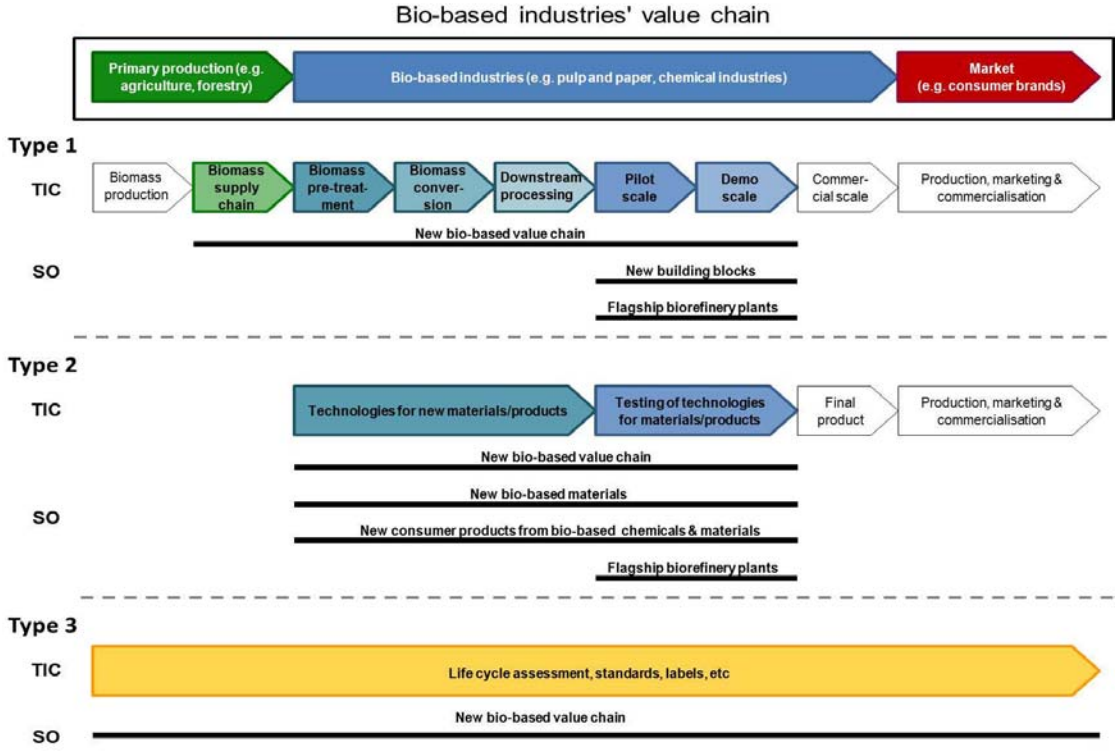
Figure 4: More detailed discussion of the specific objectives and their relationship to general and operational objectives

When implementing the specific objectives, three types of R&I activities can be distinguished. They fall in the TRL range of 2 to 8:

- **Type 1 R&I** assists in improving the sourcing of sustainable biomass (TRLs 2-4) and develops technologies (TRLs 2-4) that make non-edible biomass accessible for conversion into chemical building blocks, chemicals, materials and fuels, which either substitute existing fossil-based equivalents or are entirely new (e.g. new characteristics and functionalities). These technologies are then up-scaled (TRLs 5-8). Some of the outputs from this R&I could go directly to market after being brought to commercial scale (e.g. biofuels), others may undergo further manufacturing step or require Type 2 R&I.
- **Type 2 R&I** develops technologies to make new bio-based chemicals, materials and products from the outputs of Type 1 R&I, especially from those that are entirely new (TRLs 2-4). These are then tested for use in consumer products (TRLs 5-8). Again, these either substitute existing fossil-based equivalents or are entirely new. While some outputs may go through a further manufacturing step to become a final product, others may go directly to the market after being brought to commercial scale. Type 1 and 2 R&I can take place in the same company.
- **Type 3 R&I** supports the development and testing of sustainability criteria, life cycle assessment tools, standards, certificates, labels etc., which are crucial to support the uptake of bio-based products and biofuels in consumer markets and green procurement. Activities need to span the whole value chain, as the overall

sustainability of a bio-based product or biofuel depends on the sustainability of the different production steps.

An overview linking the different types of R&I activities to be carried out under a Bio-based PPP to its objectives is provided under Figure 5. Another correlation is provided in Table 3 under Section 5.



Note: The PPP on Bio-based industries only covers the coloured boxes. TIC = Technological & Innovation Challenges, SO = Specific objective

Figure 5: Linkage between specific objectives and technological and innovation challenges

3.2. Consistency of objectives with other EU policies and objectives

The general and specific objectives of the proposed Bio-based PPP make it a driver of smart, sustainable and inclusive growth, in line with the objectives of the Europe 2020 Strategy and its flagship initiatives "Innovation Union", "A Resource Efficient Europe" and "An Industrial Policy for the Globalisation Era".

Through the implementation of its objectives, the Bio-based PPP can significantly contribute to meeting the EU's targets on climate change and energy efficiency. Its objectives are also in line with those of several recent policy initiatives, such as the European Bioeconomy Strategy, the updated Industry Policy, the EIP for Agricultural Productivity and Sustainability and the proposal for rural development under the revision of the CAP, the Smart Specialisation Strategy and the proposal for the 7th Environmental Action Programme, as well as the proposal to amend the Renewable Energy and Fuel Quality Directives with regard to ILUC[60]. See Annex 9 for more detailed information.

[60] COM(2012) 595

Several of these policies and their evolution will strongly influence the eventual impact of the PPP. At the same time, the PPP will provide research- and innovation-based inputs that can help shaping the regulatory environment.

4. POLICY OPTIONS

The Commission proposal on Horizon 2020, which is currently under discussion, envisages activities supporting bio-based industries under two pillars "Societal Challenges" and "Leadership in Enabling and Industrial Technologies". The Horizon 2020 proposal was subject to an earlier impact assessment[61].

Since R&I activities supporting bio-based industries are foreseen under Horizon 2020, the present impact assessment will use Horizon 2020 as a baseline or "zero option", against which the two different forms of PPPs that can be created in accordance with Horizon 2020 will be analysed. The aim is to identify the most cost effective and efficient option to support the development of sustainable and competitive bio-based industries in Europe in view of the problems identified under Section 2. A schematic comparison of three options on several parameters is included in Table 1.

The three options will be compared assuming the allocation of an EU contribution of € 1 000 million to bio-based industries under Horizon 2020, which will be drawn from the Societal Challenge "Food Security, sustainable agriculture, marine and maritime research and the bio-economy" and the Key Enabling Technology (KET) "Biotechnology". Cross-cutting activities with other parts of Horizon 2020 are foreseen, such as the Societal Challenge "Secure clean and efficient energy" or the KET on "Advanced Materials", as well as with other potential PPP initiatives, such as SPIRE.

Alternative scenarios with a reduced EU contribution will not be taken into consideration as they would imply that raising the necessary resources for demonstrating technologies and supporting deployment at the relevant scale and across the five value chains, as described under Section 3, will not be possible.

4.1. Option 1 – Business as Usual

The "Business as Usual" option (BAU) is based on Horizon 2020 only ("zero option"). This implies a continuation of the Collaborative Research model applicable under FP7, integrating Horizon 2020 improvements (e.g. more emphasis on demonstration). Projects will be carried out jointly by several partners in accordance with the conditions and rules for participation set out by Horizon 2020. The FP will:

- Implement (bi)annual work programmes prepared by the European Commission in consultation with Member States and stakeholders. The work programmes are subject to approval by the Member States in the Programme Committee and will be carried out by the Commission or by an Executive Agency. Based on the experience from previous FPs, the BAU option will: Cover a broad range of topics, depending on Member State policies and stakeholders' interests in the area of bio-based industries;
- Formulate specific objectives at the project level, rather than supporting cross-project execution of an elaborated long-term strategic vision;

[61] SEC(2011) 1427

- Finance projects with a modest demonstration component, typically covering TRLs from 2 to 5 rather than TRLs from 4 to 8;

Result in limited industrial participation (e.g. less than 10% of large industries and up to 30% of SMEs in FP7), compared with at least 60% share of participation of RTOs and academia.

4.2. Option 2 – Contractual PPP

The "Contractual PPP" option (c-PPP) implies a contractual agreement between the European Commission and the private partners, who are organised in a dedicated industry group. This option gives a stronger advisory role to the industry group, which proposes a SIRA. As under BAU, standard Horizon 2020 rules and procedures fully apply, also with regard to the preparation of the (bi-)annual work programmes, which are subject to approval by the Member States in the Programme Committee. Therefore, c-PPP option will:

- Follow a similar programming approach as the BAU, see above, that does not foresee the adoption of a long-term strategic research agenda or of a large-scale multi-annual funding commitment from the EU;
- Have a limited leverage effect in terms of additional industrial investment in R&D&I.

4.3. Option 3 – Institutional PPP

The "Institutional PPP" option (i-PPP) involves the creation of a Joint Technology Initiative (JTI) established as a Community body under Article 187 of the Treaty on the Functioning of the EU (TFEU). It is foreseen under Article 19 of Horizon 2020 when justified by the scope of the objectives pursued and the scale of the resources required.

As a Community body, the JTI has a dedicated administrative structure with a governance system of its own, the so-called Joint Undertaking (JU). The JU is constituted by the European Commission and the private partners, who are organised in a dedicated industry group. It is in charge of programming and implementing the JTI's activities. Funding rules derogating from the general Horizon 2020 rules can be defined where necessary. As a consequence, the i-PPP option will:

- Allow for a long term EU and industrial budget commitment, providing industrial partners with a stable long-term perspective and an opportunity to adopt a long-term strategic innovation and research agenda (SIRA);
- Offer industry with a stable framework and the opportunity to adopt a long-term strategic vision.
- Provide greater scope for financial contributions by the industry as funding rules derogating from the general Horizon 2020 rules can be defined where necessary;
- Fund projects that contribute to a strategic long-term objective;
- Put more emphasis on demonstration activities (TRLs 4 to 8), paving the way for industry to deploy and commercialise the results;
- Attract substantial industrial participation (typically at least 25% in research projects; more than 75% for demonstration projects).

i-PPP is the only of the three options to include a legally binding financial industry commitment. It builds upon the past experience and the lessons learnt from JTIs

operating under FP7 in other areas, see Section 2.7. A JTI on Bio-based Industries will thus immediately benefit from the improvements in design and suitability of the JTI instrument under Horizon 2020, including simplified administration, lighter financial procedures, possible use of common services/functions, and increased stakeholder commitments to the JTI. The governance structure is described in more detail in Box 4.

The principles of openness and transparency applicable in Horizon 2020 will be fully respected in i-PPP. New stakeholders interested in participating directly in the JTI will be able to join the JU. This will ensure that actors in the bio-based industry that are not fully involved in the initiative are not excluded. Non-EU organisations may also join the JTI, provided that they fully adhere to its regulations and obligations. The co-funding principle will be assessed for new stakeholders, also in relation to the technical and financial risks to be assumed at each moment.

Member States have been involved as additional public partners funding R&I activities in some JTIs under FP7. This is not the case in the case in i-PPP, as it was considered that they could have a much more significant impact on its success by facilitating the deployment of the value chains developed in the JTI. As in all JTIs they will participate in a Member States Representatives Group.

While the JTI would be established from 2014 to 2020, in line with the duration of Horizon 2020, the JU would need to remain in place until 2024, in order to follow through projects selected in the final years of the JTI until the end. A similar mechanism also exists for FPs.

Box 4: Governance of a JTI under Horizon 2020

In line with the Court of Auditors's (CoA) positive report on JTIs[62], the implementation of a JTI foresees:

- Clear commitment of the stakeholders;
- Visible legal, contractual and organisational framework to structure the specific joint commitments to which stakeholders are ready to sign up;
- Firm governance structure, including shared decision-making powers and management by the public and private partners, visible to all stakeholders;
- Budgetary certainty via the budget ceiling for EU contribution to cost of the operations and the private partners' financial commitment;
- Efficient use of public resources as the Commission passes operational roles to the JU while retaining focus on regulation and supervision.
- Even with the current small-sized bodies, JTIs are already approximately cost neutral for the Commission in comparison to Collaborative Research initiatives and contractual PPPs in terms of administrative, supervision, establishment and winding up costs, as shown by an in-house cost-benefit analysis by DG RTD[63]. The private partners pay 50% of the running costs of the JTI. Increasing the size of operations of JTIs and simplifying their functioning on the basis of the common participation rules for Horizon 2020 will make the JTI a cost-effective means of implementation. The following simplification measures are being

62 http://eca.europa.eu/portal/pls/portal/docs/1/22482779.PDF

63 http://intranet-rtd.rtd.cec.eu.int/int_com/docs/CBA_JU.pdf

considered to ensure a good balance between cost-neutrality of the JTI under Horizon 2020 and increase in cost-effectiveness:

- Foreseeing a single set of Rules for Participation and Dissemination that will, subject to derogations where appropriate, render participation easier and ensure a single and sufficiently flexible regulatory framework, will create a more coherent set of instruments covering both research and innovation, enhance programme accessibility and attractiveness, and increase the scientific and economic impact while avoiding duplication and fragmentation.
- Introducing lighter financial procedures, which reduce the staff needed for such functions, and thus lower administrative costs. Specifically, the new general Financial Regulation foresees a new category of body under centralised indirect management: the special EU body entrusted with the implementation of a PPP. This body is entitled to adopt financial rules based on a new, tailor-made, simplified "model" Financial Regulation proposed by the Commission. The draft proposal for a simplified "model" Financial Regulation includes the JTI/JUs in the general discharge procedure of the Commission. Such indirect discharge will lead to simplification, due to a relatively light procedure for the establishment of the budget and for financial reporting.
- Using common IT systems, including the proposal evaluation system for Horizon 2020 which increases harmonisation, reduces the costs for such services and allows JU staff members to better adapt to the common software management programme. Moreover, by using the "commons" of the programme, the JUs coordinate better their internal processes regarding portfolio management, as well as monitoring and reporting towards the legislator and the Commission regarding management of programmes and projects.
- Exploring different options regarding establishing common services/functions (IT, Audit, Legal issues) for PPP/JTIs. These options are:
  1) Commission provides common services to JTIs/JUs and requests from them the payment of a proportional contribution;
  2) JTIs JUs set up their own common functions, which are specific and shared among them;
  3) Each JTI JU organises itself individually.
- Sharing functions in the context of the internal audit or for the accounting officer (the latter case being explicitly provided for by the Rules of Application (RAP), Service Level Agreements, common service and supply contracts and exchange of information among JU colleagues.

- At the same time, the above simplifications envisaged for the new JTI/JUs to be set up under Horizon 2020 will also allow them to become more effective by:
  - Increasing stakeholder commitment to the JTI through a definition of in-kind contributions of their private partners, which are their essential contribution to the PPP, rendering their financial involvement more transparent, improved representation of the public and private partners in governing bodies, a

balance influence between the Commission and Industry in the appointment of the Executive Director, etc.)

– Introducing more flexible budgetary and procurement procedures through adjusted legislative framework building on the new Financial Regulation.

Increasing the accessibility and attractiveness of the programmes. The Horizon 2020 JTI/JUs shall apply the common set of rules of the Horizon 2020 Rules for Participation, thus providing a coherent legal framework. Any derogation requested by the JU would have to be duly justified for specific needs and should be cost-effective for the implementation of Horizon 2020.

Table 1: Schematic comparison of the three options

OPTION	BAU	c-PPP	i-PPP
Multiannual EU budget commitment	No	Indicative budget (not legally binding)	Yes
Implementing body	Commission / Executive Agency	Commission / Executive Agency	Joint Undertaking Programme Office set up by Commission and industry group.
Governance	Commission	Commission	Joint Undertaking Programme Office set up by Commission and industry group.
Critical mass	Stand-alone projects	Stand-alone projects with increased industry commitment	Projects addressing whole value chains, including capital investment
Multi-annual Strategic Research Agenda	Commission, consulting with stakeholders	Commission, strong advisory role for industry group	Industry group, but subject to joint decision with the Commission.
Work Programme	Commission, (bi-)annual	Commission, (bi-)annual	Joint Undertaking, multi-annual on the basis of the SIRA
Role of Member States	Programme Committee approval required	Programme Committee approval required	State Representatives Group in the JTI structure, in principle advisory role. Additional competencies / responsibilities could be considered.
Financing level / source	€ 1 000 million from Horizon 2020, Horizon 2020 general rules apply	• € 1 000 million from Horizon 2020 • Undefined industry contribution Horizon 2020 general rules apply	• € 1 000 million from Horizon 2020 • € 2 800 million from industry (€ 202.5 million in cash; € 2 597.5 million in kind) Derogations to Horizon 2020 general rules possible, allowing for greater contribution by private stakeholders
Applicable when?	Default option	Use following criteria[64]: (a) Added value of the action at Union level (b) Scale of impact on industrial competitiveness, sustainable growth and socio-economic issues (c) Long-term commitment from all partners based on a shared vision and clearly defined objectives (d) Scale of resources involved and ability to leverage additional investments in research and innovation (e) Clear definition of roles for each of the partners and agreed key performance indicators over the period chosen	As for c-PPP plus: (a) R&I cannot be optimally implemented through BAU and Horizon 2020 Rules for Participation and Dissemination may need to be adapted to reach the objectives. (b) Objectives are particularly long term and/or complex and/or expensive. (c) Market failures (resource constraints, risks and 'spill-overs') large, justifying large-scale EU level public intervention. (d) Long term commitment based on (i) industry driven research and innovation agenda with corresponding public and private financial contributions, and on (ii) specific implementation modalities, is required. (e) Private partners are prepared to co-share responsibilities (including costs) and decision-making with public partners within a dedicated legal entity with a specific governance structure.

[64] COM(2011) 808

5. ASSESSMENT OF IMPACTS

The assessment of the impacts of the three policy options was carried out on the basis of a number of input and output parameters. The criteria used for the current Impact Assessment were defined in line with the criteria for PPPs established in the Horizon 2020 proposal, see Table 2.

Table 2: List of criteria for the assessment of impact based on input or output

Input parameters	Output parameters
Critical mass of resources and leverage effect on R&I	Environmental impacts
Critical mass of participants and overcoming fragmentation	Economic impacts
Innovation impacts	Social impacts
Efficiency of the governance structure	Addressing the technological and innovation challenges
Coherence with Member State programmes	

Input parameters influence the framework conditions under which the R&I activities dedicated to bio-based industries will take place in the three options. The effectiveness and efficiency of these R&I activities will then influence the impact on a set of output parameters, for example in environmental, economic and social terms.

5.1. Input parameters

5.1.1. Critical mass of resources and leverage effect on R&I

As described in Section 2, the participation of industry in R&I activities needs to be strengthened under Horizon 2020 in order to ensure higher impact. At a time where public budgets are under strain, it is also more relevant than ever to leverage additional R&I investments from the private sector in the EU. It is therefore important to assess the three options on their ability to motivate industrial partners to participate in R&I activities at EU level and to mobilise additional R&I resources (input additionality).

For BAU and c-PPP general Horizon 2020 rules apply. The participants' financial contributions to R&I projects will be modest compared to the EU contribution. The total project contribution under the programme will therefore only marginally exceed the € 1 000 million EU funding (e.g. as a result of less than 100% funding for demonstration activities).

Under i-PPP specific derogations from the general Horizon 2020 funding rules are possible. The industry group will contribute substantially to the financing of research, demonstration and deployment activities. A matching contribution of € 1 000 million consisting of in-kind and in-cash contributions from industry will effectively double the available resources for the R&I activities under the i-PPP. This will be supplemented by an additional € 1 800 million from the industry group for infrastructure-based activities. These will be invested in demonstration and flagship biorefinery plants, as needed to support the up-scaling of biorefineries. See Box 5 for more detailed information on the budget.

The commitment of € 2 800 million by industry under i-PPP is motivated by the stable long-term budgetary framework and the enhanced degree of industry impact on the R&I agenda offered by the option. Whereas c-PPP also allows for a greater industry involvement than BAU, its programming lacks the long-term stability required to mobilise the same level of additional private sector resources as i-PPP.

Box 5: Strategic Research and Innovation Agenda (SIRA) and proposed budget for Bio-based PPP

The SIRA provided by the industry group backing the Bio-based PPP proposal outlines the R&I priorities identified to meaningfully address the challenges listed under Section 2.5, also see Annex 3. They are complemented by a set of ambitious objectives presented under Section 3. Fully implementing the SIRA and meeting these objectives will be vital for maintaining the competitiveness of European bio-based industries and giving them a strong stand against global competition.

The SIRA estimates that a minimum budget of € 3 800 million will be required. Two types of activities are distinguished: project-based and infrastructure-based activities:

- Project-based activities have been allocated a budget of € 2 000 million, which will be allocated through calls for proposals, and include three major types of projects: **Value Chain Demonstration Projects**, which aim to integrate and deploy technologies and R&I results into five different value chains, bringing technology close to commercial scale through up-scaling in demonstration activities and flagship biorefinery plants. – 65 % of the activities budget (main emphasis of the SIRA) **R&D Projects**, which focus on filling the gaps in technological innovation for the three main parts of the value chains, i.e. biomass supply, biorefineries and products/markets. Dedicated projects will develop the specific technologies and concepts needed to realise the value chains and provide the principles in pilot installations. – 30% of activities budget **Supporting Projects**, which address the cross-sectoral challenges and support the value chains in becoming a reality. – 3.2 % of activities budget
- Infrastructure-based activities have been allocated a budget of € 1 800 million for the construction of demonstration and flagship biorefinery plants. This is not eligible for public funding under Horizon 2020 but is part of the overall commitment taken by industry.

The BIC is willing to commit at least € 2 800 million of investment (€ 202.5 million in cash; € 2 597.5 million in kind) based on a European Union commitment of an additional € 1 000 million. A more detailed explanation of the budget is included in Annex 3.

In summary, the legally binding financial commitment of a wide range of industry partners under i-PPP make the participation of industry and the leverage of additional resources for R&I activities more certain than under the other options. This is further complemented by a significant additional investment in infrastructure-based activities While the stronger involvement of industry in the programming of c-PPP is likely to have a positive effect on their participation, the mobilisation of significant additional R&I resources is likely to be marginal. Although the stronger focus on innovation aspects is likely to attract interest from the private sector, the industrial participation and leverage of private investment under BAU is considered to remain within the range of previous programmes.

BAU =	c-PPP +	i-PPP ++[65]

5.1.2. Critical mass of participants and overcoming fragmentation

As described in Section 2, the dispersion of stakeholders across various sectors, disciplines and Member States is one of the main hurdles to the development of successful bio-based

[65] ++ Very good potential for progress; + Good potential for progress; = Neutral progress/status quo;− Negative progress

industries. In view of the complex technological and innovation challenges bio-based industries are facing, the ability of the three options to motivate these stakeholders to work together in an integrated way along value chains to resolve them in a cost-effective and efficient manner should be assessed.

BAU could build on the experience of FP7 (e.g. Joint Biorefinery Call) by increasing the emphasis on large projects that aim to bring together participants along the value chain. While this is likely to attract relevant participants from academia and RTOs and further mobilise SMEs, it does not offer a realistic possibility to involve large industry to the extent required. However, the latter are key to successfully implement costly demonstration and flagship biorefinery plant activities and bridging the "valley of death" between research and deployment.

c-PPP is expected to be similar to BAU, although the involvement of an industry group in programming is likely to further encourage and facilitate collaboration between stakeholders along the value. Indeed, the positive impact on industry participation in R&I activities is likely to be limited by the fundamental mechanisms for managing the calls, which is the same as under BAU and will not achieve the necessary leverage of private investments.

The stable long-term perspective and the strong financial leverage of i-PPP create incentives for bringing together and promoting collaboration between market players along value and supply chains. This will contribute to overcoming fragmentation and reducing duplication of private sector R&I, by diminishing the significant transaction costs and addressing the lack of necessary “social capital” that often prevent companies to engage in the desired level of collaboration. In this context, i-PPP will also bring together many players who have no tradition of working together and will aim to create connections between value chains of seemingly entirely separate sectors that have a potential for synergies, for example through the conversion of each other’s side streams or wastes into new products (e.g. food and chemical industry).

The multidisciplinary setting and the common development of the SIRA by industry and the research community will also ensure intense collaboration between stakeholders in the innovation chains. Based on the experience of JTIs under FP7, i-PPP is likely to achieve high industry participation rates due to the requirement for a matching contribution from industry and a high level commitment to the projects based on industry's involvement in programming. This particularly applies to large industry, while the picture for SMEs may be a bit more mixed. The benefits from integrating emerging value chains, which will provide them with up- and down-stream partners, as well as with better support for demonstration activities (e.g. access to infrastructure), should however represent strong incentives for SMEs to participate in i-PPP. This is supported by the interim evaluation of existing JTIs[66], which signals mainly positive elements for SMEs, and the current membership of the industry group that aims to have an important and well-balanced participation of SMEs. While the participation of academia and RTOs may be a bit lower in demonstration activities, it should be comparable to the BAU in research activities. Specific targets and Key Performance Indicators (KPIs) related to involvement of research institutes, universities and SMEs will be defined.

In summary, the stable long-term framework provided under i-PPP allows for more integrated strategic programming than c-PPP and BAU. It thus is expected to achieve a better balance between the private and public partners required to address the technological and innovation challenges in a value chain approach. While academia and RTOs may be a bit less involved in demonstration than in research activities under i-PPP, this imbalance is not likely to be as

[66] DG RTD Expert Group (2011) First interim evaluation of the Fuel Cell and Hydrogen JU, Expert Group Report 24862

significant as the one caused by limited industry participation under the two other options and by lack of integration of the projects in the wider economic context. Moreover, c-PPP is likely to fare better than BAU due to the stronger involvement of industry.

BAU =	c-PPP +	i-PPP ++

5.1.3. Innovation impacts

Horizon 2020 will provide more support for innovation and for activities closer to market compared to previous FPs with the aim of providing seamless and coherent funding from idea to market. W

While BAU will support pilot scale and demonstration activities, it will not be able to attract the necessary large industries to finance the construction of demonstration and flagship biorefinery plants, which are essential for the deployment of bio-based industries.

Greater industry involvement under c-PPP will enhance the chances for technology deployment, as industry will tend to participate in projects for which they see good deployment opportunities. However, like BAU, c-PPP does not provide any mechanism to mobilise the necessary industry resources for developing demonstration and flagship biorefinery plants.

i-PPP takes industry commitment to another level. The strong financial commitment from industry – possible only in a setting with long term stability – guarantees that the necessary resources will be available for work on demonstration and flagship biorefinery plants. This commitment also shows industry's confidence that the technologies developed in the JTI setting will truly provide a competitive edge and that there will be significant opportunities for subsequent commercial deployment.

The fact that research, demonstration and flagship activities are operated under a common roof, with industry participants involved along the entire chain of events and with substantial commitment of private financial resources, will help ensuring a smooth transition between different phases in technology development. This will result in a reduction of the time required to move from one TRL to another, or more simply put, in a reduction of "time to market".

Beyond TRL 8, funding is no longer within the mandate of Horizon 2020. Nevertheless public funding still has a role to play in stimulating commercial deployment of technologies with major sustainability benefits. In contrast to both other options, option i-PPP leads to the creation of a legal entity, the JU, with an identity of its own. Due to its broad-based support from the public and private sector and its long-term character, it has an opportunity to build strong visibility and credibility. It can therefore act as an interlocutor with other institutions (e.g. EIB, national or regional authorities, private investors) and help leverage additional private and public funds for setting up flagship biorefinery plants and for the commercial deployment of technologies developed and demonstrated with Horizon 2020 support.

In summary, the integrated long-term strategic programme under i-PPP leverages significant resources for demonstration activities and infrastructure, and the building of flagship biorefinery plants, which will allow activities under i-PPP to reach higher TRLs than under c-PPP and BAU and to facilitate the financing of the commercial deployment by other public and private sources. c-PPP is expected to fare bit better than BAU due to stronger industry involvement, which is likely to push for higher TRLs within the available resources.

BAU =	c-PPP +	i-PPP ++

5.1.4. Efficiency of the governance structure

In times of austerity it is more important than ever to assess the three options on the basis of the cost-effectiveness and efficiency with which they implement their activities.

The governance structure of Horizon 2020, as applicable under BAU, is in the process of being established, it can however be assumed that it will follow the standard means of implementation of an FP, which is done "in house" by the Commission and possibly Executive Agencies.

c-PPP will be implemented in the same way as BAU with the addition of an industry consultation process. Since the cost for this will be borne by the Commission, the costs under c-PPP will be marginally higher than under BAU.

The efficiency of i-PPP has to be assessed against BAU and c-PPP, on the basis of experiences with JTIs under FP7. These show that JTIs constitute a highly effective means of implementing the FP.

The use of a small-sized JU to implement the JTI, as proposed under i-PPP, is already at least cost neutral and probably even more cost-effective for the Commission, than implementing the FP in terms of administrative, supervision, setting-up and winding down costs. This is mainly owed to the fact that 50% of the administrative costs of the JU's operation are covered by the private partners. It can also be expected that the costs of and time for setting up a new JU for bio-based industries will be significantly lower than for the ones set up under FP7; the experience gained from the latter favours a short setting-up phase, which tends to reduce costs.

Benefits of a JU, compared to the standards means of implementing an FP, can be non-monetary, such as shared decision-making with private partners, or monetary by leveraging significant additional financial resources from the private sector (e.g. € 2 800 million from the private sector matching € 1 000 million public funding from Horizon 2020). Some of the costs and benefits of the public intervention to set up the JU will only become apparent over long periods of time. Thus, the more efficient use of public resources in a JU allows the Commission to transfer operational tasks to the JU while retaining activities focused on regulation and supervision.

In summary, i-PPP is expected to fare better than BAU and c-PPP in terms of the cost-effectiveness of the governance structure, as administrative costs are shared between the public and private partners. It will also give rise to additional monetary and non-monetary benefits.

BAU =	c-PPP =	i-PPP +

5.1.5. Coherence with Member State and regional programmes

EU funding of R&I only represents about 5% of the total funding for these type of activities in the EU. The remaining 95% are mostly managed at Member States and regional level. It is therefore important to avoid duplication between the different funding scheme as far as possible.

In the case of BAU and c-PPP, the Programme Committee serves as a relay to exchange information between EU, Member State and regional programmes.

Under i-PPP, Member States will contribute through a Member States Representatives Group (MSRG), which serves as a relay for information exchange and aligning national and

European programmes. i-PPP is expected to achieve more coherence and synergies between the EU and Member States than BAU and c-PPP, because:

- Companies as well as national and regional clusters, i.e. "users of national programmes" are shaping the mandate of the JTI. They can be expected to actively push for a maximum level of synergy when shaping the JTI programme and providing "user" feedback to their national and regional authorities;
- The long-term character of the SIRA and the strong industry commitment will send clear signals to Member States and regional authorities about long-term goals of EU R&I policy, encouraging a better alignment of national or regional programmes.

In addition, the MSRG will contribute to identifying, at an early stage, opportunities for deployment and local investment of the i-PPP results with a view to matching these with the interest of various public institutions and private investors. Mobilisation of funds from the EIB, Structural Funds and private investors, including venture capital, can thus be facilitated.

This approach will be particularly advantageous from the perspective of EU Cohesion Policy. Several Member States have difficulties in identifying a sufficient number of economically viable projects for meaningfully investing the resources available to them for rural development or "Smart Specialisation". The development of a network of biorefineries provides an excellent opportunity to leverage Structural Funds, creating new sources of employment and sustainable economic growth. The JTI as an institutional actor will thus play an active role in matching investment plans of industry with deployment of Cohesion Policy instruments.

In summary, while Member States have less direct influence on the programming of i-PPP than under BAU and c-PPP, coherence and synergies with their activities will be ensured through the MSRG, as well as through some of the partners involved in local and regional bioeconomy initiatives. Furthermore, Member States will be actively consulted and involved in the deployment of the JTI results. i-PPP thus gives them the opportunity to benefit much more directly from its outputs than c-PPP or BAU.

BAU =	c-PPP =	i-PPP +

5.2. Output parameters

5.2.1. Environmental impacts

Bio-based industries can contribute significantly towards reaching EU objectives on climate change, renewable energies, a low-carbon economy and sustainability, see Section 2.2.1. Environmental benefits of the bio-based industries will mainly depend on the scale and speed of deployment, see Section 5.1.3. The main boundary conditions are however related to the sustainable sourcing of biomass, which needs to take into account biodiversity and ecosystems.

Strong emphasis on environmental aspects can be put in the work programmes under BAU. However, the difficulty to take activities to higher TRLs and to effectively involve all stakeholders will hinder the optimal deployment of bio-based industries. BAU can therefore not be expected to deliver a strong environmental impact.

Under c-PPP, there will be more interaction between the industry group and the European Commission than under BAU, creating an additional channel to convey the importance of environmental boundary conditions to industry. As under BAU, the Commission and Member States have the final say on programming, they can thus decide to put strong emphasis on

environmental aspects in the research actions. Since c-PPP will not significantly improve commercial deployment over BAU, its environmental impact will however also be limited.

The successful deployment of bio-based industries under i-PPP could have a very favourable impact on a number of environmental issues. Industry's strong impact on decision making and focus on deployment could raise concerns as to the strict application of environmental boundary conditions under i-PPP. However, the equal number of representatives of Commission and industry representatives in the Governing Board (GB), the main decision body of the JTI, should ensure that they are respected. The GB creates a discussion forum between the public and private partners in which the Commission can raise awareness on and push for taking on board important policy objectives, such as biodiversity and ecosystem protection. If necessary, the Commission can use its voting rights to make sure that the JTI will act in line with these policy objectives.

i-PPP will ensure a positive environmental impact of bio-based industries in a number of other ways:

- **Reducing GHG emissions** by replacing products and fuels produced from fossil resources by bio-based products and biofuels. The production of "advanced bioethanol" is estimated to deliver emission savings of 101 million tonnes CO_2 equivalent, i.e. more than 2% of the total EU emissions in 2010, see Annex 10 for examples. In the chemical industry, moving from 10% to 30% bio-based chemicals overall (the industry group's target for 2030) will have an even larger emission reduction impact[67]. Bio-based industries will play a key role in moving towards a low-carbon economy by 2050;
- **Improving resource efficiency** of industrial processes and value chains. The use of innovative technologies, such as industrial biotechnology, can make production processes more environmentally friendly by improving their resource efficiency (e.g. lower temperature, water and energy consumption, and CO_2 and waste production). Grouping different industrial sectors in a JTI with the aim of setting up new value chains will help identify and prioritise the smart use of feedstock from the outset, for example when the by-products or wastes from one industry become the feedstock of another one. Bio-based industries will have an important role in making the transition to a circular, resource-efficient and resilient economy in Europe[68];
- **Reducing waste** in line with the waste hierarchy and the aim to reduce landfilling of biodegradable waste. Bio-based industries can contribute directly to reducing biodegradable waste streams by preventing their generation through more resource efficient industrial processes, see above, and by developing new technologies for re-using them to produce value added products. For example, 138 million tonnes of food are wasted in the EU every year. Disposing it costs European taxpayers up to € 90 per tonne and produces 170 million tonnes of CO_2 per year. Converting this waste into value added products would thus save taxpayers money, generate economic revenue and mitigate climate change. Significant advances in processing technologies may also allow bio-based industries to make use of biodegradable wastes that are currently classified as hazardous, such as discarded construction wood. Another concrete example for the environmental impact from bio-based industries on waste reduction is provided in Box 6;

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67 Hermann, Blok and Patel (2007) Producing Bio-based bulk chemicals. Using industrial biotechnology saves energy and combats climate change. Environ. Sci. Technol. 41, 7915-7921.

68 MEMO/12/989

- **Ensuring sustainable biomass sourcing** taking into account environmental boundary conditions. Key lines of action for the Commission in the governance of i-PPP will be to insist on the use of life cycle analysis (LCA) and the consistent application of sustainability criteria (including biodiversity) with regard to sourcing of biomass. In this regard, use of biomass fractions from industrial and municipal waste will be encouraged. Removal rates for the use of residues from agricultural land and forests will be controlled to avoid harming soil fertility, ecosystem and biodiversity. This subject will also require further research. The production of dedicated industrial crops needs to be well considered in terms of total area and type of land allocated as well as in terms of developing sustainable agricultural practices. The focus on non-edible biomass produced in the EU should assist in mitigating the competition between different uses of biomass (e.g. food versus industrial and energy purposes) and a potential increase in commodity prices.

Box 6: Assessment of the environmental impact of the substitution of all single-use carrier bags with biodegradable bags in Europe[69]

An average plastic carrier bag weighs 12g. With a European market of about 100 billion bags, a total of 1.2 million tonnes of plastic are used every year to produce these bags. Assuming that this plastic is substituted by biodegradable bioplastic made exclusively from maize starch, it can be estimated that 280 000 hectares (ha) will be required to grow this maize. The calculation is based on the assumption that 1.2 million tonnes of starch (dry matter) have to be extracted from about 1.82 million tonnes of grain (dry matter) with a starch content of 66%. European maize productivity is estimated at 6.6 tonnes grain/ha. 280 000 ha represents about 0.06% of the EU's agricultural land.

The successful development of advanced biorefinery processes that use residues and waste as a raw material would reduce the use of agricultural land for this type of activity to almost nothing.

In summary, i-PPP is likely to have a higher environmental impact than c-PPP and BAU. While the three options do not differ strongly in the Commission's ability to impose environmental boundary conditions if necessary, they do on several other accounts. Activities taking place under i-PPP will be part of a integrated long-term strategic vision for the development of bio-based industries that is largely owned by industry. By ensuring that industry takes environmental boundary conditions into account from the outset when developing new value chains will encourage the adoption of a harmonised approach for the sustainable sourcing of biomass, which may become a standard for future value chains in Europe and possibly even world-wide. While industry will also be more strongly involved in the programming of c-PPP, the lack of a strong strategic vision is likely to dilute the impact, although it is still expected to be better than under BAU. Finally, the much more efficient deployment of i-PPP results compared to c-PPP and BAU is further going to enhance any positive environmental impact.

BAU =	c-PPP +	i-PPP ++

[69] ECOPEC/Novamont (2013) Biobased and Biodegradable Carrier Bags. Is competition between bioplastics and food a real issue? Abstract published in Bioplastics: A case study of bioeconomy in Italy

5.2.2. Economic impacts[70]

Bio-based industries can significantly contribute to increasing the competitiveness of European industries and generating growth and jobs, as described under Section 2.2.2. However, like the environmental benefits, these economic benefits depend on the scale and speed of deployment of bio-based industries in Europe, which in turn depends on the participation of SMEs and large industries, as described under Section 5.1.3.

BAU will not achieve the necessary reduction in time to market and deliver the required technology deployment boost in Europe, due to its inability to attract sufficient industry participation, in particular from large industries. It will thus not assist critical industries for the EU, such as the chemical or pulp and paper industries, to gain competitiveness in the major future-oriented and rapidly growing bio-based segment of the market, which is projected to grow from currently approximately 10% on average to up to 25% in 2025[71]. BAU will also not deliver a meaningful boost to achieve important EU policy targets such as the required production level of advanced biofuels to fulfil the 10 % biofuel target by 2020 in the Renewable Energy Directive.

Under c-PPP, stronger and more structured input from the industrial group in programming will achieve greater success in applied research and promote industrial participation in the programme. Since c-PPP is subject to standard Horizon 2020 rules, it does however not offer industry a guaranteed long-term stability and is not equipped to generate the financial leverage with large private sector contributions as required to realise the required progress towards high TRL levels (especially TRL levels 7 and 8). Although c-PPP will succeed in achieving better industry participation and thus provide greater economic benefits than BAU, it will nonetheless not be able to deliver the necessary substantial improvements to assist bio-based industries to overcome the technological and innovation challenges they are facing.

i-PPP is best suited to complement the existing research strengths in Europe with a strong focus on activities with high TRLs (in particular, for demonstration and flagship biorefinery plants). The stable long-term framework of the JTI allows for integrated strategic programming with industry and will thus succeed in mobilising relevant market players around selected value chains and leveraging the private investment required to address the technological and innovation challenges bio-based industries are facing. In particular, it will allow:

- **Biomass producers** to connect with a wide range of processing industries, opening new markets for agricultural and forestry residues, bio-wastes and industrial crops. It will also support the development of new technological and logistical solutions for cost-effective and efficient collection, storage and transport of the feedstocks. In order to take into account environmental policy objectives relating to sustainability and the protection of biodiversity and ecosystems, biomass producers will work with other players along the value chain in developing sustainability criteria for the sourcing of biomass;
- **Processing industries** to access reliable and sustainably sourced feedstock by connecting them to biomass producers across Europe. It will assist them in

[70] Note: Due to the fragmented and nascent nature of the bio-based industries sector only limited economic data is publicly available on bio-based products and biofuels. The Copenhagen Economics paper on "Biobased industries - The case for investment" (2013) explicitly highlight the difficulty in obtaining current data on the sector, in particular on costs, as these are often confidential and there is no experience from large scale projects.

[71] OECD – The Bioeconomy to 2030 – Designing a Policy Agenda.

developing new processes to separate, pre-treat and convert different feedstocks into intermediates, and to transform these into bio-based products and biofuels.

The grouping of key market players around five value chains concentrating on different feedstocks will allow for improved technology and knowledge transfer and sharing of infrastructure for demonstration activities, which will contribute to higher cost-effectiveness and efficiency. This integration into a value chain will particularly benefit SMEs.

Given the relatively high price of feedstock in Europe, processing industries will explore integrated biorefinery processes that allow for the co-production of bio-based products and bioenergy in order to maximise the valorisation of the resource and reducing production costs, following the example of petro-chemical refineries. A biorefinery co-producing cellulosic ethanol and biochemicals could thus reduce the sales prices for biofuels by 30%, compared to a biorefinery only producing biofuel.

The significant resources allocated for demonstration activities and infrastructure to support the techno-economic assessment of new processes and products, as well as for the development of a number of flagship biorefinery plants. These will assist in decreasing the per unit costs of production by 2020, and provide a knowledge base for decreasing the investment costs as of 2020[72].

Finally, processing industries will work together with biomass producers and end users to develop sustainability criteria for the sourcing of biomass and the environmental efficiency of production processes to be used for life cycle assessments, as well as for the development of standards and labels for bio-based products;

- **End users** or consumer brands to have access to more environmentally-friendly alternatives to petro-chemical products and fuels, as well as to entirely new products (e.g. materials) with new characteristics and functionalities, which can be used to develop and test new consumer products. End users will work together with biomass producers and processing industries to develop standards and labels for bio-based products taking into account the sustainability of biomass production and conversion processes.

By bringing together the relevant market players using a value chain approach i-PPP will accelerate the development of sustainable and competitive bio-based industries in Europe, see Annex 2 for a more detailed description of the market players. In particular demonstration and flagship biorefinery plants will have a multiplier effect, which will pave the way to the construction of a greater number of commercial scale biorefineries in the EU. The number and scale of commercial biorefineries and the extent to which these rely on EU biomass sources will determine economic impact: creation of revenue and added value, competitiveness of bio-based industries, less dependence on fossil resource imports and improved security of supply. This will boost the EU's biofuel sector and chemical industry[73], see Annex 10 for examples. In particular, it will help the latter in maintaining a position of global leadership with a strong EU manufacturing base as the global trend towards a rapidly increasing share of bio-based chemicals materialises.

In summary, i-PPP is expected to have the most significant economic impact as it mobilises market players along the entire value chain, as well as the significant private investment, in order to address the technological and innovation challenges that are hampering the

[72] Dalberg (2011) Biorefinery Feasibility Study

[73] BNEF (2010) Next generation ethanol and biochemicals, what's in it for Europe

development and deployment of bio-based industries in Europe in a cost-effective and efficient manner. While c-PPP is likely to mobilise industry better than BAU, it fails to provide the integrated strategic vision needed to leverage the scale of resources necessary to tackle the technological and innovation challenges.

BAU =	c-PPP +	i-PPP ++

5.2.3. Social impacts

Like the environmental and economic impact, one part of the social impact of bio-based industries as a powerful engine for job creation and for rural development will depend on their level of deployment, see Section 5.1.3. The other part is linked to the introduction of bio-based products and biofuels into mature consumer markets, where they will either replace existing less sustainable goods or try to establish themselves as entirely new ones. Their success will depend on pricing and environmental performance, and most importantly public acceptance.

As discussed under Section 5.2.2, BAU does not achieve optimal impact on deployment due insufficient industry involvement. It will hence not deliver the desired impact on job creation and rural development. While BAU may support the introduction of bio-based products into consumer markets, e.g. by continuing to develop standards for certain bio-based products as under FP7 or communicating their benefits to the general public, the social impact of introducing bio-based products and biofuels is likely to be limited by the difficulty of research activities reaching high TRLs in view of developing products that are close to the market.

With a limited enhancement in terms of deployment over BAU, c-PPP will also provide a limited improvement in job creation and rural development. The social impact on consumer markets is likely to be better than under BAU, due to the stronger involvement of industry. The public perception of bio-based products and biofuels may however be hampered by the lack of integration between different market players, which may lead to inconsistencies in the development of sustainability criteria, standards and communication activities.

The superior performance of i-PPP in terms of deployment drives its potential to deliver jobs. These jobs relate, on the one hand, to the construction and operation of biorefineries and on the other hand, to production, collection and transport of biomass. Both activities involve plenty of opportunity for low-skilled workers.

Lack of economic activity in many rural areas currently leads to declining standards of living, a loss of population and difficulties to maintain the quality and diversity of agro-eco systems. Contrary to most other industries, the rule that "biorefineries" follow "biomass production" creates a strong driver for the bio-based industries to develop first and foremost in rural areas. The most important cost for the operation of most biorefineries is the feedstock, hence their potential to contribute significant new income streams to farmers and foresters and additional jobs in the biomass logistics and supply chain. An example on the social impact of bio-based chemical products is provided in Annex 10.

i-PPP is also likely to fare better with regard to the introduction of bio-based products and biofuels into consumer markets. The integrated strategic vision of the JTI will ensure that only the most sustainable and cost-effective bio-based products and biofuels in the different value chains are up-scaled in order to ensure their competitiveness on consumer markets. The application of a harmonised approach on sustainability criteria, LCAs, standards and labels will provide consumers with more transparency as to the benefits of these goods.

The establishment of a JU furthermore provides bio-based industries with a clear identity and one voice to reach out to the general public and explain to them how the feedstock for these

advanced bio-based products and biofuels was sourced, why these products are more sustainable (e.g. replace fossil based products and possibly toxic chemicals by bio-based alternatives, more resource efficient production processes), what novel characteristics they offer (e.g. biodegradability).

In summary, the social impact of i-PPP is considered to be higher than that of c-PPP and BAU. This is largely due to the value chain approach, which brings on board a wide range of regional market players, but also allows for the development of more sustainable and cost-effective bio-based products and biofuels. The creation of a JU under i-PPP also gives a face to the nascent sector of bio-based industries, which is otherwise hard to grasp due to the very diverse market players it encompasses, which will allow for better outreach to the general public. c-PPP is likely to have a slightly better impact than BAU due to its stronger involvement of industry, which will improve deployment and develop a larger number of bio-based products and biofuels to high TRLs.

BAU =	c-PPP +	i-PPP ++

5.2.4. Addressing the technological and innovation challenges

A number of specific objectives (and their operational objectives) have been identified under Section 3 to address the technological and innovation challenges identified in Section 2.5. Some objectives will only contribute to one challenge, others to more than one or all. Based on the discussion of the different input and output parameters above, the three options have been assessed with regard to their ability to deliver the specific objectives in Table 3.

While BAU is likely to improve in the development of bio-based materials compared to FP7, its ability to increase industry participation, in particular from large industry, and leverage private investments in R&I will be limited. It can also be expected that it will not succeed in mobilising additional resources for the development of flagship biorefinery plants.

c-PPP is expected to fare better than BAU on all activities in which a stronger industry involvement will be determining for success. While the consultation of industry in the programming is likely to also enhance their participation in R&I activities, the lack of additional leverage and of a strategic long-term perspective will dilute the impact of c-PPP. Like BAU, it will not succeed in mobilising additional resources for the development of flagship biorefinery plants.

Under i-PPP, industry's strong involvement in the development of the SIRA and its important financial commitment, both in terms of supporting R&I activities and the development of infrastructure, offer optimal conditions for delivering all the specific objectives. The ability of i-PPP in mobilising such significant resources relies on the stable long-term strategic framework it provides, which allows for a value chain approach that brings together all necessary stakeholders in a cost-effective and efficient manner.

In summary, the technological and innovation challenges bio-based industries are facing will be best addressed under i-PPP, as the framework it provides best succeeds in mitigating the significant number of market failures this nascent sector is struggling with. While the impact of c-PPP is better than that of BAU due to the better involvement of industry, it will not be able to create the coherent and integrated framework required to motivate industry partners to invest significant additional resources in the programme. BAU will essentially follow in the footsteps of previous FPs and support bio-based industries in a more punctual fashion through its wide range of projects.

BAU =	c-PPP +	i-PPP ++

Table 3: Linking technology and innovation challenges, specific objectives and the three options

PROBLEMS (See Section 2.5 Technology and innovation challenges)	**OBJECTIVES (See Section 3.1.2 Specific objectives)**	**OPTIONS (See Section 4 Policy options)**		
		BAU	**C-PPP**	**I-PPP**
Accessing sufficient sustainable feedstock	Establish new bio-based value chains that integrate players along the whole value chain	=	+	++
	Create new cross-sector interconnections in bioeconomy clusters	=	=	++
	Support cooperation projects through cross-industry clusters	=	+	++
Developing efficient conversion processes for advanced biorefineries	Develop new bio-based materials	+	+	++
	Establish new bio-based value chains that integrate players along the whole value chain	=	+	++
	Create new cross-sector interconnections in bioeconomy clusters	=	=	++
	Support cooperation projects through cross-industry clusters	=	+	++
Demonstrating and deploying advanced biorefineries	Demonstrate consumer products from bio-based chemicals and materials	=	+	++
	Validate at demo scale new chemical building blocks from European biomass	=	=	++
	Set up flagship biorefinery plants producing cost-competitive bio-based materials, chemicals and fuels from the PPP	–	–	++
	Establish new bio-based value chains that integrate players along the whole value chain	=	+	++
	Create new cross-sector interconnections in bioeconomy clusters	=	=	++
	Support cooperation projects through cross-industry clusters	=	+	++
Supporting demand-side actions for the uptake of bio-based products	Demonstrate consumer products from bio-based chemicals and materials	=	+	++
	Establish new bio-based value chains that integrate players along the whole value chain	=	+	++
	Create new cross-sector interconnections in bioeconomy clusters	=	=	++
	Support cooperation projects through cross-industry clusters	=	+	++

++ Very good potential for progress + Good potential for progress = Neutral progress/status quo – Negative progress

6. COMPARING THE OPTIONS AND SELECTING THE PREFERRED OPTION

6.1. Comparison of the three options

The impact of the three options has been assessed and compared based on a number of input and output parameters under Section 5. The outcome of this assessment has been summarised in Table 4.

Table 4: Comparison of the three options

CRITERIA		BAU	c-PPP	i-PPP
Input parameters	Critical mass of resources and leverage effect on R&I	=	+	++
	Critical mass of participants and addressing fragmentation	=	+	++
	Efficiency of the governance structure	=	=	+
	Coherence with member state and regional programmes	=	=	+
	Innovation impacts	=	+	++
Output parameters	Environmental impact	=	+	++
	Economic impact	=	+	++
	Social impact	=	+	++
	Addressing the technological and innovation challenges	=	+	++

Note: Option BAU represents the baseline scenario.

6.2. Justification of ratings based upon the assessment of impacts

i-PPP's strong position is based on its capacity to mobilise greater project resources due to the significant contribution by industry. It would provide a stable framework with long-term guarantees that is essential to mitigate risk and incite industry commitments, not only in terms of R&I resources but also for investments in expensive demonstration activities and infrastructure. The conditions offered by i-PPP have motivated industry to match the EU contribution of € 1 000 million for R&I activities and to leverage an additional indicative € 1 800 million for demonstration and flagship biorefinery plants.

i-PPP incites much higher industry participation rates than BAU or c-PPP. Its structure would help overcome fragmentation by facilitating cross-sectorial and pan-European linkages along whole value chains, which will particularly benefit SMEs. Such linkages are required to successfully implement new technologies and resolve innovation problems. The scope for taking technologies to high technology readiness levels is clearly greater under i-PPP than under the other two options due to strong industry commitment. i-PPP thus contributes much more effectively to bridging the innovation gap than BAU or c-PPP.

i-PPP also offers a moderate advantage in terms of efficiency of the governance structure. It will also have a positive influence on coherence with Member State and

regional programmes by involving them in its Advisory Committee and consulting them on deployment.

Altogether, the advantages of i-PPP on the above-mentioned criteria give it a strong advantage in terms of addressing the technological and innovation challenges bio-based industries face and will result in a larger expected scale of technology deployment and shorter time to market. Since the positive environmental, economic and social impacts of bio-based industries strongly depend on their deployment, i-PPP will most significantly contribute to achieving the Europe 2020 objectives of smart, sustainable and inclusive growth. Impacts include the development of new cost-effective and efficient value chains that transform sustainably sourced biomass into value added bio-based products and biofuels through resource efficient and environmental processes, generating benefits for all involved market players and consumers.

6.3. Preferred option

Based on the assessment above, option i-PPP offers a strong benefit over option c-PPP both on input and output parameters, which in turn have a certain advantage over option BAU. The establishment of a JTI on Bio-based Industries is thus the preferred option.

7. EVALUATION AND MONITORING

7.1. Operational monitoring

Progress and efficiency of the JTI operations will be closely monitored at different levels. The JTI will publish an annual activity report with the results of a monitoring based on a range of Key Performance Indicators (KPIs).

7.1.1. KPIs on implementing the SIRA

The JTI's progress on implementing the objectives outlined under Section 3 and the SIRA at different points in time using three levels of quantitative and qualitative Key Performance Indicators:

- KPIs “Level 1” address the contribution to accomplishment of the general objectives of the JTI with a vision to 2020 and 2030 (outcome and impact). These objectives will however not be direct results of the PPP;
- KPIs “Level 2” aim at monitoring the progress of JTI, measuring how the specific operational objectives/results are met by 2020 (output and outcome), with milestones end of 2016 and 2018;
- KPIs “Level 3” allow monitoring the success of each project to be funded under the JTI. KPI level 3 will be defined by each project as ad-hoc KPIs attuned to KPI level 2.

Efficiency of the JTI

For the sake of monitoring progress and implementation of the JTI, the direct quantitative objectives could be used as KPIs Level 2 to monitor the progress of the programme. A limited selection from these objectives is made as key specific objectives. These objectives are directly linked to a set of KPIs, to be measured and monitored during the progress of the JTI, and to be used to steer the JTI activities accordingly.

The monitoring at this level will be a task of the programme management. Frequent monitoring gives insight into 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 JTI performance to be monitored continuously:

- Overall percentage % of industry investments (cash + in-kind) in the total JTI organisation and projects;
- A well balanced SME involvement in JTI 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 JTI 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).

Effectiveness of the JTI

To get insight into the effectiveness of the programme, i.e. answering the question "are we doing the right things?", a monitoring for the KPIs at Level 1 has to be set-up. This is a task of the programme management that might be addressed by a Supporting Project within the JTI, 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 the JTI. 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.

In addition to the monitoring of the implementation of the objective, monitoring will be carried out on good governance of the PPP with regard to:

- Openness and transparency of procedures;
- Avoidance of conflicts of interest;
- Financial auditing.

7.1.2. KPIs relating to Horizon 2020

As the JTI would be co-funded by Horizon 2020, its achievements will also be measured against the KPIs of the relevant parts of Horizon 2020, such as a) supply security of bio-based products, b) the development of competitive and low carbon supply systems, and the c) establishment of a resource-efficient and environmentally-friendly transport system.

The JTI performance will be quantitatively assessed against the following Horizon 2020 KPIs:

- Achievement of an overall investment of 3% of GDP in R&D activities in the EU;
- Achievement of, on average, 20 publications in high impact journals (and two patent applications per € 10 million funding[74]).

Throughout the lifetime of the JTI, the efficiency, effectiveness and throughput of operations will be monitored as follows:

- 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.

7.2. Monitoring progress of technology and markets

An additional set of quantitative and qualitative KPIs will be established to follow the progress of the JTI technologies as well as its impact on market development with a view to assess progress of the bio-based industries in the EU towards the general objectives.

Such KPIs aim to measure the level and speed of technology deployment in the EU, the EU's competitiveness in the bio-based industries and market adoption of bio-based products and biofuels. These indicators will be assessed against a baseline reflecting the state of affairs at the start of the JTI. Where possible, the impact of the JTI on these parameters will be assessed.

A number of suitable KPIs have already been proposed by industry in the SIRA, see Annex 3. A selection of the most appropriate KPIs as well as specific methods for measuring them will be further elaborated in the Multi-Annual Implementation Plan. Where appropriate, the agreement between the JTI and the industry group will include a requirement to provide specific data that are essential for measuring the KPIs. Certain tasks related to monitoring of KPIs may also be included in projects under the segment for "cross-cutting" actions.

The definition of KPIs for the JTI will take advantage of the important work already undertaken within the European Industrial Bioenergy Initiative (EIBI) and the SET plan information system with regard to the definition of KPIs.[75]

Finally, it will be examined how the Bioeconomy Observatory which is being established in the framework of the Commission's Bioeconomy strategy, can be involved in monitoring the KPIs.

7.3. Performance evaluations of the JU to be conducted from outside the JTI

The Commission will organise evaluations of the JTI by calling on independent experts. These evaluations will cover the quality and efficiency of the JTI and its progress towards its objectives. A mid-term and an end-of-term evaluation (as customary with JTIs) will take place. The latter is based on the observation that the innovation impact of

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74 Note: Since the JTI will put emphasis on pilot, demonstration and flagship activities, for which the valorisation of intellectual property is more important than its creation, the target of two patent applications per € 10 million invested may not be realistic.

75 European Industrial Bioenergy Initiative (EIBI) (2011) Boosting the contribution of Bioenergy to the EU climate and energy ambitions Implementation Plan 2010 - 2012

projects often only becomes visible several years after project completion and there is a lack of monitoring of these post-project innovation impacts.[76] This will allow to monitor progress towards 2030 targets as defined in the industry vision document and as discussed in this impact assessment.

7.4. Monitoring the financial commitment by industry

The Commission will monitor on an annual basis the nature and the level of the industry contribution, in order to ensure that the R&I budget receives the necessary support both from the public and private partners. Corrective measures will be applied to ensure that the contributions from the partners are sufficient and appropriately balanced.

Annexes

ANNEX 1 – GLOSSARY

ANNEX 2 – BIO-BASED INDUSTRIES – MARKET PLAYERS AND THE "BIC"

ANNEX 3 – STRATEGIC INNOVATION AND RESEARCH AGENDA (SIRA)

ANNEX 4 – REPORT ON THE EUROPEAN COMMISSION'S ON-LINE PUBLIC CONSULTATION

ANNEX 5 - CURRENT AND FUTURE POTENTIAL OF BIOMASS AS A SOURCE OF MATERIALS AND ENERGY

ANNEX 6 – DEFINITION OF TECHNOLOGY READINESS LEVELS (TRLS)

ANNEX 7– OVERVIEW OF RESEARCH AND INNOVATION AT REGIONAL AND NATIONAL LEVEL

ANNEX 8 – EXAMPLE OF A REGIONAL BIOECONOMY CLUSTER MOVING UP-SCALING ACTIVITIES OUTSIDE THE EU

ANNEX 9 – DETAILED DESCRIPTION OF THE SPECIFIC OBJECTIVES AND LINK TO WIDER POLICY CONTEXT

ANNEX 10 – EXAMPLES ILLUSTRATING THE POTENTIAL SOCIO-ECONOMIC IMPACT OF A OPTION I-PPP

ANNEX 11 – BIBLIOGRAPHY OF THE IMPACT ASSESSMENT

[76] Biotechnologies panel report, Food Agriculture and Biotechnology 25/02/2011 prepared in the context of the impact assessment of Framework Programme Activities in FAFB.