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D6.4

**Synergies and cooperation for biobased economy in
Europe and at international level**

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About S2Biom project

The S2Biom project - Delivery of sustainable supply of non-food biomass to support a “resource-efficient” Bioeconomy in Europe - supports the sustainable delivery of non-food biomass feedstock at local, regional and pan European level through developing strategies, and roadmaps that will be informed by a “computerized and easy to use” toolset (and respective databases) with updated harmonized datasets at local, regional, national and pan European level for EU28, western Balkans, Turkey and Ukraine. Further information about the project and the partners involved are available under www.s2biom.eu.

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About this document

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Introduction

Good cooperation between EU Member States, neighbouring countries and between Europe and the rest of the world will be a key element in the development of a sustainable and competitive bioeconomy.

Although innovation across the lignocellulosic biomass value chains remains important for their future uptake, policy is considered pivotal to their future market deployment. Robust, well designed and timely policies¹ are required to steer markets towards efficient and innovative paths, maintain current capacities, support the industry by sharing risks of commercialisation and guide regions on how to plan their smart specialisation strategies and use efficiently their structural and innovation funds (ESIF).

The aim of the report is to provide an advisory document in the fields of cooperation and potential synergies between Member States (MS) and at international level and how this can provide added value for the progress towards a biobased economy.

The value chains included in this report derive from non-food lignocellulosic biomass deriving from the agriculture, forestry and waste sectors.

Based on work in the S2Biom project and discussions with policy and industrial stakeholders the following fields of cooperation in policy are included in the analysis for synergies and future collaborations:

- Bioeconomy strategy
- Financial mechanisms
- Involvement of industrial actors
- Research funds
- Communication and interaction with public

The under-study regions are firstly analysed for their current activities, challenges and opportunities in the sector and then a 'matching' matrix with recommended fields of cooperation and specific regions/ countries is presented.

Depending on the combination of countries and regions different challenges can be identified in the field of policy formation and tailored suggestions can be made.

Fields of cooperation

In this section, these criteria are described and then discussed in relation to their stage of implementation and potential synergies.

¹ Including regulatory, financing and information provision mechanisms

Bioeconomy strategy

The European Union and several Member States have developed bioeconomy strategies which have as primary aim the development of biobased economies with efficient collaboration among the relevant sectors involved as well as biomass exploitation in a resource efficient manner. As expected, these differ in ambition, target sectors and actors involved and consequently there are elements which could be enriched and new fields of cross country/ region collaborations can also be included.

Financial mechanisms

Strong financial mechanisms are required when innovation pathways are involved. Loan guarantees and other risk management tools can be an efficient way to stimulate private debt funding for large scale projects while credit lines and funds can stimulate markets in the smaller scale applications.

Involvement of industrial actors

Fostering the development of a lignocellulosic based bioeconomy requires long term, strong and consistent commitment from both the industry and the governments to share the risks, uptake the innovative components and facilitate their commercialisation.

Research funds

Innovation capabilities are an important element for companies to gain and retain competitiveness. The ability to introduce new products and adopt new processes within a shorter lead time is a key competitive advantage², as is the availability of well-educated and trained personnel to run innovative production processes. Thus, the competitiveness of a region can be linked to the strength of research within companies and research institutions that reside in the region.

Communication and interaction with public

Raising awareness, providing clear messages with societal and consumer benefits deriving from bioeconomy and actively engaging with public are considered essential 'pull' mechanisms for the wide acceptance of bio-based materials and products.

² Guan, J. C., Yam, R.C.M., Mok C.K., and Ma N. (2006) A study of the relationship between competitiveness and technological innovation capability based on DEA models. *European Journal of Operational Research* 170: 971–986

Cooperation at international level

Current activities

Even though policy formation for bio-based economy is quite new in most of the EU and Europe as a whole, the continent has several strengths on which it should be able to build to achieve leadership in the development of bio-based products and develop strong co-operations and partnerships. At international level, Europe compares with USA, Brazil and China³. There are fields where synergies can be drawn and lessons learnt among the regions. The following table shows the level of activity in the understudy fields categorised as high (green highlight), emerging (amber highlight) and low (grey highlight).

Table 1 Current activities in policy formation for biobased economy in Europe, USA, Brazil and China

	Europe	USA	Brazil	China
Bioeconomy strategies	High	High	High	Emerging
Financing mechanisms	Emerging	High	Emerging	Emerging
Involvement of industrial actors	Emerging	High	Emerging	Emerging
Research funds	Emerging	High	Low	Low
Communication and interaction with public	Low	Emerging	Low	Low

USA

The US has, since 2000, demonstrated an interest in the biochemical sector. The Biomass Research and Development Act of 2000 showed the US Government's interest in the conversion of biomass into bio-based industrial products⁴ as added value products which can also provide environmental benefits, and promote rural economic development. The U.S. Department of Agriculture (USDA) and U.S. Department of Energy (DOE) coordinated allocation of \$500m of funds in 2002 from the Commodity Credit Corporation, and \$14m each year from 2003-2007.

The 2002 Farm Security and Rural Investment Act introduced the requirement for each Federal agency to, in procuring items, give preference to those composed of the highest percentage of bio-based products practicable. The subsequent scheme is known as the BioPreferred Program, with an expanding list of thousands of bio-based chemicals and materials (e.g. cleaners, carpets, lubricants, paints, bed linen, fertilisers, toner cartridges) with minimum biobased contents, all mandated for federal purchasing⁵

³ E4tech, From the sugar platform to biofuels and biochemicals, final report for EC DG Energy, ENERC/C2/2012/423-1, 2015

⁴ <http://www.biopreferred.gov/files/Biomass.pdf>

⁵ <http://www.biopreferred.gov/BioPreferred/faces/Welcome>

The *Energy Policy Act of 2005* (Section 943)⁶ supported biofuels and biochemicals by offering small businesses marketing and certification grants. It also established the Renewable Fuel Standard (RFS)⁷. The *Energy Independence and Security Act* (2007) established RFS targets of 36 billion gallons of renewable fuels by 2022, with a cap of 15 billion gallons on corn-biofuels. This policy has been the main driver of the corn ethanol industry in the US, with gasoline vehicles now blending around 10% ethanol in gasoline. The mandated future volumes for cellulosic biofuels are equally significant.

In 2012, the US National Bioeconomy Blueprint was published to reinforce activities around the bioeconomy and bio-based products and defined five strategic objectives for the Bioeconomy. These include supporting R&D investment, facilitating the transition from lab research to market, the development and reformation of regulation to reduce barriers to market entry, updating of training programs, and identification and support of opportunities for the development of public-private partnerships and precompetitive collaborations⁸.

The US Department of Energy Loan Programs Office has developed a very focused Federal Loan Guarantee programme in support of Renewable Energy and Energy Efficiency. This provided access to Loans to various projects, including advanced biofuel demonstration and first commercial plants. To date, the US DOE have supported approximately US\$ 1.4 billion of investment in 29 integrated biorefinery projects, supporting different scale plants with a variety of fuel and chemical outputs (although with a strong focus on LC ethanol and BTL hydrocarbons)⁹. The DOE are currently undergoing a new Solicitation for another US \$ 2.5 billion of loan guarantees, with a dedicated area to Biofuels including drop-in fuels¹⁰. In addition, the US Department for Agriculture supports the development of innovative biorefining projects through a dedicated loan programme¹¹. The Bio-refinery Assistance Program Guaranteed Loans provides guarantees up to \$250m and the Biomass Crop Assistance Program (BCAP)¹² provides significant financial assistance to owners and operators of agricultural and non-industrial private forest land who wish to establish, produce, and deliver biomass feedstocks. US financing models therefore cover both the downstream conversion plants and upstream feedstocks.

⁶ <http://www.biopreferred.gov/files/EPACTSection943.pdf>

⁷ <http://www.epa.gov/oms/fuels/renewablefuels/>

⁸ http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

⁹ <http://energy.gov/sites/prod/files/2014/07/f17/Renewable%20Energy%20and%20Efficient%20Energy%20Projects%20Solicitation%20FINAL.pdf>

¹⁰ <http://energy.gov/sites/prod/files/2014/07/f17/Renewable%20Energy%20and%20Efficient%20Energy%20Projects%20Solicitation%20FINAL.pdf>

¹¹ http://www.rurdev.usda.gov/supportdocuments/sc_9003.pdf

¹² <https://www.fsa.usda.gov/FSA/webapp?area=home&subject=ener&topic=bcap>

Brazil

Brazil is a leading country in biofuel production, due to fuel ethanol blending mandates which were first introduced in the 1930s. This has resulted in flexible fuel cars representing almost 90% of the car park¹³. The current bioethanol mandate has recently been raised to 27.5%, although has fallen in the past, and fossil gasoline remains subsidised in Brazil¹⁴.

Biotechnology was identified as a national strategic priority in 2003 culminating in the 2007 decree No. 6,041 (Política de Desenvolvimento da Biotecnologia¹⁵) containing policies regarding R&D support, human capital training and development¹⁶. A Biotechnology Committee was established comprising 23 Federal level agencies and ministries with the aim of developing Brazil's biotech sectors.

The Brazilian Development Bank (BNDES) is the main financing agent for development in Brazil. Since its foundation in 1952, the BNDES has played a fundamental role in stimulating the expansion of industry and infrastructure in the country. In 2011, the Brazilian government released a national development plan called *Plano Brazil Maior 2011 – 2014*¹⁷ to stimulate the national economy and industry, specifically to develop new technologies and innovation, and to enable Brazil to compete with other world economies including in the biofuels and biochemical sectors¹⁸. The benefits include tax relief (including certain import tax reliefs) and project finance amongst others. During 2011-2014, the BNDES and the state research-financing agency FINEP funded ~US\$ 450 million to carry out the Joint Plan for Supporting Industrial Technological Innovation in the Sugar-based Energy and Chemical Sectors (PAISS)¹⁹, ²⁰ focused on second generation bioethanol, new sugarcane products and gasification pathways.

The PAISS was extended in 2014, with an additional ~US\$ 600 million of low interest loans (10 years at 4% interest), plus some grant funding, for 2014-2018²¹. The bank's investment arm, BNDESPar, has also taken equity stakes in the projects. Many companies have benefitted from the PAISS including GranBio, Solazymes, Bunge, CTC and Abengoa Bioenergy.

In 2013, the *Bioeconomy Brazil agenda*²² underlined the need to address the gap between the supply of researchers trained in relevant academic fields and the demand for researchers, and proposed supporting the development of a financial

¹³ <http://www.greenpowerconferences.com/EF/?sSubSystem=Prospectus&sSessionID=5ock61hc8861hb9e006nmm1050-12708618&sEventCode=BF1409BR&sDocument=Factsheet>

¹⁴ <http://www.bloomberg.com/news/2014-09-03/brazilian-senate-approves-higher-ethanol-mandate.html>

¹⁵ http://www.mct.gov.br/upd_blob/0016/16386.pdf

¹⁶ Building the Bioeconomy Examining National Biotechnology Industry Development Strategies, A Briefing Paper, April 2014

¹⁷ <http://www.equilibri.net/nuovo/es/node/2041>

¹⁸ Building the Bioeconomy Examining National Biotechnology Industry Development Strategies, A Briefing Paper, April 2014

¹⁹ <http://domesticfuel.com/2014/02/17/paiss-program-to-help-brazilian-sugarcane-industry/>

²⁰ <http://www.biofuelstp.eu/spm5/pres/kutas.pdf>

²¹ <http://www.biofuelsdigest.com/bdigest/2014/02/18/bndes-approves-618-million-in-loans-for-cane-ethanol-innovation/>

²² A Report by Harvard Business Review Analytic Services (2013) BIOECONOMY An Agenda for Brazil (http://arquivos.portaldaindustria.com.br/app/conteudo_24/2013/10/18/411/2013101813582453739)

system to assist SMEs in the field of technology by establishing a venture capital industry, integrating and reinforcing the operations of BNDES and FINEP, and providing government guarantees for the financing of technological development projects.

China

China shows a great interest in the “biotechnology sector” as a key element for industrial development. Their 11th Renewable Energy Five Year Plan (2006-2010) reiterated ethanol targets of 3 million tonnes for 2010 (with only 1m tonnes allowed from grains), and set guidelines to use marginal land, avoid environmental damage and competition with food and feed – i.e. no increase in grain-based ethanol allowed. Consequently, only 1.8m tonnes of ethanol production were achieved in 2010. China’s 12th Five-year Plan (2011-2015) has set a target of 3.5-4m tonnes of ethanol for 2015, with a continued emphasis on marginal lands, non-grain and advanced biofuels. Incentives include funding, tax rebates and investment grants.

Challenges & Opportunities

Despite the detected progress in formulating policy mechanisms for the bio-based economy there are still important challenges with respective opportunities which must be addressed till 2030. These derive from the variety of sectors involved- sometimes with conflicting interests, the complex value chains, the active engagement of industrial actors and the state of the economy which shapes the prioritisation of available funds. Table 2 below provides an overview for Europe, USA, China and Brazil categorised in the main fields analysed in this report.

Table 2 Challenges and opportunities for the development of bioeconomy in Europe, USA, China and Brazil

	Challenges	Opportunities
Bioeconomy strategies	Consistent framework for biobased economy allowing for cross sectorial integration and new product developments	Create the framework conditions for mobilising waste and residual streams, defining standards, working out logistics and specifying workable arrangements for pre-processing Develop “green public procurement” policies promoting biobased products
	No uniform standardisation, certification and labelling and statistical procedures for biobased products	Develop tailored standards for feedstock and product sustainability, biodegradability, biobased content, etc. Brand biobased products through ecolabeling Facilitate harmonisation in ecolabeling activities
	Knowledge transfer and information exchange at international level	Develop thematic bioeconomy ‘knowledge’ platforms to facilitate knowledge exchange (methodologies, indicators, open access data) and information provision to research and industry for collaboration options.
Financing mechanisms	Ensure adequate public support for scale-up activities	Introduce financial incentives for biobased products Invest in infrastructure at pilot and demonstration scale to bring innovative ideas to market Promote funding support for trials at dedicated pilot plant facilities Shift barriers affecting biobased materials and products in market, development and trade policies.
	Limited access to finance for spin-offs, start-ups and SMEs	Setting up funding programmes and innovation awards for bio-entrepreneurship Development of demonstration projects as proof of concept and flagship projects Setting up of specific funding programmes targeted to innovative SME’s
Involvement of industrial actors	Maintain interest, ensure active involvement and long term commitment from industrial actors	Create stable policy and financing conditions to facilitate stronger engagement from the industry
	Facilitate industrial operations at international level; among continents	Introduce flexible support solutions for industrial actors operating across continents and reduce administrative steps. Organise annual industrial forums focused on financing and policy issues
Research funds	Limited availability of public R&D funding	Increasing R&D funding, national and regional level is necessary to pioneer public research in collaboration with the industrial sector in a co-funding scheme.
Communication and interaction with public	Public awareness: advantages of biobased products are not visible enough	Organise targeted campaigns

Suggestions for collaboration

Table 3 below ranks the compared regions for their performance in the policy areas mentioned above. They are further grouped as high (green highlight), emerging (amber highlight) and low (grey highlight). The ones with low ranking can benefit from the ones with high in the respective fields.

Table 3 Suggestions for future collaboration in the non- food bio-based economy at international level

	Europe	USA	Brazil	China
Bioeconomy strategies				
Sustainability	Green	Green	Amber	Amber
Standardisation	Green	Green	Grey	Grey
Green procurement	Amber	Green	Grey	Grey
Ecolabelling	Amber	Green	Grey	Grey
Financing mechanisms				
Public support	Amber	Green	Amber	Amber
Access to finance	Amber	Amber	Grey	Grey
Involvement of industrial actors				
Joint Technological Ventures	Amber	Green	Amber	Amber
Public Private Partnerships	Green	Green	Grey	Grey
Research funds				
Funds for large scale demonstration	Amber	Green	Amber	Amber
Funds for 'flagship' projects	Amber	Green	Grey	Grey
Communication and interaction with public				
Public awareness activities	Amber	Green	Grey	Grey

The USA has clearly a more refined and detailed policy framework which places biobased economy in the focus of several sectors and implements a variety of policy mechanisms to facilitate its implementation. As such, lessons can be learnt from them and their trajectory during the last ten years.

Europe, with EU leading, as expected, while neighbouring countries follow as part of political ambitions and agreements with the Union, has placed strong efforts in sustainability, standardisation and the formation of Public Private Partnerships in the field of biobased economy. This is evident from the recent European Bio-Based Industries^{23, 24} public-private partnership with budget 3 billion Euro /1 billion Euro from industry and EU respectively over the period 2014-2021.

Brazil and China have still low progress in the development of cross sectoral bioeconomy strategies, access to finance is difficult and respectively Public Private Partnerships and funds for flagship projects are lacking behind. Similarly communication and interactions with public are low.

²³ BBI (2016). Biobased Industries Initiative. <http://www.bbi-europe.eu/>

²⁴ <http://biconsortium.eu/sites/biconsortium.eu/>

Cooperation among European countries

The level of development in the field of policy making for bioeconomy among European countries is highly variant with Belgium, Denmark, Finland, Germany, Italy, the Netherlands, Spain, Sweden and the UK paving the way with national and or regional bioeconomy strategies and financing measures including the use of structural funds (ESIF²⁵).

²⁵ http://ec.europa.eu/regional_policy/en/funding/

Current activities

The following table shows the level of activity in the understudy fields categorised as high (green highlight), emerging (amber highlight) and low (grey highlight).

Table 4 Current activities in policy formation for biobased economy in European countries

	Bioeconomy strategies (N-national or R-regional)	Financing mechanisms (European Structural & Investment Funds- ESIF)	Involvement of industry	Research funds	Communication with public
AL					
AU					
BA					
BE	Regional: Flanders				
BG					
CY					
CZ					
DE	National				
DK	Regional: Central Denmark				
EE					
ES	Regional: Castilla-León Navarra	ESIFs in: Asturias, Extremadura Navarra			
FI	National Regional: Oulu, South Ostrobothnia; Central Finland, North Karelia, Kainuu, Satakunta	ESIFs in all			
FR	National	ESIFs in: Lower Normandy			
GR					
HR					
HU					
I	Regional: Lombardy, Basilicata	ESIFs			
IE	National				
KS					
LV					
LT					
LUX					
MD					
ME					
MLT					
NL	Regional: Gelderland	ESIFs			
PL		ESIFs in Lodzkie			
PT					
RO					
RS					
SK					
SI					
S	Regional: North Sweden, Östergötland (East Sweden), Varmland	ESIFs			
UK	Regional: Scotland, Wales	ESIFs			

Germany

National Bio-economy Research Strategy 2030

In 2010, The German Federal Ministry for Education and Research published the “National Research Strategy BioEconomy 2030: Our Route towards a biobased economy²⁶”. The central objective is the optimal utilisation of the chances created by the knowledge-based bioeconomy, and to translate these into enduring economic growth. The research strategy lays out five priority fields of action for further development towards a knowledge-based, internationally competitive bioeconomy: global food security, sustainable agricultural production, healthy and safe foods, the industrial application of renewable resources, and the development of biomass-based energy carriers. The National Research Strategy BioEconomy 2030 identifies the measures that are required for each of these fields, and defines priority areas for the coming years, and adaptations to current developments, in the sense of a learning programme.

The Bio-economy Research and Technology Council (BioÖkonomieRat²⁷), was funded jointly by the German Ministry of Education and Research and the Ministry of Food, Agriculture and Consumer Protection, and is an independent advisory body to the German government for all matters relating to bio-economy. The Council is made up of experts from university and non-university research institutes, the federal government’s own departmental research, and from research in the private sector. The first work phase (2009-2012) has been completed. The tasks were

- to provide a thorough overview of the area of bioeconomy, and the opportunities and prospects from a scientific and economic perspective of research in the area of the bioeconomy. In 2010, the Council published its analytical “Bio-economy Innovation Report²⁸”, placing emphasis on increasing biomass yield volumes and more efficient production processes in the food and energy sectors.
- to develop scientifically-founded recommendations for strategic measures to improve the environment for innovative research, technological development, and the introduction of products to the market. The report “Combine disciplines, improve parameters, seek out international partnership²⁹” suggested for a restructuring of research funding and recommended incentive systems for private investment. In its report “Priorities in Bio-economic Research³⁰”, the BioEconomy Council defined the priorities with regard to relevance and urgency of the research topics identified in its report “Bio-

²⁶ http://www.bmbf.de/pub/bioeconomy_2030.pdf

²⁷ <http://www.biooekonomierat.de>

²⁸ <http://www.biooekonomierat.de/reports.html?file=files/downloads/092010/bio-economy-innovation-report-2010.pdf>

²⁹ http://www.biooekonomierat.de/files/downloads/presse/BOER-Empfehlungen2009_en.pdf

³⁰ http://www.biooekonomierat.de/files/downloads/Publikationen/BOER_Recommendations_No%202.pdf

economy Innovation” and made recommendations with regard to time scales and financial backing.

The implementation of the national Research Strategy BioEconomy 2030 is a shared responsibility by BMBF/BMELV (public funding of projects); HGF, WGL, FhG, MPG (institutional contributions); industry; the Federal states; and the European and International cooperations. The total funding is 2.4 billion EUR (1.4457.6 Mio EUR project funding and 976.6 Mio EUR institutional funding).

The Netherlands

Vision of the Dutch Cabinet

In the Netherlands, the Cabinet of Economic Affairs, Agriculture and Innovation has decided that the biobased economy is one of the strong emerging economic pillars to be supported. The High Level Group Bio-based Economy and the Bio-renewable Resources Platform, both Dutch public-private frameworks of cooperation in the field of the bio-based economy, were asked to give input for a future strategy. In addition, in September 2011, 43 stakeholders (business and NGOs) signed the Manifest Biobased Economy³¹, supporting the development of a sustainable biobased economy.

So the development of the national strategy was the result of an on-going interaction between business, society, and science, stimulated by policy makers.

In April 2012, the Cabinet presented its “Hoofdlijnennotitie Biobased Economy”³², a mid- and long term vision and strategy for the biobased economy, as an answer on independent advices of the “Sociaal-Economische Raad” (SER) and the “Commissie Duurzaamheidsvraagstukken Biomassa” (CDB). In parallel, an “innovation contract for the biobased economy” was worked out in collaboration with the industry and the research organisations.

The main headlines of the strategy are:

- **Sustainable use of biomass:** sustainable production of biomass and yield increase; development of better technologies (e.g. biorefining); development of the cascading principle to use the biomass; optimal use of side-streams.
- **Integrated policy:** bringing stakeholders (industry, science and policy) together in order to stimulate interaction between value chains and co-production of products, and to use in a more efficient way side streams; removing obstacles; development of a coherent policy.

³¹ http://www.iucn.nl/actueel/iucn_nl/manifest_biobased_economy_ondertekend/

³² <http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2012/04/02/hoofdlijnennotitie-biobased-economy.html>

- **Knowledge and innovation:** focus on technological research (e.g. availability and use of biomass and side streams) as well as on solving social, environmental and economic problems; stimulating collaboration between, universities; improve participation to European Programmes; improve valorisation; develop innovation contract with all stakeholders (see 3.2.2)
- **Clear and transparent sustainability criteria:** support development of European sustainability criteria for biofuels; broaden sustainability criteria to other uses of biomass (via Commissie Duurzaamheidsvraagstukken Biomassa)
- **Intensive European and international collaboration:** stimulate companies and research organisations to participate to European Programmes (e.g. Horizon 2020); as a Member State, politically influence European policies (e.g. resource efficiency, climate change, energy and transport, industrial policy, agricultural policy, regional development); removing obstacles at EU level (e.g. trade); closer collaboration with third countries (e.g. Brazil, USA, Canada, Malaysia, Ukraine, Russia); removing trade barriers at international level; organisation of economic missions (e.g. Germany, USA)

Innovation Contract Biobased Economy

The innovation contract biobased economy “Groene Groei – van biomassa naar business”³³ is an joined agenda developed by the industry and the research organisations. It contains 6 working packages, each covering the entire innovation chain (from more basic research until valorisation). The working packages are:

- Biobased materials
- Bio-energy and bio-chemicals
- Integrated biorefinery
- Cultivation optimisation and biomass production
- Recycling and re-use: water, nutrients and soil
- Economy, policy and sustainability

In total more than 100 companies will participate to the projects, and have committed more than 200 million EUR.

³³ http://www.top-sectoren.nl/chemie/sites/default/files/documents/Innovatiecontract%20BBE_0.pdf

Public-private partnership: BE-BASIC

BE-Basic³⁴ (Bio-based Ecologically Balanced Sustainable Industrial Chemistry) is a public-private partnership that develops industrial bio-based solutions for a sustainable society. BE-Basic is coordinated by Delft University of Technology and has an R&D budget of more than 120 million euros. Half of this is funded by the Ministry of Economic Affairs, Agriculture and Innovation. BE-Basic was founded early 2010.

BE-Basic is a consortium of large industries, small and medium enterprises (SME's), knowledge institutes and academia. The following partners participate within the BE-Basic consortium:

- Industrial partners: Amyris, AkzoNobel, Bioclear, BioDetection Systems, Bird Engineering, BLGG AgroXpertus, DSM, Essent New Energy, Microdish, Microlife Solutions , Purac, Synthon, Waste2Chemical
- Institutes: Deltares, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen UR, Food & Biobased Research
- Academic partners: Delft University of Technology, Imperial College London, Karlsruhe Institute of Technology, Maastricht University, Radboud University Nijmegen, Technische Universität Dortmund, University of Amsterdam, University of Groningen, University of Twente, MESA+ Institute for Nanotechnology, Utrecht University, VU University Amsterdam, Wageningen University

The strong international focus of BE-Basic is reflected by the membership of the consortium of several leading institutions in the EU. Moreover BE-Basic puts its international focus into practice through strategic partnerships in a selected number of countries: Brazil, Malaysia, the U.S.A. and Vietnam.

BE-BASIC is constructing a Bioprocess Pilot Facility. Located in Delft, the facility will be a center of expertise and technology open to researchers and students from all over the world. The Bioprocess Pilot Facility is funded by universities, companies, the European Union, the Dutch Ministries of Agriculture, Nature & Food Quality and Economic Affairs, the Province of South Holland and the Municipalities of Rotterdam, Delft and The Hague. The facility has a modular setup. Users themselves select the process to be investigated from the available modules, ranging from various methods of biomass pretreatment, fermentation, recycling and purification to third-generation bioprocesses. In the Bioprocess Pilot Facility companies and knowledge institutions can develop novel, sustainable and environmentally friendly production processes based on biomass. Another important aspect of the facility is to provide training and education.

³⁴ <http://www.be-basic.org/>

Sweden

In Sweden, Vinnova (The Swedish Governmental Agency for Innovation Systems) in June 2008 granted SEK 13 million (around 1.2 million Euro) to a project called “The biorefinery of the future” .

In September 2011 the Swedish Government commissioned Formas, in consultation with VINNOVA and the Swedish Energy Agency, to prepare a national strategy for the generation of a bio-based economy and sustainable development. A dedicated steering group was established to manage the project, and contacts have been made and discussions held with a large number of stakeholders connected with bioeconomy efforts, both in Sweden and abroad. This resulted in a “Swedish Research and Innovation Strategy for a Bio-based Economy³⁵”, which was adopted in February 2012.

Following research and development needs were defined:

- ***The replacement of fossil-based raw materials with biobased raw materials.*** Some examples of this are: intensified production of bio-based raw materials, nutrient and fertilizer optimization systems, crop and animal breeding, cultivation system such as multifunctional farming and forestry systems, adaptation of seeds, crops and production systems to cope with climate change, new and improved biomass properties, use of ecosystems other than fields and forests for biomass production, for example marine ecosystems or urban environments.
- ***Smarter products and smarter use of raw materials.*** Some examples of this are: further refinement of biomass products, bi-products and waste products become raw materials, new products, biorefineries.
- ***Change in consumption habits and attitudes.*** Some examples of this are: increased product lifetimes, increased recycling, more efficient transport, distribution and storage, new services, consumer behaviour.
- ***Prioritisation and choice of measures.*** Some examples of this are: Environmental consequences, socio-economic consequences, conflict of objectives, governing policies.

In addition, research and development will be complemented by innovation-fostering initiatives and measures that specifically address bioeconomy challenges. The nature and extent of these challenges necessitates widespread collaboration among actors and that sectors work together to be able to deal with the complex issues and demands for solutions that the challenges give rise to. This includes:

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http://www.formas.se/upload/EPiStorePDF/Swedish%20Research%20and%20Innovation%20Strategy%20for%20a%20Bio-based%20Economy_R3_2012/Strategy_Biobased_Economy_hela.pdf

- **Stimulating cross-industry collaboration in research and development** in order to develop and implement solutions that contribute to a growing bio-based economy. Universities and research institutes play a central role in forging links in such collaborations, but public actors and civilian society also has important roles.
- **Stimulating the growth of strong research and innovation environments** that contribute with relevant knowledge and create preconditions for innovation within the area. These strong environments gather together Swedish competence and actors and augment the innovative capabilities of regions and organisations.
- **Accelerating development, verification and commercialization of new bio-based solutions** and provide continued support for the demonstration of products, systems and services other than fuels and energy technology solutions.
- **Offering support to small and medium-sized enterprises** for the commercialisation of new technologies. This particularly applies to collaborations between these and larger companies in order to accelerate development and innovation.

Denmark

Denmark has implemented a national bioeconomy strategy, via the 2009 agreement on Green Growth³⁶. The purpose of the Agreement is to ensure that a high level of environmental, nature and climate protection goes hand in hand with modern and competitive agriculture and food industries. A total of 1.8 billion EUR funding until 2015 is foreseen, which is a 50% increase compared to previous initiatives.

Finland

The vision of the first Finnish Bioeconomy Strategy is that Finnish well-being and competitiveness will be based on sustainable bioeconomy solutions. The objective of the Bioeconomy Strategy is to push the bioeconomy output up to €100 billion by 2025 and to create 100,000 new jobs. In Finland current turnover of bioeconomy is €60 billion and employed by 300,000 people³⁷. Finland's long-term objective is to be a carbon-neutral society. This challenge is particularly great in the energy sector. Approximately 80% of all greenhouse gas emissions in Finland come from energy production and consumption, when energy used for transport is included.

In 2011, SITRA (the Finnish Innovation Fund) prepared a report "Sustainable Bioeconomy: Potential, Challenges and Opportunities in Finland"³⁸. The study claims

³⁶ http://www.mim.dk/NR/rdonlyres/54887891-D450-4CD7-B823-CD5B12C6867A/0/DanishAgreementonGreenGrowth_300909.pdf

³⁷ Sustainable growth from bioeconomy – The Finnish Bioeconomy strategy, <http://www.biotalous.fi/?lang=en>

³⁸ <http://www.sitra.fi/julkaisut/Selvityksi%C3%A4-sarja/Selvityksi%C3%A4%2051.pdf>

that the market for small-scale solutions is large, which provides a basis for mass-production of bio-economic solutions. The side benefits can be identified and measured. A fully integrated solution creates a hybrid where different systems complement each other, thereby increasing the profitability of the investment. In addition, a system consisting of many small production plants is highly reliable. Functional modularisation provides economies of scale and adaptability which can be turned into a business-driven offering. Last but not least, the capability to develop, design, deliver and operate bioeconomic solutions can be exported.

Also in Finland, the BioRefine 2007-2012 programme of Tekes has allocated 137 million Euro to the development of innovative technologies, products and services related to biorefineries and the processing of biomass in general for the international market.

Ireland

Already in 2008, Ireland published its Foresight Report “Towards 2030 – Teagasc’s Role in Transforming Ireland’s Agri-Food Sector and the Wider Bioeconomy³⁹”. The four pillars are:

1. Food production and processing
2. Value-added food processing
3. Agri-environmental products and services
4. Energy and bio-processing.

Although there is no specific Irish bio-economy strategy yet, some aspects have been defined through two documents issued by the Irish Government: “Building Ireland’s Smart Economy- A Framework for Sustainable Economic Renew⁴⁰” (2008) and “Developing the Green Economy in Ireland⁴¹” (2009).

The Smart Economy is a ‘Green Economy’ in that it recognises the inter-related challenges of climate change and energy security. It involves the transition to a low-carbon economy and recognises the opportunities for investment and jobs in clean industry. The core of the “Green New Deal” is a move away from fossil-fuel based energy production through investment in renewable energy and increased energy efficiency to reduce demand, wastage and costs. The five Action Areas of the Framework are:

1. Meeting the Short-term Challenge – Securing the Enterprise Economy and Restoring Competitiveness;

³⁹ <http://www.teagasc.ie/publications/2008/20080609/ForesightReportVol1.pdf>

⁴⁰ http://www.taoiseach.gov.ie/eng/Building_Ireland's_Smart_Economy/Building_Ireland's_Smart_Economy_-_Executive_Summary.pdf

⁴¹ http://www.forfas.ie/media/dete091202_green_economy.pdf

2. Building the Ideas Economy – Creating ‘The Innovation Island’;
3. Enhancing the Environment and Securing Energy Supplies;
4. Investing in Critical Infrastructure;
5. Providing Efficient and Effective Public Services and Smart Regulation

The key actions of the “Green Economy” strategy are:

1. Promote Green Sectors That Drive Exports And Job Creation (e.g. renewable energy, energy efficiency and management, waste management, water/wastewater)
2. Deliver Green Zones and a Green international financial services sector (IFSC)
3. Create World-Class Research Centres and Human Capital
4. Remove Hurdles to the Development of the Green Economy (e.g. technical, regulatory and planning barriers to the development of renewable energy projects; implementing green public procurement in Ireland; ensuring that green firms can access finance and developing Ireland’s brand).

France

National initiative

In France the R&D expenditures were increased with the Programme “Investments for the Future⁴²” with an growing role for the bioeconomy. Within this national programme, around 1,5 billion Euros are dedicated to the bioeconomy for a 10-year period:

- €1 billion in the area of “Decarbonated Energy” with as main projects GreenStar for algae, PIVERT for biorefinery and oleochemistry and IFMAS for sustainable chemistry
- 0.5 billion euro were allocated to 40 R&D projects, industrial demonstrators and dedicated equipments for biotechnologies, bioresources and bioprocessings.

Regional clusters

In 2005, the French General Directorate for Competitiveness, Industry and Services (DGCIS) has created the so-called Competitiveness Clusters⁴³, an initiative that

⁴² <http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=24707>

⁴³ <http://competitivite.gouv.fr/>

brings together companies, research centers and educational institutions in order to develop synergies and cooperative efforts.

The objectives of the Competitiveness clusters is to strengthen the competitiveness of the French economy and to develop both growth and jobs in key markets through increased innovation, by encouraging high-value-added technological and creative activities at a regional level, and by attracting businesses to France thanks to a higher international profile.

Within these competitive clusters, the French Government is particularly interested in promoting an overall environment favourable to enterprise and innovation, and in supporting R&D efforts, and accompanies cluster development in the following ways:

- By allocating financial support for the best R&D and innovation platform initiatives via calls for projects
- Partial financing for cluster governance structures, alongside local authorities and companies
- Financial support for theme-based collective actions initiated by clusters in a wide range of areas, via the various Regional Directorates for Industry, Research and the Environment (DRIRE)
- By carrying out and publishing studies
- By involving various partners, such as the Caisse des Dépôts, or the French National Research Agency (ANR) and OSEO both of which finance R&D projects led by cluster stakeholders
- By bringing new means from public research centres.

Following the positive assessment of the first phase of the cluster policy, the French Government has decided to allocate €1.5bn to the launch of a second phase (2009–2012).

One of the clusters is the “Industries and Agro-Resources” Cluster or IAR⁴⁴. This cluster unites stakeholders from research, higher education, industry & agriculture in the Champagne-Ardenne and Picardy regions of France around a shared goal: the value-added non-food exploitation of plant biomass. In order to achieve this ambitious objective, the IAR cluster has defined 4 strategic fields of activity around the biorefinery concept: bioenergy, biomaterials, biomolecules, and green ingredients. The IAR cluster's end goal and strategy involve bringing together skills and technologies for the extraction, transformation and formulation of biomass components, enabling the performance of all the steps - from the laboratory to industrial development - of innovative, sustainable development projects:

- by intensifying collaboration between the two regions - matching supply and demand in the industrial, research and agricultural sectors and funding the resulting projects.

⁴⁴ <http://www.iar-pole.com/>

- by integrating external know-how and opening out to other regions in France or abroad as part of a collaborative strategy.
- by developing a specialized economic intelligence platform focused on opportunities for substituting fossil carbon and creating new functionalities.
- by adapting and mobilizing the plant-based resources required for specific industrial uses.

The IAR cluster is also organizing international trade missions and hosts foreign delegations in order to forge technological and industrial collaborations in the field of plant biomass exploitation. A large number of international-scale R&D projects have already been launched covering the four target markets. A special relationship has been build up with several international clusters in Canada, Finland, Hungary and elsewhere.

UK

Strategy for UK life sciences

On 5 December 2011, the Prime Minister launched the Government's Strategy for UK life sciences⁴⁵ to help life sciences businesses grow and succeed. The strategy focuses mainly on the health-related aspects of the sector. It is a long-term strategy, looking forward 10 to 15 years, building on the March 2011 Plan for growth.

Industrial biotechnology and the bioeconomy

The Technology Strategy Board⁴⁶ has created an Industrial Biotechnology Special Interest Group (IB-SIG) to operate across its networks to implement the recommendations of the 2009 Industrial Biotechnology Innovation and Growth Team (IB IGT)⁴⁷. The Industrial Biotechnology Special Interest Group (IB-SIG) activities are managed by the Biosciences and Chemistry Innovation Knowledge Transfer Networks⁴⁸, funded by the Department for Business Innovation and Skills via the Technology Strategy Board.

To ensure that biotechnology companies, especially SMEs and start-ups, can overcome market barriers related to the restrictive cost associated with capital

⁴⁵ <http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences.pdf>

⁴⁶ <http://www.innovateuk.org/>

⁴⁷ IB 2025 - Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy (2009) https://connect.innovateuk.org/c/document_library/get_file?p_l_id=79343&folderId=169208&name=DLFE-1715.pdf

⁴⁸ <http://www.innovationuk.org/informations/special-area/0004-the-knowledge-transfer-networks.html>

assets needed to test new biotechnologies, a new BIS co-funded 10,000 litre IB Demonstrator facility has been set up. This pilot plant can provide expertise and equipment for companies to demonstrate the feasibility of up-scaling their production and processes to commercial levels.

Also in the UK, the “Integrated Biorefining Research and Technology Club (IBTI Club)⁴⁹” was launched in 2009. This group consists of a research and technology partnership involving the Biotechnology and Biological Sciences Research Council, the Engineering and Physical Sciences Research Council, industry and the Bioscience for Business Knowledge Transfer Network (KTN). The club will interface with the KTN's wider Integrated Biorefinery Technologies Initiative (IBTI) and is investing around £6 million in industrially relevant, innovative, basic biological, chemical and engineering research in biorefining technologies.

Italy

Since the launch of the EU Bioeconomy Strategy, the Minister of Economic Development has set up a working group on green chemistry with the aim of starting at a national level the elaboration of a possible national strategies. In May 2012 the Minister of Innovation launched a call for implementing clusters focused on top innovative sectors for the country and one of them is green chemistry.

⁴⁹ <http://www.bbsrc.ac.uk/business/collaborative-research/industry-clubs/ibti/ibti-index.aspx>

Challenges & Opportunities

Table 5 below provides an overview of the challenges and opportunities for the development of bioeconomy in European countries.

Table 5 Challenges and opportunities for the development of bioeconomy in European countries

	Challenges	Opportunities
Bioeconomy strategies	Planning: There is a variety of regulations and funding mechanisms- but it is fragmented and difficult to access and understand within regions	Develop regional roadmaps with realistic short, medium and longer term objectives – including quantified targets – for increased use of lignocellulosic biomass.
	Mobilise indigenous feedstock supply	Promote the availability of feedstock-related information. Investigate routes for using multi-feedstock processing capability
	Cross border collaboration	Evaluate synergies and create joint partnerships
Financing mechanisms	Improve regional attractiveness for investments	Work with regional authorities to improve the investing environment in terms of simplified procedures, outreach to industry, etc. More cooperation between regions and the industrial sectors but also among industries themselves (fear of competitors)
	Mobilise capital and infrastructures	Regions with low development can initiate the bio-based economy with pilot and demonstration facilities while regions with higher development will benefit from improved innovation for existing value chains.
	Limited financial support for new production facilities	Increase awareness about grants and funding opportunities Facilitate integration of public grants across regional and national administration levels Consider the establishment of BioEconomy Strategic Investment Funds
Involvement of industrial actors	Networking different sectors to form regional bioeconomy societies with producing different biobased products and bioenergy for local use.	By forming bioeconomy societies (like Åänekoski) resource-efficiency is taken better into account, also energy by RES will increase and waste is reused or recycled better.
Research funds	Lack of long term research programmes for bioeconomy	Bigger R&D&D projects to be established.
	Lack of skilled workforce	Leverage education value from innovation projects
Communication and interaction with public	Improve clarity: Messages for bio-based economy should be clear and simple, yet factual and scientifically solid	Ensure that producers can make informed decisions on the use of their residues/wastes. Enhance also education to serve bioeconomy sector.

A dedicated discussion on potential suggestions for future collaboration has also taken place during a workshop that took place on September 2016 and was organised by Directorate General for Research & Innovation in collaboration with Directorate-General for Regional and Urban Policy.

The three following discussion points have been considered and participants provided input regarding to opportunities, challenges and R&D needs for collaboration in the field of biobased economy among countries. The tables below present the main conclusions from the discussions among the participants.

1. How do you see the possibility of enhancing the potential of local non-food biomass in order to stimulate development of complete biomass value chains from biomass to end-use (innovative) bioproducts?

Challenges	Opportunities	R&D needs
Lack of appropriate knowledge for indigenous biomass in terms of availability and suitability for non-food bio-based products. Difficulty to understand the terminology used in the legislative documents by farmers and other stakeholders, including on policy maker level (policy coherence). Increase awareness and inform consumers and policy makers on the concrete and evidence-based benefits.	Large biomass resource base that can create value for regions and local communities	Capacity building and tools for understanding and assessing local potentials for bio-based value chains
		Improve research infrastructure with equipment and necessary methodologies for feedstock valorisation
		Improve industrial participation to H2020 funding for demos and flagships
Not well managed forests	Develop well managed, sustainable forest services that will in return stimulate the markets for biobased products	Best forest practices (paying attention to sustainability issues and biodiversity protection)
		Capacity building accounting for private forest owners as well
Very low development of appropriate infrastructure for biomass logistics	The required cost reductions across the supply chains can facilitate business developments in the feedstock supply and logistics	Logistics & infrastructure – sharing best practices
		Capacity building in agricultural, forest and bio-waste industries
		Develop co-existing industrial logistics for food, feed and non-food bio-based products
Lack of knowledge at regional level of the multiple benefits of biomass uses and bio-based economy in general	Bring together stakeholders into biocluster formations	Regional cluster formation
		Capacity building synergies and trust with information exchange for best practices among all actors, farmers included. Increase international cooperation for exchange of best practices and for trust building measures.

2. How do you see the way forward for the regional bioeconomy development and cooperation in your region (financial tools, local/regional strategies, etc.)?

Challenges	Opportunities	R&D needs
Mobilise capital and infrastructures	Regions with low development can initiate the bio-based economy with pilot and demonstration facilities while regions with higher development will benefit from improved innovation for existing value chains.	Pilot & demonstration activities
		Improve innovation in existing industrial activities and bio-based value chains
		Improved financing tools for regions (including with ESIF/H2020)
Cross border collaboration	Evaluate synergies and create joint partnerships	Map bio-based economy at regional level, including of biomass resources, especially non-food
		Facilitate and promote cross border collaborations among regions and countries.
Consistency and firmness in policy formation Continuous changes in policies risk to increase the administrative burden and delay the adoption of regulations	Cross sectoral coherence in policy: this includes not only the biomass provision sectors (i.e. agriculture, forestry, marine, wastes) but also the ones using the same ecosystem services, like tourism, etc., where conflicts and synergies arise	Strategy formation (including skills) for local and regional bioeconomies
		Develop policy frameworks, which will integrate the appropriate elements from all relevant sectors. Create public procurement to speed up and implement the development of bio-based products.

3. What should be done in the future in EU funded programs (Horizon 2020 and BBI calls) to make it happen? Any gaps?

Challenges	Opportunities	R&D needs
Planning: There is a variety of regulations and funding mechanisms- but it is fragmented and difficult to access and understand within regions	Organise events at regions	Business coaching /Advisory system
		Workshops, B2B, etc. tailored to regional capacities and needs Research topics for plants: this will require involving applied research side to use the research output for the farmers (i.e. 'multi-actor approach').
Regional attractiveness for investments: industrial actors miss information on how investments operate in certain regions of CEE. Difficulty to get funds for pilot infrastructure Sustainability criteria: how to interpret them in different sectors?	Work with regional authorities to improve the investing environment in terms of simplified procedures, outreach to industry, etc. More cooperation between regions and the industrial sectors but also among industries themselves (fear of competitors)	Regional investment guides for industry, including for sustainability criteria and their implementation
		Best practices for simplified procedures to invest in bio-based economies.
Clarity: Messages for bio-based economy should be clear and simple, yet factual and scientifically solid	Communicate the benefits of bio-based economy to the public (including schools, universities etc), farmers, foresters and local industries	Public awareness
		Trainings and information campaigns

Suggestions for collaboration

Table 9 below ranks the compared regions for their performance in the policy areas mentioned above. The ones with low ranking can benefit from the ones with high in the respective fields.

Table 6 Suggestions for future collaboration in the non- food bio-based economy in European countries

	Knowledge providing countries with good practices	Countries with emerging interest	Countries with low activity in the field
Bioeconomy strategies	BE, DE, DK, ES, FI, FR, I, NL, S, UK	AU, CZ, GR, HR, HU, PL, PT, RS, SK, SI	AL BA, BG, CY, EE, KS, LV, LT, LUX, MD, ME, MLT, RO
Financing mechanisms	AU, DE, ES, FI, FR, I, NL, PL, S, UK	BE, DK, IE, SK, SI	AL BA, BG, CZ, CY, EE, GR, HR, HU, KS, LV, LT, LUX, MD, ME, MLT, RO, RS
Involvement of industrial actors	AU, DE, ES, FI, FR, NL, S, UK	BE, DK, I, IE, PL	AL BA, BG, CZ, CY, EE, GR, HR, HU, KS, LV, LT, LUX, MD, ME, MLT, RO, RS, SK, SI
Research funds	DE, NL, S, FI, UK	BE, DK, ES, FI, FR, I, IE, PL	AL BA, BG, CZ, CY, EE, GR, HR, HU, KS, LV, LT, LUX, MD, ME, MLT, RO, RS, SK, SI
Communication and interaction with public	DE, NL, S, FI, UK	BE, DK, ES, FI, FR, I, IE, PL, S	AL BA, BG, CZ, CY, EE, GR, HR, HU, KS, LV, LT, LUX, MD, ME, MLT, RO, RS, SK, SI

Germany, Finland, the Netherlands, Sweden and UK rank on the top list of countries, which can act as knowledge providers based on good practice in terms of:

- developing bioeconomy strategies,
- formulating and implementing financing mechanisms,
- involving industrial actors,
- having tailored research funds, and
- communicating with the public.

France and Spain can provide knowledge on the first three of the above issues while Austria has strong activity and experience in financing mechanisms and involving industrial actors. Belgium is also active in the formation of bioeconomy strategies at regional level and can provide guidance to other countries on such issues.

Conclusions

Based on the analysis of the current state, challenges and opportunities across countries and regions analysed the following concluding remarks can be made for synergies and future collaborations:

A. Bioeconomy strategy formation can use as guiding principles the aims of the existing SET Plan⁵⁰ and the Biobased Industries Joint Undertaking strategy for widening participations:

- Address the whole innovation chain, from research to market uptake and tackles both financing and the regulatory framework;
- Support inclusive growth for development of the European Bioeconomy;
- Mobilise the full biomass potential;
- Open new investment opportunities in the EU bioenergy and bio-based industrial sectors.

B. Financial mechanisms should be tailored to regional and national capacities by:

- Understanding the types of indigenous, lignocellulosic biomass potentials;
- Appreciating the cost supply for resources;
- Matching quality characteristics to indigenous biomass, and
- Getting evidence for markets and policy.

C. Involvement of industrial actors

- Improve conditions for “Access to finance” in Europe;
- Introduce financial incentives for biobased products.

D. Research funds

- Invest in infrastructure at pilot and demonstration scale to bring innovative ideas to market;
- Increasing R&D funding, national and regional level is necessary to pioneer public research in collaboration with the industrial sector in a co-funding scheme.

E. Communication and interaction with public

Advantages of bioenergy and bio-based products are not always visible enough to the wider public. To increase awareness and avoid misconceptions more elaborate forms of communications are required.

⁵⁰ <https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan>