Bio Base NWE analysis report on the bottlenecks SMEs encounter in the bio-economy

Study to support interregional partnerships and collaboration in the field of the biobased economy

Bio Base NWE
Innovation and training for the biobased economy

Investing in Opportunities
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Study prepared by :

Clever Consult BVBA (Belgium)
www.cleverconsult.eu

Partners:

Ghent Bio-economy Valley (B)
CLIB2021 (D)
Bio Base Europa Pilot Plant (B)
NNFCC (UK)
Bio Base Europe Training Centre (NL)
Technology Center for Biorefining and Bioenergy (IE)
REWIN West-Brabant (NL)

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CONTENT

1. INTRODUCTION

The objective of this study is to support the different regions involved in the Bio Base NWE project (Flanders, Germany, Ireland, The Netherlands, UK) to develop their own roadmap and action plan in order to stimulate and facilitate collaboration, to find complementarities and synergies, to streamline cross-regional funding channels, to create cross-regional value chains, and to improve access to finance and pilot plants. This study has put the focus on existing strategies and funding programmers, and selected best practices where possible.

The report is divided in several chapters. The European Union as well as several Member States have developed already a Strategy and Action Plan for the bio-economy. In chapter 2 these different Actions Plans were analysed and compared. This should facilitate possible common actions between Member States and Regions.

In chapter 3, following a specific survey involving SMEs active in the biobased economy, the main hurdles and bottlenecks were identified. These were compared to the hurdles identified by larger companies (results from the Bio-TIC project).

In a forth chapter, the national and regional biobased related funding programmes of the different regions and Member States were analysed. The different funding schemes, the scope, the characteristics and criteria, and the focus of each funding programme were analaysed in more detail. This should help to identify possible common funding opportunities between different regions and Member States.

An overview of the most important clusters and major pilot and demonstration plants in North-West Europe is given in respectively chapter 5 and 6.

In chapter 7 a SWOT analysis was developed for this study, based on input from the different partners. The results from this SWOT analysis, together with the information from the previous chapters, were used to draft a series of best practices and recommendations in order to facilitate and stimulate interregional collaboration.

Finally, chapter 8 describes the other main hurdles identified by the SMEs, together with a few recommendations on how to overcome these barriers.

In a next step, each Region or Member State will analyse which concrete actions could be taken.

2. BIO-ECONOMY STRATEGIES AND INITIATIVES IN EUROPE

2.1. European Union

2.1.1. Introduction to the European Bio-economy Strategy

In February 2012, the European Commission has adopted a strategy and action plan entitled "Innovating for Sustainable Growth: a Bio-economy for Europe[1]" to shift the European economy towards greater and more sustainable use of renewable resources. This bio-economy strategy is part of the Europe 2020[2] flagship initiatives "Innovation Union[3]" and "A Resource Efficient Europe[4]". The goal is a more innovative and low-emissions economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection.

The strategy and action plan outlines a coherent, cross-sectorial and inter-disciplinary approach to the issue with three key pillars, with as main actions:

- **Investment in research, innovation and skills for the bio-economy:**
  - Ensure substantial EU and national funding as well as private investment and partnering for bio-economy research and innovation. Support bioclusters for partnering with the private sector.
  - Increase the share of multi-disciplinary and cross-sectoral research and innovation in order to address the complexity and inter-connectedness of societal challenges by improving the existing knowledge-base and developing new technologies.
  - Promote the uptake and diffusion of innovation in bio-economy sectors and create further feedback mechanisms on regulations and policy measures where necessary.
  - Build the human capacity required to support the growth and further integration of bio-economy sectors by organizing university fora for the development of new bio-economy curricula and vocational training schemes.

- **Development of markets and competitiveness in bio-economy sectors:**
  - Create a Bio-economy Panel[5] that will contribute to enhancing synergies and coherence between policies, initiatives and economic sectors related to the bio-economy at EU level, and encourage the creation of similar panels at Member State and regional level.
  - Establish a Bio-economy Observatory[6] in close collaboration with existing information systems that allows the Commission to regularly assess the progress and impact of the bio-economy and develop forward-looking and modeling tools.
  - Support the development of regional and national bio-economy strategies by providing a mapping of existing research and innovation activities, competence centers and infrastructures.

1 http://ec.europa.eu/research/bio-economy/press/press_packages/index_en.htm

2 http://ec.europa.eu/europe2020/index_en.htm

3 http://ec.europa.eu/research/innovation-union/index_en.cfm

4 http://ec.europa.eu/resource-efficient-europe/

5 http://ec.europa.eu/research/bioeconomy/policy/panel_en.htm

6 https://biobs.jrc.ec.europa.eu/

- Develop international cooperation on bio-economy research and innovation to jointly address global challenges, such as food security and climate change, as well as the issue of sustainable biomass supply.

- **Reinforced policy coordination and stakeholder engagement:**
  - Provide the knowledge-base for sustainable intensification of primary production. Improve the understanding of current, potential and future availability and demand of biomass (including agricultural and forestry residues and waste) across sectors. Support the future development of an agreed methodology for the calculation of environmental footprints, e.g. using life cycle assessments (LCAs).
  - Promote the setting up of networks with the required logistics for integrated and diversified biorefineries, demonstration and pilot plants across Europe, including the necessary logistics and supply chains for a cascading use of biomass and waste streams.
  - Support the expansion of new markets by developing standards and standardized sustainability assessment methodologies for biobased products and food production systems and supporting scale-up activities. Facilitate green procurement for biobased products by developing labels, an initial European product information list and specific trainings for public procurers. Contribute to the long-term competitiveness of bio-economy sectors by putting in place incentives and mutual learning mechanisms for improved resource efficiency.
  - Develop science-based approaches to inform consumers about product properties and to promote a healthy and sustainable lifestyle.

2.1.2. Major "biobased economy" related actions in the EU strategy

- **Investment in research, innovation and skills**
  - Increase EU public funding for research and innovation on bio-economy. Strengthen coherence and synergies between EU and national/regional programmes.
  - Provide scientific advice for informed policy decisions on benefits of bio-economy solutions.
  - Support knowledge acquisition and technology exchange, advisory and support services, cooperation and training opportunities among all actors of the supply chain and end-users, for example new businesses in the biobased product.
  - Promote the uptake and diffusion of innovation in bio-economy sectors.
  - Stimulate the development of bio-economy skills in higher education.

- **Reinforced policy interaction and stakeholder engagement**
  - Engage with civil society and promote informed public debates on bio-economy issues, research and innovation activities and societal implications, through stakeholders discussion platforms involving scientists, entrepreneurs, policy makers and civil society at large.
  - Improve availability and quality of information on bio-economy products and processes, and on their socio, economic and environmental impacts, to facilitate informed societal choices.
  - Review regularly the progress and delivery of EU and national/regional bio-economy strategies.
  - Produce regular foresights and forecasts and updates of ex-ante impacts assessments for the bio-economy, contributing to policies' orientations as well as research and innovation directions.
  - Contribute to the mapping of EU, national and regional bio-economy policies, research and innovation capacities, activities and infrastructures, as well as public and private investments in research and innovation.

- Support the development of regional and national bio-economy strategies.
- Promote international cooperation and synergies among R&I programmes related to the bio-economy in the EU, Member States and strategic third countries.

- **Enhancement of markets and competitiveness in bio-economy sectors**
  - Develop tools to aggregate data on biomass and biowaste availability and their use in biobased industries in order to examine the use of available resources and the need for imports from third countries.
  - Enhance the markets in Europe for quality biomass and waste to provide producers of biobased products, biofuels and bioenergy with equal accessibility.
  - Promote the setting up of networks with the required logistics for integrated and diversified biorefineries, demonstration and pilot plants across Europe, including the necessary logistics and supply chains for a cascading use of biomass and waste streams.
  - Support the establishment of a network of diversified biorefineries across Europe, as well as the creation and networking of one or more clusters of integrated and diversified biorefineries in every Member State.
  - Support the expansion of new markets by developing standards and standardised sustainability assessment methodologies for biobased products and supporting scale-up activities. Facilitate green procurement for biobased products by developing labels.
  - Contribute to the development of methodological standards for biobased products (e.g. using LCAs) with regard to, e.g. biobased content, biodegradability and functionalities.
  - Improve the accessibility to existing and invest into additional pilot plant infrastructures and activities in order to support the up-scaling of biobased products and processes. Increase investments in demonstration infrastructures and activities in order to support the up-scaling of processes for the manufacturing of biobased products.
  - Better integrate research projects with the use of pilot and demonstration activities.

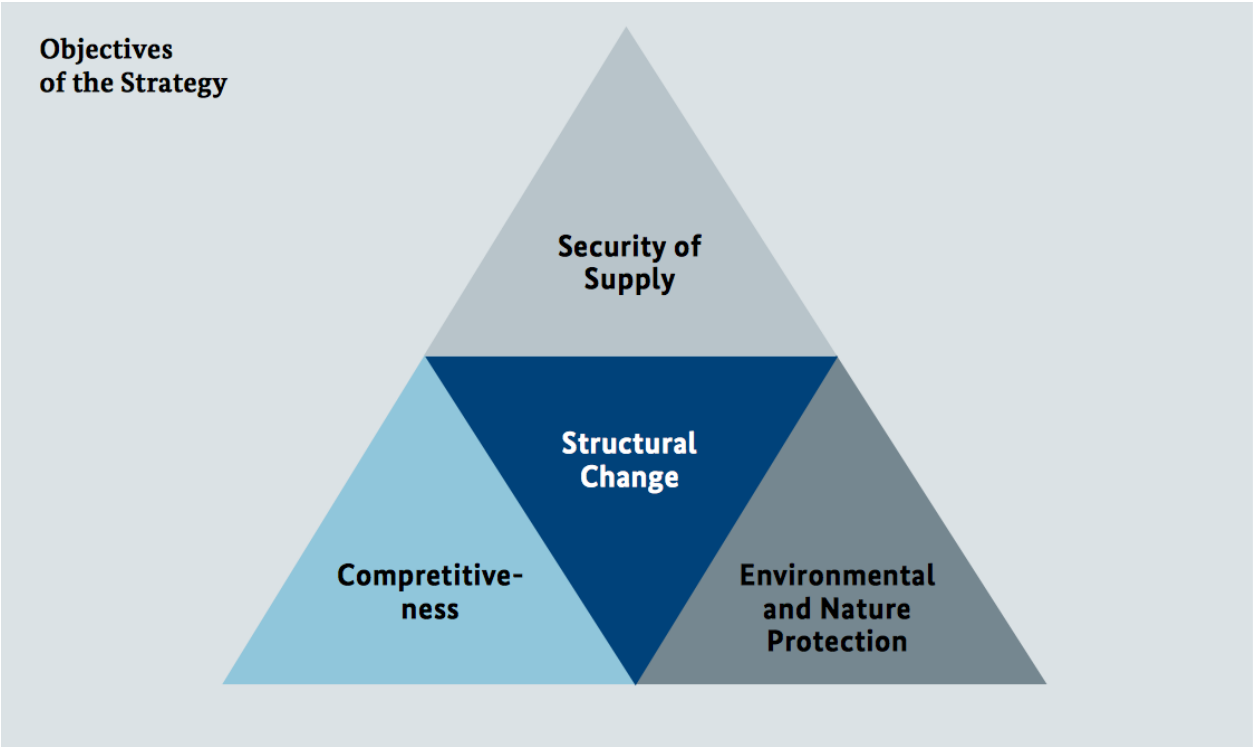
2.2. Member States and Regions

2.2.1. Germany

National Bio-economy Research Strategy 2030

In 2010, The German Federal Ministry for Education and Research published the "National Research Strategy Bio-Economy 2030: Our Route towards a biobased economy[7]". The central objective is the optimal utilisation of the chances created by the knowledge-based bio-economy, 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 bio-economy: global food security, sustainable agricultural production, healthy and safe foods, the industrial application of renewable resources, and the development of biomass-based energy carriers.

As follow-up the Federal Ministry of Food and Agriculture has released in March 2014 the "National Policy Strategy on Bio-economy[8]". This strategy sets out different goals and strategic approaches based on guiding principles and developed in three cross sectoral and five thematic areas of action, supported by specific measures.



7 Federal Ministry of Research and Education (2010) - National Research Strategy Bio-economy 2030-our route towards a biobased economy
http://www.bmbf.de/pub/Natinal_Research_Strategy_BioEconomy_2030.pdf

8 Federal Ministry of Food and Agriculture (2014) - National Policy Strategy on Bio-economy
http://www.bmel.de/SharedDocs/Downloads/EN/Publications/NatPolicyStrategyBio-economy.pdf?__blob=publicationFile

The three cross-sectoral thematic areas are:

1. Coherent policy framework for a sustainable bio-economy
2. Information and dialogue within society
3. Vocational training and apprenticeships

The thematic areas of action are the following:

1. Sustainable production and provision of renewable resources
2. Growth markets, innovative technologies and products
3. Processes and value-adding networks
4. Competition among uses of land
5. International context

The "Energy Concept for Environmentally Sound, Reliable and Affordable Energy Supply (2010)[9]", the "Raw Materials Strategy (2010)[10]", the "German Resource Efficiency Programme (2012)[11]", the "Biorefineries Roadmap (2012)[12] and other strategies and concepts formulated by the Federal Government are complementary to the National Policy strategy on Bio-economy.

The Bio-Economy Council

The Bio-economy Council (BioÖkonomieRat[13]), 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 the 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 mission of the Bio-economy Council is to improve parameters, accelerate the development of innovative technologies, and identify the need for future research. Another task of the Council is to analyse the strategic goals of Germany as a whole, the individual Länder (Regions), as well as those set within the EU and other international partner countries. The Bio-economy Council's first term was set at three years and ended in spring 2012. In summer 2012, a new Bio-economy Council was appointed by the Federal Government and has taken up its work. The body is supported by an office in Berlin.

The concrete aims of the Bio-Economy Council are:

- To offer an overview of the opportunities and prospects of the bio-economy in Germany

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9 German Federal Government (2010) - Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply http://cvi.se/uploads/pdf/Master%20Literature/Wind%20Resource/Energy%20Concept.pdf

10 Federal Ministry of Economics and Technology (2010) - The German Government's Raw Materials Strategy http://www.bmwi.de/English/Redaktion/Pdf/raw-materials-strategy,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf

11 Federal Ministry for the Environment, Nature Conservaton, and Nuclear Safety (2012) - German Resource Efficiency Programme (ProGress) http://www.bmub.bund.de/en/topics/economy-products-resources/resource-efficiency/german-resource-efficiency-programme-progress/

12 The Federal Government (2012) - The Biorefineries Roadmap http://www.bmbf.de/pub/BMBF_Roadmap-Bioraffinerien_en_bf.pdf

13http://www.biooekonomierat.de

- To deliver scientifically-based recommendations for measures to improve parameters
- To develop scenarios to create parameters for research, education and training, and student support
- To help strengthen networks of relevant actors from science, business and politics with a view to achieving maximum harmonisation on strategic questions.

The findings of the Council's work are published in reports, recommendations and other publications:

- In 2010, the Council published its analytical "Bio-economy Innovation Report[14]", placing emphasis on increasing biomass yield volumes and more efficient production processes in the food and energy sectors.

- The Council has delivered its first recommendations already in 2009. The report "Combine disciplines, improve parameters, seek out international partnership[15]" suggested for a restructuring of research funding and recommended incentive systems for private investment. The Council members supported the establishment of integrative structures in research within Germany as in the past these have followed traditional discipline boundaries too strictly. In addition to the formation of strategic partnerships with other countries and an improvement in student education, the Council believed that another focus should be the creation of solid legal frameworks, such as in the area of green gene technology.

- In 2011, in its report "Priorities in Bio-economic Research[16]", the Bio-Economy Council defined the priorities with regard to relevance and urgency of the research topics identified in its report "Bio-economy Innovation" and made recommendations with regard to time scales and financial backing. The primary objectives are to increase the volume of biomass available for various applications and to use the limited natural resources efficiently in order to fully exploit potential and to reduce the likelihood of newly competing demands arising, as for example, between those of the bio-energy and foodstuff industries. The Bio-economy Council also recommended that a National Bio-economy Platform be set up to carry out the coordination work and to provide impetus for the corresponding conversion processes with the relevant actors.

In May 2014, the Bio-economy Council published ten recommendations[17] to lead the way to the biobased economy in Germany:

(1) the transition of the economy to biobased value chains,
(2) the early identification and timely reaction towards resource conflicts and undesirable developments,
(3) regulations, standards and labels are important instruments to strengthen the demand for biobased products,
(4) investments in the biobased economy and its innovations,
(5) the expansion of education and research capacities,
(6) a fundamental revision of the German bioenergy policy,

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14 Bio-economy Council Report (2010) - Bio-economy Innovation
http://biooekonomierat.de/fileadmin/Publikationen/Englisch/bioeconomy_council_report_2010.pdf

15 BioÖkonomieRat (2011) - Combine disciplines, improve parameters, seek out international partnership
http://biooekonomierat.de/fileadmin/Publikationen/Englisch/BOER_recommandation01.pdf

16 BioÖkonomieRat (2011) - Priorities in Bio-economic Research
http://biooekonomierat.de/fileadmin/Publikationen/Englisch/BOER_Recommendation02_research.pdf

17 http://biooekonomierat.de/fileadmin/Publikationen/Englisch/Strategy_paper.pdf

(7) a more intense cooperation between Germany, emerging and developing countries to secure global nutrition,
(8) a trade agenda for the sustainable bio-economy,
(9) the installation of global control mechanisms for consumption, trade and resource protection,
(10) the extension of the participation of the civil society.

Regional clusters

In 2007, the German Federal Ministry of Education and Research initiated the creation of five German industrial biotech clusters. Among these clusters is CLIB2021[18] (cofounded by the Ministry of Innovation, Science and Research of the German State of NRW) with 32 founding members. Since then the cluster grew to include more than 100 academic institutes, companies and investors, launched R&D projects with a total volume of 62 million Euros, helped to found 5 start-ups and attracted 30% international members. Another cluster is BioM WB[19] (today called IBB Netzwek) with two demonstration plants for cellulosic ethanol and acetic acid, a new multi-purpose pilot plant for and a degree program of industrial biotechnology at the Technical University of Munich.

2.2.2. The Netherlands

Vision of the Dutch first Rutte Cabinet (2010 – 2012)

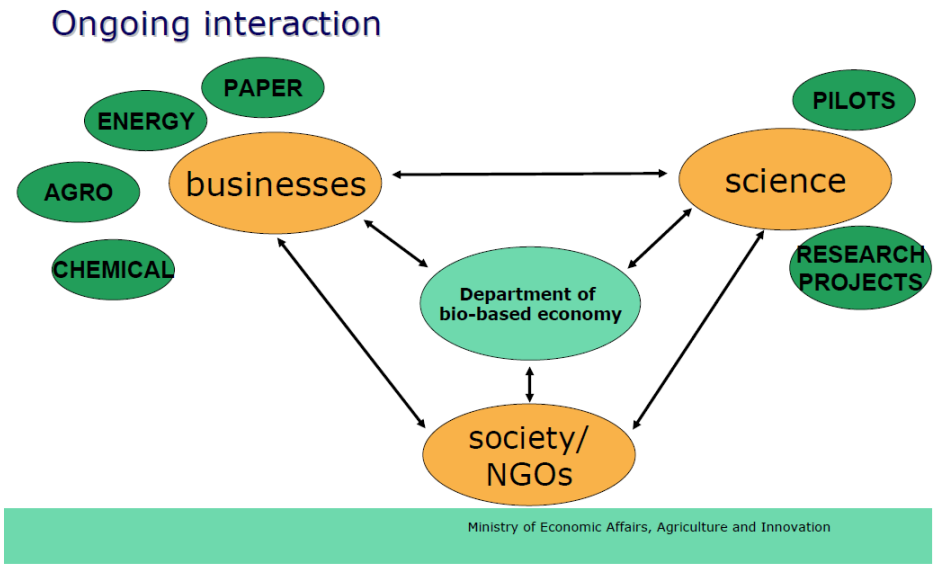
In the Netherlands, the previous Cabinet of Economic Affairs, Agriculture and Innovation decided that the biobased economy is one of the strong emerging economic pillars to be supported. The High Level Group Biobased Economy and the Bio-renewable Resources Platform, both Dutch public-private frameworks of cooperation in the field of the biobased economy, were asked to give input for a future strategy. In addition, in September 2011, 43 stakeholders (business and NGOs) signed the Manifest Biobased Economy[20], 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.

18 http://www.clib2021.de/en/

19 http://www.ibbnetzwerk-gmbh.com/de/startseite/

20 Manifest Bio-based Economy (2011)
http://www.biobasedeconomy.nl/wp-content/uploads/2011/10/Manifest-BBE-def-29-sep.pdf



In April 2012, the Cabinet presented its "Hoofdlijnennotitie Biobased Economy"[21], 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.

- **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

21 Hoofdlijnennotitie Biobased Economy Kamerstuk 02-04-2012 http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2012/04/02/hoofdlijnennotitie-biobased-economy.html

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)

The second Rutte Cabinet (2012 – ongoing)

The new Cabinet decided to continue the support for the biobased economy. The ambition with regard to the Biobased Economy is confirmed in the policy document "Groene Groei: voor een sterke, duurzame economie" (28 March 2013, Kamerstuk 33 043 nr. 14). According to the Dutch government the Biobased Economy considers the transition of the economy from fossil raw materials towards an economy based on renewable biomass as a raw material: from 'fossil based' towards 'bio based'.

Rutte II[22,23] chooses sustainable ´green´ economic growth, meaning that the economy will grow without negative effects on the climate, water, soil, raw materials and biodiversity. The Dutch governmental policy is based on the fact that sustainable innovations result in financial benefits and employment. For that reason, economic growth and environmental improvement can be addressed jointly.

The policy of Rutte II regarding Green Growth is based on 4 pillars:

1. Intelligent use of market stimulants
2. A stimulating legal frame work that improves market dynamics
3. Innovation
4. Government as a network partner

This policy is the basis to take action in 8 promising domains. One of these domains is the BioBased Economy: transition from fossil based towards biobased. The Cabinet has formulated actions to be taken:

1. Optimal use of biomass (cascading) through biorefinery technologies aiming at the development and further application of biobased materials.
2. Enhancing the establishment conditions of knowledge based and biobased processing industries.
3. Establishing EU-criteria for sustainable production and origin of raw materials.
4. Stimulation of research, innovations en experiment areas for demonstration projects en test production facilities.
5. Elimination of bottlenecks and stumbling blocks for a Biobased Economy within the national legal framework.

Green Deals

The Dutch government takes it responsibility by organising co-operation between societal initiatives, companies and (research) organisations in order to enable them to develop sustainable projects themselves. The government establishes the platform, moderates and eliminates legal bottlenecks where possible. This co-operation between the government and societal partners is being put down in a contract for a well-defined project: Green Deal.

22 Kamerstuk 33 043, nr 14 d.d. 28 maart 2013

23http://www.parlementairemonitor.nl/9353000/1/j9vvij5epmj1ey0/vj99d3jau0y2

Innovation Contract Biobased Economy

The Innovation Contract Biobased Economy "Groene Groei – van biomassa naar business"[24] is a 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.

Cluster initiative: BioBased Delta

South-western Netherlands is a frontrunner in the area of a biobased economy. The region's well-developed agricultural and chemical sectors, its favourable geographical location (centred along the Antwerp-Rotterdam axis), deep sea ports and collaboration between multinationals, SMEs, knowledge institutes and government agencies make this area particularly entrepreneurial, distinctive and application-orientated. Under the name **Biobased Delta**[25], the further development of this collaboration and strengthen the frontrunner position is facilitated.

Biobased Delta's 2013–2016 business plan is a follow-up to the Agro Meets Chemistry development strategy (2010) that explored a long-term vision for boosting a biobased economy in South-western Netherlands. The business plan defines goals and focus areas in order to realise and develop Biobased Delta's frontrunner position.

Biobased Delta's ambition for 2016 is being one of the leading biobased regions. It aims to achieve this by applying the latest biobased economy insights to both its process industry and its agrifood sector. These goals can be outlined as follows:

- Focusing on converting biomass from agricultural and non-agricultural residue into alternative natural resources and intermediates for the process industry. Three key themes play a central role in this respect:
    1. Alternative natural resources
    2. Green building blocks for the chemical industry
    3. Creating a more sustainable process industry and continuous cycles (cradle to cradle)
- Expanding the Biobased Innovations investment programme to € 600 million by 2020.
- Emphasise investments through projects aimed at the expansion and development of a biobased economy to generate substantial business results. Various demo projects will be developed at pilot plants in the years ahead.

24 https://biobs.jrc.ec.europa.eu/sites/default/files/generated/files/policy/Innovatie%20rapport-NL.pdf

25 http://www.biobaseddelta.nl/

- Involving as many businesses as possible, both multinationals and SMEs. The goal is to assist with the gradual implementation of biobased products and/or processes within existing businesses. Companies that employ approximately 15,000 people are eligible for this form of assistance. Additionally, new companies will also be established that will focus on biobased products and/or processes. The aim is to create several thousand jobs by 2020 either by means of start-ups or by attracting companies from outside the region.
- Intensifying collaborations with partners elsewhere in the Netherlands and Flanders in order to capitalise on European programmes as effectively as possible aw well as to utilise available resources as efficiently as possible. This will stimulate large projects aimed at scaling up implementation and establishing continuous cycles (cradle to cradle).

The approach to Biobased Delta's three key themes is based on five concepts:

1. R&D and Business Development
2. Top Locations
3. Knowledge and Education
4. Financing Instruments
5. Branding, Communications and Acquisition

BE-BASIC

BE-Basic[26] (Biobased Ecologically Balanced Sustainable Industrial Chemistry) is a public-private partnership that develops industrial biobased 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 centre 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

26http://www.be-basic.org/

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.

2.2.3. 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 (The Research Council for Environment, Agricultural Sciences and Spatial Planning, in consultation with VINNOVA and the Swedish Energy Agency, to prepare a national strategy for the generation of a biobased economy and sustainable development. This resulted in a "Swedish Research and Innovation Strategy for a Biobased Economy[27]",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 biobased 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 bio-economy 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:

- ***Stimulating cross-industry collaboration in research and development*** in order to develop and implement solutions that contribute to a growing biobased 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.

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27 Swedish Research and Innovation Strategy for a Bio-based Economy (2012)
http://www.formas.se/PageFiles/5074/Strategy_Biobased_Ekonomy_hela.pdf

- ***Accelerating development, verification and commercialization of new biobased 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.

2.2.4. France

At national level

In France the R&D expenditures were increased with the Programme "Investments for the Future[28]" with an growing role for the bio-economy. Within this national programme, around 1,5 billion Euros are dedicated to the bio-economy for a 10-year period:

- 1 billion euro 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 Competitivenes Clusters[29], an initiative that brings together companies, research centres 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).

28http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=24707

29http://competitivite.gouv.fr/

One of the clusters is the "Industries and Agro-Resources" Cluster or IAR[30]. 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.
- 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 built up with several international clusters in Canada, Finland, Hungary and elsewhere.

2.2.5. UK

Industrial biotechnology and the bio-economy

Until recently the concept of the bio-economy has not explicitly mentioned or defined in UK Government policies but has been within the spirit of many. However the UK Government has embraced the concept of bio-economy as bringing enormous economic benefits as well as a considerable number of green jobs. This resolution came after the 2014 "Report: Waste or resource? Stimulating a bio-economy"[31]. It is expected that a long term plan for delivering and supporting a growing bio-economy will be developed by early 2015 and that the Minister of State for Business and Energy in the Department for Business, Innovation and Skills (BIS), will take on the role of Ministerial champion for the bio-economy. This action consolidates previous initiatives where the term bio-economy was not explicitly mentioned by the initiatives were in line with its principles.

The UK initiatives related to the bio-economy can be generally categorised as either;

- Supporting the use of biomass as a resource.
- Supporting the use of low carbon technologies in order to meet UK commitments around climate change and renewable energy use e.g. 2008 Climate Change Act[32] and Renewable Energy Directive (Directive 2009/28/EC)[33]

30http://www.iar-pole.com/

31 http://www.publications.parliament.uk/pa/ld201314/ldselect/ldsctech/141/14102.htm

32 Climate Change Act 2008 - http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf

33 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources - http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT

- Supporting high value manufacturing through the use of Industrial Biotechnology.

Achieving renewable energy targets is largely through the use of market targeted mechanisms such as the Renewables Obligation for electricity suppliers (soon to be replaced by contracts for differences[34]) and the Renewable Transport Fuels Obligation[35] for transport fuel suppliers.

The UK strategy to increase the use of Industrial Biotechnology in UK manufacturing has been developed based on the findings of a 2009 report prepared by an independent Industrial Biotechnology Innovation and Growth Team.

Industrial Biotechnology Innovation and Growth Team (IB-IGT)

The IB-IGT was established by the Department for Business, Enterprise and Regulatory Reform (now part of the Department for Business Innovation and Skills)[36] in November 2007. The IB-IGT was set up to develop a strategic collective industry position on the objectives of the innovation & growth challenge, its future and how industrial biotechnology (IB) could improve the competitiveness of the chemicals sector and its related downstream industries. The team, comprising industry, academics, research organisations and NGOs, published its report to Government in May 2009[37]. The report set out the vision for IB up to 2025 and made a series of recommendations to Government and industry on how to achieve this vision.

The team identified five key barriers to IB development in the UK:

- Facilities and funding for projects, especially at the demonstration stage of the development lifecycle;
- Innovation and knowledge transfer;
- Skills;
- Public and commercial perception and awareness; and
- Connectivity in the UK.

Five critical recommendations to enable the realisation of IB opportunities were put forward, namely:

- Provide leadership to promote and connect IB activities across all supply chains;
- De-risk access to new IB products, processes and technologies;
- Accelerate the innovation and knowledge transfer process for IB;
- Position IB to attract and retain high quality scientists, engineers and managers; and
- Create a truly supportive 'public' and 'business' environment for IB.

The Department for Business Innovation and Skills published the Government's response to the report in June 2009. The response outlined the actions to be undertaken by Government which included two key actions:

- The formation of an IB Leadership Forum tasked with coordinating the development of IB in the UK; and
- Investment in the construction of an open access IB demonstration facility in the UK.

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34 https://www.gov.uk/government/publications/electricity-market-reform-contracts-for-difference

35 https://www.gov.uk/renewable-transport-fuels-obligation

36 The Department for Business, Innovation & Skills (BIS) was created on 5 June 2009 by the merger of the Department for Innovation, Universities and Skills (DIUS) and the Department for Business, Enterprise and Regulatory Reform (BERR).

37 http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file51144.pdf

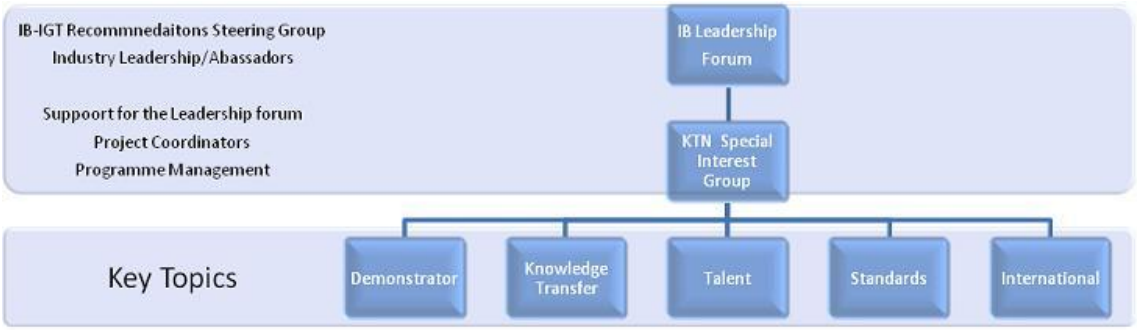

Figure: UK Industrial Biotechnology Strategy Coordination

Industrial Biotechnology Leadership Forum (IBLF)

The IBLF was formed on the recommendation of the IB-IGT. The forum is tasked with overseeing the delivery of the actions agreed by Government in their response to the IB-IGT report. Members of the forum act as ambassadors for IB in the UK and Europe and develop a coordinated promotion plan of UK IB strengths.

UK Innovation & Research Strategy

The actions agreed in the Government response to the IB-IGT report lie in the area of the UK Innovation and Research Strategy[38] developed by the Department for Business Innovation and Skills. A large portion of the Innovation & Research Strategy is implemented by the UK research councils and Innovate UK (formally the Technology Strategy Board).

In the area of Industrial Biotechnology this is predominantly the Biotechnology and Biological Science (BBSRC), and the Engineering and Physical Science (EPSRC) Research Councils, working with Innovate UK and its outreach organisation the Knowledge Transfer Network (KTN).

Catapult centres

As a result of the UK innovation & Research strategy, a national network of technology and innovation centres was planned, operating under the brand name of Catapult centres. These provide comprehensive access to specialist capability and expertise, to transform innovative ideas and technologies rapidly into valuable products, processes and systems. The capability to use design to commercialise technology is integrated within the Catapults. Innovate UK has invested over £200 million in six centres, with the network completed in 2013.

The High Value Manufacturing Catapult is a consortium of seven centres based across the UK, with expertise including, design and manufacturing technologies for metals, composites and hybrids; for plastic electronics; for the process industries; and automation, control and simulation/modelling technologies. This supports key manufacturing sectors including aerospace, automotive, industrial biotechnology, chemicals, food and drink and microelectronics. Part of this catapult is the National Industrial Biotechnology Facility (NIBF). A significant output of the IB-IGT was the £12M expansion of the Centre for Process Innovation's (CPI) National Industrial

38 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32450/11-1387-innovation-and-research-strategy-for-growth.pdf

Biotechnology Facility (NIBF) at Wilton, Redcar. The existing NIBF facility; a collaboration between the University of Manchester and CPI, had a fermentation capacity of up to 1000 litres. The expansion added a range of new capabilities including;

- Feedstock handling and pre-treatment capability.
- A range of up and downstream sterilisation vessels, including a 1000-litre small addition vessel, 10,000-litre upstream dilution and media sterilisation vessel, 10,000 fermentation vessel for batch or continuous operation and aerobic or anaerobic operation, and 4000 and 10,000-litre downstream process vessels.
- Below 0^{o}C to 130^{o}C temperature control on processing vessels.
- 2000-litre glass lined vessel.
- Capability for centrifugation, crystallisation, chromatography, homogenisation, filter drying, solvent extraction and distillation.

£140 million are allocated to this Catapult.

Industrial Biotechnology Special Interest Group (IB-SIG)

The IB-SIG is responsible for the delivery of the actions agreed in the IB-IGT report. The IB-SIG activities are managed by the Biosciences and Chemistry Innovation KTNs[39], funded by the Department for Business Innovation and Skills via Innovate UK.

The group's purpose is to ensure that UK companies understand the research and commercial opportunities presented by IB and by biobased chemicals in general. By identifying and supporting activity in key IB and biobased research areas, the group will lower barriers to innovation through the acceleration of knowledge transfer and de-risking access to new products and technologies.

Integrated Biorefining Research and Technology Club (IBTI)

The IBTI industry club was formed by BBSRC in 2008 with the aim of supporting the development of biological, chemical and engineering processes for the production of chemicals, materials and polymers from biomass. The current phase of the programme will run until 2016.

The club derived its funding from its industry members and jointly from the BBSRC and the EPSRC. Funding to a value of around £6M (BBSRC £4M, EPSRC £1.2M, Industry £660K) has been allocated over 3 research calls.

The IBTI club has funded research in the following areas;

- Optimisation of wheat and oilseed rape straw co-products for bio-alcohol production
- Aromatic feedstock chemicals from degradation of lignin
- In silico study of lignocellulosic biofuel processes
- Engineering oilseeds to synthesise designer wax esters
- Biotransforming phenylpropanoids derived from biorefining: a toolkit approach
- Fine chemicals from lignocellulosic fermentation residues using heterogeneous catalysis
- Process intensification for acceleration of bio & chemo catalysis in biorefining

39 https://connect.innovateuk.org/knowledge-transfer-networks

BBSRC Sustainable BioEnergy Centre (BSBEC)

Established in January 2009, the BBSRC Sustainable BioEnergy Centre addresses major areas of biological research underpinning the development of the bioenergy pipeline, from biomass crop improvement production to bio processing. This also covers the social, economic and legal implications of bioenergy production and utilisation. The Centre brings together 12 universities and research institutes and 14 industrial partners and has an initial budget of £27M over the first five years. The supported research themes are:

- Ensuring sustainability;
- Widening the range of starting materials for bioenergy;
- Making plant cell walls easier to break down; and
- Optimising fermentation to produce fuel.

The 6 integrated programs are:

- Perennial Bioenergy Crops
- Cell Wall Sugars
- Cell Wall Lignin
- Lignocellulosic Conversion to Bioethanol
- Second Generation, Sustainable, Bacterial Biofuels
- Marine Wood Borer Enzyme Discovery

BBSRC Networks in Industrial Biotechnology and Bioenergy (BBSRC NIBB)

The BBSRC has allocated up to **£18M** for this networking initiative and aims to **fund 13 networks**[40]. Two of the networks are being funded with support from the Engineering and Physical Sciences Research Council (EPSRC).

The purpose of the networks is to foster collaborative activities between academic researchers and business at all levels to identify and to drive new ideas to harness the potential of biological resources for producing and processing materials, biopharmaceuticals, chemicals and energy. The networks are cross-disciplinary, working across the boundaries of biology, chemistry and engineering. Participation from other disciplines including mathematics, computational modelling, environmental science, economics and social science is strongly encouraged.

The key aims are:

- To support a number of networks in industrial biotechnology and bioenergy and through them, facilitate the development of internationally competitive cross-disciplinary communities capable of undertaking innovative research and attracting further investment from UK and international sources
- To provide the resources to support proof of concept funding for a range of research projects identified by the networks, ultimately leading to more competitive, collaborative, cross-disciplinary and integrative research proposals to BBSRC and elsewhere
- To encourage the interaction between the academic research base and technology-deploying, associated value-chain and end-user businesses, promoting the translation of research particularly involving genomic, systems and synthetic biology
- To enable the supported networks to provide the leadership to develop, in collaboration with business, challenges to be addressed by the IB Catalyst fund

40 http://www.bbsrc.ac.uk/funding/opportunities/2013/networks-in-industrial-biotechnology.aspx

This is the list of the current networks:

Anaerobic Digestion Network. The Network addresses scientific and technical challenges in the development of anaerobic biotechnology, drawing on the expertise of leading academics underpinned by new tools and concepts. As well as enhancing the performance of anaerobic digestion (AD) as a second generation bioenergy process, these open up new areas of application in the creation of value-added biobased products, widening the process scope to a biorefinery. Bio-molecular tools open up the possibility of improved diagnostics and advanced on-line process control, topics of immediate interest to industry.

A Network of Integrated Technologies: Plants to Products. The Network will focus on the conversion of plant material, including agricultural by-products and agro-industrial co-products to chemicals and materials. The aim is to overcome barriers to biorefining of feedstocks by optimisation of multi-stream processes through integration of disciplines and exploitation of emerging technologies.

Bioprocessing Network: BioProNET[41]. This Network in the field of bioprocessing and biologics, engages academics, industrialists and other special interest groups to accelerate innovation and deliver change in this area. The Network will thus establish an internationally-recognized, sustainable and integrated cross-disciplinary network able to address major research challenges in the area of bioprocessing and non-therapeutic (e.g. diagnostics, drug screening, crystallization/structural studies) biologics.

C1NET: Chemicals from C1 Gas[42]**.** A Network formed by a community of UK academics tasked with unravelling the biological, chemical and process engineering aspects of gas fermentation and to steer translational outputs towards commercial application. The network will provide the 'glue' to bring together a UK-based cadre of biologists, chemists, computational modellers/mathematicians and process engineers to better understand and thence exploit gas fermentation processes for translation into industry.

Crossing biological membranes: Engineering the cell-environment interface to improve process efficiency (CBMNet). Moving molecules across membranes is a barrier to improving many existing Industrial Biotechnology and Bioenergy (IBBE) processes that utilize cell factories. With the advent of synthetic biology, identifying transport systems for integration into chassis organisms will be crucial in expanding the economic and social impacts of IBBE. The motivation for this network is that understanding the mechanisms by which substances are transported into, within, and out of cell factories will lead to the development of enabling technologies that are crucial for the future development of almost all cell-based IBBE applications. The goal is to develop innovative solutions and technologies to overcome yield restrictions due to inefficient transport systems in existing IBBE processes and to embed consideration of transport systems in future IBBE activities.

Food Processing Waste and By-Products Utilisation Network (FoodWasteNet)[43]**.** The aims of the Network is to foster the interaction between researchers and industrialists in order to realise the potential of using food waste and by-products to produce chemicals and biomaterials with market potential. For this, the Network aims at identifying suitable feedstocks, novel products and product applications, and at developing scalable technologies based on industrial biotechnology and process engineering for their sustainable production.

High Value Chemicals from Plants Network[44]**.** There is broad consensus across Government and Industry that exploitation of high value chemicals from plants can play a major role in the contribution that industrial biotechnology will make to the UK economy in the coming decade. The High Value Chemicals from Plants Network will help realise this potential by developing a coordinated critical mass of academic expertise, working in partnership with industry, focused on identifying novel products and optimising and developing both

41 http://biopronetuk.org/
42 http://www.c1net.co.uk/
43 http://www.foodwastenet.org/
44 https://hvcfp.net/

feedstocks and processes in planta. Platform technologies will relate to Bioactive Discovery, Feedstock Development (which will include molecular breeding, metabolic engineering and new production platforms), Extraction and Processing Technologies, Biotransformation, Chemical Transformation and Product Evaluation.

IBCarb - Glycoscience Tools for Biotechnology and Bioenergy[45]. Carbohydrates constitute the largest source of biomass on Earth and their exploitation for novel applications in biomaterials, energy, food and health will be critical in moving away from dependence on hydrocarbons to develop sustainable biotechnologies and reduce GHG emissions, ensuring both energy and food security. The analysis, synthesis and biosynthesis of carbohydrates and their modification to industrial products are central challenges in both industrial biotechnology and bioenergy. Great demand and opportunities are possible in diverse areas such as biopharmaceuticals (8 out of 10 top selling drugs worldwide are glycoproteins), foods (prebiotics designed for the human gut microbiota), antimicrobials (targeting cell surface recognition and biosynthesis), materials (from biorenewable polysaccharides) or energy (digesting the indigestible).

Metals in Biology: The elements of Biotechnology and Bioenergy[46]. The prevalence of metallo-enzymes means that success in synthetic biology may pivot upon an ability to engineer metal-supply inside microorganisms, plants and animal cells. For example, the sustainable manufacture of isobutanol has required the engineering of cellular iron-circuits. The abundance of each metal is controlled inside cells by sensors that regulate metal import, metal export, metal trafficking and metal storage systems, they also switch metabolism to take advantage of more available metals and to minimise demand for those in deficiency. Network members will work with the bio-processing sector to optimise metal availability, collaborate with multiple companies to engineer synthetic metallo-enzymes and will optimise metal uptake and assimilation into biomolecules required for bio-energy production, bioremediation, biomedicine and synthesis of high value industrial feed-stocks.

Natural Products Discovery and Bioengineering Network (NPRONET)[47]. Secondary metabolites produced by microorganisms and plants have inspired the development of leading pharmaceuticals including anticancer, immunosuppressive, cholesterol-lowering agents as well as most of the antibiotics in clinical use today. NPRONET will integrate genomics data and utilise systems/synthetic biology tools in order to discover new natural products and to guide the bioengineering of natural product scaffolds for therapeutic, agricultural and other applications including more efficient and diverse routes for the production of fine and commodity chemicals. A key goal of NPRONET will be to devise methods for activating unproductive biosynthetic pathways to provide the quantities of natural products needed for further development. In addition, NPRONET will utilise the expanding mechanistic and structural knowledge of biosynthetic enzymes to develop new strategies for re-programming biosynthetic pathways.

Network in Biocatalyst Discovery, Development and Scale-Up[48]. Access to a broad range of biocatalysts for R&D is widely recognised as rate limiting in the uptake of IB, particularly by the chemical industry where there is desire to replace existing processes with those based upon sustainable feedstocks and catalysts. The Network will provide significant long-term benefits to a substantial percentage of the IB community: seeking to discover, develop and make available a broader range of biocatalysts which can be screened and applied by the end-users. The Network with have three main themes: (i) Biocatalyst discovery and screening (ii) Biocatalyst development and optimisation (iii) Biocatalyst scale-up.

PHYCONET: unlocking the IB potential of microalgae[49]. Eukaryotic and prokaryotic microalgae are diverse photosynthetic microorganisms that have considerable potential as industrial biotechnology (IB) platforms for a wide range of natural and engineered bio-products, from bioplastics and biofuels to high value bioactives.

45 http://ibcarb.com/
46 http://prospect.rsc.org/MiB_NIBB/
47 http://npronet.com/
48 http://biocatnet.com/
49 http://www.phyconet.org.uk/

However, microalgal IB is an immature field that requires step-changing advances in algal biology, genetic engineering, cultivation at scale and downstream processing. The network will limit its remit to high-value products produced by microalgae in closed photobioreactors, since industrial and public acceptance will occur most rapidly through clear demonstrations that microalgae can be viable platforms for small-scale production of high-value commodities.

Lignocellulosic Biorefinery Network (LBNet)[50]. Plant biomass is currently the only renewable and sustainable non-food feedstock available on a scale commensurate with current use of petroleum. Lignocellulosic biomass is a rich source of fixed carbon incorporated into a range of polymers comprising mainly polysaccharides and lignin. Lignocellulosic plant biomass also contains a wide range of less abundant chemicals and polymers including sterols, waxes and fatty acids. Thus, this non-food feedstock has the potential to provide a wide range of bulk and speciality chemicals that can serve as the basis for producing most of the products we currently obtain from petroleum. The Lignocellulosic Biorefinery Network (LBNet) will establish a cohesive multi-disciplinary network of researchers and stakeholders with interests in lignocellulose-derived biorenewables in order to overcome fragmentation of the research community in this area and develop systems based approaches to move this area forward.

IB Catalyst

The IB Catalyst[51] is an initiative funded by the EPSRC and the TSB that provides funds to support major integrated research projects involving collaborations between the academic and business communities. This is achieved through a range of competitions with the aim of bridging the gap between the lab and the marketplace. In 2014-15 £45M are allocated to address one or more of the major challenges using biological processes, or processes in which biological and chemical approaches are used in combination. The funds want to support:

- research and development for the processing and production of materials, chemicals (including pharmaceutical precursors and biopharmaceuticals) and bioenergy
- development and commercialisation of innovative IB processes to manufacture a wide range of existing and new products through collaborative and non-collaborative research grants

Projects should focus on:

- Production of fine and speciality chemicals and natural products (e.g. fragrances, flavours, pharmaceutical intermediates)
- Production of commodity, platform and intermediate chemicals and materials (e.g. plastics, resins, silks)
- Production of liquid and gaseous biofuels
- Production of peptides and proteins (e.g. enzymes, antibiotics, recombinant biologics)
- Novel or improved upstream or downstream processes to reduce costs or improve efficiency in industrial biotechnology applications

Synthetic Biology

The UK has a strong industrial life sciences sector, which underpins UK support for synthetic biology as an emerging technology area. The UK research councils have been developing UK strategy in synthetic biology since

50 http://lb-net.net/
51 http://www.bbsrc.ac.uk/ibcatalyst

2007. A Synthetic Biology Leadership Council (SBLC)[52] has been established to be a coordinating body for the UK's interests in the rapidly developing field of synthetic biology.

The SBLC will work with industry, the relevant academic disciplines (including engineering, biology, chemistry, physics, mathematics, the social sciences and ICT), regulators, NGOs and Government, to strategically oversee the development of a successful synthetic biology industry sector in the UK.

In July 2012 a strategic roadmap[53] for synthetic biology was published with the key purpose of defining the likely timeframe and actions required to establish a world leading Synthetic Biology industry within the UK. The Roadmap made five over-arching recommendations to:

- establish a SynBio Leadership Council,
- Invest in a network of multidisciplinary research centres to establish an outstanding UK SynBio resource,
- build a skilled, energised and well-funded UK-wide SynBio community,
- invest to accelerate technology responsibly to market, and to
- assume a leading international role.

The SBLC will provide a steering structure governance body to assess progress, update recommendations and shape priorities for the implementation of this roadmap.

The Synthetic Biology Special Interest Group[54] is funded by the Technology Strategy Board, the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC). The SynBio SIG is hosted and coordinated by the Biosciences Knowledge Transfer Network (BKTN), in partnership with other relevant KTNs such as HealthTech and Medicine; Nanotechnology; Electronics, Sensors and Photonics; Chemistry Innovation; Environmental Sustainability; Information & Communications Technologies. he SynBio SIG aims to build on the UK's bioscience and engineering expertise to develop a world class synthetic biology research community, and establish strategic partnerships with UK industry to ensure the translation and development of this knowledge for business benefit. The SynBio SIG role will be to ensure opportunities to use synthetic biology approaches in commercial applications are realised to enhance future business performance.

A number of investments have been announced to support the development of synthetic biology;

- £1 million funding competition in Synthetic biology applications in defence
- £40 million plus investment (by BBSRC and EPSRC) was announced in January 2014 to establish the first three Synthetic Biology Research Centres (SBRCs) at Bristol, Nottingham and a Cambridge/Norwich partnership. These multidisciplinary research centres will also make available industrially-relevant training thus providing cohorts of next generation researchers and the basis of a skilled industrial workforce.
- £1 million from the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC) for UK scientists to join an international consortium attempting to build a synthetic version of the yeast genome by 2017.
- £10 million from BBSRC, EPSRC and the Technology Strategy Board (TSB) to establish a multi-partner Innovation and Knowledge Centre (IKC) in synthetic biology based at Imperial College London.

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52 https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/synbio-leadership-council;jsessionid=4F65AD67046399FDF5CBBAB132137DA4.5bccdcf600f

53 UK Synthetic Biology Roadmap Coordination Group (2012) A synthetic biology roadmap for the UK http://www.rcuk.ac.uk/publications/reports/syntheticbiologyroadmap/

54 https://connect.innovateuk.org/web/synthetic-biology-special-interest-group

- £20 million to fund a new set of multidisciplinary research centres, supported by additional investment from BBSRC and EPSRC.
- £10 million for a synthetic biology seed fund managed by BBSRC for companies to commercialise research.
- £18 million from the research councils for DNA synthesis.
- £2 million to support training in synthetic biology.

The Innovation and Knowledge Centre (IKC) in Synthetic Biology (SynbiCITE Centre) based at Imperial College London has received £10M of public support from the BBSRC, EPSRC and the TSB with a further commitment of a further £14M from industry. The Centre will act as a hub for UK research and currently as 17 academic and 13 industrial partners.

2.2.6. Norway

In Norway, an official "Norwegian Industrial Biotech Network[55]" was set up in 2012. The main objective of the Industrial Biotech Network is to stimulate innovation through partnerships and dissemination of knowledge. The network will connect academia and industry across research disciplines, industry sectors and geography. The network is the result of a joint initiative by Innovation Norway, The Research Council of Norway, and SIVA (Industrial Biotech Network Norway, 2012).

In 2013, Innovation Norway introduced a new grant program to support the emerging bio-economy, "Bioraffineringsprogrammet". This program is intended to stimulate industry investments and the uptake of new technologies related to biorefining, i.e. advanced processing of renewable feedstock. It will mediate risk by providing financial support for the development or verification of novel manufacturing processes. During 2013 the program has contributed to 14 new business-led projects, exhausting the financial frame of NOK 20 million. The Biorefinery Program will continue in 2014 with a slightly increased budget, close to 25 mill.

In February 2011, a memorandum of understanding was signed between Innovation Norway and the Technology Strategy Board in the UK. This collaboration agreement intends to foster transnational collaboration between industries and research institutions in the area of industrial biotechnology and biorefining. Beginning of 2012, it was decided to work together to support nine new research and development projects that will create innovative processes to generate high-value chemicals through industrial biotechnology and biorefining. The UK Technology Strategy Board has offered grant funding totaling GBP 1.82 million to the nine UK-led projects (four full-scale collaborative R&D projects and five feasibility projects) and four of these will also be supported by Innovation Norway, which is providing additional funding of GBP 400,000 to the Norwegian businesses that are taking part. The projects will look at how industrial biotechnology and/or biorefining can be competitively applied to the production of high value chemicals and will see collaboration between industrial biotechnology developers, higher education institutions and the chemicals sector.

Norway has published a preliminary research programme from 2012-2022 on "Sustainable Innovation in Food and Biobased Industries", BIONÆR.The following cross-cutting perspectives will apply to all research activities under the BIONÆR programme:

- Sustainable production and consumption, emissions reductions and adaptation to climate change.

55 http://www.indbiotech.no

- Improved resource efficiency in new and existing biomass production and full utilisation of all biological resources in closed-loop systems. Focus on reducing food loss and discard and on using residual raw materials as a resource
- Further refinement of existing and development of new types of value-creating cross-utilisation between resource streams.
- Further refinement of existing and development of new processes, products and services.
- Enhanced value creation and competitiveness in the biobased industries, with a focus on market orientation and innovation in all segments of the various value chains.

UK-Norwegian partnership supporting industrial biotechnology[56]

In February 2011, a memorandum of understanding was signed between Innovation Norway and the Technology Strategy Board in the UK. This collaboration outlines 4 main objectives: 1. Identifying projects and markets: Opportunity mapping, 2-4 networking events per year, connecting national webportals. 2. R&D grants: Intention of £ 5 mill (2,5 mill from each agency) over 3 years, funding 5-15 industry led projects. 3. Process scale-up: Mutual exchange of knowledge and personnel and strategic cooperation between demonstration facilities (RTOs). 4. EU related projects (FP/ERA-nets): A broad bilateral R&D and business interface would pave the way for joint applications.

Beginning of 2012, it was decided to work together to support nine new research and development projects that will create innovative processes to generate high-value chemicals through industrial biotechnology and bio-refining. The UK Technology Strategy Board has offered grant funding totaling £1.82 million to the nine UK-led projects (four full-scale collaborative R&D projects and five feasibility projects) and four of these will also be supported by Innovation Norway, which is providing additional funding of £400,000 to the Norwegian businesses that are taking part. The projects will look at how industrial biotechnology and/or biorefining can be competitively applied to the production of high value chemicals and will see collaboration between industrial biotechnology developers, higher education institutions and the chemicals sector.

A new grant-calls was published in 2013.

2.2.7. Italy

Since the launch of the EU Bio-economy 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 possible national strategy. 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.

56 http://www.indbiotech.no/british-norwegain-collaboration

2.2.8. Ireland

In 2008 Ireland issued its Foresight Report "Towards 2030-Teagasc's Role in Transforming Ireland's Agri-Food Sector and the Wider Bio-economy"[57] based on four pillars:

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

Ireland has set out its commitment to developing the "green" economy in a number of national policy documents. Whilst there is currently no single overarching bio-economy strategy, the following documents show the current policy framework in relation to the bio-economy in Ireland: "Building Ireland's Smart Economy- A Framework for Sustainable Economic Renewal[58]" (2008) and "Developing the Green Economy in Ireland[59]" (2009).

Building Ireland's Smart Economy - A framework for Sustainable Economic Renewal

The Smart Economy is a 'Green Economy' in that it recognises the inter-related challenges of sustainable means of industrial production and consumption, climate change and energy security. The Smart Economy framework included a commitment to the roll-out of the industry-led Competence Centre Programme of which the Technology Centre for Biorefining and Bioenergy (www.tcbb.ie) now has responsibility for getting industry members, academic experts, institutions and government agencies working together to expedite the commercial development of the vast potential of the Irish biomass resource.

One of the overall strategies of the framework is to create a "new green deal" to move Ireland away from fossil fuel-based energy production through investment in renewable energy and to promote the green enterprise sector and the creation of "green-collar" jobs.

The five Action Areas of the Framework are:

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

Many of the points raised in the current policy documents, especially those in respect of development of a wider bio-economy, are aspirational. Actionable measures strongly focus on further development of Ireland's very strong international position in the agri-food sector, with a focus on increasing outputs in the dairy, beef, food & beverage and primary production of tillage and forestry outputs, More recently, the Dept. of Agriculture has commissioned a panel of experts to develop a critical analysis and a corresponding set of recommendations to

57 Towards 2030-Teagasc's Role in Transforming Ireland's Agri-Food Sector and the Wider Bio-economy, 2008 http://www.teagasc.ie/publications/2008/20080609/ForesightReportVol1.pdf

58 http://www.taoiseach.gov.ie/BuildingIrelandsSmartEconomy_1_.pdf

59 https://www.djei.ie/en/Publications/Publication-files/Developing-the-Green-Economy-in-Ireland-01-12-09.pdf

underpin development of a detailed, integrated, implementable plan for wider bio-economic development in bio-chemical, bio-materials and biofuels.

Developing the Green Economy in Ireland

The Smart Economy framework was followed by the Report of the High-Level Group on Green Enterprise titled Developing the Green Economy in Ireland in November 2009[60]. The report lays out the actions that must be taken for Ireland to realise its potential to become a hub for green enterprise. The report has since then been followed by a government policy statement on the green economy in 2012: Delivering our Green Potential – Government Policy Statement on Growth and Employment in the Green Economy 2012[61] (tied-in with Government Action Plan for Jobs 2012). The Policy Statement further affirms the Irish Government's commitment to further developing the green economy in the years ahead. The Statement identifies the opportunities in the Green Economy for sustainable economic growth and job creation, sets out how the Government is supporting the Green Economy and outlines new implementation structures to oversee the development of the sector.

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).

Strategy for the Renewable Energy Sector

To complement the focus on further development of the agri-food sector, and the early stage aspirations for development of a wider bio-economy, Ireland has a well-developed strategy in place for expansion of renewable energy, which is laid down in several documents. The Strategy for Renewable Energy 2012-2020[62] sets out five strategic goals – increasing on and offshore wind, building a sustainable bioenergy sector, fostering R&D in renewables such as wave & tidal, growing sustainable transport and building out robust and efficient networks. Strategic Goal 2 of the document is stated as the attainment of a sustainable bioenergy sector supporting renewable heat, transport and power generation. Ireland has set out its 2020 commitments and targets under the EU's renewable energy directive in its National Renewable Action Plan[63]. The primary means of achieving its renewable energy obligations include wind generated electricity, however a recent (draft) National Bioenergy

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60 Developing the Green Economy in Ireland, 2009, http://www.forfas.ie/media/dete091202_green_economy.pdf

61Delivering our Green Potential-Government Policy Statement on Growth and Employment in the Green Economy 2012 http://www.agriculture.gov.ie/media/migration/ruralenvironment/environment/bioenergyscheme/DeliveringOurGreenPotential171212.pdf

62Department of Communications, Energy and Natural Resources (2012) Strategy for Renewable Energy 2012-2020 http://www.dcenr.gov.ie/NR/rdonlyres/9472D68A-40F4-41B8-B8FD-F5F788D4207A/0/RenewableEnergyStrategy2012_2020.pdf

63 National Renewable Energy Action Plan Ireland http://www.dcenr.gov.ie/energy/SiteCollectionDocuments/Renewable-Energy/The%20National%20Renewable%20Energy%20Action%20Plan%20(PDF).pdf

Strategy incorporates a continuation of established support tariffs for biomass CHP, and will incorporate a new improved support measure for generation of biomass heat, to promote wider utilization of biomass-based energy. Additionally, a favourable excise tax incentive has been included for use of gaseous transport fuels (including biogas fuels) and other promotional measures are being finalised in the Department of Communications, Energy and Natural Resources for imminent publication by the Irish Government. The National Bioenergy Strategy will set out an approach to developing and utilizing the resources and addressing the supply and demand side issues to optimize the electricity, heat and transport targets and to job creation, growth and regional development[64].

Ireland's waste management strategies also support development of a biobased economy, as Ireland's commitment to divert more waste away from landfill creates opportunities for the bio-economy in Ireland to use waste as a resource, for energy in particular, but also for biobased materials and chemicals.

Other initiatives

As one of its 10 priority goals in its Horizon 2020 Strategy, Ireland's state agency for attracting overseas investment, IDA Ireland highlights that Ireland can be the ideal place for a multinational to test a new technology, service or business process before launching it to other markets. IDA Ireland has included "cleantech" in particular as an area where foreign direct investment can be attracted to "develop, testbed and internationalise" new technology.

The current Programme for Government 2011-2016 contains a commitment to favouring a coherent approach to waste management that minimises waste going to landfill, and that maximises the resources that can be recovered from it. The Programme also includes a commitment to merge Bord na Móna and Coillte to create a new company called BioEnergy Ireland to become a global leader in the commercialisation of next generation bio-energy technologies, including an annual 14,700 hectare afforestation programme[65]

2.2.9. Denmark

Denmark has been integrated the Bio-economy sector into a wider, longer-term purpose, which is an part of country's vision of development and aims to create a "green, sustainable society". In this regard, the most important challenges, given their economic and societal impact, are making Denmark a green growth laboratory of green technologies, creating the conditions so the agricultural sector to become a supplier of green energy and setting up a cleaner environment[66]. A total of 1.8 billion EUR funding until 2015 is foreseen, which is a 50% increase compared to previous initiatives.

The "Agreement on Green Growth" comprises two parts: The "Environment and Nature Plan Denmark up to 2020" and "The Strategy for Green Agriculture and Food Production Industry Undergoing Growth", with following actions:

- Strengthening the agricultural sector as a supplier of green energy so up to 50% of livestock manure to be used for green energy by 2020

64 http://www.raslres.eu/2012/06/publication-of-a-new-strategy-for-renewable-energy-in-ireland/

65 Government for National Recovery 2011-2016, http://www.socialjustice.ie/sites/default/files/file/Government%20Docs%20etc/2011-03-06%20-%20Programme%20for%20Government%202011-2016.pdf

66http://www.sitra.fi/julkaisut/muut/A%20Natural%20Resource%20Strategy%20for%20Finland.pdf

- the establishment of a plan for efficient assimilation of biogas; further tax equalization between vegetable biomass and livestock manure; tax deductions for of perennial energy crops' cultivation; dissemination of information on biogas and manure, and more.
- Developing Denmark as a green growth laboratory and investment in new green technologies

2.2.10. Finland

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.

In 2011, SITRA (the Finnish Innovation Fund) prepared a report " Sustainable Bio-economy: Potential, Challenges and Opportunities in Finland[67]". The study claims that the market for small-scale solutions is large, which provides a basis for mass-production of bio-economic solutions.

The Finnish government announced in 2014 its new strategic plan to invest in bio-economy[68]. The goal of the Finnish government is to increase the yield of the bio-economy from the present €60 billion to €100 billion and to create 100,000 new bio-economy jobs by 2025.The four focal points of the Finnish strategy are:

1. creating a competitive operating environment for growth in the bio-economy,
2. creating new bio-economy business activities through risk financing, bold experiments, and transcending boundaries between different sectors,
3. upgrading the bio-economy knowledge base by developing education and research activities and
4. securing the availability of biomass, a functioning market for raw materials, and the sustainability of use.

The bio-economy strategy has been prepared as a collaborative effort between the Ministry of Employment and the Economy, the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Education and Culture, the Ministry of Social Affairs and Health, the Ministry of Finance, the Prime Minister's Office, and their administrative sectors, as well as VTT Technical Research Centre of Finland and the Finnish Innovation Fund Sitra.

The implementation of the strategy will be launched under the leadership of the Ministry of Employment and the Economy.

67http://www.sitra.fi/julkaisut/Selvityksi%C3%A4-sarja/Selvityksi%C3%A4%2051.pdf

68http://www.tem.fi/files/40366/The_Finnish_Bioeconomy_Strategy.pdf

2.2.11. Belgium

The Region of Flanders

The Region of Flanders has recently defined its bio-economy strategy through the Flemish Interdepartmental Working Group (IWG) for the Bio-economy. In its strategic roadmap 'Bio-economy in Flanders' (2013)[69], the Government of Flanders has set out a vision and strategy with an integrated cross-policy approach for a sustainable and competitive bio-economy in 2030. Besides sustainability to cope with climate change, the scarcity of raw materials, pressure on ecosystems, and food security, strong emphasis is put on economic growth, job creation and innovation. Flanders underlines the importance of the further development of the sustainable (circular) economy with the optimal use of raw materials resulting in smart and green economic growth. This is in line with the Flanders in Action (VIA) project that has the intention to develop Flanders into an economically innovative, sustainable and socially warm society by 2020.

A number of powerful ambitions were set based on key principles put forward by stakeholders through the joint opinion of 13 February 2013 of the advisory councils, Minaraad and SALV, and the Europe 2020 strategy for the bio-economy. The bio-economy was also identified in the Flemish Materials Programme (VIA project) as contributive to cope with societal challenges facing Flanders. The bio-economy vision with clear strategic objectives was presented to all stakeholders on19 April 2013.

The vision for the bio-economy in Flanders is rooted in the following starting points:

1. The bio-economy is necessary because of the major societal challenges
2. The bio-economy must form part of a more sustainable economy, and thus be economically, ecologically and socially viable
3. The switch to an economy based on renewable raw materials requires a transition
4. Biomass as a factor in the energy mix
5. In the Flemish bio-economy the available biomass streams will be used according to an accepted cascade
6. The European strategy and action plan serves as a framework for the vision and strategy of the Government of Flanders
7. Learning from cooperation opportunities and inspiration from the strategies of other countries and regions

Three ambitions are part of the vision of the Flemish bio-economy in 2030:

1. By 2030 Flanders will be one of the most competitive regions in Europe
2. In 2030, Flanders will be one of the top regions in Europe for innovation and research relating to the bio-economy
3. In the Flemish bio-economy the available biomass streams will be used according to an accepted cascade

The strategy is based on five strategic objectives (SOs):

1. The development of a coherent Flemish policy that supports and facilitates a sustainable bio-economy
2. To put Flanders at the top for education, training and research and innovation in future-oriented bio-economy clusters

69 Bio-economy in Flanders, The vision and strategy of the Government of Flanders for a sustainable and competitive bio-economy in 2030 (2013)
http://www.vlaanderen.be/nl/publicaties/detail/bio-economy-in-flanders

3. Biomass is optimally and sustainability produced and used across the entire value chain
4. Strengthening of markets and competitiveness of bio-economy sectors in Flanders
5. Flanders is a key partner within European and international joint venture

The interdepartmental Working Group for the Bio-economy is responsible for the further development of the action plan and for monitoring its implementation.

The Walloon Region

In 2013 the project "Le Coq Vert"[70] was launched through a public-private partnership between one of Wallonia's competitive poles Greenwin (innovation and environmental technology accelerator)[71], AWEX (Agence Wallone à l'Exportation et aux Investissements étrangers)[72], and the association Valbiom[73] with amongst others Essenscia Wallonia[74]. With this ambitious project the partners want to contribute creatively to the development of a competitive bio-economy in Wallonia. The biobased chemistry sector and particularly the green chemistry sector are the main targets. The strategy is focused on valorization of non-food biomass streams (co-products, waste, residues…) and the second generation biorefineries. The specific objectives are the identification of priority R&D projects, trainings and platforms; establishment of a permanent baseline on the bio-economy in Wallonia; investment stimulation and attracting of foreign investors.

70 http://www.coqvert.be

71 http://www.greenwin.be

72 http://www.awex.be/fr-BE/Pages/Home.aspx

73 http://www.valbiom.be/association/presentation.htm#.U0OmSP2-RFI

74 http://www.essenscia.be/fr/essenscia_wallonie

2.3. Comparison and summary of the European bio-economy strategies

Following tables summarise and compares the different European bio-economy strategies.

	European Union	Germany	The Netherlands
Strategy	• Innovating for Sustainable Growth: a Bio-economy for Europe (2012)	• The National Bio-economy Research Strategy 2030 (2010) • National Policy Strategy on Bio-economy (2014)	• Hoofdlijnennotities Biobased Economy(2012)
Framework	• The Bio-economy encompasses the production of renewable resources of land, fisheries and aquaculture and their conversion into food, feed and fibre, biobased products and bio-energy as well as related public goods	• The concept of the bio-economy covers the agricultural economy and all manufacturing sectors and associated service areas that develop, produce, process, handle or utilise any form of biological resources, such as plants, animals, and microorganisms	• The Biobased economy considers the transition of the economy from fossil raw materials towards an economy based on renewable biomass as a raw material
Objective	• A more innovative and low-emission economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection	• To become a dynamic research and innovation centre for biobased products, energy, processes, and services • To meet responsibilities for global nutrition, as well as protection of the climate, resources, and the environment	• From a "fossil based" towards "biobased" economy
Main actions	• Investment in research, innovation and skills for the bio-economy • Development of markets and competitiveness in bio-economy sectors • Reinforced policy coordination and stakeholder involvement	• Sustainable production and provision of renewable resources • Growth markets, innovative technologies and products • Processes and value-adding networks • Competition among uses of land • International context	• Sustainable use of biomass • Integrated Policy • Knowledge and Innovation • Clear and transparent sustainability criteria • Intensive European and international collaboration
Focus	• R&D, sustainability, innovation, competitiveness, Job creation, economic growth, coherent policy framework, stakeholder participation	• Sustainability (including biomass vs food security), competitiveness, innovation, economic growth, integrated policy, education •	• Sustainable use of biomass and agricultural biomass production, sustainable production processes, innovation, integrated policy
Coordination	The European Bio-economy Panel	The Bio-economy Council	The High Level Group Biobased Economy

Country	***Sweden***	***Belgium (Region of Flanders)***
Strategy	• Swedish Research and Innovation Strategy for a Biobased Economy (2012)	• The vision and strategy of the Government of Flanders for a sustainable and competitive bio-economy in 2030 (2013)
Framework	• The biobased economy (bio-economy) is an economy based on: - A sustainable production of biomass to enable increased use within a number of different sectors of society. The objective is to reduce climate effects and the use of fossil-based raw materials. - An increased added value for biomass materials, concomitant with the reduction in energy consumption and recovery of nutrients and energy as additional end products. The objective is to optimize the value and contribution of ecosystem services to the economy.	• The bio-economy includes all activities associated with the production of biomass and the various ways in which this biomass and its residual streams are subsequently used.
Objective	• The replacement of fossil-based raw materials with biobased raw materials • Smarter products and smarter use of raw materials • Change in consumption habits and attitudes • Prioritization and choice of measures	• By 2030 Flanders will be one of the most competitive regions in Europe • In 2030, Flanders will be one of the top regions in Europe for innovation and research relating to the bio-economy • In the Flemish bio-economy the available biomass streams will be used according to an accepted cascade
Main actions	• Research and Development: - Stimulating cross-industry collaboration - Stimulating the growth of research and innovation environments • Accelerating development, verification and commercialisations of new biobased solutions	• The development of a coherent Flemish policy that supports and facilitates a sustainable bio-economy • To put Flanders at the top for education, training and research and innovation in future-oriented bio-economy clusters • Biomass is optimally and sustainability produced and used across the entire value chain • Strengthening of markets and competitiveness of bio-economy sectors in Flanders • Flanders is a key partner within European and international joint venture
Focus	• Sustainabiliy, agricultural biomass production, research and development, innovation, market introduction	• Sustainability, innovation, market introduction, competiveness education, integrated policy •
Coordination	User Forum	Interdepartemental Working Group (IWG)

Country	***France***	***UK***	***Italy***
Strategy	• French National Reform Programme 2011-2014 (2011)	• Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy (2009)	• Green chemistry policies
Objectives		• Supporting the use of low carbon technologies • Supporting high value manufacturing through the use of IB	
Main actions	• Setting up regional "competiveness clusters"	• Industrial Biotechnology Special Interest Group (IB-SG) • National Industrial Biotechnology Facility (NIBF) • Integrated Biorefining Technology Initiative • BBRSC Sustainable Bioenergy Centre (BSBEC) • BBSRC Networks in Industrial Biotechnology and Bioenergy (NIBBE) • IB catalyst • Innovation and Knowledge Centre (IKC) in Synthetic Biology	• Green chemistry cluster
Focus	• R&D and innovation, competitiveness	• Innovation, business skills, market introduction, industrial biotechnology, synthetic biology	• Green chemistry, innovation

Country	***Norway***	***Ireland***
Strategy	• Norwegian Industrial Biotech Network (2012) • BioNAER - Research Programme on Sustainable Innovation in the Biobased Industries (2012)	• Building Ireland's Smart Economy-A framework for Sustainable Economic Renewal (2008) • Developing the Green Economy in Ireland (2009) • Strategy for the Renewable Energy Sector 2012-2020 (2012)
Objectives	• Support of companies in developing their advantage and to enhance innovation (via Norwegian Industrial Biotech Network)	• Investment in renewable energy • Promote the green enterprise sector and the creation of "green collar" jobs • Promote green sectors that drive exports and job creation • Ireland to become a hub for green enterprise • Building a sustainable bio-energy sector • Fostering R&D in renewables • Growing sustainable transport • Building out robust and efficient networks
Main actions	• Enhancing Innovation in Norwegian enterprises and industry • Building competitive Norwegian enterprises at both domestic and international markets • Securing development in rural areas • Transforming ideas into successful business cases • Promote interaction between enterprises, knowledge communities and R&D institutions	• Meeting the short-term challenge-Securing the Enterprise Economy and Restoring Competiveness • Building the Ideas Economy-Creating the Innovation Island • Investing in Critical Infrastructure • Providing Efficient and Effective Public Services and Smart Regulation • Promote Green Sectors • Deliver Green Zones and Green international financial services sector • Create World-Class Research and Human Capital • Remove Hurdles for the Development of the Green Economy
Focus	• Innovation, competitiveness	• Enterprise, innovation, Economic Growth, Competiveness

Country	***Denmark***	***Finland***	***Belgium (the Walloon region)***
Strategy	• Agreement on Green Growth (2009)	• Sustainable growth from bio-economy – The Finnish Bio-economy Strategy (2014)	• Le "Coq Vert" (2013)
Objectives	• To ensure that a high level of environmental and climate protection goes hand in hand with modern and competitive agriculture and food industries	• To increase the yield of the bio-economy from the present €60 billion to €100 billion and to create 100,000 new bio-economy jobs by 2025	• valorization of non-food biomass streams (co-products, waste, residues…) • second generation biorefineries.
Main actions	• A more self-sustaining agricultural sector • Simpler and more flexible regulation of the environment and food production • The agricultural sector as a supplier of green energy • Denmark as a green growth laboratory • Investments in new green technologies • A more value creating food industry	• creating a competitive operating environment for growth in the bio-economy, • creating new bio-economy business activities through risk financing, bold experiments, and transcending boundaries between different sectors, • upgrading the bio-economy knowledge base by developing education and research activities and • securing the availability of biomass, a functioning market for raw materials, and the sustainability of use.	• identification of priority R&D projects, • trainings and platforms • establishment of a permanent baseline on the bio-economy in Wallonia • investment stimulation and attracting of foreign investors.
Focus	• Environmental sustainability	• Innovation, competitiveness	• Green chemistry, competitiveness

3. HURDLES AND BOTTLENECKS FOR COMPANIES IN THE BIOBASED ECONOMY

3.1. Main hurdles for SMEs

Small and medium enterprises(SMEs) are crucial in thriving innovation and the development of the bio-economy towards sustainable economic growth. Some bottlenecks for the industry, especially SMEs, in the realisation of the bio-economy and commercialisation of industrial biotechnology applications, have been identified before[75]. Framework conditions for boosting entrepreneurship, an appropriate regulatory framework , international standards as wells as access to risk and benefits have been recommended in the vision paper "The European Bio-economy in 2030".

For this report a new survey (see Annex 2) was conducted with 43 companies (SMEs) active in the biobased sector (industrial biotechnology, bioenergy, chemistry and food industry) in the Northwest of Europe (Belgium, North of France, UK, Ireland, Germany and the Netherlands) on possible hurdles and specific barriers for participating in the bio-economy. Respondents could give a rating on different topics as what they experience most as hindering the development of biobased business. Based on the rating (1 to 5) a relative score was calculated and the critical hurdle categories and topics or barriers were put in a prioritization ranking (see Table 1).

Table 1: Ranking of main categories of hurdles based on a survey with 43 respondents, biobased companies in Northwest Europe from Belgium, North of France (5), UK (10), Ireland (10), Germany (12), and The Netherlands (7). The relative score was calculated based on the total sum of the ranking (1 to 5) by all participants to the maximum possible sum of ranking (5) of all participants.

	Category	Sum per category	Rel score per category	Ranking per category
A	**Investment barriers**	*1224*	0,67	1
F	**Intellectual property related hurdles**	*450*	0,65	2
G	**Demand-side policy barriers**	*436*	0,63	3
E	**Hurdles for efficient collaboration**	*559*	0,61	4
H	**Regulatory barriers**	*823*	0,60	5
C	**Public perception barriers**	*678*	0,59	6
B	**Feedstock related barriers**	*1195*	0,58	7
D	**Human resource barriers**	*132*	0,57	8
I	**Policy barriers**	*500*	0,54	9

Overall the main top three hurdles identified were investment barriers, intellectual property related hurdles, and demand-side policy barriers. More specifically capital requirements, public procurement policy, patent filing cost and regulation, the perception of industrial biotechnology and biobased sectors as high investment risk sectors,

75White paper "The European Bio-economy in 2030" – http://www.epsoweb.org/partnerships/becoteps

and a suitable network and cooperation strategy were ranked as the most important hurdles. Capital requirements were in particular related to access to finance for spin-offs and start-ups (e.g. seed funding, VC funding), availability of public R&D funding at regional, national and European level, the financial support for new production facilities, access to finance for SMEs and the time before "return to investment" being too long for VCs. Patent filing cost and regulation was especially linked to the lack of a harmonized international IP regulation. Also (absence of) public procurement regulation was considered of main importance. As regulatory barrier unequal or unfair sustainability comparisons were experienced as most hindering. A fundamental lack of understanding industrial biotechnology as part of a poor public perception is equally ranked with the top ten of specific barriers for the development of the biobased sector.

Table 2: Ranking of major barriers based on a survey with 43 respondents, biobased companies in Northwest Europe from Belgium, North of France (5), UK (10), Ireland (10), Germany (12), and The Netherlands (7). The relative score was calculated based on the total sum of the ranking (1 to 5) by all participants to the maximum possible sum of ranking (5) by all participants.

	Category	Main barrier (general)	sum per barrier	Rel score per barrier	Ranking per barrier
A	**1**	**Capital requirements**	*786*	0,68	1
G	**12**	**Public procurement policy**	*302*	0,66	2
F	**10**	**Patent filing, cost and regulation**	*450*	0,65	2
A	**2**	**Industrial biotechnology and biobased sectors perceived as sector with high investment risk**	*438*	0,63	4
E	**8**	**Suitable network and cooperation strategy**	*420*	0,61	5
E	**9**	**Knowledge exchange**	*139*	0,60	6
H	**13**	**Full assessment guidance**	*823*	0,60	7
H	**14**	**Robust standards and methods**	*407*	0,59	8
C	**6**	**Poor public perception**	*678*	0,59	9
B	**3**	**Logistics: securing large quantities of biomass**	*402*	0,58	10
G	**11**	**Demand-side policies**	*134*	0,58	11
B	**4**	**Feedstock at affordable prices**	*398*	0,58	12
D	**7**	**Skilled workforce**	*132*	0,57	13
B	**5**	**Sustainability of feedstock supplies**	*395*	0,57	14
I	**15**	**National and European policies and regulations**	*500*	0,54	15

Table 3: Ranking of the specific barriers per category (A,B,C,D,E,F,G,H) and main barriers (1 to 15) based on a survey with 43 respondents, biobased companies in Northwest Europe from Belgium, North of France (5), UK (10), Ireland (10), Germany (12), and The Netherlands (7). The relative score was calculated based on the total sum of the ranking (1 to 5) per specific barrier by all participants to the total overall sum of all replies of all specific barriers.

Category		Specific barrier		Sum per specific barrier	Rel score per specific barrier	Ranking per specific barrier
A	**1**	C	access to finance for spin-offs and start-ups (e.g. seed funding, VC funding)	164	0,027	1
F	**10**	A	lack of a harmonized international IP regulation	164	0,027	2
A	**1**	A	availability of public R&D funding (regional/national/European)	136	0,027	3
A	**1**	E	financial support for new production facilities	156	0,026	4
C	**6**	D	fundamental lack of understanding of industrial biotechnology	155	0,026	5
G	**12**	B	public procurement regulation	155	0,026	5
A	**1**	B	public support for scale up activities	153	0,026	7
H	**13**	B	unequal or unfair sustainability comparisons	152	0,025	8
A	**1**	D	access to finance for SME's	150	0,025	9
A	**2**	C	time “return to investment” too long for VCs	150	0,025	9
C	**6**	A	biobased products not visible enough: stakeholder knowledge in respect of bio refining activities is virtually non-existent	149	0,025	11
G	**12**	A	lack of an efficient green procurement legislation at regional/national level	147	0,025	12
A	**2**	A	lack of investor confidence in industrial biotechnology	146	0,025	13
E	**8**	C	difficult to establish (or take part in) an international network	142	0,024	14
F	**10**	A	long patent filing & award systems	143	0,024	15
F	**10**	B	high patent cost	143	0,024	15
A	**2**	B	lack of visible tangible products & blockbusters	142	0,024	17
H	**14**	C	lack of international agreed sustainability criteria	141	0,024	18
E	**8**	B	difficult to establish operational alliances between possible partners	140	0,023	19
C	**6**	E	negative messages in the media create fear for the unknown (e.g. indirect land use, genetic modification, food versus fuel, …)	139	0,023	20
A	**9**	A	inefficient technology transfer from academia to industrial applications	139	0,023	20
H	**13**	C	lack of commonly agreed and global assessment tools	138	0,023	22
H	**14**	C	lack of an international agreed certification system	136	0,023	23
E	**8**	A	inefficient collaboration between the partners of the value chain feedstock producers, converters, processing industry, downstream industries)	135	0,023	24

B 3	A	inefficient collection of feedstock	135	0,023	24
B 4	A	cost for feedstock biomass too high	135	0,023	24
B 4	B	varying feed stock prices	135	0,023	24
B 5	B	difficult to obtain “sustainable” feedstock	135	0,023	24
B 3	B	inefficient transport and distribution of biomass	134	0,022	29
G 11	A	commercial frameworks are not yet developed to promote biobased products (incentives, taxation, market supports, product standards and specifications etc.)	134	0,022	29
B 3	C	inefficient recovery systems for biowaste	133	0,022	31
B 5	C	sustainability' certification system inefficient and too expensive	133	0,022	31
D 7	A	lack of human resources with right skills and curricula	132	0,022	33
I 15	C	specific (regional/national/European) environmental regulation blocking the development of biobased products and/or processes	131	0,022	34
H 14	A	lack of efficient and transparent standards	130	0,022	35
I 15	A	lack of an international harmonized regulatory framework	129	0,022	36
B 4	C	(high) import costs for certain feedstock (e.g. ethanol)	128	0,021	37
C 6	C	benefits of biobased products not well-enough communicated	128	0,021	37
B 5	A	non-stable supply of feedstock	127	0,021	39
H 13	A	life cycle thinking not yet part of product development	126	0,021	40
I 15	A	inefficient agricultural policy	126	0,021	40
I 15	D	"sustainable" agenda creates hindering regulations and policies	124	0,019	42
C 6	C	lack of labelling (environmental performance, origin etc.)	107	0,018	43

Interestingly, when a breakdown of the results is done per country, some differences are visible between the countries. Whereas investment barriers are perceived within the top three hurdles in all countries, and hurdles for efficient collaboration and intellectual property related hurdles in some countries (The Netherlands, UK, Germany and Ireland, Germany, Belgium and France respectively) public perception barriers are only seen as prominent in Ireland, regulatory barriers in Belgium and France, demand side policies in the UK, and human resource barriers in the Netherlands.

3.2. Comparison with hurdles for larger companies (Bio-TIC project)

In the Bio-TIC project[76], possible hurdles for Industrial Biotechnology and biobased products were identified via literature study, stakeholder interviews, and during the several workshops. During these workshops, hurdles were also prioritised. Table 4 gives an overview of the hurdles with the biggest impact, selected by the participants of the workshops. In this case, stakeholders were mostly larger companies. As many of these companies are also producers of biobased products, and they want to do so in a cost-competitive way, it is not a surprise that in this table feedstock availability, supply and price was a major issue. For the innovative SMEs on the other hand, IPR issues, lack of financing and inefficient collaboration is a major issue.

76312121 – FP7-KBBE-2012-6-singlestage - http://www.industrialbiotech-europe.eu/

Table 4: Main hurdles identifies in the Bio-TIC project (larger companies)

Feedstock related barriers	Logistics: securing large quantities of biomass all year round	• Seasonability of biomass cropping versus need of continuous feedstock supply • Inefficient transport and distribution of biomass • Inefficient recovery systems for (bio)waste
	Feedstock at affordable prices	• Costs of feedstock produced in Europe are too high compared to other regions • Varying feedstock prices • (High) import costs for certain types of feedstock • No commonly accepted "sustainability" certification system
Investment barriers and financial hurdles	Capital requirements	• Limited availability of public R&D funding • Limited public support for scale-up activities • Limited access to finance for spin-offs and start-ups • Limited access to finance for SMEs • Limited financial support for new production facilities
	IB perceived as sector with high investment risk	• Too long "return of investment" time • Lack of visible tangible products and blockbusters • Lack of investors' confidence
Public perception and communication	Poor public perception and awareness of IB and Biobased products	• Advantages of biobased products are not visible enough • Negative messages in the media on GMO and biofuels influence perception of IB
Demand side policy barriers	Absence of incentives or efficient policies	• No framework to promote biobased products • Lack of a "green public procurement" policy promoting biobased products • Wide variety of ecolabels and no uniform standard present for sustainable and Biobased products

4. National and regional biobased related funding programmes

4.1. Schemes and scope

All countries have several funding programs in place at national and/or regional level oriented to innovation and equally fitting into the bio-economy concept. In general they have a broad scope of applicable areas based on new innovative technologies with clear economic objectives and targeted to SMEs. The focus is either on cooperation of academia with the industry, technopreneurship, product development including feasibility studies, prototype development, patent request, funding of high-risk and precompetitive R&D, or pilot and demo-activities (Table 5).

Some countries and/or regions in particular the UK, Germany (North Rhine Westphalia, Bayern), and The Netherlands have strongly invested in programs that are specifically oriented to biobased R&D and product development. Germany and The Netherlands are well advanced in biobased funding programs as they have a specific bio-economy strategy in place. The UK has implemented side policies that strongly point to that direction. The schemes for biobased funding are varying from R&D projects, feasibility studies, study grants, individual and collaborative research grants, innovation vouchers or awards, networks and consortia. The majority of the schemes are joint (collaborative, tandem) or individual research projects.

According to respective bio-economy strategies and policies the scope of the programs of each country is slightly different. The FNR Funding Program (Germany) is focusing on research in the field of renewable resources, bioenergy, renewable materials, biobased products, IB, and biofuels. The Netherlands have the TKI Biobased program in place facilitating the cascading use of biomass with innovation projects on biorefinery and conversion, and reduction projects on electricity, heat and green gas. The "MKB innovatieregeling (MIT)" program is meant to strengthen the knowledge based bio-economy through research and innovation under the form of technical feasibility studies, knowledge vouchers, deployment of highly educated personnel and researchers, R&D cooperation projects, innovation and performance contracts, as well as networking and valorization activities. UK is running at the forefront with its IB Catalyst program for biobased research, integration of new technologies and processes, exploration and evaluation of recent ideas build on recent discoveries to develop new technologies/processes, testing of proven processes at greater scale of operation, and new altered or improved processes or services. Also the funding through the IBT Club for the development of biological, chemical, and engineering processes for the production of chemicals, materials and polymers, is largely contributing to the development of the bio-economy. 'Sustainable Industrial Systems' is dedicated to the cost-effective production of chemicals and materials from sustainable and raw materials. Also the 'Manufacturing High Value Chemicals through IB' program, and the 'Developing added value chemicals from UK arable production' program is oriented to development and commercialization of innovative processes for high value chemicals. 'Bioscience' funds amongst others advanced materials, bioscience and energy, characterization and discovery tools, production and processing. Innovation vouchers are also given for the engagement of external experts in the agri-food, energy and water and waste sector.

Biobased R&D is also funded within networks (e.g. Belgium-Flanders with the International Industrial Biotechnology Network; The Netherlands with CAPITA, UK with the NIBBs), consortia (e.g. UK with the BBRSC Sustainable Bioenergy Centre) and technology platforms (e.g. Belgium-Wallonia with Greenwin; and Belgium, Germany and the Netherlands with SUSCHEM). Participation in consortia at European level in the field of bioenergy and/or industrial biotechnology is concretized through the European Research Area (ERA) Networks in Bioenergy and Industrial Biotechnology. Belgium (Flanders), Germany, The Netherlands and the UK participate in the ERA-IB2 and the latter three also in the ERANET Bioenergy. The objective of ERA-IB2 is on joint research projects and more intense communication and dissemination activities.

Table 6: Overview of schemes and main scope of activities of biobased funding programmes per country (Belgium, Germany, Ireland, The Netherlands and UK) and funding agencies

Funding agency	Funding Program	Scheme	Scope/priority areas
Belgium			
Flanders			
IWT	R&D Projects	Industrial R&D projects	New knowledge and development of innovative solutions
	SME-Innovation Project	R&D projects	Innovation, development of a new process or innovation of an existing process
	SME-Feasibility Study	Feasibility study	Innovation including technological and non-technological competences
	BM	Study grant	Support research with clear economic objectives leading to a PhD
	IM	Postdoctoral study grant	Active transfer, exploitation and utilization of findings through collaboration with existing company or establishment & spin off company
	TETRA project	R&D projects	Translate scientific knowledge or explore the application domain of new technologies or methods (prototype)
	VIS	Feasibility Studies	Development of innovation strategy or initiative by a sector/group of companies
IWT & EWI	ERA-IB	ERA-net	Increasing Europe's competitiveness in the area of IB
EWI	IIBN	International network/demo projects	Tech transfer and knowledge exchange in the field of IB
Walloon Region			
Regional government	Greenwin	Platform and R&D projects	Innovation and environmental technologies accelerator
Germany			
BMBF	Innovations Initiative "Industrielle Biotechnologie"	Collaborative research projects	Development of innovative processes or products using a biological process
	Next Generation Biotech. Process	Research Award	Enabling technologies
	Biotechnologie 2020+	Individual, joint & tandem	Relevant research and technological milestones for biotechnological processes
	Go-Bio2 round 6	R&D projects	Enabling novel production processes
	KMU-innovativ:Biotechnologie-BioChance	Industrial R&D project	Validation/spin-off projects in biotechnology and high-risk and precompetitive industrial R&D projects in the field of modern biotech

	Ideenwettbewerb "Neue Produkte fur die Bioökonomie"	Exploratory stage; feasibility studies	Development of a new product idea for the biobased economy and technical plan for implementation
	Bio-economy International 2014		Securing global nutrition, shaping agricultural production sustainably, producing safe & healthy food products, using renewable resources on an industrial scale; developing energy sources based on biomass Focus on international cooperation
BMBF & FNR & SMUL	ERA-IB	ERA-net	Increasing Europe's competitiveness in the area of IB
FNR	ERA-Bioenergy	ERA-net	Structural cooperation between national bioenergy research programs in the MS
BMELV & FNR	FNR Funding Program	Individual & joint R&D projects Funding for research and pilot projects	Research in the field of renewable resources, bioenergy, renewable materials, biobased products, IB, and biofuels
BMWI	ZIM	Individual & joint R&D projects; cooperation networks	Market based funding of technology for innovative German SMEs
Ireland			
EI	R&D Fund Standard Projects	R&D project	Support of projects with the potential to develop novel products and services
	R&D Fund Small Projects	R&D project	Strengthen key market offering through developing novel product and services: • establish or increase R&D activity • demonstrate connection between R&D and the overall business activities • a culture of innovative thinking which aims to harness the skills of all staff, establish or increase R&D capability • establish or develop quality R&D management, systems and procedures
	Innovation Partnership	Collaborative research project	Encourage companies to access the research of universities, technology institutes and other RO
	Technical Feasibility Study Grants	Feasibility study	• development of new products, technological processes or international traded services • improvement, redesign or development. of existing products, services, or processes • viability of extending or expanding company facilities to meet increased operational capacity needs • investing the potential or application of new technologies or licensing in new technologies • researching and developing a project proposal for funding under FP7
	Industry Led Research Network Programme	Shared agenda research project	Engage wide spectrum of companies with a commercial interest-sharing benefits & risks
	High Potential Start-up Feasibility Starting Grant	Feasibility study	Investigate viability of new export oriented business or proposition: market research,

			business plan development; technical research and prototyping
	Internationalisation Grant	Market Study	Research and explore business in international markets
	New Geographic Market Research Grant	Market study	Undertake an intensive market research assignment in a new geographical market
SEAI	ERANET-Bioenergy	ERA-net, joint calls	Structural cooperation between national bioenergy research programs in the MS
N&S Ireland			
InterTradeIreland	FUSION programme	Tech transfer through mentorship, feasibility study	Bolster business, bottom-line and get ahead of competition
EI	Competitive Feasibility Fund for Female Entrepreneurs	Feasibility study	Assistance of a female-led start-up company or female entrepreneur to investigate the viability of a new growth oriented business
	Competitive Feasibility Fund		Investigate the viability of a new growth oriented business in the region(High Potential Start-Up Companies)
IRO	Employment Based Feasibility Programme	Study grant	Offer researchers to undertake an MSc/PhD programme in a private company
The Netherlands			
National	TKI Biobased	R&D projects	Facilitatates cascading use of biomass: biorefinery, chemical& biological conversion technologies, biorefinery and conversion (innovation projects); electricity, heat and green gas (reduction projects)
	MIT	• Technical feasibility study Knowledge voucher • Deployment of highly educated personnel & researchers • R&D cooperation project • Networking & valorization activities	Strengthening the KBBE through facilitation of research and innovation
NOW	ERA-IB	ERA-net	Increasing Europe's competitiveness in the area of IB
	CAPITA	R&D Network	Transnational cooperation in applied research leading to innovative and exploitable manufacturing technology for chemicals, materials and energy
RVO	ERANET-Bioenergy	ERA-net	Structural coop. between national bioenergy research programs in the MS
	SUSCHEM	Technology platform	Sustainable energy: resource and energy efficiency, water, raw materials, smart cities, enabling technologies, education
Min. Economic Affairs	Starterslift Preseed Loan	Feasibility studies, patent request, etc.	Facilitating initial steps taken in business

Regional	Proof of Concept Fund	Shares	Participative financing in combination with subordinated loans
	REAP West Brabant subsidy	Projects	Contrib. to the Strategic agenda of W-Brabant (biobased, logistics, maintenance)
	BOM Venture		Fund for development
	BOM Development Fund	Project, shares	Loan for initial startup and further development towards first production.
UK			
BBSRC/EPRSC	IB catalyst R&D grants	Translation award	Biobased research
TSB		Early & late stage feasibility award	Integration of new technologies and processes
		Industrial research awards	Exploration/evaluation of commercial potential for innovative ideas
		Late stage development award	• Build on recent discoveries to develop new technologies/processes • Test proven processes at greater scale of operation • New altered or improved processes or services
BBRSC/EPSRC/ Industry	IBT Club	Research grant	Development of biological, chemical, and engineering process for the production of chemicals, materials and polymers
BBRSC/EPSRC	NBBs	Network	Networking and development of multidisciplinary research proposals and industrial biotechnology and bioenergy
BBRSC	SLoLas	Research grant	Industrial Biotechnology and Bioenergy (IBBE)
	Responsive mode	Research grant	Fundamental research
	LINK	Collab. research grant	Collaborative research with at least one company and one science-based partner
	IPA	Collab. research grant	Collaborative research with at least 1 company and 1 science-based partner
	BBRSC Sustainable Bioenergy Centre	Consortium	Bioenergy research /conversion of biomass to biofuels
EPRSC	IPA	Student scholarship	industrial partnerships
EPRSC	Sustainable Industrial Systems	Research calls	e.g. Cost-effective prod. of chem. & materials from sustainable and renewable raw material
TSB	Bioscience	Technology inspired compet.	Innovation/advanced materials, bioscience/energy, health care, resource efficiency, characterisation and discovery tools, production and processing
	Innovation Vouchers	Voucher	Engagement with external experts/agri-food, built environment, space, energy, water and waste, open data

	Smart Awards	Grants for proof of market, proof of concept, prototype development	
TSB/BBRSC	ERA-IB	ERA-net	Increasing Europe's competitiveness in the area of IB
TSB/BBRSC	ERANET-BIOENERGY	ERA-net	Structural cooperation between national bioenergy research programs in the MS
HGCA of AHDB	Developing added value chemicals .	Research calls	Deliver a world class industry through independence, innovation, & investment

4.2. Characteristics of the funding programmes

The emphasis of regional programmes is on regional economic growth and development based on innovation. In some cases regional programmes are linked to certain aspects of the biobased economy related to the infrastructural capacity, industrial and agricultural activities of the region. There are however few specific regional funding R&D programmes that are specifically targeted to biobased activities. The REAP subsidy of the West-Brabant region in the Netherlands for example is linked to biobased funding, logistics and maintenance.

Biobased regional funding is allocated to clusters that often also carry out R&D activities with a region specific scope. The Walloon region in Belgium with Greenwin as an innovation and environmental technologies accelerator puts a strong accent on environmental sustainability with as priority areas the development of sustainable products and materials, the sustainable integration and roll-out for materials, and the treatment and recovery of waste effluents.

Many regional clusters are working transnational or interregional. Biobased Delta, for example, cooperates with the regions of Flanders, North Rhine Westphalia and the North of France. The European Interregional Programme INTERREG (e.g. INTERREG Vlaanderen-Nederland) is stimulating cooperation between the regions and can be applied to the bio-economy as well. For example, the Bio Base Europe Pilot Plant is supported by INTERREG Vlaanderen-Nederland[77] and through the Bio Base NWE European and regional partners joined forces to accelerate the bio-economy development in North West Europe [78]. Interestingly, Bio Base NWE provides financial support for SMEs in the different regions under the form of an innovation coupon worthy of 10 000 or 30 000 Euros.

Further to the ERA and INTERREG projects, few programmes at national and regional level are immediately directed to interregional cooperation. The German FNR program stimulates the interregional cooperation at condition that the feedstock is cultivated in Germany.

Although not specifically mentioned in national and regional programs, there is often room for transnational and interregional cooperation with funding of activities in the own region or country. The main bottleneck to co-fund an interregional project through current programs may be the not corresponding timing of the calls and/or the duration of the programs. Grants for feasibility studies for example could be combined by several partners in different regions (countries) at condition that they are linked in an integrated multidisciplinary approach where each partner has a specific task within the study. The same principle can theoretically be applied for any other project (e.g. R&D project, demonstration project) or study (market study, prototype development etc.).

77 http://www.grensregio.eu
78 http://www.biobasenwe.org/en/home/

Table 6:: Overview of funding programmes with call period, call frequency and target group (Belgium, Germany, Ireland, The Netherlands, and UK)

Funding agency	Funding Programmes	Call Period	Call frequency	Target Group	Interregional collaboration possible
Belgium					
Flanders:					
IWT	R&D Project	3y	permanent	SMs/large business/RO	x
	SME-Innovation Project	2y	permanent	SME /RO	x
	SME-Feasibility Study	1y	permanent	SME /RO	x
	BM	2y		SME/RO	
	IM	2 to 3y		SME/RO	
	TETRA project	2y		SME/RO	x
	VIS	2-6y		SME/Industry	
IWT & EWI	ERA-IB	2012-2015/4y		RO/Industry	
EWI	IIBN	2011-2015		SME/Industry/RO	x
Walloon Region					
Regional Government.	Greenwin			SME	
Germany					
BMBF	Innovationsinitiative industrielle Biotechnologie	2011-2015		SME/RO	x
	Next Generation Biotech. Processss-Bioetchnologie 2020+	2011-2013		RO/Industry	x
	Go-Bio2 round 6	3y phase I; 3y phase II		Spin off/Start-up/SME/RO	
	KMU-innovativ:Biotechnologie-BioChance	2007-		SME/RO	
	Ideenwettbewerb "Neue Produkte fur die Bioökonomie"(Exploratory stage; feasibility study)	2013-/9m phase I		SME	
	Bio-economy International 2014	2014-		RO/Industry	x
BMBF & FNR & SMUL	ERA-IB	2012-2015/4y	1 per year	RO/Industry (mandatory)	x
FNR	ERANET-Bioenergy	2011-2014/4y		Translational consortia, industry/SMEs/ RO, stakeholder associations	x
BMELV & FNR	FNR Funding Program	2013-	permanent	SME/large business/RO	X (if feedstock

BMWI	ZIM	2014-		SME/RO	cultivated in Germany)
Ireland					
EI	R&D Fund Standard Projects	2013-	Monthly	SME	
	R&D Fund Small Projects			SME	
	Innovation Partnership			SME/RO	
	Technical Feasibility Study Grants			SME	
	Industry Led Research Network Pogramme	9m-2y		SME/RO	
	High Potential Feasibility Starting Grant			SME/Startup/Entrepreneur	
	Internationalisation Grant			SME	x
	New Geographic Market Research			SME	
SEAI	ERANET-Bioenergy			RO	
N&S Ireland					
InterTradeIreland	FUSION Programme	12-18m		SME/RO	x
EI	Competitive Feasibilty Fund for Female Entrepreneurs			SME	
	Compettitive Feasibility Fund for NE/NW Region			SME	
IRO	Employment Based Feasibility Programme			SME/RO	
The Netherlands					
National	TKI Biobased:				x
	TKI Innovation Projects	2013-		SME/Industry/RO	
	TKI Reduction Projects	2013-		SME	
	MIT: • Technical feasibility study • Knowledge voucher • Deployment of highly educated personnel & researchers • R&D cooperation project • Networking & valorization activities	2013-		SME	
	Deployment Highly Educated Personnel & Researchers			SME/RO	

	R&D Cooperation Projects				
	Networking and valorization activities	2012-2015			x
NOW	ERA-IB			RO/Industry (m)	x
	CAPITA				x
RVO	ERANET-BIOENERGY			Transnational consortia, Industry/SME/RO	x
	SUSCHEM			Industry/SME/RO	
Min. Economic Affairs	Starterslift Preseed Loan			SME	
Regional	Proof of Concept Fund			SME	
	REAP West Brabant Subsidy				
	BOM Venture	2014-			
	BOM Development Fund	2014-2018	2 per year	SME/Consortia	
UK					
BBSRC/EPRSC/	IB catalyst:				
TSB	• Translation Awards	2014/11	2 per year	RO	x
	• Early Stage Feasibility Awards	2014/12	2 per year	Industry/RO	x
	• Industrial Research Awards	2014/13	2 per year	Industry/RO	x
	• Late Stage Feasibility Awards	2014/14	2 per year	Industry/RO	x
	• Late stage Experimental Development Awards	2014/15	2 per year	Industry/RO	x
BBRSC/EPSRC	IBT Club	2010-2015/5y	Closed	RO	
	NBBs	2014-2019/variable	Open	RO	
BBRSC	SLoLas	up to 5y	Open	Industry/RO	x
	Responsive mode	Variable	Open	RO	x
	LINK	3-5y	Open	Industry/RO	x
	IPA Collaborative Research Grants	Variable	Open	Industry/RO	x
	BBRSC Sustainable Bioenergy Centre	Closed	Closed	Industry/RO	x
	IPA (Student Scholarships)		Open	Industry/RO	x no UK
TSB	Bioscience	up to 4m	not defined	Industry	x
	Manufacturing High Value Chemicals through IB				
	• Innovation Vouchers	Variable	Open	Start-up/SME	no
	• Smart Awards: proof of market	9m	Open	SME	x

	• Smart Awards: proof of concept	18m	Open	SME	x
	• Smart Awards: prototype development	2y	Open	SME	x
TSB/BBRSC	ERA-IB	Variable	1 per year	RO/Industry (m)	x
TSB/BBRSC	ERANET-BIOENERGY	2012-2015/4y		Transnational consortia	x
tabeHGCA of AHDB	Developing added value chem. from UK arable production	2011-2014/variable	3 per year	RO	

4.3. Budgets

The majority of the funding programs in all countries and regions stimulate the participation of SMEs in projects in collaborations with research organisations. Some of them are particularly targeted on novel technologies and production processes, and also SMEs. Most of these funding programs are however not specifically linked to biobased activities (Table 5 and 6).

Total budgets for SME-oriented R&D programs in the biobased field range from 2M GBP for a technology inspired competition project on innovation/ advanced materials, bioscience/energy, health care, resource efficiency (Bioscience, TSB, UK) to 60M Euro maximum (FNR funding program, Germany) for R&D in the field of renewable resources, bioenergy, renewable materials, biobased products, IB and biofuels.

The funding per project varies from 5k pound for an innovation voucher (UK) to 650k Euro for support of R&D standard projects with the potential to develop novel products and services.

In most cases for all projects that are open for cooperation between RO and the industry co-financing is required from the latter.

Table 7: Overview of total budget and maximum budget per project per country (Belgium, Germany, Ireland, The Netherlands, and UK) and funding agency (* Requires co-funding from the industrial partner).

Funding agency	Funding program	Total budget	Max budget per project
Belgium			
Flanders	O&O projects		100k to 3M*
IWT	SME-Innovation Project		50k to 250k*
	SME-Feasibility study		10 to 25k (exc.50k)
	BM		160k
	IM		ND*
	TETRA projects		100 to 480k*
	VIS		8 FTE/y *
&EWI	ERA-IB		ND*
EWI	IIBN	1250k	15k*
Walloon Region			
Regional Government	Greenwin	60M	60-80%
Germany			
BMBF	Innovations initiative industrielle Biotechnologie	ND	50% SME or 100% RO*
	Nachste Generation biotechnologischer Verfahre-	ND	ND*
	Biotechnologie 2020+		ND*
	Go-Bio2 round 6:phase I		75k*
	phase II		200k*
	KMU-innovativ:Biotechnologie-BioChance	ND	50% SME or 100% RO*
	Ideenwettbewerb "Neue Produkte fur die Bioökonomie"		50k RO*
	Feasibility study		250k individual projector 250k per partner

	Exploratory stage		25k SMEs
&FNR&SMUL	ERA-IB		
FNR	ERA-BIOENERGY		
BMELV&FNR	FNR Funding Program	60M	100% fund., 50% industr.* 20% exp.res.
BMWI	ZIM		2M*

Ireland

EI	R&D Fund Standard Projects		650k*
	R&D Fund Small Projects		150k
	Innovation Partnership		200k*
	Technical Feasibility Study Grants		35k*
	Industry Led Research Network Programme		ND*
	High Potential Start-up Feasibility Starting Grant		15k*
	Internationalisation Grant		35k*
	New Geographic Market Research Grant		80k*
	FUSION Programme		52,8k*
	Competitive Feasibility Fund for Female Entrepreneurs		25k*
	Competitive Feasibility Fund North East/West Region		25k*
IRO	Employment Based Feasibility Programme		96k

Netherlands

National	TKI Biobased		
	TKI Innovation orojects	3,7M	500k*
	TKI Reduction projects	24,6M	1M
	MIT:	22M	
	Technical feasibility studies		50k*
	Knowledge vouchers		7.5k*
	Deployment of highly educated personnel and researchers		50k*
	R&D cooperation projects		150k*
	IPC		30k
NWO	Networking and valorization activities		100k
	ERA-IB		
	CAPITA		
RVO	ERANET-BIOENERGY		
	Starterslift preseed loan		35k
	Proof of concept fund		125k
	REAP West Brabant subsidy		25k
min Ez	BOM Venture		100k
Regional	BOM Development Fund	20M	200k

UK

BBSRC/EPRSC/	IB catalyst R&D grant:	45M	
TSB	Translation Awards		2-5M
	Early stage feasibility awards		0,25M*
	Industrial Research Awards		5M*
	Late stage (pre-experimental) feasibility awards		1M*
	Late stage (experimental) development awards		10M*
BBRSC/EPRSC/ Industry	IBTI Club	6M	
BBRSC/EPRSC	NBBs	15M	variable for feasibility studies
BBRSC/EPRSC	SLoLas		over 2M each*
BBRSC	Responsive mode	ND	ND
	LINK Collaborative Research	ND	ND*
BBRSC	Industrial Partnership Awards Collaborative Research	ND	ND*
	BBRSC Sustainable Bioenergy Centre	27M	
	Industrial Partnership Awards student Scholarships	ND	68,648k*
	Sustainable Industrial Systems	10.7M + 1.1 M BBSRC	
TSB	Bioscience	2M	0,33M
	Innovation Vouchers		5k
	Smart Awards: proof of market	ND	25k*
	Smart Awards: proof of concept	ND	100k*
	Smart Awards: prototype development	ND	250k*
TSB/BBRSC	ERA-IB	ND	300k per UK* industrial participant
TSB/BBRSC	ERANET-BIOENERGY	ND	Idem above
HGCA of AHDB	Developing added value chemicals from UK arable production	ND	defined per theme

5. NATIONAL AND REGIONAL CLUSTERS

Dedicated clusters are groups of similar and related firms, research institutes, agencies, investors, etc. in a defined geographic area that share common markets, technologies, worker skill needs, and which are often linked by buyer-seller relationships. In some cases these clusters are real public-private partnerships and/or funding research and innovation projects. In other cases the focus is more on networking and /or financing specific studies of common interest.

Each country harbours a number of biobased regional clusters (see Table 8). In few cases clusters are at national level with the aim to network and stimulate cooperation, partnering and knowledge exchange. Regional clusters are often dispersed at geographically important intersections along industrial axes with an elaborated infrastructure. Biobased Delta for example harbours knowledge institutions and biobased agro and chemistry business in the Green Chemistry Campus and is stretched along the industrial axis Antwerp-Rotterdam in the Southwest Netherlands near the port of Vlissingen.

Most of the regional clusters are in Germany (Bayern, North Rhine Westphalia) followed by The Netherlands and Belgium. In most cases the clusters are constituted of the public and private sector organisations and strongly supported by regional funding agencies or organisations. The scope of their activities varies from networking, service provider, R&D in the field of industrial biotechnology, bioenergy, green technology, environmental technology and green sustainable chemistry. The emphasis of the R&D depends on national and regional innovation and science policies. At TCBB for example research is carried out on the next generation feedstock such as grasses and algae that do not compete with food and can achieve a higher energy balance and a greater potential to reduce greenhouse gas emissions. Other research themes are conversion process technologies to unlock the energy and co-product potential from feedstocks with a particular relevance to Ireland and onwards commercialization of platform chemicals. The Biobased Delta has a Centre of Expertise Biobased Economy (CoE EBBE) that serves as a knowledge centre, a centre for education and R&D on sustainable biomass (algae and agricultural waste), green building blocks, sustainable process technologies with closed loops.

In the Netherlands, many regions are actively involved in the biobased economy, as it offers new economic opportunities and possibilities for existing sectors, e.g. between the agro, chemical and energy sectors. Each region has its specific opportunities and characteristics, e.g. existing infrastructure such as ports, but also existing industry or agriculture. A nice overview of all local initiatives in The Netherlands is given at the Dutch Biobased Economy website[79].

Some clusters also have a bioincubator or biobased business accelerator to stimulate entrepreneurship, have pilot and/or demo facilities (TCBB) or closely cooperate with nearby pilot plants (e.g. GBEV and Biobased Delta with the Bio Base Europe Pilot Plant). Many clusters give targeted support for SMEs that are eligible for funding of national and regional funding programmes. BIO-NRW (North Rhine Westphalia) has even a Business Angel Network to assist start-ups to get established. An non-exhaustive overview of all clusters is given in Table 8.

79 http://www.biobasedeconomy.nl/bedrijfsleven-biobased/regios/

Table 8: Overview of most important federal and regional biobased clusters with main scope, activities, funding agencies and sponsors per region and country (Belgium, Germany, Ireland, The Netherlands). Clusters marked with an asterisk allocate funding to SMEs and/or assist SMEs in acquiring funding.

Name and website	Main Scope/Activities	Region/Country	Main funding agencies/sponsors
CINBIOS www.cinbios.be	Industrial biotechnology, networking	Flanders, Belgium	Flandersbio, Essenscia, GBEV
*FISCH** www.fi-sch.be	Sustainable chemistry, networking, SME service provider	Flanders, Belgium	IWT, Agentschap Ondernemen, TINA, European projects
GBEV www.gbev.org	Biobased economy, innovation, communication	Flanders, Belgium	Ghent University, City of Ghent, Port of Ghent, the Development Agency of East Flanders
TWEED http://clusters.wallonie.be/tweed-en/	Renewable energy, sustainable development, networking, studies	Wallonia, Belgium	Companies, investors, local authorities
*GREENWIN** www.greenwin.be	Green chemistry, sustainable materials, environmental technology, R&D, service provider	Wallonia, Belgium	Local authorities, associations, companies
*CLIB2021** www.clib2021.be	Industrial biotechnology, networking, innovation	North Rhine Westphalia, Germany	Local authorities, companies, universities
BIOKATALYSE 2021 www.biokatalyse2021.de	Industrial biotechnology, networking, R&D service provider	Federal, Germany	Federal agency BMBF, companies, universities
CIB-Frankfurt www.cib-frankfurt.be	Industrial biotechnology, cooperation, information, communication	Hessen, Germany	Hessen Ministry for Economics, Hessen Trade and Invest
Biocampus www.straubing-sand.de/biocampus	Renewable feedstock, networking, bioincubator	Bayern, Germany	Local authorities, companies
Industrielle Biotechnologie Bayern Netzwerk Gmbh www.ibbnetzwerk.gmbh.com	Industrial biotechnology, networking, tech transfer	Bayern, Germany	Local authorities, companies
*TCBB** www.tcbb.ie	Biorefining, bioenergy, networking, R&D	Federal, Ireland	Enterprise Ireland, IDA Ireland
*Biobased Delta** www.biobaseddelta.nl	Biobased economy, networking, R&D education	Southwest Netherlands	Regional authorities, MKB
*Be-BASIC** www.be-basic.org	Industrial biotechnology, green chemistry, networking, service provider	Netherlands	Ministry of Econ. Affairs, Agriculture, and Innovation, companies, knowledge institutions

6. PILOT AND DEMO PLANTS

Large and small scale pilot and demonstration facilities for biobased products and processes are strategically located near ports, or industrial and technological parks. Most biobased pilot plants are located in the UK (4) and Germany (3). Some are specialized in specific bioprocesses or production schemes such as gasification, cellulosic ethanol production, plastic manufacturing from CO_2, while others are multipurpose and multifeedstock and/or specialised in alternative feedstock development and biomass exploitation. Pilot and demoplants are in general subsidised by the Region, interregional programmes and the European Union or at federal level. Collaboration schemes are sometimes a public-private partnership (e.g. ETP-W) or partnership between universities (e.g. the BEACON Centre) or other forms of cooperation.

Several pilot plants offer practical training and education programmes. Bio Base Europe for example organises training for skilled process operators and technical staff for biobased and sustainable energy processes in its training center in Terneuzen, The Netherlands. NBIRT offers flexible training programmes targeted at the industry and education at undergraduate and postgraduate level to learn bioprocessing procedures. An overview of the different pilot and demo plants is given in Table 9.

Table 9: Overview of pilot plant (and demo) facilities and scope of activities per region and country (Belgium, Germany, Ireland, The Netherlands, UK)

Name	Website	Scope	City/Region/Country
Bio Base Europe Pilot Plant	www.bbeu.org	Multipurpose plant for biobased products and processes	Port of Ghent, Flanders, B
ETP-W	www.etp-w.be	Integrated gasification process demo plant	Liège, Wallonia, B
NIBRT	www.nibrt.ie	Pilot plant facilities of varying size for scale up	Dublin, Ulster, EI
Biorefinery CBP	www.cbp.fraunhofer.de	Lignocellulose refinery	Leuna, Saksen-Anhalt, D
IBB Gmbh	www.ibbnetzwerk-gmbh.com/de/	Cellulosic ethanol and acetic acid demonstration plants	Bayern, D
Chempark Leverkusen	www.chempark.de	Plastic manufacturing with CO_2	Leverkussen, North Rhine-Westphalia, D
BE-BASIC	www.be-basic.org	Industrial chemistry and bioprocess facility	Delft, South Holland, NL
The Biorefinery Centre	biorefinerycentre.ifr.ac.uk	Second generation biofuels, biomass exploitation, fibre modification, yeast screening and propagation	Norwich, East of England, UK
CPI, NIBF	www.uk-cpi.com	Small scale pilot production	North East of England, UK
BDC	www.biorenewables.org	Scale up including feedstock development and molecular analysis	York, UK
The BEACON Centre	www.beaconwales.org	Bioenergy refinery from grasses e.g. rye	Aberyswyth, Wales, UK

7. INTERREGIONAL COLLABORATION in NWE: SWOT ANALYSIS and RECOMMENDATIONS

7.1. SWOT analysis

7.1.1. Strengths

- Several countries and regions have a specific strategy and action plan for the bio-economy
- Some countries and regions have already funding programs in place that are specifically linked to the biobased economy
- There are many regional clusters geographically located along industrial axes
- Some regional clusters offer training and educational programs (human capacity building)
- In all countries there are several programs in place that are targeted to technology driven innovation (SMEs, industry and cooperation with academic institutions) that can be applied within areas of the biobased economy
- There are already a few examples of successful transnational cooperation schemes with a focus on integrated approaches and private and public sector participants (e.g. ERA-NET Bioenergy, Interregional clusters)
- Many innovation programs based on new technologies are oriented to SMEs
- Many biobased topics are addressed (e.g. by clusters and pilot plants) which gives a solid basis to enhance further development of technologies and business cases

7.1.2. Weaknesses

- Although many countries or Regions have a bio-economy strategy, concrete actions plans (implementation) with a specific budget are often missing
- There are no interregional R&D programs oriented to cooperation between specific regions (with the exception of UK-Norway)
- Overlapping activities (duplication) and not fully using the biobased potential available (as a result of lack of interregional coordination and focus)
- Demand-side and market development staying behind on technology development
- Funding programs are oriented to development within the region (borders)
- Some countries have no specific biobased funding programmes in place
- The funding landscape is scattered: different budgets, call period and frequency, duration of the project
- The main bottleneck to co-fund an interregional project through current programs may be the not corresponding timing of the calls and/or the duration of the programs

7.1.3. Opportunities

- Some regional clusters are starting a more structural cooperation
- Although complex, combination of existing national and regional funding programmes is possible (cfr. Era-Nets)
- Interregional cooperation along industrial axes with elaboration of existing infrastructure has started (cfr. Bio Base Europe, UK-Norway collaboration)
- Combination of individual strengths of respective regions to cover value chain and make closed loops
- EU programmes to enhance interregional co-operation provide opportunity to formulate an interregional biobased programme

7.1.4. Threats

- Self-centered regions focusing on their own region specific targets
- Investment for new infrastructure or for of elaboration infrastructure often absent
- Not enough human capital
- There is still an innovation gap
- Incomplete biomass value chains
- Insufficient financial flow for SME participation
- Still low attractiveness for investors, and often lack of confidence
- Inefficient use of R&D, finances and human capital (as a result of the overlapping activities)

7.2. BEST PRACTICES AND RECOMMENDATIONS

7.2.1. Interregional clusters

Clusters are often situated at geographically important locations and along industrial axes with extensive infrastructure and equipped logistics chains e.g. Biobased Delta (Southwest Netherlands) is located along the industrial axis Antwerpen-Rotterdam with several ports and in an area with a strong chemical and agrosector. The infrastructure was the basis for strategic cooperation with other regions nearby in the Netherlands and also Flanders.

Interregional clusters consisting of sub regional clusters and/or companies and research organizations can largely contribute to integrated regional cooperation in biobased activities. This allows not only strategic networking, sharing of facilities, infrastructure and know-how between the different clusters and regions, but to combine regional and/or national funding. For example, the recently created bio-innovation megacluster BIG-C[80] composed of 10 leading public and private organisations in biobased innovation of North Rhine Westphalia, The Netherland and Flanders, has been launched. The megacluster covers an important industrial region for innovation in North Western Europe and concerted efforts will add value for the whole region. The strong point of the megacluster is the connectivity of the subclusters in the region by pipeline, river and road. Problems e.g. related to feedstock and production can also easier and more strategically be tackled with an integrated strategic closed loop approach. Moreover, coordinated actions create not only attractive environment for pilot and demo activities in frame of large innovation programmes (e.g. EU programs such as BBI and SPIRE) but also create an attraction pool for foreign investors and venture capital, which facilitates the participation of SMEs. The megacluster is an initiative of FISH (Flanders), Biobased Delta (The Netherlands) and CLIB 2021.

7.2.2. Multidisciplinary cooperation under the form of interregional PPPs

Public private partnerships under the form of e.g. consortia and clusters, are an efficient way to close the innovation gap that is often experienced between the actual research stage, development of a prototype and the development of the product in the commercial pipeline. Most of the clusters are a mixture of associations, regional authorities, companies, universities and research organizations. The formation of a PPP, where all parties commit to invest from their own resources, strengthens the cooperation between the public and private sector resulting in targeted research and actions towards development and commercialization of a product.

Ghent Bioeconomy Valley[81] for example was founded in 2005 as a public private partnership between Ghent University, the City of Ghent, the Development Agency East-Flanders and different industrial companies of the region.

80 http://www.fi-sch.be/nl/wp-content/uploads/Version-180414-BIG-C-position-paper.pdf
81 http://www.gbev.org

Within this partnership the different players joined forces and were able to realize 80% of the Flemish quotum for biofuels.

PPPs stimulate the participation of companies and SMEs, and are more attractive for external funding and are also subject to European funding. Additionally PPPs can facilitate the access to investors and venture capital, which is beneficial to SME participation. Therefore, funding by local and regional governments should be strongly encouraged.

7.2.3. Interregional government partnerships

Partnerships between regional governments with the same ambitions and vision on the bio-economy and priorities in the field may foster collaborations that are specifically directed to join forces to promote green economic growth in a strategic economically important area.

For example, the UK and Norway have recently decided to form an energy partnership for sustainable growth[82]. The partnership will contribute to reach green growth, climate change and energy security objectives by providing a clear policy framework to support industry in developing the full potential for North Sea renewable energy; supporting the commercial development of electricity interconnection between the UK and Norway, cooperating to develop the Carbon Capture and Storage (CCS) technology; improving discussions on natural gas and leading efforts on international climate change policy and diplomacy. The partnership will work on biomass utilization (marine co-products, seaweed, microalgae and wood) and ensures the industrial stakeholder engagement through industry driven projects through joint funding calls. The budget for R&D grants is 2.5 million GBP from each country over 3 years for funding of 5-15 projects. The partnership also allows identification of common projects and markets (opportunity mapping, networking events, interlinked webportals) and the mutual exchange of knowledge, personnel and strategic cooperation between demonstration activities.

7.2.4. Shared pilot and demonstration facilities

Interregional cooperation can also create a win-win situation through sharing facilities such as pilot and demo plants for scaling up and proof of concept. Demonstration projects are not only an important step in the commercialization process, they are also crucial in gaining confidence and attracting investors. The sharing of pilot and demo facilities can be obtained through cooperation within an interregional cluster or consortia.

As an example, Flanders and The Netherlands (with the support of the European Union via Interreg) have joined forces to build state-of-the-art research and training facilities to speed up innovation and the economic growth in the area of the biobased economy. Bio Base Europe consists of the Bio Base Europe Pilot Plant (located in Ghent, Flanders) and the Bio Base Europe Training Center (located in Terneuzen, Netherlands).

7.2.5. Mobility grants

Interregional mobility grants at different education levels are important for knowledge exchange and stimulation of interregional cooperation and development on joint themes. Within cooperation schemes such as interregional

82 Promoting a British-Norwegian energy partnership for sustainable growth
https://connect.innovateuk.org/web/norway-and-uk

clusters and PPPs, mobility should be strongly encouraged to strengthen the human capacity. Advantage can also be taken from existing educational programmes. Several clusters have training centers to form skilled work force or have a graduate degrees at the MSc and PhD level.

7.2.6. Integrated and joint R&D calls

Integration of innovation and/or SMEs and biobased targeted actions would contribute to bridging the innovation gap towards processing and marketing of biobased value added products. Also the integration and concerted actions for R&D projects and grants, scholarships, feasibility grants, market studies etc. at regional and interregional level could be done to allow the combination of the funding resources at each level. To achieve this, calls could be made e.g. at a commonly defined fixed time/period of the year or alternatively be permanent or open access throughout a longer period of the year. Also the duration of the projects should be harmonized so that advantage can be taken of combining resources and efforts from different regions and regional partners in an interregional cooperation with common targets with different backgrounds and disciplines. The UK-Norway initiative is a good example how this can be done.

7.2.7. Setting up sustainable value chains: web-portal inventory

To develop a competitive biobased economy, it is important to create sustainable value chains (from feedstock production or supply, collection and logistics, conversion, production to market), and these do not necessary have to be developed within one single region. Often one Region has a surplus of a certain feedstock and a other region the technological know-how or the industrial expertise.

An interregional platform coupled to a web-based portal database would be very useful to stimulate co-operation between all stakeholders in the biobased field. Such an open web portal could be helpful to find the partners for new and innovative value chains. But it can also give an overview of all research and demo biobased activities in the different regions and existing interregional cooperation, calls for partners etc.

In addition, the web-based portal could contain a search engine for funding resources, including calls launched by government agencies, European funding programs and an overview of all business angels and potential investors. Biobased Delta cluster for example gives on its website a very good overview of all possible funding channels, including for innovation targeted at SMEs.

8. Other hurdles and recommendations

8.1. Access to finance

8.1.1. Availability of public R&D funding

The latest statistics show that the 3% of GDP target of the Lisbon strategy was missed by a considerable margin. The R&D spending (as % of the GDP) is lower than Japan, the USA, or growing economies like China or Korea[83].

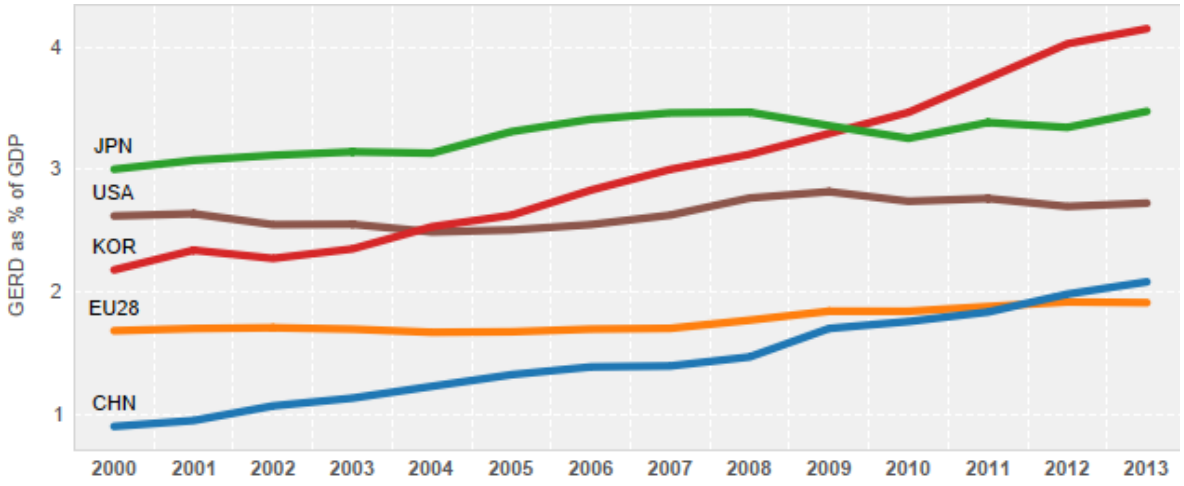

Figure 1. R&D intensity in OECD countries and other economies

Increasing R&D funding at EU, national and regional level is necessary in order to pioneer public research in collaboration with the industrial sector in a co-funding scheme.

8.1.2. Public support for scale up activities

The development of new products and technologies requires several steps to take it from the lab scale to a commercial product. These steps are needed to test that the technology is scalable and to provide data to prove to investors that an idea is commercially viable. However, access to scale-up equipment is commonly cited as a barrier to development of biobased processes and equipment is costly and requires specialist staff to operate it. SMEs find it a particular challenging to finance trials at a large enough scale and to develop suitable data for investment decisions to be made whilst not compromising on IP rights.

Europe has several excellent open access pilot facilities, such as the Bio Base Europe Pilot Plant in Belgium, the Centre for Process Innovation (CPI) in the UK, the Delft Bioprocess Facility in the Netherlands, and the ARD Bio demo facility in France. They could play a key role in technology development within the biobased sector. These plants have significant knowledge on process development, flexible equipment and highly skilled, knowledgeable workers offering full support and capability therefore. Ideally, should any additional infrastructure/equipment be required, this should be deployed at such open-access facilities where the

[83] OECD - MSTI(2015)/1 (July 2015) - http://www.oecd.org/sti/msti.htm

investment cost and risk can be shared across multiple projects. This would allow capability to be developed and retained in niche, highly technical areas whilst ensuring maximum value for money from the initial investment.

However, piloting trials can be financially challenging, especially for start-ups and SMEs. In order to ensure that promising ideas do not fail due to the inability to trial processes, an appropriate level of financial support is needed. The scale of funding will depend upon the nature of the work being carried out, but should ideally be between 30-50 kEUR for a small pre-pilot study, to around 250K EUR for piloting and around 1 MEUR for advanced pilot scale tests.

8.1.3. Need for seed and VC funding

Grants are vital for funding young start-up companies. Relative to early-stage equity funding, start-ups report that grant funding is more attractive and easier to access and manage. Grants from a respected agency provide reputational as well as financial leverage. EU funding, which tends to be directed at more established companies, has been much less so.

Venture capital on the other hand generally requires a foreseeable exit within a relatively short period of time, often within three to seven years depending on the development stage of the company and the time it takes to push products through. There is a clear tendency towards funding later-stage companies. The reasons for this are simple: the time to exit is shorter, and the technology risk and market risk are reduced. VCs are reluctant to invest because historic returns on early-stage funds have been poor. The capital required to build and operate new production plants is too high and the time it takes to develop them to the point when they become commercial is too long for most investors.

Banks are mostly extremely reluctant to lend to early-stage “biobased” companies. Without larger scale validation, it remains very hard for SMEs to attract the large industrial partners or other private investors that they need to become sustainable.

Setting up a special funds for feasibility studies for start-ups or special grants for product development and commercialisation such as the Small Business Investment Company Program (SBIC) in the US[84] could be a step in the good direction. This could be combined with the development of demonstration projects as proof of concept that cover the whole product value chain in order to minimize the risk, install confidence, and attract investors. Finally specific funding programmes targeting innovative SME’s at national and regional level, comparable to the European Investment Fund (InnovFin), could also be set up.

8.1.4. Financial support for new production facilities

Investments required for building a new bio-industrial facility or converting an existing production facility are very high. Due to the recent current economic and financial crisis, it has become difficult to obtain bank loans and funding for investing into building new, full-scale commercial plants and infrastructure.

[84] https://www.sba.gov/content/sbic-program-seeking-financing-your-small-business

The costs and risks associated with the market entry of biobased products are high. The cost of the conversion process of some biobased products is often not competitive with their non-renewable counterparts (e.g. hydrocarbons) and performance is often a reason for lack of cost-competitiveness.

The new Biobased Industries PPP (BBI-JU) is bridging some of the funding gap but cannot support all commercial scale projects. And although several other instruments exist in Europe (such as Horizon 2020, LIFE 2014-2020, Connecting Europe Facility (CEF), Interreg V; Transnational level EUREKA, ESIF, ERA-NET, National, Regional and Local Grants, …), accessibility to funding remains an issue. Financing is fragmented and the procedures involved from one institution to the next, or from one region to another, are different, and the process of applying for funds can also be very long-winded and complex.

At EU Level, a strategic fund may be created under the leadership of the BBI-JU and the EIB. This European BioEconomy Strategic Investment Fund's (EBISIF) should produce loans and loan guarantees for large scale bioeconomy investments.

8.2. Demand side barriers & public procurement

8.2.1. Lack of dedicated framework promoting ALL biobased products

To be successful, it is essential that the regulatory fragmentation across the range of policy areas that can enhance the bioeconomy is addressed as well at EU, national and regional level. More innovation-friendly market framework conditions and incentives are therefore necessary in Europe to reduce the time-to-market of new goods and services and to enable emerging sectors to grow faster. When adopted, legislation should also be stable in the long term to secure investments.

There is also a significant imbalance in subsidies for energy and material use. A range of emerging non-fuel technology areas fall outside the scope of the legislation supporting renewable energy. For example, there are no incentives to support the case for investment in biobased chemicals or plastics. The absence of incentives makes these technology areas less attractive for investment.

8.2.2. Lack of a "green public procurement" policy promoting biobased products

The potential for increasing demand for biobased products through public procurement is huge, as European public authorities spend between 15% and 20% of GDP on goods and services yearly. Almost all product areas could potentially feature products made entirely or partly from renewable raw materials. A public procurement system for biobased products requires i) biobased products to be available; ii) information on products and products to be classified and compiled in a database; iii) products to meet defined criteria and standards and to be recognisable through labels; iv) public procurers at European, national and regional level to be aware, convinced and trained to buy biobased products; and v) mandates, political support and legislation.

In Europe, biobased products have begun to be classified and compiled in databases. These activities are currently being undertaken at several levels and should be coordinated. While several environmental labels exist (EU EcoLabel, national and regional labels), none recognise biobased as an indicator. Discussion should be pursued within the CEN TC 411 on biobased products and with labelling stakeholders to assess the relevance of developing a specific biobased label.

8.3. IPR issues

8.3.1. Lack of harmonized international IP regulation

The costs of worldwide protection and enforcement have soared, and patent holders continue to seek ways to acquire and maintain their exclusive rights more efficiently in an integrated world marketplace. They also bear increasing frustration because of the need to pursue multiple actions for infringement in cross-border disputes. Under the bedrock principle of territoriality, successive litigations can trigger different applications of domestic and international patent norms to the same set of facts, which can lead to conflicting judgments and arguably irreconcilable outcomes. So a simplification and harmonisation of patent procedures is urgently needed in Europe and globally.

8.3.2. High patent cost

In the absence of a global IP system and strategy, the costs for acquiring IP rights are extremely high. Start-ups, spin-offs, and innovative SMEs that are crucial in the development of biobased products, cannot only easily secure patents but also not afford to bear infringement costs.

And although the "Framework for state aid for research and development and innovation[85]" clearly indicate that member states or regions can financially support the costs for "obtaining, validating and defending patents and other intangible assets" for SMEs, today only a few member states make use of this opportunity.

8.4. Public perception & awareness

The main barrier to public acceptance of biobased products is fear of the unknown, based on a limited knowledge of science in general. So the public acceptance of biobased products could certainly be further improved.

Producers are also concerned about the lack of willingness to pay the premium for biobased products. There is a general appreciation for sustainability amongst many EU consumers and biobased products are increasingly being sold for the same cost as fossil ones with similar or even improved performance. Nevertheless, the combined lack of awareness of the existence of biobased products coupled with a lack of understanding of their benefits still presents a significant barrier to the creation of new markets for these beneficial and resource efficient products and processes. More transparent communication is needed in particular to the public at large and toward consumers and consumer organisations. Consumers should be informed in a straight-forward manner based on fact findings about the sustainability, challenges and benefits of biobased products as well as the societal innovation benefits to shift to the bio-economy.

There is certainly a need to design an informed and effective communications campaign to improve public perception and awareness of biobased products.

[85] http://ec.europa.eu/competition/state_aid/modernisation/rdi_framework_en.pdf

Within the larger aim of improving public perception and awareness, it is also crucial to ensure that businesses are aware of biobased products and solutions. This could be done by gathering European success stories as separate case studies which are accessible to companies throughout Europe for their communications towards brand owners.

8.5. Collaboration issues

8.5.1. Need to create strong relationships in value chains

To develop a competitive biobased economy, it is important to create sustainable value chains (from feedstock production or supply, collection and logistics, conversion, production to market). To do so, exploiting synergies for mutual advantage is a key issue. This includes a good level of integration within a specific value chain as well as between different value chains. Cooperation between farmers or forest owners with processing industries is a very simple example and shows the importance of the integration of the biomass supply sector with all downstream industries. Another good example at the processing site is the integration of different technologies and processes in order to be able to work efficiently. This integration can take place at the same site or between two or more processing sites, where, for instance, sharing of utilities and waste treatment are common modes of cooperation.

There is often not enough cooperation and knowledge exchange between different players in the value chain, and one of the primary causes is that the players in the different industrial sectors are not used to work together. The different players in the value chain should be stimulated to cooperate across sectoral borders to overcome the barriers between for instance processing, the feedstock supply and the food chain. But also an improved relationship between industrial sectors themselves could develop new opportunities, e.g. the pulp and paper sector with the chemical industry, or the food industry with the bioenergy sector.

In order to stimulate the collaboration between different industrial sectors, projects should be set up (funded by EU such as Horizon2020 or BBI JU, or by the member states and the Regions) in order to study and communicate synergies and complementarities between technologies, feedstock and waste (availability and quality), and to bring representatives from the different sectors together in one room or during specific partnering events.

Research and innovation programmes (being European, national or regional) should always cover the entire value chain (including feedstock supply, processing, logistics, pre-treatment, processing, compounding, side-product valorisation and product recovery, etc.) in order to obtain funding. By supporting research covering the entire value chain – from feedstock to end-product – these programmes will stimulate integration of the individual bioeconomy sectors, facilitate innovation and encourage the uptake of its results by the industrial partners involved.

8.5.2. Difficulties to establish operational alliances between industry and academia

In order to better align academic knowledge to industry needs, industry will need to continue to develop an earlier understanding of the application potential of new technologies provided by academia. Similarly, academic researchers will need a sharper focus on industry's needs and specifications. Therefore, initiating specific bioeconomy networks at European and national level, building on existing sectorial networks such

as European Technology Platforms (ETPs), industry associations etc. and involving funding authorities, industry and academia could be the key to overcome the knowledge gap and competence hurdle that currently exists. Similarly to and in connection with ETPs, the bioeconomy networks could develop research and innovation roadmaps, organise matchmaking events and any other type of activity supporting closer relations between industry and academia/RTOs.

9. Summary – overview of main hurdles and recommendations

CATEGORY	HURDLE	POSSIBLE SOLUTIONS
Efficient collaboration	Lack of interegional collaboration	• Setting up interregional clusters (e.g. BIG-C megacluster) • Stimulate multidisciplinary cooperation via interregional PPPs • Set up partnerships between regional governments • Create shared pilot and demonstration facilities • Stimulate knowledge exchange via mobility grants • Publish joint R&D calls with several regions • Develop interregional platforms coupled to a web-based portal database in order to develop sustainable and innovative value chains
Access to finance	Availability of R&D funding Public support for scale up activities Need for seed and VC funding Financial support for new production facilities	• Increase R&D funding at EU, national and regional level • Make financial support possible for advanced pilot scale and demo tests • Setting up specific funds for feasibility studies for start ups • Develop special grants for production development and commercialization • Support demonstration projects as “proof of concept” • Create specific funding programmes targeting innovative SME’s at national and regional level (cfr InnovFin) • Harmonise and simplify procedures for different funding instruments (Horizon, BBI, ESIF, Interreg, …) • Create a strategic investments funds for the Bioeconomy at EU level
Demand side barriers & public procurement	Lack of dedicated framework promoting ALL biobased products	• Develop market framework conditions and incentives to reduce the time-to-market of new goods and to enable emerging sectors to grow faster • Energy and material/products use should be treated at the same level

	Lack of a "green public procurement" policy promoting biobased products	• Environmental labels (EU EcoLabel, national and regional labels) should integrate biobased as an indicator • Discussion should be pursued within the CEN TC 411 on biobased products to assess the relevance of developing a specific biobased label
IPR issues	Lack of harmonised international IP regulation	• Simplification and harmonisation of patent procedures in Europe and globally
	High patent cost	• Member states and/or regions to financially support the costs for "obtaining, validating and defending patents and other intangible assets" for SMEs, as allowed by the State Aid Rules for Innovation
Public perception and awareness	Lack of awareness of the existence of biobased products and lack of understanding of the benefits, resulting in a lack of willingness to pay a premium	• More transparent communication in particular to the public at large and toward consumers and consumer organisations • Design an informed and effective communications campaign to improve public perception and awareness of biobased products • Publish European success stories as separate case studies which are accessible to companies throughout Europe for their communications towards brand owners
Collaboration issues	Need to create strong relationships in value chains	• Different players in the value chain should be stimulated to cooperate across sectoral borders • Develop an improved relationship between industrial sectors themselves • Projects should be set up in order to study and communicate synergies and complementarities between technologies, feedstock and waste, and to bring representatives from the different sectors together • Research and innovation programmes should always cover the entire value chain
	Difficulties to establish operational alliances between industry and academia	• Initiate specific bioeconomy networks at European and national level, building on existing sectorial networks such as European Technology Platforms (ETPs) • Develop research and innovation roadmaps, organise matchmaking events and any other type of activity supporting closer relations between industry and academia/RTOs.

Annex 1 - LIST OF ABBREVIATIONS

ADB	Agriculture and Development Board
BBEP	Bio Base Europe Pilot Plant
BBRSC	Biotechnology and Biosciences Research Council
BE-BASIC	Biobased Ecologically Balanced Sustainable
BM	Baekeland Mandate
BMBF	Federal Minister of Education, Research and Innovation
BMEL	Federal Minister of Food and Agriculture
BMWI	Federal Minister for Economic Affairs and Bioenergy
CIP	Center for Process Innovation
EI	Entreprise Ireland
EPSRC	Engineering and Physical Sciences Research Council
ERA	European Research Area
ETP-W	Ecotechnopole Wallonie
FISCH	Flanders Innovation Hub for Sustainable Chemistry
FNR	Agency for Renewable Resources
Go-Bio	Gründungsinitiative Biologie
HGCA	Cereals and Oil Division
IBB	Industrielle Biotechnologie Bayern
IBTI	Integrated Biorefining Research and Technology
IIBN	International Industrial Biotechnology Network
IM	Innovation Mandates
IPA	Industrial Partnerships Awards
IPC	Innovation Performance Contracts
IRO	Independent Research Organisation

IWT	Agency for Innnovation through Technology and Science
MIT	MKB Innovatieregeling
MKB Nederland	Medium and Small Entreprises The Netherlands
NIBF	National Industrial Biotechnology Facility
NL Agency	The Netherlands Agency for Sustainability, Innovation and International Affairs
RO	Research Organisation
SME	Small Medium Entreprise
SMUL	Saxon State for Environment and Agriculture
TINA	Transformation, Innovation and Acceleration of Flanders
TKI	Topsector Knowledge and Innovation
TSB	Technology Board
VIS	Flemish Cooperative Networks Feasibility Studies
ZIM	The Central Innovation Program

Annex 2 – SME SURVEY (template)

Industrial Biotechnology (IB) & Biobased Economy
Main barriers for SMEs

Category	Specific barrier	Please indicate if this is a barrier for your company/business on a scale from 0 (no impact) to 5 (high impact)
Investment barriers	**Capital requirements:** • availability of public R&D funding (regional/national/European) • public support for pilot and demonstration activities • access to finance for spin-offs and start-ups (e.g. seed funding, VC funding) • access to finance for SME's • financial support for new production facilities (cheap loans, subsidies, etc.)	
	IB and Biobased sectors perceived as sector with high investment risk: • lack of investor confidence in industrial biotechnology • lack of visible tangible products &blockbusters • time "return to investment" too long for VCs	
Infrastructure related hurdles	**Logistics:** • collection of feedstock (biomass) • transport and distribution of biomass • low number of operational biorefineries	
Feedstock related barriers	**Securing large quantities of biomass:**	

		• inefficient supply chain and transport logistics • absence of long-term supply agreements • inefficient recovery systems for (bio)waste
	Feedstock at affordable prices:	• cost for feedstock too high • varying feed stock costs
	Sustainability of feed stock supplies:	• non-stable supply of feedstock's • difficult to obtain "sustainable" feedstock • "sustainability" certification system inefficient or too expensive
	Inadequate agricultural policy :	• agricultural policies does not take into account the non-food sector
Public perception barriers	**Poor public perception**	• Biobased products not visible enough • lack of labeling (environmental performance, origin, etc.) • benefits of biobased products not enough communicated • fundamental lack of understanding of industrial biotechnology • negative messages in the media create fear for the unknown (e.g indirect land use, genetic modification, food versus fuel, …)
Trade barriers	**Tariff trade barriers**	• (high) import costs for certain feedstock
Human resource barriers	**Skilled workforce**	

		• lack of human resources with right skills and curricula
Hurdles for efficient collaboration	**Suitable network and cooperation strategy**	• inefficient collaboration between the partners of the value chain (feedstock producers, converters, processing industry, downstream industries, …) • difficult to establish operational alliances between possible partners • difficult to establish (or take part in) a international network
	Knowledge exchange	• inefficient technology transfer from academia to industrial application
Intellectual property related hurdles	**Patent filing and cost**	• long patent filing &award systems • high patent cost
	IPR	• lack of a harmonized international IP regulation
Supply- and demand-side policy barriers	**Demand-side policies**	• lack of incentives for non-biofuel biobased products • lack of supporting policies stimulating market introduction and penetration • too narrow focus of the renewable energy policies
	Public procurement policy	• lack of an efficient “green public procurement” legislation at regional/national level • Public procurement regulation does not take into account Biobased products

Regulatory barriers	**Full assessment guidance** • life cycle thinking not yet part of product development • Unequal or unfair sustainability comparisons • Lack of commonly agreed and global assessment tools **Robust standards and methods** • Lack of efficient and transparent standards • lack of international agreed certification system • Lack of international agreed sustainability criteria	
Policy barriers	**National and European policies and regulations** • inefficient agricultural policy • lack of an international harmonized regulatory framework • specific (regional/national/European) environmental regulation blocking the development of Biobased products and/or processes • "sustainability agenda" creates hindering regulations and policies	
Other barriers	*These barriers could be general or product specific (please specify)*	