Bioökonomierat

Bioeconomy Policy (Part I)
Synopsis and Analysis of Strategies in the G7

A report from the German Bioeconomy Council

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Abstract

The bioeconomy leverages innovations in the (life)sciences and bio-industries to achieve ecological and social sustainable growth and employment based on the wealth of biological resources. The usefulness and the potential benefits of such a bioeconomy have been acknowledged and embraced by all the members of the G7 and by more than 30 countries globally. Both, the European Union and the OECD have provided a lot of political momentum in recent years and are calling for increased international collaboration to foster the development of a global bioeconomy. Germany, the USA and Japan have set themselves ambitious goals with specific national bioeconomy strategies. France, the UK, Italy and Canada are also providing much support to promote the development of the biobased economy in practise. With this report, the German Bioeconomy Council, seeks to prepare the grounds for an intensified dialogue on bioeconomy policy among the countries concerned. Therefore, the report firstly presents an overview of bioeconomy strategies and important policy measures adopted by the members of the G7, including the EU. By discussing similarities as well as differences in political approaches, this synopsis hopes to provide valuable insights and to signal opportunities for mutual learning and future collaboration. Finally, the report assesses and compares the G7 activities in individual policy areas, such as bioenergy, research, education and training, technology transfer, commercialization as well as social change. The authors conclude with an outlook on future G7 and global political collaboration to foster the development of the bioeconomy.

Content

Introduction

Bioeconomy has become an integral part of the strategic activities of all G7 members, including the European Union. Although terminology and definitions might vary between the members, bioeconomy policies embrace innovation and sustainability, as well as economic growth and employment. For the purpose of this report, bioeconomy is defined as the knowledge-based production and utilization of biological resources to provide products, processes and services in all sectors of trade and industry within the framework of a sustainable economic system. (German Bioeconomy Council, 2012.)

Aims

The study is directed at policy makers, industry, research communities, and representatives of civil society. Its primary aim is to contribute to the establishment of an international discussion and coordination platform for the future development of a global bioeconomy. For the first time, it provides an overview of the political strategies for promoting the bioeconomy within the G7 members, including the EU, and demonstrates both the diversity and commonalities of political aims, approaches and activities. The study thus intends to provide a common ground for mutual learning and for increased international exchange. For this purpose, the report concludes with an analysis of similarities in approaches to the bioeconomy and its assessed potential. Finally, it identifies promising areas for political collaboration to further promote the global bioeconomy.

Methodology

The study is essentially based on desk research on bioeconomy policy with reference to publicly accessible documents and statements from the EU and the G7 governments. The search was extended to include information from the websites of ministries, government agencies and public research institutions concerned with the bioeconomy[1]. If there was no specific bioeconomy strategy published in one of the countries studied, a search was conducted for strategies using the keywords “biomass”, “renew able resources”, “biotechnology”, “bioenergy”, “green growth”, “green industry”, “green economy” and “biobased”.

In order to keep the scope of the study within workable limits, political strategies in the traditional bioeconomic areas, such as the primary production sector and the manufacture of food, timber products etc., were only considered if they are specifically oriented towards the bioeconomy or towards innovations. The same logic was applied to policy strategies relating to the overriding objectives of the bioeconomy, especially sustainability, green growth and food security. In individual cases, additional information was requested directly from ministries or industry clusters.

The information presented in this report therefore reflects bioeconomy-specific strategies and measures officially notified by governments and their agencies. As far as possible, the notified measures were also verified by means of Internet searches. However, this study can neither judge the degree of implementation of the strategies and measures nor their effectiveness. This would go beyond the scope of an Internet search and will be covered in Europe, for example, by the EU Bioeconomy Observatory.

[1] Based on the methodology report on the „Bioeconomy Information System and Observatory Project“ of the EU Joint Research Centre, the authors identified the following departments as responsible for bioeconomy policy: Education, Research and Innovation, Agriculture, Forestry, Fisheries, Industry, Environment and Energy.

Bioeconomy Policy: G7 Member Reports

Moving from fossil to renewable resources is an important element of the ecological transition envisaged by most industrialized countries. The following chapter descibes bioeconomy-related policy making in the G7, including the EU. At the end of each member report, important policy measures are summarized in an overview table.

Overview

This study presents for the first time a detailed analysis of bioeconomy policy in the G7 group. In recent years, bioeconomy has become an important component not only of innovation but also of economic policy in the G7. The different political approaches share many characteristics. Most involve measures to promote technological innovation, economic growth, ecological sustainability and resource efficiency. Furthermore, the political focus has increasingly changed from promoting bioenergy as a stand-alone solution to fostering the value-added, cascading use of biological resources. In this respect, biotechnology plays an important role for all G7 members. In addition to being considered a key enabler for sustainable agricultural innovation, it has become an important driver of ecological, industrial progress. These days, biotechnology is used to fabricate basic chemicals and innovative materials, such as biopolymers or biobased carbon fibres. Lately, G7 research programmes also address the use of airborne carbon dioxide, microbes and biological waste, e.g. for the production of fuels and basic commodities. However, the report also identifies basic differences in bioeconomy policy approaches among the G7 members. The US, Germany or Japan have developed strategies with detailed plans on how to foster the use of biomass and biosciences for different purposes. Other countries like Italy or Canada act rather pragmatically and seek to leverage existing private sector and public research initiatives. Time will tell whether top-down or bottom-up approaches are more suitable to promote the transition to bioeconomy. Reviewing the policy strategies of the G7 also reveals that there is no such thing as "the" bioeconomy. Countries with few natural resources such as Germany, Japan, France and Italy typically focus on their industrial and technological leadership. The UK, seeks to build on its highly developed services sector and its excellence in biosciences to develop high-value industries. In contrast to the EU and its member states, both Canada and the US consider biomedicine not only as a sector but as a driver of the bioeconomy. However, only the US has developed a bioeconomy strategy aiming at technological leadership and market development in the bio-industries. Additionally, being resource-rich countries, the US and Canada extensively fund innovation activities in the primary production sector.

Tab. 1: Overview on bioeconomy (BE) policy in the G7, including the EU

Member	Name of Strategy	Main Actors	Key Funding Areas
Canada	Growing Forward	Ministry of Agriculture	R&D on renewable resources and biobased materials, Bioenergy
EU	Innovating for Sustainable Growth	DG Science, Research, Innovation	Research & Innovation (Horizon 2020), Public-Private-Partnerships
France	bundle of BE-relevant policies	Ministry for Ecology, Ministry for Research	Bionergy, green chemicals, clusters, circular economy
Germany	1. Research Strategy BE 2. Policy Strategy BE	1. Ministry for Research 2.Ministry for Agriculture	R&D on food security, sustainable agriculture, healthy nutrition, industrial processes, bioenergy
Great Britain	bundle of BE-relevant policies	Parliament, Depts: Energy & Climate, Environment, Transport, Business	Bioenergy, agri-science and -technology
Italy	no specific BE policy	–	Participation in EU programmes
Japan	Biomass Utilization and Ind. Strategies	Cabinet, National Biomass Policy Council	Research & innovation, circular economy, regional development
United States	1. Bioeconomy Blueprint 2. Farm Bill	1. White House 2. USDA	1. Life Sciences (Biomedicine) 2. Agriculture (multiple areas)

Canada

Resource Wealth as Leverage for Growth

	Yes	No
1 Is this a specific bioeconomy strategy?		✘

2 If No, what are the key points? How are they being addressed within the bioeconomy?

So far, Canada has not developed a federal bioeconomy strategy or vision. In 2006 it adopted a strategy for renewable energies, in which timber plays a key role as a raw material (e.g. Bio-Pathways Project, 2009). The agricultural strategy "Growing Forward 2" (2013–2018) defines Canada's agricultural policy and provides for total investments of CAD 3 billion for innovation, competitiveness and marketing. The Canadian government has high hopes of the use of biotech applications in agriculture and forestry. Accordingly, the commercial cultivation of genetically modified crops was accepted at a comparatively early stage.

Inspired by the preparatory efforts of a US Bioeconomy Blueprint, the national biotechnology association, BioteCanada, produced the strategic document "Blueprint beyond Moose and Mountains" in 2009. This Blueprint represents a competitive strategy motivated by the fact that the Canadian biotech/bioeconomy industry might fall behind internationally, compared to the USA, France and even Brazil. Although the strategy was discussed at a roundtable with relevant political stakeholders, it was not adopted as a federal policy (Public Policy Forum. 2009. The future of the bio-based economy

in Canada. Roundtable outcomes report). However, there are several dedicated political bioeconomy actions taken on provincial levels. For example, in 2011 the government of British Columbia appointed a Bioeconomy Council under the responsibility of the Ministry for Labor, Tourism and Innovation. The province is concentrating primarily on utilizing its huge forest and agricultural resources to provide bioenergy but is also recognizing the need of promotin life sciences and cleantech industries. Alberta, another example, is one of the strongest agricultural provinces in Canada and is also banking on the bioeconomy. Apart from agriculture, the strategy also fosters the production of biobased chemicals and materials as well as bioenergy.

3 Who is the author of the strategy?

The Ministry of Agriculture is responsible for developing the "Growing Forward" agricultural strategy, which is implemented in the individual provinces on a co-funding basis. Natural Resources Canada is responsible for policy making in the bioenergy and forestry sectors.

4 What measures are used to promote the strategy?

The political strategies are supported by traditional research and technology funding measures as well as commercialization projects. It is expected that private sector stakeholders will co-fund these investments. The "Growing Forward" agricultural strategy provides for co-funding programs in the areas of agricultural research (particularly cluster projects) and the commercialization of innovations. However, these programmes are not specifically focused on ecological or bioeconomic applications. The Forest Innovation Program (FIP) of Natural Resources Canada supports research, development and technology transfer in Canada's forestry sector, with biobased materials being explicitly mentioned. The ministry also manages the Canadian Biomass Innovation Network (CBIN), consisting of researchers, politicians, industry experts, researchers and NGOs. The CBIN awards innovation projects in the areas of sustainable resources management, biomass conversion technologies, biorefineries and how to measure sustainability. The funds come from the outgoing "ecoENERGY Technology Initiative" (ecoETI) or the BEST (Bio-Based Energy Systems and Technologies) program. The "NextGen Biofuels Fund" promotes the building of demonstration plants for producing second-generation biofuels. Some Canadian provinces also plan to establish a joint biohybrid cluster with the focus on sustainable chemistry, similar to the industrial clusters being developped in Lampton County and Sarnia, where industrial-scale production plants for biobased chemicals are being built by an international industrial consortium. To push the demand side, a national "green" procurement policy specifies that ecological criteria must be considered in the procurement process.

5 Is there a time limit on the initiatives?

R&D programmes are limited to terms of 5–7 years.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

Federal R&D efforts are concentrated on the optimized use of the country's natural resources. Bioenergy is a priority (see, e.g., the evaluation report on "Sustainable Bioenergy Strategic Priority" from Natural Resources Canada, 2012). Research into biobased materials (e.g. wood-based) is recently taking a more important role.

7 What are the implicit effects/side-effects of the strategy?

At present, the federal government is restricting itself to the coordination of strategic goals, without defining its own comprehensive bioeconomy strategy. As an example of a provincial strategy, British Colombia is aiming to establish a long-term «bioeconomic vision», which incorporates various other goals such as climate protection, opening of new markets, creating jobs and fostering energy production.

8 Are any quantitative targets specified?

No

Tab. 2: Important Measures for Promoting the Bioeconomy in Canada

Key Points	Policy Measures	Concrete Implementation	Budget in CAD	Timetable	Sources
a) Promoting innovation	Basic research and applied research	Funding programmes in the areas of agricultural research (particularly cluster projects) and the commercialization of innovations.		2013–2018	Growing Forward 2 (website)
		Forest Innovation Program (FIP): research, development and technology transfer in Canada's forestry sector, with biobased materials being explicitly mentioned.	92 m	2013–2016	Natural Resources Canada (website)
		Canadian Biomass Innovation Network (CBIN)			CBIN (website)
		EcoENERGY Innovation Initiative und Clean Energy Fund: innovation projects in the areas of sustainable resources, biomass conversion technologies, biorefineries and measuring sustainability and its performance.		2009–2013	Natural Resources Canada (website)
	Pilot and demonstration plants	NextGen Biofuels Fund: demonstration plants for second generation biofuels.	500 m	2007–2017	Sustainable Development Technology Canada SDTC (website)
b) Commercialization	Marketing	Funding programmes relating to the commercialization of agri-tech innovations		2013–2018	Growing Forward 2 (website)
	Support for biomass producers	Grants for and tax relief on biofuel production			Growing Forward 2 (website)
c) Demand-side instruments:	Public procurement	"Green" procurement policy		from 2006	http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/index-eng.html

European Union

Innovation for Sustainable Growth

	Yes	No
1 Is this a specific bioeconomy strategy?	✘	

2 What are the key points? How are they being addressed within the bioeconomy?

In 2005, Janez Potocnik, the EU Commissioner for Research, Science and Innovation at that time, firstly presented the concept of a knowledge based bioeconomy („Knowlegde based bioeconomy: Transforming life sciences knowledge into new, sustainable, eco-efficient and competetive products“). According to this concept, the bioeconomy encompasses all industrial and economic activities that make use of renewable biological resources for the provision of products and services by applying innovative biological and technological knowledge and processes. The biomedical industry, however, is largely attributed to the health sector. Only veterinary medicine and the production of pharmaceuticals are considered bioeconomy activities.

Consequently, the “Cologne Paper” published under the German EU Council Presidency in 2007 defined the new economic concept as mainly based on biological instead of fossil resources, with biomass as primary feedstock and biorefineries as important production facilities. In parallel, biobased products and processes have been acknowledged as the key elements of future markets

by the “Lead Market Initiative”. Accordingly, the Directorate-General for Enterprise and Industry has since been considering biobased products in the development of product standards and norms as well as public procurement policies. Finally, in 2012 the European Union presented a dedicated bioeconomy strategy together with an action plan under the title “Innovating for Sustainable Growth: A Bioeconomy for Europe“. The strategy document thus consists of two sections, a “communication document” and a detailed “working document”. Additionally, the European Innovation Partnership (EIP-AGRI) for Agriculture was founded in 2012 by the EU Commission. It plays an important role in fostering the development of the bioeconomy. The EIP is intended to promote sustainable intensification in agriculture and forestry (“achieve more from less”) and to contribute to the provision of the right quality and amount of biomass for food, feed and the production of new bio-materials.

3 Who is the author of the strategy?

The bioeconomy strategy document was drafted under the guidance of the Directorate-General for Science, Research and Innovation. The Directorates for Agriculture and Rural Development, for Maritime Affairs and Fisheries as well as the Directorate for Enterprise and Industry, though, increasingly contribute to bioeconomy policy making in the EU.

4 What measures are used to promote the strategy?

The EU takes a comprehensive approach to the development of the bioeconomy. The political strategy relies on three pillars, (1) investments in skills, research and innovation (2) coordination of policy and with stakeholders and (3) market development. The research and innovation pillar specifically focuses on co-funded investments in near-market innovation. Consequently, the means dedicated to this purpose in the Horizon 2020 research programme “food security, sustainable agriculture, marine and maritime research, and the bioeconomy” have been doubled compared to the 7th framework programme to reach nearly Euro 4 billion. A quarter of these funds alone is dedicated to a public private partnership leveraging European industry activities (“The Biobased Industries Consortium”). Support is further granted for engaging in effective stakeholder dialogue and for agricultural, forestry or marine research projects. Additionally, several other Horizon 2020 programmes support bioeconomic innovations, for example with regard to resource efficiency (e.g., a public private partnership in the chemical industry named “Spire”) or clean energy (e.g., the “European Industrial Bioenergy Initiative EIBI”).

In order to ensure policy coherence in the EU, the Bioeconomy Panel has been nominated as an expert committee in 2013 with the task to provide cross-sectoral and interdisciplinary policy advice for the duration of two years. EU-wide coordination of bioeconomy-related public research funding should be further improved with the help of ongoing ERA-Net activities (e.g., see the report on “Bioeconomy ERA-NET Actions”, 2014) and Joint Programming Initiatives of member states. Additionally, a Bioeconomy Observatory is being established to inform policy making and coordination efforts. By 2016, the observatory will reflect and scientifically accompany the development of the EU bioeconomy with the help of statistical monitoring and modelling studies.

The third pillar of the strategy addresses market development and the competitiveness of the bioeconomy sector. The support activities mainly relate to research on standardisation and to the coordination of the respective implementation activities in the European Committee for Standardisation (CEN). These implementation activities encompass the development of measurement methods and standards for different biobased products as well as labels for the commu-

nication of product characteristics to the consumer. The approach of the European Innovation Partnership for Agriculture is based on “operational groups” to facilitate hands-on communication and interactive knowledge transfer in agriculture and forestry. The EIP is also backed by funds from Horizon 2020 together with Regional Development Funds to foster the work of the “operational groups”, especially in the development of new products, methods, processes and technologies in agriculture, forestry and the food industry. Furthermore, pilot projects and cooperation initiatives targeting, for example, improved supply chains, food security, climate or environmental protection, are supported.

5 Is there a time limit on the initiatives?

Both, the bioeconomy strategy and the innovation partnership relate to the timeframe of the Europe 2020 strategy.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

The bioeconomy strategy is mainly implemented via research and innovation funding under the new framework programme “Horizon 2020”. Content-related, the strategy emphasizes agricultural, forestry and technological aspects. Recently, more focus has been put on marine resources, which are attributed a high innovation potential (“blue growth”). The particular thematic priorities of research funding are defined in the biannual working programmes. This also applies to the large public private partnership projects, such as “Bi-obased Industries Consortium” and “Spire”.

7 What are the implicit effects/side-effects of the strategy?

As one of the few bioeconomy strategies globally, the EU document recognises that the community – given its relatively privileged economic situation – has to make a fair contribution to solving the most important global challenges, specifically climate change, resource stress and food security. This also involves questions of (material) consumption.
In Europe, the promotion of the bioeconomy should further strengthen the competitiveness and innovation ability of the member states and should contribute to a sustainable reindustrialisation of Europe. Furthermore, with their focus on multi-disciplinarity and new innovative cooperation models between the private and the public sector, the bioeconomy support programmes are intended to modernize education and training systems.

8 Are any quantitative targets specified?

No

Tab. 3: Important Measures for Promoting the Bioeconomy in the EU

Key Points	Policy Measures	Concrete Implementation	Budget in Euro	Timetable	Sources
a) Promoting innovation	R&D	Horizon 2020 Call "Food security, sustainable agriculture, marine and maritime research, and the bioeconomy"	2,8 bn.	2014–2020	Horizon 2020 (website)
		Horizon 2020 Calls "Climate action, resource efficiency and raw materials", "Secure, clean and efficient energy", "Health, demographic changes and well-being" und "Inclusive, innovative and secure societies".		2014–2020	Horizon 2020 (website)
	Key enabling technology	Horizon 2020 "Industrial Leadership and Competitive Frameworks", promotes the development of bioeconomy-relevant technologies, e.g. biotechnology, material science		2014–2020	Horizon 2020 (website)
	Clusters, Public-Private-Partnerships	SPIRE: chemical PPP (Horizon 2020 "Resource efficiency")		2014–2020	http://www.spire2030.eu
		BIC Bio Industries Consortium (Horizon 2020 "Bioeconomy")	1 bn.	2014–2020	http://biconsortium.eu
b) Commercialization	Financing and venture capital	Horizon 2020 "Industrial Leadership and Competitive Frameworks", promotes SME innovation and access to venture capital		2014–2020	Horizon 2020 (website)
c) Demand-side instruments	Public procurement	Public Procurement Network (Horizon 2020 "Bioeconomy")			Horizon 2020 (website)
	Standards and labels	e.g., CEN/TC 411: standards for biobased products and labels		ongoing	http://www.cen.eu/work/areas/chemical/biobased/Pages/default.aspx
e) Political framework conditions	Policy coherence	EU Bioeconomy Panel		2013–2015	http://ec.europa.eu/research/bioeconomy/policy/panel_en.htm
		EU Bioeconomy Observatory (monitoring and modelling)		2013– 2016	https://biobs.jrc.ec.europa.eu
		Key Enabling Technologies Observatory: Monitoring of the development of industrial biotechnology in the EU		2013–2015	https://webgate.ec.europa.eu/ketsobservatory/

France

Industrial and Ecological Renaissance

	Yes	No
1 Is this a specific bioeconomy strategy?		✘

2 If No, what are the key points? How are they being addressed within the bioeconomy?

France has not so far defined a specific research and policy strategy relating to the bioeconomy. The term "bioeconomy" is rarely used in France. Instead the biobased economy is discussed in the context of the green economy (économie verte) or industrial ecology (écologie industrielle) and lately also the circular economy (économie circulaire). The Ministry for Ecology, Sustainable Development and Energy defined 18 sectors as being strategic industrial sectors of the green economy. The following of these can be assigned to the bioeconomy: biofuels, energy from biomass, "green" chemistry, production of biobased materials (especially bioplastics), CO_2 separation, storage and utilization, water treatment and environmental engineering.

Basically, two distinct approaches to the bioeconomy can be identified in France: firstly, promoting cutting-edge technologies and, secondly, motivating ecologic transformation. Thus, important areas of a bioeconomy policy are addressed in autonomous strategies, for example the Strategic Agenda for Research, Technology Transfer and Innovation (France Europe 2020), the plan for industrial renaissance ("The new face of

industry in France"), the biodiversity strategy and the national plan for adapting to climate change.

In the interests of policy coherence, a proposal for a comprehensive national strategy on ecological transition of the country ("Stratégie nationale de transition écologique vers un développement durable", SNTEDD) was published in the 1st quarter of 2014, with the aim of ensuring sustainable development. The driving idea is to achieve ecological transition by means of an industrial transition based on scientific and technological innovations, accompanied by a comprehensive societal transition based on a shared vision and commonly practised sustainable patterns of consumption.

The proposed strategy defines nine overarching areas and identifies 34 political priorities for inducing ecological transition. The main areas focus on developing sustainable and crisis-resistant landscapes, implementing life-cycle management, reducing the unequal distribution of ecological, social and spatial resources, developing new economic models and financial instruments, supporting trade and industry in becoming more ecological, on the development of knowledge for ecological changes, on education and raising awareness about ecological changes and finally on mobilizing key stakeholders on all levels to do so on a European and international level.

3 Who is the author of the strategy?

On the government side, the Ministry for Ecology, Sustainable Development and Energy as well as the Ministries for Research and Agriculture are responsible for developing strategies for promoting cutting-edge technology and ecological transition. The proposed SNTEDD was proposed by the Ministry for Ecology, Sustainable Development and Energy and underwent a public consultation process in spring 2014.

4 What measures are used to promote the strategy?

The government's research and innovation agenda supports important sectors of the bioeconomy, such as industrial biotechnology or renewable energies. State bodies, in particular INRA (National Institute for Agricultural Research), Adème (Agency for Renewable Resources) and the national research institute CNRS fund research projects and participate in consortia. International cooperation in research projects, with the Benelux countries, Italy, Germany and lately also the USA, Canada and Brazil as partners, is politically wanted and supported.

The "Future Investments" funding programme set up by the government plays a key role in promoting cutting-edge technologies for the bioeconomy. Over a period of ten years, around EUR 1.5 billion are being spent on infrastructure, research and training in the area of biotechnology, agricultural science, bioinformatics and nanobiotechnology, as part of the "Health and Biotechnologies" programme. Demonstration and test facilities for green chemistry and bioenergy are covered by the programme "Energy and Life-Cycle Management", with around EUR 1.35 billion of funding. Key areas are the use of algae ("GreenStar"), biorefineries ("Pivert") and sustainable chemistry ("Ifmas"). The innovation programme also provides around EUR 1 billion of funding for centres of excellence for non-fossil energy (IEED).

In France, research and industry collaborations have been organized on a regional basis since 2005, within the framework of competitiveness clusters ("pôles de compétitivité") and this is also true of the bioeconomy sector (e.g., "union des pôles de la chimie verte du vegetal", "France Green Plastics"). The central themes

of these clusters are bioenergy, ecological industrial processes, plantbased chemistry, agriculture, as well as the production and utilization of biological marine resources. Agricultural waste and forests, in particular, play a fundamental role as a source of renewable energy for the future.

As part of the industrial regeneration policy measures ("The new face of industry"), a plan has been developed for promoting green chemistry and biofuels. Since the second half of 2014, policy is accompanying and supporting existing industry projects in this area by improving the framework conditions. Barriers to investment will be identified and appropriate solutions proposed. The plan aims at the leverage of EUR 3 billion of extra added value, 5,000 jobs and EUR 2 billion of additional private investment. Such industrial regeneration plans have also been developed for other bioeconomy related sectors, such as food innovations, recycling and green materials as well as the wood construction industry.

As regards the commercialization of bioeconomic innovations and the development of markets, the government recently adopted a new plan for sustainable public procurement in order to promote the use of ecological products. Furthermore, France uses new approaches regarding standards and labels for market development, for example a label for biobased buildings ("batiment biosourcé") and a standard for sustainable investment funds for generating more private venture capital (IRS).

The proposed SNTEED specifies numerous ongoing political measures for promoting ecological transition, the majority of these measures being legislative initiatives. Examples are: measures for making agriculture more ecological (Grenelle law), plant management (law on biodiversity or EcoPhyto Plan), a ban on plastic bags (law on the future of agriculture, food and forestry) and the raising of green taxes to the average EU level.

5 Is there a time limit on the initiatives?

Most of the listed policy strategies and plans cover the period up to 2020 or even 2050.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

Energy production from renewable resources, making chemical and plastics processing more ecological and the transition to the circular economy play a key role. Recently, bioeconomic R&D is becoming more important as a means for innovating the economic system.

7 What are the implicit effects/side-effects of the strategy?

Generally, green innovations should make the country more competitive, stimulate growth and generate jobs, as well as reducing dependence on energy imports. However, France also sees the bioeconomy as a contribution towards ecological transition, in order to combat climate change, hold the loss of biodiversity, of dwindling natural resources and the multiplication of health risks due to environmental damage.

As a side-effect of the industrial projects («économie verte", "new face of the industry"), conscious effort is being put into manufacturing biobased products with enhanced properties, in particular in the chemical value chain. New potential is also being exploited to benefit agriculture and rural development.

8 Are any quantitative targets specified?

The proposed SNTEDD strategy specifies key quantitative targets for each area, arising from the policy strategies or legislation in question, for example, doubling the acreage used for organic farming by 2017 and halving pesticide use by 2018. As regards energy consumption, the stated target is a 30% reduction in the consumption of fossil fuels by 2030 and halving energy consumption by 2050. Green taxes are to be increased to the average EU level. The use of renewable raw materials in the chemical industry is to increase from 8% to 15% by 2017.

The industrial renaissance plans set clear objectives as to the creation of value-added and jobs.

Tab. 4: Important Measures for Promoting the Bioeconomy in France

Key Points	Policy Measures	Concrete Implementation	Budget in Euro	Timetable	Sources
a) Promoting innovation	Basic research and applied research	Establishing interdisciplinary INRA meta-programmes in the areas of food, ecology and agriculture	30% of the INRA budget	2010–2020	INRA website
		"Future investments": promoting research, education and innovation with special programmes on biotechnology plus bioenergy and green chemistry. Centres of excellence in the area of non-fossil energy (IEED)	2–3 billion	2010–2020	http://www.gouvernement.fr/investissements-d-avenir-cgi
	Pilot projects and demonstration plants	Biorefineries: e.g. IAR Pomacle-Bazancourt, Bio HUB, Axelone, Pivert, ARD-BRI, Biobutterfly			Report on the strategic sectors of the "économie verte" (2013)
		Bioplastics: e.g. Plastipolis, Xylofutur, Pôle Fibre Grand Est, PEP			
		Biotechnology: e.g. Toulouse White Biotech			
b) Infrastructure	Cross-cutting technology	"France Genotoul": network with 5 competence centres (GeT) and more than 140 research teams in the areas of genome sequencing, high-throughput analyses, bioinformatics			http://get.genotoul.fr
c) Commercialization	Private innovation capital	Three official labels for sustainable investment funds (ISR) are used in France. Life insurance companies and pension funds may invest in such funds.			White Paper on financing ecological transition (2013)
d) Demand-side instruments:	Tax relief on sustainable investments	Improvements in the tax deduction provisions for investments in sustainable energy		2014	White Paper on financing ecological transition (2013)
	Public procurement	Extended national action plan for sustainable public procurement: energy efficiency, bio-based products and life-cycle analyses		2014–2020	Plan national d'action pour les achats publics durables (PNAAPD)
	Labels	Label for buildings made from renewable resources (Batiment biosourcé)		2012	http://www.certivea.fr/certifications/label-batiment-biosource

Key Points	Policy Measures	Concrete Implementation	Budget in Euro	Timetable	Sources
e) Policy framework conditions	Plans for industrial renaissance	Analysis of barriers to investment and to industrial transition in 34 areas, e.g. green chemistry, biofuels, wood construction, food systems		2014–2020	The new face of industry (2014)
	Participation and political representation	Eco-industry committee for closer cooperation between green economy and policy makers		since 2008	COSEI (Comité stratégique des éco-industries)
	Green taxes	Taxes on CO_2 emitting propellants and fossil fuels are being progressively increased.			Comité pour la fiscalité écologique (website)
		Tax exemption for biofuels is gradually being phased out over 3 years.			
	Laws and regulations	Examples: Ban on plastic bags with the exception of compostable plastics. Approval of natural pesticides and plant health measures. Ban on aerial spraying of pesticides.		2014	Legislative initiative for biodiversity. Law on the future of agriculture, food and forestry (2014)

Germany

Comprehensive Bioeconomy Strategy

	Yes	No
1 Is this a specific bioeconomy strategy?	✘	

2 What are the key points? How are they being addressed within the bioeconomy?

With a dedicated national research strategy ("Forschungsstrategie BioÖkonomie 2030"), published in 2010, and a dedicated Bioeconomy Policy Strategy, published three years later, Germany is among the world leaders when it comes to bioeconomy policy. Already in 2009, an independent expert committee has been established (German Bioeconomy Council) to advise the Federal Government in bioeconomy policy questions and to promote stakeholder dialogue.

Although both strategy documents are intended to strengthen the domestic bioeconomy, they also provide a global perspective, for example on questions of world food security and social standards. Alongside these strategies relating explicitly to the bioeconomy, the action plan on the use of renewable resources for material and energy production (2009/2010), the action plan on renewable energies (2010) and the forestry strategy 2020 (2011) also play a central role in fostering the biobased economy.

3 Who is the author of the strategy?

The national bioeconomy research strategy was developed under the responsibility of the Federal Ministry for Education and Research (BMBF). The bioeconomy policy strategy is the result of collaboration between the Federal Ministry for Food and Agriculture (BMEL), the BMBF, the Federal Ministry of Economics and Energy (BMWi), the Federal Ministry for Economic Cooperation and Development (BMZ), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB), the Federal Ministry of the Interior (BMI) and the Foreign Office (AA). The action plan on the use of renewable resources for material and energy production and the forestry strategy were issued by the BMEL. The action plan on renewable energies was developped by the Ministry of Economics and Energy.

4 What measures are used to promote the strategy?

The national research strategy (NFS, 2010) has been awarded Euro 2.4 billion and is primarily intended to reinforce the innovation ability of research organisations and businesses. Various programmes are funded under the NFS, for example the renewable resources funding programme, BonaRes (land), GlobE (world food security), IPAS (plant breeding), DPPN (plant phenotyping), ANIHWA (animal health) and basic research for Biotechnology and Bioenergy. On top of this, support measures encourage the formation of unusual alliances between the scientific community, SMEs and larger industrial enterprises from different sectors with the aim to establish new bioeconomy value chains. In this respect, the lignocellulose refinery of the Bioeconomy Cluster in Leuna is being funded to the tune of Euro 40 million.

The development of demonstration and pilot plants is supported by different federal and regional ministries. Examples are a second-generation bioethanol production plant in Straubing , a plant for recycling biogenic waste in Karlsruhe and a refinery for producing kerosene from algae in Jülich.

The policy strategy covers a broad spectrum of application fields and measures along the entire bioeconomy value chain. It provides a comprehensive list of quite specifically formulated political actions to promote the bioeconomy, taking account of potential conflicts of interest. The policy strategy describes funding schemes for R&D regarding renewable resources, industrial biotechnology and agricultural sciences as well as measures for the enhanced and accelerated transfer of technology. The latter includes support for start-ups, clusters and demonstration plants, for example. The development of education and training courses and the increased involvement of the enterprise sector in the qualification of employees for the bioeconomy are also considered necessary by the strategy. Another package of measures is aimed at informing consumers and supporting social dialogue.

5 Is there a time limit on the initiatives?

The national research strategy covers the period up to 2016. The policy strategy does not have a specific time horizon.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

The research strategy rather focuses on innovation in five target areas: global food security, sustainable agricultural production, healthy and safe nutrition, industrial use of renewable resources and expanding the use of sustainable bioenergy. Sustainable production of renewable resources and advances in biotechnology are considered key drivers of the bioeconomy.

7 What are the implicit effects/side-effects of the strategy?

The policy strategy primarily intends to ensure consultation and collaboration between the various political and societal stakeholders. The strategy intends to increase transparency, identify potential conflicts of interest and promote the discussion of appropriate solutions at regional, federal and international levels.

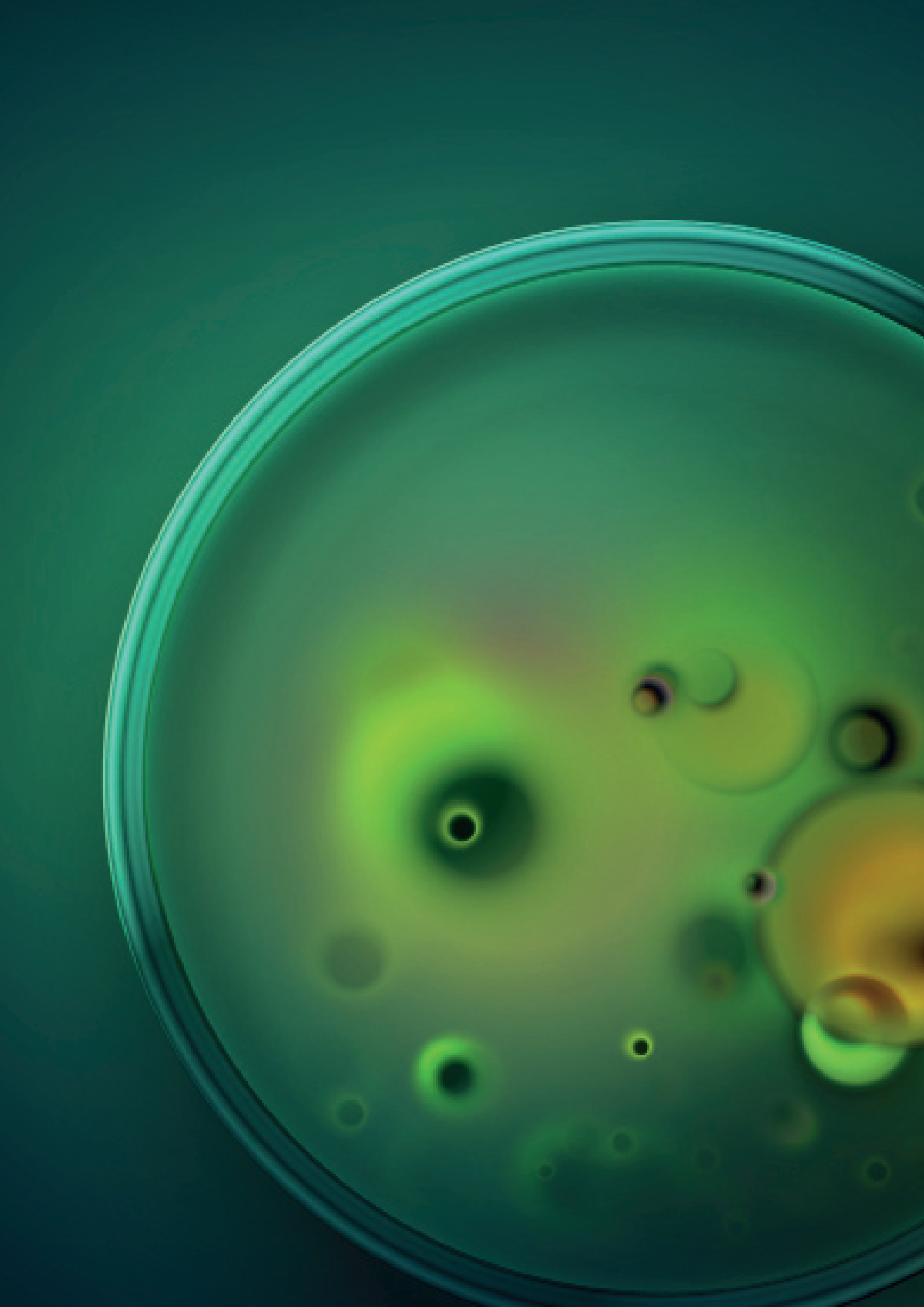
8 Are any quantitative targets specified?

Some of the individual measures are associated with quantitative targets.

Tab. 5: Important Measures for Promoting the Bioeconomy in Germany

Key Points	Policy Measures	Concrete Implementation	Budget in Euro	Timetable	Sources
a) Promoting innovation	Basic research and applied research	For example: Biotechnology 2020+, Innovative Alliances (industrial biotechnology), BonaRes (land), Plant-KBBE (plant biotechnology), IPAS (plant breeding), Renewable Resources Funding Programme, Federal Organic Farming Programme, Bioenergy2021	2.4 bn	2010–2018	Bioeconomy 2030 research strategy
		Forest Carbon Fund: research the potential of forests to reduce CO_2 emissions and adapting to climate change	c. 100 m	2013–2016	www.waldklimafonds.de
	Clusters, demonstration and pilot plants	Funding of pilot plants (biorefineries) in Leuna, Straubing, Karlsruhe and Jülich			
		Cluster BioIndustrie 2021 (5 clusters)	c. 60 m	2008–2012	
		Bioeconomy Cluster Central Germany (Leading-Edge Cluster Competition High-Tech Strategy)	up to 20 m	2014–2017	
	International collaboration	Bioeconomy International (international collaboration on R&D projects with non-EU countries),			Bioeconomy 2030 research strategy
		GlobE: German-African research networks re. food systems			Bioeconomy 2030 research strategy
b) Infrastructure	Centres of competence	Genome sequencing, systems biology, DPPN (plant phenotyping) and, from 2014: bioinformatics		ongoing	
	Research networks and training of specialists	Educational partnerships and thematic subject networks at individual sites and centres, e.g. Bioeconomy Science Centre Jülich, Hohenheim University, Halle Plant Bioeconomy-Science Campus			Bioeconomy 2030 research strategy
c) Commercialization	Market development	INRO network for sustainability certification of renewable biological resources			Initiative Nachhaltige Rohstoffbereitstellung für die stoffliche Biomassenutzung INRO (website)
		"Renewable Energies" export initiative		ongoing	BE policy strategy
	Start-up funding	e.g. GO-Bio start-ups for biotech researchers, life-science incubators		ongoing	BE policy strategy
	Financing and venture capital	Competitive call on ideas, e.g. for new bioeconomy products Support to innovative SMEs (e.g. biotechnology)		ongoing	BE policy strategy

Key Points	Policy Measures	Concrete Implementation	Budget in Euro	Timetable	Sources
		Non-bioeconomy-specific: high-tech start-up fund, capital grants for Business Angels, mezzanine floor funds, Central SME Innovation Programme (ZIM)		ongoing	
d) Demand-side instruments	Support for biomass producers	Feed-in tariffs for bioenergy, focus on biomass from waste		ongoing	Amendment of the Renewable Energy Sources Act 2014
	Information and social dialogue	Communication initiatives and recommendations, e.g. on bio-based products, food waste		2004–2014	BE policy strategy
	Label for consumer products	Blue Angel (e.g. paper products), Developing a methodology for sustainability labelling			
e) Policy framework conditions	Policy coherence	Interministerial Bioeconomy Working Group		ongoing	BE policy strategy
		Information and knowledge management, monitoring studies, etc.		ongoing	BE policy strategy
	Access to renewable resources	International biomass partnerships in compliance with sustainability criteria		ongoing	BE policy strategy



Great Britain

Unleashing High-Value Potential

	Yes	No
1 Is this a specific bioeconomy strategy?		✘

2 If No, what are the key points? How are they being addressed within the bioeconomy?

The UK does not have a specific bioeconomy strategy and the explicit naming of it is rather rare, mostly in the Parliament. However, important aspects of the bioeconomy are addressed in various other strategy papers. As far as agriculture is concerned, the Natural Environment White Paper (NEWP), published in 2011, laid down a sustainable vision for the next 50 years. This gave rise to the "green food" project, for example, dedicated to sustainable intensification in agriculture and the food supply chain.

With its Science and Innovation Strategy for Forestry in Great Britain, the UK published its own innovation strategy for forestry in 2014. The aim of the strategy is to strengthen the ecosystems and resilience of the forests and contribute to a sustainable, low-carbon timber industry. Similar key aims for marine research are defined in the Marine Science Strategy 2010–2015.

Following a biomass strategy in 2007, a specific bioenergy strategy was adopted in 2012, emphasizing the use of various waste materials and perennial

energy crops. The first strategy for agricultural technologies (Agri-tech Industrial Strategy) was agreed in 2013,specifically aiming at the transfer of technology and the commercialization of agricultural and forestry research.

The High-value Manufacturing Strategy adopted in 2012 is a re-industrialization strategy aimed particularly at the commercialization of innovative technologies. Among others, it fosters industrial projects associated with the development of biofuels, biobased plastics and materials and industrial biotechnology. Accordingly, the 2014–2015 strategic plan of the UK innovation agency (Technology Strategy Board, or InnovateUK since 2014) explicitly names the agricultural sciences, biosciences and advanced material sciences as key areas for a high-value industry, for the food supply chain and for resource efficiency. The Biotechnology and Biological Science Research Council (BBSRC) is also concentrating on the promotion of biosciences with its latest strategic plan named “The Age of Bioscience”.

3 Who is the author of the strategy?

The 2012 Bioenergy Strategy was developed and published by the Department of Energy & Climate Change (DECC), the Department for Environment, Food and Rural Affairs (Defra) and the Department for Transport (DfT). The 2013 Agri-tech Strategy was devised by the Department for Business, Innovation & Skills, the Department for Environment, Food & Rural Affairs and the Department for International Development. In parallel, parliamentary committees published reports of enquiries into the potential of the bioeconomy in 2012 and 2013. These discussions seem to excert major political influence.

4 What measures are used to promote the strategy?

Public research funding primarily takes the form of project calls, competitions and catalyst programmes. Private participation is encouraged, particularly for the technology transfer programmes. For example, in the area of agricultural research, yearly state expenditure is around Pound 225 million and business expenditure is expected to contribute at least Pound 100 million.

A large number of bioeconomic R&D activities, especially in the field of biosciences, are funded by the Ministry for Universities and Science. With regard to industrial biotechnology, the government agreed to fund a demonstration fermentation plant based on the recommendations of the “Industrial Biotechnology Innovation and Growth Teams” in 2009.

In addition to agriculture (sustainable intensification, food security and industrial raw materials), bioenergy and industrial biotechnology are listed as key themes of the bioeconomy in the BBSRC’s 2013/14 strategic plan. For example, the BBSRC is funding the Sustainable Bioenergy Centre, which is a partnership between leading academic research institutions, up to Pound 25 million over five years. “Research clubs” adressomg integrated biorefineries and biobased processing have also been supported since 2008. Together with the Innovation Agency, research and development has been funded in the fields of renewable energies and the industrial use of biobased raw materials along the entire value chain. In the agricultural sector, work is being supported to gain a better understanding of the potential and consequences of “sustainable intensification”. Investments in veterinary immunology, livestock research and especially plant genomics and phenotyping,are increasing.

The UK’s main food-related research funds are working together through the Global Food Security programme, which aims at contributing to a sustainabe, healthy and safe supply of food for a growing world popula-

tion. The programme is interdisciplinary and focuses on food security throughout the UK food supply chain. The programme thereby also addresses global issues of hunger and poverty. Global bioeconomy issues are also adressed by the Science and Innovation Fund (Newton Fund) recently set up by the UK Treasury for collaboration with developing countries. This has produced the first examples of bioeconomic collaboration e.g. with Brazil.

The measures supported by the Agri-tech Strategy should help better translate agricultural research into practice (e.g. via the Biotechnology Catalyst and Agritech Catalyst programmes). Supportive measures (coaching, networks, partner programmes, etc.) are promoted to help innovative businesses with funding and business development.

With regard to market development, bioenergy suppliers benefit from tax reliefs and feed-in tariffs. State grants are provided for the establishment of anaerobic digestion plants converting organic waste to energy (e.g. WRAP programme).

5 Is there a time limit on the initiatives?

Typically, the strategies cover the period up to 2020 or even 2050.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

So far, policy measures have focused primarily on bioenergy and agricultural research, also with a strong emphasis on livestock research and veterinary medicine. It was only in the 2013 Agri-tech strategy and the 2014 BBSRC plan that greater emphasis was placed on industrial products.

7 What are the implicit effects/side-effects of the strategy?

As a future centre for innovation and global services, the UK sees an opportunity to further develop, offer and package its skills in life-sciences, agricultural sciences, information technologies, trade and finance. The aim is to stimulate industrial regeneration and to develop a competitive, «high-value» industry. Specifically, Bioenergy should help to achieve these goals in the area of new energies and also promoting rural development.

8 Are any quantitative targets specified?

The Bioenergy Strategy defines that by 2020, 15% of the energy consumption should be supplied by renewable sources. Bioenergy should contribute to this and create 50,000 new jobs.

Tab. 6: Important Measures for Promoting the Bioeconomy in Great Britain

Key Points	Policy Measures	Concrete Implementation	Budget in GBP	Timetable	Sources
a) Promoting innovation	Basic and applied research	BBSRC R&D relating to biotechnology and biobased chemistry	6 m	2008–2013	BBSRC (website)
		Bioprocessing Research Industry Club	23 m	since 2005	BBSRC (website)
		BBSRC Sustainable Bioenergy Centre	24 m	2009–2014	BBSRC (website)
		UK Global Food Security Programme	410 m p.a.	2011–2016	Global Food Security Strategic Plan
		Centres for Agricultural Innovation to promote sustainable intensification	90 m	2014–2018	Agri-tech Strategy
	Pilot and demonstration plants	Anaerobic Digestion Loan Fund: state grants for building anaerobic digestion plants	10 m	2011–2015	Wrap programme (website)
b) Infrastructure	Key enabling technologies	Centre for Agricultural Informatics and Metrics of Sustainability: bioinformatics and Big Data			Agri-tech Strategy
	Rural development	On Farm AD Fund: business plan advice and loans to farmers to build small anaerobic digestion plants		since 2013	Wrap programme (website)
	Education	Academic courses and doctoral programmes in the context of the BBSRC Research Clubs and the Bioenergy Centre			BBSRC (website)
c) Commercialization	Feasibility studies	"Agri-tech Catalyst": project funding for feasibility studies for near-market agricultural innovations	70 m p.a.	2014–2018	Agri-tech Strategy
		"Industrial Biotechnology Catalyst": commercialization of process and product developments	45 m	2014–2015	Technology Strategy Board (website)
		"High-value Manufacturing Catapult": commercialization of production technologies			Technology Strategy Board (website)
	Advice to businesses	Coaching, networks, partner programmes, etc. should help life-science companies to raise capital and to globalize.			Agri-tech Strategy
d) Demand-side instruments	Support for producers	Grants for biomass producers			Biomass Energy Centre, Grants and Support
		Funding of tax relief and feed-in tariffs for bioenergy producers			
e) Political Framework conditions	Green taxes	Climate Change Levy: tax on commercial energy con-sumption, tax exemptions for renewable energy.			Biomass Energy Centre, Grants and Support
		Renewables Obligation: energy providers must buy a cer-tain percentage of renewable energies			

Italy

Cluster Chimica Verde

	Yes	No
1 Is this a specific bioeconomy strategy?		✘

2 If No, what are the key points? How are they being addressed within the bioeconomy?

In Italy, the concept of the "green economy" has greater political prominence than that of the bioeconomy. An area of central importance is the chemical industry's transition to so-called green or plant-based chemistry. Innovative effort is less focused on agriculture or aquatic resources than in other countries. There is intense debate about biofuels, however, because of competition for land and food, little has been done in practice. Furthermore, genetically modified organisms in agriculture and the food industry are discussed controversially.

Although Italy has been developing a federal bioeconomy research strategy for some time now, no document has yet been published. Important international events relating to the bioeconomy have been and will be hosted in Italy, namely the 3rd EU Bioeconomy Stakeholder Conference in 2014 and the World Fair 2015 focusing on world food security. This might increase political awareness and stimulate the development of a bioeconomy strategy in Italy.

3 Who is the author of the strategy?

Not ascertainable

4 What measures are used to promote the strategy?

In the scientific area, the state financed universities of Bologna, Milan, Turin and Florence are very active in the bioeconomy sector. In 2012, the Ministry for Education, Universities and Research called for the creation of innovation clusters, which are primarily to be financed by EU programmes, such as the Structural Fund or Horizon 2020. At the end of 2012, the ministry approved the SPRING national biotechnology cluster, which is focused on “green chemistry”. The cluster is supported by eight regions and began its activities in 2014. In 2013, the Ministry for Economic Development set up the Sustainable Growth Fund (Fondo per la Crescita Sostenibile) with the aim of supporting SMEs in particular with total funding of around EUR 300 million for R&D projects, aimed at the key innovation areas of the EU Horizon 2020 programme.

Italy took a pioneering role in market development and banned businesses from providing non-biodegradable plastic bags in 2011. This law seems to have made a significant contribution towards stimulating green chemistry in Italy. Especially in the North, Italian industry is building up parts of a bioeconomy in the area of green chemistry. This is happening by way of a bottom-up approach, without any significant national support but with the help of EU research programmes. Examples are the building of large-scale demonstration plants for biobased succinic acid in Cassano Spinola, or for biobased butanediol near Venice, as well as conversion of the largest fossil-based chemical complex on Sardinia to large-scale biobased production by ENI and Novamont. In this sector there are a number of important collaborations with French, Belgian, Dutch and recently also US industry.

5 Is there a time limit on the initiatives?

Not ascertainable

6 Are there any identifiable key funding areas within the bioeconomic value chain?

So far, the state has been concentrating on funding research and supporting clusters taking part in EU programmes in the areas of biotechnology and biobased chemistry.

7 What are the implicit effects/side-effects of the strategy?

The aim is to rapidly modernize key industrial and research sectors. Italian companies should foster their competitiveness by participating in international research networks and technology clusters.

8 Are any quantitative targets specified?

Not ascertainable

Japan

Regional Energy and Circular Economy

	Yes	No
1 Is this a specific bioeconomy strategy?	✗	

2 What are the key points? How are they being addressed within the bioeconomy?

The term “bioeconomy” is hardly used in Japan. However, there are strategies and plans directed exclusively at the production and industrial use of biomass, which correspond to the concept of a bioeconomy strategy as addressed in this study. As an example, the first biomass strategy (Biomass Nippon Strategy) was developed in 2002 with the aim of generating a sustainable economy by efficient use of biological resources. In 2009, the law “Basic Act for the Promotion of Biomass Utilization” was passed, outlining the principles of biomass utilization and specifying government responsibilities, the political stakeholders and political funding measures. The National Biomass Policy Council was appointed under this law. The National Plan for the Promotion of Biomass Utilization was then adopted in 2010. This sets quantitative utilization targets up to 2020 and defines fundamental policy on a national, prefectural and district level. Following the great eastern earthquake and tsunami disaster, the Biomass Industrialization Strategy was developed in 2012 and this lays down guidelines for promoting the industrial use of biomass. The aim is to achieve autonomous and decentralized energy production.

Following the change of government, the Abe Cabinet passed a revitalization strategy for Japan in 2013. Research and technology should move Japan towards new growth. On this basis, the Cabinet adopted the Comprehensive Science and Technology Strategy in June 2013, which focuses among others on a clean energy system and the revitalization of the regional economy. The national strategy and action plan for biodiversity (2012–2020) also promotes the development of the bioeconomy. Living in harmony with nature is acknowledged as a new paradigm for the Japanese people. The biodiversity strategy emphasizes the importance of the Satoyama, the traditionally farmed agricultural and forestry areas, in order to maintain and restore the resilience and efficiency of the ecosystems. This should also serve to revitalize rural regions, which are suffering from migration of younger people to urban areas. Moreover, from a socioeconomic perspective, it is acknowledged that it is necessary to achieve a fairer distribution and more intensive exchange of resources between rural areas (ecosystem service providers) and urban areas (Annual Report on the Environment, the Sound Material-Cycle Society, and the Biodiversity in Japan, 2013).

3 Who is the author of the strategy?

The Cabinet decided the national strategies, such as the National Plan for Promoting Biomass Utilization, the comprehensive research and technology strategy and the biodiversity strategy. The biomass industrialization strategy was decided by the National Biomass Policy Council. The council is made up of representatives from seven relevant ministries, which are the Cabinet Office (National Strategy), the Ministry of Economy, Trade and Industry, the Ministry for Agriculture, Forestry and Fisheries, the Ministry for Internal Affairs (Regional development), the Ministry for Education and Science, the Ministry for Transport and Infrastructure (infrastructure policy) and the Environment Ministry (policy for reducing greenhouse gases). A so-called liaison conference on biomass utilization has been set up to coordinate between the departments with the aim of ensuring comprehensive and effective promotion of biomass utilization. The liaison conference office is housed within the Ministry of Agriculture, Forestry and Fisheries (MAFF).

4 What measures are used to promote the strategy?

The National Plan for the Promotion of Biomass Utilization (2010) was intended to define the political bases for increasing the utilization of available biomass. Funding measures were aimed at ensuring collaboration of stakeholders along the value chain through the primary, secondary and tertiary sectors. The plan also focused on a technological path (key technologies and sources of raw materials) and the training of consultants.

The Biomass Industrialization Strategy (2012) defines seven initiatives or action areas for achieving its goal. 1) Basic research 2) Technology, 3) Biomass supplies 4) Demand and market development, 5) Specific biomass strategies 6) Comprehensive support strategy and a 7) Globalization strategy. The strategy provides measures for each of the seven action areas. Basic research and technology are comprehensively supported, with specific ideas as to content. For example, basic research is to be funded for biorefineries and microalgae technologies. Applied research is to be funded, for example in the area of biofuels and thermal utilization of biomass. This area also includes pilot plants and trials. The “Advanced Low Carbon Technology Research and Development Program” (ALCA) of the Japanese S&T agency (JST) is one of the funded innovation programs. In addition to solar and fuel cell research, investment is also being made in “game-changing” biotechnology.

The RIKEN research institute is running a comprehensive biomass research programme, covering the value chain from raw materials via chemical processes right through to biobased materials. The National Institute for Advanced Industrial, Science and Technology (AIST) is researching important topics in the area of green chemistry and renewable energies. For example, it maintains its own research centres for biorefineries (including demonstration plants), biobased production, renewable energies and biobased materials.

With regard to demand and market development, a uniform feed-in tariff for renewable energies (including biomass) was set up in 2012. The "Act on Promoting Green Purchasing" was also passed in 2012. State departments are required to purchase environmentally-friendly products. Japan has also introduced various labels to identify environmentally-friendly and biobased products for consumers, e.g. the biodiversity label, Ecoleaf (products with quantitative details about their environmental footprint) or GreenPla and BiomassPla (for bioplastics). Quantitative targets, for example in the food sector (Food Recycling Law), are being introduced in order to improve biomass supplies and the circular economy. Recycling of food waste is primarily used for producing animal fodder, 38% of which should come from domestic production by 2020 (Basic Plan for Food, Agriculture and Rural Areas). Furthermore, local recycling concepts and management systems for biomass are being set up by means of pilot projects and direct payments (Environment Ministry Annual Report, 2013). There is tax relief (on wealth tax and corporation tax) for biofuel producers. A CO2 tax ("Carbon Dioxide Tax of Climate Change Mitigation") was introduced in 2012. The rate of tax on CO2 emissions is gradually being increased up until April 2016. In parallel, a standardized system is to be introduced for carbon certificates or credits. Private financing for green innovations is to be encouraged by tax advantages for companies with high R&D expenditure and by making losses from venture capital holdings tax deductible.

In terms of the support strategy, regional biomass industrialization networks are being promoted. The purpose of these networks is to implement the concept of the biomass town, to create biobased, environmentally-friendly and disaster-resistant communities. Business clusters along the industrial biomass value chain should also contribute to this development. The Globalization Strategy concentrates on the development of business models and links within Asia.

5 Is there a time limit on the initiatives?

The National Plan for Promoting Biomass Utilization was passed in 2010 and sets quantitative targets for biomass use by 2020. The Biomass Industrialization Strategy (2012) is oriented towards these targets.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

The key areas are research and technological development, where Japan traditionally has a high quota of company research. The National Plan (2010) is aimed at the effective utilization of available biomass along the entire value chain. In the short term, the main priorities are to develop technologies for using wastes and residues (sewage, paper and wood, food, agriculture and forestry) to produce energy and, in the medium term, to develop industrial technologies (bioplastics, biofuels, logistics, etc.). In the longer term, innovations in the area of new biological resources (e.g. algae) and biorefineries are being promoted. The main thrust of the Industrialization Strategy (2012) is the development of renewable energy systems (currently accounting for less than 10%) in rural re-

gions and the development of industrial conversion technologies (e.g. fermentation, incineration, fuel conversion) as well as new products. Another particular priority is the need to establish a biomass system (including logistics) along the entire value chain. Information campaigns are to be conducted to make society and consumers aware of the issues and pilot projects are planned to encourage them to take action.

7 What are the implicit effects/side-effects of the strategy?

As well as increasing the proportion of renewable energies and reducing greenhouse gases, the Biomass Strategy should also help to regenerate rural areas and encourage more sustainable systems of land use. The Biomass Strategy is also consistent with the politically desirable implementation of resource-efficient life-cycle management. Interdisciplinary and international collaboration in the bioeconomic research and industrial sectors contributes towards the cultural change in Japanese society that the government believes to be necessary.

8 Are any quantitative targets specified?

The Japanese policy implements the various strategies by means of targets, action plans and measurable indicators. The National Plan for Promoting Biomass Utilization (2010) specifies three national targets: 1) Use of 26 million tonnes of biomass per annum (CO2 equivalent) and utilization targets for individual types of resources, 2) Formulation of plans for all prefectures and for 600 districts, 3) Development of a new biobased economy (industry) to the value of JPY 500 billion. The Biodiversity Strategy provides for a 50% reduction in the use of pesticides and chemical fertilizers in agriculture via the introduction of natural plant protection methods and better management.

Tab. 7: Important Measures for Promoting the Bioeconomy in Japan

Key Points	Policy Measures	Concrete Implementation	Budget in JPY	Timetable	Sources
a) Promoting innovation	Basic research and applied research	Bioeconomy research by the National Institute for Advanced Industrial, Science and Technology (AIST); industrial biotechnology: Advanced Low Carbon Technology Research and Development Program (ALCA)			http://www.aist.go.jp/index_en.html http://www.jst.go.jp/alca/en/index.html
		RIKEN: comprehensive bioeconomy research programme			http://www.riken.jp/bmep/english/index.html
b) Infrastructure	Rural development and biomass suppliers	Pilot projects: regional biomass industrialization clusters and infrastructure			Annual Report on the Environment, the Sound Material-Cycle Society, and the Biodiversity in Japan, 2013
		Local biomass-recycling zones (waste-to-electricity systems)			
c) Commercialization	Market development	Collaboration with neighbouring Asiatic countries on strategy and development of business models			Biomass Industrialization Strategy
	Innovation capital	Tax advantages for companies with high R&D expenditure, making losses from venture capital holdings tax deductible			
d) Demandside instruments	Support for biomass producers	Uniform feed-in tariff for biomass			Biomass Industrialization Strategy
	Support for biofuel producers	Tax relief (on wealth tax and corporation tax) for biofuel producers.		2012	
	Public procurement	Green procurement policy		2012	Act on Promoting Green Purchasing
	Labels	Biodiversity label, Ecoleaf (products with quantitative details about their environmental footprint), GreenPla and BiomassPla (for bioplastics).			
e) Political framework conditions	Green taxes	Carbon Dioxide Tax of Climate Change Mitigation		from 2012	Carbon Dioxide Tax of Climate Change Mitigation
	Recycling	e.g. Food Recycling Act			Plan for Establishing a Sound Material-Cycle Society, 2013

USA

Development of New Markets

	Yes	No
1 Is this a specific bioeconomy strategy?	✗	

2 What are the key points? How are they being addressed within the bioeconomy?

The Obama administration's Bioeconomy Blueprint covers the entire bioeconomy portfolio including explicitly the health sector. The agricultural strategy or "Farm Bill" does not specifically relate to the bioeconomy but promotes key subsegments in the areas of agriculture, bioenergy and food.

3 Who is the author of the strategy?

The Bioeconomy Blueprint was published by the White House in 2012. The agricultural strategy is developed under the responsibility of the Department for Agriculture. State research agencies under the Departments for Agriculture, Economic Affairs, Defense, Energy, National Security, the Interior, Environmental Protection and Health were and are involved in the development of bioeconomy strategies and policy measures.

4 What measures are used to promote the strategy?

Both strategies include extensive packages of policy measures relating to the promotion of innovation, infrastructure, commercialization, demand-side instruments and political framework conditions . The Bioeconomy Blueprint not only defines traditional R&D funding in life-sciences but also provides for measures to ensure improved and accelerated technology transfer. Some of the measures to facilitate this transfer include simplifying the procedure for forming clusters and start-ups, adapting to regulatory mechanisms and eliminating obstacles to innovation. Particularly in the health sector, approval processes should be accelerated and be more efficient. A further package of measures aims at the reform of education and training courses, as well as enhanced involvement of industry in the qualification of employees. The agricultural strategy is also based on a broad spectrum of incentive measures fostering the bioeconomy, especially in the area of "Renewable Energies and Energy Efficiency". Noteworthy in this context is the "Biorefinery Assistance Program", which promotes the production of biofuels and, since 2014 via amendments of the Farm Bill, other biobased materials. Plant research, in particular for energy production, is heavily supported as a continued measure. The US government's Biopreferred Program relating to public procurement of biobased products is being extended to include forestry products. Together with the Department for Agriculture, the Energy and Defense Departments also play a significant role in promoting and even creating new markets for biofuels. For example, in 2014 more than USD 200 million of funding was allocated for building three biorefineries in association with the "Farm to Fleet" biofuel procurement programme for the US Navy. Although biofuels will be purchased via regular public tenders this measure intends to ensure sufficient production capacity for cost-competitive biofuels for military use by 2018.

5 Is there a time limit on the initiatives?

There is no time limit on the Bioeconomy Blueprint. The Farm Bill was adopted for the period 2014–2018.

6 Are there any identifiable key funding areas within the bioeconomic value chain?

Development of the bioeconomy is being promoted along the entire value chain. However, applied research, cross-cutting technologies and technology transfer, including easier access to market, are particularly important.

In terms of content, there seems to be a gradual shift from a strong emphasis on using biomass for energy purposes towards non-energy applications (see adaptation of the Biorefinery Assistance Program to biobased materials). Lately, more attention is paid towards biobased consumer goods for sports, leasure time, health care, ecosmetics, etc. The Bioeconomy Blueprint also highlights the role of biomedical research and its impact on health. Particular weight is given to gene and DNA sequencing and to high-throughput protein engineering. Other areas that are mentioned are synthetic biology, proteomics and bioinformatics.

7 What are the implicit effects/side-effects of the strategy?

In particular, the bioeconomy should produce technical innovations to secure the future competitiveness and sustainability of the US economy. The content of the Farm Bill is more concerned with rural development and agricultural competitiveness. On top of that, the Bill deals with questions of food security and environmental protection. As an important customer for new technologies and fuels, the Department of Defense funds both biotech research and the development of alternative fuel sources.

8 Are any quantitative targets specified?

No

Tab. 8: Important Measures for Promoting the Bioeconomy in the USA

Key Points	Policy Measures	Concrete Implementation	Budget in USD	Timetable	Sources
a) Promoting innovation	Bioeconomy research	Biomass Research and Development Initiative USDA-DOE	112 m	2014–2018	2014 Farmbill
		DOE Genomic Science Program: 3 Joint Bioenergy Research Centres		2013–2018	GS program (website)
		Agricultural and Food Research Initiative (National Institute of Food and Agriculture)	136 m	since 2011	BE Blueprint
		Research into organic farming	100 m	2014–2018	2014 Farmbill
		Advanced Research Projects Agency-Energy (ARPA-E): Biofuels and bioenergy		since 2009	BE Blueprint
		Research into special crops	c. 400 m	2014–2018	2014 Farmbill
		Living Foundries Program (biomanufacturing), Department of Defense		since 2011	BE Blueprint
	Cross-cutting technologies	High through-put technologies, e.g. TOX21 screening of chemicals		since 2008	TOX21 (website)
		Synthetic biology: DOE Biological and Environment Research Program	30 m		BE Blueprint
	Interdisciplinary research	NSF Research at the Interface of Biological, Mathematical, and Physical Sciences	c. 50 m	2014	BE Blueprint
		NSF project "Science, Engineering, and Education for Sustainability"	c. 220 m	2014	
	Promoting innovative research	COMPETES Reauthorization Act gives authorities the right to put contracts and prices out to tender, these are listed on Challenge.gov		since 2010	BE Blueprint, COMPETES (website)
		INSPIRE (NSF) as a continuation of the CREATIV program for funding high-risk, interdisciplinary research		since 2012	NSF (website)
	Public-Private partnerships	Foundation for Food and Agriculture Research: use of private funds for research	200 m	since 2014	2014 Farmbill
		Plant biotech research: BREAD program in collaboration with the Gates Foundation	c. 48 m	2009–2014	BE Blueprint

Key Points	Policy Measures	Concrete Implementation	Budget in USD	Timetable	Sources
b) Infrastructure	Education	Science Technology Engineering and Mathematics (STEM) Education Initiative, including: NSF Research relating to STEM education (1.2 bn p.a.)	3 bn p.a.		FY2014 Research Funding, STEM Education Initiative
	Vocational training and further education	Courses available at the Community Colleges, business partnerships, e.g. via the TAACCCT program			BE Blueprint
		Beginning Farmer and Rancher training	100 m	2014–2018	2014 Farmbill
		FDA entrepreneurs-in-residence pilot program		since 2013	BE Blueprint
	Cyberinfrastructure	NSF: Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF-21)		since 2011	BE Blueprint
	Rural Development	Biomass Crop Assistance Program (grants for biorefineries to develop value chains with agricultural and forestry businesses)	125 m		2014 Farmbill
c) Commercialization	Lab-to-Market plans	For example:· Tech to Market from ARPA-E;· NSF Innovation Corps (I-Corps);· Innovation-6 (i6) Challenge, U.S. Department of Commerce;		since 2013	Lab-to-Market Interagency Summit, 2013
		Investor consortium: USDA Agricultural Technology Partnership Innovation Foundation ATIP		since 2011	ATIP Foundation
	Market readiness and penetration	Small Business Innovation Research Program (biofuels and biobased products) and Small Business Technology Transfer	c. 18 m	2011–2017	BE Blueprint
		Passing of the America Invents Act (faster patenting and marketing of innovations)		since 2011	BE Blueprint
	Innovation capital	USDA “Biorefinery, Renewable Chemicals, and Bio-based Product Manufacturing Assistance Program”	c. 200 m	2014–2016	2014 Farmbill
		Research and Experimentation Tax Credit extended to start-up firms and adapted to the needs of SMEs		2014–2015	
	Globalization of businesses	USDA Foreign Market Development and Market Access Program	200 m p.a.	2014	2014 Farmbill

Key Points	Policy Measures	Concrete Implementation	Budget in USD	Timetable	Sources
d) Demand-side instruments	Public procurement	Procurement guideline for the preferential treatment of biobased products on a federal level.	c. 25 m	2014–2018	Biopreferred program
		Farm-to-Fleet program: procurement of biofuels by the US Navy. In parallel: promotion of biofuel production by the Defense Production Act, Advanced Drop-in Biofuels Production Project and USDA Commodity Credit Corporation funds.	c. 400 m	since 2013	USDA News Release No. 0237.13
	Labels	"USDA certified biobased product"		2014–2018	Biopreferred program
	Use of bioenergy	Repowering Assistance Program: biorefineries should use biomass for energy and heating purposes	c. 75 m	2014–2018	2014 Farmbill
		Investment in energy efficiency and renewable energies	c. 350 m	2014–2018	2014 Farmbill
		Bioenergy Program for Advanced Biofuels	c. 175 m	2014–2018	2014 Farmbill
e) Political framework conditions	Legislation for and approval of new technologies	New principles for the regulation and control of new technologies		2014	BE Blueprint
		FDA reform: increased involvement of patients and industry in approval processes		2012	FDA Safety & Innovation Act
		USDA reforms concerning risk assessments and regulations, pilot projects for improving the approval process for genetically modified organisms			

Summary and Conclusions

Given the background of climate change, dwindling fossil and mineral resources, the global food situation and great advances in life sciences, the G7 members have made considerable efforts to position themselves in the biobased economy. These efforts are described in detail in this study. Germany, the USA and Japan have set themselves ambitious goals with specific national bioeconomy strategies. France, the UK, Italy and Canada are also providing much support to promote the development of the biobased economy in practise. Within the G7 group, the European Union has become a driving force behind bioeconomy policy. As well as being anchored within EU policy strategies, considerable funding has been planned for the bioeconomy under the Horizon 2020 framework research programme. Apart from the G7, many other EU members are now implementing country or regional-specific bioeconomy strategies, for example the Netherlands, Belgium, Denmark, Sweden, Spain and Finland. In the upcoming structural fund debates, 18 of the 28 EU countries even specified the bioeconomy as a priority.

Differences Between The Strategies

There is a great variation in the political aims and measures of the individual countries. They are characterized by the prevailing industrial and economic profiles of the countries and by the amount of resources they have, especially by their natural resources potentials. Their underlying motivations range from a desire to secure access to raw materials through to comprehensive regeneration of the innovation system and the ecological transformation of the economy. The way nations approach the issue is also very different. Countries like Germany, Japan or the USA have published government-wide, coordinated and comprehensive bioeconomy strategies, involving numerous departments (Environment, Agriculture, Economy, Research etc.). Other countries, such as Italy or Canada, are relying primarily on industryled or regional initiatives and limit themselves to designing framework conditions at national level.

The USA and Canada both have huge areas of forest, coast line and arable land. They both traditionally practice bioeconomy on a large scale, in the sense of agricultural and forestry production. However, it has been recognized that new technologies can further increase the value of the agricultural and forestry sectors while promoting rural development. Consequently, Canada and the USA have developed utilization strategies focused on their natural assets. Key areas are the production of platform chemicals or bioenergy, such as wood pellets, bioethanol, and recently also next-generation biofuels. Both the USA and Canada have supplemented their agricultural strategies by an agricultural research strategy focusing primarily on industrial biotechnology (conversion technologies). When it comes to innovation policy, the term bioeconomy is generally synonymous with biotechnology. For example, both North American nations foster the use of biotechnology in agriculture, in industry and in medicine in the hope of gaining a technological advantage. In this interpretation, the bioeconomy also incorporates the health sector, including the pharmaceutical industry and innovative services such as e.g. bioinformatics.

In countries with few natural resources and a strong industrial structure, such as Germany, Japan, France and Italy, the bioeconomy is viewed much more from the point of view of its innovative potential and recently also its potential for industrial renaissance. The latter is currently being strongly promoted by the EU, in particular by the new EU Commission. In contrast to North America, the EU does not classify medical-biotech innovations as part of the bioeconomy. Its focus is firstly on replacing fossil fuels, and the associated reduction in greenhouse gases, and secondly on achieving a technological advantage by means of new methods for processing biomass to make new products. In countries with scarce resources, access to and utilization of “alternative biomass” such as CO_2, waste or other residues, play a significant role. In order to secure access to raw materials, Germany, Japan and the UK are also trying to establish international technology and resource partnerships with emerging countries, which have a plentiful supply of biomass.

The UK, in particular, has a highly developed service sector and excellent bioscience research. The country regards the bioeconomy first of all as an opportunity to capitalize on these strengths to develop science-based, high-value industries. Secondly it is pursuing a reindustrialization strategy, which consists of developing extensive production capability, for instance, by converting decommissioned industrial facilities for biofuels.

Political Approaches

Some G7 countries act on a “top-down” approach. The development of the bioeconomy is driven by the political sector that develops visions, strategies and action plans to promote and shape the biobased economy. The EU, Japan and Germany, together with the USA, can be attributed to this category. Germany is the only G7 country to have both a dedicated research and policy strategy approved by cabinet. Japan defined a National Plan for promoting biomass utilization with quantitative deployment targets for renewable resources and also adopted a biomass industrialization strategy. With its technologically oriented “Bioeconomy Blueprint”, the USA has defined a comprehensive package of measures, primarily promoting biotechnology innovations. This is complemented by its agricultural policy outlined in the “Farm Bill”, which includes measures for agriscience innovations, the development of bioeconomic infrastructure and the production of biomass. Moreover, the USA is the only country with a specific public procurement programme for biobased products, in order to stimulate market demand. Similar initiatives are currently being discussed in the EU.

In Italy, France and Canada, it is rather industry driving the bioeconomy on a “bottom-up” approach. Initiatives are primarily started and funded by the private sector. The political sector restricts itself to funding research and accompanying developments. Where appropriate, it sets framework conditions by means of seed financing for clusters, legal and regulatory interventions or demand-side stimuli (ecological procurement, feed-in tariffs for bioenergy etc.). The role of the political sector is therefore a less active one than in the USA, Japan or Germany, but should not be underestimated. For example, the buoyant activity of biobased chemistry and plastic processing industry in Italy is partially attributable to a ban on the use of disposable plastic bags. Besides numerous cluster initiatives, France is making interesting advances in the area of consumer standards and labels. For example, certificates for sustainable investment funds to generate venture capital for the “green” economy were introduced. In the construction industry, a special label for biobased buildings has been in use.

The UK occupies a unique position as regards policy approaches. To a large extent, the industrial sector drives the bioeconomy in the UK, although, for example, the bioenergy strategy of the government has not been underpinned with further support measures. Parliament is however playing a very active role, to the extent that there have already been two in-depth enquiries on the potential of the bioeconomy, which has not yet taken place in any other G7 country.

Regional Stakeholders

Regional stakeholders also play a considerable role in the political promotion of the biobased economy within some G7 countries. For example, in Canada, regions such as British Colombia, Alberta and Ontario have developped their own bioeconomy concepts, aimed at biobased production or more efficient and more profitable utilization of agricultural or forestry products. Similarly, in Italy, regional green clusters have been launched in Sardinia, Piedmont and Lombardy. France is backing regional “Poles de competitivité” (competitiveness clusters) with an ecological focus, especially concerned with “Chimie du vegetale” or biobased chemistry. In Germany, two federal states have produced their own bioeconomy strategies. Apart from the chemical industry, North Rhine-Westphalia is primarily focusing on medical biotechnology, diagnostics or regenerative medicine, which – unlike at national or European level – is expressly included in its concept. Baden-Württemberg has also issued a tailor-made bioeconomy research strategy. The key areas here are biogas, lignocellulose-based value chains, the optimization of algae utilization and bioeconomy modelling in support of business strategies.

Global Stakeholders

Together with the OECD, the EU is the only supranational stakeholder with a bioeconomy strategy. So far, neither the United Nations (e.g. UNEP, UNCTAD or FAO), nor the World Bank, nor the IPCC (Intergovernmental Panel on Climate Change), or the like have positioned themselves on the subject of the bioeconomy. Elements of bioeconomy, however, do play an important role in the World Bank initiated Green Growth Knowledge Platform. The EU has already been promoting the bioeconomy for about ten years and is therefore internationally regarded as a pioneer. Alongside numerous research projects, which are anchored in the respective framework programmes, the primary aim is to establish new value chains between industries that have not previously seen themselves as economic partners. Because of the competition policy in Europe, individual nations have to content themselves with promoting precompetitive areas, whereas the EU, as an overarching stakeholder, is also able to fund close-to-market projects. This has been happening for some years now, primarily under the banner of innovation funding, within the framework of which individual countries can also develop their own funding measures. An example of this is the public-private partnership of the "Biobased Industries" (BIC). The expressly stated goal is to set up "flagships" in the form of industrial production plants and biorefineries. The BIC initiative has total funding of EUR 1 billion from public funds (Horizon 2020) and EUR 2.8 billion from private funding.

Analysis of Individual Policy Areas

Notwithstanding their different strategic approaches, all the G7 nations and the EU are united by similar goals in terms of the bioeconomy. From an ecological perspective, the bioeconomy should help to reduce greenhouse gases, facilitate the transition to using renewable resources as part of a circular economy and help to maintain vital ecosystem services. All the countries acknowledge the contribution the bioeconomy makes to sustainability and also, more recently, to the so-called international "Circular Economy" but they each set different priorities. From an economic perspective, all G7 nations are expecting the knowledge-based bioeconomy to boost innovation and growth ("green growth", "blue growth"). From a social perspective, they are hoping for positive impacts on jobs including high-tech employment. In addition, it is expected that the bioeconomy will create new concepts for strengthening rural development and recently also for improving living conditions in cities.

Energy

Whereas, in the 2000s, most G7 countries prioritized funding for bioenergy, cascading utilization has become more important in recent years. Biotech innovations, in particular, should facilitate greater and progressive valorisation of biomass, whereby it is used to create energy at the very end of the process chain. On the one hand, this development can be attributed to technological advances in life sciences. On the other hand, the expected medium-term and long-term availability of fossil resources due to new exploratory techniques also plays a role. Cheaper prices for energy and raw materials meant that many energy applications of the bioeconomy (first-generation processes in particular) became non-viable. Many nations and organizations such as the EU had encouraged the production of biodiesel or bioethanol by means of premiums. However, recently there has been growing concern about indirect changes in land use and negative impacts upon food security and biodiversity. Thus, the EU and Germany reduced the deployment targets for bioenergy or changed the funding targets (e.g. amendment of the German Renewable Energy Sources Act 2014). Reports indicate that the UK's bioethanol production plants, which are capable of a very high output in European terms, regularly operate at less than 50% capacity and have seen numerous changes of

ownership and production outages. Following the recent discoveries of shale gas and tight-light oil in the USA, the arguments about achieving energy independence via bioenergy have lost some of their power. Nevertheless, biofuels are continuing to be funded, especially in the “US Farm Bill” and by the US military also, with a view to gaining more independence.

Research Strategies

The bioeconomy research policies of the G7 countries have many commonalities; these relate not only to important research topics but also to the desired “cultural changes” in the research sector (greater interdisciplinarity and international orientation of research activities). On top of that, basic and applied research are becoming more interlinked. This (desired) cross-linking in itself involves collaboration between numerous institutions. Some governments, such as Japan and France, for example, see the cross-structural and interdisciplinary concepts of the bioeconomy as an opportunity for modernizing their national research landscape.

Most funding programmes do not therefore explicitly differentiate between industrial, applied and basic research but are aimed at collaboration along the entire value chain. In addition to this, publicly funded research is taking on new tasks, i.e., identifying possible opportunities for industrial applications and motivating commercialization of research findings. In this context, the technical and scientific infrastructure for important cross-cutting technologies, such as genome sequencing, high throughput technologies and bioinformatics, has been created in the form of national centres of excellence in the USA, Germany, France and the UK.

Important research topics include plant research and the use of other biological resources (e.g. algae, microorganisms, waste residues), conversion technologies and biorefining as well as agricultural and marine technologies. An important difference between the analysed strategies can be found in the attitude towards genetic engineering of crops. While the USA, Canada and Japan support gene technology in agriculture and forestry for breeding plants with optimized characteristics, the European countries are much more sceptical about it.

Education and Training

The bioeconomy is a highly complex field, which demands interdisciplinary knowledge. The USA has set itself ambitious goals in the area of natural and life sciences education. Within the framework of various STEM (Science, Technology, Engineering and Mathematics) programs, work has already started on updating and adapting school and university education. Japanese policy is particularly looking for cultural change in schools and universities. Research and education should become more interdisciplinary and internationally oriented. In the European G7 nations, specific bioeconomy training programs are being developed and tested within the industrial clusters: for example, in the “Industries et Agro-Ressources” (IAR) cluster at Pomacle-Bazancourt in France or the CBP Leuna cluster in Germany. The two federal states with bioeconomy strategies, namely North Rhine-Westphalia and Baden-Württemberg, each offer their own bioeconomy study courses.

Technology Transfer and Commercialization

Promoting innovation is now a predominant factor in the G7 countries. Particular emphasis is being placed on technology transfer and the early commercialization of research findings. Recently, in the USA, public research calls are asking for Lab-to-Market plans, which take account of commercialization opportunities at the time of tendering. In addition, it is being made easier for third parties to use patents originating from publicly funded research. At the same time, investment consortia are supporting the marketing of such property rights. In its agricultural support programme (Growing Forward 2), Canada provides separate programmes for the commercialization of agriscience innovations. The UK is also supporting the commercialization of biotech and agritech research by means of feasibility studies. Coaching schemes, modernized extension services and partnering programmes should help innovative life science companies to obtain international capital and to conduct international marketing. Germany

is encouraging innovations by “unusual alliances” and industrial clusters involving the scientific and industrial sectors and SMEs. In Japan, France and Italy company research and industrial participation in bioeconomy clusters play a key role.

All G7 countries are promoting the establishment of demonstration plants directly via various co-funding models and indirectly via the involvement of publicly funded research organisations. The lack of seed financing for innovative ventures is an important issue, especially in Europe. Measures for mobilizing capital are thus provided for small and medium-sized enterprises in the bioeconomy sector. However, most of these are non-specific and relate to all areas of innovation. Support to the transfer of technology to private companies is coupled with the hope of a higher return-on-investment for public research funds. However, all G7 countries report challenges when it comes to technology transfer and successful commercialization. They face the risk that ecologically and socially desirable innovations, which have been publicly funded, may fail to establish themselves under prevailing market conditions. This is exacerbated by increased competition from emerging countries to gain market share in many areas of the bioeconomy – for example in the area of bioplastics. In this context, the advantages of international collaboration in developing promising business models (including raising capital) and markets for biobased products and processes have not yet been fully understood or even exploited. Synergistic benefits might result from division of labour, optimization of education pathways and exchange of personnel, sharing of “best practices”, harmonization of standards, etc.

Society

Sustainable, biobased economic practices are not only associated with industrial change but also with comprehensive societal change, involving, for example, changes in educational concepts and of patterns of consumption and behaviour. This change is acknowledged by all G7 nations. Germany, in particular, has included a strong element of engaging in social dialogue as part of its bioeconomy strategies. Furthermore, monitoring structures are to be established in Germany in conjunction with the European Union in order to be able to measure the impact of the bioeconomy upon society, the environment, the economy and the scientific sector. The aim is to have an evidence-based bioeconomy policy that is transparent and capable of assessing its own impact and which has the backing of German society. The policy measures of the other G7 nations are more vague on the subject of monitoring and fostering social change.

Outlook

In terms of content, the bioeconomy policy of the G7 nations has evolved over the past few years from a research-oriented resource strategy into an innovation and industry strategy with strong sustainability and growth elements. It is now seen as an important component of an economy that uses resources as sustainably as possible. Whereas, initially, the focus was on the utilization of biomass for producing energy, it is now moving increasingly towards cascading use of materials. With the aid of biotechnology, important basic chemicals such as acrylic or succinic acid and innovative materials in the form of biopolymers or biobased carbon fibres are being produced from renewable raw materials also for consumer goods with enhanced properties that are also ecofriendly. Biobased products respond to the growing social demand for products that are natural, healthy and sustainable. Consequently, all the G7 nations are directing their bioeconomic activities towards innovation, growth and sustainability.

Currently, it is not possible to say whether countries with a top-down or a bottom-up approach will be more successful. In the meantime, it is becoming increasingly clear that there is not just one bioeconomy but rather many different forms of bioeconomy. General regional characteristics and global framework conditions should determine the direction in which the individual bioeconomy strategies develop.

In many branches of industry, the technological advantage of the industrialized countries is generally shrinking relative to developing and emerging countries; this pattern may also be true for the bioeconomy. Biotech innovations put emerging countries in a position where they are able to process their huge biomass resources to produce higher value products for the global market. These countries might in the future cease to be suppliers of raw materials and become suppliers of finished products. Brazil, Russia, India, China, South Africa and Malaysia have developed their own policy strategies on various aspects (e.g. bioenergy, biotechnology) or on the whole area of the bioeconomy and are determinedly implementing measures to underpin them. New branches of industry are emerging in these countries, for which biotech production facilities are being built (with considerable direct foreign investment). Once again, the bioeconomy is acting as an industrial growth or regeneration strategy. Bioeconomy is therefore becoming an increasingly strategic issue for the G20 and beyond.

The G7 group has not yet issued a clear position statement or initiative on the bioeconomy, although important goals or topics of the bioeconomy are addressed in several summit statements and G7 initiatives. Specifically, the G8 group has been addressing the challenges of global food security and climate change for several years. During the Summit in Brussels in 2014, the G7 jointly declared that they are still committed to continue their collaboration targeting climate protection (e.g., Climate and Clean Air Coalition 2012), a low-carbon energy system (e.g., G7 Rome Energy Initiative) and global food security and nutrition (e.g., New Alliance for Food Security and Nutrition 2012). In 2013, the G8 summit declaration further specifically addressed the need to contribute to good governance in land transactions in developing countries with a focus on ensuring food security and sustainable development.

Résumé

As outlined in the summary, the bioeconomy strategies of the G7 countries are primarily aimed at their own territories. International collaboration is only in its early stages, for example in the German GlobE programme or the UK Newton fund fostering global food security and development of the bioeconomy. The impact of “national bioeconomies” would be considerably increased if there were a move beyond national strategies and programmes toward an international initiative. This would also foster the social support for and the economic impact of national promotion programmes that involve considerable levels of investment.

In this respect, an intensified international exchange on the development of the bioeconomy seems necessary. This might take place in the format of a future Global Bioeconomy Platform, which would identify obstacles and problems and exploit synergistic benefits and growth effects by means of common political approaches in all countries involved in bioeconomy innovations and strategies.

About the Bioeconomy Council

In 2009, the German Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) established the Bioeconomy Council as an independent advisory committee to the German Federal Government. In 2012, the Council has been newly nominated for a second four-year term. The 17 members represent industry, society and science and their expertise covers the full spectrum of the bioeconomy value chain. The Council is mainly tasked with providing advice on how to foster the development of a sustainable bioeconomy in Germany and in a global context. For this purpose it engages in political and scientific dialogue, publishes position statements and promotes the future vision of the bioeconomy to broader society. The activities of the council are oriented both towards long-term objectives as well as day-to-day policy requirements. Documents download and further information in English is available under www.bioekonomierat.de/english.html

About this report

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