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INTERNATIONAL (EUROPEAN) REGIONAL POLICY ON THE BIOECONOMY

Subtask 3.1 Draft Report

This report analyses international (European) regional bioeconomy policy to identify approaches that can inform future regional strategy in Ireland. It first situates regional strategies within the evolving EU bioeconomy, Green Deal and circular economy frameworks, then selects Germany, France and Belgium as case-study locations based on comparable agricultural, climatic and natural-capital profiles. Through documentary analysis of national and sub-national strategies, it distils four cross-cutting approaches – research and innovation, partnership, governance, and economic, environmental and social sustainability. The report identifies transferable policy strands and cautions that lessons must be adapted to Ireland's predominantly livestock-based agroecosystems, institutional context and rural capacities.

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1. Introduction

This report explores international (European) regional policy on the bioeconomy with a view to understand how various strands of international policy may be transferable in an Irish context. In order to accomplish this task, the report first discusses the European context, followed by the identification of three case study European regions deemed suitable for analysis. These regions include Germany, France, and Belgium. Following this, the analysis examines the various regional strategies employed to advance bioeconomy development. In this respect the bioeconomy policy context within these regions is investigated and the broad policy solutions contained within these strategies is examined under four interrelated approaches to bioeconomy development, which include: 1) the research and innovation approach; 2) the partnership approach; 3) the governance approach; and 4) the economic, environmental, and social sustainability approach. Although inherently interrelated and overlapping at times, this broad classification of policy solutions is considered instructive for understanding the nature and direction of EU bioeconomy policy in Europe. Finally, respective approaches are explored in respect to the key challenges and opportunities for policy transfer in the Irish context.

1.2 The European Context of Regional Strategy

The European agenda for research and development, energy, and agricultural policies has become increasingly focused on the bioeconomy, creating a distinct policy field in its' own right (Lühmann, 2020). The development of a European Bioeconomy Strategy in 2012, revised in 2017, and updated in 2018, has led to the wide-spread interest in developing national and regional bioeconomies across Europe. As such, diverse strategies and initiatives have developed over the last decade (Kirs, Karo, and Ukrainski, 2022). The European Commission (Mubareka et al., 2023) has reported that ten European Member States (Finland, France, Ireland, Latvia, Spain, Italy, Germany, Netherlands, Austria, and Portugal) have published dedicated national bioeconomy strategies, and an additional six (Belgium, Bulgaria, Estonia, Denmark, Romania, and Slovenia) have policies dedicated to the bioeconomy through sub-national and macro-regional strategies (European Commission, 2023). Sub-national strategies in this context are strategies concerned with a particular region within a countries' administrative boarder geographically classified as "Nomenclature of Territorial Units for Statistics" (NUTS) (Hutzschenreuter, Matt, and Kleindient, 2020), whilst macro-regional strategies represent integrated frameworks located within a designated geographical area to address shared challenges and opportunities through long-term objectives (European Commission, 2022). The nature of current bioeconomy initiatives in Europe is shown in Figure 1.

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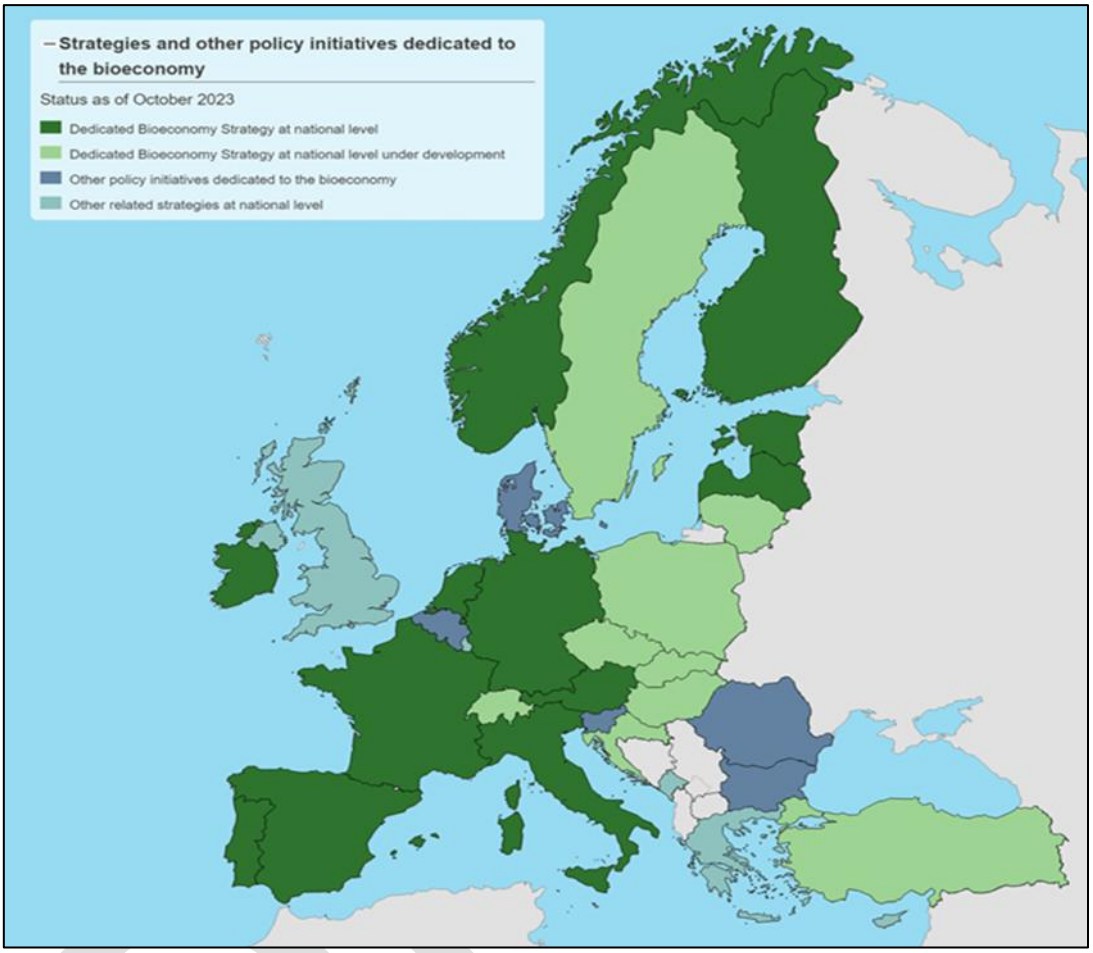
Figure 1: National bioeconomy strategies in EU 27 & neighbouring countries (Source: European Commission, Knowledge Centre for Bioeconomy, 2023)



According to Rozon et al. (2022) the revised European Bioeconomy strategy (2017) has placed a greater focus on environmental objectives and territorial development and in an effort to align with the Paris Agreement (2015), United Nations Sustainable Development Goals (2015), European Green Deal (2019), and Circular Economy Action Plan (2020). The revised strategy has also placed a greater focus on the social and ecological aspects of the bioeconomy and have recognised the potential ecological risks (*ibid*). This has led to the development of broad policy objectives (pillars) dedicated to understanding the ecological boundaries of the bioeconomy as well as the establishment of fair territorial development of the bioeconomy across the EU (*ibid*).

In transitioning away from fossil-fuel dependency it is important that nations engage in strategic planning for advancing national and regional bioeconomy development. This should be facilitated by evidence-based decision-making through knowledge transfer and good practice assimilation (Navarro et al., 2014) through cross-border, cross-sectoral, and multi-stakeholder exchanges and collaborations (Kiresiewa et al., 2020). The creation of a strong knowledgebase in this regard is important for the fostering of innovation and the sustainable advancement of the European

bioeconomy. Collaboration between sectors (public and private), international and local stakeholders, as well as civil society are a key component in creating relevant bioeconomy experts and initiatives at all scales across Europe (Bioregions, 2024). It is important to note that these interactions tend to primarily occur at a regional level (De Besi and McCormick, 2015). Therefore, the regional aspect of the bioeconomy plays a critical role in the development of innovation in a sustainable manner. This is accomplished through the establishment of networks and clusters (*ibid*) for the sharing of expertise, good practices, and experiences.

Regions have their own capacities with regards to institutions, industries and agriculture, and are highly contextualised, providing the opportunity for inter-regional (international and national) collaboration (de Besi and McCormick, 2015). These collaborations aim to encourage coherence and innovation (*ibid*). Regional collaboration can be used as an instrument to leverage regional specialisations and strengths, as well as contexts to facilitate the sharing of good practice and address common challenges (*ibid*), it is important to note that collaboration and exchanges between similar/comparable regions enhances replicability and scalability of good practice and policy.

The success of the bioeconomy depends on effective collaboration among various sectors involving biological resources, including agriculture, marine, forestry, innovation, chemical production, energy, and biotechnology (Devaney and Henchion, 2017). As a result of Ireland's abundant natural capital, rapid growth of biomass, as well as its strong competitive agri-food sector, it is in a unique position to take full advantage of the opportunities presented by the bioeconomy (*ibid*). Due to the wide range of Ireland's renewable resources, as well as the multitude of sectors involved, the bioeconomy is extremely complex from the perspective of policy. Its growth and progress needs to be shaped by this diverse and complex policy implemented at local, regional and national scales.

At present, Ireland does not have a specific regional strategy for the bioeconomy. In response to the EU Bioeconomy Strategy (2018), and in line with commitment to the UN Sustainable Development Goals for 2030, the European Green Deal, and Farm to Fork Strategy Ireland has developed a National Policy Statement on the Bioeconomy (2023-2050), Bioeconomy Action Plan (2023-2025) and a Whole of Government Circular Economy Strategy (2022-2023). In the absence of a regional strategy, this report aims to consider how regional strategies are implemented in Europe, with the view that such strategies play an important role in achieving a more spatialised and specialised approach. It is also considered how partnerships between various sectors, primary producers, and research institutions contribute to innovation within the bioeconomy landscape in the attempt to optimise the use of biomass. It is the contention of this report that regional strategies are important for determining the desired path and allocation of resources to appropriate areas, as well

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as identifying relevant stakeholders (Losacker et al., 2023). The impact of regional strategies are significant in shaping both current and future priorities of the bioeconomy because they enable localised innovation, resource optimisation, and tailored policy implementation (*ibid*). This also enables local innovation and resource optimisation to be aligned with national policies and global sustainability goals (*ibid*).

1.3 Ambition and Trends in European Regional Policy

European bioeconomy policy emphasises the importance of regional contexts in fostering sustainable and circular bioeconomy systems (Szarka et al., 2021) which aim to promote economic growth, competitiveness, and foster innovation across regions, whilst mitigating negative impacts on ecological systems and resources (Befort, 2023). These strategies aim to balance food security, renewable resource use, recycling, and environmental protection (Jafari et al., 2023). Regional bioeconomy strategies are designed to leverage local resources, coordinate stakeholders, and develop innovation within specific regional contexts, often focusing on regional actor engagement across the multiple value chains (*ibid*). Bioeconomy strategy in Europe plans to boost local economic growth, predominately in rural areas, through the promotion of sustainable regional economies (Albrecht et al., 2021) with the objective of promoting rural development. From a practitioner perspective, the bioeconomy represents the potential for agricultural modernisation, transformation, and renewed rural economic development (Morales, 2022), where regional policies are envisioned as the driving force of green investment that is intended to shape a regional roadmap for the bioeconomy to achieve decarbonisation (Kirs et al., 2021), thereby contributing to the target of carbon neutrality by 2050.

A fundamental objective of European regional strategy is the formulation of a smart specialisation approach which aligns with distinct regional characteristics to foster bio-based value chain development and the generation of new business and employment models (Kangas and Ryynänen, 2022). According to Kogut-Jaworska and Ociepa-Kicińska (2023), smart specialisation programmes can serve as a complementary approach to existing regional innovation strategy, positively impacting the local economy. The implementation of smart specialisation also aims to identify promising investment areas, optimise resource allocation, and promote strategic development through multilateral interaction to unlock economic potential and stimulate innovation at the regional level (Kangas and Ryynänen, 2022). The advancement of the bioeconomy is considered crucial for transitioning toward a post-fossil fuel future. Regional bioeconomy hubs play an important role in this transition by bringing together stakeholders from policy making bodies or agencies, educational institutions, industries, as well as civil society organisations in order to coordinate

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strategic pathways for regional bioeconomy growth (Szarka et al., 2021). In this respect, some of the most advanced bioeconomy infrastructures in Europe tend to rely heavily on collaboration dynamics, which refers to the interactions, coordination, and exchange of knowledge between primary producers, stakeholders, and various sectors, enabling the establishment of networks and partnerships that foster innovation, knowledge dissemination, and the integration of bio-based solutions into the bioeconomy (Faslino et al., 2023).

Understanding local contexts and narratives is crucial to the interpretation of different regions and how bioeconomy policy should be implemented to harness the unique spatial characteristics of differentiated territories (Morales, 2022). Recognising these differences helps to understand how policies unfold in diverse ways across regions, enabling practitioners to effectively interpret and implement bioeconomy strategies within specific spatial contexts (*ibid*). By understanding the regional context, a more context-specific approach to the bioeconomy can be developed so that progress is aligned with specific socio-spatial conditions that promote inclusivity, plurality, and economic growth (*ibid*). This is important because once regional difference is characterised and understood, this allows for the appropriate identification of various stands of transferable policy which can then be transmitted cross-regionally in both national and international contexts.

2. Identification of Case Study Regions

The following section provides the rationale for the identification of three European case study regions in order to analyse how various strands of policy can be transferred to the Irish context. The approach for case study selection focuses on regional contexts analogous to rural Ireland.

2.1 Approach

The selection process was based on cross-national investigation, whereby preliminary research was conducted across all EU Member States on the basis of agricultural profile, climate and natural capital profile, and regional policy investigation. First, countries/regions were identified where on the basis of whether or not they had a dedicated regional bioeconomy strategy. Second, regions/countries with analogous agricultural, climate, and natural capital profiles to that of Ireland to allow for the potential for policy transfer. Based on this approach case study regions were identified in Germany, France, and Belgium. Figure 2 shows the approach for selecting the case study regions derived from de Almeida (2024).

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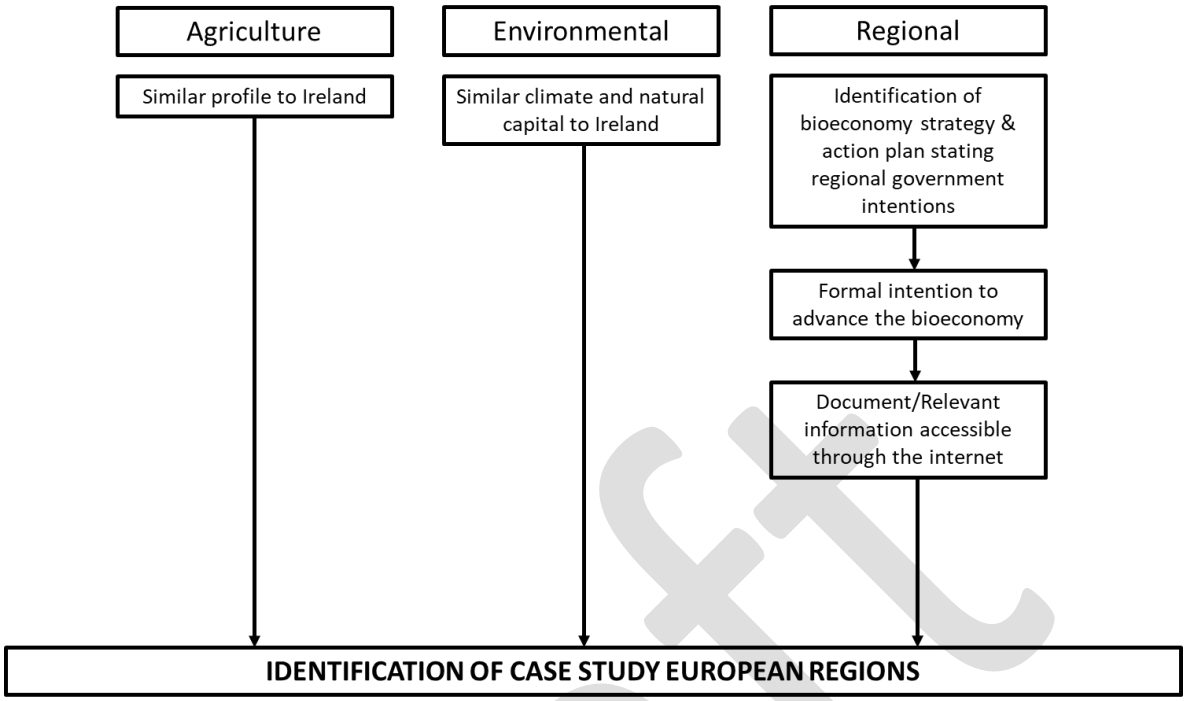
Figure 2: Modified Version of Selected Criteria for Case Study Regions (Source – de Almeida)



2.2 Regional Bioeconomy Strategies

Figure 3 illustrates the extent to which counties have prioritised regional bioeconomy strategy.

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Figure 3: Regions with strategies related to the bioeconomy-EU 2022 (Source: Haarich and Kirchmayr-Novak 2023; 6)

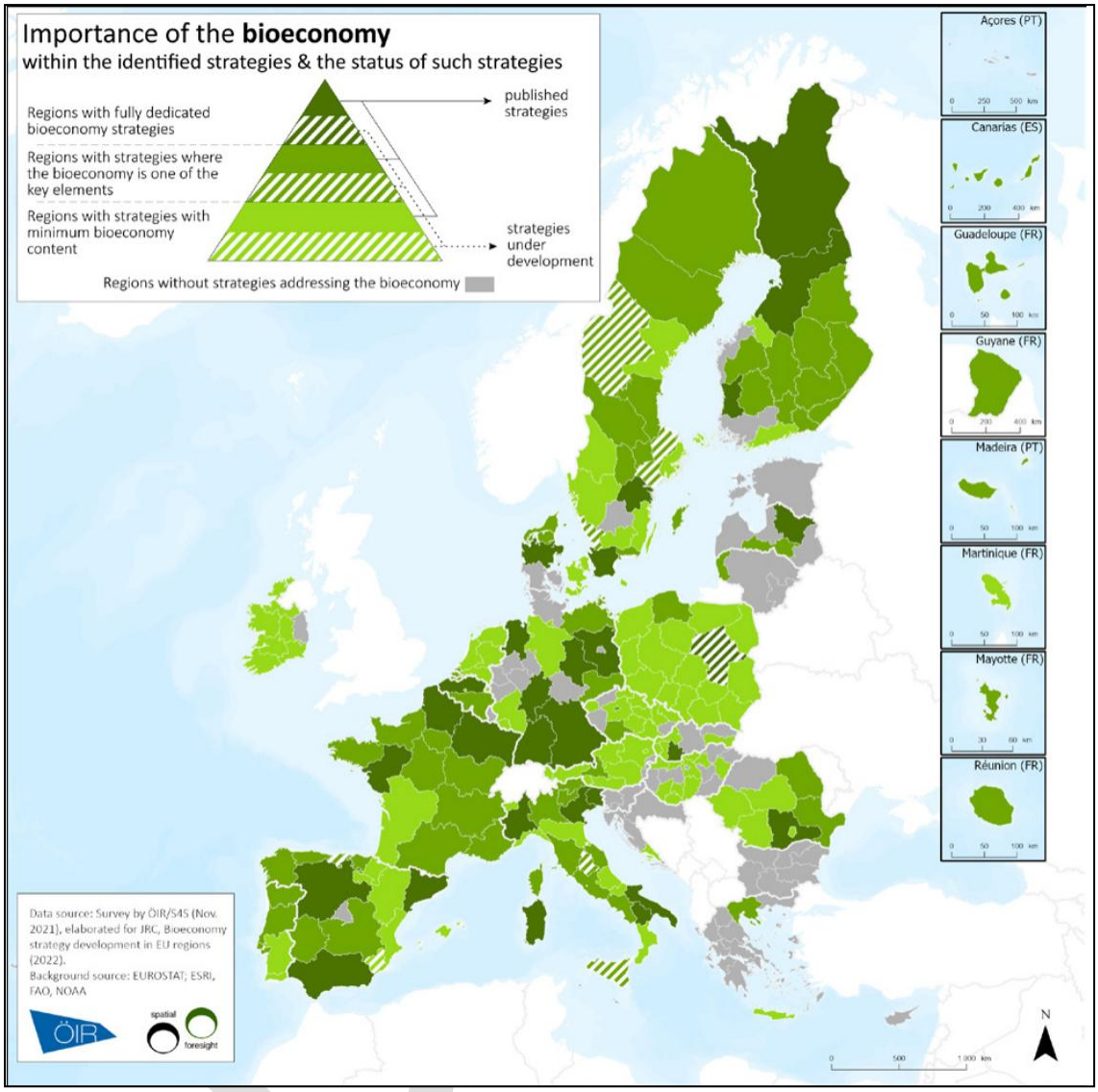


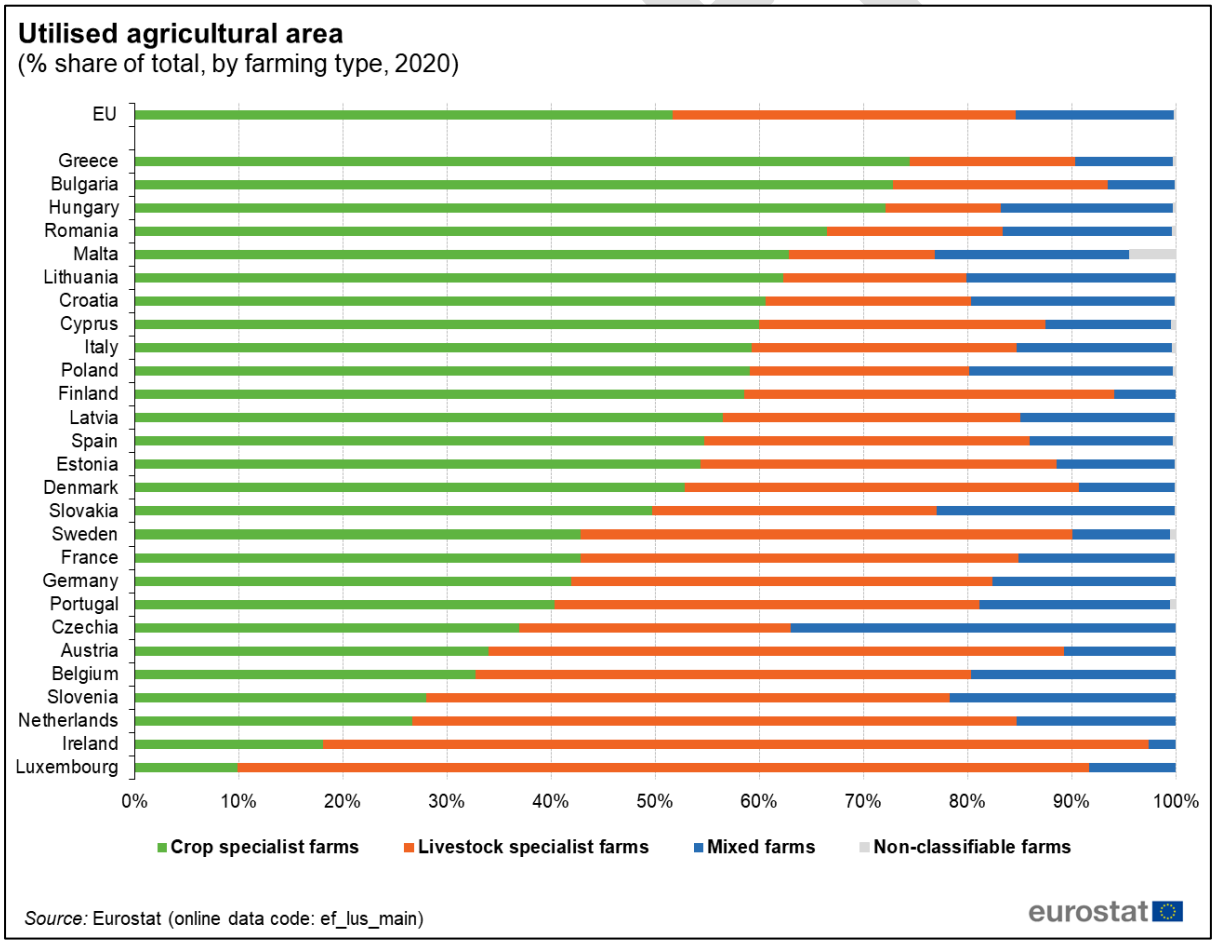
Figure 3 shows that Finland, Sweden, Germany, Denmark, Latvia, Romania, Italy, France, Spain, Belgium, Denmark, the Netherlands and Slovakia have all developed dedicated regional bioeconomy strategies. For the present analysis, these regional strategies were cross-referenced with agricultural, climate and natural capital profiles of European countries (described below) in order to ascertain the most suitable candidates for case study selection. In respect to agricultural profile, Finland, Latvia, Romania, Italy, Spain, Denmark and Slovakia exhibited high proportions of crop specialist farm systems. This was considered dissimilar to Ireland's predominantly livestock-based system and thus these nations were excluded from selection. Of the remaining regional strategies under consideration, Sweden had a dissimilar climate and natural capital profile to Ireland and thus was excluded from selection. Denmark was also excluded from selection due to a relatively high proportion of crop

specialist farming typology but also due to the inaccessibility of its regional strategy for Middle Jutland relative to other candidate nations. As such, it was considered that Germany, France and Belgium were the most suitable case study locations for analysis. Before investigating regional policy in these jurisdictions it is important to consider the agricultural, climate and natural capital profiles of case study locations as previously referenced.

2.3 Agricultural Profiles

Figure 4 shows the total share of farming type in Europe as of 2020.

Figure 4: Utilised Agricultural Area (Source: Eurostat, 2020)



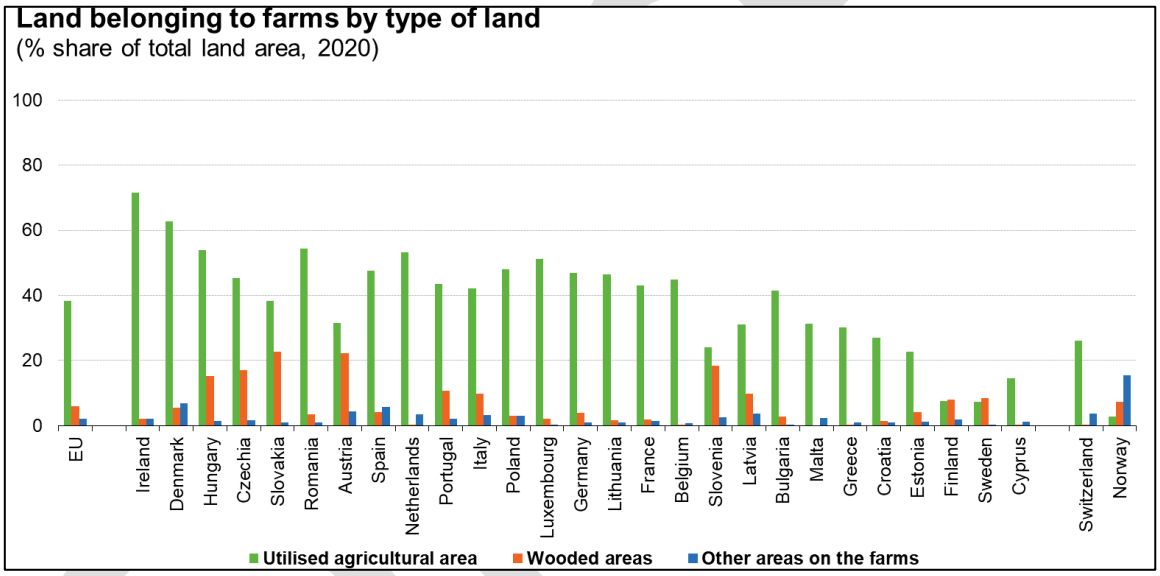
According to Figure 4 many Eastern European and Mediterranean countries had high proportions of crop specialist farms as of 2020, whilst North-West European countries such as Ireland, the Netherlands, Belgium, and Luxemburg had high proportions of livestock specialist farms. Other North-

West European countries such as Germany, Denmark, France, and Sweden exhibited high proportions of crop and livestock specialist farming.

According to Eurostat's (2023) statistics on EU agriculture, approximately 9.1 million farms were recorded in 2020. In respect to land use, 1.55 million km² of land was used for agriculture (±38%) across the total EU land area.

Figure 5 shows the percentage of land that belongs to farms according to type.

Figure 5: Land belonging to farms by type of land (% share on total land area, 2020) (Source: Eurostat, 2022)



As Figure 5 illustrates, the EU landscape is dominated by agriculture, with Ireland exhibiting the highest proportion (±72%), followed by Denmark (±63%), Romania (±55%), Netherlands (±53), Poland (±48%), Germany (±47), France (±45%), Italy (±42), Latvia (±31%), Finland (±7.5%), and Sweden (±7.4) (Eurostat, 2023).

2.4 Ireland

The Irish agricultural industry is predominately centred around specialist cattle (beef) and sheep production, followed by specialist dairying, and to a lesser extent general field crops and cattle-dairying, rearing and fattening. Figure 6 illustrates the main Irish farm types according to Eurostat (2020).

Figure 6: Farm type in Ireland (Eurostat, 2020)[1]

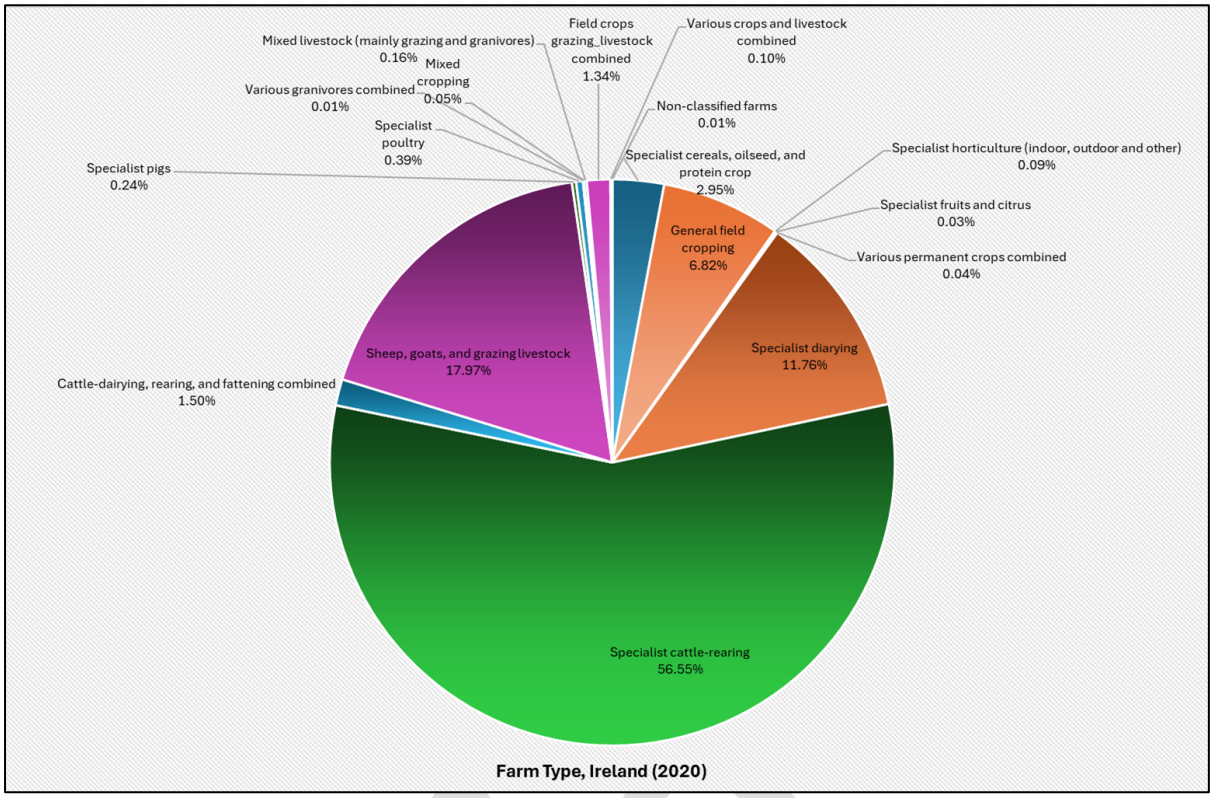


Figure 6 shows that most dominant farm type in Ireland as of 2020 was, by far, specialist cattle-rearing (56.55%), followed by sheep, goats, and grazing livestock (17.97%), specialist dairying (11.76%), and general field cropping (6.82%).

2.5 Germany

Germany has a diverse agricultural landscape, with different regions specialising in various crops and livestock. The country has a significant portion of its agriculture dedicated to arable farming (general field cropping, 29.61%) (Britannica, 2024), and also has a strong dairy industry, being the largest milk producer in the European Union (Orth, 2019). Organic farming accounts for more than 10% of all agricultural holdings in the country (*ibid*). Figure 7 illustrates the percentages of farm types in Germany as of 2020.

[1] Figure 6 was generated by the author based on statistics from Eurostat (2020).

Figure 7: Farm type in Germany (Eurostat, 2020) (Chart by de Almeida)

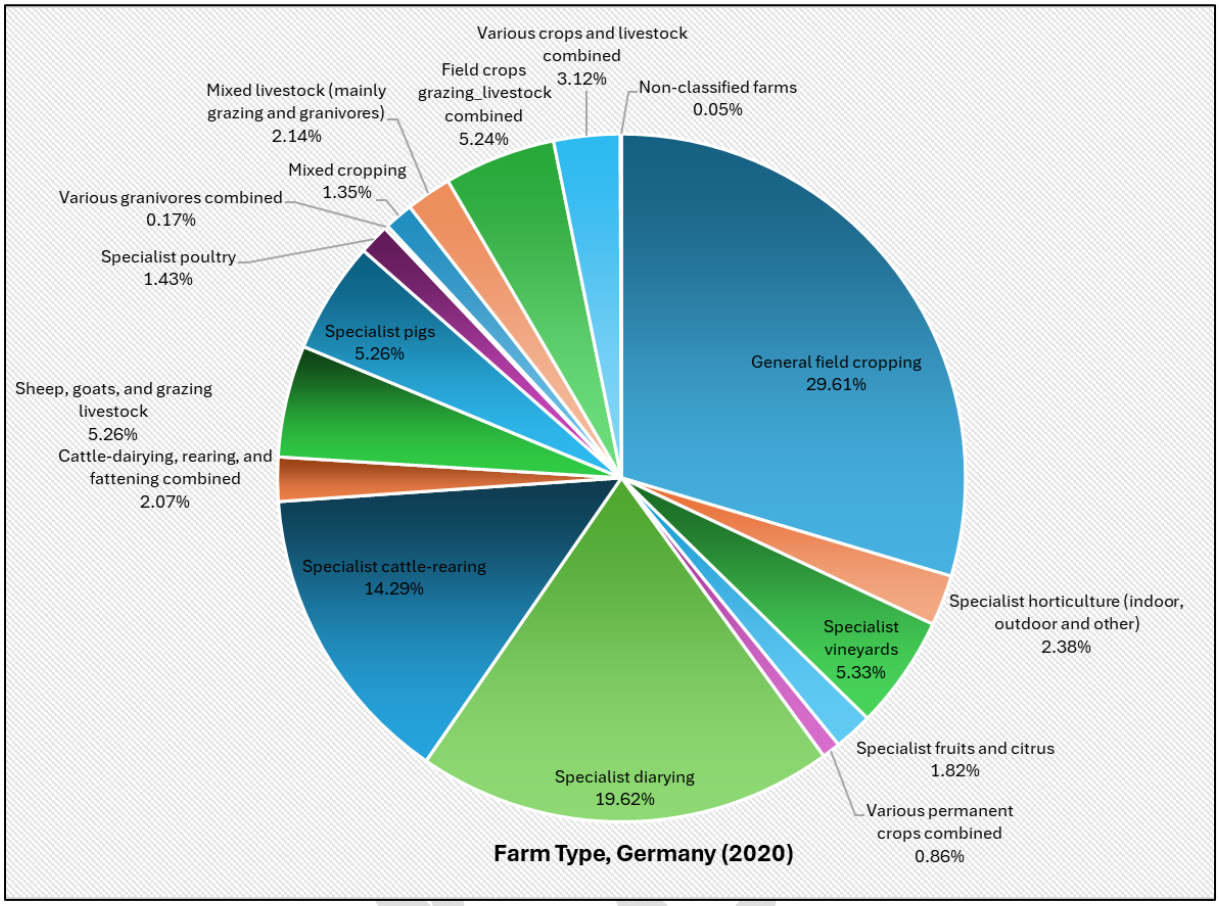


Figure 7 illustrates that the predominate farm types in 2020 included general field cropping (29.61%), specialist dairying (19.62%), specialist cattle-rearing (14.29%), specialist vineyards (5.33%), and specialist pig farming (5.26%), followed by sheep, goats and grazing livestock (5.26%).

2.6 France

The main types of farming in France are arable and livestock farming. Arable farming dominates in the northern and western regions (Britannica, 2024), while livestock farming, particularly cattle raising, occurs in most areas (*ibid*). Figure 7 shows dominate farm types in France as of 2020.

Figure 8: Farm type in France (Eurostat, 2020) (Chart by de Almeida)

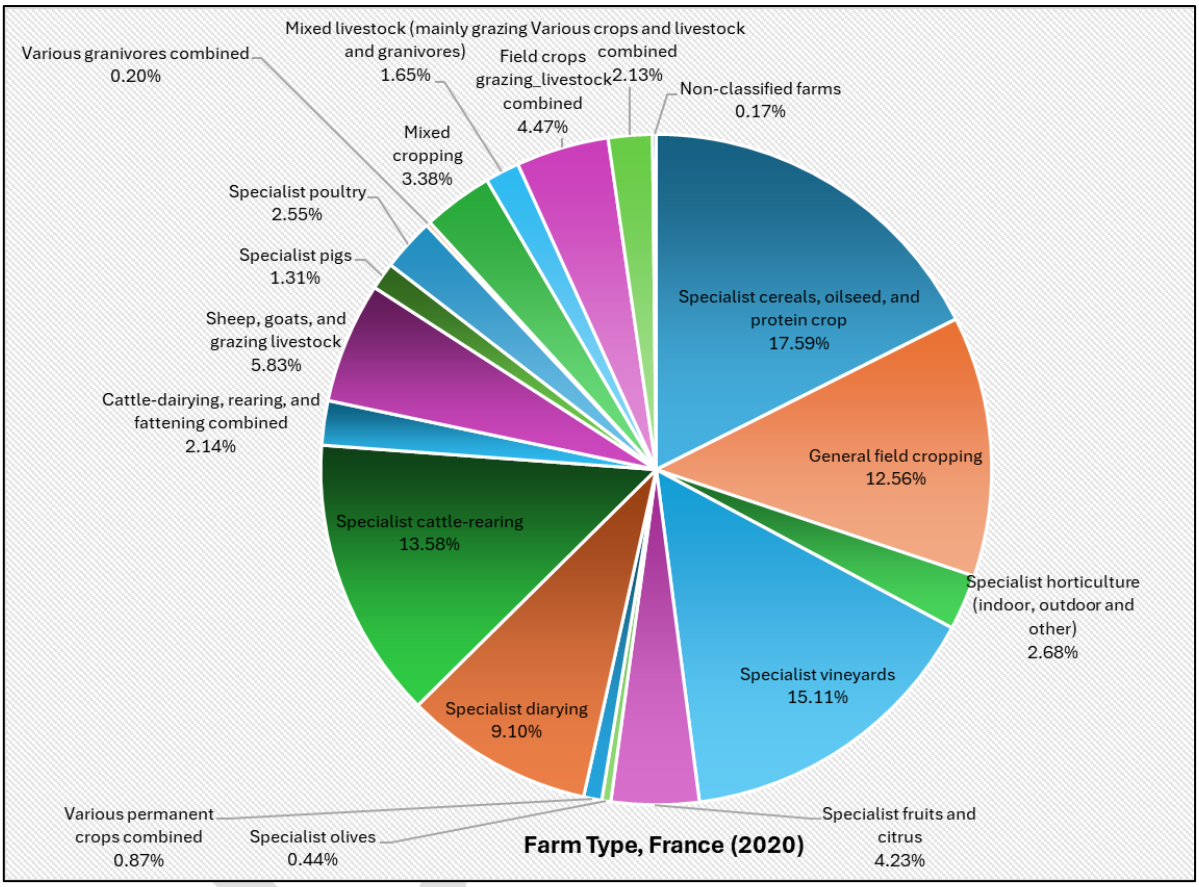


Figure 8 illustrates that in 2020 the most common farming type was specialist cereals, oilseed, and protein crop (17.59%), followed by specialist vineyards (15.11%), specialist cattle rearing (13.58%), general field cropping (12.56%), specialist dairying (9.10%), and sheep, goats, and other grazing livestock (5.83%).

2.7 Belgium

Belgium's agricultural landscape is mainly livestock farming and crop production. Figure 9 illustrates the percentage of farm types found in Belgium as of 2020.

Figure 9: Farm type in Belgium (Eurostat, 2020) (Chart by de Almeida)

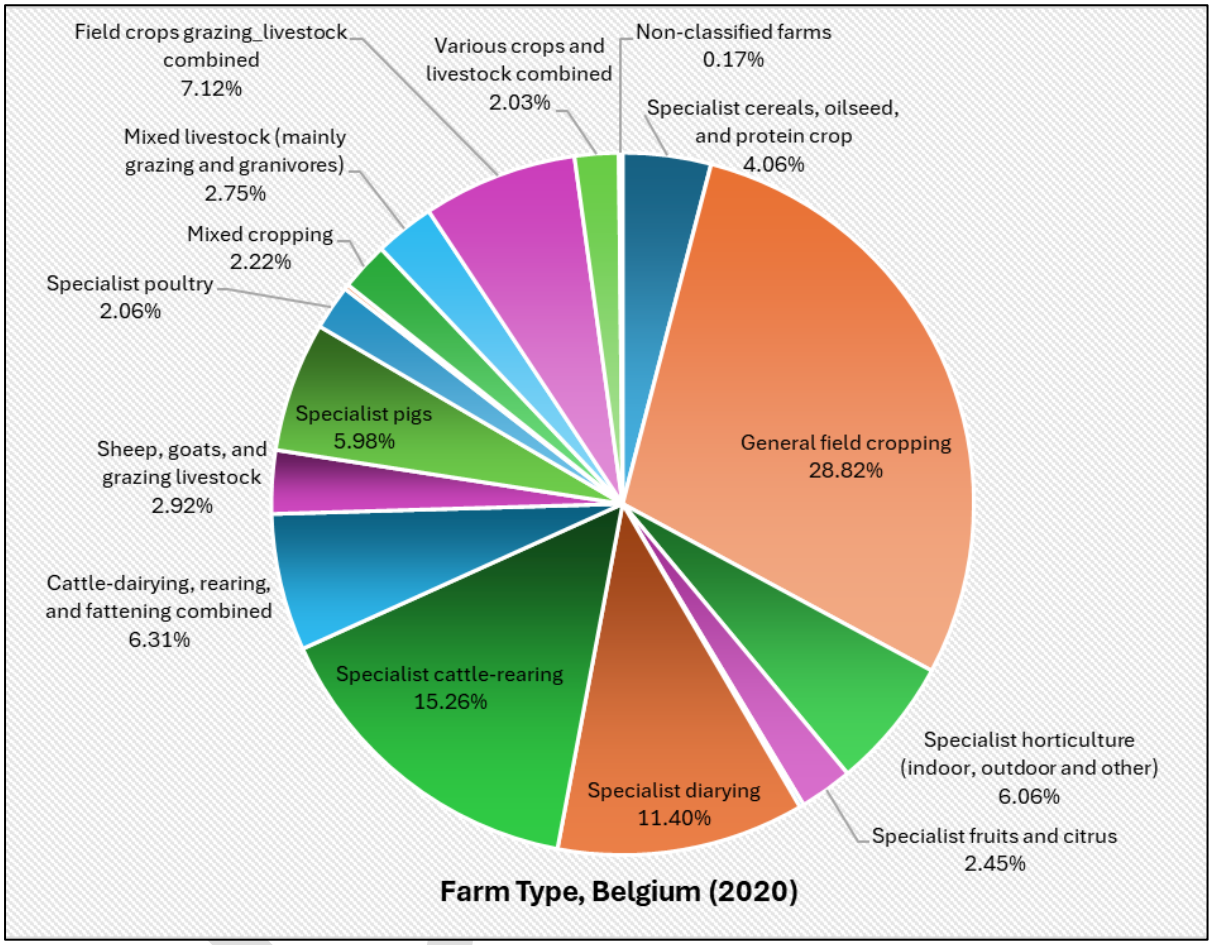


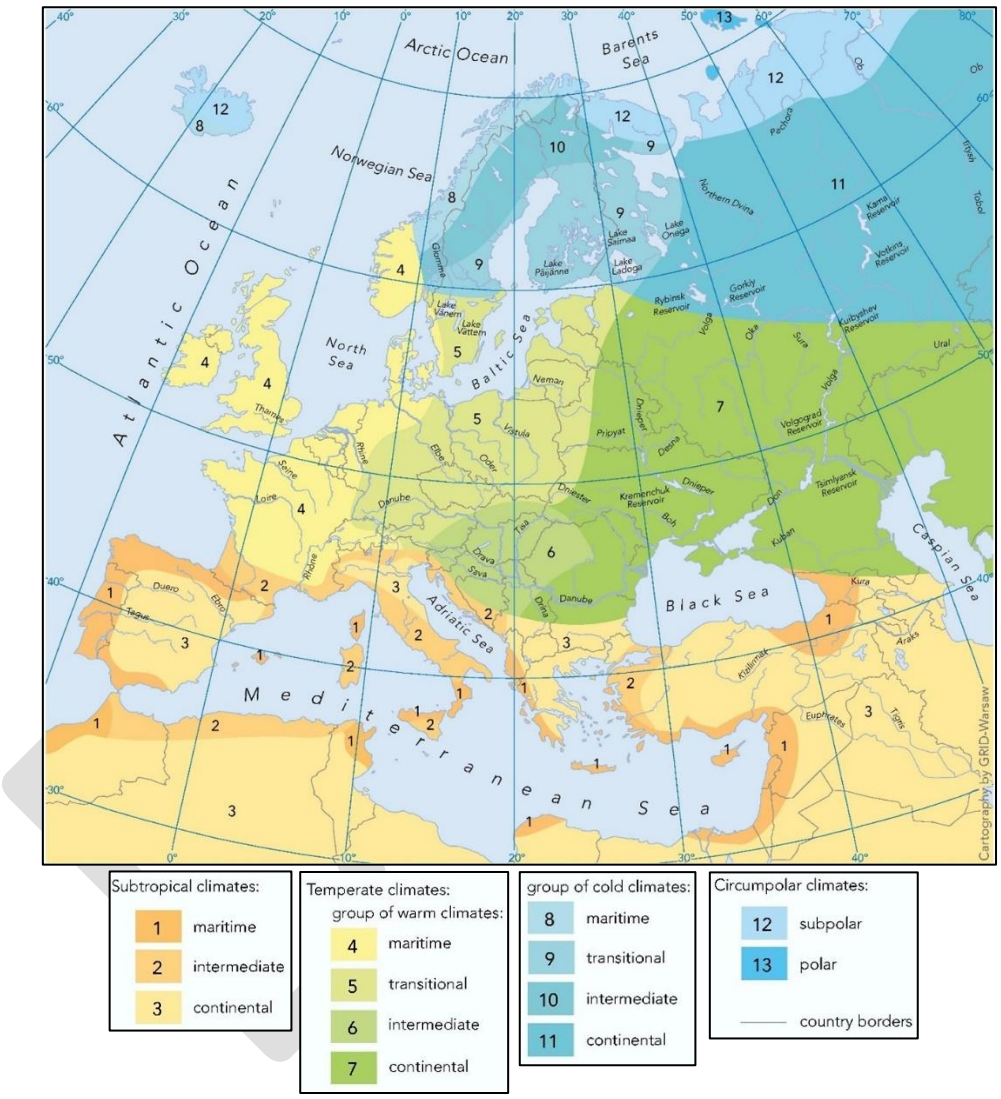
Figure 9 shows that general field cropping (28.82%) was the dominate type of farm holding in 2020, followed by specialist cattle-rearing (15.26%), specialist dairying (11.40%), cattle-dairying (6.31%), specialist horticulture (6.06%), and specialist pig production (5.98%).

In summation, compared to other EU nations, Germany, France and Belgium exhibit relatively analogous agriculture profiles to Ireland. They all have high proportions of livestock farming, though Ireland's cattle specialist typologies far outnumber respective case studies, while general field cropping typologies are far fewer. Nevertheless, as intimated, this disparity is more apparent across other EU nations.

2.8 Climate

Figure 10[2] illustrates the primary climate scenarios present across the European continent as of 2002.

Figure 10: Map of Main Climate Types of Europe (Source: EEA, 2002; 19)



The Figure shows that Ireland's maritime temperate climate (type 4) is shared with the United Kingdom, the majority of France, Belgium, northern Germany, the Netherlands, Denmark, and western Norway.

[2] https://www.eea.europa.eu/publications/report_2002_0524_154909

2.9 Natural Capital Profiles

In respect to natural capital, the Biodiversity Information System for Europe 2019 (https://biodiversity.europa.eu/) states that agroecosystems comprising of croplands and grasslands amount to approximately 47% of landcover in the EU. Such landcover important for biodiversity, hosting approximately 50% of all species in the EU. Agrobiodiversity plays an important role in food and agriculture, ensuring the resilience of food security and safeguarding against the uncertainties of climate change. The natural capital profile of case study region relative to Ireland are illustrated in Figure 11.

Figure 11: Ecosystems coverage of terrestrial territories: Ireland, Germany, France, and Belgium (Biodiversity Information System for Europe, 2019) (Chart by de Almeida)

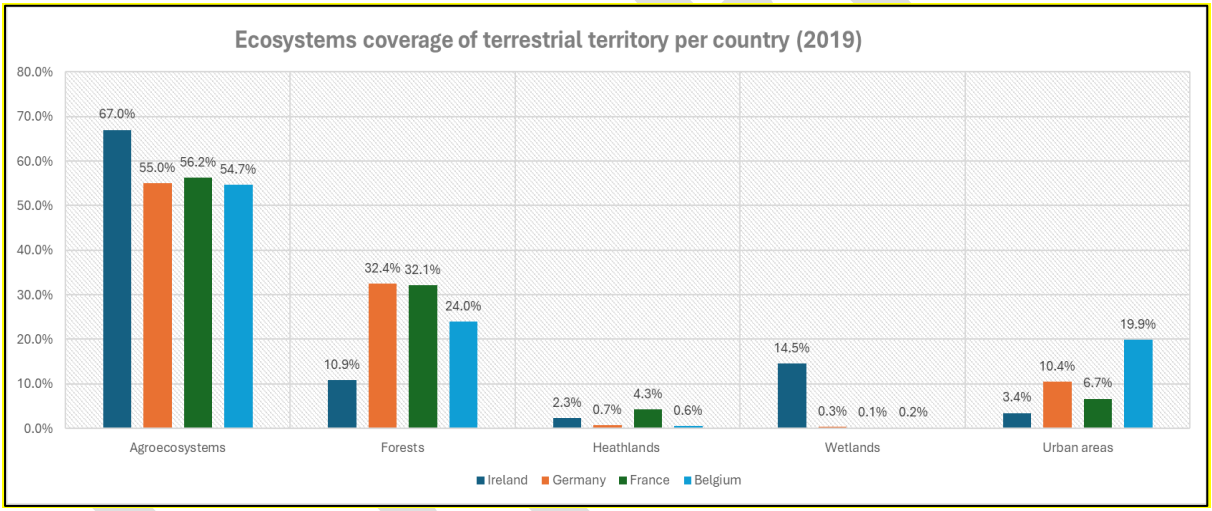


Figure 11 shows the main types of ecosystem coverage in case study locations as of 2019. Ireland's ecosystem consisted of agroecosystems (ecosystems supporting food production and agriculture) which constituted 67% of total land cover, followed by wetlands (14.5%), forests (10.9%), urban areas (3.4%) and heathlands (2.3%) (https://biodiversity.europa.eu/). In Germany, agroecosystems accounted for 55% of total landcover, followed by forests (32.4%), urban areas (10.4%), heathlands (0.7%) and wetlands (0.3%) (*ibid*). France's ecosystem consisted of agroecosystems (56.2%), followed by forests (32.1%), urban areas (6.7%), heathlands (4.3%), and wetlands (0.1%). Finally, agroecosystems in Belgium accounted for 54.7% of total landcover, followed by forests (24%), urban areas (19.9%), heathlands (0.6%) and wetlands (0.2%) (*ibid*). It is notable that Ireland exhibited the highest percentage of agroecosystem coverage as well as the highest percentage of wetland. On the contrary Ireland also exhibited the lowest coverage of forestry as well as urban areas. Germany and France exhibited the highest percentage of forestry coverage, with Belgium exhibiting the highest extent of urban area.

3. Introduction to Bioeconomy Policy in Case Study Locations

As previously discussed, Germany, France and Belgium have dedicated regional policy frameworks in place (Haarich and Kirchmayr-Novak, 2022). German strategy encompasses several regions such as Frankfurt Rhein Main, Hessen, Bayern/Bavaria, Baden-Württemberg, Sachsen-Anhalt, Weser-Ems, and Brandenburg**.** Similarly in France, the Hauts-de-France, Grand Est, and Pays de la Loire regions have developed dedicated bioeconomy strategies. While in Belgium, the Flemish (Vlaams Gewest) region has a dedicated strategy.

3.1 Germany

Germany's first national bioeconomy strategy was published in 2010 and focused on fostering research and innovation and based on five key action areas, including: 1) securing global food supplies; 2) making industrial production more sustainable; 3) developing biomass-based energy carriers; 4) expanding bio-based materials and products; and 5) preserving biodiversity (Federal Ministry of Education and Research (BMBF), 2010). The strategy was updated in 2020, and focused on four strategic areas including: 1) promoting bio-based innovations; 2) ensuring sustainability in the bioeconomy; 3) strengthening Germany as a leader in bioeconomy research and innovation; and 4) fostering international collaboration in the bioeconomy. The German bioeconomy policy framework offers diverse approaches across the country's regions. While some states have developed comprehensive strategies with specific measures and proposals to drive innovation in the field, others have integrated bioeconomy priorities within broader green or sustainability frameworks (Haarich and Kirchmayr-Novak, 2022). Even regions without dedicated strategies often support bioeconomy clusters and networks, although the impact of these softer measures may be limited (*ibid*). This is because without a dedicated strategy, these measures lack the overarching guidance and specific objectives necessary to align actions across sectors and stakeholders, with informal collaboration and minimal funding unable to drive large-scale innovation.

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Figure. 12 illustrates the extent of bioeconomy-related strategy in Germany according to the EC Bioeconomy Strategy Development in EU Regions report (2022).

Figure 12: Bioeconomy-related strategy Germany (Haarich and Kirchmayr-Novak, 2022)

As illustrated in Figure 12, there are 17 regional strategies orientated towards bioeconomy development in some respect. Of these, 7 are fully dedicated bioeconomy strategies, while 10 have bioeconomy topics embedded within broader frameworks (*ibid*). However, amongst the latter group, only 2 feature the bioeconomy as a key priority, with bioeconomy development playing a minor role in the remaining 8 strategies (*ibid*).

The NUTS 2[3] Weser-Ems region stands out as a leader in bioeconomy development, particularly in the agricultural sector (*ibid*). This is due to the region's early adoption of strategic bioeconomy development and the publication of a dedicated strategy in 2015 (*ibid*). Since then, relevant institutions in Weser-Ems remain active, such as the Bioeconomy Strategy Council Weser-Ems (*ibid*). Nevertheless, the regional strategy has not been updated since its initial publication in 2015 (*ibid*).

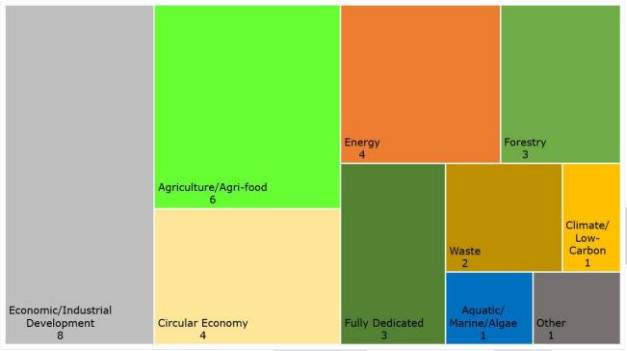
3.2 France

France has had a national bioeconomy strategy in place since 2017. The strategy includes an action plan comprising 49 actions across 5 key areas including: 1) strengthening the sustainable supply of biological resources; 2) encouraging demand for bio-based products and services; 3) improving the sustainability and circularity of bioeconomy systems; 4) reinforcing regional and territorial dynamics; and 5) boosting research, innovation, and investment in the bioeconomy (Ministère de l'Agriculture et de l'Alimentation, 2017). Furthermore, 18 French regions were found to have bioeconomy-relevant strategies, with 3 of these being exclusively dedicated to bioeconomy development (*ibid*). At the

[3] NUTS 0: national boundaries; NUTS 1: major socio-economic regions; NUTS: basic regions for the application of regional policies; NUTS 3: small regions for specific diagnoses.

regional level, the bioeconomy is integrated into 2 mandatory policy schemes, namely the Economic Development Strategy for Innovation and Internationalisation, and the regional circular economy strategy (*ibid*). Additionally, numerous regions across France have developed biomass-focused strategies related to agriculture, organic waste management, or forestry. (*ibid*). Figure. 13 illustrates the extent of bioeconomy-related strategy in France according to the EC Bioeconomy Strategy Development in EU Regions report (2022).

Figure 13: Bioeconomy-related strategy France (Haarich and Kirchmayr-Novak, 2022)



Bioeconomy strategy in France typically relates to biomass utilisation and energy (*ibid*). The most active regions are Grand Est and Pays de la Loire, were Pays de la Loire has developed a bioeconomy strategy as part of Interreg Project (*ibid*).

3.3 Belgium

Belgium does not have a national bioeconomy strategy, as bioeconomy policy is handled at the regional level due to the country's decentralised governance structure. Each of Belgium's three regions, Flanders, Wallonia, and the Brussels-Capital Region, has developed its own bioeconomy-related strategy. Flanders published its first regional bioeconomy strategy in 2013, making it one of the first regions in Europe to adopt a dedicated bioeconomy strategy (Government of Flanders, 2013). Wallonia focuses on bioeconomy as part of broader strategies such as circular economy and agricultural plans, but no dedicated bioeconomy strategy has been published to date (Walloon Government, 2020). While the Brussels-Capital Region addresses bioeconomy through sectoral plans like waste management and climate strategies with no dedicated bioeconomy strategy published to date (Brussels Government, 2016). According to Haarich and Kirchmayr-Novak (2022) there are approximately 15 strategies in Belgium related to the bioeconomy (see Figure 14), with 3 fully dedicated to the bioeconomy and all in the Flanders region. Figure. 14 illustrates the extent of

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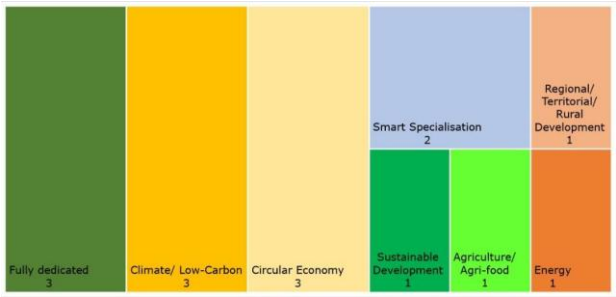
bioeconomy-related strategy in Belgium according to the EC Bioeconomy Strategy Development in EU Regions report (2022).

Figure 14: Bioeconomy-related strategy Belgium (Haarich and Kirchmayr-Novak, 2022)



In the Belgian region of Wallonia, there are 5 strategic frameworks related to the bioeconomy (*ibid*). These include the *Development Plan for Biological Production in Wallonia*, which considers the bioeconomy as a key priority (*ibid*). However, the remaining 4 strategies only address the bioeconomy in a very minor way, with a greater focus on the circular economy, as well as biomass and biofuel-based energy generation *(ibid*). The Brussels-Capital Region has published 3 bioeconomy-related programs. However, due to its densely populated and predominantly urban character, the region faces limitations in terms of primary production capabilities (*ibid*). Brussels Smart Specialisation Strategy (S3) emphasises the optimisation of resource utilisation in both food systems and waste management (*ibid*). The bioeconomy is linked to these priorities through opportunities in biowaste valorisation and the optimisation of energy processes within food production and distribution (*ibid*).

4. General Policy Overview

4.1 Germany

Table 1 outlines the most relevant national and regional policy documents relating to the bioeconomy in Germany.

Table 1: Bioeconomy Strategies and Related Government Strategies (Germany)

Policy Document	Administration	Date	Level	Main Objective/Aim
National Research Strategy	BMBF[4]	2010	National	To promote Germany as a global dynamic research & innovation centre for biobased products, energy, process, & services, as well as meet Germany's responsibility for global

[4] Federal Ministry of Education and Research (BMBF)

Bioeconomy 2030				nutrition, the protection of resources, the climate & environment (BMBF, 2010, p.3).
National Policy Strategy Bioeconomy	BMEL[5]	2013	National	The aim is to create bioeconomic solutions that support sustainability, recognise and harness the potential of the bioeconomy within ecological constraints[6]. The goals include expanding and using biological knowledge, moving industry's resource base towards sustainability, and further solidifying Germany's position as a leading bioeconomy innovation hub (BMEL, 2013, p.12).
Sustainable Bioeconomy in Brandenburg	Min. of Agriculture, Environment & Climate Protection	2020	Regional	Aims to strengthen a sustainable bioeconomy in Brandenburg, through the cooperation of relevant public administration departments, as well as promote knowledge transfer from research to practice, and establish networks of actors to develop new bioeconomic value chains (Rupp et al., 2020, p.6).
Bioeconomy as a driver of value creation and innovation: Saxony-Anhalt	Min. of Education & Economy; State Chancellery & Min. of Culture of the State of Saxony-Anhalt; Metropolitan Region of Central Germany Management	2021	Regional	The aim is to support the state of Saxony-Anhalt in achieving its sustainability goals, particularly in developing rural areas, meeting climate protection targets, strengthening the job market, and securing the future of its key economic pillars. This will be done by turning the Central German mining region into a European model for the bioeconomy by 2030 (Mayers et al., 2021, p.13).
Bioeconomy in Hesse on the pathway to the economic form of the future	Min. Economic Affairs, Energy, Transport and Regional Development	2017	Regional	Hesse as a leading biotechnology region with strong scientific institutions and sectors in the bioeconomy. The strategy aims to strengthen the Hessian bioeconomy as a global competitor through innovative industrial parks, the region's position as a communication and sales hubs, as well as existing research and teaching infrastructure (DECHEMA e.V & KADIB Kircher Advice in Bioeconomy, 2017, p.9).
BioBall-position paper, accelerating the bioeconomy in the	BMBF; Provadis School of International Management & Technology AG; DECHEMA e.V.	2021	Regional	The position paper's main objective is to status of the metropolitan region and unpacks the aim to achieve a circular bioeconomy in the region (Andreeßen et al., 2021, p.6).

[5] Federal Ministry of Food and Agriculture (BMEL)

[6] Boundaries or constraints imposed by the natural environment on human activities and economic growth

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metropolitan area of Frankfurt Rhein Main				
Bioeconomy strategy in Bavaria: Future bioeconomy Bavaria	Bavarian State Government	2020	Regional	The strategy is meant to address key players such as society, administration and politics, agriculture and forestry, and industry and science to actively develop the transformation towards a successful bioeconomy through the implementation of 50 measures, enclosed in the document (Bavarian State Government, 2020, p.5).
Federal strategy sustainable bioeconomy Baden-Württemberg	Min. of the Environment, Climate Protection & the Energy Sector	2019	Regional	To advance and encourage the utilisation of renewable raw materials to protect natural resources and promote the region as an economic/business location (Ministry of the Environment, Climate Protection and the Energy Sector & Ministry of Rural Affairs and Consumer Protection, 2019, p.11).
Masterplan Bioeconomy 2020 Weser-Ems	Strategy Council Bioeconomy Weser-Ems	2015	Regional	The regional master plan forms as a guideline for innovation-orientated bioeconomy development in Weser-Ems (Strategy Council for Bioeconomy Weser-Ems, 2015, p.9).
Circular Bioeconomy for Germany: Roadmap	Fraunhofer Strategic Research Field Bioeconomy	2023	National	To explore the viability of a circular bioeconomy from a scientific and technical perspective to create a roadmap for the implementation of the bioeconomy across Germany (Buller et al., 2023, p.6).
Arable Farming Strategy	BMEL	2021	National	The goal to transition the highly productive model of arable farming in Germany towards an approach that reconciles the diverse requirements of society and offers a sustainable outlook for the agricultural industry (BMEL, 2021, p.16).
Climate Protection Plan 2050	BMUB[7]	2016	National	The Climate Action Plan outlines a framework to guide action across diverse sectors, including energy, buildings, transportation, trade and industry, agriculture, and forestry, in order to meet our national climate objectives in accordance with the Paris Agreement (BMUB, 2016, p.6).
Forest Strategy 2050	BMEL	2021	National	Aims to establish a sustainable equilibrium, tailored to future needs, between the increasing demands placed on forests and their long-term viability. This approach is grounded in the equal consideration of the

[7] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

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				three pillars of sustainability (BMEL, 2021, p.8).

The development of bioeconomy policies across different levels and regions in Germany reflects a combination of national and regional objectives tailored to the specific needs of each administration. At the national level, the National Research Strategy Bioeconomy 2030 (BMBF, 2010) and the 'National Policy Strategy Bioeconomy (BMEL, 2013) initiated foundational frameworks for a biobased economy. The former emphasized Germany's global leadership in research and innovation, focusing on biobased products, energy, and processes while addressing global challenges like climate change and resource protection. The latter shifted slightly towards integrating ecological constraints and sustainability into bioeconomic solutions, aiming to consolidate Germany's position as a bioeconomy innovation hub. Regional initiatives further diversified bioeconomy development. For example, Brandenburg's 2020 strategy targeted sustainable practices by promoting knowledge transfer and fostering networks to create new bioeconomic value chains. Saxony-Anhalt's 2021 approach focused on regional sustainability, targeting rural development and job market improvements while aiming to position its mining region as a European bioeconomy model by 2030. In Hesse, the 2017 strategy highlighted its strength in biotechnology, using existing infrastructure and industrial parks to solidify its global competitiveness. Similarly, the BioBall position paper (2021) in Frankfurt Rhein-Main prioritized a circular bioeconomy, emphasizing resource efficiency in a metropolitan context. Bavaria's 2020 strategy addressed transformation comprehensively through 50 specific measures targeting key societal and economic stakeholders. Baden-Württemberg's 2019 strategy aimed at renewable resource utilization while promoting the region's economic and environmental leadership. Weser-Ems's 2015 master plan offered a regional innovation-oriented roadmap for bioeconomy development, emphasizing sustainability and local engagement. Later strategies like the Circular Bioeconomy for Germany: Roadmap (2023) outlined national frameworks to advance circular bioeconomy scientifically and technically, aligning with climate and sustainability objectives. Complementary policies like the Arable Farming Strategy (2021), Climate Protection Plan 2050 (2016), and Forest Strategy 2050 (2021) integrated bioeconomy themes into agriculture, climate action, and forestry, ensuring coherence with broader national sustainability goals. This array of policies demonstrates a blend of overarching national goals with tailored regional approaches, balancing innovation, sustainability, and specific local needs in the pursuit of a bioeconomy transition.

According to Hildebrandt et al. (2020) German bioeconomy strategy seeks to achieve sustainable and innovative conversion and utilisation of biomass resources to produce adequate and high-quality food and feed, as well as high-value-added products, concurrently ensuring resource conservation, fossil fuel decoupling, and food security towards a sustainable bioeconomy. Initiatives like the Leibniz

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Innovation Farm for Sustainable Bioeconomy have sought to integrate research, industry, and farming communities to develop holistic approaches for sustainable agriculture, bio-based materials production, and climate adaptation (Jafari et al., 2023). According to Lühmann and Vogelpohl (2023), the analysis of Germany's bioeconomy begins with the initial political strategies developed in the late 2000s. The concept of "knowledge-based bioeconomy" (KBBE) and advancements at European and OECD levels led to the establishment of the German Bioeconomy Council in 2009, followed by the introduction of the National Research Strategy for Bioeconomy" by the Federal Ministry of Education and Research in 2010 (Lühmann and Vogelpohl, 2023). Germany's bioeconomy plans are predominantly advanced through research programs and various initiatives across different policy levels (*ibid*). This progression was influenced by two consecutive strategies, the Federal Ministry of Food and Agriculture's (BMEL) "National Policy Strategy on Bioeconomy" in 2014, followed by a joint "National Bioeconomy Strategy" developed by the Federal Ministry of Education and Research (BMBF) in 2020 (*ibid*). The transition towards a sustainable regional bioeconomy is exemplified in the Rheinisches Revier case, where the phasing-out of coal power has presented the opportunity to develop and implement key structural and institutional frameworks, while accounting for the underlying socio-technical dynamics involved (Venghaus et al., 2024; Siekmann and Venghaus, 2024). These included the establishment of a regional transformation council consisting of a multi-stakeholder body involving government, industry, civil society, and academic representatives to oversee and guide the transition process; coordination between regional policies and broader frameworks such as Germany's Sustainable Development Strategy and the EU's bioeconomy goals; the development of innovation hubs and clusters focusing on bio-based industries, renewable energy, and technology transfer to replace the economic void left by coal; infrastructure modernisation including investment in biorefineries, renewable energy facilities, and transport systems to support the bioeconomy; funding for structural change including allocations from Germany's "Structural Strengthening Act" (Strukturstärkungsgesetz) and EU Just Transition funds, aimed at supporting regions affected by the coal exit; grants and subsidies for businesses and research initiatives targeting bioeconomy sectors such as bio-based materials, sustainable agriculture, and forestry; regional bioeconomy networks including platforms for collaboration among research institutions, universities, and industry stakeholders to foster innovation and knowledge exchange; educational programs and reskilling initiatives including training programs for former coal industry workers to prepare them for employment in emerging bio-based sectors; socio-economic planning including stakeholder-inclusive decision-making processes, mechanisms to incorporate public input, ensuring local communities' needs and concerns are addressed; strategies to balance technological innovation with societal acceptance, promoting a fair distribution of benefits from the bioeconomy; and monitoring and

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evaluation processes including indicators and milestones to monitor progress. (Venghaus et al., 2024; Siekmann and Venghaus, 2024).

Germany's overall regional bioeconomy approach tends to focus on enhancing crop productivity, establishing bioeconomy hubs, integrating innovative technologies in the chemical sector, wood industry, and creating living labs for interdisciplinary research (Federal Ministry of Food and Agriculture, 2013). Emphasis has been placed on achieving socially accepted and environmentally friendly practices (Szarka et al., 2021; Lühmann and Vogelpohl, 2023; Hildebrandt et al., 2020). However, despite progress, challenges remain in integrating bioeconomy practices to achieve socio-ecological transformation within Germany (Szarka et al., 2021). The challenges in Germany's transition toward a sustainable bioeconomy revolve around reconciling fragmented data systems, balancing resource allocation across competing sectors, reducing dependency on imports, addressing market and policy misalignments, and overcoming technological and institutional barriers (*ibid*). These issues underscore the complexity of achieving an integrated socio-ecological transformation within the bioeconomy framework. According to Lühmann and Vogelpohl (2023) the bioeconomy in Germany has remained a largely abstract concept with limited public recognition and minimal integration into broader societal discourses. Attempts to involve civil society and broaden participation have been critiqued as superficial, with decision-making power and influence remaining concentrated within the original triple-helix coalition of government, industry, and research (*ibid*). Lühmann & Vogelpohl (2023) suggest that the practical outcomes of the bioeconomy have been modest, with little evidence of significant transformation in economic or societal structures. For instance, while considerable research funding has been allocated, the results have been skewed towards technological innovation and economic growth, rather than achieving the broader ecological and social goals originally envisioned (*ibid*). Ultimately, Lühmann and Vogelpohl (2023) argue that the bioeconomy, while partially successful in advancing the agendas of specific stakeholders and securing funding, has largely failed as a transformative political project. Its reliance on a neoliberal growth-oriented framework, combined with a lack of meaningful societal engagement and concrete impacts, highlights the disconnect between its lofty aspirations and real-world implementation (*ibid*).

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4.2 France

Table 2 outlines relevant national and regional strategy documents relating to the bioeconomy.

Table 2: Bioeconomy Strategies and Related Government Strategies (France)

Policy Document	Administration	Date	Level	Main Objective/Aim
Bioeconomy Strategy for France	MEIN; MAAF; MEDDE; MESR[8]	2016	National	The primary objective is to address socio-economic and environmental concerns through a systems-based approach. This encompasses all aspects of bioresource production, distribution, and processing, as well as the valorisation of products and the associated solutions, while also ensuring the preservation of regional ecosystems. The French vision for the bioeconomy places human beings and citizens at the core of its approach (MAAF, 2016, p.4)
Bioeconomy Action Plan 2018-2020	MEIN; MAAF; MEDDE; MESR	2018	National	The action plan outlines five key areas to implement the bioeconomy strategy: expanding knowledge, raising public awareness, aligning supply and demand, and promoting sustainable bioresource production and processing (MAAF, 2018, p.2).
Pays de la Loire bio-based circular economy action plan	BIOREGIO; ADEME	2020	Regional	This action plan, part of the BIOREGIO project under the INTERREG Europe Program, outlines four main steps to boost the bio-based circular economy in Pays de la Loire. These steps are improving communication and awareness with real-world examples, updating the Regional Call for Projects to better support bio-based initiatives, engaging key stakeholders to enhance local coordination, and conducting small-scale research to test new solutions and innovations (BIOREGIO, 2020, p.2-3).
Masterplan bioeconomy Hauts-de-France	Hauts-de-France Chamber of Agriculture; Regional Council of the Hauts-de-France	2018	Regional	Adopt more efficient production and consumption methods, particularly those that make better use of bioresources in food markets, the creation of novel molecules, products, materials, and energy sources, serves as a significant strategy for mitigating global warming. These approaches also address the challenges of energy transition and ecological

[8] Ministry of Economy, Industry, and Digital Technology (MEIN); Ministry of Food, Agriculture, and Forestry (MAAF); Ministry of Ecology, Sustainable Development, and Energy (MEDDE); Ministry of National Education, Higher Education, and Research (MESR)

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				sustainability, which are central to the bioeconomy (Hauts-de-France region, 2018, p.19).
Make the Grand Est region a European leader in bioeconomy - the regional strategy for bioeconomy	la Région Grand Est	2020	Regional	The Grand Est Region is implementing a strategy to enhance the growth and competitiveness of businesses, with the backing of all stakeholders to address residents' basic needs, revitalise the economy by creating jobs, innovation, and added value, distribute value fairly across value chains and regions, ensure resources and stakeholders remain sustainable, and use a holistic approach, considering the unique characteristics of economic actors and regions (la Région Grand Est, 2020, p.4).
National Strategy for Research and Innovation	MESR	2009	National	Outlines key guidelines to enhance the global development and competitiveness of French research. It identifies three main priorities: health, welfare, food, and biotechnology in response to longer life expectancies, emerging infectious diseases, and changing lifestyles; tackling the "environmental emergency" and advancing environmental technologies to address the depletion of natural resources, territorial disparities, climate change, and the need for energy independence; and focusing on information, communication, and nanotechnology (MESR, 2009, p.11).
National Waste Plan 2014-2020	MEIN & ADEME[9]	2016	National	Sets specific targets for reducing waste by 2020. These goals include a 7% per capita reduction in household and economic waste collected by public waste management services, compared to 2010 levels, which was later increased to 10% by the Energy Transition for Green Growth Law of August 17th, 2015. Additionally, the program aims to at least stabilize the amount of waste generated by economic activities, excluding construction and demolition waste. For construction and demolition waste, the law mandates at least stabilization, with a focus on achieving a reduction by 2020 (European Environment Agency, 2016, p.2)

[9] French Environment and Energy Management agency (ADEME)

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The development of bioeconomy policies in France is characterised by a blend of national strategies and regional action plans, addressing socio-economic and environmental concerns while promoting sustainability and innovation. At the national level, the Bioeconomy Strategy for France (2016) adopts a systems-based approach, focusing on the sustainable management of bioresources, their processing, and valorisation, while emphasizing the preservation of ecosystems and placing citizens at the centre of its strategy. This comprehensive framework is operationalized through the Bioeconomy Action Plan 2018-2020, which prioritizes knowledge expansion, public engagement, and the alignment of supply and demand for bioresources to facilitate sustainable production and processing. The National Strategy for Research and Innovation (2009) complements these efforts by identifying biotechnology, environmental technologies, and resource efficiency as key priorities to enhance France's global research competitiveness and address pressing challenges such as climate change and energy independence. The National Waste Plan 2014-2020 aligns with the bioeconomy goals by setting ambitious waste reduction targets and emphasizing the stabilization and eventual reduction of waste generation, particularly in construction and economic activities. Regionally, the Pays de la Loire bio-based circular economy action plan (2020) supports the bioeconomy through enhanced communication, stakeholder engagement, and research-driven innovation, underlining the circular economy's role in sustainable development. Similarly, the Masterplan Bioeconomy Hauts-de-France (2018) focuses on efficient bioresource use in food, materials, and energy to support ecological sustainability and energy transition, mitigating global warming. In the Grand Est region (2020), the bioeconomy strategy aims to strengthen economic competitiveness, create jobs, and promote innovation while ensuring sustainable resource use and equitable value distribution across regions. These regional strategies emphasize localized solutions and stakeholder collaboration to meet regional and national bioeconomy objectives effectively. Overall, France's bioeconomy development reflects a coordinated approach to integrating sustainability, innovation, and economic growth through national frameworks and region-specific strategies.

According to Journel et al. (2018) bioeconomy policy in France is characterised by its emphasis on integrating sustainable biomass production and utilisation, particularly in agriculture, to drive economic growth, innovation, and ecological preservation, while addressing the complementary demands of food and non-food sectors within a systemic, stakeholder-driven approach. Policies focus on innovative business models within the agri-food sector, emphasising circular economy principles such as recycling, sustainable procurement, and industrial ecology in alignment with the French Agency for the Environment and Ecological Transition's guidelines (Albrecht et al., 2021). In 2015, the Paris Conference on Climate Change acknowledged the critical importance of global food security and recognised the vulnerability of food production systems (Donner and de Vries, 2023). It stressed the

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need for more resource-efficient and resilient production and consumption systems (*ibid*). This agreement set the stage for France's Sustainable Development Strategy between 2015–2018 and the law for Energy Transition and Green Growth (*ibid*). In addition, a national bioeconomy strategy aligned with the European Commission Bioeconomy policy was published in 2017, followed by an action plan in 2018 (*ibid*). According to Donner and de Vries (2023) France's cultural connection to localised food production, exemplified by its protected designation of origin labelling system, informs its approach to promoting regionally tailored methods for collecting bio-resources for both food and non-food applications, supported by regionally driven public policies that emphasise sustainability and local economic development.

4.3 Belgium

Table 3 outlines the most important regional policy documents and strategies related to Belgium's bioeconomy.

Table 3: Bioeconomy Strategies and Related Government Strategies (Belgium)

Policy Document	Administration	Date	Main Objective/Aim
Bioeconomy in Flanders	Flemish Government	2013	The aim is to establish a bioeconomy that aligns with the earth's ecological and social limits by integrating socio-economic development into a smart, resource- and energy-efficient circular system. This approach prioritises system innovations that reduce energy and material use and keep bio-based materials within closed-loop cycles (Flemish Government, 2013, p.10).
Moonshot Policy	Catalisti & Flanders Innovation and Entrepreneurship	2020	The goal is to support innovation and transition in Flanders' industry toward a carbon-circular and carbon-smart approach. The Flemish refining, chemical, and iron and steel sectors are key targets due to their substantial CO_2 emissions (Catalisti, 2020).
New Industry Policy[10]	Flemish Government	2011	Designed to accelerate the transformation of industry both economically and socially. It seeks to enhance competitiveness through a productivity drive. Beyond traditional automation, the NIP includes a broad range of initiatives focused on knowledge intensification through open innovation, efficient energy and material use, new product-service combinations,

[10] New Industrial Policy and Smart Specialisation Strategy (a general S3 strategy) exists in Flanders, but it is not specific to the bioeconomy. However still important in the establishment of clusters and hubs within the bioeconomy.

			intelligent infrastructures, and smart specialisations (Larosse, 2012, p.99-101).
Cluster Policy	Flemish Government	2016	The cluster policy aims to unlock untapped economic potential and boost competitiveness among Flemish companies through active, sustainable collaboration between stakeholders (Flanders Innovation and Entrepreneurship, 2024).
Flemish Climate Plan 2013-2020	The Flemish Environment, Nature, and Energy Department	2013	The framework consists of two closely related sections: the Flemish Mitigation Plan (VMP) and the Flemish Adaptation Plan (VAP). The VMP aims to reduce greenhouse gas emissions in Flanders between 2013 and 2020 to combat climate change, while the VAP focuses on assessing Flanders' vulnerability to climate change and enhancing its ability to adapt to its impacts (Dept. Environmental Policy for Energy, Climate and Green Economy, 2013).
2nd Walloon Sustainable Development Strategy	The Walloon Government; Service Public de Walloon	2016	Adopted in 2016, it serves as a guide and action plan to encourage initiative and ensure consistency in promoting sustainable development within the public policies of the Walloon Region (Interreg, 2018, p.2).

The Bioeconomy in Flanders policy (2013) emphasises creating a resource-and energy-efficient circular system that integrates socio-economic growth with ecological sustainability, focusing on reducing energy and material consumption while maintaining closed-loop bio-based material cycles. The Moonshot Policy (2020) advances Flanders' industrial transition toward carbon-smart and circular processes, targeting high-emission sectors like refining and chemicals. The New Industry Policy (2011) seeks to modernise Flemish industry through productivity enhancement, energy and material efficiency, and knowledge-driven innovation. The Cluster Policy (2016) aims to boost competitiveness through stakeholder collaboration and leveraging untapped economic potential. Meanwhile, the Flemish Climate Plan 2013-2020 (2013) addresses both mitigation and adaptation to climate change, aiming for greenhouse gas reductions and enhanced resilience. In Wallonia, the 2nd Walloon Sustainable Development Strategy (2016) integrates sustainable development into public policy, serving as a cohesive action plan to guide regional initiatives in sustainability and innovation. Together, these policies highlight the region's commitment to ecological, economic, and social dimensions of bioeconomy development.

Belgium's bioeconomy policy emphasises the use of renewable biological resources to produce food, energy, and industrial goods (Allen et al., 2015). Its overarching aim aligns closely with the European Union's Green Deal objectives, which aim for climate neutrality by 2050 (European Commission, 2020). Along with the Netherlands, Belgium exhibits the highest density of biorefineries in Europe

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(Parisi, 2018). Belgium also demonstrates leadership in circular bioeconomy practices, particularly through initiatives at the Port of Ghent (Allen et al., 2015). Advanced biorefinery infrastructure in such regions focus on converting agricultural residues and waste streams into bio-based chemicals, minimising waste, and optimising resource use through industrial symbiosis (Bilsen et al., 2015). The Flemish government supports this innovation by forming strategic alliances with global companies and adopting triple helix collaborations involving business, government, and academia (Segers, 2017). Biotechnology, healthcare, and energy are also a strong focus for bioeconomy development, particularly in Flanders and Wallonia (*ibid*). In this respect, Flanders leads in biotechnological innovation, supported by hubs like BioVille and clusters such as FlandersBio, while Wallonia boasts a dynamic biotech industry that accounts for 35% of the region's exports. According to Vorontsova (20220 multinational companies such as Takeda, Johnson & Johnson, GSK, and Zoetis play a crucial role, fostering collaboration with start-ups and small-to-medium-sized enterprises (SMEs) through research networks, financial support, and market access initiatives.

However, Belgium also faces significant challenges in sustainable resource management. Its production-based land footprint exceeds its land biocapacity, necessitating reliance on imported biomass to meet domestic demands (Liobikiene et al., 2020; Galli et al., 2023). This dependency increases the country's vulnerability to supply chain disruptions (*ibid*). While the economic contribution of the bioeconomy is substantial, encompassing sectors such as bio-based chemicals, pharmaceuticals, and energy, the imbalance between economic growth and environmental sustainability remains a critical issue (Spekreijse et al., 2021). Belgium's over-reliance on imported biomass underscores the need for a more resilient and self-sufficient bioeconomy (Galli et al., 2023). This makes Belgium's bioeconomy an interesting case study for navigating sustainable growth under constrained environmental resources (Dolge et al., 2023).

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5. Policy Analysis

National and regional bioeconomy policy was examined in Germany, France and Belgium. In respect to regional policy, as of time of writing, there are 7 fully dedicated regional strategies for the bioeconomy in Germany, 3 in France, and 1 in Belgium. Content analysis identified four interrelated approaches to bioeconomy development found in regional and national policy in case study locations, these included: 1) research and innovation; 2) partnership; 3) governance; and 4) economic, environmental, and social sustainability.

5.1 The Research and Development Approach

The dominant theme in bioeconomy policy in Europe focuses on research and development (R&D), which aims to drive innovation in regional bioeconomies (Andersen et al., 2022). R&D features as a significant component of most bioeconomy strategies and action plans (Besi & McCormick, 2015).

5.1.1 Germany

The following table provides some examples of the R&D approach found in national and regional bioeconomy policy in Germany:

Table 4: Research and Development in National and Regional Bioeconomy Policy (Germany)

National Policy Germany
National Research Strategy Bioeconomy 2030 "The promotion of research by the Federal Government will be conducted through medium-and long-term institutional support, as well as through short- to medium-term project funding. In the implementation of the research strategy, project funding and institutional support should be examined for possible synergies more closely than to date." "In its implementation, the research strategy strives towards close coordination with the federal states and other R&D-financing stakeholders (e.g. foundations) on issues that affect all partners in the area of national, European, and international research policy" (Federal Ministry of Education and Research, 2011, p.46) *Bioeconomy Factsheet – Germany (June 2015)* "The main funding bodies responsible for bioeconomy R&D are the Federal Ministry for Education and Research (BMBF) and the Federal Ministry of Food and Agriculture (BMEL). The Project

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Management Jülich implements research and innovation funding programmes on behalf of public authorities. Main task of the FNR is the professional and administrative supervision of research projects for the use of renewable raw materials. The national research strategy on bioeconomy 2030 was launched in 2010 with €2.4B funds over the following 6 years, for research into climate change, sustainability of food, bioenergy, and industrial biotechnology. A €1.5M share was allotted for project funding, the rest for institutional funding and other commitments. A number of major research initiatives aim(ed) to support bioeconomy R&D, such as:"

- BioChance
- Biofuture
- BioRegio

(Bio Base NWE, 2015, p.3)

Regional Policy Germany

Bavarian Bioeconomy Strategy

"An open approach to technology within the bioeconomy affords the opportunity to develop innovation-driven, bio-based approaches to solutions for current and prospective challenges. Promoting innovation through research and development, technology and knowledge transfer, application-oriented strategies as well as practical implementation projects provides opportunities to strengthen our domestic economy and society. Bavaria can thereby become a model region for a sustainable bioeconomy in Germany and Europe as well."

"Innovations within the bioeconomy are founded on science and research conducted in Bavaria. Viable solutions are created through interdisciplinary approaches and the merging of various research fields and technological areas beyond the limitations of specific industries and disciplines. Systemically linked knowledge about (bio)technological and ecological processes combined with economic and social-scientific competence constitute the precondition for sustainable innovations. Strengthening the exchange between life sciences and converging technological areas is especially important within this context."

(Bavarian State Government, 2021, p.10)

Table 4 describes how national and regional bioeconomy policy in Germany aims to adopt a comprehensive and synergistic approach to research and development, focusing on long-term sustainability, innovation, and collaboration across multiple sectors and stakeholders. Table 4 how the National Research Strategy Bioeconomy 2030, launched by the Federal Ministry of Education and Research, emphasises a dual funding model that balances medium- to long-term institutional support with short-to-medium-term project funding. The approach is intended to ensure that foundational

research receives consistent support while enabling flexibility to address emerging challenges and innovation needs. The strategy prioritises aligning efforts among federal states, foundations, and other R&D-financing stakeholders, fostering coordination that spans national, European, and international levels. Key areas of focus include climate change, sustainable food systems, bioenergy, and industrial biotechnology. Initiatives such as BioChance, BioFuture, and BioRegio serve as platforms to channel this funding and drive advancements in these fields. With a total allocation of €2.4 billion over six years beginning in 2010, the strategy supports both large-scale institutional initiatives and targeted project funding, ensuring a comprehensive push towards bioeconomic development.

In 2009, the German government established a national bioeconomy council to provide advisory services. It was this council that ultimately advanced the publication of the National Research Strategy for the bioeconomy (2030) in 2010 (Bogner and Dahlke, 2022). This national strategy aims to put Germany at the forefront of research and innovation with regards to bioeconomy activities and development (BMBF, 2010), by focusing on research and innovation as a key driver for transitioning towards a renewable based economy (Lühamann and Vogelpohl, 2023). This approach is advanced through publicly funded R&D networks that facilitate knowledge diffusion through diverse actors and project collaborations, enhancing cross-sector knowledge exchange for sustainable bioeconomy development (Bogner, 2019), however collaborative knowledge creation and innovation initiatives tend to be concentrated within urban regions like Stuttgart (Bogner and Dahlke, 2022). According to Stöber et al. (2023), the case of Stuttgart demonstrates the potential benefits of a knowledge-based bioeconomy through innovation networks that facilitate the transformation of urban regions. However, innovation and dissemination should not be limited to urban networks and regions but should instead develop cooperatively across all regions (Prochaska and Schiller, 2024) for the interregional flow of new and relevant knowledge, which offers potential for cross-fertilisation[11] of data and expertise across various manufacturing sectors (Stöber et al., 2023) This is facilitated through collaborative networks, technological convergence, and policy-driven initiatives (*ibid*). This dynamic interaction is intended to enhance innovation and sustainability within sectors (*ibid*), and a long-term process of technological cross-fertilisation to strengthen the foundational knowledge bases (Hoffmann & Glückler, 2023).

Table 4 also shows that regionally, bioeconomy strategy in Bavaria underscores an innovation-driven, interdisciplinary approach that positions the region as a model for sustainable bioeconomy practices.

[11] "*Cross-fertilization refers to the interdisciplinary combinations of different knowledge and technologies, creating extensive technological opportunities in terms of product performance and functionality*". (González-Piñero et al., 2021, p.36)

The Bavarian State Government promotes technological and knowledge transfer alongside application-oriented strategies to translate research into practical solutions. Such regional strategy prioritises systemic linking of biotechnological, ecological, economic, and social sciences to address complex challenges. This interdisciplinary integration fosters innovations that extend beyond traditional industry boundaries. Emphasis is placed on strengthening collaborations between life sciences and converging technological areas to drive breakthroughs in bioeconomy research and development. Bavaria's approach seeks to merge scientific innovation with practical implementation to bolster the domestic economy and society, paving the way for a sustainable, regionally adapted bioeconomy model.

Regional bioeconomy policy in Germany emphasises a research and development (R&D) approach that is predominantly techno-economic in orientation, focusing on technological advancements as a primary mechanism for addressing sustainability challenges (Bogner and Dahlke, 2022). This approach aligns with the German Federal Government's goal of transitioning to a Sustainable Knowledge-Based Bioeconomy (SKBBE), where direct project funding serves as a central policy mechanism (BMBF and BMEL, 2020; Imbert et al., 2017). While effective in producing technological innovations, this strategy is critiqued for its reliance on established research institutions and universities, often excluding diverse stakeholders such as NGOs, civil society groups, and grassroots movements (Urmetzer et al., 2018; Urmetzer et al., 2022). Consequently, the policy framework generates predominantly techno-economic knowledge focused on biotechnological applications, resource efficiency, and market-driven innovations, while underutilising transformative and normative insights critical for systemic sustainability (Abson et al., 2014; ProClim, 1997; Schlaile et al., 2017).

The shift in German bioeconomy policy from a biotechnology-centred vision to a broader framework incorporating bioresources and bioecology marked a significant turning point. Initially, R&D funding focused on biotechnology, clustering around urban centres and high-tech regions under initiatives like BioRegio and BioProfile, which leveraged agglomeration effects and knowledge spillovers (Audretsch and Feldman, 2004; Capello, 1999). However, this emphasis left rural and lagging regions marginalised, with limited access to the benefits of bioeconomic innovation (Prochaska and Schiller, 2024).

The introduction of the German bioeconomy strategy in 2010 sought to decentralise R&D efforts by promoting bio-based activities in less affluent and rural areas. This strategy emphasised the use of natural resources, such as biomass production and bio-based energy, alongside sustainable practices closely tied to rural economies (Prochaska and Schiller, 2024; National Academies of Sciences, Engineering, and Medicine, 2020). By diversifying into bioresources and bioecology, traditional

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industries like agriculture, forestry, and food production gained new opportunities for engagement and innovation (OECD, 2018).

Empirical analysis by Prochaska and Schiller (2024) demonstrates that the broader bioeconomy, encompassing bioresource and bioecological dimensions, achieved a more equitable geographic distribution compared to the biotechnology core. This redistribution targeted less densely populated regions with higher unemployment rates, as evidenced by a declining Gini coefficient for bioeconomy funding, signalling greater spatial inclusivity (Prochaska and Schiller, 2024). Nevertheless, the biotechnology core remains integral, serving as a cross-cutting enabler that facilitates the transfer of advanced biotechnological knowledge into traditional industries and rural regions (Asheim, Boschma, and Cooke, 2011; Isaksen, 2015). Such integration is crucial for unlocking bioeconomic potential, especially in areas with underdeveloped local knowledge bases (Prochaska and Schiller, 2024).

Despite these advances, regional bioeconomy policy in Germany retains significant challenges. Its heavy reliance on techno-economic innovation risks neglecting normative considerations necessary for truly sustainable transformations (Urmetzer et al., 2021). The assumption that market-driven technological advancements inherently leads to sustainability overlooks complex ethical, social, and environmental dimensions (Bryden and Gezelius, 2017; Schlaile et al., 2021). Current policies tend to focus on isolated technical solutions, optimising agricultural practices or developing bio-based materials without addressing systemic issues in production and consumption paradigms (Blok, 2020; Pyka et al., 2021). Stakeholder involvement remains limited, often superficial, failing to incorporate the diverse perspectives of NGOs, marginalised groups, and consumers who are essential for equitable and robust systems (Hoes et al., 2021; Urmetzer et al., 2021). Moreover, consumers are frequently treated as passive recipients rather than active participants in the bioeconomy transition (Wilke et al., 2021; Otto et al., 2021). According to Urmetzer et al. (2021) policies must actively reduce barriers to sustainable consumption and enhance societal motivation for bioeconomic participation, ensuring that transitions are inclusive and reflective of collective values.

The centralisation of the research network around universities and elite institutions perpetuates existing power dynamics and limits interdisciplinary collaboration essential for addressing sustainability's complexities (Bogner and Dahlke, 2022; Schot and Steinmueller, 2018). While efforts have been made to include societal perspectives through advisory committees and dialogue initiatives, these often lack the depth required for meaningful engagement, leaving the bioeconomy narrowly defined as an economically driven initiative (Heimann, 2019; Prochaska and Schiller, 2021).

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To address these limitations, Germany's R&D approach must prioritize the integration of normative and transformative knowledge. Ethical reflection, systemic thinking, and participatory approaches are essential for aligning bioeconomic innovation with societal values and long-term ecological goals (Urmetzer et al., 2021). Building local knowledge infrastructures and fostering interdisciplinary research can support the diversification of bioeconomic activities, ensuring that the transition contributes to environmental sustainability and social equity (*ibid*).

While Germany's bioeconomy R&D policies have made strides in promoting innovation and inclusivity, they fall short of addressing the normative and participatory dimensions critical for systemic transformation. Future efforts must integrate ethical, social, and environmental considerations into innovation processes to realise a bioeconomy that is not only economically viable but also environmentally sound and socially just.

5.1.2 France

Table 5 provides some examples of the R&D approach found in national and regional bioeconomy policy in France:

Table 5: Research and Development in National and Regional Bioeconomy Policy (France)

National Policy France
National Research and Innovation Strategy (2010) "Since 2005, France's approach to research and innovation has undergone significant change: we have seen the creation of competitiveness clusters, the National Research Agency, the National Agency for the Evaluation of Research and Higher Education, the strengthening of the autonomy of universities and the support of public-private partnerships particularly through the research tax credit scheme and the Carnot institutes. The aim is to enhance the performance, visibility, international influence and promotion of French research." "A major purpose of National Strategy for Research and Innovation is to respond, under the best possible conditions, to the need for the economic and competitive development of French companies." (Minister of Higher Education, Research and Innovation, 2010, p.14;16) *A Bioeconomy Strategy for France: 2018-2020 Action Plan* "Biomass production and mobilisation must be sustainable. Development of knowledge of the conditions required for sustainable primary production is necessary. This action will be conducted in adherence to the recommendations of the SNMB and the core focuses of the French

National Research Strategy." (Ministry of Agriculture and Food, 2018, p.7)

The National Research and Innovation Strategy covers three priority areas:

- Health, care, nutrition and biotechnology
- Environmental urgency and eco-technology
- Information, communication and nanotechnology

(Minister of Higher Education, Research and Innovation, 2010)

Regional Policy France
Pays de la Loire Bio-based Circular Economy Action Plan "The fourth action aims to implement action research, involving a research laboratory and local authorities, in order to observe and test solutions to develop the bio-based circular economy on a small scale, based on new solutions and innovation. This action-research will serve as a showcase and laboratory for Loire actors, who will be encouraged, through concrete examples, to bring the bio-based circular economy to life and inspire the consultation and implementation of future regional policy on the subject." "Research-action: observation of territories, diagnosis of biomass streams and mapping of stakeholders. Highlighting the levers that allow the development and adaptation of these projects to other territories. Observation of the working groups developed in Action 3. Identification and formulation of recommendations on techniques that allow cooperation, on loops that are interesting to replicate in a territory. This action research will lead to experiments in the test territories." (BIOREGIO, 2019, p.3;20-21)

Table 5 demonstrates how France's research and development approach to bioeconomy development is structured around a balance of strategic innovation, sustainability, and stakeholder collaboration. At the national level, the National Research and Innovation Strategy (2010) provides a broad framework that enhances the infrastructure and visibility of French research. The strategy focuses on fostering competitiveness and economic growth by integrating initiatives such as competitiveness clusters, the autonomy of universities, and support for public-private partnerships through mechanisms like the research tax credit. These measures aim to bolster French research's international standing and contribute to the economic development of domestic companies. Within this framework, the bioeconomy is incorporated under three priority areas: health and biotechnology, environmental urgency and eco-technology, and advanced communication technologies. This emphasis aligns with France's goal of positioning itself as a leader in sustainable innovation and technology development.

The Bioeconomy Strategy for France: 2018–2020 Action Plan builds on this foundation, emphasising sustainability as a central principle. The plan focuses on the sustainable production and mobilisation of biomass, which is informed by the recommendations of the National Biomass Mobilisation Strategy (SNMB) and the National Research Strategy. By investing in knowledge development for sustainable primary production, the action plan seeks to integrate ecological balance into the bioeconomy's operational framework. This reflects a commitment to harmonising technological advancement with environmental stewardship and aligns with France's broader research and innovation priorities.

Table 5 also show that regionally, bioeconomy policy, such as the Pays de la Loire Bio-based Circular Economy Action Plan, represents a localised application of these national strategies. The regional approach focuses on action research, wherein research laboratories collaborate with local authorities to observe, test, and refine bioeconomic solutions. This involves detailed assessments of biomass streams, stakeholder mapping, and the identification of replicable processes for bio-based circular economies. The results of these experiments serve as concrete examples to inspire further innovation and policy implementation in other territories. By emphasising experimentation in test territories, the region acts as a laboratory for the practical application of bioeconomy principles, highlighting levers for development and adaptation.

In general France's national and regional policies demonstrate a multi-layered R&D approach to bioeconomy development that integrates strategic innovation, sustainability, and regional adaptability. The national framework establishes overarching priorities, while regional initiatives provide actionable insights through localised experimentation. Together, these efforts aim to advance France's bioeconomy as a model of competitive, sustainable innovation that bridges national goals with regional implementation.

Regional bioeconomy R&D is notable within regions of Grand Est, Hauts-de-France, and Normandy (Bioeconomy for Change, 2023). These regions demonstrate more advanced development and implementation of the bioeconomy within France (*ibid*), with institutions like The French National Research Institute for Agriculture, Food, and Environment (INRAE) and VAALBIO of the Unité de Catalyse et Chimie du Solide (UCCS) laboratory, focusing on green chemical processes, catalytic transformations, biomass valorisation, and recycling of waste (INRAE, 2021; Araque-Marin et al., 2022). The Bazancourt-Pomacle site in the Champagne-Ardenne (Grand Est and Hauts-de-France) in the Marne department is considered the sophisticated prominent biorefinery complex in Europe. The

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site serves as the foundation of an agro-industrial cluster, hosting an innovation platform (Allais et al., 2021; Alfano et al., 2023). The site's operations are characterised by a combination of diverse industrial facilities (*ibid*), with a focus on innovation and knowledge-based activities. This facilitates the transfer of bioeconomy expertise to French universities (Alfano et al., 2023).

France has more recently adopted a distinctive approach to research within the bioeconomy, with a particular emphasis on investigating business models (Donner and de Vries, 2023). These bioeconomy business models are generally viewed as innovative management tools for developing new products or services, especially those targeting biomass as an alternative to fossil-based resources through recycling and/or the cascading model (*ibid*). An example of this, is the integration of regional bioeconomy strategies into a region's Business Act (Bioeconomy for Change, 2023). Pays de la Loire is experimenting with "bio-based circular economy territories" and action research to develop tools which aims to support the creation of a regional bioeconomy (BIOREGIO, 2019). In partnership with Le Mans University, Pays de la Loire is conducting action research to diagnose biomass streams, map stakeholders, and identify levers for adapting bio-based circular economy projects to other territories (*ibid*). Action research is an emergent, collaborative, and iterative research approach that aims to simultaneously generate knowledge and bring about practical change within a specific context (George, 2023). It is characterised by an interwoven relationship between research and action, where researchers work alongside practitioners to address real-world issues, develop practical solutions, and generate theoretical insights (Zandee and Coghlan, 2024). In the context of Pays de la Loire this research approach aims to observe the effectiveness of cross-cutting policy approaches and guide the Regional Council in implementing its Waste-Resources Observatory (BIOREGIO, 2019). Furthermore, the region is implementing territorial projects in collaboration with local authorities (*ibid*). These projects align with the "ConcerTO" methodological guide on the territorial management of organic matter, developed by ADEME. This methodology is described as a structured, collaborative process that engages various stakeholders, such as local governments, businesses, citizens, and research organisations, to enhance the management of organic resources at the regional level and Pays de la Loire will serve as a test area to finalise this guide (BIOREGIO, 2019; ADEME, 2023). Table *6* below outlines the key elements of the ConcerTO methodological approach designed By ADEME (2023).

Table 6: Key Elements of the ConcerTO Approach (Source: ADEME, 2023)

KEY ELEMENTS OF THE CONCERTO APPROACH	
10-step process	Lays out a 10-step framework for managing organic materials at a territorial level. This structured process covers strategic planning,

	stakeholder engagement, consultation, and implementation, with the goal of developing a comprehensive and actionable plan.
Collective intelligence	Emphasises using the collective knowledge and expertise of all stakeholders to identify issues, generate solutions, and create action plans.
Adaptability and relevance	Can be applied at different scales, from small communities to large regions, adapting the process to the specific context and challenges of the area.
Focus on concrete outcomes	Is designed to achieve tangible, quantifiable results that improve the recovery and recycling of organic materials, thereby minimising organic waste generation.
Emphasis on communication and engagement	The ConcerTO document provides practical guidance and examples from five regions [12] where the approach has been implemented in how to conduct effective communication and stakeholder engagement throughout the process to ensure buy-in and foster a sense of ownership.
Improved understanding of the organic materials landscape	Facilitates a comprehensive understanding of the flow of organic materials within a territory, including sources, processing channels, existing infrastructure, and stakeholder roles.

Zaparucha and Sadeski (2017) regard Pays de la Loire as exemplifying open innovation through a network of technical centres and research institutes designed to support companies in developing and testing new technologies. Platforms like Proxinnov specialise in industrial robotics, assisting regional businesses in integrating advanced technologies into production processes (Zaparucha and Sadeski, 2017). Other research institutes such as Clarté (virtual reality), design'in Pays de la Loire (industrial design), PRI Orace (energy consumption), and PRI Primabor (agricultural machinery) further support innovation in advanced manufacturing sectors (Zaparucha and Sadeski, 2017). This regional infrastructure not only accelerates technological advancements but also fosters collaboration between academic and industrial stakeholders, ensuring that innovation aligns with regional economic and environmental goals (Zaparucha and Sadeski, 2017).

According to Donner and de Vries (2023) French regional bioeconomy policy also emphasises participatory, localised governance that integrates circular economy principles with bioeconomic

[12] Pays de la Loire Region; Valor'Aisne treatment union; Syndicat du Bois de l'Aumône and Billom Communauté (these two entities worked together); Grand Annecy urban community; Grand Lac urban community.

innovation. These policies are intended to foster inclusive collaboration among public authorities, enterprises, academia, NGOs, and citizens, ensuring that decision-making processes address local contexts and priorities (Donner and de Vries, 2023). A distinctive feature of these strategies is their reliance on geographical embeddedness and relational proximity, enabling efficient resource management and strengthening partnerships (French Agency for the Environment and Ecological Transition, 2017). In Pays de la Loire action research projects test circular bioeconomy practices on a small scale, creating laboratories for innovation focused on sustainable biomass management and stakeholder mapping (Donner and de Vries, 2023). These projects align with ADEME's seven pillars of the circular economy, addressing both production and consumption challenges through sustainable procurement, eco-design, and industrial ecology practices (BIOREGIO, 2019; Donner and de Vries, 2023).

One notable aspect of French regional bioeconomy policy is its support for smaller, often rural initiatives that valorise agricultural by-products and food waste. These efforts create local jobs, reduce waste, and produce renewable energy or biobased materials. Many initiatives emphasise low-tech, decentralised solutions, such as composting and biogas production, which are particularly suited to rural economies (Donner and de Vries, 2023). These policies address socio-environmental challenges while fostering economic resilience. The strength of France's bioeconomy policies lies in their robust institutional frameworks. The Circular Economy roadmap and the AGEC law mandate waste reduction and promote circular practices, enhancing the viability of bioeconomy initiatives by addressing economic and logistical barriers (AGEC Law n°2020-105). Public subsidies and institutional support have been instrumental in advancing these projects, although transitioning to market-oriented models remains a priority for long-term sustainability (Donner and de Vries, 2023).

The Grand Est and Hauts-de-France regions exemplify France's cluster-based innovation ecosystem, particularly through the Industries and Agro-Resources (IAR) cluster. Launched in 2005, the IAR cluster integrates farmers, cooperatives, SMEs, multinational corporations, universities, and research organisations into cohesive value chains, emphasising the development of biobased chemicals, materials, bioenergy, and food and feed ingredients (Stadler and Chauvet, 2018). The Bazancourt-Pomacle biorefinery within the IAR cluster serves as a model for circular economy practices, integrating agricultural by-product processing, energy optimisation, and waste management. Open innovation platforms like the Bioraffinerie Recherches & Innovations (BRI) further bridge early-stage research and industrial application, enabling companies to test and scale technologies (Stadler and Chauvet, 2018). These initiatives demonstrate the transformative potential of leveraging public and

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private funding, with over €1.525 billion invested in 219 R&D projects to date (Stadler and Chauvet, 2018).

The Grand Est region showcases four distinct bioeconomic models, reflecting diverse approaches to sustainability:

1. Biobased Carbon Farming: Produces standard biomass for biofuels and platform molecules, emphasising economies of scale. While it supports precision agriculture, its industrial processes raise environmental concerns due to significant resource consumption in biorefineries (Giampietro and Mayumi, 2009).
2. Energy Farming: Converts biomass into green energy via anaerobic digestion, aligning with carbon neutrality goals. Despite its circular economy benefits, such as using digestate as bio-fertiliser, land use conflicts and resource-intensive practices persist (Longhurst et al., 2019).
3. Molecule Farming: Targets niche markets like pharmaceuticals and cosmetics with multifunctional plants. This model blends high-tech and traditional approaches, highlighting potential for agroecological practices despite dependency on industrial cooperatives and R&D investments (Befort, 2021).
4. Non-Food Agroecology: Focuses on systemic and localized approaches, prioritising biodiversity, ecosystem services, and minimal chemical inputs. This model exemplifies strong sustainability principles and is characterized by short value chains and farmer-led associations (Vivien et al., 2019; Grouiez et al., 2023).

Despite successes, challenges remain in maintaining economic viability, particularly amid fluctuating market conditions like low oil prices, which affect the competitiveness of biobased products. Adaptive business models and sustained policy support are crucial for long-term investment and market growth (Stadler and Chauvet, 2018; Schieb et al., 2015). France faces research challenges related to policy and investment gaps that hinder research, as well as the need to address ethical considerations in optimising biomass production for various bioeconomy sectors while preserving agro-ecosystem performance (Marvik and Philp, 2020). Additionally, research on circular bioeconomy business models in France has been predominantly focused on large international bioeconomy or biotechnology clusters, while local small-scale initiatives have received less attention (Donner and de Vries, 2023).

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5.1.3 Belgium

Table 7 provides some examples of the R&D approach found in regional bioeconomy policy in Belgium:

Table 7: Research and Development in Regional Bioeconomy Policy (Belgium)

Regional Policy Belgium
Flanders Industry Innovation: Moonshot In 2019, the Flemish Moonshot programme was developed with the aim to stimulate research and innovation to contribute to low carbon Flemish industry that is economically viable (Catalisti, 2024). "The MOONSHOT consists of four essential and closely connected research trajectories: 1) bio-based chemistry that leads to unique added-value products, 2) circularity of carbon in materials, 3) electrification and radical transformation of processes, and 4) energy innovation. These four MOONSHOT research trajectories are supported by and can build on five core competencies ('enablers') for which top expertise is present in Flanders, being 1) conversion technology, 2) separation technology, 3) predictive technology, 4) energy storage and 5) energy transport." (Catalisti, 2019, p.3-4) List of projects, studies, and programmes dedicated to bioeconomy R&D in Belgium: **"FLANDERS** • IWT fund R&D Projects for SMEs and ROs (including TETRA projects) and large businesses, SME-Innovation Projects and Feasibility Studies • FWO funds fundamental research • Flanders Innovation Hub for Sustainable Chemistry (FISCH) projects • I-Cleantech Flanders MIP Research and Innovation programme **WALLONIA** Greenwin fund R&D projects for SMEs, with regional Government funds, prioritising environmental" sustainability, sustainable products and materials, sustainable integration and roll-out for materials, and the treatment and recovery of waste." (Bio Base NEW, 2015, p.3)

Table 7 describes how The Flemish Moonshot programme, introduced in 2019, adopts a comprehensive research and development approach aimed at fostering a low-carbon, economically sustainable bioeconomy in Flanders, Belgium. This policy framework emphasises the integration of cutting-edge research with industrial innovation, targeting transformative advancements in key sectors. The programme is built around four interconnected research trajectories that collectively

contribute to a robust bioeconomy framework: bio-based chemistry for high-value products, circularity of carbon in materials, electrification and radical process transformation, and energy innovation. These trajectories are further reinforced by five core technological competencies—conversion, separation, predictive technology, energy storage, and energy transport—that reflect Flanders' existing strengths in research and expertise.

Table 7 also shows how a variety of funding initiatives and programmes bolster the R&D landscape in Flanders. These include the IWT fund for R&D projects, catering to SMEs and larger businesses, as well as the FWO, which supports fundamental research. Collaborative hubs like the Flanders Innovation Hub for Sustainable Chemistry (FISCH) and targeted programmes such as the I-Cleantech Flanders MIP initiative drive research and innovation in sustainable chemistry and clean technologies. Collectively, these efforts are intended to position Flanders as a leader in sustainable industrial innovation, while also contributing to regional and global advancements in the bioeconomy.

The Flanders region has developed a regional strategy where the research and innovation approach aims to support the development of innovative bioeconomy clusters designed to stimulate innovation and allocate resources to companies (Allen et al., 2015). The approach provides financial incentives such as grants, subsidies, and a tax-friendly ecosystem to encourage companies to invest in R&D (Flanders Innovation and Entrepreneurship, 2024), such as offering a 13.5% tax incentive for research and development and a 3% tax break for reusable packaging projects (Allen et al., 2015). The Policy Research Centre for Sustainable Materials Management in Flanders brings together five leading research institutions to collaborate with public organisations, which fund research papers and publications to develop a knowledge foundation for the bioeconomy (*ibid*). Beyond collaborative research, funding supports specific projects and initiatives, such as the VISIONS project (2011-2015)[13](*ibid*). The agency for innovation through science and technology coordinates applied research and innovation in the bio-based economy, involving both research institutions and private companies (*ibid*). Additionally, the non-profit Flanders Innovation hub for Sustainable Chemistry was created to facilitate the transition of the Flemish chemical industry towards sustainability (*ibid*). Research and monitoring initiatives, such as those conducted by ILVO and VITO, generate valuable insights into the bioeconomy's performance and trends (Flemish Government Environment, Nature and Energy Department, 2019). An example of this is the 'Klimrek project' initiated by ILVO, VITO, and Boerenbond, which is a climate assessment tool for farmers (Gobin, 2023). It serves as a company-

[13] The VISIONS project begun in September 2011 aimed to systematically list all the main waste and residues streams in Flanders and assessing the most valuable bio-based applications.

specific screening mechanism to support farmers in implementing the most suitable climate-related measures (*ibid*).

A SWOT analysis carried out by the Flemish government (2013, p.16) revealed that the Flemish bioeconomy research and innovation ecosystem suffers from a fragmented research landscape, which can impede coordination and collaboration, thereby hindering the development and commercialisation of novel bio-based products and technologies. Although Flanders possesses a robust knowledge base in biotechnology and process technology, the government has observed a failure to fully leverage this research capacity into practical application (Flemish Government, 2013). This may be attributed to various factors, such as inadequate funding for upscaling research, bureaucratic obstacles in translating research into commercial applications, or a shortage of effective industry-academia partnerships (*ibid*).

5.2 The Partnership Approach

The bioeconomy relies heavily on the development and implementation of new technologies, processes, and products (D'Amato et al., 2022; Martínez, 2019; de Besi and McCormick, 2015). Therefore, collaboration among research institutions, industries, and government agencies is critical to the acceleration of innovation by pooling resources, expertise, and knowledge (*ibid*). The development of the bioeconomy, given its complex and contentious relationship with economic growth and sustainability, necessitates extensive interdisciplinary and cross-sectoral collaboration (D'Amato et al., 2022). Therefore, it requires aligning diverse stakeholders with potentially conflicting viewpoints towards a shared understanding through the careful consideration of various perspectives and potential impacts that can better contribute to a more nuanced, equitable, and holistic outcome (*ibid*). Recognising the significance of collaborative knowledge generation is essential to actively incorporate the involvement of primary producers, such as farmers, in bio-based initiatives (Stöber et al., 2023; Fasolino et al. 2023). Despite their pivotal role as providers of biomass, they are often marginalised (Harrahill et al., 2023; Park and Grundmann, 2023). Hence, genuine collaboration will require transcending beyond transactional relationship with primary producers, where they are solely perceived as suppliers of raw materials (*ibid*). Instead, it requires acknowledging them as equal partners, equipped with valuable insights, traditional knowledge, and practical expertise that can shape the trajectory of land management, resource extraction, and development within the bioeconomy context (*ibid*).

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These partnerships not only enhance the competitiveness of firms/sectors and support local systems, but also contribute to the transformation towards sustainable and circular bioeconomy systems (Szarka at al., 2023). Partnership provides a pathway to achieving this by enabling sector companies to integrate into new, potentially more stable and lucrative, value chains, such as textiles, energy, chemicals, and plastics (Martínez, 2019). According to Szarka at al. (2023), by leveraging networks and partnerships, regions can strategically mobilise actors and resources along the value chain, develop regional bioeconomy strategies, and keep value added within the region, ultimately driving the transition towards more sustainable economic practices and models. Collaborative models, such as clusters and hubs, facilitate the translation of academic research into commercial applications, fostering new business models and organisational structures, strategic alliances, and open innovation (Segers, 2017).

The establishment of Regional Bioeconomy Hubs (RBHs) is often seen as best practice (Stöber et al., 2023). These hubs facilitate coordination among relevant actors to help in developing strategies (Szarka at al., 2023). Additionally, fostering research collaborations beyond regional borders and across different industries can enhance knowledge co-creation, with policy and industry associations playing a key role as network facilitators to strengthen collaboration between actors (Giordano and de Gennaro,2023).

The collaborative co-creation of knowledge is a crucial aspect of partnership, it entails integrating diverse forms of expertise from multiple stakeholders (D'Amato et al., 2022). This fusion of varied perspectives enables a more comprehensive understanding of the problem at hand and potential solutions (*ibid*). Collaborative ventures provide access to complementary capabilities and knowledge that a single organisation may lack, ultimately leading to more effective outcomes (Martínez, 2019). Partnership often involves joint research projects, shared facilities, and the pooling of knowledge and skills (Mytelka, 1999). This enables stakeholders to tackle complex challenges (*ibid*). For example, within the European bioeconomy context, universities and research institutions frequently collaborate with biotechnology companies to translate scientific discoveries into commercially viable products (Fonseca and Nieth, 2021). These partnerships facilitate the transfer of technology and knowledge, accelerating the development of new bio-based products and processes (Bauer et al., 2018). Moreover, partnership helps in optimising resource use, reducing duplication of efforts, and enhancing the overall efficiency of the bioeconomy (Segers, 2017). These academic institutions and industry players often result in the establishment of research consortia and innovation clusters that focus on specific areas of the bioeconomy, such as biofuels, bioplastics, and biopharmaceuticals (Segers, 2017). By leveraging the strengths of each partner, these consortia can enable organisations to aggregate financial resources, knowledge, and workforce capabilities, thereby overcoming the

significant investment costs and risks involved in developing novel technologies and processes within the bioeconomy sector (Bröring and Vanacker, 2022; Kircher et al., 2022). Consortia can better access public funding opportunities like the EU's Public-Private Partnership for Bio-based Industries (BBI), especially for projects focused on commercial-scale development (Kircher et al., 2022). By sharing the risks and costs of advanced-stage projects/TRL (Technology Readiness Level), consortia become more appealing to venture capitalists and investors, enabling the development and commercialisation of new processes and products in the circular bioeconomy (*ibid*).

Government bodies also play a crucial role in fostering partnerships by providing funding and facilitating networking opportunities (Mertens et al., 2019). In Germany, for instance, the Bioeconomy Council (Bioökonomierat) works to promote partnerships between public and private sectors, ensuring that the bioeconomy remains a national priority (Segers, 2017). Networks are a vital part of the bioeconomy, providing the infrastructure for communication, collaboration, and knowledge exchange (Segers, 2017). Bioeconomy networks encompass a wide range of stakeholders, including researchers, entrepreneurs, policymakers, and investors (*ibid*). These networks serve several critical functions (*ibid*). Firstly, they facilitate the dissemination of information and best practices, enabling stakeholders to stay abreast of the latest developments in the field (*ibid*). Secondly, they provide platforms for stakeholders to connect, collaborate, and form partnerships (*ibid*). Thirdly, they help in identifying and addressing common challenges, such as regulatory hurdles, funding gaps, and market barriers (*ibid*).

Germany

The following table provides some examples of the partnership approach found in national and regional bioeconomy policy in Germany:

Table 8: Partnership in National and Regional Bioeconomy Policy (Germany)

National Policy Germany
National Research Strategy Bioeconomy 2030 It is critical that there be "the further development of collaboration between academia and business, between partners from a broad range of countries and disciplines, and between different institutes, whereby the knowledge of one is enriched by the discoveries of the other. These collaborations are interfaces and sources of innovation. By 2030, aided by the research strategy, an

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understanding of biological systems and their sustainable utilisation will ensure a structural change in German industrial production, secured by scientific creativity in synergy with engineering ingenuity. Through innovative products and processes, the biobased economy will create new opportunities for economic for economic growth and employment, also in traditional sectors"

"In accordance with the Federal Government's strategy for the internationalisation of science and research, national research priority areas will be expanded through collaborations with key partner countries and institutions worldwide and in the European Research Area (ERA), with the objective of enhancing local competitiveness. Included here is active participation in European measures, e.g. in the context of ERA-NETs, in joint programme planning ('Joint Programming'), as well as through the implementation of the EU strategy 'Europe 2020'. Moreover, Germany is actively supporting the European Commission in the creation of a knowledge-based bioeconomy in Europe." (Federal Ministry of Education and Research, 2011, p.14;42)

Regional Policy Germany

Bavarian Bioeconomy Strategy

"Research institutes as well as cluster structures play an important role for new cross-industry cooperation and technology transfer. The Cluster Initiative Bavaria provides both sector-specific and cross-sectoral networking opportunities for economic players and represents an important success factor of the Bavarian innovation landscape. Besides further regional clusters, sector-specific networks also offer a platform for transferring knowledge and practices to industrial application.

The clusters of the Free State of Bavaria are positioned at the interface of science, industry and politics. The clusters are aware of the demand and specific challenges of their partners from industry and science and advance the networking of players within the respective sector or the respective field of technology." (Bavarian State Government, 2021, p.50)

Table 8 demonstrates the partnership approach to bioeconomy development in Germany, as outlined in both national and regional policies. It emphasises the importance of collaboration across multiple sectors, disciplines, and geographical areas to foster innovation and drive the bioeconomy forward. At the national level, Table 8 describes how the National Research Strategy Bioeconomy 2030 highlights the critical role of collaboration between academia, industry, and international partners. The policy envisions these partnerships as dynamic interfaces where knowledge exchange enriches innovation. By 2030, the strategy aims to harness a deep understanding of biological systems for sustainable industrial transformation, leveraging the interplay of scientific creativity and engineering

expertise. International partnerships, particularly within the European Research Area (ERA), and alignment with broader European initiatives like the EU strategy "Europe 2020," are described as central to expanding research priorities and enhancing Germany's global competitiveness in bioeconomy innovation. Table 8 also shows that regionally, the Bavarian Bioeconomy Strategy focuses on the importance of cluster structures and networks in enabling cross-industry cooperation and technology transfer. The Cluster Initiative Bavaria exemplifies this by facilitating sector-specific and cross-sectoral collaborations that bridge science, industry, and politics. These clusters act as responsive intermediaries that address the unique challenges of their partners while fostering knowledge and technology transfer, thereby driving the industrial application of bioeconomic innovations. Both levels of policy are intended to reflect a commitment to creating ecosystems that integrate diverse actors and expertise, leveraging both local and international networks to position Germany as a leader in the bioeconomy. These collaborative frameworks are seen as foundational to achieving sustainable economic growth and employment opportunities through bio-based innovations.

In Germany, networks like CLIB2021 (Cluster Industrial Biotechnology) play a pivotal role in fostering innovation and collaboration (Segers, 2017), that integrate users and actors to generate low-resource innovations (Potters et al., 2022). CLIB2021 aims to connect stakeholders in the industrial biotechnology sector, including large companies, SMEs, academic institutions, and universities, to initiate new research and business projects (Herzberg, 2015). They host events such as an annual conference, forum events, workshops, and site visits to facilitate networking and partnerships (*ibid*). CLIB2021 works to identify unique value chains within the bioeconomy, revealing joint interests between stakeholders and leading to targeted partnering opportunities. They also provide expert advice on funding options and help members find research partners in academia, SMEs, and industry at national, European, and international levels (*ibid*). Additionally, CLIB2021 supports R&D cooperation projects within the bioeconomy, focusing on industrial biotechnology (*ibid*).

The German Living Lab infrastructure supports actor-integrated sustainability research and innovations, aiming to create sustainable products and services (Lupp et al., 2020). Additionally, the concept of living labs is gaining attention across the European Union for its collaborative planning benefits, particularly in the design and implementation of Nature-Based Solutions (NBS) to address natural hazards and climate vulnerabilities (von Geibler et al., 2016). Living labs are user-centric, open innovation systems that employ a systematic user co-creation approach, integrating research and innovation processes within the community settings (Collins et al., 2022). They are perceived as a collaborative framework where users actively participate in the innovation process within their real-world context (Arnould et al., 2022). By involving stakeholders extensively, living labs facilitate in-

depth participatory stakeholder involvement, as seen in award-winning cases like the Isar-Plan River Restoration in Munich and the Bavarian Mountain Forest Initiative (Abel, 2020). This collaborative approach aligns with the paradigm that important societal questions are best answered through joint efforts of science, business, and civil society (Meurer et al., 2015). Table 9 summarises the methodology of Living Labs.

Table 9: Snapshot of Living Labs Methodology (Source: Lakatos et al., 2024; Rădulescu et al., 2021; Habibipour et al., 2020)

Snapshot of Living Labs (LLS) Methodology	
Planning (Phase 1)	**Defining the Living Lab's framework:** Clearly outlining the problem the living lab aims to solve, setting objectives, determining the scope (temporal and spatial), identifying potential stakeholders, outlining methods for collective work, and projecting expected outcomes. **Understanding the context:** Thoroughly researching and understanding the real-world environment where the living lab will operate, including its political, economic, and social landscapes. Identifying existing projects that could be integrated or leveraged is also crucial. **Mapping stakeholders:** Identifying and analysing key actors in the ecosystem, classifying them based on their roles (public, private, population) and their interest in the project. This step involves understanding their motivations, potential contributions, and potential conflicts of interest. **Mobilising stakeholders:** This crucial step uses a Public-Private-Population Partnership (PPPP) approach, actively recruiting and involving stakeholders through clear communication of individual and collective benefits, ultimately fostering a collaborative environment.
Exploration (Phase 2)	**Validating the Living Lab's direction:** Presenting the initially defined framework to all stakeholders and users for discussion, adjustment, and final validation. This ensures everyone is aligned before proceeding with solution design.

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	Formalising a shared vision: Through collective workshops and discussions, participants co-create a common understanding of the problem and establish a shared vision for the living lab's goals. **Understanding the context of use:** Analysing the ways in which the targeted users currently interact with the problem area. This helps in anticipating how potential solutions might be received, used, and integrated into existing practices. **Characterising end-users and lead-users:** This step goes beyond simply identifying users to understanding their specific needs, expectations, and experiences. This can involve using methods like 'personas', which are detailed representations of different user groups.
Creative Co-design of Solutions (Phase 3)	**Idea generation and prioritisation:** Employing brainstorming workshops, participants generate a wide array of potential solutions. Subsequent discussions then prioritise these ideas based on their feasibility, potential impact, and alignment with the shared vision. **Distributed workshops for solution design:** Rather than a single, large workshop, this step advocates for smaller, focused workshops tailored to specific solutions. This allows for targeted expertise and ensures each solution receives dedicated attention.
Solution Evaluation	The co-designed solutions are rigorously tested and evaluated based on their effectiveness in addressing the initial problem. This phase often involves real-world trials and feedback collection from users.
Deployment and Replication	Successful solutions are then implemented on a larger scale. The methodology and findings are also adapted and replicated in different contexts to test their wider applicability.
Iterative Nature	It's important to note that these phases often don't follow a strictly linear sequence. Feedback and learning from each phase inform and potentially require revisiting earlier stages. This iterative process ensures flexibility and allows for adaptation based on real-world insights and challenges.

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The Bavarian cluster model encourages collaboration between public and private entities, bringing together diverse stakeholders such as production, distribution, and educational institutions (Sahaidak-Nikitiuk at al., 2020). This cooperative approach is meant to cultivate an environment that supports innovation and market competitiveness (*ibid*). The Straubing region of lower Bavaria, predominantly rural, maintains a robust agricultural and forestry industry. The Straubing-based "Renewable Raw Materials" cluster, established in 2009, concentrates on the region's primary biomass resources, energy production, chemical manufacturing, and research and development services related to biomass (BERST, 2015). Straubing's strategic location on the Danube River facilitates access to biomass from Eastern Europe (*ibid*). However, despite the private sector being the majority of the cluster's 100 members, their engagement is reportedly weak, as the cluster tends to be politically driven rather than industry-led (*ibid*).

The Bavarian cluster model is not simply a network platform; it also provides mechanisms for the translation of scientific research into industrial applications, a critical aspect for bioeconomy advancements (Philp and Winickoff, 2017). However, as Töller et al. (2021) highlight, these clusters often operate within a fragmented policy framework where responsibilities are distributed across different ministries and institutional mandates (Hagemann et al., 2016). Despite these challenges, regional policies strive to leverage local expertise and stakeholder engagement to implement bioeconomic initiatives. This aligns with observations by Leipold & Petit-Boix (2018) that localised governance models in Germany often provide a more adaptable framework for advancing bioeconomy principles, albeit within the constraints of broader national and EU policies. For instance, the regional implementation of bioeconomy policies emphasises the integration of small and medium-sized enterprises (SMEs) into innovation chains, supporting them through tailored funding and research partnerships (BMBF/BMEL, 2020).

Regional bioeconomy development in Germany relies heavily on fostering partnerships across science, industry, and politics through structured cluster networks and localised institutional support. While these initiatives highlight the potential of collaborative models, they are often constrained by the overarching challenges of policy fragmentation and inconsistent national-level directives (Töller et al., 2021). These dynamics underscore the importance of aligning regional and national policy frameworks to enhance the efficacy of bioeconomy strategies.

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France

The following table provides some examples of the partnership approach found in national and regional bioeconomy policy in France:

Table 10: Partnership in National and Regional Bioeconomy Policy (France)

France
A Bioeconomy Strategy for France The French bioeconomy strategy represents a forward-looking approach to sustainable development, recognising the importance of biomass-based supply chains in addressing environmental, economic, and social challenges. Through a comprehensive partnership and network framework, the strategy seeks to leverage France's resources and innovation capabilities to promote a bioeconomy. The involvement of multiple government ministries (Ministry for Ecology, Sustainable Development and Energy, the Ministry of National Education, Higher Education and Research, the Ministry of the Economy, Industry and the Digital Sector, and the Ministry of Agriculture, Agrifood and Forestry) and the emphasis on stakeholder engagement reflect a concerted effort to build a bioeconomy that is inclusive and benefits from a wide range of expertise and perspectives. Furthermore, France's active participation in European and international initiatives underscores its commitment to playing a significant role in shaping the global bioeconomy landscape, particularly through the European Commission's strategy for the bioeconomy titled "Innovating for Sustainable Growth: A Bioeconomy for Europe." France is also involved in various initiatives, such as the formation of working groups in the Standing Committee on Agricultural Research (SCAR), the European Bioeconomy Observatory, and a public-private partnership with a consortium of manufacturers, demonstrating the importance of transnational collaboration (Ministry of Agriculture and Food Sovereignty, 2017).
Pays de la Loire, Western France
Pays de la Loire Bio-based Circular Economy Action Plan “Encourage cooperation between stakeholders (e.g., businesses, universities, administrations, and consumers). Collaboration is the foundation of a functioning circular economy.” The “third action aims to develop links between local authorities and with non-institutional actors: it draws on the many good practices of the partners, demonstrating the major role of local authorities and the value of collaboration with private partners in financing and developing actions

in the field. The BIOREGIO project has made it possible to reveal the progress made by other European regions in the construction of multi-sector and multi-actor networks, bringing together small and large structures, companies, local authorities, associations and research laboratory. It also revealed the importance of local, small-scale actions to advance the subject of bio-based circular economy."

"The regional stakeholders' group for the Pays de la Loire Region in the BIOREGIO project is composed of the following organisations:

- Pays de la Loire Regional Council (local authority)

- Mauges Communauté (local authority)

- Municipality of Ile d'Yeu (local authority)

- AILE (association)

- AlgoSource Technologies (private company)

- Le Mans University (research)

- Cluster Méthatlantique (company representative)

- Chamber of Agriculture of the Pays de la Loire (farmer representative)

- Association of the Chambers of Agriculture of the Atlantic Area (association)"

(BIOREGIO, 2019, p.11-13;18)

Table 10 demonstrates how the partnership approach to bioeconomy development in France integrates multi-level and multi-actor collaboration to create a cohesive and inclusive framework for advancing the bioeconomy. At the national level, the Bioeconomy Strategy for France underscores the importance of leveraging diverse expertise and resources from various sectors to address environmental, economic, and social challenges. This strategy is characterised by its inclusion of multiple government ministries—ranging from ecology and education to industry and agriculture—highlighting an interdisciplinary approach to policy formulation and implementation (Ministry of Agriculture and Food Sovereignty, 2017). This institutional collaboration is complemented by active stakeholder engagement, ensuring that a broad spectrum of perspectives contributes to shaping the strategy. France's involvement in European and international initiatives, such as its participation in the Standing Committee on Agricultural Research (SCAR) and the European Bioeconomy Observatory,

reinforces its commitment to fostering transnational partnerships and aligning its goals with global bioeconomy efforts.

Table 10 also shows that regional policy such as the Pays de la Loire Bio-based Circular Economy Action Plan embodies the principle of cooperation at the local and community level. This plan emphasises collaboration between diverse stakeholders, including businesses, universities, local authorities, associations, and research institutions, to advance a circular bioeconomy. The role of local authorities is particularly significant, with initiatives such as the BIOREGIO project showcasing the value of multi-sector and multi-actor networks. These networks facilitate partnerships among entities ranging from small businesses to research labs, enabling the pooling of resources, knowledge, and expertise. The regional stakeholders' group for Pays de la Loire exemplifies this collaborative ethos, bringing together entities like the Chamber of Agriculture, private companies like AlgoSource Technologies, research institutions like Le Mans University, and associations such as AILE, to create synergies that drive innovation and implementation at a local scale (BIOREGIO, 2019).

The French model, both nationally and regionally, highlights the importance of integrating institutional frameworks with grassroots and transnational initiatives. It recognises that partnership—across government levels, sectors, and international borders—is essential for developing a robust and sustainable bioeconomy.

The "Demonstrator Site Network" was established to promote growth in bioeconomy sectors within Northern France, particularly by showcasing the region's ability to produce and utilise the agricultural biomass required to supply these sectors (Ambition Bioeconomy, 2020). Collaboratively, the project partners have established the FILABIOM initiative to facilitate the design and creation of supply chains for local, sustainable, and long-term agricultural biomass sources (*ibid*). The Bioeconomy Hub in Pays de la Loire aims to facilitate a collaborative environment that enables the development of European projects in response to funding opportunities from the European Commission and regional structural funds (Regional Council of Pays de la Loire, 2024). The Hub is jointly managed by the European Policy Directorate of the Pays de la Loire Region, the Pays de la Loire Representative Office in Brussels, and the Technocampus Alimentation (*ibid*). It leverages the expertise from the "Agriculture, Fisheries and Food" and "Environmental and Energy Transition" Directorates of the Pays de la Loire Region (*ibid*). The Hub serves as an access point for European initiatives and support through its connections with the European Action Service and the Brussels Office (*ibid*).

At the national level, French bioeconomy policy largely aligns with mainstream European Union strategies, emphasising the commercialization of bio-based products, economic growth, and the preservation of natural resources within planetary boundaries (Allain et al., 2022). However, the

regional and local implementations reveal a more nuanced picture (*ibid*). In practice, partnerships in France's regional bioeconomy policy often bridge governmental bodies, private sector stakeholders, and local communities to foster innovation and adaptability (*ibid*). For instance, regional approaches incorporate ecological transition contracts, local food projects, and energy sobriety initiatives (*ibid*). These efforts are often heterogeneous and guided by the specific ecological, economic, and cultural contexts of regions, rather than a rigid adherence to national frameworks (*ibid*). However, the partnership approach in bioeconomy policy in France is fraught with competing narratives (Vivien et al., 2019). Some stakeholders prioritise technological innovation and market competitiveness, aligning with the bioeconomy's growth-centric vision, while others advocate for agroecological approaches emphasising local resilience and sustainability (Allain et al., 2022). These dual goals can create friction, requiring careful negotiation to ensure policy coherence (*ibid*). Béfort et al. (2020) caution against the risk of "greenwashing" in bioeconomy policies. Such critiques have driven the need for transparent metrics and inclusive participatory governance models (Béfort et al., 2020).

The partnership approach in France is marked by efforts to reconcile the bioeconomy and bioeconomics paradigms. Effective partnerships must integrate principles of strong sustainability, balancing economic objectives with social equity and ecological preservation (Allain et al., 2022). This involves not only supporting top-down measures but also empowering local initiatives and fostering horizontal exchanges between regions (*ibid*).

Belgium

Table 10 provides some examples of the partnership approach found in regional bioeconomy policy in Belgium:

Table 11: Partnership in Regional Bioeconomy Policy (Belgium)

Regional Policy (Belgium)
Cluster Policy in Flanders "On 4 March 2016, the Flemish government approved the resolution that defines the support for the innovation clusters in Flanders. The goal of the cluster policy is to unlock unused economic potential and to realise competitiveness growth among Flemish companies through active and sustainable collaboration between actors."

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"This cluster policy concentrates on collaboration agreements of Flemish companies with growth ambitions, innovation awareness, an international attitude and a willingness to collaborate with other companies and knowledge centres, both for the realisation of their individual company targets and to contribute to competitiveness growth among a large group of Flemish companies.

The Flemish cluster policy distinguishes two types of clusters, namely the spearhead clusters and the Innovative Business Networks." (Flanders Innovation and Entrepreneurship, 2024)

Table 11 shows how the partnership approach to bioeconomy development within Belgium's Flemish region is articulated in the Flanders Cluster Policy, and emphasises collaboration as a cornerstone for fostering innovation, competitiveness, and sustainable growth among companies. Established through a government resolution on March 4, 2016, this policy aims to harness untapped economic potential by bringing together diverse actors, including companies, knowledge centres, and other stakeholders. This approach is built on creating synergies among Flemish companies that are characterised by a strong inclination toward growth, innovation, and international engagement. These companies are encouraged to engage in partnerships that simultaneously advance their individual objectives and contribute to a collective enhancement of regional economic competitiveness. By promoting shared goals and cooperation, the policy seeks to amplify the collective impact of these entities on the regional economy. The policy delineates two distinct types of clusters: spearhead clusters and Innovative Business Networks. Spearhead clusters are focused on strategic areas that align with the region's economic strengths and global trends, aiming to position Flanders as a leader in these domains. Meanwhile, Innovative Business Networks offer a platform for companies to collaborate on innovation-driven initiatives, ensuring that businesses of varying scales and capacities can participate meaningfully. Central to this partnership approach is the integration of knowledge centres as pivotal contributors to the innovation ecosystem. These centres serve as conduits for research and expertise, facilitating the translation of theoretical insights into practical applications. The emphasis on active collaboration ensures that the bioeconomy benefits from a multidisciplinary perspective, combining scientific advancements with entrepreneurial agility. Overall, the Flemish cluster policy exemplifies a structured and inclusive model for regional bioeconomy development. It leverages the strengths of collaboration to foster innovation, drive economic growth, and establish Flanders as a competitive player in the global bioeconomy landscape.

The Flemish cluster policy emphasises the establishment of 'Spearhead Clusters' to drive innovation and enhance the competitiveness of both cluster members and their broader sectors (Angelino et al., 2024). These collaborative initiatives bring together stakeholders from industry, academia, and

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government, focusing on specific areas where Flanders holds a comparative advantage in the international arena (*ibid*). Rather than supporting declining sectors or regions, the cluster policy aims to further bolster the 'winning' industries, the 'spearheads' of the Flemish economy (*ibid*). Since 2017, a total of seven Spearhead Clusters have been set up, with three of them concentrating on the industrial domains of chemistry, food, and materials (Catalisti, 2024). The regional government provides partial financial support for collaborative R&D projects within the cluster (Angelino et al., 2024). The cluster institutions not only offer R&D subsidies for joint innovation initiatives, but also a range of complementary services to address various material needs of their members (*ibid*). In summary, the policy features emphasise the significance of designing an appropriate combination of policy instruments, guided by a systemic perspective cognisant of the specific requirements and potential of the local context under policy consideration (*ibid*).

5.3 The Governance Approach

Governance is a critical aspect of the bioeconomy, requiring a multifaceted approach to address the complex challenges posed by the transition to a bio-based and renewable economy. Applying principles of good governance, emphasising accountability and participation, is essential for ensuring the economic, environmental, and social sustainability of the future bioeconomy in European regions (Devaney et al., 2017). The governance of the bioeconomy involves restructuring of value chains and demanding a focus on governance issues and measures in various areas such as science and technology, policy and law, market and economy, ecology, and society (Leventon et al., 2016). Effective governance is essential for transitioning to a sustainable bioeconomy (Kircher, 2021). This involves creating policies that encourage the use of renewable materials and streamline regulations for bio-based technologies (*ibid*). Governance can also promote investment through funding programs and a stable policy environment that attracts private capital (*ibid*). Supporting skills and training programs is key to building a capable workforce for the bioeconomy (*ibid*). Addressing potential negative social and economic impacts, like excluding small-scale producers or job losses, is a critical governance role (Kircher, 2021; Mac Clay and Sellare, 2022). By setting clear sustainability standards and fostering cooperation, policymakers can cultivate an integrated and environmentally responsible bioeconomy (Mac Clay and Sellare, 2022). In essence, governance provides the framework and tools to navigate the complex transition to a sustainable bio-based future.

Enhancing biodiversity in agricultural landscapes requires a re-evaluation of the governance system to identify alternative ways of managing agricultural landscapes for biodiversity (Leventon et al.,

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2016). Effective governance arrangements are crucial for the development of a legitimate Science-Policy Interface (SPI) to support biodiversity and sustainability politics, emphasising the need for a reflexive approach in designing SPIs (Görg et al.,2016). Government intervention is deemed necessary to steer the transition to a sustainable bioeconomy, addressing existing market distortions that favour fossil-based products and promoting a fair competition environment (Purkus et al., 2012).

Germany

The governance framework for the bioeconomy sector plays a crucial role in shaping the sustainability and effectiveness of bioeconomic developments European nations such as Germany, France, and Belgium, which have established governance mechanisms to guide their transition towards a bio-based economy. However, despite the recognition of some limitations, Germany finds itself at a critical juncture, facing criticism from NGOs and civil society for a governance approach that is argued to be strongly shaped by a neoliberal economic growth narrative, which fails to sufficiently address environmental and social sustainability considerations (Riemann et al., 2022). The main contention lies with the perceived narrow framing of the bioeconomy by policymakers, where economic growth is prioritised over ecological and social considerations (*ibid*). An example of this is that the German National Policy Strategy Bioeconomy (2013) tends focus mainly on technology and optimisation, overlooking the need for agricultural reform (Fortuna et al., 2020). It does not address the Common Agricultural Policy's (CAP) objectives regarding food chain restructuring and landscape preservation (*ibid*). Additionally, it fails to adequately resolve the tensions between increased biomass production and environmental protection (Eversberg et al., 2023). Highlighting that policy documents and the federal government's approach are often aligned with a vision of the bioeconomy that emphasises technological innovation and market-driven solutions, instead of a more inclusive, deliberative governance model that prioritise environmental justice and broader public participation (Riemann et al., 2022).

An illustration of this is the land-use competition in the German bioeconomy increasing pressure on arable land due to various demands, such as housing, transport, reforestation, and biomass production for energy purposes (Zscheischler et al., 2016). This competition is further exacerbated by the political support for energy crops, leading to conflicts over land-use both domestically and globally (Delzeit et al., 2010). The interaction of the global multi-regional general equilibrium model (DART), a regionalised agricultural sector model for Germany (RAUMIS) and a location model for biogas plants reveals the complex economy-wide effects of biomass cultivation, emphasising the importance of

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considering existing land-use restrictions and competition to understand the full implications of bioenergy production (Delziet et al., 2010). Addressing these trade-offs and synergies is crucial for sustainable land management and the long-term viability of the German bioeconomy.

The German government has been endeavouring to take more resolute actions to heighten societal awareness regarding production and consumption concerns and fostering greater accountability on their part (Riemann et al., 2022). This includes the development of a new Bioeconomy Council in 2020 with a more diverse membership, comprising of experts from various fields such as social sciences, engineering, and natural sciences (*ibid*), as well as the enactment of the 'Supply Chain Act' on January 1st, 2023, which is also known as the German Act on Corporate Due Diligence in Supply Chains (Mittwoch and Bremenkamp, 2023). This Act aims to promote corporate sustainability and human rights protection in global supply chains by requiring companies to conduct due diligence on human rights and environmental risks within their operations and direct suppliers (*ibid*). However, the Act has been criticised for primarily focusing on human rights while giving secondary consideration to environmental concerns (*ibid*). Additionally, its impact is limited as it only applies to large companies and focuses on direct suppliers, overlooking potential violations earlier in the supply chain (ibid). According Mittwoch and Bremenkamp (2023) despite these shortcomings, the German 'Supply Chain Act' is significant as it represents a step towards greater corporate accountability for human rights and environmental impacts within global supply chains.

France

France's approach to governance involves a multi-level framework with various public actors focused on sustainability and economic development (Agro-Transfert Ressources et Territoires, 2017). At the national level, the government has established a dedicated bioeconomy strategy, complemented by regional biomass plans (*ibid*). This strategy is influenced by EU bioeconomy policies but tailored to regional needs (*ibid*). Public institutions play a crucial role in promoting biomass use by providing financial support, allocating land, and offering guidance (*ibid*). For example, the French Agency for Ecological Transition (ADEME) supports renewable energy and waste management projects involving biomass (*ibid*). Regional authorities are meant to prioritise biomass projects that create jobs and enhance the region's influence in the bioeconomy regional decision-making process, which is meant to carefully consider economic, environmental, and social factors to ensure initiatives align with sustainability and economic development goals (*ibid*). France's approach showcases a commitment to advancing a sustainable and circular bioeconomy by integrating it across various sectors and fostering

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collaboration among public institutions, businesses, and local communities (*ibid*). However, the overreliance on public funding sources may pose a risk to the long-term sustainability of bioeconomy projects, as exemplified by the case of liquidation of the SCIC Picardie Energie Bois (*ibid*). The Picardy Regional Council actively promoted the creation of this SCIC to foster a collective approach in the wood energy sector, but this strong reliance on regional support made the initiative vulnerable (*ibid*).

Dependence on public funding poses several challenges such as (Stadler and Chauvet, 2018; Agro-Transfert Ressources et Territoires, 2017):

- *Shifting Political Priorities:* Changes in political leadership or regional priorities can lead to reduced or withdrawn funding, jeopardising operations.
- *Lack of Financial Self-Sufficiency:* Continuous reliance on public funds can hinder the development of a robust and independent business model, leaving the businesses/sectors such as the SCIC perpetually vulnerable to funding cuts.
- *Distortion of Market Dynamics:* Excessive public funding can create an uneven playing field, potentially disadvantaging private sector competitors and disrupting natural market forces.

This suggests that the governance structure should prioritise diversifying funding sources and developing mechanisms to attract private investment, ensuring the long-term viability of bioeconomy initiatives. Table 12 outlines Policy and Governance Framework for the French bioeconomy.

Table 12: France's Policy and Governance Framework & Integration of the Bioeconomy (Source: Agro-Transfert Ressources et Territoires, 2017; Naudet and Marrazzo, 2021)

France's Policy and Governance Framework & Integration of the Bioeconomy
National Bioeconomy Strategy: France has a dedicated national bioeconomy strategy, aligning with the broader European Union framework but tailored to address specific national and regional priorities. This strategy establishes a clear direction for bioeconomy development and encourages collaboration between various ministries and government agencies. **Regional Biomass Plans:** Recognising the diverse resources and needs of different regions, France encourages the development of regional biomass plans. These plans often incorporate elements of the circular economy, focusing on local resource utilisation, waste reduction, and the creation of closed-loop systems. **Multi-Level Governance:** France's approach to bioeconomy governance involves collaboration between national, regional, and local authorities. This ensures that decision-making processes consider both national

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priorities and local specificities, facilitating the adaptation of bioeconomy initiatives to different territorial contexts.

Cascading Use of Biomass: France prioritises the cascading use of biomass, aiming to maximise resource efficiency and minimise waste generation. This involves using biomass for multiple purposes, starting with high-value applications like food and feed production, followed by the extraction of valuable materials, and concluding with energy generation from residual streams.

Integration with Waste Management: France seeks to integrate bioeconomy activities with existing waste management systems, viewing organic waste as a valuable resource for bio-based products and energy. This approach reduces the environmental impact of waste disposal, promotes resource recovery, and creates opportunities for local job creation within the waste management sector.

Emphasis on Environmental Impact Assessment: Public actors in France conduct thorough environmental impact assessments before approving bioeconomy projects, ensuring that potential negative consequences are mitigated. This involves evaluating factors like greenhouse gas emissions, potential pollution, and impacts on biodiversity.

France's approach to land-use management in the bioeconomy involves navigating complex trade-offs between competing interests. This is exemplified with regards to the intersection of the multifunctional role of French forests, which provide not just timber but also support biodiversity, recreation, and other valuable ecosystem services (Roux et al., 2023). Two primary approaches have emerged in the forestry sector: increasing wood harvesting to bolster the bioeconomy, or prioritising carbon storage by limiting harvests (*ibid*). The former emphasises substituting wood for more emissions-intensive materials, potentially accelerating decarbonisation (*ibid*). The latter stresses the importance of maintaining forest carbon sinks and preserving ecosystem services (*ibid*). This tension plays out across different forest management scenarios, with implications for carbon sequestration, economic outcomes, and land-use patterns (*ibid*). A central trade-off involves balancing the short-term bioeconomy gains from expanded harvesting against the long-term benefits of preserving forest carbon stocks and ecological integrity (*ibid*). Expanding forest areas for biomass production could compete with land used for food crops or livestock (*ibid*). Promoting agroforestry could integrate trees into agricultural landscapes, changing traditional farming and creating new diversification opportunities (*ibid*).

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Belgium

The governance structure of Flanders' bioeconomy has evolved from a dedicated strategy to an integrated approach within a larger circular economy framework (Naudet and Marrazzo, 2021). Initially led by an Interdepartmental Working Group that published a bioeconomy strategy in 2013, the focus shifted to incorporating bioeconomy into the 2014 Smart Specialisation Strategy and then the 2016 Vision 2050 for a transition towards a circular economy (*ibid*). Circular Flanders, established in 2017, serves as a partnership hub to guide actions related to circularity, including bioeconomy (*ibid*). The current structure, established in 2020, features a cross-cutting governance approach that links circular economy concepts across the Flemish Government (*ibid*). This is implemented through thematic working agendas and coordinated by the Departments of Economics, Science and Innovation, and Agriculture and Fisheries (*ibid*). A quadruple helix governance board oversees this model, while a dedicated steering group of diverse stakeholders develops the bioeconomy working agenda within the circular economy framework, ensuring alignment with other policy domains (Naudet and Marrazzo, 2021; Roman et al., 2020).

The transition of Flanders' bioeconomy governance from a dedicated strategy to integration within a broader circular economy framework raises concerns about the potential dilution of focus (Naudet and Marrazzo, 2021). While the alignment with overarching sustainability objectives is advantageous, this shift risks obscuring the distinct aspects and pressing priorities of bioeconomy development (*ibid*). This concern is exacerbated by the challenges in maintaining active stakeholder engagement, as initial enthusiasm may wane, potentially hindering early input and broad consensus-building (*ibid*). Moreover, the absence of a well-defined public engagement strategy could impede the social acceptance and support for bioeconomy initiatives, particularly those pertaining to land-use (*ibid*).

Flanders bioeconomy faces significant competition for land-use and trade-offs, especially in establishing Short Rotation Coppice plantations [14]for bioenergy (Broeckx et al., 2012). Planting SRC with poplar on former farmland has shown high productivity potential, with variations in plant genetics affecting growth rates and yields (*ibid*). This competition for land-based ecosystem services, including bioenergy, highlights the trade-offs and synergies between different land uses, emphasising the need to understand functional relationships to navigate land-use effectively (Müller et al., 2016).

[14] Specialised form of biomass production that utilises fast-growing tree species cultivated on agricultural lands for energy purposes (Schiberna et al., 2021).

5.4 The Approach to Economic, Environmental and Social Sustainability

In an effort to facilitate the transition towards sustainable development, countries like Germany, France, and Belgium have implemented bioeconomy policies and strategies aimed at substituting fossil and mineral-based resources with biomass (Bringezu et al., 2021). However, the increased utilisation of biomass presents the potential for unintended consequences, such as the overexploitation of resources, water, and land, as well as the potential loss of biodiversity and increased greenhouse gas emissions in certain cases (e.g. combustion inefficiencies, supply chain impacts, land-use changes, fertiliser application, and delayed carbon payback periods) (Bringezu et al., 2021; Brack, 2023).

Germany

The evaluations of alternative de-fossilisation pathways in Central Germany have shown positive socio-economic impacts and reduced environmental footprints, especially when transitioning away from natural gas (Zander, 2022). However, citizen perceptions in Germany reveal mixed views on transitioning to a bioeconomy, with concerns about socio-economic effects and product prices (Bogner and Dahlke, 2022). Additionally, despite the emphasis on sustainability, there are concerns regarding the actual transformation towards sustainability and the lack of tangible outcomes in aligning the economy with sustainable practices (Lühmann and Vogelpohl, 2020). The environmental footprint of the German bioeconomy, particularly in terms of agricultural and forestry biomass consumption, highlights issues such as substantial land-use change, water stress, and significant contributions to carbon footprints attributed to livestock farming, primarily due to methane emissions from ruminant animals and fertiliser management (Bringezu et al., 2021). In 2015, Germany's agricultural biomass consumption footprint was ±415 million metric tons, which was 81% higher than the global average, this transformation was predominantly facilitated by the conversion of forested areas to agricultural land, resulting in habitat degradation and diminished biodiversity (*ibid*). It is important to note that there is a lot of variation in how the size and impact of the bioeconomy are measured across different studies (Iost et al., 2019). This is mainly because there is no widely accepted definition of "bioeconomy", and current economic classifications have trouble distinguishing between fossil-based and bio-based resources (*ibid*). This impedes the ability to accurately monitor progress and determine the full extent of bioeconomy growth, consequently posing challenges in formulating evidence-based policies, setting realistic objectives, and appropriately allocating resources.

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France

France faces various challenges in developing a sustainable bioeconomy. A key issue is the unbalanced flow of biomass resources (Marty et al., 2022). For example, northern Aube relies on imported organic fertilisers due to a shift towards crop-only farming (*ibid*). This imbalance is worsened by the rise of agricultural biogas production, which diverts biomass and intensifies competition for critical resources like manure (*ibid*). While biogas is financially attractive for individual farmers, its expansion raises concerns about the long-term sustainability of agricultural practices, including potential negative impacts on soil fertility and existing agro-industries (*ibid*). The situation is further complicated by uncertainties in the agricultural sector, such as climate change and agronomic challenges, that affect biomass availability and use (*ibid*). Addressing these complexities requires a comprehensive, multi-scale approach to bioeconomy development that considers the interconnected value chains and prioritises the long-term sustainability of agricultural and industrial activities (*ibid*).

Belgium

Flanders faces multiple challenges in developing a sustainable bioeconomy, mainly due to a lack of coordination and trust among stakeholders (Mertens et al., 2019). The absence of a shared vision for end products and limited stakeholder engagement beyond research have hindered progress (*ibid*). Funding for comprehensive value chain development is lacking, limiting access to critical resources (*ibid*). This has led to reliance on subsidies, further deterring private investment and perpetuating insufficient knowledge generation (*ibid*). The fragmented research landscape and inadequate information sharing have also stifled trust building (*ibid*). To overcome these issues, Flanders needs to foster collaboration, set clear objectives, secure stable funding, and promote transparent communication to build confidence in the bioeconomy's potential (*ibid*). These challenges are similar to those faced in Belgium's manure treatment sector, where manure availability is the main constraint on bioeconomy growth, which highlights that focusing only on technology development, without addressing the core issue of resource availability, is inadequate approach (Maes and Passel, 2019). Therefore, addressing resource constraints is essential for the success of industrial and R&D policies in the bioeconomy (*ibid*).

This shift towards increased biomass consumption is expected to have potential impacts on ecosystems primarily related to land-use change such as loss of carbon stocks, biodiversity loss, excess nutrients, and high-water usage. This highlights the importance of monitoring land-use displacement

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and spillover effects of bioeconomy development (Többen et al., 2022). Monitoring the bioeconomy is crucial for tracking progress towards sustainability goals, informing policy decisions, understanding the economic impact, and evaluating environmental implications (Iost et al., 2019). As nations transition to more sustainable and bio-based economies, a robust monitoring system allows policymakers and researchers to assess policy effectiveness, identify areas for improvement, and ensure the bioeconomy contributes to a sustainable future (*ibid*). By measuring the bioeconomy's contribution to employment, value, and revenue, policymakers can gain insights, attract investments, and promote growth (Pyka et al., 2022). A comprehensive monitoring system should assess the bioeconomy's environmental impacts, such as land-use, emissions, and biodiversity, to mitigate negative consequences (Iost et al., 2019.

6. Transferable Policy Stands identified for the Irish Bioeconomy Context

Based on the analysis of research and development (R&D) approaches in Germany, France, and Belgium, several transferable policy strands can be identified for the Irish bioeconomy context. Ireland could benefit from adapting these strategies to foster innovation, sustainability, and regional inclusivity within its bioeconomy.

6.1 The Research and Development Approach

Comprehensive Funding Models and Coordination

Ireland could adopt Germany’s dual funding approach from the National Research Strategy Bioeconomy 2030. This model combines medium to long-term institutional funding with flexible, short-to-medium-term project funding. Such an approach ensures consistent support for foundational research while enabling adaptive responses to emerging challenges like climate change and bioresource management.

Ireland should establish mechanisms for synergistic funding coordination, involving government agencies, private stakeholders, and EU funding programs. For instance, Germany's Project Management Jülich and France's National Research Agency provide models for Ireland to streamline funding administration while ensuring alignment with national and EU priorities.

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Belgium's emphasis on targeted funding incentives, such as tax breaks for reusable packaging and R&D investments, could further encourage industry participation. Adopting a tax-incentive scheme like Belgium's 13.5% R&D credit could boost private sector involvement in Ireland.

Collaborative Innovation Ecosystems

Germany's approach to fostering innovation networks such as BioRegio and BioProfile illustrates the value of cross-sectoral collaboration. Ireland could replicate these networks to connect universities, SMEs, and larger corporations in innovation clusters. This would be particularly effective in enabling interdisciplinary R&D projects in agriculture, forestry, marine resources, and biotechnology.

In addition, Ireland could adopt France's cluster-based models, such as the Industries and Agro-Resources (IAR) cluster, to create integrated value chains. These clusters could focus on biobased chemicals, renewable energy, and sustainable food production, enabling Ireland to develop cohesive and competitive bioeconomy sectors.

Regional hubs like Belgium's Flanders Innovation Hub for Sustainable Chemistry (FISCH) could inspire Ireland to establish similar innovation centres that serve as platforms for translating research into industrial applications.

Localised and Regional Approaches

The French model of regional experimentation, particularly the Pays de la Loire Bio-based Circular Economy Action Plan, demonstrates how localised testing can inform national strategies. Ireland could adopt action research initiatives to pilot bioeconomy projects in specific regions. These pilots could explore sustainable practices in biomass utilisation, waste recycling, and renewable energy production, generating insights that are scalable across the country.

Additionally, Belgium's focus on regional adaptability through programmes like the Flemish Moonshot illustrates the value of tailoring bioeconomy policies to local strengths. Ireland could develop regional strategies that leverage its unique resources, such as marine biomass in coastal areas or agricultural residues in rural regions.

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Focus on Circular Economy and Sustainability

France's ConcerTO approach provides a replicable model for structured and inclusive resource management. Ireland could adopt this methodology to create comprehensive frameworks for managing organic waste, emphasising stakeholder collaboration, collective intelligence, and adaptability.

Belgium's emphasis on circular carbon strategies within its Moonshot programme could also guide Ireland in designing policies that focus on circularity in materials and energy use. These policies should integrate biowaste recycling, biogas production, and resource recovery into the bioeconomy framework.

Technological Convergence and Innovation

Ireland could draw from Germany's emphasis on technological integration across sectors, fostering interdisciplinary collaboration between life sciences, digital technologies, and material sciences. For example, initiatives like Germany's BioFuture and BioChance could inspire Ireland to develop similar programs to accelerate the deployment of advanced bioeconomy technologies.

France's and Belgium's focus on green chemistry and process innovation highlights the importance of advancing sustainable technologies. Ireland could establish centres of excellence in areas like bio-based materials and energy storage, supported by government and private funding.

Participatory and Inclusive Governance

France's model of participatory governance is highly relevant for Ireland. Policies should ensure the inclusion of diverse stakeholders, such as NGOs, farmers, local communities, and academic institutions, in decision-making processes. This inclusivity can help ensure that bioeconomy strategies reflect societal priorities and foster community engagement.

Belgium's Klimrek project, which provides tailored climate assessments for farmers, is a prime example of stakeholder-focused initiatives. Ireland could replicate this by developing tools that help farmers and rural businesses adapt to bioeconomy innovations while addressing climate challenges.

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Institutional and Knowledge Infrastructure

Ireland could benefit from Belgium's approach to building institutional frameworks that support bioeconomy R&D. Establishing policy research centres and dedicated agencies for bioeconomy innovation would strengthen Ireland's capacity to coordinate research, monitor progress, and disseminate knowledge.

For example, Germany's integration of advisory bodies, such as the National Bioeconomy Council, could guide Ireland in developing strategic policies and aligning them with EU goals.

Equitable Regional Development

Germany's shift from a biotechnology-centric bioeconomy to a broader focus on bioresources and bioecology highlights the importance of inclusivity in regional development. Ireland could adopt policies that promote equitable bioeconomic growth, targeting both urban innovation hubs and rural areas with tailored initiatives.

Belgium's decentralised funding model, which supports projects in less-developed regions, offers a way to ensure geographic inclusivity. Ireland could implement similar measures to balance the development of bioeconomy activities across its regions.

Support for SMEs and Local Enterprises

France's emphasis on integrating bioeconomy strategies into regional business models and Belgium's targeted SME funding illustrate the potential of empowering smaller enterprises. Ireland could establish innovation grants and incubators for SMEs, particularly those focused on sustainable agriculture, marine resources, and forestry.

Ethical and Normative Dimensions

Germany's critique of its own bioeconomy policies for neglecting normative considerations offers a valuable lesson. Ireland should integrate ethical reflection, systemic thinking, and participatory approaches into its bioeconomy strategies. This could involve fostering discussions on sustainability trade-offs, consumer roles, and equitable resource distribution.

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Concluding note

To fully benefit from the transferable policies of Germany, France, and Belgium, Ireland must integrate these elements into a coherent strategy that emphasises funding, collaboration, inclusivity, and innovation. By combining local experimentation with strategic national initiatives, Ireland can create a bioeconomy that is not only innovative but also sustainable, equitable, and tailored to its unique socio-economic and environmental context.

6.2 The Partnership Approach

Establish Regional Bioeconomy Hubs (RBHs) as Collaborative Platforms

Ireland's bioeconomy can be significantly enhanced by establishing Regional Bioeconomy Hubs (RBHs), inspired by the regional approaches in Bavaria, Germany, and Pays de la Loire, France. These hubs would act as decentralised platforms to coordinate stakeholders from industry, academia, local authorities, and communities. Each hub could focus on Ireland's distinct resources and regional capacities. For instance, the Shannon Estuary could center its activities on marine bioresources, while Munster and Connacht might prioritise agricultural biomass and food processing waste. The hubs would not only support the commercialisation of bioeconomy innovations but also serve as knowledge-sharing centers, hosting training programs, conferences, and collaborative projects.

RBHs in Ireland would act as localised ecosystems where innovation aligns with community needs. They could provide incubators and accelerators for bio-based startups, drawing on lessons from Germany's cluster model in Bavaria, which integrates regional expertise with practical industrial applications. These hubs would also help retain economic value within rural areas, creating employment opportunities and supporting regional growth.

Build Multi-Actor Innovation Clusters

The development of multi-actor innovation clusters is key to Ireland's bioeconomy growth, following the models seen in Belgium's cluster policy and Germany's Bavarian bioeconomy clusters. These clusters would connect universities, SMEs, industry leaders, and government bodies to foster interdisciplinary research, innovation, and commercialisation in areas such as bioplastics, biofuels, and marine bioresources. Ireland's strong ICT and life sciences sectors could collaborate with agriculture

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and fisheries to drive breakthroughs in precision farming, biopharmaceuticals, and circular bio-based technologies.

Clusters would provide infrastructure for shared R&D, networking opportunities, and access to funding. Drawing from Belgium's Spearhead Clusters, Ireland could emphasise high-impact sectors, such as renewable energy, sustainable packaging, and bio-based chemicals, offering tailored funding and tax incentives to attract investment and innovation. These clusters would align with EU priorities for sustainable and circular bioeconomic development.

Leverage Living Labs for Participatory Innovation

Germany's Living Lab model demonstrates how participatory innovation frameworks can address local bioeconomy challenges. Ireland could establish Living Labs in regions such as Donegal or Kerry to engage stakeholders, including farmers, fishers, SMEs, and local communities, in co-designing bioeconomy solutions. These labs would test and refine innovations in real-world contexts, such as bioenergy systems using agricultural residues or seaweed-based materials for renewable products.

Living Labs would promote inclusive innovation by ensuring that local voices shape solutions, creating a sense of ownership and ensuring practical applicability. For example, coastal Living Labs could involve marine researchers and fishing cooperatives to develop bio-based energy systems while inland labs might focus on biowaste management and valorisation. These labs would also align with EU programs and foster grassroots contributions to Ireland's bioeconomic transformation.

Empower Primary Producers as Partners

Primary producers, including farmers, foresters, and fishers, are integral to the bioeconomy as suppliers of biomass. Drawing from Germany's emphasis on including primary producers as equal partners, Ireland could create programs that empower these stakeholders to actively shape bioeconomy strategies. This would include formalising their involvement through advisory councils and cooperatives linked to bioeconomy hubs. These structures would enable farmers and foresters to guide land management practices, resource extraction, and the development of bio-based products.

Training programs, informed by France's farmer-focused initiatives, would equip producers with the skills to engage in sustainable practices and value-added processing. For example, farmers could learn

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to produce bio-based fertilisers from agricultural residues or engage in bioenergy projects, ensuring that they benefit economically from the bioeconomy while contributing to sustainability goals.

Strengthen Knowledge Co-Creation

Germany's National Research Strategy Bioeconomy 2030 and France's interdisciplinary governance model emphasise the importance of integrating diverse expertise in bioeconomy innovation. Ireland could establish bioeconomy consortia that unite universities, private enterprises, NGOs, and local authorities to collaboratively address challenges such as climate-neutral farming and marine resource optimisation. Teagasc, as a central knowledge institution, could expand its role to coordinate these consortia, ensuring that cutting-edge research aligns with industry and societal needs.

Knowledge co-creation would also involve partnerships with international networks, allowing Ireland to tap into EU funding programs like Horizon Europe. Collaborative research could focus on priority areas such as biodegradable materials, bioenergy, and sustainable aquaculture, ensuring alignment with EU Green Deal objectives.

Advance Circular Economy Practices

Circular economy principles are central to sustainable bioeconomic development, as demonstrated in Belgium's Moonshot programme and France's ConcerTO framework. Ireland could adopt similar strategies to create closed-loop systems that optimise resource use and minimise waste. For instance, agricultural residues could be converted into bio-based fertilisers or biogas, while food waste could be used for composting or bioenergy production.

Ireland could develop regional programs to scale these practices, particularly in areas with strong agricultural or food-processing industries. Cross-sectoral collaborations would ensure efficient resource flows, linking food processors with waste recovery projects and biogas plants. These efforts would reduce environmental impacts while promoting sustainable economic growth.

Foster Public-Private Partnerships

France's success with public-private partnerships illustrates the value of combining government support with private-sector expertise. Ireland could establish similar mechanisms to drive innovation

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and commercialisation in its bioeconomy. Joint funding initiatives could support high-risk projects in bio-based energy, packaging, and chemicals, with the government providing seed funding and tax incentives to attract private investment.

Collaboration between public bodies such as Bord Bia and Enterprise Ireland with private companies would help scale bio-based products for domestic and international markets. Partnerships with large enterprises could also facilitate technology transfer and capacity building for SMEs, ensuring broad-based growth.

Develop Multi-Level Governance

Effective governance is critical to aligning national and regional bioeconomy efforts. Ireland could establish a National Bioeconomy Council, modelled after Germany's cross-ministerial approach, to coordinate policies across agriculture, energy, environment, and education sectors. This council would ensure that bioeconomy strategies are integrated into national development plans and aligned with EU frameworks.

Regional governance structures, similar to France's localised initiatives, would empower local authorities to adapt strategies to specific needs. These councils could oversee regional hubs, ensuring coherence between national objectives and local implementation, while fostering stakeholder engagement and accountability.

Enhance Funding Mechanisms

Germany and Belgium's funding models highlight the importance of targeted financial support for bioeconomy innovation. Ireland could create dedicated funding streams for early-stage ventures, advanced commercialisation, and regional projects. These funds could prioritise areas such as marine bioresources, biowaste valorisation, and renewable materials.

Access to EU funding, such as the European Circular Bioeconomy Fund, would be facilitated by streamlining application processes and building cross-border consortia. Public-private partnerships could also be used to share risks and attract private investment in high-potential bioeconomy projects.

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Promote International Collaboration

Germany and France's active participation in EU and global bioeconomy initiatives highlights the benefits of international collaboration. Ireland could strengthen partnerships with EU neighbours to address shared challenges, such as sustainable agriculture and marine biomass utilisation. Participation in Horizon Europe projects and other global networks would enhance Ireland's innovation capacity while aligning its bioeconomy goals with global sustainability trends.

Build Awareness and Engagement

France's public outreach campaigns and local demonstration projects offer valuable insights for raising awareness about the bioeconomy. Ireland could launch similar initiatives to showcase successful bioeconomy ventures, emphasising their environmental and economic benefits. Nationwide campaigns could highlight the potential for rural job creation, reduced waste, and community-led innovation, fostering public support for bioeconomic practices.

Create Equitable Policies for Small and Rural Enterprises

Belgium's emphasis on supporting SMEs through cluster policies underscores the importance of equitable participation. Ireland could develop incubator programs to support rural bioeconomy startups, providing mentorship, funding, and market access. Simplifying regulatory processes and ensuring fair competition would enable smaller enterprises to thrive within Ireland's bioeconomy framework, ensuring inclusivity and broad-based growth.

Concluding note

A comprehensive adoption of these partnership approaches would position Ireland as a global leader in sustainable and inclusive bioeconomic development. By tailoring these strategies to its unique strengths in agriculture, marine resources, and innovation, Ireland could create a robust bioeconomy that aligns with EU objectives while fostering regional growth, environmental sustainability, and societal well-being.

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6.3 The Governance Approach

Adopt Multi-Level Governance Structures

Ireland can benefit from France's multi-level governance framework, which integrates national, regional, and local authorities to ensure alignment between broad national objectives and specific regional needs. France's regional biomass plans, tailored to local resources and economic conditions, offer a model for Ireland to adopt similar regional frameworks. These frameworks could empower local councils and regional bodies to coordinate bioeconomy initiatives in tandem with the Department of Agriculture, Food and the Marine (DAFM). For instance, Ireland could establish regional bioeconomy committees to manage site-specific challenges, such as maximising marine resources in coastal regions or optimising forestry in the midlands. This structure would ensure that Ireland's national bioeconomy strategy is adaptable and responsive to diverse regional contexts, promoting both inclusivity and efficiency.

Integrate Bioeconomy with Circular Economy Strategies

Belgium's integration of the bioeconomy within a broader circular economy framework presents a valuable lesson for Ireland. While circular economy principles emphasise resource efficiency, waste reduction, and closed-loop systems, combining them with bioeconomy objectives focuses attention on renewable biological resources. Ireland can adopt a cross-sectoral governance structure similar to Flanders' Circular Flanders initiative. By establishing a coordinating entity, perhaps under the Department of the Environment, Climate, and Communications, Ireland could synchronise bioeconomy and circular economy efforts. This would include creating "bio-circular economy action plans" that address overlapping challenges in waste management, renewable energy, and sustainable agriculture. Such integration would enhance the resilience of Ireland's economy while fostering innovation.

Develop Reflexive Science-Policy Interfaces

Germany's reflexive approach to Science-Policy Interfaces (SPIs) demonstrates the importance of bridging scientific research and policymaking with active societal engagement. Ireland could establish its own SPI framework, ensuring that bioeconomy governance is informed by cutting-edge science

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while remaining flexible to societal demands. For example, Ireland could convene interdisciplinary panels that include scientists, policymakers, industry leaders, and civil society groups to evaluate bioeconomy initiatives regularly. These panels could advise on the development of policies that mitigate unintended consequences such as land-use conflicts, biodiversity loss, and socio-economic inequalities. Reflexive governance would ensure that Ireland's bioeconomy strategy evolves in response to emerging data and public feedback.

Address Land-Use Competition and Trade-Offs

Germany's challenges with land-use competition highlight the need for integrated land management strategies. Ireland faces similar pressures, including the competing demands for agriculture, afforestation, and renewable energy production. France's cascading biomass use principle, prioritising high-value applications such as food, feed, and biobased materials before energy production, offers a transferable policy framework. Ireland could formalise cascading use in its bioeconomy policy, mandating its application in both public and private sector projects. This approach would reduce conflicts over resource allocation while maximising the value of biomass. Additionally, Ireland could implement agroforestry practices, integrating trees into agricultural landscapes to balance productivity, biodiversity conservation, and carbon sequestration.

Promote Inclusive Governance and Public Participation

Inclusive governance is critical for ensuring equity and social acceptance of bioeconomy policies. Germany's new Bioeconomy Council, established in 2020 with representation from diverse fields, underscores the value of broad stakeholder engagement. Ireland could replicate this model by forming a Bioeconomy Advisory Council that includes representatives from farmers, fishers, indigenous communities, environmental groups, and industry leaders. This council would act as a forum for addressing diverse concerns, fostering dialogue, and building trust. Public consultations and participatory planning processes could further enhance transparency and ensure that bioeconomy policies reflect the values and priorities of Irish citizens.

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Diversify Funding Mechanisms

France's reliance on public funding for bioeconomy initiatives, while effective in the short term, highlights vulnerabilities such as susceptibility to political shifts. Ireland could take a diversified funding approach, combining public investment with private sector incentives and international funding sources. For instance, Ireland could establish a Bioeconomy Development Fund that provides grants and low-interest loans to startups and SMEs, while offering tax credits for investments in bio-based industries. Leveraging EU funding programs such as Horizon Europe and the European Circular Bioeconomy Fund would also enable Ireland to attract external capital and reduce reliance on domestic public resources.

Implement Robust Environmental Impact Assessments

France's emphasis on thorough environmental impact assessments (EIAs) ensures that bioeconomy projects align with sustainability objectives. Ireland could adopt similar measures, requiring EIAs for all significant bioeconomy initiatives. These assessments would evaluate greenhouse gas emissions, biodiversity impacts, and resource efficiency, providing a transparent mechanism for balancing economic and environmental goals. The findings from these EIAs could be made publicly accessible, fostering accountability and trust.

Mandate Corporate Responsibility in Supply Chains

Germany's Supply Chain Act, which mandates corporate accountability for human rights and environmental impacts, serves as a model for Ireland to enhance its governance framework. Ireland could enact similar legislation tailored to bioeconomy industries, requiring companies to monitor and report on the environmental and social impacts of their supply chains. Such policies would ensure the ethical sourcing of biomass and promote Ireland's reputation as a leader in sustainable bioeconomy practices. Additionally, extending these requirements to SMEs and indirect suppliers could address gaps identified in the German model, ensuring comprehensive supply chain oversight.

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Support Agroecological Approaches

France's exploration of agroecological practices within its bioeconomy highlights the potential for balancing productivity with ecological preservation. Ireland could integrate agroecology into its bioeconomy strategy by promoting practices such as organic farming, crop diversification, and sustainable forestry. Training programs and subsidies for farmers adopting agroecological methods would encourage widespread adoption, enhancing Ireland's resilience to climate change while supporting rural livelihoods.

Enhance Public and Private Sector Collaboration

Belgium's cluster-based governance, exemplified by Flanders' Spearhead Clusters, demonstrates the value of structured collaboration between academia, industry, and government. Ireland could develop sector-specific clusters in areas such as biopharmaceuticals, marine bio-resources, and renewable energy. These clusters would act as hubs for innovation, facilitating knowledge transfer and joint ventures. By fostering strong partnerships between research institutions and private enterprises, Ireland could accelerate the commercialization of bio-based technologies and enhance its competitiveness in global markets.

Foster International Collaboration

Both Germany and France have actively engaged in international bioeconomy initiatives, such as the European Research Area (ERA) and the Standing Committee on Agricultural Research (SCAR). Ireland could similarly prioritise cross-border collaboration to share best practices, pool resources, and strengthen its position in global bioeconomy networks. Establishing partnerships with EU and non-EU countries in areas such as marine bioresources and advanced biotechnologies would align with Ireland's strategic strengths and enhance its access to international funding and expertise.

Invest in Education and Training

Governance of the bioeconomy requires a skilled and adaptable workforce. Germany's emphasis on skills development highlights the importance of education and training programs tailored to

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bioeconomy needs. Ireland could introduce specialised bioeconomy curricula in universities and vocational training centres, focusing on areas such as biotechnology, renewable energy, and sustainable agriculture. Collaborations with industry stakeholders would ensure that these programs align with labour market demands, preparing Irish workers for emerging opportunities in the bioeconomy.

Monitor and Evaluate Governance Outcomes

Effective governance requires continuous monitoring and evaluation to ensure alignment with sustainability goals. Germany's reflexive approach offers a model for Ireland to implement regular assessments of its bioeconomy governance framework. Independent evaluations could measure progress against key performance indicators such as greenhouse gas reductions, biodiversity preservation, and economic benefits. These findings would inform policy adjustments, ensuring that Ireland's bioeconomy remains dynamic and responsive to emerging challenges.

Concluding note

Ireland's transition to a bioeconomy necessitates a governance framework that balances economic growth with environmental and social sustainability. By adopting multi-level governance structures, fostering inclusivity, diversifying funding sources, and integrating bioeconomy and circular economy strategies, Ireland can position itself as a leader in sustainable bioeconomic development. Drawing on the experiences of Germany, France, and Belgium, Ireland can craft a governance approach that is innovative, adaptable, and aligned with both domestic and global priorities. These measures will ensure that Ireland's bioeconomy contributes to a prosperous, equitable, and environmentally resilient future.

6.4 The Approach to Economic, Environmental and Social Sustainability

Developing a Comprehensive Biomass Resource Management System

The bioeconomy experiences of Germany, France, and Belgium demonstrate the necessity of managing biomass resources to address imbalances and inefficiencies effectively. For example, France has faced challenges with the uneven flow of biomass, where crop-centric farming in northern Aube

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has necessitated the importation of organic fertilisers. Similarly, Belgium struggles with resource constraints in its manure treatment sector, highlighting the need for better coordination in resource allocation. Ireland can adopt strategies to prevent similar resource bottlenecks by implementing a comprehensive biomass resource management system.

Such a system would prioritise the cascading use of biomass, maximising its value across multiple stages of use. This approach ensures that high-value applications, such as food and feed production, precede lower-value uses like energy generation. Ireland could also establish regional biomass management plans to coordinate resource flows between regions, addressing potential imbalances and conflicts among competing uses. These regional plans would provide a framework for sustainable biogas production and agricultural practices, ensuring the long-term health of soil fertility and ecosystem services.

Balancing Environmental and Socio-Economic Objectives

Germany's emphasis on sustainability has highlighted significant trade-offs between land use, biodiversity preservation, and economic development. The high carbon footprints associated with agricultural biomass and the pressures on arable land reveal the challenges of achieving genuine environmental sustainability. In Ireland, bioeconomy policies must aim to achieve a balance between environmental conservation and socio-economic development.

One approach would be to mandate environmental impact assessments (EIAs) for all bioeconomy initiatives, ensuring they account for carbon footprints, water usage, and biodiversity implications. Additionally, Ireland could develop socio-economic equity measures to ensure that small-scale farmers and rural communities benefit equitably from bioeconomy initiatives. These measures might include subsidies or incentives for sustainable practices and investments in rural infrastructure to support bio-based industries. A transparent and data-driven monitoring system would also be crucial for tracking the effectiveness of these policies in achieving environmental and social objectives.

Fostering Multi-Stakeholder Collaboration

The fragmented research landscape and lack of trust among stakeholders in Belgium's bioeconomy underscore the importance of fostering collaboration. Ireland can avoid similar pitfalls by establishing bioeconomy clusters that connect government agencies, research institutions, farmers, and industry

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players. These clusters should aim to develop a shared vision for the bioeconomy and ensure the equitable distribution of benefits across all stakeholders.

Such initiatives would require the creation of regional innovation hubs, akin to the cluster structures seen in Flanders or Bavaria, to drive collaboration and innovation. These hubs could host regular stakeholder engagement sessions, workshops, and conferences to align goals and expectations. Transparent communication and resource-sharing platforms could further promote trust and cooperation, ensuring that all parties are informed and included in the bioeconomy transition.

Implementing a Robust Bioeconomy Monitoring Framework

Belgium's challenges with insufficient monitoring and measurement reveal a critical gap in evaluating bioeconomy impacts. Ireland can learn from these experiences by establishing a comprehensive monitoring framework to assess the economic, environmental, and social dimensions of its bioeconomy policies.

This framework should include standardised metrics for measuring the contributions of the bioeconomy to employment, GDP, and innovation. Environmental indicators, such as land-use changes, greenhouse gas emissions, and biodiversity impacts, should also be closely monitored. Regular reporting and public access to data would enhance transparency and accountability, enabling policymakers to make informed adjustments to their strategies.

Aligning Policies with Long-Term Sustainability Goals

France's approach to integrating bioeconomy initiatives with circular economy principles provides a useful model for Ireland. By aligning bioeconomy policies with broader sustainability goals, Ireland can ensure that short-term economic gains do not compromise long-term environmental and social objectives.

This alignment would involve prioritising resource efficiency, waste reduction, and the integration of circular economy practices into all bioeconomy sectors. Ireland could also establish sustainability benchmarks for bio-based industries, encouraging the adoption of technologies and practices that minimise environmental impacts while maximising economic value. Such measures would position Ireland as a global leader in sustainable bioeconomic innovation.

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Addressing Land-Use Challenges and Spillover Effects

Germany's land-use pressures, exacerbated by bioenergy crop production, underscore the importance of strategic land-use planning. Ireland faces similar challenges as it seeks to expand its bioeconomy without compromising agricultural productivity or biodiversity.

A key policy approach would be the development of land-use planning tools, such as geographic information systems (GIS), to identify optimal areas for bioeconomy projects. Agroforestry initiatives could also play a significant role, integrating trees into agricultural landscapes to enhance carbon sequestration, biodiversity, and resilience to climate change. Additionally, Ireland must monitor the international spillover effects of its biomass consumption, ensuring that imported resources do not contribute to deforestation or other environmental harms abroad.

Promoting Private Sector Investment

Belgium's reliance on subsidies highlights the risks of overdependence on public funding for bioeconomy projects. Ireland can address this issue by creating a more favourable investment environment for private sector participation. This could involve the establishment of a bioeconomy investment fund that combines public and private capital to finance innovative projects.

Tax incentives for companies adopting sustainable practices and investing in bio-based technologies would further attract private investment. Public-private partnerships (PPPs) could also play a key role, allowing the government to share risks and rewards with private entities while fostering innovation and economic growth.

Building Public Awareness and Acceptance

Germany's mixed public perceptions of the bioeconomy underscore the importance of engaging citizens in the transition process. In Ireland, public awareness campaigns could highlight the benefits of the bioeconomy while addressing concerns about environmental impacts and socio-economic inequalities.

Participatory policy development processes would also enhance public acceptance, allowing communities to have a voice in shaping bioeconomy initiatives. Regular updates on policy progress

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and transparent communication about the environmental and social impacts of the bioeconomy would build trust and support among citizens.

Strengthening the Science-Policy Interface

The variability in definitions and metrics for the bioeconomy, as observed in Germany, poses challenges for effective policymaking. Ireland could establish a dedicated Science-Policy Interface (SPI) to standardise bioeconomy definitions and ensure that policies are informed by the latest scientific research.

The SPI could facilitate interdisciplinary collaborations among economists, ecologists, social scientists, and technologists to address complex bioeconomy challenges. It could also provide a platform for integrating scientific insights into policy decisions, ensuring that bioeconomy strategies align with both national priorities and EU objectives.

Concluding note

The experiences of Germany, France, and Belgium offer valuable insights for Ireland's bioeconomy development. By adopting a comprehensive approach that integrates robust resource management, stakeholder collaboration, and sustainability monitoring, Ireland can navigate the complexities of transitioning to a bio-based economy. Policies that balance environmental, economic, and social objectives while fostering innovation and public engagement will position Ireland as a leader in sustainable bioeconomic development.

7. Limitations of Study

The study highlights a lack of rigorous monitoring and evaluation of the real impact and success of the implemented bioeconomy strategies in the selected regions, which is evident in the limited depth of analysis of regional approaches and their true effectiveness. The depth of analysis varies across different bioeconomy development approaches, with research, development, and collaborative partnerships receiving more attention than governance and sustainability considerations. This reflects a focus on R&D and collaborative approaches as key drivers of innovation in the European bioeconomy. Regarding the academic literature on regions in France and Belgium there are fewer

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comprehensive studies conducted compared to the more extensively documented German bioeconomy. This is reflected in the limited number of academic sources cited and the dominance of certain publications and authors. The study acknowledges the existence of land-use competition and trade-offs based on the available published information regarding regional approaches and strategies, suggesting the need for further in-depth research to gain a comprehensive understanding of the sustainability implications of land-use decisions in these regions.

References

Abel, P. (2020). Living Lab: Forschung und Praxis am Universitätscampus. HMD Praxis der Wirtschaftsinformatik, 57(2), p.285–295. doi:https://doi.org/10.1365/s40702-020-00593-z.

Abson, D.J., von Wehrden, H., Baumg¨artner, S., Fischer, J., Hanspach, J., H¨ardtle, W., Heinrichs, H., Klein, A.M., Lang, D.J., Martens, P., Walmsley, D. (2014). Ecosystem services as a boundary object for sustainability. Ecol. Econ. 103, 29–37. https://doi.org/10.1016/j.ecolecon.2014.04.012.

Agro-Transfert Ressources et Territoires (2017). Démarche d'accompagnement pour le développement des filières de la bioéconomie sur les territoires. [online] p.5–86. Available at: https://www.agro-transfert-rt.org/wp-content/uploads/2019/03/Processus-de-decision-des-acteurs-publics-et-bioeconomie-territoriale.pdf.

Albrecht, M., Grundel, I. and Morales, D. (2021). Regional bioeconomies: public finance and sustainable policy narratives. Geografiska Annaler: Series B, Human Geography, 103(2), p.116–132. doi:https://doi.org/10.1080/04353684.2021.1921603.

Alfano, M.R., Cantabene, C., Lepore, A. and Palermo, S. (2023). The green to circular bioeconomy transition: Innovation and resilience among Italian enterprises. Business Strategy and the Environment, 32(8), p.6094–6105. doi:https://doi.org/10.1002/bse.3474.

Allain, S., Ruault, J.F., Moraine, M. and Madelrieux, S. (2022). The 'bioeconomics vs bioeconomy'debate: Beyond criticism, advancing research fronts. Environmental Innovation and Societal Transitions, 42, pp.58-73.

Allais, F., Lescieux-Katir, H. and Chauvet, J.-M. (2021). The continuous evolution of the Bazancourt–Pomacle site rooted in the commitment and vision of pioneering farmers. When reality shapes the biorefinery concept. EFB Bioeconomy Journal, 1, p.1–6. doi:https://doi.org/10.1016/j.bioeco.2021.100007.

Draft

Allen, B., Nanni, S., Schweitzer, J.-P., Baldock, D., Watkins, E., Withana, S. and Bowyer, C. (2015). International review of Bio- economy Strategies with a focus on waste resources. [online] p.5–64. Available at: https://ieep.eu/wp-content/uploads/2023/01/IEEP_2015_International_review_of_Bio-economy_Strategies_with_a_focus_on_waste_resources.pdf [Accessed 2 Dec. 2024].

Ambition Bioeconomy (2020). PROJECT IAR DEMONSTRATOR SITE NETWORK. [online] The official bioeconomy portal of the Hauts-de-France. Available at: https://www.bioeconomie-hautsdefrance.fr/en/projets/project-iar-demonstrator-site-network/ [Accessed 26 Jun. 2024].

Andersen, M., Skou, Christensen, L., Dalgaard, Donner-Amnell, J., Eikeland, P., Ove, Hedeler, B., Hildingsson, R., Johansson, B., Khan, J., Annica Kronsell, Inderberg, J., Helle Ørsted Nielsen, Massimo Pizzol, Rauno Sairinen, Jon Birger Skjærseth, Patrik Söderholm, Tuula Teräväinen and Thomsen, M. (2022). To facilitate a fair bioeconomy transition, stronger regional-level linkages are needed. Biofuels, Bioproducts and Biorefining, 16(4), p.929–941. doi:https://doi.org/10.1002/bbb.2363.

Andreeßen, C., Bayer, T., Kircher, M., Lehr, D., Michels, J., Rentmeister, B. and Bioball, G. (2021). Positionspapier Beschleunigung der Bioökonomie in der Metropolregion FrankfurtRheinMain. [online] Available at: https://biooekonomie-metropolregion.de/bioball/uploads/publications/bioball/Positionspapier_BioBall_Beschleunigung_der_Biooekonomie_in_der_Metropolregion_FrankfurtRheinMain_2021-10-15.pdf [Accessed 1 Dec. 2024].

Angelino, P., Czarnitzki, D. and Volckaert, A. (2024). Cluster Policy, Innovation, and Firm Productivity. An Econometric Assessment of the Flemish Spearhead Cluster Program. SSRN Electronic Journal, [online] p.1–37. doi:https://doi.org/10.2139/ssrn.4855958.

Araque-Marin, M., Bellot Noronha, F., Capron, M., Dumeignil, F., Friend, M., Heuson, E., Itabaiana, I., Jalowiecki-Duhamel, L., Katryniok, B., Löfberg, A., Paul, S. and Wojcieszak, R. (2022). Strengthening the Connection between Science, Society and Environment to Develop Future French and European Bioeconomies: Cutting-Edge Research of VAALBIO Team at UCCS. Molecules, 27(12), p.3889. doi:https://doi.org/10.3390/molecules27123889.

Arnould, M., Morel, L. and Fournier, M. (2022). Embedding non-industrial private forest owners in forest policy and bioeconomy issues using a Living Lab concept. Forest Policy and Economics, 139, p.1–19. doi:https://doi.org/10.1016/j.forpol.2022.102716.

Asheim, B., R. Boschma, and P. Cooke. (2011). “Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases.” Regional Studies 45 (7): 893–904. doi:10.1080/00343404.2010.543126.

Asheim, B.T. and Coenen, L. (2005). Contextualising Regional Innovation Systems in a Globalising Learning Economy: On Knowledge Bases and Institutional Frameworks. The Journal of Technology Transfer, 31(1), p.163–173. doi:https://doi.org/10.1007/s10961-005-5028-0.

Audretsch, D., and M. Feldman. (2004). "Knowledge Spillovers and the Geography of Innovation." In Handbook of Regional and Urban Economics - Cities and Geography, edited by J. V. Henderson and J.-F. Thisse, 2713–2739. Amsterdam: Elsevier.

Bălăcescu, A., Zaharia, M., Gogonea, R.-M. and Căruntu, G.A. (2022). The Image of Sustainability in European Regions Considering the Social Sustainability Index. Sustainability, 14(20), p.13433. doi:https://doi.org/10.3390/su142013433.

Barbier, L., Simoens, S., Soontjens, C., Claus, B., Vulto, A.G. and Huys, I. (2021). Off-Patent Biologicals and Biosimilars Tendering in Europe—A Proposal towards More Sustainable Practices. Pharmaceuticals, 14(6), p.499. doi:https://doi.org/10.3390/ph14060499.

Barret, P., Marq, P., Mayer, C. and Padel, S. (2015). Research for transition: Europeans deserve a better agricultural and food policy. Université catholique de Louvain and Organic Research Centre commissioned bythe Greens/EFA in the European Parliament , Brussel.

Baudry, G., Delrue, F., Legrand, J., Pruvost, J. and Vallée, T. (2017). The challenge of measuring biofuel sustainability: A stakeholder-driven approach applied to the French case. Renewable and Sustainable Energy Reviews, 69, p.933–947. doi:https://doi.org/10.1016/j.rser.2016.11.022.

Bauer, F., Coenen, L., Hansen, T., McCormick, K. and Palgan, Y.V. (2017). Technological innovation systems for biorefineries: a review of the literature. Biofuels, Bioproducts and Biorefining, 11(3), p.534–548. doi:https://doi.org/10.1002/bbb.1767.

Bauer, F., Hansen, T. and Hellsmark, H. (2018). Innovation in the bioeconomy – dynamics of biorefinery innovation networks. Technology Analysis & Strategic Management, 30(8), p.935–947. doi:https://doi.org/10.1080/09537325.2018.1425386.

Bavaria State Government (2020). Bavarian Bioeconomy Strategy. [online] Bavarian Ministry of Economic Affairs, Regional Development and Energy, p.1–67. Available at: https://www.stmwi.bayern.de/fileadmin/user_upload/stmwi/publikationen/pdf/2021-02-15_FutureBioeconomyBavaria_BF_2020_02_15.pdf.

Befort, N. (2020). Going beyond definitions to understand tensions within the bioeconomy: The contribution of sociotechnical regimes to contested fields. Technological Forecasting and Social Change, 153, p.119923.

Draft

Befort, N. (2021). The promises of drop-in vs. functional innovations: The case of bioplastics. Ecological Economics, 181, p.106886.

Befort, N. (2022). The Bioeconomy. Routledge, p.1–176. doi:https://doi.org/10.4324/9781003103011.

BERST (2015). Good Practices in selected bioeconomy sector clusters; a comparative analysis. [online] p.1–66. Available at: https://edepot.wur.nl/356160.

Bezama, A., Hildebrandt, J. and Thrän, D. (2022). Analyzing the Potential Environmental and Socio-Economic Impacts of Regional Energy Integration Scenarios of a Bio-Based Industrial Network. Sustainability, 14(23), p.15886. doi:https://doi.org/10.3390/su142315886.

Bilsen, V. Debergh, P., de Graaf, L., Kallay, T.K., Laureysens, I., Meindert, L., Nelen, D., Pollitt, H., Sørensen, S.Y., Szuppinger, P., Van Acoleyen, M., Vanderreydt, I., Vermeulen, J. (2015). Analysis of certain waste streams and the potential of Industrial Symbiosis to promote waste as a resource for EU Industry Final report On behalf of European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. Luxembourg: Publications Office of the European Union.

Bio Base NWE (2015a). BIOECONOMY FACTSHEET BELGIUM. [online] pp.1–4. Available at: https://www.bioeconomy-library.eu/wp-content/uploads/2019/10/BBNWE-Factsheet-BE_Sept15_Final.pdf [Accessed 16 Jun. 2024].

Bio Base NWE (2015b). BIOECONOMY FACTSHEET GERMANY. [online] p.1–4. Available at: https://www.bioeconomy-library.eu/wp-content/uploads/2019/10/BBNWE-Factsheet-DE_Sept15_Final.pdf#:~:text=Bioeconomy%20Governance%20The%20key%20government%20bodies%20are%20the%3A,Government%2C%20consisting%20of%20experts%20from%20research%20and%20industry [Accessed 13 Jun. 2024].

Biodiversity Information System for Europe (BISE) (2019). BISE - Biodiversity Information System for Europe. [online] biodiversity.europa.eu. Available at: https://biodiversity.europa.eu/.

Bioeconomy for Change (2023). [online] Bioeconomy for Change. Available at: https://www.bioeconomyforchange.eu/en/ [Accessed 21 Jun. 2024].

BIOREGIO (2019). PAYS DE LA LOIRE BIO-BASED CIRCULAR ECONOMY ACTION PLAN Pays de la Loire Regional Council Association of the Chambers of Agriculture of the Atlantic Area. [online] p.2–25. Available at: https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1576567323.pdf [Accessed 2 Dec. 2024].

Draft

BMBF, BMEL. (2020). National Bioeconomy Strategy. Federal Ministry of Education and Research (BMBF) / Federal Ministry of Food and Agriculture (BMEL), Berlin.

BMBF/BMEL. (2020). Nationale Bioökonomiestrategie: Kabinettversion. Federal Ministry of Education and Research/Federal Ministry of Food and Agriculture.

Bogner, K. (2019). Knowledge Networks in the German Bioeconomy: Network Structure of Publicly Funded R&DNetworks. [online] Available at: https://www.researchgate.net/publication/331487992_Knowledge_Networks_in_the_German_Bioeconomy_Network_Structure_of_Publicly_Funded_RDNetworks.

Bogner, K. and Dahlke, J. (2022). Born to transform? German bioeconomy policy and research projects for transformations towards sustainability. Ecological Economics, 195, p.107366. doi:https://doi.org/10.1016/j.ecolecon.2022.107366.

Brack, D. (2020). 1. Is Biomass Carbon-neutral? [online] Chatham House – International Affairs Think Tank. Available at: https://www.chathamhouse.org/2017/02/woody-biomass-power-and-heat/1-biomass-carbon-neutral.

Brand, U., Muraca, B., Pineault, É., Sahakian, M., Schaffartzik, A., Novy, A., Streissler, C., Haberl, H., Asara, V., Dietz, K., Lang, M., Kothari, A., Smith, T., Spash, C., Brad, A., Pichler, M., Plank, C., Velegrakis, G., Jahn, T. and Carter, A. (2021). From planetary to societal boundaries: an argument for collectively defined self-limitation. Sustainability: Science, Practice and Policy, 17(1), p.265–292. doi:https://doi.org/10.1080/15487733.2021.1940754.

Bringezu, S., Distelkamp, M., Lutz, C., Wimmer, F., Schaldach, R., Hennenberg, K.J., Böttcher, H. and Egenolf, V. (2021). Environmental and socioeconomic footprints of the German bioeconomy. Nature Sustainability, 4(9), p.775–783. doi:https://doi.org/10.1038/s41893-021-00725-3.

Broeckx, L.S., Verlinden, M.S. and Ceulemans, R. (2012). Establishment and two-year growth of a bio-energy plantation with fast-growing Populus trees in Flanders (Belgium): Effects of genotype and former land use. Biomass and Bioenergy, 42, p.151–163. doi:https://doi.org/10.1016/j.biombioe.2012.03.005.

Bröring, S. and Vanacker, A. (2022). Designing Business Models for the Bioeconomy: What are the major challenges? EFB Bioeconomy Journal, 2, p.100032. doi:https://doi.org/10.1016/j.bioeco.2022.100032.

Draft

Bruckner, M., Häyhä, T., Giljum, S., Maus, V., Fischer, G., Tramberend, S. and Börner, J. (2019). Quantifying the global cropland footprint of the European Union's non-food bioeconomy. Environmental Research Letters, 14(4), p.045011. doi:https://doi.org/10.1088/1748-9326/ab07f5.

Brussels Environment, 2016. Regional Programme for a Circular Economy (RCEP). Brussels: Brussels Environment.

Bryden, J., & Gezelius, S. S. (2017). Innovation as if people mattered: The ethics of innovation for sustainable development. Innovation and Development, 7(1), 101–118. https:// doi. org/ 10. 1080/21579 30X. 2017. 12812 08

Buller, J., Daschner, R., Grimm, L., Hofer, M., Hüsing, B., Krayer, J., Miehe, R., Präg, E., Stahl, E., Stäbler, A., Stumpf, A.-K., Vieres, L., Volkert, B. and Wydra, S. (2023). Circular Bioeconomy for Germany: A roadmap by the Fraunhofer-Gesellschaft for implementing the bioeconomy in Germany. Fraunhofer, p.8–47.

Cabus, P. (2002). Governance in Flanders' regional policy: subregional platforms as development coalitions. Belgeo, (3), pp.277–294. doi:https://doi.org/10.4000/belgeo.15747.

Cakmak, E.K., Atasoy, M., Owusu-Agyeman, I., Khatami, K. and Cetecioglu, Z. (2022). Circular city concept for future biorefineries. Clean Energy and Resource Recovery, 2, p.335–352. doi:https://doi.org/10.1016/b978-0-323-90178-9.00009-3.

Capello, R. (1999). "Spatial Transfer of Knowledge in High Technology Milieux: Learning Versus Collective Learning Processes." Regional Studies 33 (4): 353–365. doi:10.1080/00343409950081211.

Catalisti (2020). About Moonshot: from Ambition to Action | Moonshot Flanders. [online] www.moonshotflanders.be. Available at: https://www.moonshotflanders.be/en/about-moonshot-ambition-action.

Charles, D., Davies, S., Miller, S., Clement, K., Hoes, A.-C., Hasenheit, M., Kiresiewa, Z., Kah, S. and Bianchini, C. (2016). Case studies of regional bioeconomy strategies across Europe. [online] p.8–24. Available at: https://www.ecologic.eu/sites/default/files/publication/2016/biostep_d3.2_case_studies_of_regional_strategies.pdf [Accessed 1 Dec. 2024].

Choi, H.S., Grethe, H., Entenmann, S.K., Wiesmeth, M., Blesl, M. and Wagner, M. (2019). Potential trade-offs of employing perennial biomass crops for the bioeconomy in the EU by 2050: Impacts on agricultural markets in the EU and the world. GCB Bioenergy, 11(3), p.483–504. doi:https://doi.org/10.1111/gcbb.12596.

Draft

Collins, J., Broggiato, A. and Vanagt, T. (2018). Blue Biotechnology. [online] Taylorfrancis.com. Available at: https://www.taylorfrancis.com/reader/download/1364f47c-ac0e-4788-9039-c30727655f67/chapter/pdf?context=ubx [Accessed 2 Dec. 2024].

D'Amato, D., Korhonen-Kurki, K., Lyytikainen, V., Matthies, B.D. and Horcea-Milcu, A-I. (2022). Circular bioeconomy: Actors and dynamics of knowledge co-production in Finland. Forest Policy and Economics, 144, p.1–9. doi:https://doi.org/10.1016/j.forpol.2022.102820.

de Besi, M. and McCormick, K. (2015). Towards a Bioeconomy in Europe: National, Regional and Industrial Strategies. Sustainability, 7(8), p.10461–10478. doi:https://doi.org/10.3390/su70810461.

DECHEMA Society for Chemical Engineering and Biotechnology e. V. and KADIB Kircher Advice in Bioeconomy (2017). Bioökonomie in Hessen Auf dem Weg in die Wirtschaftsform der Zukunft. [online] Available at: https://redaktion.hessen-agentur.de/publication/2021/3317_biokonomie_in_hessen_final_screen.pdf [Accessed 1 Dec. 2024].

Delzeit, R., Gömann, H., Müller, K.H., Kreins, P., Kretschmer, B., Münch, J. and Peterson , S. (2010). Analysing Bioenergy and Land Use Competition in a Coupled Modelling System: The Role of Bioenergy in Renewable Energy Policy in Germany. Kiel Working Papers, [online] 1653, p.1–22. Available at: https://www.ifw-kiel.de/publications/analysing-bioenergy-and-land-use-competition-in-a-coupled-modelling-system-the-role-of-bioenergy-in-renewable-energy-policy-in-germany-25543/ [Accessed 22 Jun. 2024].

Department of Environmental Policy for Energy, Climate and Green Economy (2013). The Flemish climate policy plan 2013-2020. A summary | Vlaanderen.be. [online] Vlaanderen.be. Available at: https://www.vlaanderen.be/publicaties/the-flemish-climate-policy-plan-2013-2020-a-summary [Accessed 2 Dec. 2024].

Devaney, L., Henchion, M. and Regan, Á. (2017). Good Governance in the Bioeconomy. EuroChoices, 16(2), p.41–46. doi:https://doi.org/10.1111/1746-692x.12141.

Diaconaşu, D., Elena, Bostan, I., Căutişanu, C. and Chiriac, I. (2022). Insights into the Sustainable Development of the Bioeconomy at the European Level, in the Context of the Desired Clean Environment. International Journal of Environmental Research and Public Health, 19(18), p.11286–11286. doi:https://doi.org/10.3390/ijerph191811286.

Dietz, T., Börner, J., Förster, J. and von Braun, J. (2018). Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies. Sustainability, 10(9), p.3190. doi:https://doi.org/10.3390/su10093190.

Draft

Dolge, K., Balode, L., Laktuka, K., Kirsanovs, V., Barisa, A. and Kubule, A. (2023). A comparative analysis of bioeconomy development in European Union Countries. Environmental Management, 71(2), pp.215-233.

Donner, M. and de Vries, H. (2023). Business models for sustainable food systems: a typology based on a literature review. Frontiers in sustainable food systems, 7. doi:https://doi.org/10.3389/fsufs.2023.1160097.

European Environment Agency (EEA) (2016). France waste prevention country fact sheet 2016. [online] p.1-8. European Environment Agency. Available at: https://www.eea.europa.eu/themes/waste/waste-prevention/countries/2016-waste-prevention-country-fact-sheets/france-waste-prevention-country-fact-sheet/view [Accessed 2 Dec. 2024].

European Environment Agency (2002). Europe's biodiversity - biogeographical regions and seas. [online] EEA, pp.1–23. Available at: https://www.eea.europa.eu/en/analysis/publications/report_2002_0524_154909.

Eurostat (2020). Farms and farmland in the European Union – statistics. [online]. Eurostat. https://doi.org/10.2908/EF_M_FARMLEG.

Eurostat (2022). Farms and farmland in the European Union - statistics. [online] ec.europa.eu. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Farms_and_farmland_in_the_European_Union_-_statistics#Farms_in_2020.

Eurostat (2023). Agriculture statistics at regional level. [online] ec.europa.eu. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agriculture_statistics_at_regional_level#:~:text=In%202020%2C%20there%20were%20approximately%209.1%20million%20farms.

Eversberg, D., Holz, J. and Pungas, L. (2022). The bioeconomy and its untenable growth promises: reality checks from research. Sustainability Science, 18(2), p.569–582. doi:https://doi.org/10.1007/s11625-022-01237-5.

Fasolino, N., Gabriella, Zavalloni, M. and Viaggi, D. (2023). The role of collaboration and entrepreneurship in strengthening the participation of primary producers in the bioeconomy. Elsevier eBooks, p.231–244. doi:https://doi.org/10.1016/b978-0-323-90569-5.00013-5.

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) (2016). Climate Action Plan 2050. [online] Berlin: Federal Ministry for the Environment, Nature

Draft

Conservation, Building and Nuclear Safety (BMUB) Public Relations Division, p.6–91. Available at: https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf.

Federal Ministry of Education and Research (BMBF) (2011). National Research Strategy BioEconomy 2030: Our Route towards a biobased economy. [online] p.1–48. Available at: http://biotech2030.ru/wp-content/uploads/docs/int/bioeconomy_2030_germany.pdf#:~:text=With%20the%20National%20Research%20Strategy%20BioEconomy%202030%2C%20the,of%20high%20quality%20products%20from%20renewable%20raw%20materials. [Accessed 9 Jun. 2024].

Federal Ministry of Education and Research (BMBF) and The Federal Ministry of Food and Agriculture (BMEL) (2020). National Bioeconomy Strategy. [online] Berlin: The Federal Ministry of Education and Research and the Federal Ministry of Food and Agriculture, p.3–62. Available at: https://www.bmel.de/SharedDocs/Downloads/EN/Publications/national-bioeconomy-strategy.pdf?__blob=publicationFile&v=2.

Federal Ministry of Food, Agriculture and Consumer Protection (2011). Forest Strategy 2020 Sustainable Forest Management - An Opportunity and a Challenge for Society. [online] Bonn: Federal Ministry of Food, Agriculture and Consumer Protection, p.5–30. Available at: https://www.bmel.de/SharedDocs/Downloads/EN/Publications/ForestStrategy2020.pdf?__blob=publicationFile&v=4.

Flanders Innovation and Entrepreneurship (2024a). Cluster policy in Flanders | Flanders innovation & entrepreneurship. [online] www.vlaio.be. Available at: https://www.vlaio.be/en/clusterorganisaties/het-clusterbeleid/het-vlaamse-clusterbeleid [Accessed 26 Jun. 2024].

Flanders Innovation and Entrepreneurship, (2024b). Let us introduce ourselves | Flanders innovation & entrepreneurship. [online] www.vlaio.be. Available at: https://www.vlaio.be/en/about-us/let-us-introduce-ourselves [Accessed 26 Jun. 2024].

Flemish Government Environment, Nature and Energy Department (2019). Bioeconomy in Flanders: The vision and strategy of the Government of Flanders for a sustainable and competitive bioeconomy in 2030. [online] p.1–22. Available at: https://publicaties.vlaanderen.be/view-file/13902.

Fonseca, L. and Nieth, L. (2021). The role of universities in regional development strategies: A comparison across actors and policy stages. European Urban and Regional Studies, 28(3), p.298–315. doi:https://doi.org/10.1177/0969776421999743.

Draft

Fortuna, G., Barbièr, C., Kucharczyk, M., Rios, J.J., Cinquemani, T., Schulz, F., and Fonseca, J.E., (2020). Measure co-financed by the European Union. [online] pp.4–16. Available at: https://en.euractiv.eu/wp-content/uploads/sites/2/special-report/EA-SPECIAL-REPORT-DGAGRI-EN-29012020.pdf [Accessed 2 Dec. 2024].

Galli, A., Antonelli, M., Wambersie, L., Bach-Faig, A., Bartolini, F., Caro, D., Iha, K., Lin, D., Mancini, M.S., Sonnino, R. and Vanham, D. (2023). EU-27 ecological footprint was primarily driven by food consumption and exceeded regional biocapacity from 2004 to 2014. Nature Food, 4(9), pp.810-822.

Gawel, E., Purkus, A., Pannicke, N. and Hagemann, N. (2018). A Governance Framework for a Sustainable Bioeconomy: Insights from the Case of the German Wood-based Bioeconomy. World sustainability series, p.517–537. doi:https://doi.org/10.1007/978-3-319-73028-8_26.

George, T. (2023). What Is Action Research? | Definition & Examples. [online] Scribbr. Available at: https://www.scribbr.com/methodology/action-research.

German Bioeconomy Council (2015). Bioeconomy Policy (Part II) - Synopsis of National Strategies around the World. [online] pp.88–89. Available at: https://knowledge4policy.ec.europa.eu/publication/bioeconomy-policy-part-ii-synopsis-national-strategies-around-world_en#:~:text=Bioeconomy%20Policy%20%28Part%20II%29%20-%20Synopsis%20of%20National,for%20the%20future%20development%20of%20a%20global%20bioeconomy. [Accessed 1 Jun. 2024].

Giampietro, M., Smil, V., Mayumi, K. and Ravetz, J. (2009). The biofuel delusion: The fallacy of large scale agro-biofuels production. Routledge.

Gobin, A. (2023). Climate-resilient agriculture in Flanders. [online] Vito.be. Available at: https://blog.vito.be/remotesensing/klimrek [Accessed 2 Dec. 2024].

González-Piñero, M., Páez-Avilés, C., Juanola-Feliu, E. and Samitier, J. (2021). Cross-fertilization of knowledge and technologies in collaborative research projects. Journal of Knowledge Management, 25(11), p.34–59. doi:https://doi.org/10.1108/jkm-04-2020-0270.

Görg, C., Wittmer, H., Carter, C., Turnhout, E., Vandewalle, M., Schindler, S., Livorell, B. and Lux, A. (2016). Governance options for science–policy interfaces on biodiversity and ecosystem services: comparing a network versus a platform approach. Biodiversity and Conservation, 25(7), p.1235–1252. doi:https://doi.org/10.1007/s10531-016-1132-8.

Draft

Government of Flanders (2013). Bioeconomy in Flanders: The vision and strategy of the Government of Flanders for a sustainable and competitive bioeconomy in 2030. [online] p.5–22. Available at: https://publicaties.vlaanderen.be/view-file/13902.

Grouiez, P., Debref, R., Vivien, F.D. and Befort, N. (2023). The complex relationships between non-food agriculture and the sustainable bioeconomy: The French case. Ecological Economics, 214, p.107974.

Haarich, S., Kirchmayr-Novak, S., Sanchez Lopez, J., Borzacchiello, M. and Avraamides, M. (2022). Bioeconomy strategy development in EU regions. Publications Office of the European Union, Luxembourg.

Habibipour, A., Ståhlbröst, A., Zalokar, S., Vaittinen, I., Mastelic, J., Włodarczyk-Gębik, A., Przybylski, W., Postmes, L., Van Dinter, M. and Ricau, N. (2020). LIVING LAB HANDBOOK FOR URBAN LIVING LABS DEVELOPING NATURE-BASED SOLUTIONS TABLE OF CONTENT TABLE OF CONTENT AUTHORS DESIGN Noéline Ricau. [online] UNaLAB, p.4–51. Available at: https://unalab.eu/system/files/2020-07/living-lab-handbook2020-07-09.pdf [Accessed 2 Dec. 2024].

Hagemann, N., Gawel, E., Purkus, A., Pannicke, N. and Hauck, J. (2016). Possible futures towards a wood-based bioeconomy: A scenario analysis for Germany. Sustainability, 8(1), p.98.

Harrahill, K., Macken-Walsh, Á. and O'Neill, E. (2023). Identifying primary producers' positioning in the Irish bioeconomy using Social Network Analysis. Cleaner and Circular Bioeconomy, 5, p.1–20. doi:https://doi.org/10.1016/j.clcb.2023.100042.

Hauts-de-France region (2018). Master Plan de la Bioéconomie en Hauts-de-France: 4 ambitions en 40 actions pour une filière compétitive, durable, créatrice de valeur ajoutée et d'emplois. [online] p.3–29. Available at: https://www.bioeconomie-hautsdefrance.fr/wp-content/uploads/2020/05/bioeconomie_master-plan-pap.pdf.

Heimann, T. (2019). Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs? Earth's Futur. 7, 43–57. https://doi.org/10.1029/2018EF001014.

Hertel, T., Steinbuks, J. and Baldos, U. (2013). Competition for land in the global bioeconomy. Agricultural Economics, 44(s1), p.129–138. doi:https://doi.org/10.1111/agec.12057.

Herzberg, D. (2015). Cluster profile CLIB2021. Green Processing and Synthesis, 4(2), p.147–149. doi:https://doi.org/10.1515/gps-2015-0006.

Draft

Hildebrandt, J., Bezama, A. and Thrän, D. (2020). Insights from the Sustainability Monitoring Tool SUMINISTRO Applied to a Case Study System of Prospective Wood-Based Industry Networks in Central Germany. Sustainability, 12(9), p.3896. doi:https://doi.org/10.3390/su12093896.

Hoes, A.-C., van der Burg, S., & Overbeek, G. (2021). Transitioning responsibly toward a circular bioeconomy: Using stakeholder workshops to reveal market dependencies. Journal of Agricultural and Environmental Ethics. https:// doi. org/ 10. 1007/ s10806- 021- 09862-3

Hoffmann, J. and Glückler, J. (2023). Technological Cohesion and Convergence: A Main Path Analysis of the Bioeconomy, 1900–2020. Sustainability, [online] 15(16), p.2–17. doi:https://doi.org/10.3390/su151612100.

Imbert, E., Ladu, L., Morone, P., Quitzow, R. (2017). Comparing policy strategies for a transition to a bioeconomy in Europe: the case of Italy and Germany. Energy Res. Soc. Sci. 33, 70–81. https://doi.org/10.1016/j.erss.2017.08.006.

Interreg (2018). Rodenhuizedok Biorefinery Cluster in the Port of Ghent © Bio Base Europe Pilot Plant. [online] p.1–4. Available at: https://vb.nweurope.eu/media/4659/180369_biobase4sme_2luik_belgium_v4_lr.pdf [Accessed 2 Dec. 2024].

Isaksen, A. (2015). "Industrial Development in Thin Regions: Trapped in Path Extension?" Journal of Economic Geography 15 (3): 585–600. doi:10.1093/jeg/lbu026.

Jafari, Y., Shang, L., Kuhn, A. and Heckelei, T. (2023). The National and Regional Impact of the EU Bioeconomy Strategies on the Agri-Food Sector: Insights from Germany. German journal of agricultural economics, 72(2), p.73–90. doi:https://doi.org/10.30430/gjae.2023.0274.

Journel, C., Hélène Zub-Preudhomme, Benoît Detot, Jullier, N., Preudhomme, M. and Loyce, C. (2018). Designing and assessing bioeconomy oriented cropping systems. The European Biomass Conference and Exhibition Proceedings.

Kangas, H.R. and Ryynänen, S.P. (2022). Fostering smart specialisation: the emergence of guided self-organisation at the regional level. Urban, Planning and Transport Research, 10(1), p.110–130. doi:https://doi.org/10.1080/21650020.2022.2057357.

Kircher, M. (2021). Bioeconomy – present status and future needs of industrial value chains. New Biotechnology, 60, p.96–104. doi:https://doi.org/10.1016/j.nbt.2020.09.005.

Draft

Kircher, M., Maurer, K.-H. and Herzberg, D. (2022). KBBE: The knowledge-based bioeconomy: Concept, status and future prospects. EFB Bioeconomy Journal, 2, p.1–8. doi:https://doi.org/10.1016/j.bioeco.2022.100034.

Kirs, M., Karo, E. and Ukrainski, K. (2021). Transformative change and policy-making: the case of bioeconomy policies in the EU frontrunners and lessons for latecomers. Innovation: The European Journal of Social Science Research, 35(4), p.1–33. doi:https://doi.org/10.1080/13511610.2021.2003186.

Kogut-Jaworska, M. and Ociepa-Kicińska, E. (2023). Practical Implications of Smart Specialization Strategy: Barriers to Implementation, Role of the Public Sector, and Benefits for Entrepreneurs. SAGE open, 13(2). doi:https://doi.org/10.1177/21582440231180520.

la Région Grand Est (2020). Une ambition : faire du Grand Est un leader européen de la bioéconomie La stratégie régionale bioéconomie. [online] p.1–8. Available at: https://www.bioeconomie-grandest.fr/wp-content/uploads/2020/06/1588-la-strategie-bioeconomie_8p-1.pdf [Accessed 2 Dec. 2024].

Lakatos, E.S., Pacurariu, R.L., Bîrgovan, A.L., Cioca, L.I., Szilagy, A., Moldovan, A. and Rada, E.C. (2024). A Systematic Review of Living Labs in the Context of Sustainable Development with a Focus on Bioeconomy. Earth, [online] 5(4), p.812–843. doi:https://doi.org/10.3390/earth5040042.

Lambin, E.F. and Meyfroidt, P. (2014). Trends in Global Land-Use Competition. The MIT Press eBooks. doi:https://doi.org/10.7551/mitpress/10011.003.0006.

Langeveld, J.W.A. (2015). RESULTS OF THE JRC-SCAR BIOECONOMY SURVEY . [online] Wageningen: Biomass Research, pp.1–309. Available at: https://knowledge4policy.ec.europa.eu/sites/default/files/2015_jrc_scar_final_report_survey_bioeconomy_report_full_text.pdf [Accessed 23 Jun. 2024].

Larosse, J. (2012). 'New Industrial Policy' in Flanders: An Integrated Policy Framework for a New Productivity Revolution. Reflets et perspectives de la vie économique, (1), p.99–115. doi:https://doi.org/10.3917/rpve.511.0099.

Leipold, S. and Petit-Boix, A. (2018). The circular economy and the bio-based sector-Perspectives of European and German stakeholders. Journal of cleaner production, 201, pp.1125-1137.

Leventon, J., Newig, J., Schaal, T. and Velten, S. (2016). Governance approaches to address scale issues in biodiversity management – current situation and ways forward. ResearchGate.

Draft

Liobikiene, G., Chen, X., Streimikiene, D. and Balezentis, T. (2020). The trends in bioeconomy development in the European Union: Exploiting capacity and productivity measures based on the land footprint approach. Land Use Policy, 91, p.104375.

Longhurst, P.J., Tompkins, D., Pollard, S.J., Hough, R.L., Chambers, B., Gale, P., Tyrrel, S., Villa, R., Taylor, M., Wu, S. and Sakrabani, R. (2019). Risk assessments for quality-assured, source-segregated composts and anaerobic digestates for a circular bioeconomy in the UK. Environment international, 127, pp.253-266.

Lost, S., Geng, N., Schweinle, J., Banse, M., Brüning, S., Jochem, D., Machmüller, A. and Weimar, H. (2020). Setting up a bioeconomy monitoring: Resource base and sustainability. RePEc: Research Papers in Economics. doi:https://doi.org/10.3220/wp1593762669000.

Lühmann, M. and Vogelpohl, T. (2023). The bioeconomy in Germany: A failing political project? Ecological Economics, 207, p.107783. doi:https://doi.org/10.1016/j.ecolecon.2023.107783.

Lupp, G., Zingraff-Hamed, A., Huang, J.J., Oen, A. and Pauleit, S. (2020). Living Labs—A Concept for Co-Designing Nature-Based Solutions. Sustainability, 13(1), p.188. doi:https://doi.org/10.3390/su13010188.

Mac Clay , P. and Sellare, J. (2022). Value chain transformations in the transition to a sustainable bioeconomy. papers.ssrn.com, [online] p.1–34. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4193583.

Maes, D. and Van Passel, S. (2019). Effective bioeconomy policies for the uptake of innovative technologies under resource constraints. Biomass and Bioenergy, 120, p.91–106. doi:https://doi.org/10.1016/j.biombioe.2018.11.008.

Martínez, J.E.G. (2019). Evaluation of Cross-sector Collaborations in Transition Toward the Bioeconomy: Benefits, Challenges, and Opportunities in the Forest Sector. [Dissertation] p.1–180. Available at: https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/6969z681z.

Marty, P., Dermine-Brullot, S., Madelrieux, S., Fleuet, J. and Lescoat, P. (2021). Transformation of socioeconomic metabolism due to development of the bioeconomy: the case of northern Aube (France). European Planning Studies, 30(7), p.1212–1229. doi:https://doi.org/10.1080/09654313.2021.1889475.

Marvik, O.J. and Philp, J. (2020). The systemic challenge of the bioeconomy. EMBO reports, 21(10). doi:https://doi.org/10.15252/embr.202051478.

Draft

Mayer, J., Kautz, A., Gansler, J. and Mertens, H. (2021). Bioökonomie als Treiber für Wertschöpfung und Innovation Strategiepapier zur Schlüsselrolle des Landes Sachsen-Anhalt bei der Etablierung einer Modellregion der Bioökonomie im Mitteldeutschen Revier. [online] Available at: https://www.mitteldeutschland.com/wp-content/uploads/2021/06/010621_biooekonomie-strategiepapier.pdf [Accessed 1 Dec. 2024].

Mejean, I. and Rousseaux, P. (2024). Identifying European trade dependencies. Europe's Economic Security. In Pisani-Ferry J., di Mauro B.W., Zettelmeyer, J. (Eds). (2024) Europe' Economic Security. Paris Report 2. Centre for Economic Policy Research, CEPR Press, London, UK.

Mertens, A., Van Lancker, J., Buysse, J., Lauwers, L. and Van Meensel, J. (2019). Overcoming non-technical challenges in bioeconomy value-chain development: Learning from practice. Journal of Cleaner Production, 231, p.10–20. doi:https://doi.org/10.1016/j.jclepro.2019.05.147.

Meurer, J., Erdmann, L., von Geibler, J. and Echternacht, L. (2016). Arbeitsdefinition und Kategorisierung von Living Labs : Arbeitspapier im Arbeitspaket 1 (AP 1.1c) im INNOLAB Projekt 'Living Labs in der Green Economy: realweltliche Innovationsräume für Nutzerintegration und Nachhaltigkeit'.

Minister of Higher Education, Research and Innovation (2019). National Research and Innovation Strategy: General Report. [online] p.1–38. Available at: https://uk.ambafrance.org/IMG/pdf_Rapport_general_de_la_SNRI_engl.pdf?3442/6770905a56e7b78fb876573e7c7efcfe638247da [Accessed 13 Jun. 2024].

Ministère de l'Agriculture et de l'Alimentation, 2017. National Bioeconomy Strategy. Paris: French Government. Available at: https://agriculture.gouv.fr [Accessed 19 Dec. 2024].

Ministry of Agriculture and Food (2018). A BIOECONOMY STRATEGY FOR FRANCE: 2018-2020 Action Plan. [online] p.1–12. Available at: https://faolex.fao.org/docs/pdf/fra210394ENG.pdf#:~:text=The%20French%20bioeconomy%20strategy%20lays%20down%20a%20framework,territory%E2%80%99s%20resources%20and%20needs%20while%20avoiding%20excessive%20exploitation. [Accessed 14 Jun. 2024].

Ministry of Agriculture and Food (2021). 2035 Arable Farming Strategy: Prospects for Productive and Diverse Crop Farming Discussion Paper. [online] Berlin: Federal Ministry of Food and Agriculture (BMEl) Division 711, p.8–62. Available at: https://www.bmel.de/SharedDocs/Downloads/EN/Publications/ackerbaustrategie-en.pdf?__blob=publicationFile&v=6

Draft

Ministry of Food, Agriculture, and Forestry (MAAF) (2016). A Bioeconomy Strategy for France: Goals, issues and forward vision. [online] p.1–36. Available at: https://r.search.yahoo.com/_ylt=Awr.rKJLpE1nAgIAopAM34lQ;_ylu=Y29sbwNpcjIEcG9zAzMEdnRpZAMEc2VjA3Ny/RV=2/RE=1734351180/RO=10/RU=https%3a%2f%2fagriculture.gouv.fr%2ftelecharger%2f88386/RK=2/RS=xwycZDPyTifaetcezj0sY7n8VcU-.

Ministry of Food, Agriculture, and Forestry (MAAF) (2018). A BIOECONOMY STRATEGY FOR FRANCE. [online] Available at: https://faolex.fao.org/docs/pdf/fra210394ENG.pdf [Accessed 2 Dec. 2024].

Ministry of National Education, Higher Education, and Research (MESR) (2009). National Research and Innovation Strategy MINISTRY FOR HIGHER EDUCATION AND RESEARCH. [online] p.3–35. Available at: https://uk.ambafrance.org/IMG/pdf_Rapport_general_de_la_SNRI_engl.pdf?3442/6770905a56e7b78fb876573e7c7efcfe638247da [Accessed 2 Dec. 2024].

Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg and Ministry of Rural Affairs and Consumer Protection Baden-Württemberg (2019). State Strategy for a Sustainable Bioeconomy Baden-Württemberg. [online] Stuttgart, p.2–40. Available at: https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/documents/Bioeconomy-strategy-barrierefrei.pdf [Accessed 2 Dec. 2024].

Morales, D. (2022). Spaces of the forest-based bioeconomy in Finnish Lapland and Catalonia: practitioners, narratives and forgotten spatialities. Fennia - International Journal of Geography, 199(2). doi:https://doi.org/10.11143/fennia.109523.

Mytelka, L.K. (1999). New trends in biotechnology networking. International Journal of Biotechnology, 1(1), p.30. doi:https://doi.org/10.1504/ijbt.1999.004475.

National Academies of Sciences, Engineering, and Medicine. (2020). Safeguarding the Bioeconomy. Washington, DC: The National Academies Press.

Naudet, P.M. and Marrazzo, G. (2021). The governance of circular bioeconomy - Practices and lessons learnt from European regions. [online] Brussels: ACR+, p.4–44. Available at: https://circulareconomy.europa.eu/platform/sites/default/files/2021_acr_circular_governance_of_bioeconomy_0.pdf.

Nelles, M., Deprie, K. and Jalalipour, H. (2023). The role of biogenic wastes and residues in a climate-neutral society: Carbon source, bioenergy and negative emissions. Waste management & research, 41(4), p.741–743. doi:https://doi.org/10.1177/0734242x231161506.

Draft

Olah, J., Chuluunbaatar, E., Balazs, E. and Popp, J. (2023). The socio-environmental challenges in the transition to sustainable bioeconomy: a review. Acta Montanistica Slovaca, [online] 28(v28/i1), p.98–112. doi:https://doi.org/10.46544/ams.v28i1.09.

Organisation for Economic Co-operation and Development (OECD). (2018). Meeting Policy Challenges for a Sustainable Bioeconomy. Paris: OECD Publishing.

Otto, S., Hildebrandt, J., Will, M., Henn, L., & Beer, K. (2021). Tying up loose ends: Integrating consumers' psychology into a broad interdisciplinary perspective on a circular sustainable bioeconomy. Journal of Agricultural and Environmental Ethics, 34, Article 8. https:// doi. org/ 10. 1007/s10806- 021- 09851- 6

Parisi, C. (2018). Biorefineries distribution in the EU, Publications Office of the European Union, Luxembourg.

Park, H. and Grundmann, P. (2022). What does an inclusive bioeconomy mean for primary producers? An analysis of European bioeconomy strategies. Journal of Environmental Policy & Planning, 25(3), p.1–17. doi:https://doi.org/10.1080/1523908x.2022.2094353.

Philp, J. and Winickoff, D.E. (2017). Clusters in industrial biotechnology and bioeconomy: The roles of the public sector. Trends in biotechnology, 35(8), pp.682-686.

Potters, J., Collins, K., Schoorlemmer, H., Stræte, E.P., Kilis, E., Lane, A. and Leloup, H. (2022). Living Labs as an Approach to Strengthen Agricultural Knowledge and Innovation Systems. EuroChoices, 21(1), p.23–29. doi:https://doi.org/10.1111/1746-692x.12342.

Prochaska, L. and Schiller, D. (2024). Spatial distribution of bioeconomy R&D funding: opportunities for rural and lagging regions? European planning studies, 32(7), p.1–21. doi:https://doi.org/10.1080/09654313.2024.2316193.

ProClim. (1997). Research on Sustainability and Global Change – Visions in Science Policy by Swiss Researchers.

Purkus, A., Gawel, E. and Thrän, D. (2012). Bioenergy governance between market and government failures: A new institutional economics perspective. ResearchGate, [online] pp.1–27. Available at: https://www.researchgate.net/publication/261062521_Bioenergy_governance_between_market_and_government_failures_A_new_institutional_economics_perspective [Accessed 14 Jun. 2024].

Pyka, A., Cardellini, G., van Meijl, H. and Verkerk, P.J. (2022). Modelling the bioeconomy: Emerging approaches to address policy needs. Journal of Cleaner Production, 330, p.1-13. doi:https://doi.org/10.1016/j.jclepro.2021.129801.

Draft

Rădulescu, M.A., Leendertse, W. and Arts, J. (2021). Living Labs: A Creative and Collaborative Planning Approach. Co-Creativity and Engaged Scholarship, p.457–491. doi:https://doi.org/10.1007/978-3-030-84248-2_15.

Regional Council of Pays de la Loire (2024). Le HUB Bio économie | Région Pays de la Loire. [online] Région Pays de la Loire. Available at: https://www.paysdelaloire.fr/mon-conseil-regional/les-missions-regionales/europe/le-hub-bioeconomie [Accessed 2 Dec. 2024].

Riemann, L., Giurca, A. and Kleinschmit, D. (2022). Contesting the framing of bioeconomy policy in Germany: the NGO perspective. Journal of Environmental Policy & Planning, 24(6), p.1–17. doi:https://doi.org/10.1080/1523908x.2022.2071689.

Robaczewska, J., Vanhaverbeke, W. and Lorenz, A. (2019). Applying open innovation strategies in the context of a regional innovation ecosystem: The case of Janssen Pharmaceuticals. Global Transitions, 1, pp.120-131.

Robaczewska, J., Vanhaverbeke, W. and Lorenz, A., 2019. Applying open innovation strategies in the context of a regional innovation ecosystem: The case of Janssen Pharmaceuticals. Global Transitions, 1, pp.120-131.

Roman, M., Varga, H., Cvijanovic, V. and Reid, A. (2020). Quadruple Helix Models for Sustainable Regional Innovation: Engaging and Facilitating Civil Society Participation. Economies, 8(2), p.1–15. doi:https://doi.org/10.3390/economies8020048.

Roux, A., Colin, A., Dhôte, J.F. and Schmitt, B. (2023). "The forestry & wood sector and climate change mitigation : From carbon sequestration in forests to the development of the bioeconomy. Category: E-book - Torrossa. [online] Torrossa.com. Available at: https://www.torrossa.com/en/catalog/preview/5663908 [Accessed 2 Dec. 2024].

Rupp, J., Bluhm, H., Hirschl, B., Grundmann, P., Meyer-Aurich, A., Huwe, V. and Luxen , P. (2020). Nachhaltige Bioökonomie in Brandenburg: Biobasierte Wertschöpfung - regional und innovativ. [online] Ministry of Agriculture, Environment and Climate Protection of the State of Brandenburg, p.6–79. Available at: https://mluk.brandenburg.de/sixcms/media.php/9/Nachhaltige-Biooekonomie.pdf [Accessed 1 Dec. 2024].

Sahaidak-Nikitiuk, R., Barnatovych, S. and Demchenko, N. (2020). RESEARCH OF BIOPHARMACEUTICAL CLUSTERS DEVELOPMENT IN EU COUNTRIES. Efektyvna ekonomika, (11), p.1–7. doi:https://doi.org/10.32702/2307-2105-2020.11.2.

Draft

Schiberna, E., Borovics, A. and Benke, A. (2021). Economic Modelling of Poplar Short Rotation Coppice Plantations in Hungary. Forests, 12(5), p.1-12. doi:https://doi.org/10.3390/f12050623.

Schieb, P.-A., Lescieux-Katir, H., Thenot, M., Clement-Larosiere, B. (2015). Biorefinery 2030: Future Prospects for the Bioeconomy. Springer-Verlag, Berlin Heidelberg.

Schlaile, M. P., Kask, J., Brewer, J., Bogner, K., Urmetzer, S., & de Witt, A. (2021). Proposing a cultural evolutionary perspective for dedicated innovation systems: Bioeconomy transitions and beyond. Journal of Innovation Economics & Management, Prépublication. https:// doi. org/10. 3917/ jie. pr1. 0108

Schlaile, M.P., Urmetzer, S., Blok, V., Andersen, A., Timmermans, J., Mueller, M., Fagerberg, J., Pyka, A. (2017). Innovation systems for transformations towards sustainability? Taking the Normative Dimension Seriously. Sustainability 9, 2253. https://doi.org/10.3390/su9122253.

Schot, J., Steinmueller, W.E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. Res. Policy 47, 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011.

Segers, J.-P. (2017). The interplay of regional systems of innovation, strategic alliances and open innovation: The Case of New Biotechnology Firms in the bioRegions of Flanders & Wallonia (Belgium). ResearchGate, [online] p.1–166. Available at: https://www.researchgate.net/publication/314229945_The_interplay_of_regional_systems_of_innovation_strategic_alliances_and_open_innovation_The_Case_of_New_Biotechnology_Firms_in_the_bioRegions_of_Flanders_Wallonia_Belgium_Collection_des_theses_de_doct [Accessed 23 Jun. 2024].

Shi, Y., Pinsard, C. and Accatino, F. (2021). Land sharing strategies for addressing the trade-off between carbon storage and crop production in France. Regional Environmental Change, 21(4). doi:https://doi.org/10.1007/s10113-021-01818-7.

Siekmann, F. and Venghaus, S. (2024). Regional transformation pathways for the bioeconomy: A novel monitoring approach for complex transitions. Journal of Industrial Ecology, 28(3), p.603–616. doi:https://doi.org/10.1111/jiec.13484.

Spekreijse, J., Boysen-Urban, K., Vikla, K., & Vis, M. (2021). Bio-based value chains for chemicals, plastics and pharmaceuticals. Publications Office of the European Union. Available at: https://www.btgworld.com/media/5f0fyy2w/jrc_technicalreport_biobased_valuechains.pdf

Stadler, T. and Chauvet, J.-M. (2018). New innovative ecosystems in France to develop the Bioeconomy. New Biotechnology, 40, p.113–118. doi:https://doi.org/10.1016/j.nbt.2017.07.009.

Draft

Stöber, L.F., Boesino, M., Pyka, A. and Schuenemann, F. (2023). Bioeconomy Innovation Networks in Urban Regions: The Case of Stuttgart. Land, 12(4), p.935–935. doi:https://doi.org/10.3390/land12040935.

Strategy Council Bioeconomy Weser-Ems (2015). nnovationen aus Weser-Ems: Masterplan Bioökonomie 2020. [online] p.7–63. Available at: https://www.li-food.de/fileadmin/user_upload/Dateien/Downloads/Masterplan_Biooekonomie.pdf.

Sudarić, T., Lončarić, R. and Zmaić, K. (2019). Bioeconomy challenges in cooperative development. Ekonomski vjesnik, 32(2), p.281–292.

Szarka, N., Laura García Laverde, Thrän, D., Orest Kiyko, Mykhailo Ilkiv, Danka Moravčíková, Cudlínová, E., Lapka, M., Nóra Hatvani, Ákos Koós, Luks, A. and Ignacio Martín Jiménez (2023). Stakeholder Engagement in the Co-Design of Regional Bioeconomy Strategies. Sustainability, 15(8), p.6967–6967. doi:https://doi.org/10.3390/su15086967.

Tarsitano, E., Giordano, S., de Gennaro, G., Turi, A., Ronco, G. and Parchitelli, L. (2023). Participatory Planning for the Drafting of a Regional Law on the Bioeconomy. Sustainability, 15(9), pp.7192–7192. doi:https://doi.org/10.3390/su15097192.

Többen, J.R., Distelkamp, M., Stöver, B., Reuschel, S., Ahmann, L. and Lutz, C. (2022). Global Land Use Impacts of Bioeconomy: An Econometric Input–Output Approach. Sustainability, 14(4), p.1976. doi: https://doi.org/10.3390/su14041976.

Töller, A.E., Vogelpohl, T., Beer, K. and Böcher, M. (2021). Is bioeconomy policy a policy field? A conceptual framework and findings on the European Union and Germany. Journal of Environmental Policy & Planning, 23(2), pp.152-164.

Urmetzer, S., Schlaile, M., Bogner, K., Mueller, M., Pyka, A. (2018). Exploring the dedicated Knowledge Base of a transformation towards a sustainable bioeconomy. Sustainability 10, 1694. https://doi.org/10.3390/su10061694.

Urmetzer, S., Schlaile, M.P., Blok, V. and Pyka, A. (2021). Quo Vadis, Bioeconomy? The Necessity of Normative Considerations in the Transition. Journal of Agricultural and Environmental Ethics, 35(1), p.1–7. doi:https://doi.org/10.1007/s10806-021-09875-y.

Vandenplas, Y., Simoens, S., Van Wilder, P., Vulto, A.G. and Huys, I. (2021). Off-Patent Biological and Biosimilar Medicines in Belgium: A Market Landscape Analysis. Frontiers in Pharmacology, 12. doi:https://doi.org/10.3389/fphar.2021.644187.

Draft

Venghaus, S., Stark, S. and Hilgert, P. (2024). Transformation Towards a Sustainable Regional Bioeconomy—A Monitoring Approach. Springer eBooks, [online] p.201–229. doi:https://doi.org/10.1007/978-3-031-54700-3_8.

Vivien, F.D., Nieddu, M., Befort, N., Debref, R. and Giampietro, M. (2019). The hijacking of the bioeconomy. Ecological economics, 159, pp.189-197.

von Geibler, J., Baedeker, C., Liedtke, C., Rohn , H. and Erdmann , L. (2017). Exploring the German Living Lab Research Infrastructure: Opportunities for Sustainable Products and Services. In: D. Keyson V and D. Lockton, eds., Living Labs: Design and Assessment of Sustainable Living. Springer, p.131–154.

Vorontsova, J. (2022). Belgium - Healthcare - The Economic Climate Of Belgium's Biotech Industry In 2022. [online] www.mondaq.com. Available at: https://www.mondaq.com/healthcare/1251462/the-economic-climate-of-belgiums-biotech-industry-in-2022 [Accessed 11 Jun. 2024].

Walloon Government, 2020. Circular Wallonia: The Regional Circular Economy Strategy. Namur: Walloon Government.

Wilke, U., Schlaile, M.P., Urmetzer, S., Mueller, M., Bogner, K., Pyka, A. (2021). Time to Say 'Good Buy' to the Passive Consumer? A Conceptual Review of the Consumer in the Bioeconomy. J. Agric. Environ. Ethics 34 (20). https://doi.org/10.1007/s10806-021-09861-4.

Zandee, D.P. and Coghlan, D. (2024). EXPRESS: Action Research for Impact in Addressing the Grand Challenges. Strategic Organization. doi:https://doi.org/10.1177/14761270241270913.

Zander, K., Will, S., Göpel, J., Jung, C. and Schaldach, R. (2022). Societal Evaluation of Bioeconomy Scenarios for Germany. Resources, 11(5), p.44. doi:https://doi.org/10.3390/resources11050044.

Zaparucha, E. and Sadeski, F. (2017). Pays de la Loire case study: Developing regional industrial policy capacity Developing regional industrial policy capacity Future of Manufacturing in Europe. [online] p.1–71. Available at: https://www.eurofound.europa.eu/system/files/2019-12/wpfomeef1706.pdf [Accessed 2 Dec. 2024].

Zscheischler, J., Gaasch, N., Manning, D.B. and Weith, T. (2016). Land Use Competition Related to Woody Biomass Production on Arable Land in Germany. Springer eBooks, p.193–213. doi:https://doi.org/10.1007/978-3-319-33628-2_12

Draft