ShapingBio

The bioeconomy of the future

Deliverable 2.1

Policy & Governance

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List of Abbreviations

Abbreviation	Full name
APRE	Agency for the Promotion of the European Research
ART	Agriculture Research Troubsko, Ltd
BBEPP	Bio Base Europe Pilot Plant
BIM	Bord Iascaigh Mhara, Ireland's Seafood Development Agency
BIT	Bioeconomy in Italy (title of Italian bioeconomy strategies)
BMBF	Federal Ministry of Education and Research (Germany)
BMEL	Federal Ministry of Food and Agriculture (Germany)
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Germany)
BMWK	Federal Ministry for Economic Affairs and Climate Action (Germany)
BÖR	Bioeconomy Council (*BioÖkonomieRat*)
CNBBSV	National Committee for Biosafety, Biotechnology and Life Science (*Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita)*
CSA	Coordination and Support Action
DAFM	Department of Agriculture, Food, and the Marine (Ireland)
DE	Germany
EC	European Commission
EE	Estonia
EMFAF	European Maritime, Fisheries, and Aquaculture Fund
EU	European Union
FAO	Food and Agriculture Organization
FBCD	Food & Bio Cluster Denmark
Fraunhofer ISI	Fraunhofer Institute for Systems and Innovation Research ISI
IMAG	Interministerial working group on bioeconomy
IMTA	Integrated Multi-Trophic Aquaculture
ISPRA	Institute for Environmental Protection and Research
IT	Italy

Abbreviation	Full name
KNAQ	Competence network aquaculture Schleswig-Holstein (*Kompetenznetzwerk Aquakultur Schleswig-Holstein*)
MAG	Multi actor group
MSP	Maritime Spatial Planning
NBCB	National Bioeconomy Coordination Board (*Gruppo di Coordinamento Nazionale per la Bioeconomia – GCNB)*
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PNRR	National recovery and resilience plan
PRIN	Projects of Significant National Interest
RAS	Recirculating Aquaculture Systems
RITA	Reinforcement of sectoral research and development activities
SUBNET	SUBMARINER Network
SVIMEZ	Association for the Development of Industry in the Mezzogiorno
TTE	Tech Tour Europe
TTG	Tech Tour Global

1. Executive Summary

Shaping Bio is a HorizonEurope funded Coordination and Support Action. Its aims are to gain a deeper understanding of the EU bioeconomy innovation eco-system and to derive recommendations on which measures should be taken, by EU, Member States, and others to strengthen bioeconomy innovation systems.

Bioeconomy policy and governance challenges

In the EU bioeconomy innovation systems, bioeconomy policy and governance challenges arise from these specific characteristics of bioeconomy and bioeconomy policy:

- Directionality. Bioeconomy deployment requires policies that provide clear direction for the transition from a ‘’linear fossil-based economy’’ to a ‘’sustainable, just, and bio-based circular economy’’.
- Innovations. Bioeconomy is knowledge-based and requires technological, organisational and social innovations to flourish.
- Spanning several sectors and policy fields. Bioeconomy cuts across traditional economic sectors and thus across different sectoral policy fields. This requires the synergistic integration of different sectoral policies to form a comprehensive and coherent bioeconomy policy.
- Novel value chains and actor constellations. Bioeconomy deployment requires the formation of novel value chains and actor constellations.
- Alignment of different stakeholder priorities. Due to its transformative, cross-cutting nature, bioeconomy deployment must align diverse, and sometimes conflicting, stakeholder priorities and interests.
- Alignment along geographical governance levels. Bioeconomy is embedded in international, national and regional value chains and therefore requires alignment of policies and activities across different geographical governance levels (e.g. international, EU, national, regional levels).
- Goal conflicts are inherent to bioeconomy. This requires agreements on priorities and finding solutions and compromises across economic sectors, sectoral policies and stakeholder interests.
- Regulations and administrative procedures. Bioeconomy deployment requires the harmonisation of regulations and administrative procedures across economic sectors and geographical governance levels.

Scope and methodological approach

In this deliverable, different combinations of bioeconomy policy and governance challenges were analysed from different angles and with different foci. In total, three in-depth analyses with nine case studies in six EU member states were conducted:

- Bioeconomy policy coordination on national level with case studies in Germany, Italy and Estonia
- Strategies to overcome policy and governance challenges in emerging bioeconomy sectors – The example of mainstreaming sustainable aquaculture to increase blue biomass, with case studies in Germany, Ireland and Denmark, and
- Fostering regional bioeconomy across the EU, with case studies in Bavaria (Germany), Southern Region (Ireland) and Southern Macedonia (Greece).

In parallel to the in-depth analyses, a multi-actor co-creation process was carried out with a multi-actor group, consisting of 12 individuals from seven EU countries with unique expertise in bioeconomy policy and governance on EU, national, or regional level. These experts were policy officers and advisors, academics with expertise in bioeconomy policy, and regional bioeconomy representatives. They convened

in three consecutive workshops in the period January to May 2024. The expert group finetuned the planned in-depth analyses, critically discussed results and contributed to conclusions and draft recommendations.

Drivers for and progress towards a comprehensive and coherent bioeconomy policy

EU member states and regions differ in the progress they have made towards a comprehensive and coherent bioeconomy policy that integrates sectoral policies and activities (Sakellaris et al. 2024; European Commission et al. 2024). For this deliverable, we analysed only cases in which the importance of bioeconomy for the country or the region, respectively, had already been recognised and had resulted in the formulation of national or regional bioeconomy policy documents (strategies, roadmap). The following key drivers for the development of a dedicated bioeconomy policy document were identified:

- International policy developments legitimizing bioeconomy (e.g. Sustainable Development Goals, Paris Agreement, EU Green Deal),
- Developments in international and EU bioeconomy policy and related policy networks
- Scientific-technological competencies and related industries in the country or region
- Demand from stakeholder groups (e.g. industry, sectors, academia)
- Evidence from commissioned analyses and recommendations
- Perceived need to consolidate sectoral policies into a comprehensive strategic framework

Leadership taken by one or several ministries, regional authorities, or agencies along with commitment from high-level policy makers to the bioeconomy, were key success factors.

In-depth analysis "Bioeconomy policy coordination on a national level"

Although the characteristics of bioeconomy make policy coordination a key prerequisite for its successful deployment, surprisingly little is known about it beyond those individuals who are directly involved in coordination. The in-depth analysis "Bioeconomy policy coordination on a national level" takes a "glimpse into the black box" how bioeconomy policy coordination between national ministries and stakeholders works in practice in the EU member states Germany, Italy, and Estonia. Each of the countries has formally established coordination bodies. Three different options for this institutionalisation could be observed: The options are located on a continuum between a single formally established body at one end of the spectrum and less hierarchical and formalised networks at the other end (Figure 1): At one end of the continuum is the National Bioeconomy Coordination Board in Italy. It is a single coordination body in which all involved ministries, representatives of regions and autonomous provinces, as well as sectoral national clusters coordinate their bioeconomy-related activities. At the other end of the spectrum is the Circular Economy Advisory Group in Estonia as the main decision-making body. It oversees and endorsed coordination activities which mainly take place in networks of bioeconomy working groups and formal and informal exchanges between ministry staff and stakeholders. The German coordination approach is located in between. It comprises an interministerial working group with all involved ministries, which is in exchange in a network structure with several separate stakeholder platforms and an advisory council.

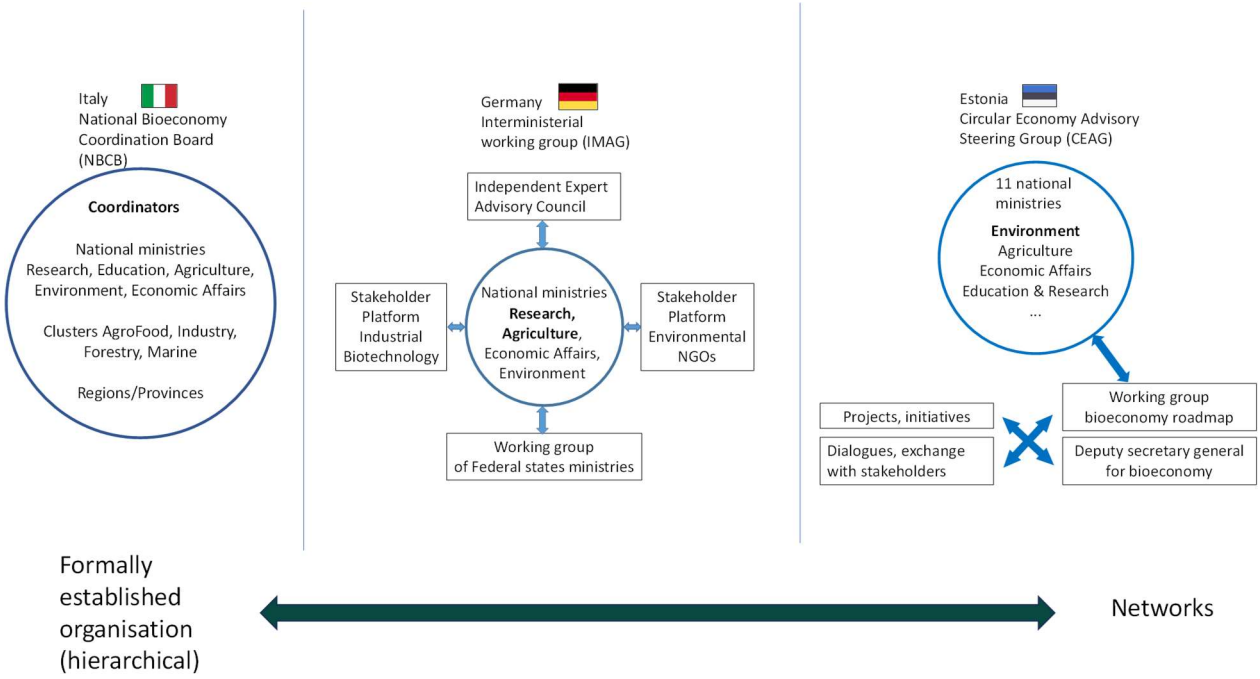

Figure 1: Continuum of institutionalised coordination bodies in Italy, Germany and Estonia

Coordination can be achieved by negotiations between the relevant actors, with the aim to come to joint agreements and compromises, or by consultations with the aim to avoid interference and conflicts between different actors, or a mix of both approaches. Given the cross-sectoral and transformative character and the strategic importance of bioeconomy, negotiations seem more appropriate as prevailing coordination mode. However, this mode is more resource-intensive, difficult and conflict-laden than a focus on consultations. The following aspects were identified as good practice for a coordination mode with a focus on negotiations:

- An open, constructive working climate with trustful relationships between the members
- A level playing field for all members of the coordination body, rather than a certain hierarchy within the body
- A prevailing mindset to find pragmatic solutions and compromises, rather than getting entangled in debates on principles
- Frequent and regular communication within the coordination body with a focus on direct personal interaction and dialogue, rather than exchange via written comments
- For the resolution of controversial issues a "neutral" chairman or coordinator of the coordination body who can more easily adopt a mediating, countervailing and facilitating role than a person who has to represent a certain ministerial position

In-depth analysis "Strategies to overcome policy & governance challenges in emerging bioeconomy sectors – The example of mainstreaming sustainable aquaculture to increase blue biomass"

The transition from a fossil-based linear to a bio-based circular economy requires technological, organisational and social innovations. Most bioeconomy strategies and policies therefore have a focus on fostering R&D&I to lay the ground for such knowledge-based innovations in bioeconomy. These innovations may be situated between traditional sectors at the interface of different policy fields. These

innovations often develop first in niches, but then need to expand and become integrated into the regime or replace incumbents.

Against this background, the in-depth analysis "Strategies to overcome policy & governance challenges in emerging bioeconomy sectors" focussed on sustainable aquaculture as example for an emerging bioeconomy sector. It falls between agriculture, fisheries and industrial activities. Germany, Denmark, and Ireland were chosen as case studies, because they differ significantly in their aquaculture governance structures for policy, regulatory and andministrative issues:

- Germany: Aquaculture governance is highly decentralised: The Federal states are responsible for aquaculture, and the local authorities issue the primary permit to establish an aquaculture facility. Only some federal states have comprehensive strategies and funding programmes for aquaculture development, leading to disparities in political support and funding access. Regarding administrative procedures, several and – depending on Federal state - different local authorities are responsible for administrative procedures. There is a notable lack of communication between different public authorities. Only very few offer specific guidelines or a central contact point, and service level and expertise may vary. This makes it challenging for aquaculture operators to navigate administrative processes, and may lead to inefficiencies and delays in the licensing process.
- Denmark: Aquaculture governance is semi-centralised: Central authorities establish the regulatory framework. Permits for land-based fish farming is the responsibility of the municipalities while the environmental protection agency is responsible for granting permits to marine fish farms. Applicants can find designated contact points at local municipalities. This decentralised approach allows for localised support but also results in varying service levels and expertise across different regions.
- Ireland: Aquaculture management is highly centralised: the Department of Agriculture, Food and the Marine (DAFM) is responsible for regulatory oversight and licensing aquaculture operations. The department has a dedicated division specifically for aquacultural licensing, offering clear pathways, guidance and comprehensive information for applicants for licenses.

From this in-depth analysis, it can be concluded that emerging sectors in bioeconomy face the following challenges and hurdles:

- Lack of incentives as established policy support measures do not apply to these innovations
- Regulatory frameworks which were tailored to conventional processes, products and services, but are not fit for purpose for these innovations
- Competency and responsibility for for the regulatory framework and administrative procedures are often distributed between several different regulatory or administrative authorities which may lack sufficient communication and collaboration with one another
- Heterogeneity across EU member states and/or regions whether the regulatory framework and administrative environment is supportive for these innovatios
- Heterogeneity across EU member states and/or regions with respect to number and expertise of the responsible administrative authorities. This makes it difficult for innovators to navigate efficiently administrative processes, and may lack reliability to obtain a decision within reasonable time and with reasonable efforts.

A comprehensive and coherent bioeconomy policy must anticipate such regulatory and administrative challenges and disincentives early in the innovation process, in order to proactively address these issues with appropriate measures. It depends on the innovative emerging sector and also the country at which geographical governance level the regulatory and administrative competences, respectively, are located.

Depending on the innovative emerging sector, this may be the EU, the national, regional or municipal level or combinations thereof.

In-depth analysis "Fostering regional bioeconomy across the EU; insights from Germany, Ireland and Greece"

The implementation of bioeconomy policies and strategies, although often developed at the national level, occurs predominantly at sub-national and local levels. The multi-faceted benefits of adopting bioeconomy practices, e.g. rural development, employment, economic growth, greenhouse gas emissions reduction, and environmental sustainability, are often most realized at the regional level.

The EU increasingly acknowledges and supports the role of regions in deploying bioeconomy, e.g. through projects, support for Smart Specialisation Strategies or Regional Innovation Valley for Bioeconomy. However, there is considerable variation in the stages of bioeconomy development among different regions within the EU. Therefore, there is a need for a deeper understanding on how to foster regional engagement efforts. Against this background, the in-depth analysis "Fostering regional bioeconomy across the EU" had the objective to gain insights into effective mechanisms, transferrable learnings, and good practices that can foster regional bioeconomy development in the EU and that can be insightful for and adopted by regions at different stages of development. The analysis was carried out in three regions

- Bavaria in Germany: This region represents a Western European member state with a high regional bioeconomy development level, possessing national and regional bioeconomy strategies.
- the Southern Region in Ireland: This region represents a Western European member state with a high bioeconomy development level, having a policy at the national level and no regional strategy.
- Central Macedonia in Greece: This region represents a Southern European member state with a medium bioeconomy development level. The country doesn't have a bioeconomy-dedicated strategy but poses a regional circular action plan that focuses on the promotion of bioeconomy, among other objectives.

Figure 2: Achieved stage of transformational change in bioeconomy in the regions Bavaria, Southern Region and Central Macedonia

The Kotter model of transformational change was used as framework to characterise which stage of transformational change has been achieved in the three regions (Figure 2).

The three regions have not followed the same pattern in bioeconomy development. However, they have in common that the process is not linear, and that besides the efforts at national level, fostering regional bioeconomy development requires actions across policy and regulation, collaboration, finance, and community engagement. These areas are interlinked and can mutually influence one another, making it essential to account for regional specificities and characteristics. The following good practice for fostering regional bioeconomy was derived from the case studies:

Policy and regulation

- Identify regional strengths (e.g. in terms of available feedstock, waste streams, human capital, and industries landscape).
- Establish priorities and develop a region-specific vision that aligns with local characteristics with local characteristics while ensuring coherence with national frameworks and policies.

Collaboration

- Mobilise existing collaborative platforms to foster a climate for change.
- Facilitate multi-stakeholder groups and cross-sectoral knowledge sharing.
- Create channels for interregional collaborations with other regions nationally and internationally.

Finance

- Establish industrial clusters, logistical support, and demonstration facilities.
- Recognise the need of the regions, and introducing funding instruments tailored to the local economics, and the strengths and priorities of the regions.

Community Engagement

- Empower communities and mobilise knowledge about the bioeconomy.
- Ongoing communication about the bioeconomy

Draft recommendations

From the three in-depth analyses, the following draft recommendations were derived:

Draft recommendations for countries and regions without a comprehensive and coherent bioeconomy policy

- Continue to strive for a dedicated national or regional comprehensive and coherent bioeconomy policy which is tailored to the specificities of your country or region. Since there is no uniform or linear path to such a policy, remain adaptable and seize opportunities as they arise.
- Create a climate and environment for the transformational change towards a bioeconomy, elaborate the facts about the opportunities available for the bioeconomy in your country or region, and secure support from influential stakeholders and decision makers.

Draft recommendations for countries and regions in the phase of developing or revising their bioeconomy policy and strategy

- Choose an appropriate option for the organisational structure, e.g. a task force or an organisation with steering group, thematic working groups and related dialogue and consultation processes For a

comprehensive, structured and effective strategy development or revision process, not only a formal, but also active leadership is important. The choice of the leading institution may pre-determine the strategic foci of the resulting strategy. It should therefore reflect not only the present bioeconomy situation, but also the anticipated future role of the country or region. Moreover, the leading institution should be in the position to create a level playing field for all involved ministries and actors.

- Choose multi-actor approaches for stakeholder engagement. In general, specific attention should be paid to other groups than „the usual suspects", e.g. to young people, regional stakeholders, citizens etc.
- Engage in dialogue formats. Consultations of experts and stakeholders are already an integral part of such strategy processes. However, it is good practice and is recommended to additionally carry out different dialogue formats. In order to engage stakeholders actively in these formats, it is important to clearly elaborate a shared understanding of broader advantages of the bioeconomy for the development of a sustainable region, economy or value chains, beyond just economic gains.
- Strive for bioeconomy strategies which gives clearer guidance for the subsequent phase of translating strategies into concrete actions. It is recommended to take inspiration from „better" strategies in other policy domains or other countries or regions how to define, if possible, quantitative strategic goals, clear priorities in goal conflicts, clear assignment of responsibilities for subsequent implementation, and a roadmap and implementation plan with actions, a schedule and a budget.
- Advocate for support at regional, national and EU or supranational level for the development of „better" bioeconomy strategies, and actively participate in corresponding fora and activities for mutual exchange of experience and mutual learning processes.

Draft recommendations for countries and regions which are in the phase of translating their bioeconomy strategy into concepts for implementation

- Advocate for support at regional, member state and EU or supranational level on how to elaborate and establish „better" coordination mechanisms and modes. Actively participate in corresponding fora and activities for mutual exchange of experience and mutual learning processes.
- Explore whether such coordination bodies should be given more decision power than they currently have, and which options could be appropriate for this (e.g. own budget for the execution of its implementation plan).

Draft recommendations for the EC and other supranational institutions

- Continue to support EU member states and their regions without a bioeconomy strategy or only a narrowly confined, sectoral one by Cooperation and Support Actions and policy networks to develop comprehensive bioeconomy strategies
- Encourage all EU member states and their regions to improve the quality of their bioeconomy strategies.
- Support EU member states and their regions in their efforts to improve the quality of their bioeconomy strategies. Options that could be considered are e.g. commissioning studies what good practice strategies entail, Coordination and Support Actions, exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Policy Forum, OECD).
- Support EU member states and their regions in their efforts to improve the quality of their bioeconomy policy coordination. Options that could be considered are e.g. commissioning studies what good practice coordination entails with respect to institutionalisation, organisation and working mode, Coordination and Support Actions, exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Policy Forum, OECD).

Draft recommendations for countries and regions regarding governance challenges in innovative, emerging sectors

- Anticipate regulatory challenges and disincentives as well as potential hurdles in administrative procedures early in the innovation process
- Develop potential solutions to anticipated regulatory challenges and disincentives in exchange with all stakeholders. This process could be led by a task force or committee in a transparent process. With the aim to share good practice and to harmonise chosen approaches, international collaboration and knowledge exchange is advisable.
- Clearly map responsibilities of the relevant authorities and communicate them together with designated contact points to innovators in order to support easy navigation in the administrative procedure. If possible, responsibilities should be (semi-centralised) in one or few authorities to establish a one-stop shop
- Invest in training and capacity building in the relevant institutions with regulatory competence and in administrative authorities, and establish platforms for mutual learning and good practice exchange
- Consider regulatory sandboxes, collect systematically experience with different regulatory frameworks to derive good solutions for tailoring the regulatory frameworks
- Tailor the relevant regulatory frameworks so that they fit the innovations, and ideally harmonise across the same governance levels
- Reduce bureaucracy, e.g. by comprehensive and harmonised guidelines for authorities and innovators, and by digitalisation of administrative procedures

The main goal of the analyses of selected policy and governance challenges in bioeconomy to show the diversity of chosen options, their strengths, potential pitfalls, success factors and good practice in a structured way. We hope that our analysis supports other countries to reflect on their own situations, using the presented options as a benchmark, and that this will foster mutual learning and inspire efforts to further improve aspects of bioeconomy policy coordination in EU member states.

2. Introduction

Shaping Bio aims at gaining a deeper understanding of the EU bioeconomy innovation eco-system and to derive recommendations on which measures should be taken, by the European Commission, Member States, and others to strengthen bioeconomy innovation systems. The overarching objective is to strengthen and deploy innovations in the bio-based sectors across Europe.

One of the tasks in the ShapingBio project is to gain a deeper understanding of bioeconomy policy and governance in the EU member states, with the aim to identify good practice and to contribute to recommendations on how policy making in this complex environment can be improved.

2.1 Bioeconomy policy and governance challenges in the EU

Despite its value and its potential contribution to green growth, economic competitiveness and sustainable development, significant heterogeneity can be observed across EU member states whether and how a bioeconomy policy is implemented. Countries especially differ in the extent to which bioeconomy has been set as a political priority and to which degree sectoral goals and policies have been aligned and integrated into comprehensive and coherent policy frameworks: The European bioeconomy strategies (European Commission: Directorate-General for Research and Innovation 2012; European Commission: Directorate-General for Research and Innovation 2018a) and action plan (European Commission: Directorate-General for Research and Innovation 2018b) have been widely perceived positively by member states in the European Union. Consequently, several countries followed and developed own national bioeconomy strategies and plans (Sakellaris et al. 2024).

Due to its cross-sectoral character and its numerous goals, bioeconomy policy falls into the responsibility of different ministries in many EU member states. However, policies in the public sector dealing with bioeconomy are still too often developed in silos, not taking adequately into account the mutual relationships and interactions between sectoral policies. Often still missing is a holistic picture of the bioeconomy that integrates common goals of different policy domains and steps towards the implementation. Bioeconomy is therefore perceived as still being in an infant stage in which sectoral policy priorities prevail and sectors act separately. Against this background, more **horizontal alignment** between the responsible (national or regional) ministries is seen as an ongoing challenge in bioeconomy policy.

Developing bioeconomy strategies and putting in place platforms for collaboration of various policy sectors and subsystems is complex and requires a **coordinated approach in bioeconomy policymaking**. A coordinated approach is understood as the capacity of actors to develop a coherent and integrated policy frame that considers the various interests and frames of all involved actors. Enabling effective coordination between ministries and stakeholders implies that intensified communication, problem-oriented and systemic perspectives as well as unintended trade-offs are embraced with political leadership and effective public sector collaboration. Especially, conflicting goals emerging from the integration of sectoral policy goals, such as land-use conflicts or the sustainable use of energy, need to be addressed in a collaborative and cooperative way that opens spaces for building trust and co-creation between a larger number of actors.

In addition to horizontal policy coordination, **vertical coordination** across different geographical governance levels is of high importance. In particular, **regions** have been recognized **as an important enablers for bioeconomy deployment** in the European Union (Haarich et al. 2022; European Commission et al. 2023). However, high heterogeneity can be observed across the EU to which extent regions actively engage in bioeconomy. How to foster their engagement is on ongoing challenge.

Bioeconomy is science- and technology-based and knowledge-intensive. The transition from a fossil-based linear to a bio-based circular economy requires technological, organisational and social innovations. These innovations often develop first in niches, but then need to expand and become integrated into the regime or replace incumbents. A major challenge for these emerging innovations is that the frame conditions, such as regulatory frameworks, infrastructures, value chains and incumbent industries do not support or even hinder their growth and wider adoption. A supportive policy and government framework, tailored to **emerging bioeconomy sectors**, would therefore contribute to their deployment.

These three challenges – bioeconomy policy coordination on national level, bioeconomy policy and governance challenges in emerging innovative sectors, and fostering regional bioeconomy - have been analysed in depth. The results will be presented in this deliverable.

2.2 Definitions

In this deliverable, we understand governance as follows:

Governance refers to all processes of governing, the institutions, processes and practices through which issues of common concern are decided upon and regulated. Good governance adds a normative or evaluative attribute to the process of governing.

We understand policy coordination as follows:

A coordinated approach is defined as the capacity of actors to develop a coherent and integrated policy frame that considers the various interests and frames of all involved actors.

2.3 Scope and deliverable structure

Three in-depth analyses will be presented in this deliverable:

- Bioeconomy policy coordination on national level (chapter 4)
- Strategies to overcome policy and governance challenges in emerging bioeconomy sectors – The example of mainstreaming sustainable aquaculture to increase blue biomass (chapter 5)
- Fostering regional bioeconomy across the EU (chapter 6).

In order to gain sufficiently deep insights, these in-depth analyses were carried out in selected countries (Figure 3). The rationale for the selection of these countries as case studies is given in the respective in-depth analysis chapters.

In each of the three in-depth analyses, a cross-country analysis (or cross-region analysis, respectively) is carried out to identify strengths and weaknesses and good practice, and conclusions and recommendations are derived.

In chapter 7, cross-in-depth analyses conclusions and recommendations for bioeconomy policy and governance are derived.

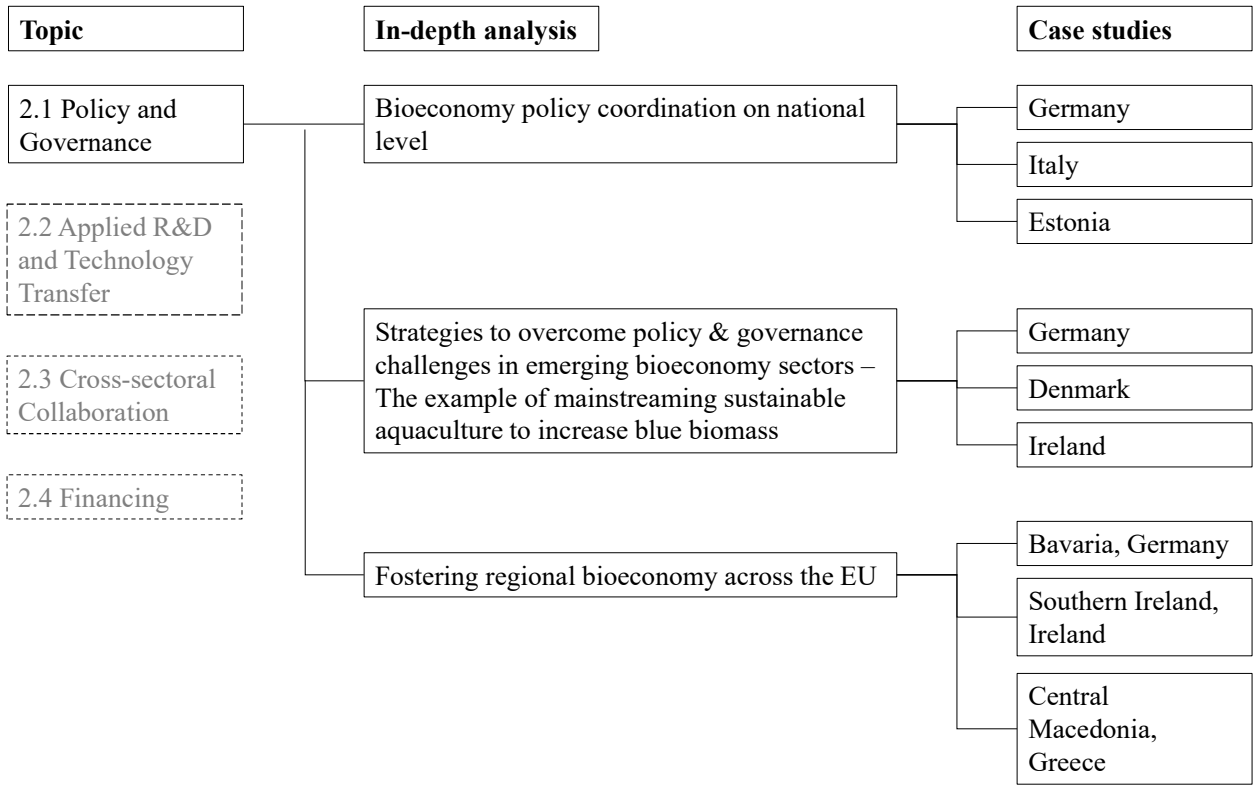

Figure 3: Overview of the topic scope and deliverable structure

3. Methodological approach

3.1 Approach

We adopted a qualitative multi-case study approach. It comprised the following steps:

- Define the scope of the topic and in-depth analyses
- Set up a multi-actor group (MAG)
- Develop selection scheme for the cases in each in-depth analysis
- Conduct a co-creation process with the multi-actor group
- Carry out the in-depth analyses by collecting information by desk research and interviews with key experts
- Synthesize and interpret the findings, draw conclusions, summarise the results in this deliverable

Findings and conclusions from the analysis of policy and governance can be refined, validated or disseminated in ShapingBio workshops (WP3) and provide the empirical basis for recommendations. The recommendations will be elaborated in work package 4 of the ShapingBio project. Figure 4 gives a schematic overview of the steps of the approach.

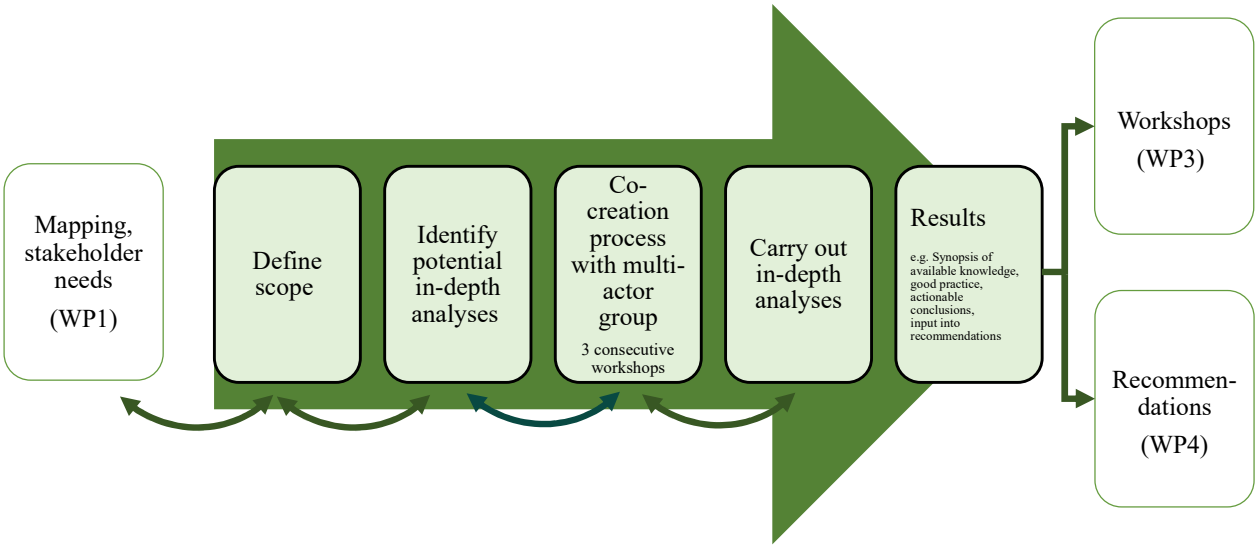

Figure 4: Steps of the approach in the analysis "Policy and governance"

3.2 Multi-actor group and co-creation process

A core element of the analysis of bioeconomy policy and governance was a co-creation process with a multi-actor group (MAG). This multi-actor group was a fixed group of invited policy experts. The invitation was sent to approximately 60 experts from all EU member states. 12 experts agreed to actively participate in the MAG.

The MAG on bioeconomy policy and governance consisted of 12 individuals with unique expertise in bioeconomy policy and governance on EU, national, or regional level from seven EU countries. These experts were policy officers and advisors, academics with expertise in bioeconomy policy, and regional bioeconomy representatives, thus representing diverse backgrounds. Table 1 shows the MAG members.

Table 1: Members of the multi-actor group "Policy and governance"

Name	Affiliation	Country	Background
Not to be disclosed	Central Office of the German Bioeconomy Council	Germany	Advisory body
Niels Gøtke	Danish Agency for Science and Higher Education	Denmark	Policy officer
Teis Hansen	University of Copenhagen, Department of Food and Resource Economics (IFRO)	Denmark	Research
Zoritza Kiresiewa	Ecologic Institute	Germany	Research
Barna Kovács	BIOEAST Initiative	Belgium	Policy advisor
Not to be disclosed	Not to be disclosed	Belgium	Policy officer
Argo Peepson	Ministry of Regional Affairs and Agricultural, Bioresources and Climate Unit	Estonia	Policy officer
Mario Plešej	Ministry of Agriculture, Forestry and Food, Department for Development and Knowledge Transfer Service	Slovenia	Policy officer
Not to be disclosed	Geonardo Environmental Technologies	Hungary	Research
Kristine Sirma	Ministry of Agriculture, Head of Sustainable Agriculture Development Division	Latvia	Policy officer
Heike Slusarczyk	Office of the Bioeconomy Science Center	Germany	Regional bioeconomy
Anne Vehviläinen	Ministry of Agriculture and Forestry	Finland	Policy officer

The MAG engaged in a co-creation process with the ShapingBio team. The co-creation process consisted of a series of three workshops in which the expert group and the ShapingBio team collaborated. The workshops took place in the period January to May 2024. In between the workshops, the ShapingBio team worked on the planned in-depth analyses. The expert group finetuned the planned in-depth analyses in workshop 1 and 2, critically discussed (interim) results of these in-depth analyses in workshop 2 and 3 and contributed to conclusions and draft recommendations in all three workshops (Figure 5).

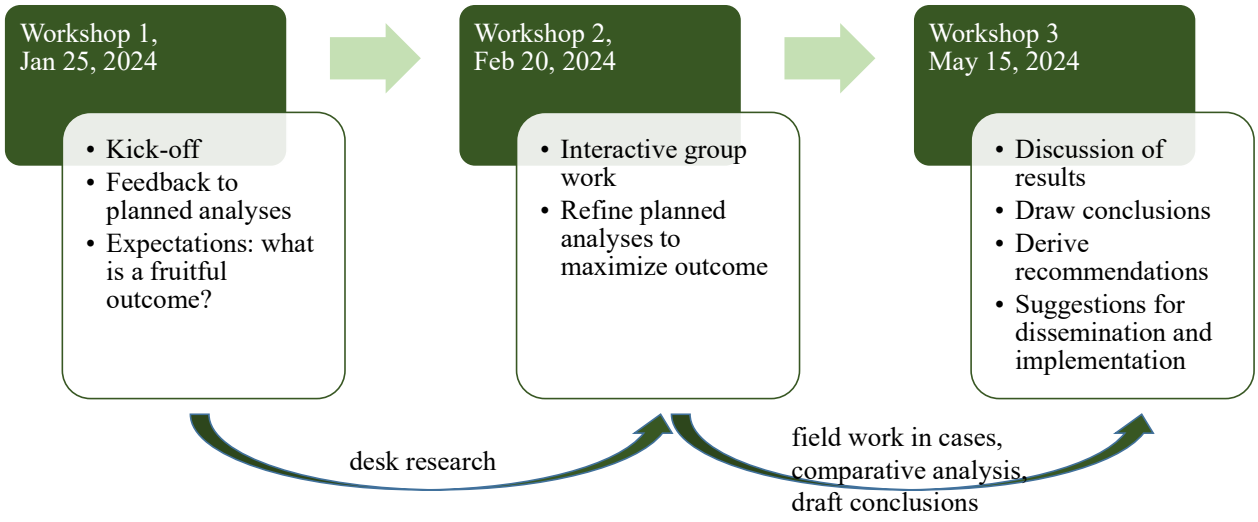

Figure 5: Co-creation process with the policy & governance multi-actor group

The terms of reference for the MAG were:

- Co-create the framework and key issues for the in-depth analyses with the ShapingBio team
- Provide further insights into the planned in-depth analyses, regarding
  - Status quo, challenges, shortcomings and gaps, reasons for the present (unsatisfactory) situation
  - which improvements are needed, what are potential solutions?
- Suggest and/or comment on the planned in-depth analyses, especially
  - Fine-tuning of guiding questions
  - selected cases
- suggest experts or literature/ studies that should be consulted during the in-depth analyses
- Critically discuss (interim) results and outputs, especially
  - How relevant and helpful are the results for practitioners?
  - What can be considered good practice?
  - What are prerequisites for successful implementation, do‘s and don‘ts?
- Contribute to overall conclusions and (draft) recommendations
  - What are the lessons learnt/conclusions?
  - To which extent/under which conditions can good practice and lessons learnt be successfully transferred to other contexts/implemented elsewhere?
  - What are actionable conclusions and draft recommendations
- Provide suggestions on how best to communicate the results, conclusions and recommendations to those who should take action

3.3 Desk research

Desk research was carried out to define the scope of the overall topic and the in-depth analyses, to set up a knowledge-based selection scheme for the cases in each in-depth analysis, to characterise the respective cases, and to gain a deeper understanding of multi-level governance and policy coordination as well as what constitutes a well-developed regional bioeconomy. This helped to place the in-depth analyses and the results within the broader academic and practical discourse on bioeconomy policy and governance.

Information sources were results from preceding work packages of ShapingBio, especially from stakeholder needs assessment and mapping of bioeconomy in the EU (Santaniello et al. 2023; Sakellaris et al. 2024), scientific publications and grey literature (e.g. reports), policy documents (e.g. bioeconomy strategies and action plans, decrees and communications), statistics, relevant regulations, home pages of relevant organisations and institutions, and internet searches. The aim was to gather information on the involved actors, bodies, governance and administrative structures and processes, and to characterize the respective regions.

3.4 Interviews

In all three in-depth analyses, a total of 47 semi-structured interviews with key experts in the subject of the respective in-depth analysis and the respective countries were carried out in the period March to May 2024. The interviewees' affiliations are listed in chapter 8.

Interviewees represented key stakeholders from different relevant stakeholder groups in order to collect different perspectives, viewpoints and experiences. This provided a richer and more nuanced understanding of how coordination processes, governance and regional engagement function and which challenges and good practice exist. More detailed information for each in-depth analysis is given below.

Interviewees were contacted by email to schedule the interview. They were informed about context, purpose and content of the interview and how the information gathered in the interview would be used. After informed consent had been collected, interviews were conducted as video calls in English, German or Italian language and lasted about one hour. Interviews were recorded for preparing notes or transcripts. A content analysis of the notes or transcripts from the interviews was carried out. Recordings were deleted, once the content analysis had been completed.

National bioeconomy policy coordination

A total of 19 semi-structured interviews were conducted, 12 in Germany, 3 in Italy and 4 in Estonia. Interviews with policy officers with responsibility for national bioeconomy policy were conducted in each country. Moreover, members of coordination bodies, advisory bodies, stakeholders from academia, industry, industry associations, governmental agency, project management organisation directly involved in bioeconomy strategy development and/or policy implementation processes were interviewed.

The interview questions focussed on the following issues:

- Interviewee's role in bioeconomy policy coordination
- Organisation and coordination of the bioeconomy strategy development and the strategy implementation processes
- Integration of stakeholders in the processes
- Dealing with goal conflicts, conflicting positions, decision-making

- Supporting and hindering factors, successes and weaknesses in the coordination processes, good practice
- Learnings from past experience, options for further improvement of bioeconomy policy coordination

Emerging sectors, example sustainable aquaculture

A total of 16 semi-structured interviews were conducted, 8 in Germany, 4 in Denmark and 4 in Ireland. Expert interviews with policymakers and/or public authorities were conducted in each studied country. Additionally, interviews with non-governmental actors involved in aquaculture governance (e.g., researchers, associations) and those affected by aquaculture policies and regulations (e.g., sustainable aquaculture farms) were also conducted. This approach ensured that the analysis reflected a broad spectrum of perspectives and provides a nuanced understanding of the governance frameworks and their practical implications in the studied countries.

The interview questions focussed on the following issues:

- Interviewee's role in sustainable aquaculture
- Characterisation of the present situation of sustainable aquaculture in the country
- Governance and administration process challenges
- Learnings from past experience, good practise
- Options for further improvement

Fostering regional bioeconomy

A total of 12 semi-structured interviews with key stakeholders from the three regions were carried out, 4 in each region. Interviewees were key representatives from the public sector, academia and industry. The purpose of the interviews was to gain a comprehensive understanding of the region and its bioeconomy development. The interview questions addressed the following issues:

- Interviewee's role in the region
- Key stakeholders involved in bioeconomy in the regions
- Catalysts that drive regional bioeconomy development
- Transferable good practices that can be adopted by other regions.

The information obtained in the interviews was used to explore the context and understand the patterns, mechanisms, and practices for bioeconomy development at the regional scale.

4. Bioeconomy policy coordination on national level

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4.1 Introduction

The bioeconomy has been proclaimed as a catalyst for green growth, economic competitiveness and sustainable development in Europe by supporting a systems transition from a linear fossil-based to a bio-based circular economy: The EU Bioeconomy Strategy and Action Plan (European Commission: Directorate-General for Research and Innovation 2012, 2018a; European Commission: Directorate-General for Research and Innovation 2018b) take a system-wide approach to deploy bioeconomies across Europe. The need for spanning multiple bio-based sectors, addressing tradeoffs and harnessing co-benefits, governance is a permanent challenge of efficient bioeconomy development (Gardossi et al. 2023). The broad scope of the bioeconomy concept implies that political responsibilities and competencies are shared and distributed between different political entities (ministries), which need to align their interests. In a Mutual Learning Experience, a reference framework has been developed for sound public governance. Among others, it calls for coordination across government and across different levels of government in order to build collective leadership capacity and to integrate the different policy domains which are relevant to the bioeconomy (European Commission et al. 2021).

Coordination is understood as the capacity to align and harmonize decisions across different government entities in order to achieve more integration and coherence between different policies. This can happen in different ways: A common way of coordination is that individual ministries with responsibility for parts of the bioeconomy design their own programmes and activities in a way that no larger negotiations with other ministries are necessary, or optimise their measures and activities until no conflicts or negative impacts arise for other ministries. Another way is that two or more policy areas or programmes are improved across ministries to create an optimal combination in order to exploit political synergies. Both ways have their strong and weak points: while the former approach is less resource- and time-consuming, this type of coordination hardly leads to solutions across different policy fields. Procedures in the latter approach are complex, more difficult, involve more conflict, have higher transaction costs and require lengthy negotiations between the responsible ministries because their respective own interests are affected (Bioökonomierat 2022a, p. 34ff), but may be more appropriate for transformational policies, which are required for bioeconomy.

Although different countries have established formal coordination mechanisms, little is known about their structures, functions and success. This in-depth analysis aims to provide a thorough account of coordination of bioeconomy policy and its mechanisms, challenges and success factors in three European countries: Germany, Italy and Estonia. It offers insights into how these coordination processes work in practice in these countries. It analyses coordinated approaches for the development of bioeconomy strategies and how to translate the strategic goals into policy actions and concrete measures (implementation). This in-depth analysis aims to provide answers to the following questions:

- How has bioeconomy policy developed over time in Germany, Italy and Estonia?
- Which coordination mechanisms are used for which purposes in these countries?
- How can the adopted coordination mode be characterised in these countries?
- Which challenges are encountered, what are success factors and good practice examples?
- Which draft recommendations can be derived?

The in-depth analysis is structured as follows: For each of the analysed countries (chapters 4.3, 4.4, 4.5), we will start with an overview of selected bioeconomy policy milestones which were important for the bioeconomy policy development in the analyzed country. We will then describe the coordination mechanisms which have been established in the respective country, displaying their formal characteristics and structures. In the following part, the country case study will analyse how coordination works between the different actors that take part on bioeconomy coordination and identify challenges and success factors. The cross-country analysis (chapter 4.6) will derive similarities and differences, and overarching findings derived from all three case-studies. In chapter 4.7, we will draw conclusions and propose draft policy recommendations on how to further improve bioeconomy policy coordination. Chapter 4.8 gives an outlook on how the topic of this in-depth analysis, bioeconomy policy coordination on national level, could be pursued further.

4.2 Selection of countries as case studies

The rationale for choosing countries as case studies is based on the following findings and recommendations from a mutual learning exercise for a framework approach for bioeconomy strategy development (European Commission et al. 2021):

- Bioeconomy policy requires the coordination and integration of numerous policy domains and thus government departments (policy message 4)
- Spaces for collective leadership and engagement are required over extended time periods (policy message 3)

In order to explore whether coordination challenges are correlated with the number of ministries and policy domains to be integrated, and whether there are changes over time, the selection of countries for case studies was based on two criteria:

- Significant differences in the number of responsible ministries for the bioeconomy strategy or respective policy document.
- Significant differences in the time span of bioeconomy policy development and implementation. We thus aimed to analyze a country that developed its bioeconomy strategy very early, a country that followed and a country that had developed its strategy in the last few years.

Based on the bioeconomy policy mapping performed in ShapingBio Deliverable 1.4 and following advice from the multi-actor group, we chose Germany, Italy and Estonia as case studies. Table 2 gives an overview of the selection criteria in these countries.

Table 2: Selection criteria for Germany, Italy and Estonia as case studies

Country	Publication year of first bioeconomy strategy/policy document	No. of leading ministries
Germany	2010 National Research Strategy BioEconomy 2030	2 Federal Ministry of Education and Research (BMBF) Federal Ministry of Food and Agriculture (BMEL)
Italy	2017 Bioeconomy in Italy (BIT I)	4 Ministry for Economic Development Ministry of Agriculture, Food and Forestry Ministry of Education, University and Research Ministry of the Environment, Land and Sea
Estonia	2023 Circular bioeconomy roadmap	1 Ministry of Regional Affairs and Agriculture

4.3 Bioeconomy policy coordination in Germany

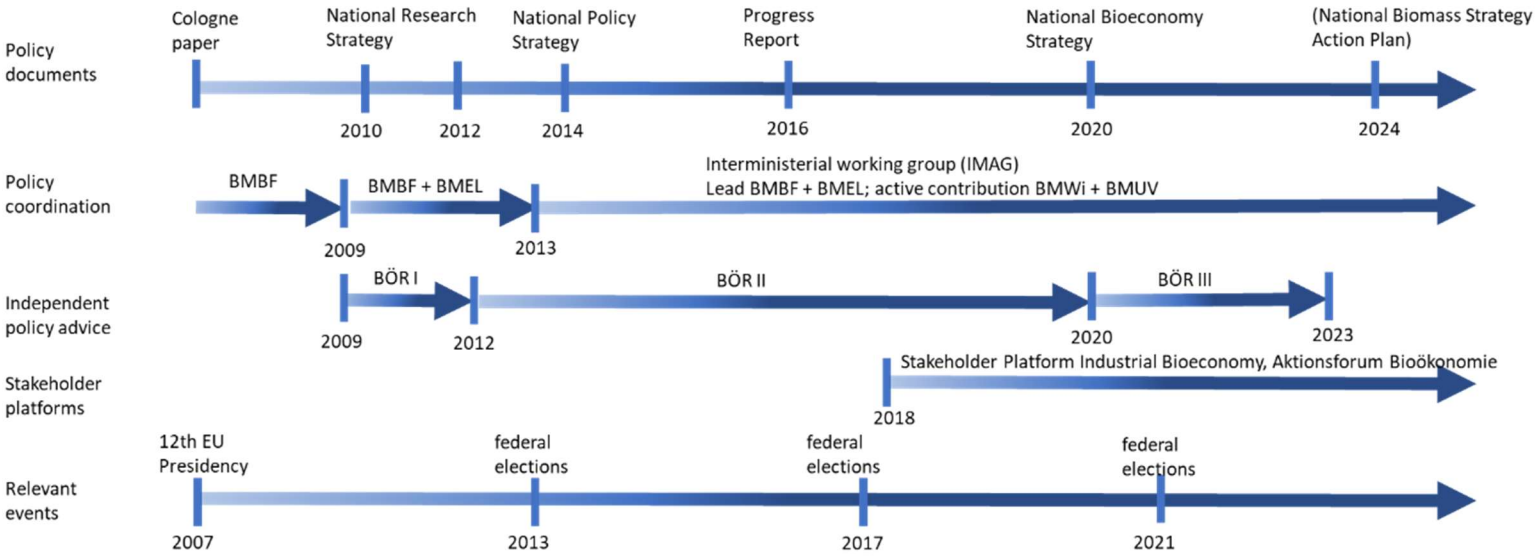
4.3.1 Bioeconomy policy milestones in Germany

Germany looks back to a long bioeconomy policy history and can be considered as an early adopter of a bioeconomy strategy (Figure 6).

Policy documents

Germany was among the few European member states which actively contributed to the evolving concept of the Knowledge-Based Bioeconomy in Europe aroung 2005 and 2007 (Patermann et al. 2018). The commitment to this concept was demonstrated with the publication of the so-called "Cologne Paper" during the German presidency of Council of the European Union in 2007 (Cologne Paper 2007). This white paper was a first milestone that outlined recommendations for policy-makers and the identification of policy priorities for the development of the bioeconomy in Germany. The Federal Ministry for Education and Research (BMBF) published its first research strategy on bioeconomy in 2010 (english version in 2011). With this strategy, the government aimed to lay the foundation for a vision towards sustainable bio-based economy until 2030 (BMBF 2011)

Four years later, this research strategy was complemented by the adoption of the "National Policy Strategy Bioeconomy "in 2014 (Bundesministerium für Ernährung und Landwirtschaft 2014), led by the Federal Ministry for Food and Agriculture (BMEL). The scope of the National Policy Strategy was broader than the scope of the National Research Strategy 2030 with its focus on bioeconomy research, and encompassed also different policy fields. In 2016, a progress report on the implementation of the national policy strategy was published, in which the government outlined how Germany had progressed so far and which further steps would be necessary to exploit the full potential of the bioeconomy in Germany (BMEL 2016). The Bioeconomy Council also gave recommendations how to develop the National Research Strategy Bioeconomy 2030 further (Bioökonomierat 2016).



Source: Fraunhofer ISI

Figure 6: Bioeconomy policy milestones in Germany

Following the coalition agreement from 2017, the federal government decided to combine both strategies into uniform and coherent national bioeconomy strategy (Federal Ministry of Education and Research et al. 2020). The national bioeconomy research strategy and the bioeconomy policy strategy had been coordinated alone by the BMBF or the BMEL, respectively. The national bioeconomy strategy was developed jointly by both ministries. Still under development are a National Biomass Strategy (NABIS), complementing the national bioeconomy strategy with strategic goals for the sustainable production and use of biomass, and an implementation action plan for the national bioeconomy strategy.

Policy coordination

The adoption of the National Policy Strategy in 2014 meant a shift in the number of ministries actively involved in the bioeconomy. An interministerial working group on bioeconomy (IMAG) was set up in 2013. The interministerial working group has become the most important instrument for bioeconomy-related exchange between the ministries. Although the group is open for all ministries interested in the bioeconomy, the most active representatives to date are the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Food and Agriculture (BMEL) as well as the Federal Ministry of Economic Affairs and Climate Action (BMWK) and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV).

Independent policy advice and stakeholder platforms

As the bioeconomy as a concept entailed the inclusion of different policy fields, different sectors and societal areas, the federal government decided to establish an independent bioeconomy advisory council[1] in 2009. It had the role to develop policy recommendations for the federal government. Until 2024, there were three council periods (2009-2012, 2012-2019, 2020-2023) with (partly) different appointed members in each period. Whereas the council in the first two periods mainly consisted of representatives from science and industry, the composition of the council changed with the third period to better represent different positions of the German bioeconomy discourse: representatives were appointed who emphasize e.g. environmental issues and planetary boundary issues.

In addition to the bioeconomy advisory council, also other bioeconomy formal networks or platforms have been set up. The Bioeconomy Action Forum[2], an alliance of mainly civil society organizations, was established with the purpose to give environmental protection a higher priority in the bioeconomy discourse. In a similar vein, the Federal Ministry for Economic Affairs and Climate Action (formerly Federal Ministry for Economic Affairs, BMWi), also intended to raise the strategic importance of the industrial bioeconomy in the German bioeconomy discourse by setting up the Dialogue Platform for Industrial Bioeconomy in 2018. The dialogue platform consists of representatives from science, industry and from ministries of the German federal states (Dialogplattform Industrielle Bioökonomie 2021).

Several German federal states (Länder) have their own bioeconomy strategies and policy instruments (Bioökonomierat 2022b). The platform for exchange between the federal and the regional state level is the federal-state working group "Renewable Resources/Bioeconomy" (*Bund-Länder-Arbeitsgruppe "Nachwachsende Rohstoffe/Bioökonomie"*).

In conclusion, the coordination of bioeconomy policy has become increasingly complex over the years: the spectrum of policy actors and stakeholders widened, and their numbers increased substantially over time with the adoption of several strategic policy documents.

[1] https://www.biooekonomierat.de/en/
[2] https://denkhausbremen.de/themen/biooekonomie/

4.3.2 Coordination mechanisms

Policy coordination is defined as the capacity of actors to develop a coherent and integrated policy frame that considers the various interests and frames of the involved actors. In order to achieve coherence in policy-making, different actors participate and have impacts on policy coordination outcomes. Germany has established different formal coordination mechanisms, serving as platforms for joint decision-making.

Interministerial working group on bioeconomy (IMAG)

Regarded by interview partners as the most important coordination instrument, the interministerial working group[3] on bioeconomy (IMAG) has the role to share information between the coordinating ministries and to develop the national bioeconomy policy further. This working group consist of only national ministries at the level of the divisions (*Referate*) and meets unregularly. Leading ministries are the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Food and Agriculture (BMEL). They organize the meetings, set up the agenda and chair the group meetings. The IMAG has the following objectives and tasks (Bundesministerium für Ernährung und Landwirtschaft 2014, p. 46):

- to facilitate the exchange of information and the coordination of policies of the ministries relating to bioeconomy
- to develop the national policy strategy further,
- to oversee bioeconomy monitoring activities, and assessing the economic impacts of bioeconomy
- to lead an open dialogue with the Bioeconomy Council
- to support the exchange with the German Parliament
- to function as link to the federal states
- to be involved in the coordination of communication and dialogues with the public on bioeconomy

Besides these two leading actors, also the Federal Ministry for Economic Affairs and Climate Action (BMWK) and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) are active players in the group. Especially, the Federal Ministry for the Environment has increased its engagement in this group in recent years. One reason is that environmental concerns, planetary boundaries and aspects of justness are clearly voiced in the German bioeconomy discourse and to a certain extent an alternative model of bioeconomy is called for, especially by NGOs. In general, the interministerial working group is open for all ministries, also for ones that are not directly related to the bioeconomy, such as the Foreign Office or other government departments. However, most of the IMAG members act as observers and only intervene if topics are discussed that affect their interests.

3 Interministerial working groups are instruments in the German government that are regularly used in order to facilitate coordination between ministries (https://www.verwaltungsvorschriften-im-internet.de/bsvwvbund_21072009_O11313012.htm; Section I, §20). Such working groups are usually set up by agreement between the federal ministers, more rarely by cabinet decision. They can be formed either on an ad hoc basis, or meet regularly, and can also exist over several legislative periods. The hierarchial level of members of interministerial working groups can range from the civil servant level to the level of state secretaries. They have no decision-making authority of their own. They serve to coordinate the ministries and to resolve conflicts between departments before the federal ministers involved in an issue reach an agreement. Cabinet decisions are usually prepared in such interministerial working groups. Issues that cannot be dealt with at a lower hierarchical level are typically passed to a higher hierarchical level. (Interministerieller Ausschuss – Wikipedia; accessed 8.9.2024).

Since the establishment of the group in 2013, the ministries listed in Table 3 have joined as members (Deutscher Bundestag 2019).

Table 3: Members of the interministerial working group on bioeconomy and their roles

Members IMAG	**Role**
Federal Ministry for Education and Research (BMBF)	leading
Federal Ministry for Food and Agriculture (BMEL)	leading
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)	active
Federal Ministry for Economic Cooperation and Development (BMZ)	active
Federal Ministry for Economic Affairs and Climate Action (BMWK)	active
Federal Foreign Office (AA)	observer
Federal Ministry of Finance (BMF)	observer
Federal Ministry of Transport and Digital Infrastructure (BMVI)	observer
Federal Chancellery	observer

Source: Information taken from Deutscher Bundestag (2019), p. 6

A characteristic of the group is that it only consists of national ministries. German federal states – although several of them have developed and implemented dedicated federal-state-specific bioeconomy policies – are not represented in the group. Information exchange with federal states takes place during sporadic meetings with the federal-state working group "Renewable Resources/Bioeconomy" (Bund-Länder-Arbeitsgruppe "Nachwachsende Rohstoffe/Bioökonomie"). To our knowledge, no joint positions of IMAG and the federal state working group have been developed.

However, although the IMAG plays a pivotal role in developing the main pillars of bioeconomy policy-making and shared decisions, the group does not have final decision-making competence and has not established formal rules for the collaboration. The group can be seen as a platform where the different ministries can align their interests and prepare decisions for bioeconomy policy. For formal decisions or the adoption of strategies and implementation plans, the interdepartmental coordination process (*Ressortabstimmung*) is the final decision-making instrument in the federal government.

Interdepartmental coordination

Bioeconomy strategies must be approved in the process of interdepartmental coordination *(Ressortabstimmung)*. The following formal process steps are taken during an interdepartmental coordination:

1. Informing the federal chancellery
2. Communicating interests with states and communities
3. Involvement of affected ministries
4. Involvement of the national regulatory control council
5. Discussion of change requests
6. Repeated discussion in the leading ministry

The ministry leading the strategy development process sends the draft strategy document to the other ministries. They comment the draft and provide input for improvement. Additionally, the interdepartmental coordination requires a formal consultation process of certain stakeholders. In the context of the adoption of the national bioeconomy strategy, several workshops were held with different stakeholder groups separately. Stakeholders from industry and civil society had the opportunity to provide their priorities for the strategy. In addition, stakeholders were given the opportunity to comment the strategy draft. Once the interdepartmental coordination process is completed successfully, the cabinet meeting has to formally approve the strategy.

Bioeconomy Networks

Other actors are also involved in bioeconomy policy coordination. Most of them are organised in platforms and are connected with the IMAG. Table 4 gives an overview.

Table 4: Bioeconomy networks in Germany, connected with the IMAG

Bioeconomy Networks	**Focus area**	**Members**
Bioeconomy Advisory Council	Develops recommendations for action regarding implementation of the national bioeconomy strategy	Science Civil Society Industry
Federal-state working group "Renewable Resources/Bioeconomy"	Information exchange about bioeconomy developments and activities	Civil servants from federal states ministries
Action Forum Bioeconomy	Coordinates environmental and development-related NGOs	Civil Society
Dialogue Platform Industrial Bioeconomy	Strengthening as industrial location with industrial bioeconomy	Industry, Academia, Federal states Labor unions

Source: Fraunhofer ISI

The **bioeconomy advisory council**[4] (*Bioökonomierat*, BÖR) is an independent high level expert committee formally appointed by the German Federal Government. It was first established in 2009 with three consecutive working periods until 2023 (2009-2012, 2012-2020, 2020-2023). The council members for the first working period had been appointed by the presidium of the National Academy of Science and Engineering (Acatec)[5], whereas the members for the following two working periods were selected by the bioeconomy-relevant ministries and appointed by the German Federal Government. The council members are experts who represent different societal stakeholder groups (science, industry, civil society) and bioeconomy visions or concepts.

Main goal and mission of the bioeconomy council as an independent advisory body to the Federal Government is the development of recommendations for action to implement the national bioeconomy strategy. The council is in exchange with the IMAG and the respective federal ministries. Another important task of the council is to contribute to a shared understanding of the bioeconomy among the involved actors.

[4] https://www.biooekonomierat.de/en/
[5] https://en.acatech.de/

Further activities of the council include the organization of technical discussions and workshops with stakeholders as transfer and participation formats. For instance, the annual bioeconomy forum conference serves as a platform for dialogue between all relevant stakeholders in the bioeconomy. Results of the work of the council are published and disseminated and communicated to the public. The operational mode of the council is based on council meetings and work in working groups. In the third working period, the council was also given the task to elaborate recommendations for an implementation plan for the National Bioeconomy Strategy. These recommendations were published in 2023 (Bioökonomierat 2023).

The **federal-state working group "Renewable Resources/Bioeconomy"** (*Bund-Länder-Arbeitsgruppe "Nachwachsende Rohstoffe/Bioökonomie"*) convenes delegates from state ministries with responsibilities for bioeconomy in the respective federal state. There are irregular exchanges between the IMAG and the federal-state working group. Little is publicly known about the composition of the group, its mandate and activities.

The **"Dialogue Platform Industrial Bioeconomy"**[6] was initiated by the Federal Ministry for Economic Affairs and Climate action (BMWK) in 2018 with the aim to strengthen Germany as an attractive industrial location in the bioeconomy. The members of the dialogue platform are representatives from industry, associations, science, trade unions and federal state ministries. The platform facilitates dialogue between all stakeholders involved and promotes cooperation between large companies and small and medium-sized enterprises (SMEs), between universities and start-ups, between research and industry. The dialogue platform has established four working groups on the topics "Feedstock supply and sustainability", "Financing, regulation, commercialisation incentives", "Demonstration plants and technology" and "Communication". The dialogue platform makes proposals for funding programmes for promoting the industrial bioeconomy, for shaping the framework conditions, for sustainability and supply structures and for communication. Some of them have been published as position papers in which a vision for the industrial bioeconomy was outlined (Dialogplattform Industrielle Bioökonomie 2021) and recommendations for the implementation plan of the National Bioeconomy Strategy were given (Dialogue Platform Industrial Bioeconomy 2023). During the development process of the National Bioeconomy Strategy, the platform also had the opportunity to comment drafts.

Several non-governmental organizations (NGOs) in Germany have critical positions towards the bioeconomy, due to its potential negative environmental and social impacts (e.g. overexploitation of resources, exceeding of planetary boundaries, loss of biodiversity, neglecting rural areas, unfair trading practices and exploitation of the global south) and related technologies (e.g. genetic engineering, genome editing, synthetic biology). To give these NGOs a stronger voice in the German bioeconomy discourse, the **"Action Forum Bioeconomy"**[7] was financially supported by the Federal Ministry for the Environment BMUV. The "Action Forum Bioeconomy" is an alliance of several non-governmental civil society organizations. The goal of the alliance is to coordinate environmental and development-related NGOs and to promote a ecologically sound and socially fair bioeconomy and a responsible production and use of biomass. The alliance critized that these sustainability aspects were insufficiently or not at all addressed in the national bioeconomy strategy (Aktionsforum Bioökonomie 2019b). In a subsequent declaration, they demanded public funding for research on a socio-ecological transformation, agroecology and other nature-friendly and socially just concepts, an equally strong role of the Federal Ministry for the Environment within the Federal Government and thus of sustainability aspects in shaping the German bioeconomy, no public

[6] https://www.bmwk.de/Redaktion/DE/Dossier/industrielle-biooekonomie-wachstum-und-innovation.html
[7] https://denkhausbremen.de/themen/biooekonomie/

funding of genetic engineering in agriculture, and questioned bioeconomy concepts which rely on the import of biomass (Aktionsforum Bioökonomie 2019a).

4.3.3 Coordination mode

This subchapter addresses how the actors interact with each other in bioeconomy policy coordination. The information presented here is based on the interviewees' subjective perceptions and opinions as they were given in the interviews conducted for this analysis.

Over the past fifteen years, bioeconomy policy coordination changed significantly. Changes took place in the number of ministries which are actively involved in bioeconomy policy coordination – from only one ministry (research) around 2009/2010 to currently at least four ministries (research, agriculture, economic affairs, environment). Since 2013, the **interministerial working group (IMAG)** is the main coordination mechanism between the relevant ministries.

Within the IMAG, there is a tendency towards a certain hierarchical relationship between the members: The ministries for research and agriculture have the lead, invite to meetings, set up the agenda and chair the group meetings. The ministries of economy affairs and environment are actively contributing members, whereas all other ministries are mainly observers.

The IMAG prepares decisions related to strategy development, monitoring and developing concepts and plans how to translate the strategy into actions and support programmes. Due to limited personel and time resources, meetings were reported to be held irregularly and to be often replaced by collecting written comments to documents instead of direct dialogue and discussion of the topics. The working group itself does not have final decision-making competence – decisions have to be taken by higher hierarchical levels in the respective ministries, or – in the case of bioeconomy strategies – by the government.

Interviewees report that is has become more difficult over the years to achieve consensus, agreements, and compromises between the IMAG members, due to the following reasons:

- Political priorities. Bioeconomy currently ranks lower on the political agenda and gets less attention than in former years
- Bioeconomy visions and narratives. Different visions and narratives of bioeconomy exist in parallel in the German discourse, and also the ministries active in the IMAG differ with respect to the bioeconomy vision and narrative they favour, and in the ways to achieve them
- Guidance by the National Bioeconomy Strategy. The National Bioeconomy Strategy (Federal Ministry of Education and Research et al. 2020) was jointly developed and presents a comprehensive bioeconomy vision which acknowledges these different visions and narratives. However, several interviewees who were involved in the strategy development process consider some parts of the strategy as "lowest common denominator": vague goals and phrases were used in cases where no consensus could be achieved on priorities or ways to address goal conflicts inherent in the bioeconomy. As a consequence, some interviewees are of opinion that the lack of clearer guidance by the strategy makes it challenging to now translate the (vague) strategic goals into an implementation plan. Its finalisation is significantly delayed: On request by the IMAG, the bioeconomy advisory council (BÖR) delivered its recommendations for an implementation plan in spring 2023 (Bioökonomierat 2023). However, no finalisation date could be given at the time when the interviews for this analysis were conducted (summer 2024).
- Due to changes in the government coalition after the federal elections in 2021, achieving consensus between ministries led by ministers from different parties became more difficult in general. This also

had implications for coordination efforts in the IMAG: more often than before, several controversial issues could no longer be resolved on the division staff level, but had to be transferred to higher hierarchical levels in the respective ministries where directions were given or decisions taken. This made coordination processes more laborious and cumbersome than before.

Stakeholder involvement

In addition to informal exchanges, conferences or events, the IMAG is also in exchange with different formally established stakeholder platforms (Table 4).

In its first working paper (Bioökonomierat 2022a), the **Bioeconomy Council** states that the broad concept of bioeconomy, comprising different concepts, narratives, and paradigms, has not yet developed into an established policy field. Rather, the involved ministries represent different political interests and therefore prioritise different concepts or visions of a bioeconomy, which makes a coordinated and coherent bioeconomy policy more difficult. The Council in its working paper calls for policy integration, i.e. a coordination of political decisions across departments and levels – spanning the EU, national and federal states levels. The Council distinguishes two different modes of coordination: so-called positive and negative coordination – these are technical terms commonly used in the political sciences. Positive coordination means that two or more policy areas or programmes are improved across departments to create an optimal combination in order to exploit political synergies. Such procedures are complex and require lengthy negotiations between the responsible ministries because their respective own interests are affected. Negative coordination in the political sciences is understood as the improvement of programmes by an individual ministry until no negative impacts arise for other ministries or with a (narrow) scope which does not require thorough negotiations with other ministries. Although less resource- and time-consuming, this type of coordination hardly leads to solutions across different policy fields (Bioökonomierat 2022a, p. 34ff). Despite its connotation, positive coordination is not necessarily “better coordination”, as it is much more difficult, involves more conflict and has higher transaction costs (Radtke et al. 2016, p. 66).

As an independent advisory body to the Federal government, the Bioeconomy Council could be in the position to provide advice to the IMAG on which issues and how to strive for the above-described synergetic coordination across different policy fields. For example, the Council strengthened the link between the national and the **Federal state level** (Bioökonomierat 2022b). However, several interviewees reported that the different bioeconomy concepts, narratives and paradigms were also represented in the composition of the Council. Therefore, the difficulties to achieve consensus and common positions, as observed in the IMAG, were also mirrored in part of the Council work which sometimes showed the tendency towards fundamental debates on principles.

The Ministry of Economic Affairs and the Ministry for the Environment, respectively, had been the driving forces behind the establishment of the **Dialogue Platform Industrial Biotechnology** and the **Action Forum Bioeconomy**. During the process for developing the National Bioeconomy Strategy, a stakeholder workshop was conducted with each of these platforms and their related communities. Moreover, they had the opportunity to comment a draft of the strategy. While there seems to be well-established exchange between the Ministry of Economic Affairs and the dialogue platform, and the Ministry for the Environment and the Action Forum, exchange of the IMAG with these platforms is mainly mediated via these two ministries. Exchange between the IMAG and these stakeholder platforms therefore often has a top-down and unilateral character, whereas dialogue formats are less frequently used. Moreover, these platforms do not seem to interact much with each other, but rather operate in silos within their respective communities.

From their experience with bioeconomy policy coordination in Germany, interviewees derived the following good practices:

- Sufficient staff and time resources for coordination
- Personal direct interaction and dialogue
- Having a shared understanding of the bioeconomy concept, narrative, and paradigm which should guide policy decisions and activities
- Having a bioeconomy strategy with clear priorities and commonly agreed ways how to deal with goal conflicts inherent to bioeconomy, to support the development of concepts for its implementation
- Having a neutral mediator who can conciliate disagreements and diverging interests to shared compromises
- In case of getting entangled in fundamental debates on principles, focussing pragmatically on topics in which common positions can be achieved
- Direct interaction and exchange between all coordination mechanisms

4.3.4 Conclusion

Germany was one of the first EU countries with bioeconomy strategies and governmental coordination structures: As a first mover, it adopted its first strategy in 2010 before the European Commission followed with its own strategy in 2012. It appointed a bioeconomy council as independent expert advisory group in 2009. Since then, bioeconomy policy and related coordination mechanisms have evolved

Over the past fifteen years, bioeconomy policy and its coordination changed significantly. The following changes could be observed:

- Scope of the bioeconomy strategies. The strategies developed from a research strategy, mainly focussing on providing the scientific-technical basis for a knowledge-based bioeconomy, to a policy strategy with a focus of replacing fossil resources by bio-based resources. Finally, the national bioeconomy strategy is the most comprehensive one, focussing on sustainable bioeconomy as a way to address challenges such climate change.
- Number of ministries. Closely linked to the thematic evolution of the strategies, the number of ministries which are actively involved in bioeconomy policy coordination – increased from only one ministry (research) around 2009/2010 to currently at least four ministries (research, agriculture, economic affairs, environment).
- Coordination mechanisms. As the number of ministries responsible for bioeconomy increased, an interministerial working group (IMAG) was established in 2013. It is the main body for policy coordination between the Federal ministries. In order to provide policy with expert advice, a Bioeconomy Council as an independent high level expert group was established in 2009. The composition of the Council has evolved over the years from an academia-industry expert group to a group in which a larger diversity of stakeholders and larger scope of bioeconomy concepts and paradigms is represented, to better reflect the different perspectives of the bioeconomy discourse in Germany. In the same vein, additional platforms which represent industrial biotechnology and civil society NGOs were established. All major stakeholders and actors – national ministries, academia, industry, civil society NGOs and Federal states ministries – are linked in this network structure.

These changes show how bioeconomy policy and its coordination has successfully reacted and adapted to changing challenges and requirements. However, despite these coordination activities, a true policy integration, i.e. a coordination of political decisions across departments and levels – spanning the EU, national and federal states levels – still remains to be achieved. It may be a German specificity that different

concepts, narratives, and paradigms within the broad concept of bioeconomy exist in parallel in Germany, each of these concepts more prevalent and prioritised in certain communities and ministries. This makes a coordinated and coherent bioeconomy policy difficult.

To achieve such a policy, it would be desirable to develop a shared understanding of the bioeconomy concept, narrative, and paradigm which should guide policy decisions and activities. This would result in a bioeconomy strategy with clear priorities and commonly agreed ways how to deal with goal conflicts inherent to bioeconomy, to support the development of concepts for its implementation. Steps towards these goals could be more direct interaction and exchange in dialogues between and within all coordination mechanisms in order to work less in silos and to complement unilateral consultations. In case of disagreements and diverging interests, a person or institution in the function of a neutral moderator could conciliate to achieve shared compromises. In case of getting entangled in fundamental debates on principles, a more pragmatic mindset focussing on topics in which compromises and agreement on solutions can be achieved.

4.4 Bioeconomy policy coordination in Italy

4.4.1 Bioeconomy policy milestones in Italy

Before Italy published its first bioeconomy strategy in 2017, bioeconomy was positioned within the strategic areas of smart specialization and research and innovation (Fava et al. 2021): It was marginally addressed as a promising area in the National Smart Specialisation Strategy (Ministerio dello Sviluppo Economico et al. 2016). Its technological basis, namely biotechnology, was covered in the National Research Programme 2015-2020 (Ministerio dell'Istruzione, dell'Università e della Ricerca 2015). The Strategic Plan for Innovation and Research in Agriculture, Food and Forestry aimed – among others – at incentivising the production of bio-based feedstocks for the chemical industry (Ministerio delle Politiche Agricole, Alimentari e Forestali 2014).

However, the Presidency of the Council of Ministers saw the need for greater coordination between ministries and between ministries and regions, as well as between public and private sector players, to better exploit the bioeconomy potential. Also following the EC request that EU Member States should develop their own national bioeconomy strategies, the Presidency of the Council of Ministers decided that a task force should develop a national bioeconomy strategy[8]. The first Italian bioeconomy strategy "Bioeconomy in Italy (BIT)" (Italian Government 2017) was developed within six months, including two months of public consultation, and was approved in February 2017 (Fava et al. 2021). It was developed in close exchange with ongoing discussions and activities at the European Commission to develop the updated EU Bioeconomy Strategy which was published in 2018 (European Commission 2018).

After a change of government in 2018 and also in light of the new European research and innovation funding plan (Horizon Europe), the new Presidency of the Council of Ministers asked for an update of the BIT I strategy[8]. This update was developed by a second task force with a similar institutional composition as the task force for the first bioeconomy strategy. The updated strategy "BIT II: Bioeconomy in Italy: A new Bioeconomy strategy for a sustainable Italy" was published in 2019 (Fava et al. 2021; Italian Government 2019), followed by an Implementation Action Plan for the years 2020-2025 (National Bioeconomy Coordination Board 2021). A revision and update of the Implementation Action Plan for the years 2024-2027 is ongoing. Its finalisation and publication are planned for summer 2024.

[8] https://cnbbsv.palazzochigi.it/it/bioeconomia/cosa-e-la-bioeconomia/presentazione/; accessed 31.7.2024

While the Italian bioeconomy strategies BIT I and BIT II had been developed by temporal task forces coordinated by staff from the Presidency of Council of Ministers, a similar coordination group was formally institutionalized in 2021 as National Bioeconomy Coordination Board (NBCB) under the National Committee for Biosafety, Biotechnology and Life Science (CNBBBSV) (Presidenza del Consiglio dei Ministri 2021). Its mandate was renewed in 2023 (Presidenza del Consiglio dei Ministri 2023). Composition and terms of reference of the NBCB are given in chapter 4.4.2.

The Italian national bioeconomy strategies BIT I and BIT II, respectively, are interrelated with other national initiatives[9]:

- In 2022, the Conference of Italian Regions and Autonomous Provinces, the official place of the interregional institutional dialogue, published a document on bioeconomy supply chains (Conferenza delle Regioni e delle Province autonome 2022). This demonstrates the commitment of the regions and autonomous provinces to a circular bioeconomy. The document is also a call for coherent actions to strengthen existing and to implement new and sustainable bio-based supply and value chains.
- The Studies and Research Department of Intesa Sanpaolo, the largest Italian bank, in collaboration with the Italian Circular Bioeconomy Cluster SPRING and the Italian Association for the Development of Biotechnology, Federchimica-Assobiotec, annually publish the reports “Bioeconomy in Europe”. These reports characterise the status of the Italian bioeconomy and put it into the EU context (Intesa Sanpaolo et al. 2021, 2022, 2023, 2024). Federchimica-Assobiotec also played an important role in advocating for national bioeconomy strategies.
- In 2021, Italy hosted the workshop “Bioeconomy in OECD countries” (Gardossi et al. 2023).

The Italian national bioeconomy strategies BIT I and BIT II, respectively, are interrelated with other national strategies[9] (Figure 7). Some of them preceded the bioeconomy strategies and covered only parts of bioeconomy (e.g. National Smart Specialisation Strategy[10], National Research Programme 2015-2020[11], Strategic Plan for Innovation and Research in Agriculture, Food and Forestry[12]), others provide important funding for bioeconomy activities (e.g. National Smart Specialisation Strategy[10], National Research Programmes[11], [13], National recovery and resilience plan[14]). Some were developed in interaction with the NBCB (National Forest Strategy[15], National Strategy for the Circular Economy[16]) or with contributions from NBCB members (National Research Programme 2021-2027[17]).

[9] CNBBSV - Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita - Iniziative nazionali (palazzochigi.it); accessed 19.8.2024
[10] Ministerio dello Sviluppo Economico et al. (2016).
[11] Ministerio dell'Istruzione, dell'Università e della Ricerca (2015).
[12] Ministerio delle Politiche Agricole, Alimentari e Forestali (2014).
[13] Ministerio dell'Università e della Ricerca (2021).
[14] Italian Government (2021).
[15] Ministero delle politiche agricole alimentari e forestali (2022).
[16] Ministerio della Transizione Ecologica (2022).
[17] Ministerio dell'Università e della Ricerca (2021).

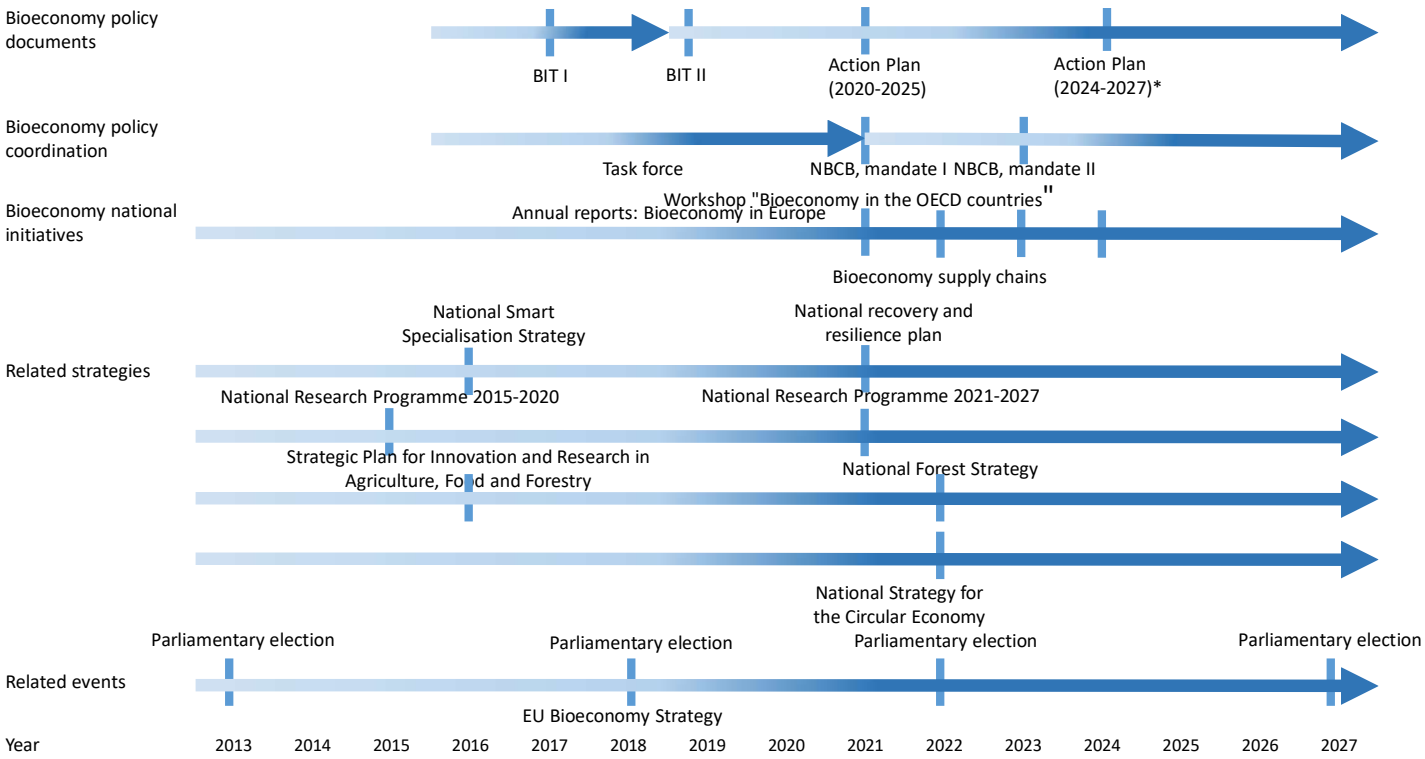


Figure 7: Bioeconomy policy milestones in Italy

Source: Fraunhofer ISI

4.4.2 Coordination mechanisms

Three major coordination mechanisms were identified for the coordination of bioeconomy strategy development and implementation in Italy:

- Task forces
- National Bioeconomy Coordination Board (NBCB)
- Regional coordination bodies and clusters

These coordination mechanisms will be characterised in more detail below.

Task forces

From 2016 to 2021, the development of the Italian national bioeconomy strategies BIT I and BIT II and their implementation were coordinated by two task forces.

The BIT I-task force which was coordinated by staff of the Presidency of the Council of Ministers and co-coordinated by the Ministry for Economical Development. The ministries of Education, University and Research, of Agriculture, Food and Forestry, of Environment, Land and Sea, the Committee of Italian Regions, the Agency for Territorial Cohesion and three technology clusters (AgriFood CL.A.N., Green Chemistry SPRING, and Blue Growth) were actively involved in this task force.

The BIT II-task force had a quite similar institutional composition as the task force for the first bioeconomy strategy[18] and was again coordinated by staff of the Presidency of the Council of Ministers. In both task forces, the coordinators were supported by scientific coordinators.

It can be concluded that all main central and regional administrations as well as representatives of research and company stakeholders were represented and actively involved in these task forces.

National Bioeconomy Coordination Board (NBCB)

Since 2021, the National Bioeconomy Coordination Board (NBCB; *Gruppo di Coordinamento Nazionale per la Bioeconomia - GCNB*) is the main formal coordination body. It is located at the prestigious Presidency of the Council of Ministers, the administrative structure which supports the Prime Minister of Italy, equivalent to Prime Minister's Office in other countries. The Presidency of the Council of Ministers comprises offices which collaborate with the Prime Minister directly, offices for specific political and institutional areas (e.g. regional affairs, European policy, digital transformation), offices for general coordination, and committees and commissions. Within the Presidency of the Council of Ministers, the NBCB is established within the National Committee for Biosafety, Biotechnology and Life Sciences (CNBBSV - *Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita*).

Tasks of the NBCB

According to Art. 2 of the decree to establish this group (Presidenza del Consiglio dei Ministri 2021), the NBCB has the following tasks:

a) to coordinate the initiatives in the bioeconomy sector, on the basis of the national, European and international regulations in force

[18] The Agency for Territorial Cohesion was not involved in the 2nd task force.

b) to ensure an effective synergy between national, regional and local public administrations and the national technology clusters operating in the bioeconomy, in order to define a regulatory, research and innovation and communication framework that is consistent and up-to-date with the actual needs of the entire country, minimising duplications and fragmentation

c) to facilitate and monitor the implementation of the National Bioeconomy Strategy and related action plans (BIT - 20 April 2017 and subsequent amendments) and to progressively propose measures and actions to make the development of a sustainable bioeconomy in a more timely and effective manner throughout the country's territory

d) to ensure the monitoring and coordination of training, technology transfer and communication actions related to the bioeconomy as well as public policies related to the latter, with particular reference to the prevention and minimisation of waste and plastics and the full use of biological and renewable resources and the circularity of the economy

e) to implement, monitor and strengthen international initiatives that can foster the bioeconomy in the Mediterranean basin

f) to ensure the alignment of the national strategy with the European strategy, drawn up and monitored by the European Commission, and to ensure the coordination of public and private actors and national and regional institutions, also through the National Technological Clusters, in order to achieve a more qualified and effective participation of the country in the definition of priorities calls for proposals of supporting research and innovation in favour of the bioeconomy, within the Horizon 2020, the Horizon Europe, and the future Public Private Partnerships and the LIFE and INTERREG programmes, supported by the European Commission.

Composition of the NBCB

The NBCB has a similar institutional composition as its predecessors, the task forces: The five[19] national ministries with major responsibilities in bioeconomy are represented (agriculture and forestry, economic affairs, environment, research, education), as well as representatives from the regions and autonomous provinces. New members, not represented in the task forces are two institutes: the Institute for Environmental Protection and Research (ISPRA) and the Association for the Development of Industry in the Mezzogiorno (SVIMEZ). The group is jointly chaired by the President of the CNBBSV and a scientific coordinator. The latter is appointed by the President of the CNBBSV (Table 5). If specific expertise is required, experts with knowledge in the respective field are regularly invited to participate in the meetings and activities of the NBCB.

There were only few changes over time in the institutions which make up the NBCB: The Agency for Territorial Cohesion was closed down in the course of administrative changes in december 2023 and could therefore be no longer a member of the NBCB. The national Cluster Italy Forest Wood (*Italia Foresta Legno Cluster Nazionale*), newly founded in 2023, became a member of the NBCN in 9/2023. The involved ministries changed their names due to governmental changes (Presidenza del Consiglio dei Ministri 2023), but retained their responsibilities for bioeconomy.

While the institutional composition remained rather constant over time, there were more frequent fluctuations on the level of individuals as members of the group. This may be due to frequent changes of

[19] Compared to the task forces, the number of ministries in the NBCB increased from 4 to 5, because the Ministry of Education, University and Research in the task forces was divided into two ministries, namely Ministry of Education (and Merit), and Ministry of University and Research. They are both institutional members of the NBCB.

the Italian government, even between parliamentary elections, and subsequent organisational changes in their respective institutions. In most cases, staff from higher hierarchical levels is delegated by their institutions to the NBCB, e.g. advisor to the respective minister, head of the respective minister's technical secretariat, Director General, head of relevant divisions, cluster presidents or directors. Both political staff as well as technical staff with bioeconomy-specific expertise from the ministries are delegated as members of the NBCB.

Table 5: Composition of the National Bioeconomy Coordination Board (NBCB)

2021 - 2023	2023 - present
Coordination/Chair: President of the CNBBSV Scientific Coordinator NBCB	Coordination/Chair: President of the CNBBSV Scientific Coordinator NBCB
Ministry of Agricultural, Food and Forestry Policies	Ministry of Agriculture, Food Sovereignty and Forestry (MASAF)
Ministry of Education	Ministry of Education and Merit (MIM)
Ministry of University and Research (MUR)	Ministry of University and Research (MUR)
Ministry of the Environment and Protection of Land and Sea	Ministry of the Environment and Energy Security (MASE)
Ministry of Economic Development (MISE)	Ministry of Enterprise and Made in Italy (MIMIT)
Permanent Conference for relations between the State, the Regions and the Autonomous Provinces of Trento and Bolzano	Permanent Conference for relations between the State, the Regions and the Autonomous Provinces of Trento and Bolzano
Agency for Territorial Cohesion (closed 12/2023)	-
Association for the Development of Industry in Southern Italy (SVIMEZ)	Association for the Development of Industry in Southern Italy (SVIMEZ)
Institute for Environmental Protection and Research (ISPRA)	Institute for Environmental Protection and Research (ISPRA)
Cluster CL.A.N. (Agrifood)	Cluster CL.A.N. (Agrifood)
Cluster SPRING	Cluster SPRING (Green chemistry, Circular bioeconomy)
Cluster BIG (Blue Italian Growth)	Cluster BIG (Blue Italian Growth)
-	Cluster Italia Foresta Legno (since 9/2023)

Source: Fraunhofer ISI compilation and translation of information available at CNBBSV - Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita - Composizione precedente Gruppo di Coordinamento Nazionale di Bioeconomia 2021-2023 (palazzochigi.it); CNBBSV - Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita - Composizione attuale Gruppo di Coordinamento Nazionale di Bioeconomia 2023 (palazzochigi.it) and Presidenza del Consiglio dei Ministri (2021).

The NBCB is administratively supported by the CNBBSV secretariat.

The NBCB has no decision-making competence regarding bioeconomy policy itself. This competence remains with the ministries and the Permanent Conference for Relations between the State, the Regions and the Autonomous Provinces, respectively. However, the NBCB prepares these decisions by gathering the relevant information, by coordinating different perspectives, and by resolving conflicts as far as possible.

Neither the CNBBSV nor the NBCB has a dedicated budget for the implementation of bioeconomy measures. It is in the competence of each of the involved ministries to decide which financial resources will be devoted to the Italian bioeconomy in their respective field of responsibility.

Regional coordination bodies and clusters

Several members of the NBCB are regional coordination bodies or clusters which send one or several delegates to the NBCB to bring in the perspectives and positions of their members.

Perspectives and positions of the **Italian regions** and autonomous provinces are brought into the NBCB by delegates from the Permanent Conference for Relations between the State, the Regions and the Autonomous Provinces of Trento and Bolzano and from the Association for the Development of Industry in the Mezzogiorno (*Associazione per lo sviluppo dell'industria nel Mezzogiorno* - SVIMEZ). The state-regions conference is a federalistic institutional structure which gathers the presidents of the 20 Italian regions and the two autonomous provinces Bolzano and Trento (Conferenza delle Regioni e delle Province autonome 2023). SVIMEZ is an association which studies the economic conditions of the Mezzogiorno and proposes concrete programmes of action for developing industrial activities in order to overcome the North-South divide[20].

Perspectives and positions of **different sectors** are brought into the NBCB by four **national clusters**. They are public-private multi-stakeholder partnerships with companies, business associations, public and private research organisations, training bodies, regional clusters, innovation hubs and regional agencies as members. The Cl.uster A.grifood N.azionale (CL.A.N.) [21] operates in the agri-food sector, the cluster SPRING[22] (acronym of Sustainable Processes and Resources for Innovation and National Growth) represents the Italian bio-based industry and circular bioeconomy, the cluster BIG (acronym of Blue Italian Growth) gathers the Italian maritime economy[23], and the cluster Italia Foresta Legno covers forest and wood value chains[24].

Several entities are members of more than one cluster. It can be assumed that all major players from research, industry and public administration in the Italian circular bioeconomy are somehow represented through one of the above-mentioned networks or coordination bodies in the NBCB. However, civil society does not seem to be well represented by relevant organisations, e.g. by environmental NGOs.

[20] SVIMEZ; accessed 20.8.2024
[21] soci/imprese - Cluster Agrifood Nazionale CL.A.N.; accessed 21.8.2024
[22] Cluster Spring; accessed 21.8.2024
[23] Cluster Big – The only National Technological Cluster of the Maritime Economy, established and recognized by the Ministry of University and Research; accessed 21.8.2024
[24] IFL Who we are - Italy Forest Wood (italiaforestalegno.it); accessed 21.8.2024

4.4.3 Coordination mode

In the following, it is characterised how coordination takes place in the NBCB, based on the information and subjective assessments gained in the expert interviews.

Tasks and activities of the NCBC

The official mandate and tasks of the NBCB are given in the decree for its institutionalisation (chapter 4.3.2). In the following, examples are given what the NBCB has done in the recent past, either from its own initiative, or on request or suggestion of ministries or members of the NBCB. In general, the group is reported to be open to suggestions and requests, and is willing and able to (re)act flexibly. The NBCB

- connects the main actors of the Italian bioeconomy. Plenary group meetings are held regularly every three months[25]. These meetings on the one hand serve the mutual information of ongoing discussions, plans and activities in the involved institutions, on EU and international level. On the other hand, various issues are discussed and endorsed.
- elaborates and revises the implementation action plan. Among others, the coordination work comprises the development of commonly endorsed concepts for six large flagship projects. These flagship projects are public-private partnerships. They are highly relevant especially for the clusters as well as the Italian regions in acquiring funding and implementing bioeconomy activities.
- contributes to the elaboration of related strategies by active involvement in the respective processes, e.g. the national forestry strategy and the circular economy strategy.
  - In the case of the national forestry strategy, the leading person for the forestry strategy was also delegated by her ministry to the NBCB. At several stages in the strategy process, the actual state and different issues of the forestry strategy were discussed within the NBCB. This led to an alignment of formerly independently developed visions of forestry and bioeconomy into a shared one.
  - In the case of the circular economy strategy, the NBCB was engaged by the leading environmental ministry in the set-up of the document, was then responsible for adding the parts on the use of biomass resources, and circular economy in the food- and bio-based industry and in the blue economy to the first draft, and was also involved in iterative revisions of the drafts until the final version. As a result, bioeconomy became an integral part of the circular economy strategy.
- assists ongoing activities of the ministries and provide inputs according to the ministries needs,
  - e.g. in the form of developing position papers which “metabolise” and integrate the different perspectives provided by the NBCB members. These balanced position papers can then be used by the responsible ministries or stakeholders to intervene at high political levels, e.g. of the European Commission. Examples of such positions papers produced by the NBCB comprise a paper on the use of biofuels after 2025 in the EU, an opinion to support the Italian position on bio-based plastics on the EU level26 regarding the transposition of the EU single-use plastic directive, or a reaction to the communication from the Commission on Biotechnology and Biomanufacturing (European Commission 2024).
- on request of the Ministry of Education contributed with bioeconomy education issues for the primary and secondary schools in the frame of the National Plan “Rigenerazione Scuola”[27]

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[25] https://cnbbsv.palazzochigi.it/it/bioeconomia/gruppo-di-coordinamento-nazionale-per-la-bioeconomia-gcnb/riunioni-plenarie-gruppo-di-coordinamento/; accessed 23.8.2024

[26] CNBBSV - National Committee for Biosafety, Biotechnology and Life Sciences - GCNB note in support of the Italian position in the transposition of the SUP Directive (palazzochigi.it); accessed 20.8.2024

[27] RiGenerazione Scuola - Homepage (istruzione.it); accessed 23.8.2024

- elaborates relevant topics in NBCB working groups. These groups are usually suggested by NBCB members who then also lead the respective working group. The working groups are also open to experts and stakeholders who are not members of the NBCB. Working groups report their progress regularly in the plenary NBCB meetings. The following working groups were active in 2023[28]:
  - Biobased made in Italy (coordinated by cluster SPRING),
  - Use of Ateco codes (coordinated by cluster SPRING)
  - Packaging, single use plastics, packaging and packaging waste regulation (coordinated by clusters SPRING and CL.A.N)
  - Ultra-processed foods (coordinated by cluster CL.A.N), and
  - Soil health (coordinated by ISPRA).

Collaborative work in such activities is usually done by collecting inputs from all group members which are then consolidated in internal discussions. Group members then share the draft within their respective institution for feedback, additional input and endorsement, until a final version is produced. Depending on the type of product and the time schedule, the NBCB is also open to additional input and comments, e.g. from less involved actors in the group members' network and also beyond. Documents such as the implementation action plan must be endorsed by the respective ministry.

Roles of NBCB members

The five Italian **ministries** with responsibilities for the bioeconomy delegate political persons on high hierarchical levels as well as technical level persons knowledgeable in bioeconomy issues to the NBCB. While in the first task force, the Ministry for Economical Development had the co-coordination besides the coordination by staff from the Presidency of Council of Ministers, in the NBCB there is a level playing field for all ministries. In line with their competencies within the bioeconomy, each ministry has a different role in that it is mainly responsible for the implementation of a specific part of the bioeconomy strategy and the related implementation plan and also decides on the respective financial issues. The ministries are free to suggest topics for the NBCB and, if taken up, usually also have the lead regarding this specific topic.

The representation of the Italian **regions and autonomous provinces** by delegates from the Permanent Permanent Conference for relations between the State, the Regions and the Autonomous Provinces of Trento and Bolzano and some of its committees, from the Agency for Territorial Cohesion and from the Association for the Development of Industry in Southern Italy (SVIMEZ) reflects that "there are many bioeconomies", and that there is also competition between regions and territories which requires coordination. The membership of regions in the NBCB facilitates their engagement in the implementation of bioeconomy activities which can be tailored to the specific needs, resources, and competencies of the respective regions or territories. On the other hand, coordination in the NBCB supports the regions in their application for funding by EU regional development funds.

The four **clusters** involved in the NBCB are public-private partnerships, operated with the objective to implement bioeconomy in their respective sectors. Their delegates specifically bring in the challenges, concerns and needs from the perspective of industry and academia. They enhance the understanding in the NBCB what the needs and potential solutions in terms of policy, research and innovation, knowledge transfer, markets are.

The NBCB has two **coordinators**: it is jointly coordinated by the President of the CNBBSV and the scientific coordinator. Currently, the scientific coordinator has a stronger role, due to this person's

[28] CNBBSV - Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita - Gruppi di Lavoro 2023 (palazzochigi.it)

outstanding expertise in bioeconomy, his high international reputation and his intense interconnectedness in bioeconomy on national, EU and international levels. He understands his role mainly as facilitator and is highly appreciated for his integrative personality.

Working mode and working climate

All in all, the working climate within the NBCB seems to be open, with the members communicating on equal terms, are encouraged to ask questions, to bring in their opinions and issues, and are being listened to, with the aim to learn from each other and develop mutual understanding. The elaboration process of joint documents, such as e.g. the implementation action plans, is described as a co-creative and co-design process.

Challenges

The following challenges are encountered in the NBCB:

- General difficulty to bring so many individuals with different backgrounds, representing different institutional interests to work together effectively.
- High fluctuations of persons delegated to the NBCB, due to frequent governmental changes, even between parliamentary elections. This reduces the continuity, slows down processes as it takes time to appoint new delegates, and requires the integration of the new person and align and recalibrate the perspectives accordingly.
- Some ministries have the interest not to address certain (controversial) topics in the NBCB.
- Challenge to engage the regions in bioeconomy and to reduce the competition between them.
- NBCB activities must be approved by government bodies, whereas the representation of regions and autonomous provinces as well as clusters can act more flexibly and more autonomously also on their own. This may occasionally create tensions between NBCB members.
- Financial restrictions imposed by the responsible ministries where the competence for financial decisions resides.
- Bioeconomy, its strategy and implementation plan are hardly known beyond the core bioeconomy community. Other challenges, e.g. the Covid pandemic, the economic situation, geopolitical conflicts, attract more attention.

Successes

Interviewees considered the following aspects as successes of the coordination carried out by the NBCB:

- Development of a revised implementation plan with agreement on cross-sectoral and cross-regional flagship projects which is endorsed by all major players
- Active contribution in the process of developing the forestry and circular economy strategies, demonstrating horizontal alignment of related strategies
- Support of ministries with some co-designed joint position papers which are more robust and have more impact because the papers collect, integrate and align different perspectives
- Gradual improvement and reduced focus on controversial topics with conflicting positions of the ministries over time, shift towards opportunities
- Increased motivation and engagement of regions in bioeconomy
- Increased collaboration between the sectorial clusters regarding concrete projects, but also intensified consultations and adoption of common positions
- Increased mutual understanding, trust and openness between the members of the NBCB, formation of informal networks between the involved institutions

- Better understanding which are the costs for companies if they would switch to bio-based and circular business models and value chains

Success factors

The following success factors were derived for bioeconomy coordination by the Italian NBCB:

- Inclusion of all major players from national and regional policies and administration, academia and industry as members of the NBCB
- Creating a level playing field for all (ministry) members of the NBCB by embedding the NBCB into the CNBBSV at the Presidency of Council of Ministers, a politically high-ranking, prestigious, but "neutral" place
- Joint coordination of the NBCB by the president of the CNBBSV and a scientific coordinator, the latter current position holder being highly appreciated for his personality, competence, reputation and way of facilitating the processes within the NBCB and the NBCB collaboration with other institutions and stakeholders
- Mindset of the NBCB members to see bioeconomy as a strategic area to address grand challenges and foster economy and quality of life, willingness to contribute, acknowledgement of the need to act when priorities change
- Open working and communication climate within the NBCB, members communicate on equal terms, their needs and concerns are listened to and are taken into consideration, NBCB is open to suggestions and inputs from all members, and from stakeholders beyond the NBCB
- Embeddedness of NBCB members into member-specific wider networks of bioeconomy stakeholders, topic-specific bidirectional exchange between NBCB and this wider community, mediated via the NBCB members
- Co-creative and co-design processes which support mutual learning processes between involved individuals and institutions and sometimes result in more robust and impactful position papers
- NBCB members experienced in several cases that the NBCB activities have positive impacts for them and the stakeholders they represent, and this impact is higher than the impact of activities of individual members alone

4.4.4 Conclusion

Italy developed its first dedicated bioeconomy strategy in 2016/2017 in response to the call from the European Commission that EU member states should develop their own bioeconomy strategies. This strategy and the subsequent revised national bioeconomy strategy BIT II were elaborated by task forces. Since 2021, the implementation of BIT II is coordinated by a formally institutionalised National Bioeconomy Coordination Board (NBCB). It has a similar, but slightly broader composition than the task forces. All major players and stakeholders, namely the five national ministries with responsibilities for the bioeconomy, representatives of the regions and autonomous provinces, as well as representatives of four national clusters are members of the NBCB. Therefore, all major players from research, industry and public administration from national and regional governance levels in the Italian circular bioeconomy are represented by the NBCB members or their corresponding networks. However, civil society does not seem to be well represented by relevant organisations, e.g. by environmental NGOs.

The task forces were coordinated by staff of the Presidency of Council of Ministers, giving the corresponding strategy processes and bioeconomy strategies a high degree of legitimacy[29]. The NBCB is also located at the Presidency of Council of Ministers, within the Committee for Biosafety, Biotechnology and Life Science (CNBBSV). This is a prestigious, but neutral space, creating a level playing field for the involved members. In line with this level playing field, the NBCB is jointly coordinated by the president of the CNBBSV and a scientific coordinator. The latter has filled this position since the first task force. This secures continuity in coordination bodies which suffer from frequent changes of the individual delegates due to frequent governmental changes and subsequent organisational changes. Moreover, the scientific coordinator is highly appreciated for his personality, competence, reputation and way of facilitating the processes within the task forces, within the NBCB, and between the NBCB and other institutions and stakeholders.

The working climate within the NBCB has been described by interviewees as open and motivating, the working mode as interactive and co-creative.

Indicators for successful coordination outcomes are

- the alignment of bioeconomy-, circular economy- and forestry strategies,
- an increasingly successful engagement of regions in the implementation of bioeconomy activities and encouragement of their collaboration,
- intensified cross-sectoral collaborations and consultations between clusters,
- setting priorities in the form of flagship projects which are endorsed by all NBCB members,
- co-design and co-creation of robust position papers for ministries and other stakeholders with increased impact.

The NBCB has neither decision-making competence regarding bioeconomy policy itself nor a dedicated budget for the implementation of bioeconomy measures. This competence remains with the ministries and the Permanent Conference for Relations between the State, the Regions and the Autonomous Provinces, respectively. However, the NBCB prepares these decisions by gathering the relevant information, by coordinating different perspectives of a broad range of stakeholders, and by resolving conflicts or aligning different interests as far as possible.

National specificities seem to be:

- The Italian Bioeconomy strategies and their subsequent implementation tend to be oriented towards and aligned with activities at the European Commission and European funding, e.g. via Horizon 2020 and Horizon Europe funding, and support for innovation-led territorial development (e.g. via the European Regional Development Fund (ERDF).
- The prevailing and shared perspective among bioeconomy stakeholders seems to be that bioeconomy is seen and implemented more from an economic perspective, benefitting industry and regional economic development, e.g. by job creation. Culturally, a more pragmatic attitude in dealing with controversial issues can be observed, e.g. compared to Germany. If decision-makers see an action as "the right thing to do" in order e.g. to benefit industry and job creation, this action is taken, even if there are concerns and protests against these actions, rather than reflecting potential trade-offs in lengthy processes.

[29] Legitimacy is "a generalized perception or assumption [by evaluating organizations in the context] that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions" (Suchman 1995).

- Although regions and provinces are to a certain extent autonomous, and their specificities need to be taken into account in order to implement regionally tailored bioeconomy activities, national "top-down" guidance of regions seems to play a larger role than e.g. in the federal structure of Germany.
- Frequent government changes, leading to high fluctuation within the NBCB and subsequently to a loss of efficiency and speed.

4.5 Bioeconomy policy coordination in Estonia

The Estonian government adopted the circular bioeconomy roadmap in 2023 (Regionaal- ja Põllumajandusministeerium et al. 2023). This chapter focuses on the development of this roadmap which was carried out as part of the efforts to elaborate a national circular economy strategy.

4.5.1 Bioeconomy policy milestones in Estonia

Attempts to develop an Estonian bioeconomy strategy started already before 2015. In 2015, a conference was organized in 2015 to collect input from different public and private stakeholders. The Ministry of Rural Affairs then prepared an analysis and proposal to develop the Estonian bioeconomy strategy until 2030 (Jaakma 2018). Several factors prevented a prompt realisation of this proposal: bioeconomy was included in a larger number of sectoral strategies. The ambiguity of the bioeconomy concept was also complicating the development of a common understanding between the different stakeholders and government entities. The governmental office's position was that the country had adopted too many strategies and should therefore limit the amount of strategic documents. The government could not find a common understanding which ministry should lead the process.

Important sectoral strategic frameworks and steps towards the adoption of the circular bioeconomy roadmap were the national energy and climate plan 2030 that was jointly developed by the Ministry for Economic Affairs and Communication, the Ministry for Climate and the Ministry for Rural Affairs. One of its main objectives outlined was the bio-economy as a prioritized topic including agriculture, forestry, fishing and other related fields (O'Riordan et al. 2024, p. 14). In addition, the strategy "Estonia 2035" outlines the objective that Estonia should become a recognized development centre for the bioeconomy in Europe. As a horizontal and cross-cutting theme, the bioeconomy has also been included as an important cross-cutting theme in the Agriculture and Fisheries Strategy adopted in 2021 (O'Riordan et al. 2024).

In 2020, the Ministry for the Environment established the Circular Economy Advisory Steering Group (CEAG). It has the mandate to advise the Minister of the Environment in developing the circular economy in Estonia further. This steering group was the main instrument for the formal adoption of the circular bioeconomy roadmap in 2023. At the beginning of 2024, the Ministry of Regional Affairs and Agriculture appointed a Deputy Secretary General for Bioeconomy who has the role to combine and harmonize the sectoral needs into a coherent bioeconomy framework. The Deputy Secretary General manages the work of the Fisheries Policy Department, the Agricultural Policy Department and the Agri-Environmental Policy Department.

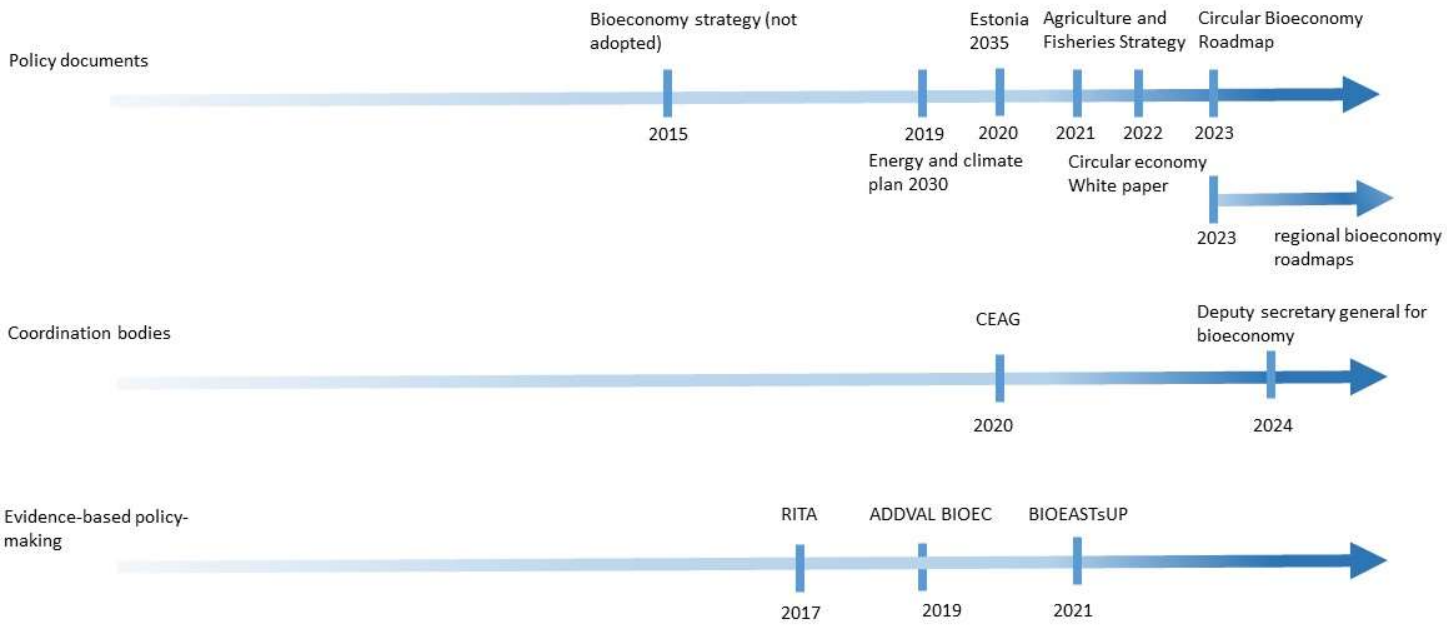

Figure 8: Bioeconomy policy milestones in Estonia

Source: Fraunhofer ISI

Evidence-based policy-making played an important role for bioeconomy policy-making in Estonia. In this respect, the RITA programme funded by the Estonian Research Council and the European Regional Development Fund (ERDF) played a crucial role in supporting the Estonian state in policy-formulation. As part of RITA, the Estonian state collaborated with applied research projects. One of the projects that dealt specifically with bioeconomy was "ADDVAL-BIOEC - Adding value and making more efficient use of raw materials in the bioeconomy and its sectors". In this applied research project, the Estonian bioeconomy was mapped and six value chains were analysed (ADDVAL-BIOEC 2021). Another important project on Estonia's path towards the integration of sectoral goals into a bioeconomy policy framework was the Horizon 2020 funded coordination and support action BIOEASTsUP that supported BIOEAST countries in developing national bioeconomy strategies.

4.5.2 Coordination mechanisms

For the development of the circular bioeconomy roadmap different mechanisms were used in order to achieve coordination between the relevant ministries and stakeholders. The initiative for developing this roadmap came from the Ministry for Rural Affairs. According to the Estonian Memorandum of Cabinet, which was the basis for the preparation of the roadmap, the coordination aimed to draw up a roadmap for the development of the circular bioeconomy including the development of regional roadmaps (Peepson 2021). It was later decided that the roadmap process should be carried out under the coordination of the CEAG.

Evidence-based policy formulation and Science-Policy-Interface

The foundation for developing the circular bioeconomy roadmap were grounded in two research projects, which aimed to support evidence-based policy formulation in Estonia: ADDVAL-BIOEC and BIOEASTsUP. They will be characterized in the following paragraphs.

ADDVAL-BIOEC

Jointly commissioned by the Ministry for Rural Affairs, the Ministry for the Environment and the Ministry for Economic Affairs and Communications, the applied research project "ADDVAL-BIOEC - Adding value and making more efficient use of raw materials in the bioeconomy and its sectors" was conducted in the period 2018-2021. The project was funded by the Estonian Research Council as part of the framework RITA (Reinforcement of sectoral research and development activities). Funded by the European Regional Development Fund (ERDF), RITA aimed to fulfil the following objectives:

- Increase the role of the state in the strategic steering of research, including in the setting of priorities and the managing of research towards tackling the challenges faced by society
- Strengthen the competency and capabilities of the ministries to organise applied research and use it to tackle socio-economic problems
- Raise the effectiveness of collaboration among ministries, state and R&D institutions in planning and conducting R&D in line with national objectives, and boost the capabilities of Estonian R&D institutions in carrying out applied research
- Develop research strands important for the state and support the emergence of the next generation of researchers in these research areas as well as increase the gender balance in the staffing of positions, and the consideration of gender aspects in research.

The aim of the ADDVAL-BIOEC project[30] was to identify the developments in the Estonian bioeconomy and its main value chains and the possibilities of using bio-resources to increase competitiveness. Taking into account the principles of sustainable development, the perspectives of increasing added value and better use of raw materials were considered. The state of the Estonian bioeconomy was analysed across six value chains:

1. Food and feed
2. Pulp, paper, wood products and wood construction
3. Textiles and clothing
4. Fuels and energy
5. Biomaterials, chemicals, pharmaceuticals, plastics and
6. Ecosystem services related to the bioeconomy

The suitability of the best possible innovative technologies for valorising Estonia's bio-resources was investigated. Scenarios for the development of the Estonian bioeconomy and business models in selected fields were developed and their social, economic and environmental impact was analysed.

The project was led by the University of Life Sciences and carried out by a consortium of researchers from Tallinn University of Technology, University of Tartu, the Estonian University of Life Science and the Institute of Baltic Studies. The results of the ADDVAL-BIOEC project served as a basis on which the involved ministries could develop a common understanding of priority topics and align their expectations with the expertise of the applied-research consortium. The results of this research project lay the ground for the topics addressed in the circular bioeconomy roadmap.

Scientific advisors

The RITA programme is used by the Estonian Research Council to support socio-economical applied research based on the needs of Estonian state. The aim is to increase the role of the state in strategic management of research and the capacity of R&D institutions in carrying out socially relevant research.

As part of RITA II, scientific advisor positions were supported at the Ministries and the Government Office. The scientific advisors should advise the ministries in strategic R&D questions and improve the ministries' capabilities on R&D issues. The role of the advisors included coordinating R&D cooperation at the national and international level, developing research plans in the governance area of the ministries. For developing the circular bioeconomy roadmap, it remained unclear from the conducted interviews which role these scientific advisors actually played. Several interviews indicated a rather complementary role in shaping the process.

BIOEASTsUP

In addition to the ADDVAL-BIOEC project, also the BIOEASTsUP coordination and support action (CSA) funded by H2020 played an important role for the coordination and the development of the circular bioeconomy roadmap. BIOEASTsUP started in 2019 and the project phase ended in 2023. The project aimed to support the deployment of bioeconomy on national, macro-regional and EU levels. It was deployed in 11 Central Eastern European countries and supported by various government ministries and bioeconomy stakeholders. It helped to prioritize bioeconomy focal points and to assist national ministries in preparing national bioeconomy strategies. In facilitating evidence-based policy-making, the project built up a framework for national bioeconomy strategy development in Eastern European countries. The work plan was structured as follows, including communication and dissemination activities and project management:

[30] https://taltech.ee/biomajandus#p35408

- WP1: Framework for national bioeconomy strategy development
- WP2: Capacity building for BIOEAST stakeholders
- WP3: Establishing macro-regional structures in support of the BIOEAST initiative
- WP4: BIOEAST strategic research and innovation agenda (SRIA) development

As part of the project, different interministerial platforms were established with the aim to develop a shared understanding how the bioeconomy should look like in the different BIOEAST countries. As a result, each country developed concept papers in which the foundations for the national strategy project were outlined. In the context of preparing the circular bioeconomy roadmap in Estonia, the consortium assisted the Ministry for Rural Affairs in providing a structure of the roadmap. For instance, the Estonian concept paper reflected the draft of the Estonian circular bioeconomy roadmap and referred to the importance of different sectoral strategies and the contribution of the ADDVAL-BIOEC project.

In addition, as part of the BIOEASTsUP CSA, the University of Life Sciences[31] had an important role in the foresight exercise for the BIOEAST countries. Moreover, it conducted several roundtables where stakeholders from science, politics, industry and civil society participated and shaped the input for the roadmap. The University of Life Sciences bundles up all academic and research activities dedicated to the sustainable development of natural resources (Jaakma 2018). Designed as an inclusive process, ideas how the roadmap should address the bioeconomy were collected and analyzed through additional roundtables. These roundtables served to discuss the bioeconomy in its basic terms in order to build a common understanding and to facilitate the dialogue between the ministries and other stakeholders. Besides formal formats of coordination, the interview partners perceived also informal networks between stakeholders as an enabling factor for the coordination of the circular bioeconomy roadmap. Due to the small size of the country, responsible civil servants and other stakeholders from the bioeconomy community know each other very well. This facilitated the collaboration between them and developing a common understanding. Especially bioeconomy related events, such as conferences or workshops are formats where the actors regularly meet.

Furthermore, input from stakeholders were also collected through the BioBaltic project[32] (Nordic-Baltic cooperation within bio-circular-economy). The project aimed to establish a platform for gaining awareness of different bioeconomy models though building networks across Baltic and Nordic countries. The project was funded by the Nordic Council and ran from 2021 – 2023. Within the project, the University of Life Sciences conducted a series of workshops to collect different perspectives of stakeholders and the BioBaltic project teams also contributed to the drafting of the circular bioeconomy roadmap.

Circular Economy Advisory Steering Group (CEAG)

For the formal adoption of the circular bioeconomy roadmap, the Circular Economy Advisory Steering Group (CEAG) served as the main decision-making platform. As outlined in the Memorandum of Cabinet (Peepson 2021), it was initially decided that the Ministry for Regional Affairs and Agriculture should set up a steering committee to develop a national roadmap for the development of the circular bioeconomy and to also coordinate regional roadmaps for the circular bioeconomy. However, later in the process it was decided that the CEAG under the lead of the Ministry for the Environment should be the coordinating body.

This steering group consists of all relevant ministries on the hierarchical level of Deputy Secretary Generals. Table 6 displays the group members and their affiliation.

[31] https://www.emu.ee/
[32] https://nordregioprojects.org/biobaltic/

Table 6: Members of the Circular Economy Advisory Steering Group (CEAG) and their affiliation

Member	**Affiliation**
Deputy Secretary of State for Higher Education and Research	Ministry of Education and Research
Deputy Secretary of State for Legal Policy	Ministry of Justice
Deputy Secretary for Defence Planning	Ministry of Defence
Deputy Secretary of State for the Arts	Ministry of Culture
Deputy State Secretary for the Internal Market	Ministry of Economic Affairs and Communications
Deputy Secretary of State for Fisheries Policy and External Relations	Ministry of Agriculture
Head of the Customs and Excise Policy Department	Ministry of Finance
Deputy Secretary of State for Assets, Planning and Technology	Ministry of the Interior
Deputy Secretary for Social Affairs	Ministry of Social Affairs
Special Envoy for Climate and Energy Policy	Ministry of Foreign Affairs
Director of Strategy, Strategy Bureau	State Chancellery

Source: Information based on Keskkonnaministeerium (2020)

The mandate of the CEAG is to advise the Minister of the Environment and to make proposals for the preparation of the Estonian Circular Economy Development Document and Action Plan, and later to monitor the implementation of the Estonian Circular Economy Development Paper and Action Plan (Keskkonnaministeerium 2020). In detail, the terms of reference entail

- Agreeing and formulating the vision and broad objectives of the Circular Economy Development Paper;
- Proposing priorities for the Circular Economy Development Paper and Action Plan, with a particular focus on Estonia's potential and local specificities;
- examining and commenting on the suggestions collected from other parties on the Circular Economy Development Paper and Action Plan;
- making proposals in relation to the implementation of relevant national or EU level strategies or actions, including for example the activities of the Green Deal;
- appointing the composition(s) of the Circular Economy Working Group(s), which will include relevant circular economy stakeholders, including research institutions, national umbrella organisation of local authorities, professional associations and chambers, NGOs;
- involvement of consultants, experts as appropriate;
- where appropriate, making proposals for further studies or analyses.

The steering group also serves as a platform for sharing information between the ministries and supports the alignment and coherence of their activities. Although not directly linked to the steering group, several stakeholder subgroups were set up for different topics, such as textiles, biowaste or plastics. However, the main negotiations between the ministries involved took place in bilateral exchange between staff from the

respective divisions. The results of these exchanges were then presented to the CEAG for approval. According to interviewees, this approval was obtained without controversial discussions in the CEAG.

4.5.3 Coordination mode

Considering the coordination of developing the circular bio-economy roadmap, the approach has been bottom-up and inclusive, according to the interviewed stakeholders. Although the interview partners regarded the ADDVAL-BIOEC and the BIOEASTsUP projects as important milestones for the process of developing the roadmap, they agreed that the influence of projects themselves is quite limited, as project consortia are not in the position and do not have the mandate to develop strategies. It depends on the initiative of the political actors whether the project results are taken up and lead to a commitment of the ministries and subsequently to activities.

From the very beginning of the coordination process, the government expressed the expectation that the input and the content of the roadmap should be provided by the different stakeholders who were included in the coordination through several formats as described in chapter 4.5.2. Stakeholders should provide bioeconomy related topics, the definition of problems and input how to solve associated challenges. They were supposed to define the main blocks of the roadmap content-wise. The main role of the ministries was to guide and moderate the process. The level of the ministries on the other side should only guide and moderate the process without affecting it very much. Stakeholders had the impression that they could significantly shape the roadmap according to their preferences. All involved actors had the possibility to bring in their prioritized topics.This resulted in a document all actors in the bioeconomy community could agree to. Especially the fact that Estonia is a very small country enabled stakeholders to find synergies and common agreements easily. This stakeholder involvement is part of science and evidence based policy-making in Estonia ensuring that these stakeholders are actively engaged in preparing political decisions of the government.

The following success factors for this bottom-up and inclusive approach of stakeholder involvement were derived from the interviews:

- Different stakeholder groups and their priorities are well represented
- Structured process with high degree of evidence-based policy formulation
- Small, well-connected bioeconomy community
- Similar and shared understanding of bioeconomy in the stakeholder groups

The interviewed stakeholders also shared the perspective that only few conflicting issues were discussed throughout the process of roadmap development. Although in Estonia bioeconomy goal conflicts are discussed in the context of forest degradation by the forest industry (Baffoni et al. 2018), such topics seemed not to be on the agenda in preparing the roadmap. Also alternative options such as food self-provisioning seemingly did not play a role (Pungas 2023). Problems that need to be solved in Estonia, according to the interviewees, are on much smaller scale than in larger countries. According to one interviewee, goal conflicts common for the bioeconomy would rather be discussed in traditional sectoral policies, such as in the context of the implementation of the forestry strategy, the agricultural strategy or the fishery strategies.

It is worth noting that the circular bioeconomy roadmap was not designed as an implementation plan with concrete measures and instruments. It was rather an outlined vision and strategic document that should provide the strategic basis for future funding decisions and activities. The vision and the objectives of the roadmap should subsequently be implemented through regional bioeconomy roadmaps that would include concrete measures for implementation. Negotiations for elaborating the circular bioeconomy roadmap had a focus on gaining a better understanding how different funding sources could be combined, but not on concrete funding decisions that might have resulted in conflicts over budgets.

4.5.4 Conclusion

The path towards the adoption of the circular bioeconomy roadmap serves as an enlightening example how coordination of bioeconomy policy is functioning in Estonia. The analysis shows that policy coordination in Estonia shows different characteristics and features than Germany or Italy.

Although this Eastern European country adopted its roadmap in 2023, Estonia is looking back to a dynamic evolution of bioeconomy policy-making. Bioeconomy had been included in sectoral strategies, but an attempt in 2016 to develop a bioeconomy strategy. In the development of the circular bioeconomy roadmap, in addition to a broad range of stakeholders, scientific actors played an important role in shaping the content of the roadmap. The research project ADDVAL-BIOEC as part of the RITA framework as well as the BIOEASTsUP project laid the fact-based foundation for the political priorities in bioeconomy. The Estonian example also shows the importance of international and European organizations, such as the ERDF in supporting policy-making in Eastern European countries. The process that followed was designed in a bottom-up approach, in which all relevant stakeholders were included in several formats. Especially this bottom-up approach can serve as an orientation for countries which have not yet developed a bioeconomy policy, strategy or roadmap: bottom-up approaches in policy-making may contribute significantly to more participation, legitimacy and ownership of results.

The Estonian circular bioeconomy roadmap was designed as a strategic vision for the future bioeconomy in Estonia, and not as an implementation plan with concrete measures. Goal conflicts between the stakeholders and the political actors were not an issue in the process. In order to develop bioeconomy coordination in Estonia further, one interviewee called for a more engaging role of the different scientific advisors at the national ministries. Additionally, it is being considered to establish a bioeconomy advisory council with stakeholders from science, industry and civil society as a means to ensure continuity and as a platform to further integrate sectoral policies into a coherent bioeconomy policy.

4.6 Cross-country analysis Germany – Italy - Estonia

4.6.1 Introduction and disclaimer

From the characteristics of bioeconomy, we derived the following requirements for effective bioeconomy policy coordination as analytical lens for the chosen case studies:

- Fulfilling two distinctive tasks: the development of a dedicated bioeconomy strategy, and the continuous implementation of the strategy by conceptualising actions and further development of the policy.
- Ability to set priorities, to resolve goal conflicts and to align diverging interests
- Coordinated and direct interaction and alignment of a multitude of stakeholders on different governance levels
- Ability to create ownership of coordination results for effective translation into actions
- Ability to flexibly adapt to changing conditions

In this chapter, we present options for coordination mechanisms and modes which were chosen by the three analysed countries how to meet these requirements. Each country had its own context, socio-economic structure, (political) culture, reasons and rationale, frame conditions and path dependencies why the respective option was chosen. These contexts can neither be changed deliberately nor do they allow the transfer of an option to another country with the expectation that the option would work the same way in the other country.

Therefore, it is not possible to decide whether one option is „better“ or „superior“ to another. This analysis cannot at all be understood as a comparison which country does better than the other. Rather, it shows the diversity of options, their strengths, potential pitfalls and success factors in a structured way. The aim is that other countries can reflect their own situation against this back-ground, using the presented options as a benchmark. We hope that this analysis and reflection induces mutual learning and gives inspiration how to further improve aspects of bioeconomy policy coordination in EU member states.

4.6.2 Bioeconomy policy milestones

One of the selection criteria for the countries to be analysed was the **length of time period with a dedicated national bioeconomy policy**, with the publication of the first dedicated bioeconomy strategy as milestone (chapter 4.2, Table 2). The underlying rationale was to capture pathways and changes in coordination challenges, mechanisms and modes over time.

Regarding the length of time period with a dedicated strategy, Germany can be characterised as a first mover with a first bioeconomy research strategy published in 2010 (Bundesministerium für Bildung und Forschung 2010), even two years before the first EU bioeconomy strategy (European Commission: Directorate-General for Research and Innovation 2012), and thus until now (2024) a period of 14 years with a dedicated bioeconomy policy.

Italy can the characterised as a follower. It published its first national strategy in 2017 (Italian Government 2017) in response to the EC call that EU member states should develop their own national bioeconomy strategies. The development of the first Italian strategy could benefit from experience gathered in first mover states and from parallel discussions on EC level for a revised EU bioeconomy strategy (European Commission 2018).

Estonia published a circular bioeconomy roadmap, developed within the circular economy strategy process, in 2023 (Regionaal- ja Pöllumajandusministeerium et al. 2023). However, the analysis showed that efforts for a dedicated bioeconomy strategy already started in 2015 – even earlier than in Italy. But for various reasons, these efforts did not result in a strategy. It can be understood as a “window of opportunity“ to integrate it into the circular economy strategy process to produce the circular bioeconomy roadmap.

*The analysis of the country-specific **pathways** (*Source: Fraunhofer ISI

Figure 6, Figure 7, Figure 8) shows that there is no single or uniform pathway towards a bioeconomy strategy, action plan and policy. The different timelines reflect that EU member states pursue different approaches. The examples of Germany and Estonia show that efforts do not necessarily result directly in a fully developed bioeconomy strategy, but that stepwise approaches can also be pursued. Different drivers led to the decisions to develop a dedicated national bioeconomy strategy. Table 7 gives an overview of relevant drivers with examples.

In Germany, the process to develop the bioeconomy strategies (research, policy and national strategy) can be characterised as a deliberate, formalized top-down approach. In Italy, the pathway towards the first bioeconomy strategy had a more emergent character: industry-driven activitities (demandside policies for bio-based plastics, changing refineries into biorefineries to support Italy’s chemical industry) preceded the formal process of developing the strategy BIT I (Imbert et al. 2017).

Table 7: Drivers for decision to develop a dedicated national bioeconomy strategy

Driver	Selected examples
International	
Developments in international bioeconomy policy and related policy networks	EU bioeconomy strategies OECD bioeconomy activities G7/G20 activities EC call to Member states to develop national strategies BioEAST Initiative, RITA European Bioeconomy Policy Forum Bioeconomy summits EU FP7 development (DE)
International policy developments legitimizing bioeconomy	Sustainable Development Goals Paris Agreement EU Green Deal
National	
Evidence from commissioned analyses and recommendations	Addval Bioec project (EE) BIOEASTsUP project (EE)
Demand from stakeholder groups	Industry (IT), e.g. demandside policies for bio-based plastics; Changing refineries into biorefineries (IT) Research policy, academia, industry (DE)
Need for consolidating sectoral policies into a comprehensive strategic framework	Germany, Italy, Estonia
Committment of hierarchically high policy levels to bioeconomy, demonstration of this committment at prominent occasions	Presidency of Council of Ministers (IT) EU presidency (DE) Hosting G7/G20 summits

Source: Fraunhofer ISI

Although we only analysed countries which have developed a dedicated bioeconomy strategy, in other countries there may be bioeconomy policy and activities even without a strategy. However, bioeconomy specificities require the integration of sectoral policies and activities into a holistic approach to sustainably harness the potentials of bioeconomy. EU member states have progressed to a different extent towards such an integrated policy. In EU member states which do not yet have a dedicated bioeconomy strategy, the notion may prevail that bioeconomy aspects are already sufficiently addressed in existing (sectoral) strategies and action plans. Concrete actions, projects and investments may be considered more important to advance the bioeconomy in the country than to develop a bioeconomy strategy. Such an approach was also followed in Italy before 2016: then, bioeconomy-related investments in biorefineries and demand-side

policy measures for bio-based plastics were initiated. This had the aim to support economic development and job creation in certain regions or industries (Imbert et al. 2017). However, these projects and activities are often sector-specific. Solely relying on such an approach bears several risks:

- Deploying only a fraction of the bioeconomy potential
- Neglecting of the systemic, cross-sectorial and transformative character of bioeconomy
- Favoring short-term gains (e.g. job creation) over long-term goals addressing all dimensions of sustainability and fostering the transformation to a circular bioeconomy
- Implementing contradictory incentives

In Italy, experience with this "project-based approach" showed its limitations and the need for gre-ater coordination between ministries and between ministries and regions, as well as between public and private sector players. As a consequence, a dedicated bioeconomy strategy was deve-loped, and subsequently the NBCB was formally established. Although flagship projects are still a major instrument of Italian bioeconomy policy implementation, cross-sectoral collaboration and benefits for several regions or territories are now considered in the design of these projects from the onset. This is prepared, co-created and negotiated in the NBCB.

The development of a dedicated bioeconomy strategy and the establishment of formal constituencies can therefore be considered as good practice. Formal constituencies (e.g. an inter-ministerial working group, a bioeconomy advisory body, a stakeholder panel) may guar-antee longevity of bioeconomy policies, consistency of discussions, and achievement of long-term goals, e.g. the transition to a sustainable circular bioeconomy. If they do not exist at all, there is the risk that the bioeconomy topic loses importance in policy, or that short-term (sectoral) gains are favored over long-term goals which address all dimensions of sustainability. However, they must also be set up in a way that they support collabora-tion and consensus-building. This will be addressed below.

Whether strategic goals and a bioeconomy strategy are to be defined requires a different mandate and a different composition of the responsible coordination body, than the translation of the strategic goals into an implementation plan and concrete actions.

Senior civil servants in the ministries on high hierarchical levels (e.g. Secretary General, Deputy Secretary General) have an important and critical role, often even more than the ministers themselves. It is a success factor if these high-level officials recognise the importance of bioeconomy and are keen pursuing it, in order to ensure continuity, to achieve longevity and impact, even under changing governments or conditions.

Changes in coordination mechanisms can be observed **over time**:

- Different coordination mechanisms for strategy development phase and policy implementation phase. Task forces were temporarily established in Germany for the purpose of developing the bioeconomy research strategy, and in Italy for developing BIT I and BIT II. A different approach was followed in Estonia: a formally appointed working group under the umbrella of the CEAG drafted the circular bioeconomy roadmap. In order to establish longevity of the efforts, coordination bodies for the following implementation phase were formally established subsequently in Germany (IMAG, Bioeconomy Advisory Council) and Italy (NBCB). This process of institutionalisation is still underway in Estonia.

  Although members of task forces, working groups and coordination bodies have different hierarchical levels, there is a tendency that higher hierarchical levels fix the overall strategic goals and directions, whereas lower hierarchical levels (e.g. division level) prevail in coordination bodies with the task to translate the strategic goals into an implementation plan. The latter reflects that expertise in

bioeconomy-specific issues is required to a larger extent in the implementation phase, once the larger strategic goals and priorities have been defined.

- Composition of formally established coordination bodies. The example of Germany shows significant changes in the composition of the IMAG and the Bioeconomy Council over more than a decade: The number of ministries in the IMAG increased. This reflects the change from fostering bioeconomy as a research- and technology-driven field to a more system- and transition-oriented, cross-sectoral approach with the aim to address grand challenges and all dimensions of sustainability. The diversity of members of the Advisory Council increased to represent all relevant stakeholder groups and their different prevailing bioeconomy narratives or visions, respectively: Academia and industry members, mainly framing bioeconomy in a green growth narrative, were complemented by members who put more emphasis on a bioeconomy within planetary boundaries and sufficiency (Hausknost et al. 2017; Kimpeler et al. 2018). This reflected the evolution of the political and societal bioeconomy discourse in Germany over time. The formation of the Platform Industrial Biotechnology and the Action Forum Bioeconomy can be seen in the same vein. In Italy, the task forces and the NBCB were composed of representatives of all major national and regional political, academic and industrial players in bioeconomy from the onset. This may reflect international experience with bioeconomy policy coordination until 2016 that multi-actor approaches are most useful.

In 2024, when this analysis was carried out, the three countries had reached **different milestones on the bioeconomy pathway, with different challenges**:

Germany and Italy have established formal, dedicated bioeconomy policy coordination bodies (Germany: IMAG, Italy: NBCB) and policy networks. Currently, their main task is to implement the strategies by elaborating implementation action plans and suggesting measures and actions. The elaboration of implementation plans requires to prioritise, align different interests and solve goal conflicts and secure adequate policy support and financing for the prioritised measures and actions. In Germany, the process for elaborating an implementation Plan is still ongoing. In Italy, work on the second, revised Italian implementation plan was completed in spring 2024, its endorsement and publication is expected in summer 2024. In Estonia, policy networks comprising all relevant stakeholders were mobilized in the development process of the circular bioeconomy roadmap. A current challenge is to keep the process going, to keep the bioeconomy community engaged and to implement actions, even under changing policy priorities. The process of establishing formal coordination bodies has only started and is still ongoing, with the appointment of a Deputy Secretary General for Bioeconomy and first considerations of establishing an advisory body.

4.6.3 Coordination mechanisms

In this subchapter, we will analyse the coordination mechanisms that have been implemented in the three analysed countries, their similarities and differences.

Table 8 gives an overview of coordination mechanisms in Germany, Italy and Estonia. Details of the listed coordination mechanisms are given in the chapters 4.3.2, 4.4.2 and 4.5.2. This list is not necessarily exhaustive. It rather reflects that the case studies had to be performed with different intensities, within the available project resources.

Table 8: Overview of bioeconomy policy coordination mechanisms in Germany, Italy and Estonia

Germany	Italy	Estonia
Task force to develop first bioeconomy research strategy	Task forces to develop national bioeconomy strategies	Circular Economy Advisory Steering Group (CEAG)
Interministerial working group on bioeconomy (IMAG)	National Bioeconomy Coordination Board (NBCB)	Working group under the CEAG to develop the dircular bioeconomy roadmap
Bioeconomy Advisory Council		ADDVAL-BIOEC, BIOEASTsUP
Dialogue Platform Industrial Biotechnology	Clusters	Deputy secretary general for bioeconomy
Action Forum Bioeconomy		
Formal consultation processes within strategy development processes	Consultation process within strategy development process	Dialogue process within strategy development process
Interministerial coordination	Interministerial coordination	
Working group between federal and regions ministries Renewable Resources/Bioeconomy (*Bund-Länder-Arbeitsgruppe Nachwachsende Rohstoffe/Bioökonomie*)	Permanent Conference for Relations between the State, the Regions and the Autonomous Provinces	
Informal exchange	Informal exchange	Informal exchange

Source: Fraunhofer ISI

In Table 9, selected formally established coordination mechanisms in the three analysed countries are characterised in more detail. Please note that currently, the main task of both the IMAG and the NBCB is the development of concepts how to translate the respective national bioeconomy strategies into implementation activities, whereas the main task of the CEAG (and its working group on circular bioeconomy) was the development of the national circular economy strategy and the circular bioeconomy roadmap as an integral part. In general, all coordination mechanisms should have well defined mandates and terms of reference, so that it is clear what is expected from them.

Table 9: Characterisation of selected formally established coordination mechanisms in Germany, Italy and Estonia

Characteristic	IMAG (Germany)	NBCB (Italy)	CEAG (Estonia)
Primary function of analysed coordination	Implementation of national bioeconomy strategy Preparation of decisions	Implementation of BIT II strategy Preparation of decisions	Development and adoption of circular economy strategy Preparation of decision in working groups Monitoring the implementation of the Estonian Circular Economy Development Paper and Action Plan
Bioeconomy-dedicated	yes	yes	No (circular economy-dedicated, with bioeconomy as part)
Mandated period	Permanent	Permanent	Permanent
Location of the body	Between ministries with responsibility for parts of bioeconomy	At Presidency of Council of Ministers, within the Committee for National Committee for Biosafety, Biotechnology and Life Science	Ministry of the Environment
Institutional Composition	National ministries	National ministries, representatives of regions and autonomous provinces, research institutes with policy-advising/implementing functions, sectoral clusters with stakeholders from industry, academia and regions	National ministries
Hierarchy between institutional members	3 levels: 2 leading ministries, 2 actively contributing ministries, several „passive members“	2 levels: coordinator, members[33]	2 levels: Chairperson from the leading ministry, members[33]

[33] It could not be figured out in the conducted interviews whether there was a hierarchy among the members, similar to the situation in Germany

Characteristic	IMAG (Germany)	NBCB (Italy)	CEAG (Estonia)
Hierarchical level of delegates to the body	Low (division level staff)	Medium to high	High in CEAG itself (Deputy Secretaries of State)
Decision-making competence	Low	Low	High
Representation of stakeholders' perspectives in the body	Indirect, mediated via members who have exchanged with stakeholders	Direct via members	Indirect (included in working groups[34])
Bioeconomy-specific expertise of delegates to the body	Ministerial staff on division level	Ministerial staff from technical secretariats Experts appointed by ministries	Provided to the delegates by ministerial staff on division level
Provision of bioeconomy-specific expertise to the body	Via exchange with IMAG- and member-specific networks, esp. Bioeconomy Council, Dialogue Platform Industrial Bioeconomy, Action Forum Bioeconomy Informal exchanges Formal consultation processes	Via delegates' exchange with experts in their respective organisation (e.g. cluster members) Via invited experts in working groups Informal exchanges Formal consultation processes	Via experts in working groups Informal exchanges Formal consultation processes

Source: Fraunhofer ISI

[34] Circular Economy Working Group(s) include relevant circular economy stakeholders, including research institutions, national umbrella organisation of local authorities, professional associations and chambers, NGOs

IMAG and CEAG have in common that they only have delegate from ministries as members. However, these members are on different hierarchical levels. It is in line with the mandate of the CEAG to prepare and suggest strategic decisions that hierarchically high-ranking delegates are members. The division-level of IMAG staff is in line with the major IMAG task of translating the strategic decisions into an implementation plan and suitable support measures. Both in the IMAG and the NBCB, especially political decisions regarding controversial issues in which the ministries have diverging positions as well as financial decisions cannot be taken in the coordination bodies themselves, but have to be taken by higher hierarchical levels in the respective ministries.

Figure 9 shows the different coordination approaches in Italy, Germany, and Estonia. They can be localised on a continuum with (only) one formally established coordination body at the one end and a more network-like character of coordination at the other end. The localisation of a coordination body within this continuum is characterized by the way how stakeholder perspectives and bioeconomy-specific expertise is brought into the coordination bodies: In the Italian NBCB, the NBCB members represent all major stakeholder groups of the Italian bioeconomy in policy, academia, and industry on national and regional levels. In the German case, the IMAG members, only staff from the responsible ministries, interact with specifically formed, separate entities for different stakeholder groups in a more formalised way. In Estonia, the CEAG oversees and endorses the results of coordination activities which take places in a network of working groups, dialogues, projects and initiatives. Informal exchanges with the aim of taking up expertise and stakeholder perspectives seem to play a larger role than in Germany or Italy. This is facilitated by the small size of the country and the small, well-interconnected Estonian bioeconomy community.

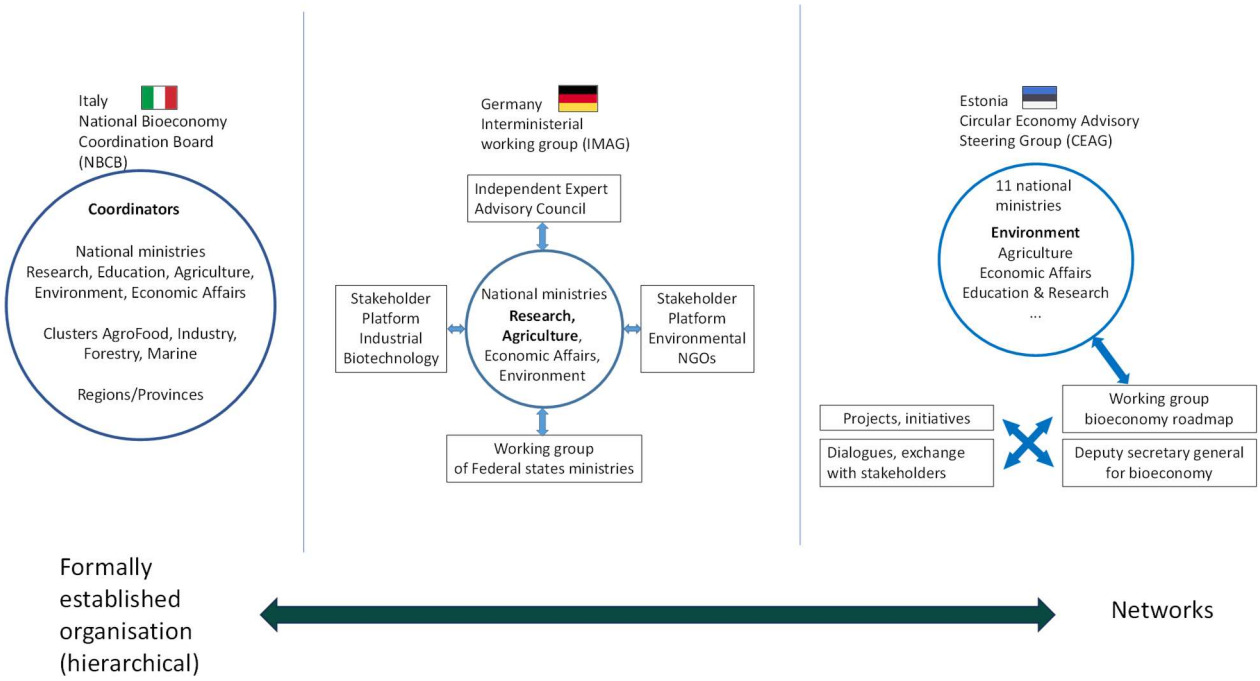

Figure 9: Schematic presentation of formally established coordination bodies in Italy, Germany and Estonia, and their interaction with stakeholders

Legend: Circle = coordination body; rectangles: formally established entities; bold: leader of the coordination body

4.6.4 Coordination mode

In this subchapter, we analyse how coordination is done in the three selected coordination bodies IMAG, NBCB and CEAG. An overview is given in Table 10.

Please note that the analysis is based on the information and subjective assessments gained in the expert interviews. Moreover, it reflects how the coordination mode was perceived by the interviewees in a certain (recent) time period. Although the formal coordination mechanism may not have changed, the perceived quality of the mode of coordination may have changed over time due to developments external to the coordination mechanism, or coordination may have turned out to become more difficult due to country specificities or context conditions. Therefore, this chapter cannot at all be understood as a comparison which country or coordination mechanism does better than the other. Rather, we would like to highlight specific challenges and success factors.

In chapter 4.6.3, it was pointed out that all relevant ministries and stakeholders need to be actively engaged in bioeconomy policy coordination. However, it is challenging to effectively and efficiently manage a coordination body with a **larger number of members**. It becomes even more challenging if fluctuation of individuals is high, e.g. due to government changes. According to interviewees' and MAG experts' experience, this requires the role of a coordinator or chairperson who oversees and manages the coordination processes and should be supported by staff from a secretariat or office in administrative-technical issues.

Finding solutions to goal conflicts and controversial issues and aligning diverging interests of ministries and stakeholders are a major objective of bioeconomy policy coordination. Our analysis showed that this became more important in the implementation phase. While vague wording may have been a way out of conflicting issues in the strategy development phase, solutions need to be found in the implementation phase. The analysed countries differ in the extent to which these controversies shape the political and societal discourse and are also represented in the analysed coordination bodies. Germany seems to face larger challenges than Italy and Estonia: in Germany, controversial issues inherent in bioeconomy have become more prominent, polarized and politicized in recent years. In the same vein, the four German ministries which play a major role in the IMAG favour quite different visions of a bioeconomy and as a consequence also quite differents ways how the bioeconomy should develop. The national bioeconomy strategy, although jointly approved, does not provide enough guidance for practical implementation decisions. In this situation, it becomes much more difficult for the division-level members of the IMAG to come efficiently to decisions by consensus. Therefore, more often than in the past, higher hierarchical levels in the ministries have to resolve such conflicts politically. This makes policy processes slow and frustrating.

Table 10: Characterisation of the coordination mode in formally established coordination mechanisms in Germany, Italy and Estonia

Characteristic	IMAG (Germany)	NBCB (Italy)	CEAG (Estonia)
Frequency of meetings	Irregular	Every three months	n.a.
Working climate	Open Tendency towards hierarchical relationship between members Tendendy towards fundamental debates on principles	Open Communication between members on equal terms Tendency towards pragmatic results	In bioeconomy working groups: Open Communication between members on equal terms
Working mode	Mutual information Often collecting written comments to documents rather than direct discussion of issues	Mutual information Collecting or receiving inputs from members, stakeholders Consolidation in internal discussions Feedback and endorsement of drafts by member institutions Co-creation, co-development	In bioeconomy working groups: Collecting or receiving inputs from stakeholders Dialogue Co-creation, co-development
Influence of controversial topics on practical work	High	Medium to low	Low
Resolution of goal conflicts and controversial issues within the body	Decisions by higher hierarchical levels	Dialogue Decisions by higher hierarchical levels	Dialogue In CEAG: Decisions taken by consensus, if no consensus, then simple majority; chairman has a casting vote
Stakeholder involvement	Indirect, are mainly represented in four separate platforms	Direct, as major stakeholder representatives are NBCB members	Directly in working groups established by the CEAG,
Mode of interaction with stakeholders and experts	Unidirectional top-down consultation prevailing	Bidirectional top-down and bottom-up interaction	bidirectional top-down and bottom-up interaction

Source: Fraunhofer ISI

In Italy and Estonia, the baseline situation seems to be less polarized than in Germany: a shared understanding of the bioeconomy vision and how to proceed to reach it seems to prevail. Nevertheless, some features of the coordination mode in these countries appear appropriate to reduce controversies and tensions in coordination processes. These are

- A "neutral" chairman or coordinator of the coordination body who can more easily adopt a mediating, countervailing and facilitating role than a person who has to represent a certain ministerial position
- A level playing field for all members of the coordination body, rather than a certain hierarchy within the body
- A "neutral", prestigious location of the body
- Frequent and regular communication within the body with a focus on direct personal interaction and dialogue, rather than exchange via written comments
- Trustful relationships between the members
- A mindset to find pragmatic solutions, rather than getting entangled debates on principles

Inclusion of bioeconomy-specific expertise and stakeholder perspectives is also a prerequisite for bioeconomy policy coordination. In Estonia as a small country, this can be easily accomplished due to the small and well interconnected bioeconomy stakeholder community. There are frequent opportunities to meet and most persons know each other personally. In Germany, bioeconomy-specific expertise and stakeholder perspectives are mainly made available to the IMAG by consulting four different institutionalised bodies or platforms (Figure 9) which altogether represent the German bioeconomy community. However, the Dialogue Platform Industrial Bioeconomy, the Action Forum Bioeconomy and the Bund-Länder-Arbeitsgruppe mainly represent the perspectives of industry and academia, environmental NGOs and Federal States, respectively, in a rather silo-like manner. They are mainly consulted by IMAG on request and top-down, perhaps sometimes with the purpose to strengthen the positions of the respective ministry. The above-mentioned platforms are not in regular exchange and dialogue with one another. Therefore, these bodies or platforms do not seem to have a significant mediating and countervailing influence, in case of difficulties to come to consensus and shared decisions. Stakeholder involvement seems to work better in Italy where these stakeholders are directly represented in the NBCB. They are actively involved in dialogues and co-creation of NBCB doccuments, rather than merely being consulted.

From the cross-country analysis, the following aspects can therefore be considered as good practice for the coordination mode:

- Establish a neutral chairman or coordinator as a mediator and facilitator, or regularly rotate this position between the members
- Acquire administrative-technical support to manage the coordination processes effectively
- Establish a collaborative, open working climate in which all members communicate on equal terms, are encouraged to bring in their issues, ask questions, are being listened to, and their issues are treated adequately
- Make personal exchanges, dialogues, and co-creation and co-development the main working mode
- Strive for positive coordination

4.7 Conclusions, good practice and draft recommendations for bioeconomy policy coordination on national level

Although the characteristics of bioeconomy make policy coordination a key prerequisite for its successful deployment, surprisingly little is known about it beyond those individuals who are directly involved in it. In this in-depth analysis, we tried to „take a glimpse into the black box“ how ministries coordinate their national bioeconomy policy. We studied coordination both in the strategy-development phase as well as in the policy-implementation phase. The policy-implementation phase in this analysis is understood as the phase in which the strategy is translated into an implementation plan and into concepts for concrete actions. We selected three countries with a dedicated national bioeconomy strategy and a formally established coordination body – Germany, Italy, and Estonia. They differed in the length of coordination experience since the first publication of a national strategy, and in the numbers of members in the coordination bodies. By doing so, we tried to capture changes over time and the influence of coordination body size and composition on coordination.

In this chapter, conclusions are drawn and draft recommendations are derived from the findings that were presented in chapters 4.2 to 4.6. Conclusions and draft recommendations were discussed with and endorsed by the multi-actor group.

In this in-depth analysis, we presented options for coordination mechanisms and coordination modes which were chosen by the three analysed countries. Each country has its own context, socio-economic structure, (political) culture, reasons and rationale, frame conditions and path dependencies why the respective option was chosen. These contexts can neither be changed deliberately nor do they allow the transfer of an option to another country with the expectation that the option would work the same way in the other country. Moreover, the analysis of the coordination modes was based on the information and subjective assessments gained in the expert interviews. They reflect how the coordination mode was perceived by the interviewees in a certain (recent) time period. Due to these restrictions, this in-depth analysis cannot at all be understood as a comparison which country or coordination mechanism or coordination mode does better than the other. Rather, it shows the diversity of options, their strengths, potential pitfalls and success factors in a structured way. The aim is that other countries can reflect their own situation against this background, using the presented options as a benchmark. We hope that this analysis and reflection induces mutual learning and gives inspiration how to further improve aspects of bioeconomy policy coordination in EU member states.

In the three countries, we reconstructed their respective strategy development and implementation phase over time, the changes that occurred, and what drove the decision to develop a dedicated national strategy. EU member states have progressed to a different extent towards the goal of a coherent bioeconomy policy which integrates objectives and ways to achieve them across different policy domains and sectors. We considered the existence of a dedicated bioeconomy strategy or roadmap as an indicator for a national bioeconomy policy. However, we acknowledge that a coherent bioeconomy policy is possible without a dedicated strategy, and that the existence of a strategy alone is not sufficient for a coherent bioeconomy policy.

Our analysis showed that in the three countries neither was there a single or uniform pathway towards a bioeconomy strategy, action plan and policy, nor did the efforts necessarily result directly in a fully developed bioeconomy strategy – it could also be achieved stepwise. In EU member states which do not yet have a dedicated bioeconomy strategy, the notion may prevail that bioeconomy aspects are already sufficiently addressed in existing (sectoral) strategies and action plans. Concrete actions, projects and investments may be considered more important for advancing the bioeconomy in the country than to develop a bioeconomy strategy. However, this should only be seen as an interim, transient stage. The full

potential of bioeconomy can only be exploited sustainably if coordination across policy domains and sectors in a coherent policy can be achieved.

Our **recommendations for countries which do not yet have a bioeconomy strategy or coherent bioeconomy policy**, but pursue bioeconomy activities within sectoral policies are

- Continue to strive for a dedicated national bioeconomy strategy and coherent bioeconomy policy which overcomes traditional sectoral policy silos
- Continue to be actively engaged in bioeconomy policy networks (e.g. EU Bioeconomy Policy Forum, OECD, BioEast Initiative) to learn from the experience of others
- Actively engage in projects and Coordination and Support Actions dedicated to bioeconomy policy, and use the resources, support and good practice developed there to advance bioeconomy in your country
- Stay flexible on your road towards a dedicated bioeconomy strategy and coherent policy and use windows of opportunity when they open up
- Convince high level civil servants (e.g. hierarchical level of Secretary General, Deputy Secretary General) in the ministries of the importance and potential of bioeconomy. Their support of your activities is a success factor and can ensure continuity, to achieve longevity and impact, even under changing governments or conditions. Prestigious opportunities, e.g. an EU presidency, could be used to show this commitment.

Our analysis showed that coordination challenges are different whether you are in the strategy development phase or in the implementation phase. Good practice for the strategy development phase is available in several countries and has already been collected and disseminated, e.g. in European Commission et al. (2021). In our analysis, we identified a few additional aspects that should be taken into consideration for strategy development or for revision processes of already existing strategies.

Our **recommendations for countries which are in the bioeconomy strategy development phase or strategy revision phase** are

- Carefully select the institution that leads the process. For a comprehensive, structured and effective strategy development process, a lead is important. The choice of option depends on the situation in the country. In our analysis, we identified as good practice that the process could be initiated, chaired and moderated by a prestigious „neutral“ national governmental institution without own high stakes in the bioeconomy, such as the Presidency of Councils of Ministers in Italy, the Department of the Taoiseach in Ireland, or a President’s office. This could demonstrate the importance of the strategy process and the government’s committment to bioeconomy, and at the same time could create a level playing field in case of controversies between the relevant ministries.
- Another good practice option is that one of the ministries which are responsible for parts of the bioeconomy leads the process. Which ministry leads the process may pre-determine the strategic foci of the resulting strategy. Therefore, the choice of the leading ministry should be considered in view of the present bioeconomy situation and of the anticipated future role of the country. In some cases of revision of strategies, this might mean a change in the leading ministry (e.g. from research to economic affairs, from agriculture to climate and environment etc.).
- Choose an appropriate option for the organisational set-up. Several options were shown to be good practice how the strategy development or revision process can be set up. One option is to temporarily establish a task force for the purpose of defining the strategy. Another option is an organisation with steering group, thematic working groups and related dialogue and consultation processes. Irrespective of the chosen set-up, success factors and good practice are the inclusion of all relevant high-ranking ministerial and stakeholder representatives with the competence to take strategic decisions, the

prominent integration of bioeconomy-specific expertise as well as taking up stakeholders' needs and perspectives in this development process. Consultations of experts and stakeholders are already an integral part of such processes. However, it is good practice and is recommended to additionally carry out different dialogue formats. Such dialogues contribute to a more nuanced mutual understanding, for considering different options, for consensus-building and for creating ownership of achieved results and compromises. Specific attention should be paid to other groups than „the ususal suspects", e.g. to young people, regional stakeholders, citizens etc.

- Strive for a bioeconomy strategy which gives clearer guidance for subsequent policy implementation. Our analysis showed that existing bioeconomy strategies may not give enough guidance for the subsequent policy implementation phase. They may lack clear priorities between different options, may have vague goals, and may represent the smallest common denominator in controversial issues. It is recommended to take inspiration from „better" strategies in other policy domains or other countries how to define, if possible, quantitative strategic goals, clear priorities in goal conflicts, clear assignment of responsibilities for subsequent implementation, and an implementation plan with actions, a schedule and a budget.
- Advocate for and engage in mutual exchange of experience and mutual learning processes on member state and EU level how to elaborate „better" bioeconomy strategies.

While the development of a bioeconomy strategy is a temporary process, it is important to establish a continuous coordination of bioeconomy activities and policies across policy fields and sectors. It requires an excellent bioeconomy expertise and inclusion stakeholders. Therefore, our **recommendations for countries which are in the bioeconomy policy implementation phase** are

- Institutionalise bioeconomy policy coordination permanently. The purpose of institutionalisation is to ensure continuity, to achieve longevity and impact, even under changing governments or conditions. Our analysis showed different options for the composition and organisational set-up for continuous coordination: at one end of the spectrum of options is a central body coordinating the ministries with responsibilities for parts of bioeconomy with linked separate platforms representing experts, stakeholder groups and sectors. At the other end of the spectrum is an integrated coordination body in which all relevant ministries, experts and stakeholders are directly represented. Country specificities may determine which option is most appropriate.
- Carefully select the institution that leads the process. In the selection process, take the aspects for the strategy development phase into consideration (listed above). If strong diverging interests between the members of the coordination body are anticipated, a neutral space or location of the coordination body (i.e. not directly in a ministry) and/or a neutral coordinator or chairperson should be considered. Another option could be the regularly rotation of this position between the members. A success factor is to avoid a hierarchy within the coordination body, thus providing a level playing field for all members.
- Clearly define mandates and terms of reference for all coordination mechanisms, so that it is clear what is expected from them.
- Adopt a multi-actor approach throughout the coordination process, either in the institutionalised coordination body itself, or via processes (e.g. via interaction with different actor networks). It is good practice to make the communication as direct and interactive as possible, favouring mutual, interactive exchange in dialogues over uni-directional consultations.
- Provide sufficient resources for coordination. Depending on the mandate, size of the body, and working mode, administrative-technical support for the coordination work should be provided. Coordination body members need sufficient working capacity and time resources to actively participate in coordination processes.

- Establish a collaborative, open, trustful working climate in which all members communicate on equal terms, are encouraged to bring in their issues and to ask questions, are listened to, and their issues are treated adequately.
- Adopt a working mode which supports the alignment of diverging interests, finding compromises in controversial issues and finding solutions to goal conflicts. Success factors for such a working mode are a neutral facilitator of dialogues and discussions, a level playing field for all contributors in the coordination processes, a mindset to find pragmatic solutions, rather than getting entangled debates on principles, frequent and regular communication and meetings with a focus on direct personal interaction, dialogue and co-creation, rather than exchange via written comments.
- Advocate for and engage in mutual exchange of experience and mutual learning processes on member state and EU level how to elaborate „better“ coordination mechanisms and modes.
- Explore whether such coordination bodies should be given more decision power than they currently have, and which options could be appropriate for this (e.g. own budget for the execution of its implementation plan).

Although it is primarily the responsibility of national governments to improve their bioeconomy policy coordination, the European Commission (EC) and other supranational institutions, such as the Organisation for Economic Co-operation and Development (OECD) and others, can play an important role to support such efforts. Our **recommendations for the EC and other supranational institutions** are

- Continue to support EU member states and their regions without a bioeconomy strategy or only a narrowly confined, sectoral one by Cooperation and Support Actions and policy networks to develop comprehensive bioeconomy strategies
- Encourage all EU member states and their regions to improve the quality of their bioeconomy strategies.
- Support EU member states and their regions in their efforts to improve the quality of their bioeconomy strategies. Options that could be considered are e.g. commissioning studies what good practice strategies entail, Coordination and Support Actions, exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Forum, OECD).
- Support EU member states and their regions in their efforts to improve the quality of their bioeconomy policy coordination. Options that could be considered are e.g. commissioning studies what good practice coordination entails with respect to institutionalisation, organisation and working mode, Coordination and Support Actions, exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Forum, OECD).

4.8 Outlook

Within the ShapingBio project, the results of this in-depth analysis will be disseminated, discussed, validated, and broadened with experience from other countries during a workshop in November 2024. The target group are policy makers in EU member states involved in bioeconomy policy coordination. The workshop has the objective to support learning from good practice and critically discussing its transferability to other countries and contexts.

This in-depth analysis was a first attempt to study how bioeconomy policy coordination works in practice in different EU member states. We suggest several avenues to pursue this topic further in other contexts than the ShapingBio project:

- Study bioeconomy policy coordination in more countries to broaden the scope of options for coordination mechanisms and coordination modes, and to identify different types of coordination. Both

formal and informal coordination mechanisms should be analysed. It could also be worthwhile to analyse the underlying causes for country differences in the policy implementation phase and ways to overcome hurdles.

- Identify and apply output, outcome and impact indicators for successful bioeconomy policy coordination
- Study vertical bioeconomy policy coordination between national and regional level in EU countries
- Study horizontal policy coordination to achieve coherence between bioeconomy policy and related policy fields, such as agriculture, environment and climate, economy, energy, education etc.
- Use additional methodological approaches, e.g. analysis of minutes of coordination body meetings, ethnographic methods such as participatory observation
- Carry out exchange of experience and support mutual learning processes between policy makers directly involved in bioeconomy policy coordination

5. Strategies to overcome policy & governance challenges in emerging bioeconomy sectors – The example of mainstreaming sustainable aquaculture to increase blue biomass

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5.1 Introduction to emerging sectors in the bioeconomy

The bioeconomy encompasses the production, utilisation, and conservation of biological resources, integrating knowledge, science, technology, and innovation to deliver information, products, processes, and services across various economic sectors. In the quest for sustainable development, emerging bioeconomic sectors are gaining momentum for their ability to tackle global challenges like food security, climate change, and resource scarcity. These sectors leverage biological resources, processes, and principles to develop sustainable solutions, promoting economic growth while maintaining ecological integrity.

Emerging sectors within the bioeconomy are revolutionising industries by leveraging biological resources and innovative technologies to create sustainable solutions. These sectors include bio-based materials, bioenergy, and biopharmaceuticals, all focusing on reducing environmental impact while promoting economic growth. For instance, advancements in bio-based materials are leading to the development of biodegradable plastics and sustainable textiles, while bioenergy innovations provide cleaner alternatives to fossil fuels. The biopharmaceutical sector is making strides in developing new treatments and vaccines using biotechnological processes. Additionally, sustainable aquaculture enhances food security by offering seafood production methods that reduce pressure on wild fish populations. Table 11 categorises various products emerging from the bioeconomy sectors, including in forestry, agriculture, food, the chemical industry, and construction. These sectors drive the transition towards a more sustainable and resilient economy.

This chapter analyses the emerging sustainable aquaculture sector in more depth, examining the policy and governance frameworks. The analysis includes detailed studies of aquaculture practices in Germany, Denmark, and Ireland highlighting each country's unique approaches, best practices, and challenges in promoting sustainable aquaculture.

Table 11: Emerging sectors and examples of products

Emerging sector	Product examples
Biobased materials	Bio-based and biodegradable plastics Sustainable textiles Bio-based packaging Bio-composites
Bioenergy	Bioethanol, cellulosic ethanol Biogas Biodiesel Algal biofuels
Biopharmaceuticals	Biotechnologically-produced vaccines Advanced therapeutic medicinal products, gene therapies Personalized medicine
Aquaculture	Algae-based feed and feed supplements Sustainable seafood Integrated multitrophic aquaculture systems Recirculating aquaculture systems
Forestry	Sustainable wood products Biochar Cellulose-based materials Forest-based bioproducts
Agriculture	Organic fertilizers, seaweed fertilisers Bio-pesticides Crop rotation systems
Food	Alternative proteins, cultivated meat Fermented foods Functional foods
Chemical industry	Bio-based and/or biodegradable bulk-, specialty- and fine-chemicals Bioplastics, biobased polymers Bio-based solvents
Construction	Bio-based insulation Wood-based composites Sustainable construction materials Green concrete

5.2 Sustainable aquaculture

Aquaculture, farming aquatic organisms such as fish, molluscs, crustaceans, and aquatic plants, has become a critical component of global food production. This practice includes breeding, rearing, and harvesting in all water environments, including ponds, rivers, lakes, and the ocean. According to the Food and Agriculture Organization (FAO), aquaculture is one of the fastest-growing food sectors globally, contributing significantly to food security and economic development (FAO, 2020).

Sustainable aquaculture refers to the farming of aquatic organisms such as fish, shellfish, and seaweed in a manner that ensures long-term environmental health, economic viability, and social responsibility. It encompasses environmentally responsible, economically viable, and socially equitable methods. Sustainable aquaculture aims to minimise negative environmental impacts, ensure animal welfare, and provide fair economic returns to producers.

Debates Surrounding Aquaculture

The rapid expansion of aquaculture has sparked significant debate regarding its environmental, economic, and social impacts. Certain forms of aquaculture, particularly intensive fish farming, can lead to environmental degradation through water pollution, habitat destruction, and spreading diseases to wild populations. Issues such as using wild fish for feed, escaping non-native species, water pollution, and habitat destruction are characteristics of many types of fish aquaculture (Naylor et al., 2000).

On the other hand, low-trophic aquaculture (LTA) has the potential to provide a sustainable and efficient means of food production and naturally cleaning water. LTA refers to the farming of species that occupy lower positions in the food chain, primarily including filter feeders and photosynthetic organisms. These species typically require fewer external feed inputs and have lower environmental impacts compared to higher trophic species like carnivorous fish. Examples of LTA species include bivalves such as mussels, oysters and clams, and seaweed. Further, technologies such as recirculating aquaculture systems (RAS) can meet demand for fish without having a negative impact on marine environments. With proper planning, management and technological advancements, sustainable aquaculture can alleviate pressure on fish stocks, reduce the carbon footprint of food production, and provide significant economic opportunities for coastal and rural communities (Bostock et al., 2010). Sustainable practices, such as the development of integrated multi-trophic aquaculture (IMTA) systems and advancements in feed technology to reduce reliance on wild-caught fish, are examples of how the industry is evolving to address environmental concerns.

Overall, the debate continues as stakeholders from environmental groups, industry, and communities work towards balancing the benefits and challenges associated with aquaculture. Sustainable aquaculture practices and sound regulatory frameworks are essential to maximising the benefits while mitigating potential adverse impacts.

This report focuses exclusively on sustainable aquaculture practices: IMTA, LTA, and sustainable land-based aquaculture, such as RAS. These practices are emphasised for their lower environmental impact and potential to contribute positively to food security and economic development.

EU Policy on Sustainable Aquaculture

Aquaculture is not an exclusive EU competence, but the EU is involved through rules on environmental protection and health standards. In 2013, the Commission adopted non-binding strategic guidelines for the sustainable development of EU aquaculture, forming the basis for national plans (European Commission,

2013). The Commission promotes best practices via the "open method of coordination" and technical seminars, with funding support from the European Maritime and Fisheries Fund. New strategic guidelines were adopted in 2021, and EU countries reviewed their strategies accordingly (European Commission, 2021).

While the European Commission provides guidance, Member States must adhere to no concrete measures or targets, leading to a lack of accountability and stagnation in aquaculture development. Aquaculture policy is embedded within the Common Fisheries Policy, which primarily focuses on managing wild catch fisheries, quotas, and stock preservation. However, aquaculture aims to increase food production and security, like agriculture. Yet, the Common Agricultural Policy is not suitable for aquaculture either. Therefore, according to interviewees' opinions, there is a pressing need for a dedicated common aquaculture policy.

5.3 Selection of countries as case studies

The analysis critically assesses sustainable aquaculture governance and representation in Germany, Denmark, and Ireland utilising both desk research and expert interviews, as described in chapter 3. This approach ensured that the analysis reflected a broad spectrum of perspectives and provides a nuanced understanding of the governance frameworks and their practical implications in the studied countries.

The countries selected for this study— Germany, Denmark, and Ireland—were chosen based on their distinct aquaculture governance structures:

- **Germany**: Aquaculture management is highly decentralised. The federal states are responsible for aquaculture, and the local authorities issue the primary permit to establish an aquaculture facility.
- **Denmark**: Aquaculture management is semi-centralised. Permits for land-based fish farming is the responsibility of the municipalities while the environmental protection agency is responsible for granting permits to marine fish farms.
- **Ireland**: Aquaculture management is highly centralised, with the Department of Agriculture, Food and the Marine (DAFM) responsible for licensing aquaculture operations.

5.4 Sustainable aquaculture production trends in Germany, Denmark, and Ireland

This section provides an overview of aquaculture production trends in Germany, Denmark and Ireland.

5.4.1 Germany

Germany's aquaculture sector has seen limited growth between 2017 and 2021. On the other hand, there is a notable presence of RAS in the country. As of 2020, at least 53 RAS farms were operating commercially, producing around 2.625 tons of fish and seafood across over 10 species. The sector is marked by a high degree of water reuse, but challenges such as stringent water laws and fragmented administrative practices hinder further expansion and innovation. Figure 10 shows the trend in aquaculture production in Germany, indicating a stagnant production level over recent years.

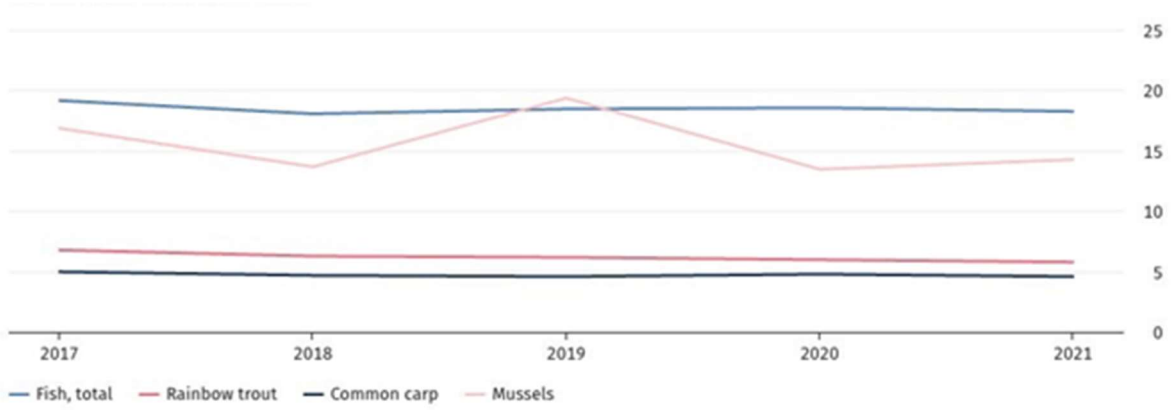

Figure 10: Aquaculture production of selected species in Germany in thousand tons (Destatis, 2022)

5.4.2 Denmark

Denmark is a pioneer in aquaculture, particularly in developing and implementing RAS. The country boasts 65 RAS farms and an additional 66 traditional land-based fish farms. Further, the country hosts a multitude of both mussel and oyster farms.

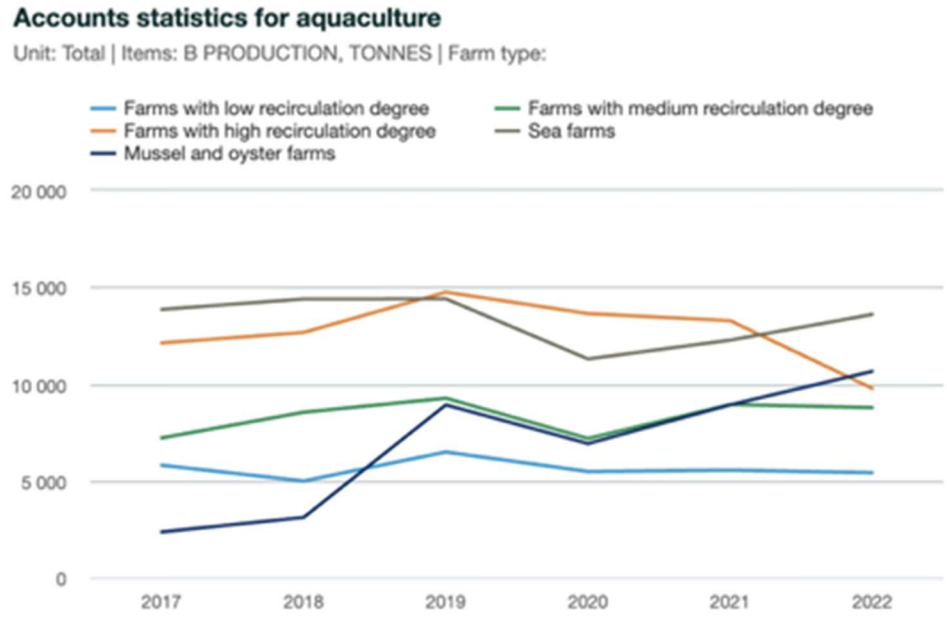

Figure 11 shows a stagnating trend in RAS production and aquaculture production in the sea in Denmark from 2017 to 2022. By contrast, the production of mussels and oysters increased by a multitude of four during this period.

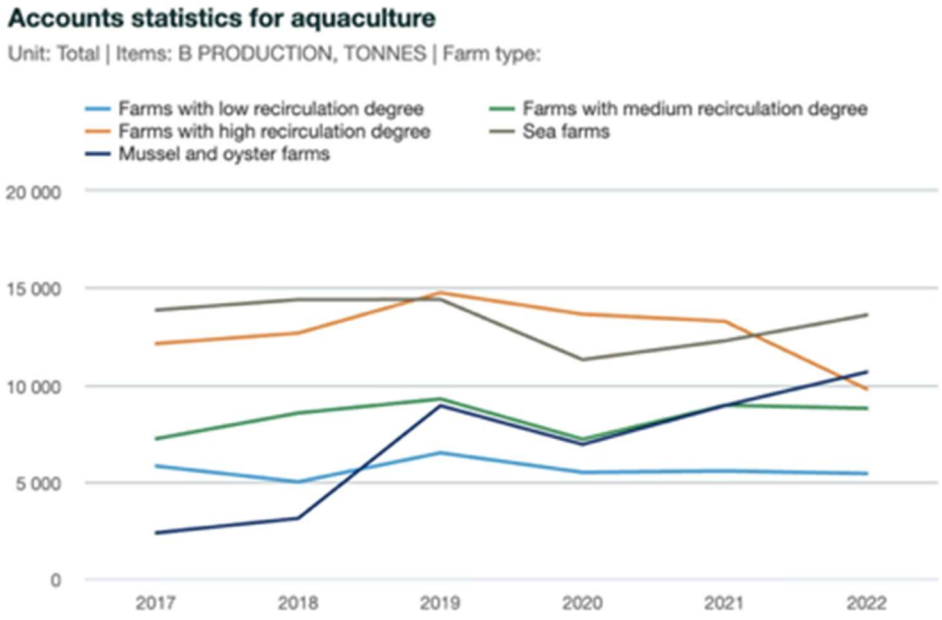

Figure 11: Aquaculture production in tons by farm type in Denmark (Statistics Denmark, 2024)

5.4.3 Ireland

Ireland's aquaculture industry includes 25 seaweed farms and 130 oyster farms. Figure 12 illustrates the trend in aquaculture production in Ireland from 2009 to 2018. The graph shows a reduction in the production of shellfish, with some fluctuations, from around 35,000 tons in 2009 to less than 25,000 tons in 2018. Further, it shows a stagnant trend, with some fluctuations when it comes to finfish production.

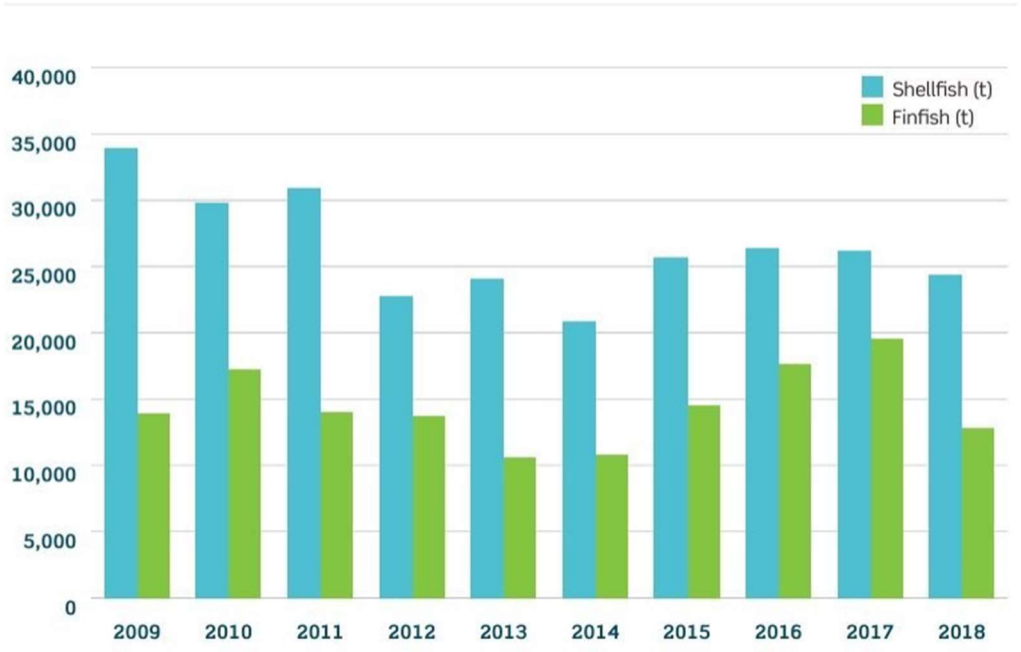

Figure 12: Finfish and shellfish production volumes in Ireland – 10-year trend (Bord Iascaigh Mhara, 2019)

The comparison of aquaculture sectors in Germany, Denmark and Ireland reveals a common trend of stagnation despite varying levels of technological adoption and regulatory frameworks. Further, although the EU has promoted sustainable aquaculture production and increased funding, the growth in the sustainable aquaculture sector in the three studied countries has been minimal. This contrasts non-EU countries like Scotland and Norway, where aquaculture is advancing (European Court of Auditors, 2023).

5.5 Governance structures in Germany, Denmark and Ireland

Table 12 gives an overview of sustainable aquaculture governance in Germany, Denmark and Ireland.

In **Germany**, aquaculture governance is primarily managed at the federal-state level, resulting in a decentralised governance system. The Federal Government, specifically the Federal Ministry of Food and Agriculture (BMEL), serves as the main point of contact for international institutions such as the European

Commission on matters related to aquaculture. Each federal state is responsible for its own aquaculture activities, reflecting Germany's federal structure. Bi-annual meetings of all federal states and the BMEL provide a forum to discuss and coordinate aquaculture policies and practices. Additionally, Germany plans to establish a working group to support further and streamline aquaculture governance.

Table 12: Aquaculture governance structures in Denmark, Germany and Ireland

Country	**Denmark**	**Germany**	**Ireland**
Governance structure	• Central authorities establish the regulatory framework • Local municipalities issue permissions for land-based aquaculture • Advisory board on mussel farming and fisheries	• Federal states are responsible for aquaculture • Federal Government (BMEL) is the direct contact for the Commission • Bi-annual meetings of all federal states and the BMEL • A working group (planned)	• A centralized authority is responsible for the regulatory framework and licensing aquaculture activities
Marine aquaculture governance structure	Mussel farming • Ministry of Food, the Directorate of Fisheries Fish farming • Ministry of Environment Seaweed, algae farming • Danish Coastal Authority	Varies at federal level Example Schleswig-Holstein: • Ministry for Energy Transition, Climate Protection, Environment and Nature • Nature conservation authority • Waterways and shipping administration+agency • Coastal protection agency • Fisheries authority • Environment, Veterinary/food control • Competence Network Aquaculture (KNAQ)	• Department of Agriculture, Food, and the Marine
RAS governance structure	• Ministry of Environment	Example Schleswig-Holstein • Regional construction authority • Water authority • Wastewater authority • Emission control authority • Veterinary authority • Competence Network Aquaculture (KNAQ)	• Department of Agriculture, Food, and the Marine

In **Denmark**, the central authorities (Ministry of Food, the Directorate of Fisheries, Ministry of Environment, Danish Coastal Authority) establish the regulatory framework in aquaculture governance, while local municipalities issue permissions for land-based aquaculture, resulting in a mixed governance system. The different types of aquaculture farms are governed by different ministries. This decentralised

approach allows for specialised oversight tailored to different types of aquacultures, ensuring both environmental protection and industry growth. Denmark has an advisory board for mussel farming and fisheries, providing a platform for diverse stakeholders to contribute to regulatory decision-making. The board includes representatives from various sectors, such as authorities from different ministries, universities, municipalities, NGOs, mussel farmers, and fishermen. This advisory board ensures that the regulatory framework is inclusive and considers the perspectives of all relevant parties, promoting sustainable and well-informed aquaculture practices.

Ireland's aquaculture governance is centralised, with a single authority responsible for establishing the regulatory framework and licensing aquaculture activities. The DAFM oversees all aspects of aquaculture, including marine, land-based and recirculating aquaculture systems. This centralised approach simplifies the regulatory process and provides clear guidelines for operators.

5.6 Country-specific findings

5.6.1 Germany

As outlined above, aquaculture governance in Germany is managed through a combination of federal and state regulations, emphasising sustainable practices and environmental protection. The primary responsibility lies with the federal states, where local water authorities issue permits for aquaculture facilities. This decentralised approach allows states to tailor regulations to regional needs.

However, the fragmented administrative structure and lack of uniform practices lead to disparities in political support and funding access. Some states have comprehensive strategies for aquaculture development, while others lack strategic plans and participation in funding programs such as the European Maritime, Fisheries, and Aquaculture Fund (EMFAF).

The absence of nationwide uniform rules for aquaculture approvals creates regulatory inconsistencies, making it challenging for operators to navigate the approval process. For RAS, strict water laws require substantial investment in wastewater treatment. RAS is complicated by its dual classification as an industrial and agricultural activity, restricting farmers from building RAS on agricultural land. Clarifying RAS within the regulatory framework is crucial for transparency in licensing processes. A coherent and standardised regulatory system is needed to effectively support the industry's growth and sustainability.

5.6.2 Denmark

Aquaculture governance in Denmark is navigating a multifaceted regulatory landscape. Since 2021, a country-wide moratorium has halted the issuance of new mussel farm licenses (The Ministry of Food, Agriculture and Fisheries, 2021). This decision, which resulted from discussions on the impact of mussel farming on seabed, has paused the processing of applications for mussel farming ventures. The moratorium is expected to be lifted in 2024. Similarly, obtaining permissions for fish farming, particularly for sea-based and RAS operations, has been challenging due to regulations like the EU Water Framework Directive. Despite the potential for sustainable production methods, concerns over nutrient discharge into the sea have led to a scarcity of approvals. Some companies, such as Skagen Salmon, which utilises RAS technology, have managed to overcome these regulatory barriers by negotiating with environmental organisations regarding their production processes. However, these solutions are not universally applicable across the industry. Clear and feasible regulations are critical for the sector's growth and sustainability in Denmark. In contrast, the Danish government recognises and endorses seaweed cultivation due to its low-risk profile.

Currently, aquaculture is regarded as an industrial activity. This classification encompasses various types of aquaculture operations, including sea-based and RAS.

5.6.3 Ireland

Aquaculture governance in Ireland has navigated a complex journey. After the year 2000, there was a 70% increase in the number of issued licenses leading to heightened competition for space and feed for fish. However, in 2007, Ireland faced a legal setback due to its failure to implement the Birds and Habitats Directive. This resulted in all aquaculture projects undergoing rigorous assessments against this directive, causing considerable delays in the processing of license applications or renewals. For about a decade, renewing aquaculture licenses became nearly impossible. When the department finally started issuing licenses, it began approving applications that in many cases were more than 10 years old. Their sudden approval led to confusion due to the lack of communication from government departments, catching many by surprise. Since then, government communication has improved, and the departments started informing stakeholders about upcoming actions.

Despite being regulated by the department responsible for agriculture, aquaculture is treated as an industrial activity. Aquaculture operations must obtain a license under the Aquaculture and Foreshore Management Division, which assesses the environmental impact and ensures compliance with marine policies, especially related to sustainability and water quality.

Currently, the major challenge related to aquaculture governance in Ireland is the lack of personnel. Only five civil servants work in the government department in Ireland specifically tasked with aquaculture. According to interviewees, this can be seen as an indicator that aquaculture is not a priority at the state level and therefore allocation of public resources is insufficient. Another challenge relates to the complex environmental protection requirements that applicants must meet. They must stay updated on these requirements, provide detailed information on marine environmental preservation methods, and submit related data. This process is costly and time-consuming. Additionally, increasing competition for space and water access, the establishment of new marine protected areas, and the potential use of space for offshore wind farms are emerging concerns. Offshore renewables are prioritised at a policy level to meet Ireland's climate change targets, posing challenges for aquaculture farmers to maintain access and continue operations. Despite these obstacles, the aquaculture sector in Ireland continues to strive for growth and sustainability.

5.7 Cross-country analysis

Germany, Denmark and Ireland each have a unique approach to aquaculture licensing, with varying levels of guidance, administrative structures, and digitalisation.

Guidance and Contact Points

- **Germany**: Germany has no standardised application guidelines. However, some federal states offer specific permit guidelines for aquaculture activities and with the exception of Schleswig-Holstein (KNAQ) no centralised contact point exists. This fragmentation can lead to inconsistencies and confusion among applicants.
- **Denmark**: In Denmark, applicants can find designated contact points at local municipalities. This decentralised approach allows for localised support but also results in varying service levels and expertise across different regions.
- **Ireland**: Ireland provides best practice guidance and comprehensive information for aquaculture licensing through the Department of Agriculture, Food, and Marine. This department has a dedicated division specifically for aquacultural licensing, offering clear pathways for applicants.

Stakeholder Involvement

All three countries engage stakeholders in the decision-making process for sustainable aquaculture licenses. Typically, this involves:

- A four-week public consultation period where producers, companies, NGOs, and the general public can express their views.
- A subsequent six-week statutory consultation during which other public authorities, agencies, and research institutes provide their expertise and data to inform the licensing decision.

Knowledge and Personnel

Public authorities in Germany, Denmark and Ireland often lack sufficient knowledge, training and personnel specialised in aquaculture, including technologies like RAS and the regulatory frameworks governing the industry. This expertise gap means applicants frequently need to hire external consultants to navigate the complex licensing processes successfully.

Communication and Coordination

- **Germany**: There is a notable lack of communication between different public authorities, which can lead to inefficiencies and delays in the licensing process.
- **Denmark**: Local municipalities in Denmark generally consult each other during the permit process, promoting some level of coordination.
- **Ireland**: Ireland has improved communication between authorities and the public, facilitating a more transparent and efficient licensing process.

Administration and Digitalisation

In all three countries, the administration process for aquaculture licensing is often described as extensive, slow, inefficient, and costly. Efforts to digitalise and streamline these processes are ongoing, particularly in Denmark and Ireland, but Germany lags in this aspect.

- **Germany**: Germany has yet to digitalise its application process, which remains manual and often cumbersome, contributing to delays and higher costs.
- **Denmark**: The application process in Denmark can be completed electronically, making it more efficient and accessible for applicants.
- **Ireland**: Ireland is in the process of digitalising its application process, which will be integrated into the existing Aquaculture Information Management System. This move aims to streamline the process and reduce administrative burdens.

By understanding these differences, stakeholders can better navigate the licensing landscape and advocate for improvements that enhance efficiency and support sustainable aquaculture practices.

Marine Spatial Planning

In Ireland, aquaculture is considered in Maritime Spatial Planning (MSP) but is not included in the underlying Marine Planning Act, which implements this policy. Consequently, while the policies and principles apply, they lack legal backing for aquaculture.

Germany does not have specific zones exclusively for aquaculture under spatial planning legislation. Instead, aquaculture is integrated into broader maritime spatial planning processes managed by federal and state laws. Coastal states include aquaculture in their spatial plans, but these areas are not exclusively dedicated to aquaculture.

In contrast, in Denmark, aquaculture is integrated into MSP.

5.8 Good Practice

Several good practices of aquaculture governance were identified. These practices promote sustainable development, streamline administrative processes, and provide significant financial incentives for adopting advanced aquaculture technologies:

- **Competence Network Aquaculture (KNAQ) in Schleswig-Holstein**: The KNAQ competence network facilitates the administrative process for individuals starting aquaculture businesses in Schleswig-Holstein. It connects them with relevant stakeholders and guides the process, ensuring smoother transitions and better support for new ventures.
- **Collaboration with Local Authorities in Germany**: Hansegarnele RAS shrimp farm successfully worked with local authorities unfamiliar with the RAS licensing process to achieve a positive outcome.
- **Bord Iascaigh Mhara (BIM) - Seafood Development Agency**: This state agency is not involved in aquaculture governance which is the domain of the Department of Agriculture, Food and the Marine. The primary focus areas of BIM comprise technical innovation, environmental management, and fostering public support for aquaculture. It assists aquaculture operators in navigating complex licensing procedures, site layout and planning, environmental information, and market prospects. Although BIM's involvement is optional, it is highly valued by the industry.
- **License Fee Exemptions for RAS in Norway**: Norway indirectly supports RAS companies by exempting them from license fees, unlike traditional aquaculture methods such as net pens, which require license payment. This policy offers a significant financial incentive for adopting RAS technology and promoting sustainable aquaculture practices.

5.9 Draft recommendations to improve Sustainable Aquaculture Policy and Governance

5.9.1 Draft recommendations at member state level

From the results of our analyses presented above, and our discussions with interviewees and the multi-actor group, these are our draft **recommendations to improve sustainable aquaculture governance** at the member state level:

1. Invest in Training and Capacity Building for Responsible Public Authorities

Adequate investment in training, capacity building, and skilled personnel recruitment is essential to strengthen national and EU-level administrative capacities. Public authorities need to be familiar with the latest technologies and methods in aquaculture, such as RAS, advanced feeding systems, and health management practices. This knowledge is crucial for the effective regulation and support of innovative and sustainable aquaculture practices. Additional support and training from entities like the European Commission can enhance the understanding and execution of aquaculture regulations, given that much of the regulatory framework originates from European law. This approach will ensure that authorities can

effectively manage technological advancements and support the growth of the aquaculture sector while maintaining compliance with environmental and health standards.

2. Designate Contact Person(s) within Public Authorities

Providing a designated contact person from a public authority to support the application processes and communicate with other public authorities on behalf of the applicant would streamline the process and reduce bureaucratic hurdles.

3. Formalise working structures with universities to identify emerging industry needs

Responsible authorities should work closely with universities or dedicated experts to obtain advice on topics such as RAS licensing and innovations in aquaculture. This collaboration would provide access to expert knowledge and ensure that authorities are responding to the market needs in a timely matter as to support innovation and market growth.

4. Develop a centralized digital platform for permitting and funding

Implementing a centralised digital platform for permitting and funding would improve governance by simplifying communication and decision-making. A central system where all relevant documentation can be uploaded and accessed by all involved parties simultaneously would foster collaboration, facilitate smoother communication, and ensure alignment throughout the process of setting up an activity.

Implementing these recommendations can significantly improve aquaculture governance, leading to more sustainable and efficient practices in the industry.

These are our **recommendations to improve sustainable aquaculture policy** at the member state level:

1. Tailor Regulatory Requirements

Tailoring regulatory requirements according to the types of aquaculture operations is crucial for effective governance. Different aquaculture practices have varying environmental impacts, resource needs, and operational challenges. By customising regulations to fit specific types of aquaculture, policymakers can ensure that each operation adheres to appropriate standards, enhancing sustainability and efficiency across the sector. Regulations should be proactively checked whether they are appropriate for emerging innovations. Potential options could be commissioned studies, collaboration with dedicated experts, advisory bodies etc.

2. Establish comprehensive and standardised guidelines for navigating the licensing process

Reducing bureaucratic effort in the planning and approval phases and later in operation is necessary to make the administrative process more efficient and transparent. Streamlining the process and establishing comprehensive and standardised guidelines for navigating the various steps involved would provide applicants with clear instructions and expectations, reducing ambiguity and expediting approvals.

3. Integrate Sustainable Aquaculture into Marine Spatial Planning

Efforts should be made to integrate aquaculture into marine spatial planning processes. By incorporating aquaculture into marine spatial planning, policymakers can ensure that these activities are conducted

harmoniously with conservation efforts and other marine economic activities, balancing economic growth with environmental protection. This integration will also help to identify suitable locations for aquaculture operations, minimising conflicts with other marine activities and ensuring sustainable use of marine resources.

4. Incentivise Sustainable Aquaculture

Incentivising sustainable aquaculture practices is essential for promoting environmentally friendly and economically viable operations. One effective incentive could be eliminating financial costs for licensing sustainable aquaculture facilities. By reducing or eliminating these costs, governments can encourage the adoption of sustainable technologies and practices. This approach supports the growth of the aquaculture sector and aligns with broader environmental goals, fostering a more sustainable industry overall.

5.9.2 Draft recommendations at EU level

1. Develop a Common Aquaculture Policy

Developing a common aquacultural policy would provide a comprehensive framework for addressing issues related to aquaculture and could inform national policies in Member States. An overarching policy would delineate clear responsibilities for each entity—Member States and the Commission—ensuring accountability. This clarity is essential for setting measurable objectives for the whole sector, which should inform national-level policies. A unified approach would streamline regulations, promote consistency, and facilitate cooperation among Member States, leading to more cohesive and effective aquaculture governance.

2. International Collaboration

Facilitating international collaboration and knowledge exchange among countries facing similar aquaculture governance challenges would promote the sharing of best practices and innovative solutions, enhancing overall governance.

By implementing these recommendations, policymakers can enhance the governance and sustainability of the aquaculture sector, ensuring it contributes positively to economic development and environmental conservation.

5.9.3 Conclusions on Sustainable Aquaculture Governance

The analysis covered three countries with different aquaculture governance structures. Each country has its unique approach to managing and regulating aquaculture activities, reflecting varying degrees of centralisation and local autonomy.

A centralised system for aquaculture activities streamlines administrative processes and provides consistency in decision-making. Centralisation helps to reduce bureaucratic hurdles, ensures a more efficient and transparent application process, and facilitates easier compliance with regulations.

Despite the differences in governance structures, all three countries face common governance challenges in the aquaculture sector:

- **Shortage of skilled personnel**: The sector struggles with a shortage of skilled personnel, which affects the capacity to manage and operate aquaculture facilities effectively and to implement innovative practices.
- **Lack of clear guidelines:** Except for Ireland and some regions in Germany, there is a general lack of clear guidelines for the application process, causing confusion and delays for applicants. Clear, standardised guidelines are essential for a streamlined and efficient regulatory environment.
- **Complicated administration process**: The administration processes are often complex and cumbersome, deterring potential investors and operators from entering the sector. Simplifying these processes is crucial for fostering growth and innovation in aquaculture.

These conclusions highlight the need for more coordinated and supportive governance frameworks that address these common challenges while leveraging the strengths of centralised systems to promote sustainable and efficient aquaculture development.

5.9.4 What we learn from sustainable aquaculture for emerging bioeconomy sectors: draft recommendations for emerging bioeconomy sectors

From the analysis of sustainable aquaculture governance, we learn valuable lessons that can be applied to other emerging bioeconomy sectors:

1. Training and Capacity Building for Public Authorities

Investing in training and capacity building ensures that public authorities have the necessary knowledge to effectively manage and regulate new technologies. This is crucial across all emerging bioeconomy sectors where rapid advancements in biotechnology, environmental science, and sustainable practices are common. Trained authorities can implement and enforce regulations more efficiently, ensuring that new innovations are safe and effective.

2. Designating Specific Contact Persons

Having designated contact persons within regulatory bodies can streamline application processes and reduce bureaucratic hurdles. This is particularly useful for emerging bioeconomy sectors, which often deal with complex and interdisciplinary innovations. Clear points of contact can provide guidance and facilitate smoother interactions between applicants and regulatory bodies, enhancing transparency and efficiency

3. Collaboration with Universities

Collaborating with universities ensures that regulatory bodies stay updated on the latest scientific and technological developments. This is essential for all emerging bioeconomy sectors, as continuous innovation requires that regulations are adaptive and supportive of new research findings. Universities can provide expert knowledge and help shape policies that foster innovation while maintaining safety and sustainability standards.

4. Centralized Digital Platforms

Developing centralized digital platforms for permitting and funding can significantly improve governance by simplifying communication and decision-making processes. For emerging bioeconomy sectors, which often involve complex regulatory landscapes, such platforms can provide a unified system for all stakeholders to access and share relevant information. This enhances coordination, reduces delays, and ensures that all regulatory requirements are met efficiently.

5. Tailoring Regulatory Requirements

Tailoring regulatory requirements to the specific needs of different bioeconomic activities ensures that regulations are both effective and practical. Emerging bioeconomy sectors encompass various activities, each with unique environmental impacts and resource needs. Customized regulations can address these specificities, promoting operational efficiency and sustainability without imposing unnecessary burdens.

6. Incentivizing Sustainable Practices

Incentivising sustainable practices, such as reducing licensing costs for environmentally friendly technologies, encourages the adoption of sustainable methods across emerging bioeconomy sectors. Economic incentives can align the goals of profitability and environmental stewardship, fostering a more sustainable and resilient industry. This approach ensures that economic growth does not come at the expense of environmental health.

Implementing these recommendations can help emerging bioeconomy sectors navigate complex regulatory environments, promote innovation, and ensure sustainable development.

6. Fostering regional bioeconomy across the EU; insights from Germany, Ireland and Greece

Noha Mahmoud, Maeve Henchion, Teagasc Ashtown Food Research Centre

6.1 Introduction

The implementation of bioeconomy policies and strategies, although often developed at the national level, occurs predominantly at sub-national and local levels (Jarosch et al., 2020). Regions act as dynamic intermediaries between national directives and local characteristics (Asheim and Coenen, 2005; De Besi and McCormick, 2015). The impacts of the bioeconomy—particularly in rural development and social sustainability—are often most realized at the regional level (Jarosch et al., 2020).

Regional engagement facilitates the development of context-specific strategies, acknowledging the priorities, resources, and socio-economic dynamics characteristic to each region (Koukios et al. 2018). Structures such as SME clusters, networks, and research institutions developed at the regional level facilitate innovation and the dissemination of knowledge tailored to the unique environmental and socio-economic attributes of each region, including water resources, soil quality, biodiversity, industrial presence, and general infrastructure (Asheim and Coenen, 2005; De Besi and McCormick 2015; Tarsitano et al. 2023). This regionalised collaboration can enhance the efficiency and effectiveness of bioeconomy initiatives, contributing to economic and social growth within regions.

The EU increasingly acknowledges the bioeconomy's role in achieving sustainability goals, with regional support mobilised through Smart Specialisation Strategies (Naudet and Marrazzo, 2021) and Regional Innovation Valley for Bioeconomy (Directorate General for Research and Innovation, 2023). Aligning with the European Commission's call for smart specialisation strategies, many regions across Europe have initiated the development of bioeconomy strategies; these are often integrated into broader regional economic development and innovation plans and influenced by national and regional policy contexts signifying sustainability objectives (Charles et al., 2016). The multi-faceted benefits of adopting bioeconomy practices, e.g. to realize the benefits for employment, economic growth, greenhouse gas emissions reduction, and environmental sustainability, facilitate this integration.

Despite that the majority of the EU regions and countries have integrated bioeconomy-related aspects into their research or innovation priorities, a significant proportion of these regions is at a low level of bioeconomy maturity (Directorate-General for Research and Innovation, 2017). Those regions are lagging behind and have a limited ability to independently harness the full potential of the bioeconomy (i.e., economic growth, and rural development) (Directorate-General for Research and Innovation, 2017). There is considerable variation in the stages of bioeconomy development among different regions within the EU (Haarich and Kirchmayr-Novak 2022), which signifies the need for in-depth understanding on how to foster regional engagement efforts. Moreover, identifying the lesson learnt from the efforts of regions in different member states, representing different developmental stages, can be insightful for other regions. This will guide member states and regions on the mechanisms for successful regional bioeconomy development and offer an opportunity for strengthened cross-regional collaboration that can enable the effective harnessing of regional dynamics in knowledge creation and application.

6.2 Selection of regions as case studies

The study objective is to identify mechanisms and practices that can foster regional bioeconomy development in the EU. Three regions at different bioeconomy developmental stages were selected to identify patterns, challenges, and good practices for regional bioeconomy development. Investigating the three regions at the different developmental stages will offer insights into the effective mechanisms, transferrable learnings, and good practices that can be adopted by regions at the different stages of development.

The methodology that was applied is given in chapter 3.

The three regions were chosen for their diverse geographical scopes and level of inclusion of bioeconomy principles in national and/or regional strategies. As such, the three case studies were expected to represent regions at different bioeconomy development levels, ranging from medium to very high. In this study, the term "regions" refers to administrative units within a country (i.e., sub-national level), while the level of bioeconomy development is gauged from a governance perspective and based on the presence of bioeconomy strategies regionally and nationally. Three distinct development levels are defined, as illustrated in Figure 13. The first case represents a country with bioeconomy strategies implemented at both national and regional levels. The second case involves a country with a national strategy exclusively, while the third case pertains to a country lacking national bioeconomy strategies but demonstrating apparent efforts and action plans towards regional bioeconomy development.

The regions were identified based on knowledge within the ShapingBio consortium, and desk-based research. Regions were selected following a pragmatic approach for an administrative region that has a potential level of interest in the study topic (i.e., involved in bioeconomy projects, active engagement of local and regional authorities). Accordingly, the regions to be studied are a) Bavaria in Germany; b) the Southern Region in Ireland; and c) Macedonia in Greece. Bavaria represents a Western European member state with a high regional bioeconomy development level, possessing national and regional bioeconomy strategies. The southern region of Ireland represents a Western European member state with a high bioeconomy development level, having a policy at the national level and no regional strategy. Central Macedonia represents a Southern European member state with a medium bioeconomy development level, as the country doesn’t have a bioeconomy-dedicated strategy but poses a regional circular action plan that focuses on the promotion of bioeconomy, among other objectives. From the desk research, the three regions are actively engaged in bioeconomy projects and activities (e.g., ROBIN, POWER4BIO). The selection of these regions for further analysis was also endorsed by the multi-actor group.

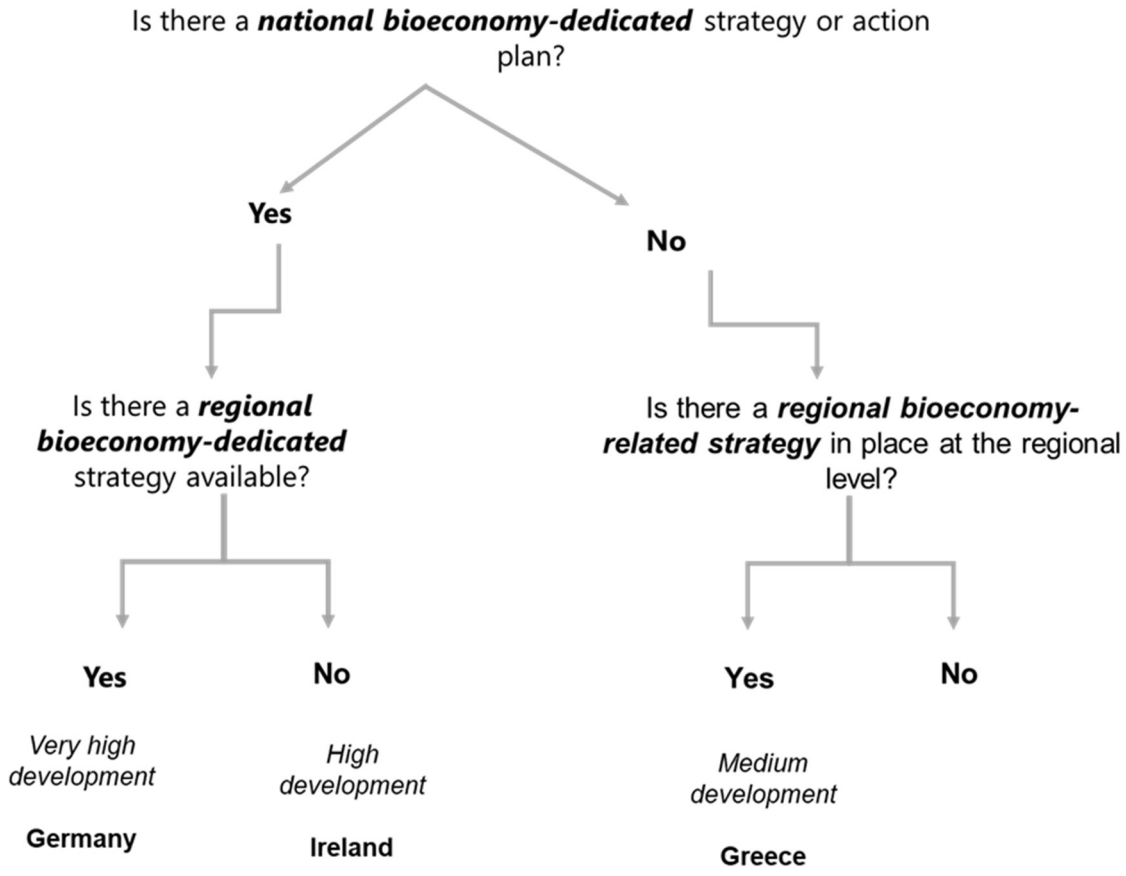

Figure 13: Rationale for selecting the regions

6.3 Results of the case studies

The main aim of this work is to enhance our understanding and identify learnings from different regions. Although the goal is not to quantify regional bioeconomy development indicators, it is necessary to understand what constitutes a well-developed regional bioeconomy to guide our interview questions. During the first co-creation workshop, we discussed with key experts how they would describe a successful regional bioeconomy in one word. The most common words were collaboration, having shared goals, decentralisation, and use of local resources. All the answers to this question are presented in Figure 14.

Figure 14: Word cloud representing successful regional bioeconomy, as identified by the MAG

6.3.1 Bavaria, Germany

Bavaria is the largest federal state of Germany, covering an area of approximately 70,552 km², which is a little larger than Ireland (Bavarian Ministry of Economic Affairs, 2024). The state is predominantly rural, with 32% of its area being forest and 48% used for agriculture. Despite the early efforts of the region within bioeconomy being focused on agriculture and biomass, it shifted overtime time to focus more on industry, innovation, and the production of market-ready bio products.

The transition towards sustainability and bioeconomy emerged as a response to climate change, the need for decarbonisation, and an opportunity for the utilisation of abundant biomass. In 2015, Bavaria became the first federal state in Germany to establish 'Bavarian Bioeconomy Expert Council' to advise the government on bioeconomy implementation, facilitate dialogue among various stakeholders and promote societal dialogue to advance bioeconomy development. The Expert Council is an independent advisory council, representing industry and academia, appointed by the Ministry for Food, Agriculture and Forestry.

Bioeconomy activities in Bavaria are mainly led by the 'State Ministry for Economic Affairs, Regional Development, and Energy', and 'State Ministry for Food, Agriculture and Forestry' with significant involvement from other ministries, including the 'Ministry for Science and the Arts' and the 'Ministry for Environment and Consumer Protection'. In addition, industry-clusters play a key role for bioeconomy development in the region. 17 industrial clusters were established since 2006 and funded by the Bavarian state government under the "Cluster Initiative Bavaria" to link research with industry, enhance the value chain, foster networking, develop innovative products, optimize processes, and boost innovation. Among the active clusters in bioeconomy are chemistry, environmental technologies, and forestry (Stricker 2021).

Other key stakeholders include research institutions and universities such as the Technical University of Munich (TUM), Technical University of Applied Sciences Rosenheim (TH Rosenheim) and University of Passau. The region is the home of numerous industries with Bavarian and international companies (e.g., the

Finnish company UPM which is working in paper industry), biochemical and biomaterials industries. The state company Bayern Innovativ is another key actor supporting industry and science stakeholders in promoting innovation and technology transfer. A large number of SMEs, start-ups and spin-offs are also active stakeholders within the bioeconomy. Bavaria is collaborating closely with other countries such as Austria, Italy and Switzerland to create channels for collaborations to facilitate logistics and transportation of biomass. Figure 15 shows the key actors in the Bavarian bioeconomy including public sector, bioeconomy expert council, industry-based clusters followed by companies such as Bayern Innovativ, research organisations and the broader community.

Figure 15: Key actors in the Bavarian bioeconomy

The Bavarian bioeconomy strategy (Future Bioeconomy Bavaria), published in 2020 was developed in close consultation with the Bavarian Bioeconomy Council, the industrial clusters, and representatives from primary producers (e.g., farmers), business, science, and society. It introduces eight objectives and 50 measures to be implemented regionally, ensuring Bavaria's leadership in the bioeconomy sector. The core aims of the strategy are to reduce the consumption of fossil raw materials, protect biodiversity, develop new technologies and processes and build up biological knowledge. The strategy highlights the significance of policy alignment and coordination, embedding the bioeconomy strategy within other pre-existing policies frameworks. Other regional strategies that are bioeconomy relevant include the cross-divisional Bavarian Sustainability Strategy (Bayerische Nachhaltigkeitsstrategie), The Bavarian Climatic Adaptation Strategy (Bayerische Klima-Anpassungsstrategie), Bavarian Hydrogen Strategy. These strategies aim to shape a sustainable path for Bavaria by addressing defossilization, climate protection, and sustainable development, thereby supporting the bioeconomy's future in the region.The Bavarian Bioeconomy Expert Council played a crucial role in developing the bioeconomy strategy and evaluated its progress, publishing a report in 2023 (available only in German). The report evaluated the implementation status of the measures presented in

the strategy. Based on this status, strengths and weaknesses of the overall strategy and obstacles to its implementation progress are identified.

Bavaria's strong political will, represented by the lead by state ministries, coupled with having a regional vision for development of the Bavarian state, a formal regional bioeconomy strategy, regional funding, existence of research institutions and industry-specialized clusters have all contributed to an enabling environment for bioeconomy development. The state government provides several innovative investment incentives for companies regardless of their size for conducting research and development projects (e.g., high-tech fund, subsidies and low-interest loans).

There is increasing momentum for involving the community in bioeconomy activities. Several initiatives have been introduced to ensure broader participation and engagement, such as street festival and NAWAREUM museum which provide interactive experience on topics such as nature, climate change, biodiversity conservation, and technology. However, primary producers, particularly farmers, are less involved as they are not easy to convince. Additionally, stakeholders at the retail end of the value chain, some industries with different goals, and end users and consumers are less engaged, often due to differing priorities and less focus on environmental goals and emissions' reduction.

6.3.2 Southern Region, Ireland

The Southern Region of Ireland, encompassing an area of 29,829 km² and has significant livestock, marine and forestry industries. Despite the absence of a regional bioeconomy strategy, the National Policy Statement on bioeconomy published in 2018 and the 2023-2025 bioeconomy action plan governs bioeconomy implementation at the national level is mirrored at the regional levels. The Irish government recognises the bioeconomy as crucial for supporting a low-carbon and circular future and as an enabler for green and just transition, responding to EU priorities. The primary drivers of the bioeconomy in the Southern Region stem from both national and European commitments to climate action and the green transition. The strategic focus of the national policies is to promote sustainable scientific practices and bio-based innovations. Additionally, they aim to support research, innovation, market development, and foster stakeholder engagement.

Other bioeconomy related policies that are available nationally are Food Vision 2030, Project Ireland 2040, Forest Strategy 2023-2023 and the Climate Action Plan 2021. The most relevant regional strategy is the Regional Spatial and Economic Strategy (RSES), which highlights key priorities such as achieving climate change targets, developing the rural economy, and supporting a sustainable economy.

Key actors in the Southern Region's bioeconomy include the public sector, academic institutions, and industry partners. Nationally, the Department of the Taoiseach (Prime Minister's Office) led the development of the bioeconomy policy statement, which is currently implemented by the Department of Agriculture, Food and Marine (DAFM) and the Department of Environment, Climate and Communications (DECC). The Department of Jobs, Enterprise and Innovation (DJEI) is also involved. Regionally, the Southern Regional Assembly and Local Authorities of the county councils play a key role in implementing bioeconomy activities. The Southern Regional Assembly is established under the Local Government Reform and is one of three regional assemblies in Ireland and oversees ten local authority areas in the Southern Region. It plays a key role in EU funding and planning, authority linking local and national policy goals through regional, spatial and economic planning, and through the implementation of the RSES.

Other key stakeholders include research institutions and universities, such as Munster Technological University (MTU), CircBIO research group, and Limerick Institute of Technology and companies (e.g., Carbery Group). Other active stakeholders are clusters (e.g., Southwest cluster), Irish Bioeconomy

Foundation and primary producers. Figure 16 presents the key actors in the Southern Region including the lead as in the DAFM, research organisations, companies followed by collaborative structures such as the clusters and the primary producers as well as the community.

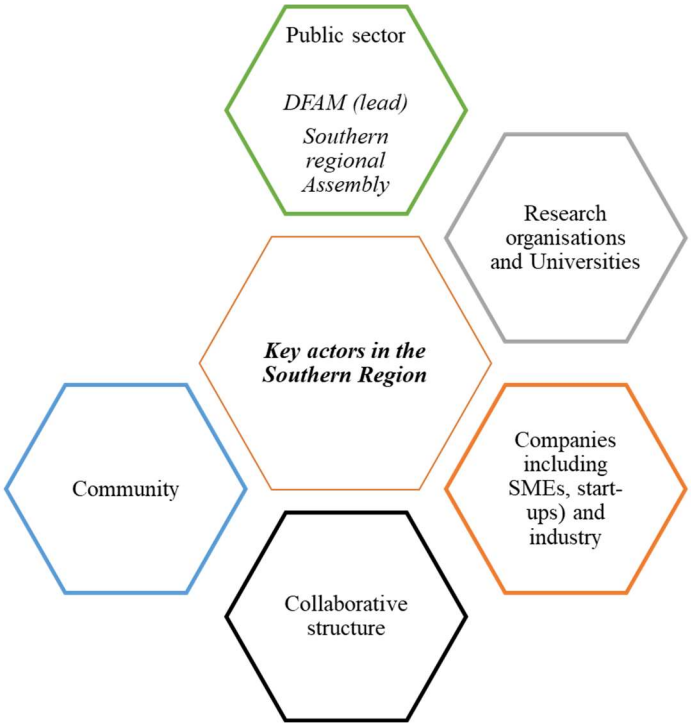

Figure 16: Key actors in the Southern Region

Education and research in the bioeconomy, as well as facilities like the Bioeconomy Campus in Lisheen, provide a robust foundation for bioeconomy activities and industry engagement in the region and all contribute to an enabling environment for bioeconomy development. Several collaborative research and development projects and programmes are currently active in the region. For example, the Farm Zero C project which brings different active stakeholders in the region to showcase an example of how dairy farms can be a net zero while maintaining their resilience and being commercially viable. CABBBIE project, to develop sustainable bio-methane and bio-based products. ROBIN project is another example aim at accelerating the achievement of circular bioeconomy targets at the regional scale. National funding for bioeconomy development also exists in the region (e.g., Shared Island Bioeconomy Demonstration Initiative).

Multiple activities designed nationally that target inclusion and awareness raising among the community, benefit the region (e.g., the annual bioeconomy week, bio-bus showing examples of daily use bio-based products). Other activities such as ‘’This City on Rock and Coal’’, a citizen science engagement initiative that brings actors and scientists to rural locations in Ireland for research-based interactive events. These events are presented in an artistic manner, incorporating comedy and music shows to support behavior change.

6.3.3 Central Macedonia, Greece

Central Macedonia, European Entrepreneurial region in 2018, is the largest in area and second most populous region in Greece, with an area of 18,810 km². The regional focus is on agriculture, municipal waste for energy, recovering materials and recycling. Greece is recovering from an economic crisis, exacerbated by COVID-19 financial impacts which impose challenges in promoting circular bioeconomy activities. However, some companies include circular economy and green practices in their corporate social responsibility efforts.

Despite that the country and the region do not have a dedicated (national) bioeconomy strategy, the region has a circular economy action plan and transition into the bioeconomy is within the broader concept of circularity ‘’circular bioeconomy’’. The regional action plan for the circular economy aims to ensure a more sustainable use of resources and lower emissions. The action plan further focusses on improved policy implementation and SME support, based on best practices from the EU on the transition towards circular economy. Several tools dedicated to support SMEs form part of the region’s development plan including the introduction of the “circular economy" criterion in the evaluation for funding of SMEs, the creation of a mechanism to promote the concept and good practices on the circular economy and innovation vouchers for SMEs to fund actions based on the circular economy. Municipal waste management is a key for circularity and the region is investing in raising awareness of the community on waste reduction, sorting waste, reusing, and recycling. Bioeconomy-related policies are The National Plan for Energy and Climate, The National Waste Management Plan, and The Regional Waste Management Plan, The National Strategy of Circular Economy, and the National Action Plan on Circular Economy, the National Recovery and Sustainability Plan. These policies and roadmaps aim to maximize resource-use efficiency, promote circularity, and drive defossilization, aligning with the principles of the bioeconomy.

Circular bioeconomy is an EU priority area, which is mirrored at the regional level in Macedonia, brings with it the potential to achieve 2050 climate targets, creating jobs, and supporting the economy. In addition, the availability of funding from the EU that encourages the inclusion of central and eastern European countries supports the bioeconomy efforts in the country. Although bioeconomy development is in its infancy, several research and EU collaboration projects exist. For example, the BioGov, BIOREGIO and ROBIN projects support informed decision-making for bioeconomy and regional policies, support best practice in circular economy and enhance engagement of all actors. Over the past years, there has been an increasing focus on knowledge exchange and raising awareness of the general public (e.g., Citizen Science Club).

The local authority of the region of Macedonia ‘RCM’ is leading bioeconomy activities and projects (Figure 17). In addition, research institutions and universities such as the International Hellenic University and Aristotle University of Thessaloniki, organisations (e.g., Q-Plan), NGOs, companies and start-ups (e.g., Ok!Thess Accelerator, SKG Makers, Staramaki) play a key role in the bioeconomy development in the region.

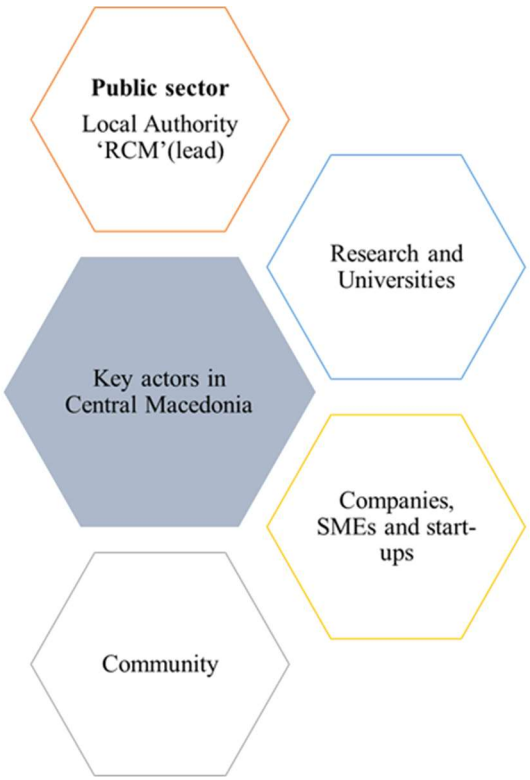

Figure 17: Key actors in Central Macedonia

6.4 Cross-regional analysis

Bavaria, the Southern Region, and Central Macedonia represent different stages of bioeconomy development, reflected in having governing regional and national bioeconomy strategies. These three regions vary geographically, in size (e.g., the whole country of Ireland is smaller than the region of Bavaria), level of urbanization, or dominance of rural areas. They also have unique regional priorities, governance structures, and local factors (e.g., agriculture intensity, forestry, or industry focus), which in turn influences bioeconomy development. Despite the differences between the three regions, they share common goals including recognition of the importance of bioeconomy for a sustainable future.

In the three regions, there is a strong governmental recognition of the bioeconomy which is led by national or regional governmental bodies such as the state Ministry of Economic Affairs, Regional Development, and Energy in Bavaria, the local authority 'RCM' in Central Macedonia, and nationally by the Department of Agriculture, Food, and the Marine (DAFM) in the Southern Region. In Bavaria, bioeconomy development was initially driven by climate action and the urgency of transitioning towards net zero future. In Southern Region, the focus on bioeconomy mirrors EU and national priorities, which was supported by key research and development initiatives, likely influenced by EU funding opportunities and driven by the national vision recognising the significance of bioeconomy. In Central Macedonia, bioeconomy is driven by EU priorities and funding opportunities, with the region considered at the early stage of development. Table 13 summarises key bioeconomy aspects in the three regions.

The three regions have a strong research and development foundations. In Bavaria, there are several bioeconomy dedicated educational programmes (e.g., BSc in bio economics from TUM) and international research collaborations (e.g., Global Bioeconomy Alliance). In the Southern Region, there is a strong landscape of research institutes offering postgraduate qualifications in bioeconomy (e.g., Diploma in bioeconomy with business), research groups (e.g., CircBIO), and projects undertaken that support the bioeconomy (Farm Zero C project and CABBBIE). In Central Macedonia, despite the existence of academic institutions, the region faces a significant gap between research and industry. The region has undertaken several projects to support bioeconomy; in fact, the action plan of circular economy was developed in the framework of EU projects.

The state of Bavaria provides multiple funding programmes that support start-ups, SMEs and spin offs. This funding is often in the form of investment incentives and innovation funding for conducting research and development projects. For example, the High-tech Agenda of Bavaria dedicates significant investment for innovation (€5.5 billion) including support for start-ups (€130 million) (Bavarian Ministry of Economic Affairs, Regional Development and Energy, 2024). In the Southern Region, national funding schemes are available to support the bioeconomy. In addition, the EU Just Transition Fund Bioeconomy Demonstration Initiative supports collaborations between stakeholders including SMEs and the €7 million Shared Island Initiative supports the integration of bio-based innovation in the agriculture and marine sectors on the island of Ireland. In Central Macedonia, the circular economy action plan highlights measures and activities through which SMEs can secure finance for investments for the transition to circular economy.

In both the Southern Region and Central Macedonia, funding, establishing effective communication channels, and fostering collaborative efforts are among the good practices for advancing bioeconomy. The significant role that EU projects play is remarkable, in the two regions, in supporting and enhancing bioeconomy developments in these regions. These projects not only provide financial support but also facilitate knowledge exchange, capacity building, and the implementation of innovative practices that can contribute to sustainable economic growth and resource utilization.

Several good practices that support bioeconomy development in Bavaria include the existence of the industrial clusters that play a significant role in bringing science and industry together, supporting companies and coordinating the translation of research outcomes into practice. Clusters, within a regional ecosystem, consolidate diverse stakeholders and supports the creation of linkage between industries, which is needed to mainstream the bioeconomy (Mercedes et al., 2014; Directorate-General for Research and Innovation, 2017). The clusters are considered as enablers in the Bavarian innovation landscape, facilitating match-making events and establishing projects between companies and research institutes (Stricker, 2021). In the recent years, cross-clusters collaborations are gaining momentum in Bavaria; the International Sustainable Economy Forum (ISEF), brings two collaborative platforms; IBB Netzwerk GmbH and Chemie-Cluster Bayern GmbH aiming at joining forces to foster sustainable economy (Stricker, 2021). The formalised advisory board (i.e., Bavarian Bioeconomy Expert group) plays a critical role in connecting stakeholders, promoting communications, and monitoring the progress of the bioeconomy.

In the Southern Region, the existence of demonstration-scale facilities enables the scaling-up of research activities. The Bioeconomy Campus in Tipperary is considered the national hub for sustainable green energy, reflecting the significance of bioeconomy in the region and nationally. It recently received a €5 million grant from the government's Just Transition Fund. Among the good practices are the community-engagement activities such as the annual bioeconomy week and its associated activities such as the bio-bus. Involvement of primary producers and knowledge sharing events are also among the good practices, for instance study visits bringing stakeholders to share knowledge locally, nationally and internationally as well as appointing advocates for bioeconomy development from primary producers and local dwellers (e.g., the Dingle hub). The integrated refineries to build up synergies and maximize the effectiveness (i.e., using grass

for protein, feed and energy production) is another example of the current practies supporting bioeconomy development in the region. For example, AgriChemWhey is an industrial-scale bio-refinery which uses by-products from the dairy industry and converts them into bio-based products.

In Central Macedonia, there are citizen involvement in science initiatives, such as the science citizen club, which is adopted nation-wide to generate knowledge and raise awareness. Central Macedonia is a good example of how to use European funding in the best way to push the agenda even in traditional sectors. This region succeeded securing funding over several rounds to progress this area. In this way, the region continues to push the agenda in the same direction, even if it is not bioeconomy per se but circular economy. Despite being located in Western Macedonia rather than central Macedonia, the CluBE Cluster of Bioeconomy & Environment of Western Macedonia is a key factor in the region. The cluster is very active in establishing links with municipal authorities, especially with respect to bioenergy and waste valorisation, and also in engaging citizens (e.g., SCALIBUR).

Table 13: Summary of key bioeconomy aspects in the three regions

	Bavaria	Southern Region	Central Macedonia
Drivers for development	Strong regional political will	Strong national political will	EU priorities driving national efforts
Strategic scope	Innovation and technology	Research and development	Circularity and municipal waste management and recycling
Current focus	Upscaling facilities and development of market-ready products	Progressive development to market stage including research and development	Bridging the gap between research and industry
Community engagement	Limited engagement with primary producers (i.e., farmers) Activities addressing the public	Engagement of community members, and primary producers are advocates for bioeconomy	Inclusion of community in scientific research and raising awareness
Good practice	Formalised advisory board (communications with stakeholders and society) and industry-specialised clusters Inter-regional collaborations Significant regional funds for innovation, SMEs, spinouts, etc.	Community engagement activities Regional and international exchange study visits (mutual learnings) Investment in integrated solutions (integrated bio refinery using grass for protein, feed and energy)	Citizen involvement in science initiatives EU funding opportunities

6.5 Fostering regional bioeconomy development

Whether at the national or regional levels, bioeconomy development can be considered as a transformational change. Among the change models is the 8 steps Kotter model (Figure 18). Although there is no single model can guarantee successful transformational change, kotter model is recognized as one of the most influential and widely used frameworks in the field of change management (Pollack and Pollack, 2015). Although the Kotter model tends to describe change as a stepwise process, it is not applied in this context due to the complex nature of the bioeconomy. Instead, we focus on the specific contextual steps and actors involved. In this model, change can be enabled through the creation of the climate for the change, organisational, engagement activities and creating an enabling environment followed by sustaining change and adopting actions for improvements. This mainly entails developing a vision for the transition, having establishment of a coalition that supports implementing the vision. Collaboration is a critical element of the Kotter model, emphasizing that formation of a powerful coalition rather than relying solely on individual motivation. This is followed by implementing actions that support transitional change, removing barriers followed by creating wins and joining forces to sustain change. Using the Kotter model as a framework, some comments can be made on the development of the bioeconomy in the three regions. Bavaria is in a more advanced stage compared to the other two, change in that case stemmed from the urgent need to develop a response for climate change and to meet decarbonisation targets whereas in Southern Region and Central Macedonia bioeconomy development stems from EU strategic priority (i.e., bioeconomy). In Bavaria and Southern Region, there is a dedicated strategy for bioeconomy. The three regions have not followed the same pattern in bioeconomy development, however in all cases it is clear that the process is not linear, and that the development has been influenced by similar factors: regulatory, governmental structure, stakeholders' involvement and availability of finances and facilities.

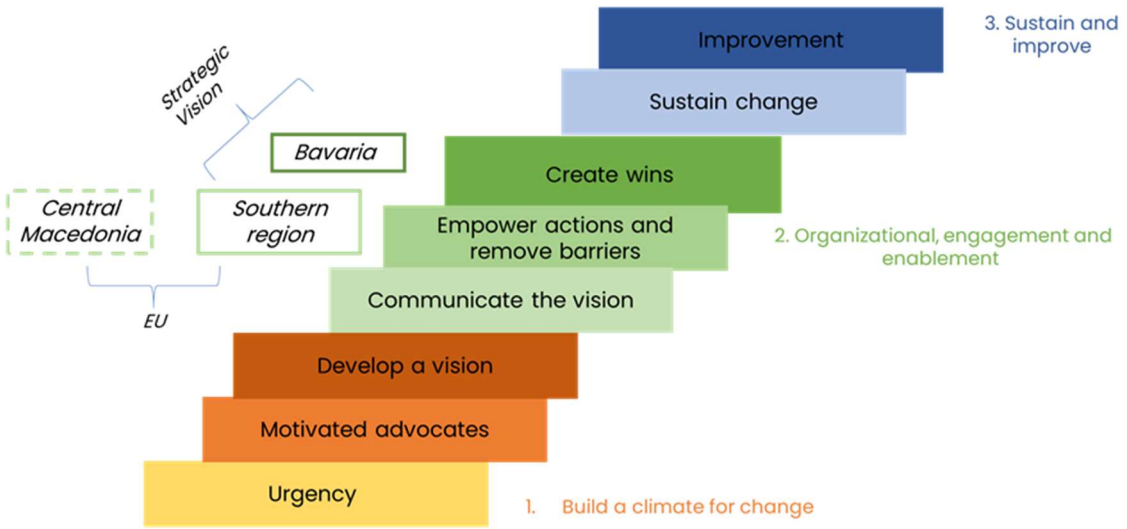

Figure 18: The three regions and Kotter model of change

Based on the expert interviews, fostering regional bioeconomy involves numerous actions relating to policy and regulations, organisational structure, financial and market and community engagement. These elements

are inter-linked and can have a mutual influence on each other. Hence, there is a need to account for regional specificities and characteristics.

Policy and regulations

In some regions, the presence of regional authorities can support systematic collaboration to explore engagement opportunities among key stakeholders. These authorities act as intermediaries between the national government and the community. Given regional differences, it is fundamental to assess the opportunities available for the bioeconomy in each region. This involves understanding the existing industry structures, available biomass resources that are currently underutilized, and potential streams that could be harnessed. It is important to develop a vision specifically tailored to the region. However, having a vision alone is not sufficient. A clear vision and flexible roadmap that considers trade-offs, interactions and overlaps with other environmental goals and national targets are crucial. This necessitates defining the purpose of regional collaboration and recognising the broader advantages of the bioeconomy for the development of a sustainable region, beyond just economic gains, to guide subsequent collaborative actions.

Multi-level policy alignment, both between different sectors and between regional and national priorities and strategies, is essential to avoid conflicting objectives. For instance, the impact of the bioeconomy on energy, land use change, trade, export and import of feed stocks, and transportation must be considered. When national policies align with local priorities, this can mainstream the bioeconomy at the regional level and maximise the benefits of localised resources. Additionally, establishing and maintaining dialogue between different public sector stakeholders regionally, nationally, and across sectors is vital. This requires an understanding of the bioeconomy co-benefits for the entire value chain.

Collaboration structures

Based on our discussions with the experts, it is clear that there is an increasing need for strong coordination at local and regional levels to support the implementation of bioeconomy initiatives, especially since bioeconomy involves many early-stage technologies. Making the most of existing networks, even if they aren't explicitly dedicated to the bioeconomy, can be more efficient than initiating entirely new collaborative platforms. Industrial networks and green development clusters have been described as the backbone of bioeconomy progress. Clusters bring relevant stakeholders from all sectors together, hence considered as "local nodes" of global knowledge within the complex landscape of regional and sectoral innovation systems, optimizing localized knowledge capabilities (Clar and Sautter, 2014). While leveraging existing networks is generally the best option, successful initiatives can emerge even without pre-existing platforms.

Top-down incentives by the government can effectively foster regional collaboration, as demonstrated by an example from Germany. Approximately three decades ago, widespread bioeconomy initiatives, particularly in biotechnology, were underway across the country. In response, the Federal Ministry of Research initiated a regional competition, offering substantial funding to regions that could mobilise stakeholders and formulate a plan or network. This proactive approach incentivised regions to organise themselves and collaborate effectively, despite the lack of pre-existing platforms. As a result, the competition successfully united scattered actors, institutions, and individuals, leading to the formation of cohesive bioeconomy regions. This initiative, led by the Federal Ministry, notably contributed to the emergence of fifteen bioregions, including Bavaria. Such top-down strategies can be instrumental in motivating effective collaboration, even in the absence of pre-established frameworks.

Funding and market

While financial support for business is a core barrier, so is the challenge of ensuring adequate and accessible funding for research and innovation. Financing for research and innovation in some countries primarily focuses on either basic research or market-ready (i.e., mature) technologies, neglecting the "valley of death"

phase. Supporting companies can take other forms like establishing facilities (e.g., industrial cluster & logistical support, demonstration facilities) and can attract investment and introduce funding instruments for SMEs and start-ups that are adequate for their needs and easily accessible.

Some countries and regions rely heavily on EU project-based funding which can present challenges in continuing activities after their initial funding ends. This can be exacerbated by the lack of the necessary resources and personnel in local government. A good example is when a region continues to push the bioeconomy agenda without ongoing European funding, creating a sense of ownership.

Community and engagement

Empowering communities (communities are often inclined to trust local and regional authorities) is crucial for driving acceptance and demand for bio-based products. In addition to building knowledge and awareness, this can also require removing misconceptions around the "bioeconomy." Engaging stakeholders through regular communication and transparent processes fosters trust and inclusivity. By involving residents in decision-making and informing them about the benefits and progress of bioeconomy initiatives, communities can better understand and support these efforts. Tailoring communication models to fit the unique governmental structures of different regions ensures that all voices are heard and that strategies are effectively implemented. This approach contributes to building a sense of ownership and commitment among stakeholders, ultimately leading to more sustainable and accepted bioeconomy practices.

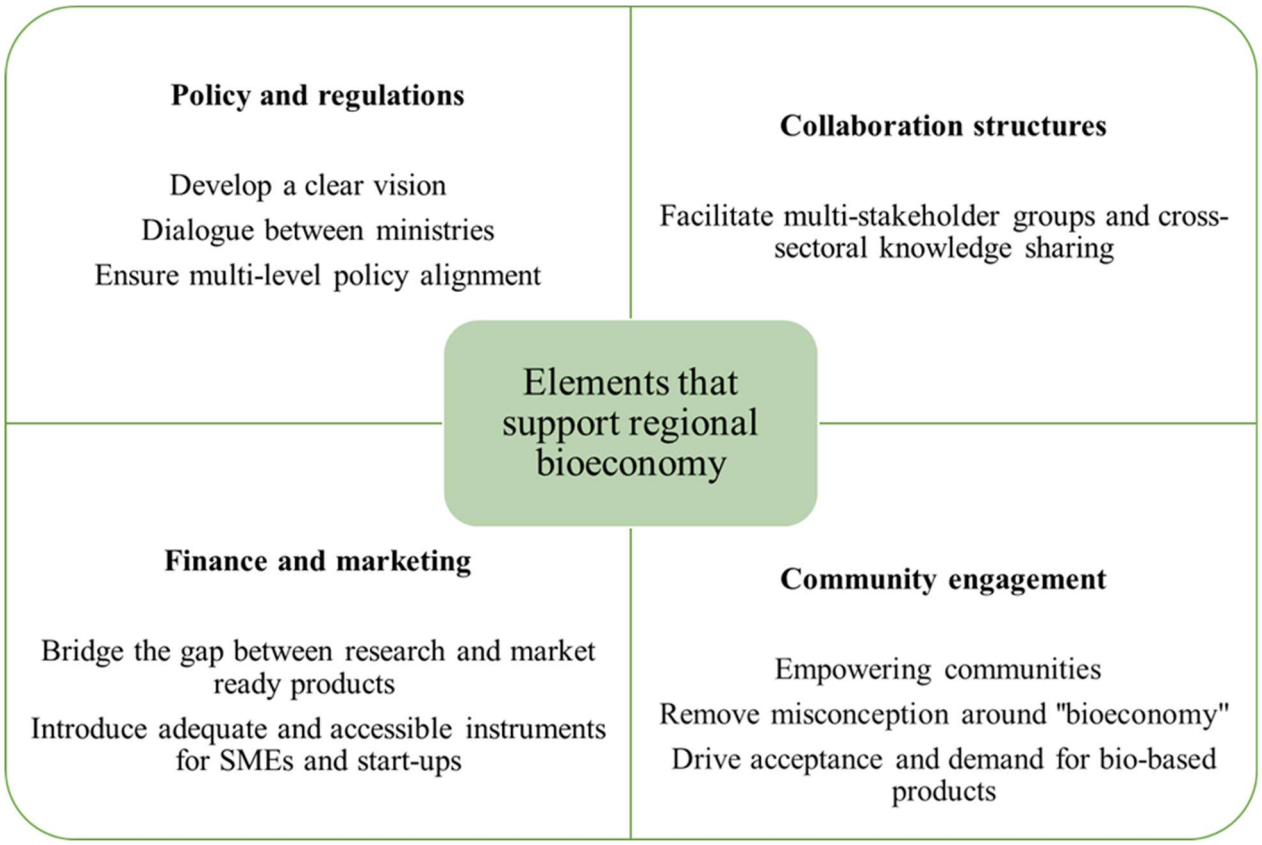

Figure 19: Summary of key elements that can support regional bioeconomy development

6.6 Insights from the three regions

Below we present common lessons from the insights derived from this research across the three regions. Key actions to initiate and support regional bioeconomy engagement include:

Start by assessing regional strengths and priorities. This entails:

- Identify regional strengths (e.g. in terms of available feedstock, waste streams, human capital, and industries landscape (i.e., what are the dominant industries regionally).
- Build a climate for change that involves capitalising on existing resources and strengths (e.g., facilities, collaborative platforms).
- Establish priorities and develop a region-specific vision that aligns with local strengths and capacities. The vision shall be adaptable to changing circumstances but also be translated into an action plan to ensure practical steps identified and actioned. It is crucial to ensure alignment with national/EU policies and other regional policies, bearing in mind trade-offs. Note that having a vision for regional bioeconomy development is neither necessary nor sufficient.

Ensure that stakeholders are engaged, and all actors are included

- Establish a comprehensive map of relevant bioeconomy stakeholders.
- Actively engage a wide array of actors to foster a collaborative environment and ensure diverse inputs into the bioeconomy development process.
- Motivate industry, NGOs and the private sector to join bioeconomy activities.
- Highlight benefits and emphasise the advantages of bioeconomy, including economic, environmental, and social benefits.
- Create channels of interregional collaborations with neighbouring countries and regions.

Financial support for research and innovation

- Establishing industrial clusters, logistical support, and demonstration facilities.
- Introducing funding instruments tailored to the needs of SMEs and start-ups, making them easily accessible.
-

7. Conclusions and draft recommendations

In this deliverable, three in-depth analyses with nine case studies were conducted to gain a deeper understanding of bioeconomy governance and bioeconomy policy coordination in six EU member states. The aim was to identify good practice and to contribute to draft recommendations on how policy making in this complex environment could be improved.

In this chapter, we give an overview of the scope and foci of the three in-depth analyses. We derive conclusions and recommendations from them on how to enhance the governance and coordination of bioeconomy policy. For specific insights and conclusions from the individual in-depth analyses, please refer to the respective chapters 4, 5, and 6.

Overview of the scope of the three in-depth analyses

Fehler! Verweisquelle konnte nicht gefunden werden. highlights the similarities and differences in the scope of the three in-depth analyses: two focus on the entire bioeconomy, albeit at different geographical levels (national or regional), while the third, on emerging sectors tackles a specific subfield of bioeconomy (sustainable aquaculture). Vertical coordination between national and regional governance levels is addressed in two in-depth analyses (emerging sectors, regional engagement), whereas the in-depth analysis on national bioeconomy policy coordination only addresses horizontal coordination. The two in-depth analyses on national coordination and regional engagement aim to cover developments over time by choosing case studies which have progressed to different stages of development at the time of analysis. The in-depth analysis on national coordination and emerging sectors study different structural models of coordination (Table 14).

Table 14: Overview of bioeconomy scope, covered geographical governance levels and selection criteria in the three in-depth analyses

Bioeconomy governance and policy challenge	Bioeconomy policy coordination on national level	Emerging sectors - Aquaculture	Fostering regional bioeconomy
Bioeconomy scope	Full scope	Innovative, emerging sectors	Full scope, but tailored to regional specificities
Number of geographical governance levels	1 (national)	2 (national, regional)	1-2 (regional, national)
Development over time	Length of time period with coordination experience	-	Regions at the different stages of bioeconomy development
Organisational governance structures	Different models of institutionalized coordination bodies	Varying degrees of centralisation and local autonomy in regulation and administrative management	-

The three in-depth analyses also cover different phases of bioeconomy policy development (Table 15). We took the existence of a dedicated bioeconomy strategy as a reference point and indicator for the formulation of a holistic bioeconomy policy approach. The in-depth analysis on national bioeconomy policy coordination focusses on coordination in the phase of developing a dedicated bioeconomy strategy and in the phase of developing concepts of how to implement the strategy. The in-depth analysis on fostering regional engagement also covers these two phases and partly extends into the phase of the deployment of bioeconomy innovations in the region. The in-depth analysis on emerging sectors focusses on the later phases of the practical implementation of innovations and their market access, and the related administrative processes.

Table 15: Overview of bioeconomy policy development phases which are covered by the three in-depth analyses

	Policy development phase		
In-depth analysis	Before dedicated bioeconomy strategy	Developing implementation plan based on dedicated bioeconomy strategy	Deployment of innovations, before market access
Bioeconomy policy coordination on national level			
Emerging sectors - aquaculture			
Fostering regional bioeconomy			

Overview of the foci of the three in-depth analyses

The rationale of choosing the three in-depth analyses was mainly to cover different combinations of challenges in bioeconomy governance and policy coordination, and to address them from different angles and with different foci. These challenges are:

- **Directionality.** Bioeconomy deployment requires policies that provide clear direction for the transition from a ‘’linear fossil-based economy’’ to a ‘’sustainable, just, and bio-based circular economy’’.
- **Innovations**. Bioeconomy is knowledge-based and requires technological, organisational and social innovations to flourish.
- **Spanning several sectors and policy fields**. Bioeconomy cuts across traditional economic sectors and thus across different sectoral policy fields. This requires the synergistic integration of different sectoral policies to form a comprehensive and coherent bioeconomy policy.
- **Novel value chains and actor constellations.** Bioeconomy deployment requires the formation of novel value chains and actor constellations.
- **Alignment of different stakeholder priorities.** Due to its transformative, cross-cutting nature, bioeconomy deployment must align diverse, and sometimes conflicting, stakeholder priorities and interests.

- **Alignment along geographical governance levels**. Bioeconomy is embedded in international, national and regional value chains and therefore requires alignment of policies and activities across different geographical governance levels (e.g. international, EU, national, regional levels).
- **Goal conflicts are inherent to bioeconomy**. This requires agreements on priorities and finding solutions and compromises across economic sectors, sectoral policies and stakeholder interests.
- **Regulations and administrative procedures.** Bioeconomy deployment requires the harmonisation of regulations and administrative procedures across economic sectors and geographical governance levels.

Table 16 gives an overview which bioeconomy governance and policy challenges are in the focus of which of the three in-depth analyses.

Table 16: Overview of the scope and foci of the three in-depth analyses

Bioeconomy governance and policy challenge	Bioeconomy policy coordination on national level	Emerging sectors - Aquaculture	Fostering regional bioeconomy
Directionality in policies	yes	(yes)	yes
Knowledge-based, technological, organisational and social innovations		yes	yes
Synergistic integration of different sectoral policies	yes	yes	
Novel value chains and actor constellations		yes	yes
Aligning different stakeholder priorities	yes	yes	yes
Resolution of goal conflicts	yes	yes	yes
Harmonisation of regulations and administrative procedures		yes	
Alignment along geographical governance levels	(yes)	yes	(yes)

Legend:
yes: challenge is addressed in the in-depth analysis
(yes): challenge is addressed to a lesser extent in the in-depth analysis
Empty cells: challenge is not explicitly addressed in the in-depth analysis

Drivers for a comprehensive, coherent bioeconomy policy, conclusions and draft recommendations for the phase before a dedicated bioeconomy strategy

EU member states and regions differ in the progress they have made towards a comprehensive and coherent bioeconomy policy that integrates sectoral policies and activities (Sakellaris et al. 2024; European Commission et al. 2024). A prerequisite for developing such a comprehensive bioeconomy policy is a

shared understanding of bioeconomy and the conviction that it may provide essential solutions to challenges in the country or region.

For this deliverable, we analysed only cases in which the importance of bioeconomy for the country or the region, respectively, had already been recognised and had resulted in the formulation of national or regional bioeconomy policy documents (strategies, roadmap). These strategies were taken as a first proxy or indicator for the formulation of a comprehensive bioeconomy policy.

The case studies showed that the countries and regions did not follow the same pattern or similar pathways towards their respective bioeconomy strategy, and that the processes were not necessarily linear, and they progressed at different speeds. Both top-down initiatives, taken by governments, as well as bottom-up initiatives, taken by stakeholder groups, or a mix of both top-down and bottom-up approaches, were observed.

We retrospectively analyzed the key drivers for the development of a dedicated bioeconomy policy document. Similar contextual drivers, though in case-specific combinations, could be identified for both national and regional strategies (see e.g. Table 7; Table 13), among them:

- International policy developments legitimizing bioeconomy (e.g. Sustainable Development Goals, Paris Agreement, EU Green Deal),
- Developments in international and EU bioeconomy policy and related policy networks
- Scientific-technological competencies and related industries in the country or region
- Demand from stakeholder groups (e.g. industry, sectors, academia)
- Evidence from commissioned analyses and recommendations
- Perceived need to consolidate sectoral policies into a comprehensive strategic framework

In addition, support from national governments was found to be effective for some regions, but not essential for all. Leadership taken by one or several ministries, regional authorities, or agencies along with commitment from high-level policy makers to the bioeconomy, were key success factors. In some regions, it was shown that existing networks and clusters initially not dedicated to bioeconomy (e.g. industrial networks, green development clusters) could successfully function as platforms to expand regional activities into bioeconomy.

While notable bioeconomy activities may be possible without a national or regional comprehensive and coherent bioeconomy policy, these efforts are likely to remain fragmented and sectoralized. They may only tap into a fraction of the bioeconomy's potential by neglecting its systemic, cross-sectoral, and transformative nature, and by prioritizing short-term gains (such as job creation) over long-term sustainability and competitiveness goals. This approach may hinder the transition to an integrated circular bioeconomy framework. Therefore, we conclude that the phase before a comprehensive policy approach (with e.g. a bioeconomy strategy as indicator), should be a transitional phase.

Conclusions and draft recommendations for countries and regions without a comprehensive and coherent bioeconomy policy

- Continue to strive for a dedicated national or regional comprehensive and coherent bioeconomy policy which is tailored to the specificities of your country or region. Since there is no uniform or linear path to such a policy, remain adaptable and seize opportunities as they arise.
- Create a climate and environment for the transformational change towards a bioeconomy, elaborate the facts about the opportunities available for the bioeconomy in your country or region, and secure support from influential stakeholders and decision makers.

Good practice examples to create such environments and capacities for developing a comprehensive and coherent bioeconomy policy

- Actively engage in projects and initiatives dedicated to bioeconomy policy and regional development, and use their resources, support and good practices to advance bioeconomy in your country or region. Examples for such activities are nationally or regionally funded projects, EU funded projects or Coordination and Support Actions, bioeconomy initiatives such as the BioEast Initiative, Regional Innovation Valleys (Directorate General for Research and Innovation, 2023) etc.
- Engage high level civil servants (e.g. hierarchical level of Secretary General, Deputy Secretary General) in the national or regional ministries, major stakeholders in industry, academia and regional development agencies to emphasize the importance and potential of bioeconomy for your country or region. Their support of your activities is a success factor and can ensure continuity, to achieve longevity and impact, even under changing governments or conditions. Prestigious opportunities, e.g. an EU presidency, the implementation of a flagship or lighthouse project in your region, could be used to show this commitment.
- Team up early and continuously in the process with relevant actors and key stakeholders on other vertical governance levels (national or even cross-regional level for regional strategies, regional level for national strategies), to align national and regional goals and priorities synergistically.
- Continue to be actively engaged in supranational bioeconomy policy networks (e.g. EU Bioeconomy Policy Forum, OECD, BioEast Initiative), EU level CSAs (e.g. CEE2Act, ROBIN) or national networks (e.g. in Germany TransBIB network) to learn from the experience of other countries and regions.

Conclusions and draft recommendations for countries and regions in the phase of developing or revising their bioeconomy policy and strategy

When the broader advantages of the bioeconomy for the sustainable development in a country or region, beyond just economic gains or sectoral goals, has been recognised, this should be fixed in respective strategies or policies. For good practice examples see box. In our analysis, we identified a few additional aspects that should be taken into consideration for strategy development or for revision processes of already existing strategies.

- Choose an appropriate option for the organisational structure, e.g. a task force or an organisation with steering group, thematic working groups and related dialogue and consultation processes For a comprehensive, structured and effective strategy development or revision process, not only a formal, but also active leadership is important. The choice of the leading institution may pre-determine the strategic foci of the resulting strategy. It should therefore reflect not only the present bioeconomy

situation, but also the anticipated future role of the country or region. Moreover, the leading institution should be in the position to create a level playing field for all involved ministries and actors.
- Choose multi-actor approaches for stakeholder engagement. In general, specific attention should be paid to other groups than „the usual suspects", e.g. to young people, regional stakeholders, citizens etc.
- Engage in dialogue formats. Consultations of experts and stakeholders are already an integral part of such strategy processes. However, it is good practice and is recommended to additionally carry out different dialogue formats. In order to engage stakeholders actively in these formats, it is important to clearly elaborate a shared understanding of broader advantages of the bioeconomy for the development of a sustainable region, economy or value chains, beyond just economic gains.

Good practice examples for the strategy development or policy revision phase
Good practice for the strategy development phase is available in several countries and regions and has already been collected and disseminated, e.g. in European Commission et al. (2021) and as outputs from various projects which foster bioeconomy in regions (e.g. ROBIN, TransBiB, regional innovation valleys) and are also given in chapter 6.

- Organisational structure. The organisational set-up of the strategy development of revision process should be carefully considered. Good practice options are task forces for the purpose of defining the strategy or policy, or an organisation with a steering group, thematic working groups and related dialogue and consultation processes. Leadership options range from having a prestigious national governmental institution in the lead via a national or regional ministry to regional (development) agencies or cluster organisations.
- Stakeholder engagement. For stakeholder engagement, multi-actor approaches are good practice. Throughout the process, they should include all relevant high-ranking ministerial and stakeholder representatives with the authority to take strategic decisions, prominently integrate bioeconomy-specific expertise, and take up stakeholders' needs and perspectives. For regional strategies, certain stakeholder groups may be more important than those at the national level, e.g. regional development agencies, primary producers, regional or local clusters and industries, regional NGOs, citizens.
- Dialogue formats. It is good practice to complement experts' and stakeholders' consultation with co-creative dialogue formats such as singular or a sequence of workshops and events, or stakeholder platforms[35]. By doing so, a more nuanced mutual understanding, consensual choice between different options, trust, and co- ownership of achieved results and compromises can be achieved.

Although a bioeconomy vision and strategy tailored to the country or region is important, it is not sufficient. Our analysis showed that existing bioeconomy strategies may not give enough guidance for subsequent efficient decisions on collaborative actions, especially across different sectors. This may be due to e.g. vague goals in the strategies or lack of clear priorities between different options. Therefore, there should be a focus shift from „having a bioeconomy strategy" to „having a comprehensive and coherent bioeconomy strategy with an action plan". It is crucial that such „higher quality strategies" consider trade-offs, interactions and overlaps with other goals and national targets. Therefore they should include clear, and possibly quantitative, goals, defined priorities, shared solutions for resolving goal conflicts, and an action plan with

[35] Overview over the seven forms of Stakeholder Dialogues - StakeholderDialogues.net

clearly assigned responsibilities for activities, policy instruments, budget, and timelines. This leads to the following draft recommendations:

- Strive for bioeconomy strategies which gives clearer guidance for the subsequent phase of translating strategies into concrete actions. It is recommended to take inspiration from „better" strategies in other policy domains or other countries or regions how to define, if possible, quantitative strategic goals, clear priorities in goal conflicts, clear assignment of responsibilities for subsequent implementation, and a roadmap and implementation plan with actions, a schedule and a budget.
- Advocate for support at regional, national and EU or supranational level for the development of „better" bioeconomy strategies, and actively participate in corresponding fora and activities for mutual exchange of experience and mutual learning processes.

We did not study in detail how vertical policy coordination between national and regional levels takes place. This coordination may not present significant challenges in small countries with small and well-interconnected bioeconomy communities or centralised governance structures. However, it may require more attention in larger countries with a higher number of regions with diverse profiles, or in federal republics or in countries with regions that have a high degree of autonomy. In these cases, actively aligning national and regional priorities, strategies and activities would more likely achieve synergies, avoid conflicting activities and could have more impact, e.g. through joint positions in negotiations with entities like the EU Commission, on sectoral, environmental or societal issues.

Conclusions and draft recommendations for countries and regions which are in the bioeconomy policy implementation phase

While the development of a bioeconomy strategy is a temporary process, it is important to establish an environment in which effective, efficient and continuous coordination of bioeconomy activities and policies across policy fields and sectors takes place, even under changing governments or conditions. To achieve longevity and impact, it requires – among other aspects - strong bioeconomy expertise and the engagement of stakeholders in a multi-actor approach. Different options may exist for such a coordination-supportive environment.

In this deliverable, we have only studied cases in which bioeconomy policy coordination was institutionalised. We did not explore other options for coordination (e.g. via networks) although they may also be effective and efficient. We observed different options for the composition and organisational set-up of institutionalised coordination: They can be localised on a continuum with (only) one formally established coordination body at the one end and a more network-like character of coordination at the other end. The localisation of a coordination body within this continuum is characterized by the way how stakeholder perspectives and bioeconomy-specific expertise is brought into the coordination bodies (Figure 9). In regions, existing networks, such as clusters or regional agencies, even if they are not explicitly dedicated to bioeconomy, may be more efficient than initiating entirely new coordination bodies. Country and regional specificities may guide which option is most appropriate. The box displays aspects which can be considered as good practice when institutionalising bioeconomy policy coordination. The following draft recommendations are derived in order to support a broad adoption of good practice in bioeconomy policy coordination:

- Advocate for support at regional, member state and EU or supranational level how to elaborate „better" coordination mechanisms and modes and actively participate in corresponding fora and activities for mutual exchange of experience and mutual learning processes.
- Explore whether such coordination bodies should be given more decision power than they currently have, and which options could be appropriate for this (e.g. own budget for the execution of its implementation plan).

Good practice for institutionalising bioeconomy policy coordination

- Process lead. Careful selection of the institution that leads the process. Aspects listed above for the strategy development phase should be considered. A success factor is to avoid a hierarchy within the coordination body, and to ensure a level playing field for all members.
- Mandate. Clear definition of mandates and terms of reference for all coordination mechanisms, so that it is clear what is expected from them.
- Dialogue-oriented and co-creative multi-actor approach. Adopt a multi-actor approach throughout the coordination process, either in the institutionalised coordination body itself, or via processes (e.g. via interaction with different actor networks). It is good practice to make the communication as direct and interactive as possible, favouring mutual, interactive exchange in dialogues over uni-directional consultations.
- Resources. Provide sufficient resources for coordination, e.g. administrative-technical support, sufficient working capacity and time resources for active participation in coordination processes.
- Working climate. The working climate should be collaborative, open, and trustful so that all members communicate on equal terms.
- Working mode. The working mode should effectively support the alignment of diverging interests, and finding compromises in controversial issues and solutions to goal conflicts. Success factors for such a working mode are a neutral facilitator of dialogues and discussions, a level playing field for all contributors in the coordination processes, a mindset to find pragmatic solutions, as well as frequent and regular communication with a focus on direct personal interaction, dialogue and co-creation.

Conclusions and draft recommendations for countries and regions regarding governance challenges in innovative, emerging sectors

Most bioeconomy strategies and policies have a focus on fostering R&D&I to lay the ground for knowledge-based innovations in bioeconomy. These innovations may be situated between traditional sectors at the interface of different policy fields. Examples for such innovations are given in Table 11. In this deliverable, we examined in depth the example of sustainable aquaculture systems, such as Integrated Multi-Trophic Aquaculture, Low Trophic Aquaculture and Recirculating Aquaculture Systems. They have a more sustainable profile than conventional aquaculture systems, but fall between agriculture, fisheries and industrial activities. Other analyses in the ShapingBio project on the topics of applied R&D and technology transfer, cross-sectoral collaboration (Fischer et al. 2024) and financing (Garthley et al. 2024) also show that this is a significant hurdle – among others – for the deployment of these innovations, for acquiring financing for scale-up, market entry and commercialisation. These hurdles may be due to

- the lack of incentives as established policy support measures do not apply to these innovations
- regulatory frameworks which were tailored to conventional processes, products and services, but are not fit for purpose for these innovations
- the fact that these innovations often fall into the competency of several different regulatory or administrative authorities which are responsible for the regulatory framework and administrative procedures for authorisations, licenses, permissions and surveillance
- heterogeneity across EU member states and/or regions whether the regulatory framework and administrative environment is supportive for these innovatios
- heterogeneity across EU member states and/or regions with respect to number and expertise of the responsible administrative authorities. This makes it difficult for innovators to navigate efficiently

administrative processes, and may lack reliability to obtain a decision within reasonable time and with reasonable efforts.

Against this background, we conclude that a comprehensive and coherent bioeconomy policy must anticipate such regulatory and administrative challenges and disincentives early in the innovation process, in order to proactively address these issues with appropriate measures. It depends on the innovative emerging sector and also the country at which geographical governance level the regulatory and administrative competences, respectively, are located. Depending on the innovative emerging sector, this may be the EU, the national, regional or municipal level or combinations thereof.

Our draft recommendations for the geographical governance level with regulatory competence (EU, national, regional level) comprise

- Anticipate regulatory challenges and disincentives early in the innovation process
- Develop potential solutions to anticipated regulatory challenges and disincentives in exchange with all stakeholders. This process could be led by a task force or committee in a transparent process. With the aim to share good practice and to harmonise chosen approaches, international collaboration and knowledge exchange is advisable.
- Invest in training and capacity building in the relevant institutions with regulatory competence
- Consider regulatory sandboxes, collect systematically experience with different regulatory frameworks to derive good solutions for tailoring the regulatory frameworks
- Tailor the relevant regulatory frameworks so that they fit the innovations, and ideally harmonise across the same governance levels

Attention should be directed not only to the regulatory frameworks, but also to their practical implementation by administrative procedures. From our analysis, we conclude that transparency of administrative procedures and which authorities are responsible can help innovators to efficiently navigate these procedures. Streamlined administrative requirements could reduce administrative burden.

Our **draft recommendations for the geographical governance level** (EC, member states, regions, municipalities) **with administrative competence** for permissions, licenses, authorisations, and surveillance comprise

- Anticipate early potential hurdles in administrative procedures
- Clearly map responsibilities of the relevant authorities and communicate them together with designated contact points to innovators in order to support easy navigation in the administrative procedure. If possible, responsibilities should be (semi-centralised) in one or few authorities to establish a one-stop shop
- Invest in training and capacity building in administrative staff and establish platforms for mutual learning and good practice exchange
- Reduce bureaucracy, e.g. by comprehensive and harmonised guidelines for authorities and innovators, and by digitalisation of administrative procedures

Final conclusions and outlook

In this deliverable, we analysed selected policy and governance challenges in bioeconomy with a focus on coordination and fostering regional engagement. We investigated these challenges in nine case studies in six different countries. Our main goal was to show the diversity of chosen options, their strengths, potential pitfalls, success factors and good practice in a structured way. This may support other countries to reflect on their own situations, using the presented options as a benchmark. We hope that this analysis and

reflection will foster mutual learning and inspire efforts to further improve aspects of bioeconomy policy coordination in EU member states.

We aim to gather additional insights on policy and governance challenges during other tasks in the ShapingBio project. Further input will be collected in several workshops scheduled for late 2024 and early 2025. These insights will inform and refine our draft recommendations, which will be further developed in dedicated policy workshops in early 2025.

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Denmark

Blue Research

Danish Aquaculture Organisation

Infinites Sea GmbH

Skagen Salmon

The Environmental Protection Agency

Estonia

Estonian Ministry of Regional Affairs and Agriculture

Estonian University of Life Sciences, Centre of Bioeconomy

Fibenol

Ministry of Climate

Ministry of Education and Research

Germany

Aqua Farm Lübesse

Bavarian Bioeconomy Council

Bavarian Ministry for Economic Affairs, Division for Bioeconomy

BIO Deutschland

Bioeconomy Action Forum

Bioeconomy Council

Chemie Cluster

Dialogue Platform Industrial Bioeconomy

European Commission, DG RTD (retired)

Federal Environmental Protection Agency (UBA)

Federal Ministry for Economic Affairs and Climate Action (BMWK)

Federal Ministry for Food and Agriculture (BMEL)

Federal Ministry for the Environment, Natur Conservation, Nuclear Safety and Consumer Protection (BMUV)

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Italy

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National Bioeconomy Coordination Board (NBCB)

9. References

9.1 References General text and Coordination of national bioeconomy policy

ADDVAL-BIOEC (2021): Increasing added value and the more efficient use of raw materials in the Estonian bioeconomy. Final report of the ADDVAL-BIOEC study. Tallinn. Available at https://taltech.ee/biomajandus, accessed 08.09.2024.

Aktionsforum Bioökonomie (2019a): Erklärung deutscher Umwelt- und Entwicklungsorganisationen zur Bioökonomie-Politik der Bundesregierung. Bremen: Denkhaus Bremen. Available at https://denkhausbremen.de/wp-content/uploads/2019/01/NGO-Erkl%C3%A4rung-Bio%C3%B6konomie.pdf.

Aktionsforum Bioökonomie (2019b): Stellungnahme an die Bundesregierung zum Entwurf einer Nationalen Bioökonomiestrategie. Bremen: Denkhaus Bremen. Available at https://denkhausbremen.de/stellungnahme-an-die-bundesregierung-zum-entwurf-einer-nationalen-biooekonomiestrategie/, accessed 16.12.2024.

Baffoni, S.; Kuresoo, S. (2018): Bio-refinery: new name, dirty old story. Concerns about pollution, forest degradation and climate change emissions from an Estonian pulp mill and biomass energy plant. EPN Discussion Document 7. Environmental Paper Network. Available at https://environmentalpaper.org/wp-content/uploads/2018/05/180517-EstFor-briefing-final.pdf, accessed 16.12.2024.

Bioökonomierat (2016): Weiterentwicklung der „Nationalen Forschungsstrategie Bioökonomie 2030". Empfehlungen des Bioökonomierates. Berlin.

Bioökonomierat (2022a): Bioökonomie: Gemeinsam eine nachhaltige Zukunft gestalten. 1. Arbeitspapier des III. Bioökonomierats. Berlin: Bioökonomierat. Available at https://www.biooekonomierat.de/media/pdf/arbeitspapiere/1._Arbeitspapier_des_BOER_-_Gemeinsam_eine_nachhaltige_Zukunft_gestalten.pdf?m=1701961551&, accessed 16.12.2024.

Bioökonomierat (2022b): Daten, Fakten, Zuständigkeiten: Wo steht die Bioökonomie in den Ländern? (Stand 28.10.2022). Eine Bestandsaufnahme des III. Bioökonomierats in Zusammenarbeit mit Akteur:innen auf Länderebene. Berlin. Available at https://www.biooekonomierat.de/media/pdf/hintergrundpapiere/Biooekonomie-Bundeslaender.pdf?m=1667395949&, accessed 10.09.2024.

Bioökonomierat (2023): Bioökonomie nachhaltig umsetzen! Erste Handlungsempfehlungen des Bioökonomierats zur Umsetzung der Nationalen Bioökonomiestrategie. Berlin: Bioökonomierat.

Bundesministerium für Bildung und Forschung (2010): Nationale Forschungsstrategie BioÖkonomie 2030. Unser Weg zu einer bio-basierten Wirtschaft. Bonn, Berlin.

Bundesministerium für Ernährung und Landwirtschaft (2014): Nationale Politikstrategie Bioökonomie. Nachwachsende Ressourcen und biotechnologische Verfahren als Basis für Ernährung, Industrie und Energie. Berlin. Available at https://biooekonomie.de/sites/default/files/files/2016-09/npsb.pdf, accessed 26.04.2024.

Cologne Paper (2007): En Route to the Knowledge-Based Bio-Economy (KBBE).

Conferenza delle Regioni e delle Province autonome (2022): Document on bioeconomy supply chains. Approved 08/06/2022. Documento sulle filiere della bioeconomia. Available at

file:///C:/Users/sb/Downloads/DocConferenza.%202022-06-13%20DOCCRP08-DOCUMENTO-FILIERE-BIOECONOMIA.pdf.

Conferenza delle Regioni e delle Province autonome (2023): The Conference of Italian Regions and autonomous Provinces. Information sheet. Available at https://www.regioni.it/cms/file/Image/INFORMAZIONI/Scheda_Sintesi_Completa_inglese_280923.pdf.

Deutscher Bundestag (2019): Antwort der Bundesregierung 04.02.2019 auf die Kleine Anfrage der Abgeordneten Thomas L. Kemmerich, Michael Theurer, Grigorios Aggelidis, weiterer Abgeordneter und der Fraktion der FDP – Drucksache 19/7102 – Bioökonomie in Deutschland. Drucksache 19/7547. Berlin: Deutscher Bundestag.

Dialogplattform Industrielle Bioökonomie (2021): Industriestandort Deutschland stärken und nachhaltig gestalten. Leitbild 2.0 der Dialogplattform Industrielle Bioökonomie. Berlin: Bundesministerium für Wirtschaft und Klimaschutz BMWK. Available at https://www.bmwk.de/Redaktion/DE/Dossier/Industrielle-Biooekonomie/neue_Dossierseite/leitbild-2-0-pdf.pdf?__blob=publicationFile&v=1, accessed 19.04.2024.

Dialogue Platform Industrial Bioeconomy (2023): Lead market bioeconomy: transformation and scaling for sustainability and the resource transition. Position paper of the dialogue platform industrial bioeconomy. Federal Ministry for Economic Affairs and Climate Action. Available at https://www.bmwk.de/Redaktion/DE/Downloads/I/Industrielle-Biooekonomie/position-paper-of-the-dialogue-platform-industrial-bioeconomy.pdf?__blob=publicationFile&v=3, accessed 19.04.2024.

European Commission (2018): A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy. Luxembourg: Publications Office of the European Union. https://doi.org/10.2777/792130.

European Commission (2024): Building the future with nature: Boosting Biotechnology and Biomanufacturing in the EU. COM(2024) 137 final. Brussels: European Commission. Available at https://research-and-innovation.ec.europa.eu/document/download/47554adc-dffc-411b-8cd6-b52417514cb3_en, accessed 14.05.2024.

European Commission; Directorate-General for Research and Innovation (2023): Regional Innovation Valleys for Bioeconomy and Food Systems. Concept note. Available at https://research-and-innovation.ec.europa.eu/document/download/81ac9157-a017-4e6d-afd8-584132f2d2b6_en?filename=ec_rtd_riv-bioeconomy-concept-note.pdf, accessed 10.12.2024.

European Commission; Directorate-General for Research and Innovation; Dupont-Inglis, J.; Maes, D.; Barrett, P.; Kulišić, B.; Vehviläinen, A. (2021): Deploying the bioeconomy in the EU: a framework approach for bioeconomy strategy development: 10 policy recommendations for building national bioeconomies toward a fair and just climate neutral Europe. Luxembourg: Publications Office of the European Union. https://doi.org/10.2777/443131.

European Commission; Korosuo, A.; Borzacchiello, M. T.; Giuntoli, J.; Lasarte Lopez, J.; M'barek, R.; Mubareka, S. B.; Camia, A. (2024): Trends in the EU bioeconomy - update 2024. JRC140285. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/0141556.

European Commission: Directorate-General for Research and Innovation (2012): Innovating for Sustainable Growth: A Bioeconomy for Europe. Luxembourg: Publications Office of the European Union. https://doi.org/10.2777/6462.

European Commission: Directorate-General for Research and Innovation (2018a): A sustainable bioeconomy for Europe – Strengthening the connection between economy, society and the environment – Updated bioeconomy strategy. Luxembourg: Publications Office of the European Union. https://doi.org/10.2777/792130.

European Commission: Directorate-General for Research and Innovation (2018b): Bioeconomy – The European way to use our natural resources – Action plan 2018. Luxembourg: Publications Office of the European Union. https://doi.org/10.2777/79401.

Fava, F.; Gardossi, L.; Brigidi, P.; Morone, P.; Carosi, D. A. R.; Lenzi, A. (2021): The bioeconomy in Italy and the new national strategy for a more competitive and sustainable country. In: New biotechnology, 61, pp. 124–136. https://doi.org/10.1016/j.nbt.2020.11.009.

Federal Ministry of Education and Research (2011): National Research Strategy BioEconomy 2030. Our Route towards a biobased economy. Bonn, Berlin.

Federal Ministry of Education and Research; Federal Ministry of Food and Agriculture (2020): National Bioeconomy Strategy. Berlin: Federal Ministry of Education and Research; Federal Ministry of Food and Agriculture.

Federal Ministry of Food and Agriculture (2016): Progress report on the National Policy Strategy Bioeconomy. Bonn, Berlin.

Fischer, P.; González Guerra, R.; Granja, K.; Haugan, K.; Layh, C. K.; Mahmoud, N.; Henchion, M. (2024): Analysis of Cross-Sectoral Collaboration. Deliverable D2.3 of the project "Shaping the future bioeconomy across sectoral, governmental and geographical levels (ShapingBio)". Karlsruhe: Fraunhofer Institute for Systems and Innovation Research ISI. Available at https://www.shapingbio.eu/media/qmhdpfjz/shapingbio_deliverable_d2-3.pdf, accessed 10.12.2024.

Gardossi, L.; Philp, J.; Fava, F.; Winickoff, D.; D'Aprile, L.; Dell'Anno, B.; Marvik, O. J.; Lenzi, A. (2023): Bioeconomy national strategies in the G20 and OECD countries: Sharing experiences and comparing existing policies. In: EFB Bioeconomy Journal, 3, p. 100053. https://doi.org/10.1016/j.bioeco.2023.100053.

Garthley, M.; Wydra, S. (2024): Bioeconomy Financing in Europe Analysis. Deliverable D2.4 of the project "Shaping the future bioeconomy across sectoral, governmental and geographical levels (ShapingBio)". Fraunhofer Institute for Systems and Innovation Research ISI. Available at https://www.shapingbio.eu/media/b5gia04g/shapingbio_d2_4_financing_await-approval.pdf, accessed 10.12.2024.

Haarich, S.; Kirchmayr-Novak, S. (2022): Bioeconomy strategy development in EU regions. JRC128740. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/065902.

Hausknost, D.; Schriefl, E.; Lauk, C.; Kalt, G. (2017): A Transition to Which Bioeconomy? An Exploration of Diverging Techno-Political Choices. In: Sustainability, 9 (4), p. 669. https://doi.org/10.3390/su9040669.

Imbert, E.; Ladu, L.; Morone, P.; Quitzow, R. (2017): Policy strategies for a transition to a bioeconomy in Europe: the case of Italy and Germany. Munich: Unitelma Sapienza; TU Berlin. Available at https://mpra.ub.uni-muenchen.de/78143/.

Intesa Sanpaolo; Federchimica Assobiotec; Cluster Nazionale per la Bioeconomia circolare SPRING (2021): La Bioeconomia in Europa 7° Rapporto. Available at https://group.intesasanpaolo.com/content/dam/portalgroup/repository-

documenti/research/it/bioeconomia/vii_rapporto/La_Bioeconomia_in_Europa%20_%20giugno%202021.pdf, accessed 16.08.2024.

Intesa Sanpaolo; Federchimica Assobiotec; Cluster Nazionale per la Bioeconomia circolare SPRING (2022): La Bioeconomia in Europa 8° Rapporto. Available at https://group.intesasanpaolo.com/content/dam/portalgroup/repository-documenti/research/it/bioeconomia/2022/Bioeconomia2022.pdf, accessed 16.08.2024.

Intesa Sanpaolo; Federchimica Assobiotec; Cluster Nazionale per la Bioeconomia circolare SPRING (2023): La Bioeconomia in Europa 9° Rapporto. Available at https://group.intesasanpaolo.com/content/dam/portalgroup/repository-documenti/research/it/bioeconomia/2023/La%20Bioeconomia%20in%20Europa_Giugno%202023.pdf, accessed 16.08.2024.

Intesa Sanpaolo; Federchimica Assobiotec; Cluster Nazionale per la Bioeconomia circolare SPRING (2024): La Bioeconomia in Europa 10° Rapporto. Available at https://www.clusterspring.it/flmngr/files/La%20Bioeconomia%20in%20Europa%20giugno%202024_Rapporto.pdf, accessed 16.08.2024.

Italian Government (2017): BIT: Bioeconomy in Italy. A unique opportunity to reconnect the economy, society and the environment. Rome. Available at https://cnbbsv.palazzochigi.it/media/1768/bit1_en.pdf, accessed 17.04.2024.

Italian Government (2019): BIT II: Bioeconomy in Italy. A new Bioeconomy strategy for a sustainable Italy. Rome. Available at https://cnbbsv.palazzochigi.it/media/1785/bit_en_2019_02.pdf.

Italian Government (2021): National recovery and resilience plan (PNRR). Piano nazionale di ripresa e resilienza. Available at https://www.governo.it/sites/governo.it/files/PNRR.pdf, accessed 16.08.2024.

Jaakma, Ü. (2018): Chapter 3: Opportunities and challenges in implementing a bioeconomy strategy: the university perspective. In: Bergeret, P.; Svedin, U.; Valceschini, E. (Eds.): Bioeconomy challenges and implementation: the European research organisations' perspective. Versailles Cedex, France: éditions Quæ. ISBN: 978-2-7592-2835-5.

Keskkonnaministeerium (2020): Approval of the composition, tasks and rules of procedure of the Circular Economy Advisory Steering Group (CEAG). Tallinn.

Kimpeler, S.; Schirrmeister, E.; Hüsing, B.; Voglhuber-Slavinsky, A. (2018): Zukunftsbilder aus dem Leben in einer Bioökonomie // Zukunftsbilder aus dem Leben in einer Bioökonomie. Langfassung. Langfassung. Karlsruhe: Fraunhofer-Institut für System- und Innovationsforschung ISI. https://doi.org/10.24406/publica-fhg-299307.

Ministerio della Transizione Ecologica (2022): National Strategy for the Circular Economy. Strategia nazionale per lèconomia circolare. Rome: Ministerio della Transizione Ecologica. Available at https://www.mase.gov.it/sites/default/files/archivio/allegati/PNRR/SEC_21.06.22.pdf, accessed 16.08.2024.

Ministerio delle Politiche Agricole, Alimentari e Forestali (2014): Strategic Plan for Innovation and Research in Agriculture, Food and Forestry, 2014-2020. Piano Strategico per l'innovazione e la ricerca nel settore agricolo, alimentare e forestale 2014-2020. Rome: Ministerio delle Politiche Agricole, Alimentari e Forestali. Available at https://www.reterurale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/u%252Fn%252Fi%252FD.868622dd728c4db05a168/P/BLOB%3AID%3D15647/E/pdf, accessed 16.08.2024.

Ministerio dell'Istruzione, dell'Università e della Ricerca (2015): National Research Programme 2015-2020. Programma nazionale per la ricerca 2015-2020. Ministerio dell Università e della Ricerca. Available at https://www.miur.gov.it/documents/20182/71637/Il+Programma.pdf/2faf018a-b63d-454b-96a4-6b55fd3a6955?version=1.0&t=1495038747623, accessed 16.08.2024.

Ministerio dello Sviluppo Economico; Ministerio dell'Istruzione, dell'Università e della Ricerca (2016): National Smart Specialisation Strategy. Strategia nazionale di specializzazione in-telligente. Rome: Ministerio dello Sviluppo Economico; Ministerio dell'Istruzione, dell'Università e della Ricerca. Available at https://www.agenziacoesione.gov.it/wp-content/uploads/2019/06/Strategia_Nazionale_di_Specializzazione_Intelligente_Italia.pdf, accessed 16.08.2024.

Ministerio dell'Università e della Ricerca (2021): National Research Programme 2021-2027. Programma nazionale per la ricerca 2021-2027. Rome: Ministerio dell'Università e della Ricerca. Available at https://www.mur.gov.it/sites/default/files/2021-01/Pnr2021-27.pdf.

Ministero delle politiche agricole alimentari e forestali (2022): National Forest Strategy. Strategia Forestale Nazionale. Rome: Ministero delle politiche agricole alimentari e forestali. Available at https://www.politicheagricole.it/flex/cm/pages/ServeAttachment.php/L/IT/D/e%252F7%252Fa%252FD.87dc28587c91855290c5/P/BLOB%3AID%3D17813/E/pdf?mode=download, accessed 16.08.2024.

National Bioeconomy Coordination Board (2021): Implementation Action Plan (2020-2025) for the Italian bioeconomy strategy BIT II. Updated version January 2021. Piano d'azione (2020-2025) per l'attuazione della strategia italiana per la bioeconomica BIT II. Rome: Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita. Available at https://cnbbsv.palazzochigi.it/media/2079/iap_2332021.pdf, accessed 16.08.2024.

O'Riordan, J.; Boyle, R.; Keating, S.; O'Leary, F. (2024): The Governance of the Circular Economy and Bioeconomy in Selected European Countries. Wexford, Ireland: Environmental Protection Agency; Institute of Public Administration. Available at https://www.ipa.ie/_fileUpload/Documents/GovernanceoftheCircularEconomy3.pdf, accessed 16.12.2024.

Patermann, C.; Aguilar, A. (2018): The origins of the bioeconomy in the European Union. In: New biotechnology, 40 (Pt A), pp. 20–24. https://doi.org/10.1016/j.nbt.2017.04.002.

Peepson, A. (2021): Memorandum to the Cabinet Meeting. Analysis and proposals for the development of the bioeconomy. Tallinn: Ministry of Agriculture.

Presidenza del Consiglio dei Ministri (2021): Decreto istitutivo Gruppo di Coordinamento Nazionale per la Bioeconomia - DSG 14.01.2021. Rome: Presideny of the Council of Ministers. Available at https://cnbbsv.palazzochigi.it/media/2069/dsg-14012021-istituzione-gcn-bioeconomia.pdf, accessed 26.04.2024.

Presidenza del Consiglio dei Ministri (2023): Novella del 27.06.2023 al DSG 14.01.2021 Decreto istitutivo Gruppo di Coordinamento Nazionale per la Bioeconomia - DSG 14.01.2021. Rome: Presideny of the Council of Ministers. Available at https://cnbbsv.palazzochigi.it/media/2980/dsg-novella-bioeconomia-27-giugno-2023.pdf, accessed 26.04.2024.

Pungas, L. (2023): Invisible (bio)economies: a framework to assess the 'blind spots' of dominant bioeconomy models. In: Sustainability Science, 18 (2), pp. 689–706. https://doi.org/10.1007/s11625-023-01292-6.

Radtke, I.; Hustedt, T.; Klinnert, A. (2016): Inter-Ministerial Working Groups as a Panacea for Coordination Problems?: The Cases of Climate Adaptation, Immigration and Raw Materials in the German Federal Government. In: dms – der moderne staat – Zeitschrift für Public Policy, Recht und Management, 9 (1), pp. 65–81.

Regionaal- ja Pöllumajandusministeerium; Kliimaministeerium (2023): Circular bioeconomy roadmap Estonia. Tallinn. Available at https://agri.ee/sites/default/files/documents/2023-08/teekaart-ringbiomajandus-2023-eng.pdf, accessed 08.09.2024.

Sakellaris, G.; Stonawska, K.; Wydra, S.; Hüsing, B.; Gomez Hernandez, M. L.; Monzon, C.; Santaniello, F.; Pietrollini, G.; Granja, K.; Haugan, K.; Garthley, M.; Meyer, T.; Denayer, S.; Mahmoud, N.; Däßler, G. (2024): Mapping of initiatives, structures, instruments and key challenges for EU's macro-regions. Deliverable D1.4 Report on macro-regions of the project "Shaping the future bioeconomy across sectoral, governmental and geographical levels (ShapingBio)". Karlsruhe: Fraunhofer Institute for Systems and Innovation Research ISI. Available at https://www.shapingbio.eu/media/qs4nxtox/t1-4_mapping_-macro-regions.pdf, accessed 10.12.2024.

Santaniello, F.; Reyhani, N. M.; Pocaterra, C.; Wydra, S.; Hüsing, B.; Garthley, M.; Sabbah, Y.; Meyer, T. (2023): Methodology and stakeholder needs report. Deliverable D1.1 of the project "Shaping the future bioeconomy across sectoral, governmental and geographical levels (ShapingBio)". Karlsruhe: Fraunhofer Institute for Systems and Innovation Research ISI. Available at https://www.shapingbio.eu/media/t3dkk2qs/shapingbio_d-1-1_final_approval-remark.pdf, accessed 10.12.2024.

Suchman, M. C. (1995): Managing Legitimacy: Strategic and Institutional Approaches. In: The Academy of Management Review, 20 (3), pp. 571–610. https://doi.org/10.2307/258788.

9.2 References Emerging sectors/aquaculture

Bord Iascaigh Mhara (2019). National Seafood Survey Aquaculture Report 2019. Available at: https://bim.ie/wp-content/uploads/2021/02/BIM-National-Seafood-Survey-Aquaculture-Report-2019.pdf

Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., ... & Black, K. (2010). Aquaculture: global status and trends. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 2897-2912.

Destatis. (2022, June 15). Fish Production in Aquafarming down 1.8% in 2021. Federal Statistical Office of Germany. https://www.destatis.de/EN/Press/2022/06/PE22_227_41362.html

European Commission (2013): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Strategic Guidelines for the sustainable development of EU aquaculture. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0229.

European Commission (2021): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Strategic Guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0236.

European Court of Auditors (2023). Special report 25/2023: EU aquaculture policy – Stagnating production and unclear results despite increased EU funding. Available at: https://www.eca.europa.eu/en/publications/SR-2023-25

FAO. (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in Action. Rome.

Naylor, R. L.; Goldburg, R. J.; Primavera, J. H.; Kautsky, N.; Beveridge, M.; Clay, J.; Folke, C.; Lubchenco, J.; Mooney, H.; Troell, M. (2000): Effect of aquaculture on world fish supplies. In: nature, 405 (6790), pp. 1017–1024. https://doi.org/10.1038/35016500.

Statistics Denmark. (2024). *Aquaculture*. Statistics Denmark. https://www.dst.dk/en/Statistik/emner/erhvervsliv/fiskeri-og-akvakultur/akvakultur

The Ministry of Food, Agriculture and Fisheries (2021): Press release. Minister introduces temporary stop for new applications for breeding mussels and oysters. Available at: https://fvm.dk/nyheder-og-pressemeddelelser/2021/jun/minister-indfoerer-midlertidigt-stop-for-nye-ansoegninger-til-opdraet-af-muslinger-og-oesters

9.3 References Fostering regional bioeconomy across the EU

Asheim, Bjørn and Coenen, Lars (2005). Knowledge bases and regional innovation systems: Comparing Nordic clusters. Research Policy. https://doi.org/10.1016/j.respol.2005.03.013.

Charles, D. et al. (2016). D3.2: Case studies of regional bioeconomy strategies across Europe. https://www.ecologic.eu/sites/default/files/publication/2016/biostep_d3.2_case_studies_of_regional_strategies.pdf

Clar, Günter and Sautter, Björn (2014). Research Driven Clusters at the Heart of (Trans-)Regional Learning and Priority-Setting Processes. Journal of the Knowledge Economy. https://doi.org/10.1007/s13132-014-0180-0.

De Besi, Matteo and McCormick, Kes (2015). Towards a Bioeconomy in Europe: National, Regional and Industrial Strategies. Sustainability. https://doi:10.3390/su70810461.

Directorate General for Research and Innovation, (2023). Regional innovation valleys for bioeconomy and food systems, Publications Office of the European Union. https://doi/10.2777/93434.

Directorate General for Research and Innovation (2017). Bioeconomy development in EU regions – Mapping of EU Member States' / regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on bioeconomy – Final report, Publications Office of the European Union. https://doi/10.2777/84684.

Haarich, S.; Kirchmayr-Novak, S. (2022). Bioeconomy strategy development in EU regions. JRC128740. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/065902

Jarosch, L. Zeug, W.; Bezama, A.; Finkbeiner, M, Thrän, D. (2020). A Regional Socio-Economic Life Cycle Assessment of a Bioeconomy Value Chain Sustainability 12 (3), 1259. https://doi.org/10.3390/su12031259.

Koukios, et al. (2018). Targeting sustainable bioeconomy: A new development strategy for Southern European countries. The Manifesto of the European Mezzogiorno. Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2017.05.020.

Stricker, Kristina (2021). The rising importance of Bavaria's cross-cluster initiatives. Retrieved 05 June, 2024, from https://www.goingpublic.de/life-sciences/the-rising-importance-of-bavarias-cross-cluster-initiatives/.

Mercedes et al. (2014). Defining Clusters of Related Industries. https://www.nber.org/papers/w20375.

Ministry for Economic Affairs, Regional Development, and Energy (2024). Retrieved 29 May, 2024. https://www.bavariaworldwide.de/en/about-bavaria/facts-figures/

Naudet, Philippe Micheaux and Marrazzo, Giulia (2021). The Governance of Circular Economy. https://hoop-hub.eu/virtual_images/99-d2a19c20ba85dcff6b4a2a5ba3d5aa8f.pdf

Pollack, J., Pollack, R. (2015). Using Kotter's Eight Stage Process to Manage an Organisational Change Program: Presentation and Practice. Syst Pract Action Res 28, 51–66. https://doi.org/10.1007/s11213-014-9317-0

Tarsitano, E., et al. (2023). Participatory Planning for the Drafting of a Regional Law on the Bioeconomy. Sustainability 15. https:// doi:10.3390/su15097192.

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