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INSTITUTIONAL ARCHITECTURE OF BIOECONOMY POLICIES: A COMPARATIVE ANALYSIS OF UKRAINE AND THE VISEGRAD GROUP COUNTRIES

Abstract

Introduction. *In the context of the European Green Transition, the development of effective bioeconomy policies has become increasingly important, necessitating the adaptation of national institutional architectures to the challenges of sustainable development. For Ukraine, which is undergoing structural transformation and post-war recovery, the design of a functional institutional model aligned with best European practices – particularly those of the Visegrad Group countries – is of paramount importance.*

Methods. *The research applies an institutional approach, qualitative comparative analysis, structural-functional method, and content analysis of official strategies, regulations, and programmes (2015–2025). It also introduces an original typology of institutional architecture based on two dimensions: the degree of strategy formalisation and the level of cross-sectoral coordination.*

Results. *The Visegrad Group countries significantly outperform Ukraine in terms of institutional prerequisites for bioeconomy policy formation. Slovakia demonstrates the most advanced model, combining an approved strategy with multi-actor coordination through clusters and hubs. Poland, the Czech Republic, and Hungary have implemented various formats of platform-based interaction and political integration of the bioeconomy into other strategic domains, such as the circular economy, agricultural policy, and R&I agendas. In contrast, Ukraine still possesses a fragmented institutional framework with*

no unified national strategy. A roadmap is proposed for the implementation of relevant practices, including the establishment of a platform under the Ministry of Agrarian Policy, the development of cluster initiatives, and integration into the BIOEAST initiative.

For the first time, this study offers a structured typology of bioeconomy institutional architectures across five countries using a two-dimensional analytical framework. It highlights key components suitable for institutional borrowing, along with justifications for their implementation.

Discussion. *Further research should focus on developing indicators of institutional capacity in the bioeconomy domain, assessing the effectiveness of multi-level coordination, and deepening the sector-specific evaluation of policy outcomes (e.g. agriculture, biotechnology, renewable energy).*

Keywords: *bioeconomy, institutional architecture, institutional economics, Visegrad Group, sustainable development policy, cross-sectoral coordination, institutional borrowing, cluster model, policy platforms, bioeconomy strategy.*

Introduction.

In the context of the global energy transition, climate change, and the degradation of natural resources, the bioeconomy is gradually evolving into a strategic paradigm for sustainable development. It integrates biotechnological innovation, agrarian transformation, the circular economy, and climate adaptation. Since 2005, the European Union (EU) has consistently advanced its bioeconomy policy, focusing on the intersection of economic efficiency, environmental safety, and social inclusion. Simultaneously, Ukraine – as an EU partner and candidate country – has begun to formulate its own bioeconomy policies, which remain in the early stages of institutional development.

Despite the existence of shared European reference points – such as the *European Bioeconomy Strategy* (2012, 2018), the *European Green Deal* (2019), and the *Farm to Fork Strategy* (2020) – each EU member state follows a distinct trajectory in designing the institutional architecture of its bioeconomy policy. This diversity underscores the relevance of comparative analysis. The updated 2018 Bioeconomy Strategy articulates an integrative vision of sustainable growth through the bioeconomy, with a focus on innovation, circularity, and regional engagement [1]. Particular attention should be paid to the Visegrad Group countries (Poland, the Czech Republic, Slovakia, and Hungary), which share structural similarities with Ukraine: economies in transition, a significant share of the agricultural sector, and the imperative for digitalisation and greening of production systems. At the same time, these countries are already embedded within the European institutional and political space, providing a relevant source of policy lessons for Ukraine.

The issue of bioeconomy policy architecture goes beyond the existence of strategic documents. It also encompasses the distribution of competences among government bodies, coordination mechanisms, financial instruments, the degree of inter-agency collaboration, and the involvement of academia and the private sector. It is at the intersection of these dimensions that the effectiveness of bioeconomy strategy implementation is shaped within national contexts.

Therefore, analysing the institutional architecture of bioeconomy policies in Ukraine in comparison with the Visegrad Group countries is of both scientific and practical significance. It enables the development of targeted mechanisms for adaptation, harmonisation, and strengthening of national bioeconomy policy in accordance with European standards.

Analysis of recent research and publications.

Institutional economics provides a useful lens for analysing sustainable development and the emerging bioeconomy. In Douglass North's classic definition, *institutions* are "the humanly devised constraints that structure political, economic and social interaction," including both informal norms (traditions, customs) and formal rules (laws, property rights) [2]. These institutions shape incentives and thus guide economic change towards growth or decline. Applying this to sustainability, the transition to a **bioeconomy** – an economy based on renewable biological resources – requires evolving institutions that promote ecological innovation and cooperation [3]. Scholars note that the bioeconomy's complex value chains (e.g. agriculture, energy, waste reuse) create **polycentric** governance features: multiple independent centres of decision-making (state, local, private, civic) that must coordinate and sometimes

compete. This echoes Elinor Ostrom's ideas on polycentric resource governance, highlighting that effective sustainable development governance often involves multi-level, multi-actor arrangements rather than a single hierarchical authority. New institutional arrangements – from legal frameworks to informal networks – are needed to support circular and sustainable production/consumption patterns.

In theoretical terms, institutional architecture refers to the system of rules, norms, and organizations that shape collective action towards sustainability Analysts distinguish **institutional layers**: a *macro* layer of fundamental laws and norms (e.g. property rights, environmental laws), a *meso* layer of domain-specific institutions (e.g. regulatory agencies, standards bodies), and a *micro* layer of institutions within organizations and communities [3]. The meso level is particularly critical in the bioeconomy, as it translates high-level rules into practice (for example, agencies enforcing biofuel standards or certifying bio-based products) and provides feedback to policymakers. Overall, the theoretical foundation suggests that achieving sustainable **ecological transformation** via the bioeconomy requires adaptive institutional frameworks. These frameworks must encourage innovation (e.g. new business models for biomass use) while providing constraints to ensure ecological limits are respected [4]. In sum, institutional economics underpins the idea that **"rules of the game"** (formal and informal) must realign to enable a sustainable, circular bio-based economy.

Between 2015 and 2025, a growing body of literature (including many Scopus/WoS Q1-Q3 journals) has examined the **institutional architecture** of bioeconomy policies and the governance needed for agro-ecological and climate transitions. One major finding is the importance of **multi-actor and multi-level governance** in bioeconomy and climate policy. Complex sustainability challenges cannot be addressed by governments alone; instead, networks of stakeholders – public authorities, businesses, farmers, researchers, civil society – must collaborate in policy design and implementation. A review of environmental governance literature finds an expanding role for multi-actor arrangements in achieving environmental outcomes [5]. This is evident in agroecological initiatives and climate-smart agriculture policies that involve cross-sector partnerships and participatory decision-making. For instance, research on climate-smart agriculture notes that creating effective adaptation/mitigation strategies in agriculture requires a supportive institutional architecture and coordination across sectors [6]. Similarly, policy network studies show that **multi-level governance** (local, national, EU/international levels) is crucial for climate and bioeconomy goals, to ensure coherence between agricultural policy, energy policy, and climate targets [7]. These differences in policy coordination and governance reflect broader conceptualizations of the bioeconomy. Among academic approaches, Bugge M., Hansen T. and Klitkou A. [8] identify three dominant visions: the biotechnology-oriented (focused on innovation and commercialization), the bioresource-based (centered on biomass and industrial processes), and the eco-oriented (prioritizing ecological sustainability and systems thinking). This typology provides a useful lens for comparing national bioeconomy strategies and institutional designs.

Another key research theme is the design of governance mechanisms for a sustainable bioeconomy. Dietz T., Börner J., Förster J. J., and von Braun J. [4] conducted a global comparative study of 41 national bioeconomy strategies, concluding that sustainability outcomes depend on creating effective governance **"pathways"**. They emphasize two broad governance tasks: enabling governance (positive support measures like R&D investment, education, and incentives for bio-based industries) and constraining governance (regulatory tools, standards and safeguards to ensure sustainability). Effective bioeconomy policies require balancing these: enabling innovation and market development, while constraining practices that harm ecosystems. Studies also highlight the need for policy integration and coherence. The bioeconomy spans multiple domains (agriculture, forestry, energy, waste, etc.), so institutional interplay is a frequent research focus. For example, agroecological policy intersects with climate policy – aligning agricultural subsidies or practices with climate mitigation goals entails coordination between institutions governing agriculture (e.g. ministries of agriculture) and those governing environment or climate [9]. Research on the EU's Common Agricultural Policy (CAP) reforms and climate objectives underscores that institutional adjustments are needed to incorporate climate and ecological

criteria into agricultural governance. Overall, scholarly work in this period calls for **adaptive, inclusive governance frameworks** – ones that engage multiple actors and knowledge sources – as essential to steering the bioeconomy towards sustainability [10]. Empirical studies in Europe have documented how multi-stakeholder platforms, public-private partnerships, and knowledge networks can enhance policy learning and implementation in bioeconomy and climate initiatives [11].

Significantly, numerous high-impact studies also analyse governance **architecture in climate policy networks**, institutional interactions, and policy coherence. For instance, Nature Climate Change published global assessments of actors in climate adaptation, revealing that while local actors carry out many adaptation actions, they often lack voice in formal institutions [12]. Such findings reinforce arguments for more inclusive institutional architectures in environmental policy. In summary, the literature (2015–2025) converges on the idea that the **institutional architecture of bioeconomy** – the set of institutions and their interactions – is a decisive factor in achieving sustainable outcomes. Key research advocates for strengthening cross-sector institutional linkages, fostering multi-actor governance arrangements, and continuously monitoring and adjusting policies to improve effectiveness and coherence in agroecological and climate governance.

The European Union has developed a comprehensive policy framework guiding the bioeconomy transition over the past decade. A cornerstone was the **"European Bioeconomy Strategy"** launched in 2012, titled *"Innovating for Sustainable Growth: A Bioeconomy for Europe."* This 2012 strategy – and its update in 2018 – laid the foundation for a more innovative, resource-efficient and competitive society, aiming to reconcile food security with the sustainable use of renewable biological resources while ensuring environmental protection The updated **2018 Bioeconomy Strategy** ("A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment") adopted a holistic, sustainability-oriented approach. It positioned the bioeconomy as central to the EU's climate and sustainability objectives, insisting that *"the European bioeconomy needs to have sustainability and circularity at its heart"*. The 2018 update came with a detailed **Action Plan of 14 measures**, launched in 2019, to accelerate bioeconomy deployment by 2025 [13]. These actions ranged from research funding to developing new value chains and scaling up bio-based innovations across Europe. Notably, the strategy update explicitly linked the bioeconomy to the EU's commitments under the UN Sustainable Development Goals and the Paris Agreement, reflecting a strong alignment between bioeconomy policy and broader sustainability agendas [14].

In late 2019, the EU introduced the **European Green Deal**, an overarching policy framework aiming for Europe's climate neutrality by 2050. The Green Deal recognizes the bioeconomy as a key component of the green transition, given its role in replacing fossil carbon, promoting circular resource use, and spurring rural economic development. The European Commission has affirmed that the bioeconomy will be "key for ensuring the EU's competitiveness and resilience" in a climate-neutral future, and signaled the need to update bioeconomy policy in light of new challenges. Indeed, as part of Green Deal implementation, the Commission announced it will **review and adjust the EU Bioeconomy Strategy by end of 2025**. Complementary sectoral strategies under the Green Deal reinforce bioeconomic principles. For example, the **Farm to Fork Strategy (2020)** is "at the heart of the European Green Deal" and aims to make food systems fair, healthy and environmentally-friendly [15]. Farm to Fork addresses sustainable agriculture, reduction of chemical inputs, and food waste – all of which intersect with bioeconomy goals such as valorizing agricultural residues and developing bio-based alternatives. Likewise, the EU's **Biodiversity Strategy 2030** and **Forestry Strategy** (2021) contribute to the bioeconomy policy mix by emphasizing sustainable biomass sourcing and ecosystem health.

To track progress, the EU established a **Bioeconomy Monitoring System**. This system was officially launched in November 2020 (during the Global Bioeconomy Summit) to provide a set of indicators and dashboards covering economic, environmental and social aspects of the bioeconomy []. Hosted by the Commission's Knowledge Centre for Bioeconomy, the monitoring framework aligns indicators under the objectives of the EU Bioeconomy Strategy and the SDGs [16]. By 2023, the Bioeconomy Monitoring System had expanded to 154 indicators spanning sustainability criteria, and

continues to evolve as a tool for evidence-based policy. Another recent development is the **EU Bioeconomy Strategy Progress Report (2022)**, which assessed achievements since 2018 and identified gaps (e.g. in scaling bio-based industries and ensuring all Member States engage fully). In 2024, the EU is moving to further strengthen its bioeconomy framework. For instance, a new **EU Bioeconomy Policy Framework** is being discussed to integrate bioeconomy with industrial policy (biotechnology and biomanufacturing) and to respond to societal and demographic challenges. Actions under the Horizon Europe program (2021–2027) and the Bio-based Industries Joint Undertaking (now Circular Bio-based Europe partnership) are also reinforcing the EU's policy architecture by funding innovation and facilitating public-private collaboration. In summary, the EU's institutional architecture for bioeconomy policy is multi-faceted: high-level strategies (2012, 2018) and the Green Deal provide direction; specific initiatives like Farm-to-Fork and the Bioeconomy Monitoring System operationalize goals; and an evolving set of regulations and funding mechanisms support implementation. This comprehensive EU framework strongly influences the Visegrad countries and Ukraine in shaping their own bioeconomy policies [14].

The Visegrad Four (Poland, Czech Republic, Hungary, Slovakia) have each taken steps – albeit at different paces – to develop institutional frameworks for the bioeconomy. As of 2015–2025, these countries generally **lag behind Western Europe** in adopting dedicated national bioeconomy strategies. However, they have pursued various institutional innovations, coordination mechanisms, and pilot initiatives:

– Poland: Poland has not yet enacted a single unified bioeconomy strategy, but bioeconomy objectives are embedded in several policy documents. A key example is the government's Roadmap for the Circular Economy (GOZ) adopted in 2019, which includes measures for bioeconomy development [17]. The GOZ roadmap was formulated by an inter-ministerial working group with stakeholder input, illustrating a cross-departmental coordination effort to integrate bio-based solutions in waste management, agriculture, and industry. Additionally, Poland's strategic plans for agriculture and rural development recognize the bioeconomy's potential. The Strategy for Sustainable Development of Rural Areas, Agriculture and Fisheries (currently being updated) identifies the bioeconomy as a promising avenue for using farm biomass and driving rural growth. Poland established a multi-stakeholder Working Group on Bioeconomy under the Ministry of Agriculture, bringing together government, academia, and industry representatives to discuss bioeconomy challenges. On the R&D side, Poland launched programs like BIOSTRATEG (a national strategic R&D program for environment, agriculture, and forestry) and participated in EU-funded projects (e.g. the H2020 BIOEASTsUP and BIOECON ERA-Chair project) to build knowledge-based bioeconomic capacity [17]. These efforts signal Poland's institutional architecture is emerging via integration into broader sustainability strategies and creating forums for cross-sector collaboration, even in the absence of a standalone strategy. Gaps remain (e.g. no central coordinating body solely for bioeconomy), but Poland shows progress through inter-ministerial coordination and stakeholder engagement mechanisms.

– Czech Republic: The Czech Republic similarly does not yet have an official national bioeconomy strategy, but it has developed a draft Concept of Bioeconomy. The Ministry of Agriculture prepared a strategic concept paper titled "Concept of Bioeconomy in the Czech Republic" [18], indicating recognition at the ministerial level. Institutionally, the Czechs have fostered several platforms to connect actors: a Platform for Bioeconomy of the Czech Republic and a Circular Economy Institute serve as forums for dialogue between government, industry and researchers. The Czech Academy of Agricultural Sciences convened an expert group on bioeconomy, showing integration of scientific knowledge into policy discussions. Coordination across ministries is informally practiced: for example, the Ministry of Environment (addressing waste and environmental aspects) and the Ministry of Industry and Trade (for bio-based industry and innovation) are identified stakeholders alongside Agriculture. This reflects a multi-sector governance approach. Moreover, the Czech Republic has engaged actively in macro-regional initiatives like Danube Region bioeconomy networks (e.g. Interreg DanuBioValNet) and the BIOEAST initiative, to exchange best practices and build capacity. By 2019, Czech representatives acknowledged

that while an official strategy was pending, the country was laying groundwork through research projects (on food waste reduction, circular opportunities) and clustering efforts. Overall, the Czech institutional architecture for bioeconomy is characterized by concept development under the Agriculture Ministry, stakeholder platforms, and alignment with EU research frameworks – but formal policy consolidation remains a work in progress.

– Hungary: Hungary has been developing its bioeconomy strategy in recent years. As of 2019, a dedicated national strategy was "under development" [19]. In the meantime, Hungary put in place several institutional elements to support bioeconomy policy. The Ministry of Agriculture created a Department for Knowledge-Based Agriculture, signalling an administrative home for bioeconomy-related innovation and knowledge transfer. A Research, Development and Innovation (RDI) working group was formed jointly with the Chamber of Agriculture to connect policymakers and researchers. Hungary improved its participation in European coordination networks – for example, joining the SCAR (Standing Committee on Agricultural Research) Working Groups on bioeconomy and engaging in FACCE-JPI (Joint Programming Initiative on Agriculture, Food Security and Climate Change). The country also organized national conferences and workshops (including an international BIOEAST conference in Budapest, 2018) to raise awareness and share knowledge. By 2019–2020, Hungary planned to establish an inter-ministerial working group on bioeconomy and thematic working groups at both national and BIOEAST (regional) levels. This indicates a move toward formal coordination across ministries (e.g. Agriculture, Innovation, Industry, Environment). Importantly, Hungary was a founding driver of the BIOEAST initiative – a Central and Eastern European effort to cooperate on bioeconomy. Joint declarations of V4+7 Agriculture Ministers in 2016–2018 endorsed BIOEAST, underlining high-level political commitment to developing the bioeconomy in the region. While Hungary's national strategy document is not yet finalized (expected mid-2020s), its institutional architecture is taking shape via a central government focal point, cross-sector working groups, and active regional collaboration. These structures aim to integrate scientific knowledge and align national efforts with EU funding opportunities. The challenge ahead is to consolidate these elements into a coherent strategy and implementation plan.

– Slovakia: Slovakia currently does not have a standalone bioeconomy strategy, but significant steps have been taken toward one. As of 2023, a national "Bioeconomy Concept Paper" has been developed with support from the EU-funded BIOEASTsUP project [20]. The concept paper (presented at the BIOEAST Congress 2022) provides a framework and rationale for a future strategy and action plan, and is intended to stimulate debate domestically about shifting to a bio-based economy. Institutionally, Slovakia has had a Bioeconomy Cluster since 2015. This cluster – an innovation network of companies, research institutes, and agencies – is actively laying the groundwork for implementation. In fact, the cluster is now partnering with the government to set up a National Bioeconomy Hub. The hub brings together a broad range of stakeholders: multiple ministries (e.g. agriculture, economy, environment), SMEs and industry players, universities and research centers, farmer organizations, and civil society groups are all involved in the hub's design. Such inclusivity indicates Slovakia's commitment to a multi-actor governance model from the outset. The hub held its first stakeholder meeting at a national agriculture fair in 2023. According to official information, "the national bioeconomy strategy is under development" in Slovakia, meaning the next step is to formalize the concept into policy. In the interim, existing sectoral policies (in forestry, agriculture, innovation) incorporate some bioeconomy principles – for example, Slovakia's R&D strategies highlight bio-based materials and the circular economy as priorities. The institutional practice in Slovakia thus far can be described as bottom-up and network-centric: leveraging a cluster and hub to integrate knowledge and coordinate action, while working toward official policy adoption. This approach may help fill capacity gaps and ensure that once the strategy is adopted, a ready coalition of actors is in place to implement it.

Across the Visegrad Group, a comparative pattern emerges: all four countries recognize the importance of the bioeconomy for future growth and sustainability, largely inspired by EU policy and funding opportunities. However, by 2025 only draft or partial strategies exist in these countries, unlike

some Western EU states that adopted national bioeconomy strategies earlier. The V4 have instead relied on **embedding bioeconomy into related strategies** (e.g. circular economy, rural development), setting up **inter-ministerial coordination bodies**, and engaging in **regional initiatives (BIOEAST)** to build their institutional architecture. The multi-actor aspect is evident: all have created or utilized platforms that involve academia and industry (e.g. Poland's stakeholder working group, Czech Republic's Bioeconomy Platform, Hungary's BIOEAST networks, Slovakia's cluster and hub) to ensure scientific knowledge and innovation feed into policy. A noted challenge in literature is the uneven progress: as one report stated, "most Central and Eastern European countries lag in dedicated national Bioeconomy Strategies… resulting in uneven development of sustainable bioeconomies across the EU" [14]. This lag could impact their ability to deliver on the European Green Deal and exploit the full potential of bio-based industries. Nonetheless, the Visegrad countries have built a foundation of institutional practices that could be rapidly scaled up once formal strategies crystallize.

In Ukraine, the concept of the bioeconomy has gained attention especially in the context of European integration, but a comprehensive **national bioeconomy policy framework** is still in nascent stages. During 2015–2025, Ukraine did not promulgate a dedicated "Bioeconomy Strategy" at the national level. Instead, elements of the bioeconomy are gradually being incorporated into sectoral strategies and reforms, driven in part by the country's alignment with EU sustainability initiatives. Ukrainian researchers note that bioeconomy development aligns with strategic national goals such as improving well-being, food security, biotechnology advancement, and environmental protection [10]. The drive toward a bio-based economy is seen as a pathway to create new green jobs, healthier ecosystems, and innovative bio-based products – outcomes much needed in Ukraine's economic modernization.

Policy integration: Ukraine has begun embedding bioeconomy principles in key strategic documents. Notably, the **Strategy for Agriculture and Rural Development until 2030**, unveiled in 2023–2024, explicitly includes the promotion of a *"circular and sustainable bioeconomy"* as part of its climate-oriented goals. Specifically, Goal 5 of this strategy (Climate-Oriented Agriculture) aims to develop organic production, circular bioeconomy approaches, and bioenergy, alongside climate change adaptation measures. This inclusion signals institutional recognition that agricultural policy must integrate environmental innovation – a step towards bioeconomy thinking in the agro-food sector. Additionally, Ukraine's **Energy Strategy** and renewable energy policies have promoted bioenergy (such as biomass, biofuels) which is one component of the bioeconomy (though these policies are often discussed under energy rather than a bioeconomy label). The **National Economic Strategy 2030** (adopted in 2021) and various innovation policies also reference high-value biological industries (e.g. biotech, forest and wood industries) as areas for growth, implying support for bio-based economic transformation. Furthermore, Ukraine's **environmental and climate policy** alignment with the EU (for example, updating laws to meet the European Green Deal and Paris Agreement commitments) creates an enabling environment for bioeconomy initiatives. For instance, Ukraine has been working on a **Climate Strategy and Adaptation plans** that involve sustainable land use and forestry, indirectly encouraging bio-based solutions and resource efficiency (important pillars of a bioeconomy approach) [21].

Institutional coordination and initiatives: Formally, Ukraine does not yet have an inter-ministerial bioeconomy task force akin to some EU countries, but there are related coordination mechanisms. The Ministry of Agrarian Policy and Food, Ministry of Energy, Ministry of Environmental Protection, and Ministry of Economy each touch on aspects of the bioeconomy (agricultural biomass, bioenergy, ecosystem services, industrial biotech, respectively). Efforts to improve coordination are underway as part of Ukraine's EU integration. For example, the agriculture strategy development involved collaboration with the EU and FAO ("Institutional and Policy Reform for Small-Scale Agriculture" project), reflecting external and cross-ministerial input. Ukraine also participates in European research and innovation programs: Ukrainian scientists and institutions have joined Horizon 2020/Horizon Europe projects related to bioeconomy (e.g. in areas of food biotechnology, bioenergy, and climate-smart agriculture). This has helped transfer knowledge and build networks. Ukraine has observer status or collaboration in regional

initiatives like BIOEAST and has attended the Global Bioeconomy Summit events, indicating an interest to learn from EU neighbors. Additionally, some public-private partnerships exist in biotechnology and agriculture (for instance, clusters in IT and agro-biotech), which could serve as nuclei for a future bioeconomy network.

Gaps: Despite these developments, significant gaps remain in Ukraine's institutional architecture for bioeconomy policy. There is no single national strategy or unified action plan to drive the bioeconomy across sectors (as of 2025). This leads to fragmentation: responsibilities and initiatives spread across different ministries without a central coordinating framework. Legislation specifically tailored to bio-based products and innovation (such as standards for bioplastics, incentives for biomass use in industry, etc.) is still limited. Another gap is the relatively limited formal integration of scientific expertise into policymaking. Ukrainian academia is active in bioeconomy-related research, and experts have proposed conceptual approaches – for example, Koval, O., Koval, I., Koval, O. [10] suggest developing regional bioeconomy strategies and knowledge networks as a precursor to national policy. However, institutional mechanisms to link these expert inputs with national policy decisions need strengthening. A related challenge is awareness and capacity at the regional level: given Ukraine's large agricultural regions, implementing bioeconomy practices (like biogas production on farms, bio-based material startups, etc.) requires local authorities and businesses to be involved, yet regional institutions may lack guidance without a national framework.

Adaptation potential: On the positive side, Ukraine has considerable potential to **adapt and adopt best practices** from the EU and Visegrad countries. Its status as an EU candidate country (granted in 2022) has accelerated reforms and openness to EU policy models. Ukrainian policymakers can look to the V4 experiences – for instance, Poland's approach of integrating bioeconomy into a circular economy roadmap and forming stakeholder working groups, or Slovakia's use of a cluster and national hub to kick-start multi-actor coordination. Such models could be adapted to Ukraine's context. The gap analysis suggests Ukraine would benefit from establishing a **formal coordinating body or taskforce on bioeconomy** involving multiple ministries (Agriculture, Economy, Energy, Environment, Education/Science) and stakeholders (industry associations, farmers' unions, academia). This could mirror the inter-ministerial groups seen in Visegrad states and help draft a cohesive strategy. Moreover, aligning with the **EU Bioeconomy Strategy 2018 and upcoming 2025 revision** provides a clear template of objectives (e.g. managing natural resources sustainably, reducing dependence on non-renewables, ensuring food security, and spurring innovation). Ukraine's close cooperation with the EU on the European Green Deal also opens opportunities – for example, the EU's Green Recovery recommendations for Ukraine emphasize climate-smart growth, which dovetails with developing the bioeconomy.

In conclusion, Ukraine's institutional architecture for bioeconomy policy is still **emerging**. The country has started to embed bioeconomic concepts into strategic plans (notably in agriculture/rural and climate contexts), and there is growing awareness in government and academia of the bioeconomy's value. However, the lack of an overarching policy means Ukraine risks a piecemeal approach. To fully capitalize on its abundant biomass resources and innovative potential, Ukraine could adapt lessons from the Visegrad and EU frameworks: creating coordinating institutions, engaging stakeholders in policy co-creation, and ensuring alignment with EU strategies and monitoring systems. Bridging the current gaps will be crucial, but the period 2015–2025 has built a foundation of understanding and initial initiatives that can be expanded. The stage is set for Ukraine to formalize its bioeconomy policy and join the European family of countries with institutional architectures geared towards a sustainable, circular bioeconomy.

Purpose.

The aim of this study is to conduct a comparative institutional analysis of the bioeconomy policy architecture in Ukraine and the Visegrad Group countries (Poland, Czech Republic, Hungary, and Slovakia) from the standpoint of institutional economics. The analysis seeks to identify the systemic factors determining the effectiveness of bioeconomy policy design and implementation, and to develop

recommendations for adapting European approaches to the Ukrainian context. As noted by El-Chichakli et al. [22], effective bioeconomy governance must rest on five foundational pillars: strategy, education, innovation, stakeholder engagement, and global cooperation. The absence of any of these pillars significantly hampers the institutionalisation of such policies.

To achieve this aim, the study pursues the following research objectives:

1. To analyse theoretical and methodological approaches to understanding the institutional architecture of the bioeconomy within the framework of institutional economics, including multilevel governance, cross-sectoral interaction, and adaptive institutions for sustainable development.
2. To systematise the current European Union approaches to bioeconomy policymaking through a review of key strategic documents (European Bioeconomy Strategy 2012, 2018; European Green Deal 2019; Farm to Fork Strategy 2020; Bioeconomy Monitoring System 2020–2023).
3. To perform a comparative analysis of the institutional architecture of the bioeconomy in the Visegrad countries, focusing on formal strategies, inter-ministerial coordination mechanisms, the role of scientific clusters, and private sector engagement.
4. To assess the current status, gaps, and potential of bioeconomy policy development in Ukraine based on an analysis of official strategic documents, institutional coordination, and Ukraine's involvement in European initiatives.
5. To identify relevant lessons and best practices from the Visegrad countries that could be adapted to the Ukrainian context for building a coherent institutional architecture for bioeconomy policy.

Methods.

The methodological foundation of this study is grounded in the framework of new institutional economics, which enables the interpretation of bioeconomy policy as the outcome of interactions between formal and informal institutions within polycentric governance systems. The analysis is centred on the institutional architecture – understood as the set of norms, organisations, procedures, and coordination mechanisms that underpin the development and implementation of bioeconomy strategies at both national and regional levels.

A combination of complementary research methods was applied:

1. **Institutional analysis** – to identify key formal structures (government agencies, strategic documents, interministerial mechanisms) and informal practices (networks, partnerships, platforms) related to bioeconomy governance in Ukraine and the Visegrad countries.
2. **Comparative method** – to examine similarities and differences in the institutional architecture of bioeconomy policy, accounting for the transitional status of the economies, depth of European integration, and degree of engagement in the EU Bioeconomy Strategy.
3. **Content analysis** – of official policy documents (strategies, action plans, regulations, decrees) published by the European Commission, the governments of the Visegrad countries, and central executive authorities of Ukraine during the period 2015–2025. Sources were selected based on relevance, normative significance, and public verifiability.
4. **Expert assessment (secondary review)** – applied to evaluate the findings of academic research indexed in Scopus and Web of Science, focusing on bioeconomy policies, multi-actor governance, inter-institutional coordination, and transformation processes in Central and Eastern Europe (CEE).
5. **Interpretative approach** – used to uncover latent institutional constraints in the Ukrainian context, such as institutional traps, weak horizontal linkages, and disjunctions between formal structures and informal practices.

The object of the analysis is the institutional architecture of bioeconomy policy. The subject of the study is the mechanisms for designing, coordinating, and implementing bioeconomy policies based on official strategies, regulatory frameworks, and governance practices in the Visegrad countries and Ukraine.

The empirical basis of the study consisted of the following sources:

– **European documents**, including: *European Bioeconomy Strategy* (2012, 2018), *European Green Deal (2019), Farm to Fork Strategy (2020), Bioeconomy Monitoring System* (2020–2023), and the *EU Bioeconomy Policy Framework 2024);

– – **National strategies and policies** of Poland, the Czech Republic, Slovakia, and Hungary, including BIOEAST documents, Circular Economy Roadmaps, and national bioeconomy concepts;

– **Strategic documents of Ukraine**, such as the *Strategy for the Development of Agriculture and Rural Areas until 2030, the National Economic Strategy 2030, the Climate Strategy of Ukraine*, and sectoral documents issued by the Ministry of Agrarian Policy, the Ministry of Energy, and the Ministry of Environmental Protection.

– Thus, the selected methodological framework ensures the comprehensiveness, comparability, and relevance of the analysis, enabling well-founded conclusions regarding Ukraine's potential for institutional adaptation to contemporary European standards of bioeconomy policy.

Results.

Between 2015 and 2025, the Visegrad Group countries have demonstrated increasing efforts to establish an institutional foundation for the bioeconomy, although these developments remain uneven in terms of both the formalisation of strategies and the depth of coordination. Despite the absence of fully adopted standalone national bioeconomy strategies, there is a noticeable trend toward the gradual integration of bioeconomy elements into adjacent policy domains, such as circular economy, agri-food development, innovation, and climate transformation.

Poland, for instance, has incorporated bioeconomy priorities into its *Circular Economy Action Plan*, while also launching an interministerial working group under the Ministry of Agriculture and the BIOSTRATEG platform aimed at funding applied research in bio-innovation. This reflects the emergence of a polycentric institutional system characterised by cross-sectoral coordination.

In the Czech Republic, although a consolidated strategy is lacking, a bioeconomy development concept has been formulated, accompanied by the establishment of a multisectoral platform involving governmental agencies, academic institutions, and the private sector. This approach indicates the development of horizontal coordination mechanisms based on transdisciplinary knowledge exchange.

Hungary, as the initiator of the BIOEAST platform, leverages regional cooperation to strengthen institutional competence. Through the creation of specialised departments within the Ministry of Agriculture and active participation in regional dialogues, Hungary has laid the groundwork for a future national bioeconomy strategy.

Slovakia, in turn, has exhibited strong institutional dynamism by establishing a bioeconomy cluster and launching a national hub that integrates governmental, scientific, and business entities. This network-oriented architecture provides a foundation for effective and inclusive policy coordination.

Overall, the institutional architecture of the Visegrad Group countries is characterised by elements of polycentricity through the establishment of interministerial and cross-sectoral structures, institutional inclusiveness via engagement with scientific and civil society actors, adaptability through the integration of bioeconomy priorities into adjacent strategic documents, and active participation in regional initiatives, particularly through BIOEAST mechanisms. These structural features underpin the capacity to implement bioeconomy policies as an integral component of sustainable development.

In contrast, Ukraine's institutional context appears considerably less structured and exhibits fragmentation. Although a comprehensive national bioeconomy strategy has not yet been adopted, the period from 2020 to 2025 has seen a gradual institutionalisation of individual policy components. For instance, the *Strategy for Agriculture and Rural Development until 2030* recognises the bioeconomy – emphasising bioenergy, organic production, and biotechnology – as a key element of a climate-oriented agri-sector. Additionally, the *National Economic Strategy 2030* and Ukraine's climate policy frameworks refer to bioeconomic approaches as instruments for low-carbon growth. However, these references lack

accompanying institutional coordination mechanisms: horizontal integration across sectors is absent, governance institutions remain siloed, and interministerial platforms – unlike those in the Visegrad states – have yet to be developed.

Moreover, Ukraine lacks a stable infrastructure for multi-actor governance. Participation in European research initiatives (e.g., Horizon Europe, ERA-Net, BIOEAST as an observer) functions more as a channel of external intellectual import rather than a mechanism for sustained domestic involvement in policymaking. The absence of clear legislative definitions for key bioeconomy terms – such as "sustainable bioresource" or "bio-based product" – hampers the development of standards, regulatory instruments, and public support schemes. Additionally, a domestic monitoring system is lacking; one that would enable the evaluation of economic, environmental, and social impacts comparable to the EU Bioeconomy Monitoring System.

As of 2024, Ukraine has not adopted a dedicated Bioeconomy Strategy, and existing government documents address bioeconomic issues only indirectly. For example, the draft *National Circular Economy Strategy* (developed by the Ministry of Environment) and the *National Energy and Climate Plan* include selected provisions on bioenergy, agro-rehabilitation, and environmental indicators, which could serve as foundational elements of a future bioeconomy policy. While Ukraine participates in BIOEAST as an observer, it has not yet established a national hub or incorporated the Strategic Research and Innovation Agenda (SRIA) documents into national planning frameworks. This reflects the incomplete institutionalisation of the bioeconomy discourse in Ukraine, despite the presence of relevant scientific institutions and applied projects in agrobiotechnology.

To synthesise the identified institutional divergences and present them in a concise and illustrative format for further analysis, Table 1 below summarises the key parameters of the bioeconomy policy architectures in Ukraine and the Visegrad Group countries.

Table 1. Comparative Characteristics of the Institutional Architecture of the Bioeconomy in Ukraine and Visegrad Group Countries

Country	Strategy Availability	Coordination Mechanisms	Multi-actor Engagement	Regional Integration	Monitoring System	Role of Science
Poland	Partial (Circular Economy Roadmap – GOZ)	Interministerial working group	BIOSTRATEG, stakeholder group	BIOEAST	Partial	Strong
Czechia	Concept paper	Bioeconomy platform	Academic councils, bio-clusters	BIOEAST	Limited	Strong
Hungary	In development	Dedicated departments at Ministry of Agriculture	Networks, conferences, SCAR involvement	BIOEAST (founding country)	Planned	Strong
Slovakia	Concept paper	National hub, cluster	Public-private platform	BIOEAST, DanuBioValNet	Under development	Strong
Ukraine	Absent (Draft Circular Economy Strategy)	No centralised coordination; fragmented interaction among relevant ministries (Agriculture, Environment, Energy)	Isolated project-based initiatives (EU4Environment, FAO, Horizon Europe); lack of permanent platforms	BIOEAST (observer status); SRIA not integrated	Absent	Limited, mainly through research institutions without institutional representation in policy-making

Note: Data systematised from regulatory documents, BIOEAST reports, EU strategies, and documents of relevant national ministries.

The comparative Table 1 highlights that Poland, Czechia, Hungary, and Slovakia have already developed either conceptual frameworks or partially integrated bioeconomy strategies, whereas Ukraine lacks a dedicated strategy. All V4 countries have established permanent or temporary mechanisms for interministerial coordination – such as working groups, national hubs, or departmental structures – while Ukraine demonstrates only fragmented coordination among key ministries.

In terms of multi-actor governance, Visegrad countries rely on institutionalised clusters, platforms, and national programmes (e.g., BIOSTRATEG, thematic stakeholder groups), in contrast to Ukraine, where initiatives are mostly project-based and lack sustainability. All four countries are full members of the regional BIOEAST platform (with Hungary as a founding country), while Ukraine participates as an observer, limiting its access to collective knowledge and funding instruments.

Bioeconomy monitoring systems in the V4 countries are at various stages of development, whereas no such system currently exists in Ukraine, creating a significant barrier to evidence-based policy-making. Finally, scientific institutions play a leading role in shaping policy across all Visegrad countries, unlike in Ukraine, where research actors remain weakly integrated into decision-making processes. Thus, Table 1 clearly illustrates a systemic asymmetry that defines priority directions for Ukraine's institutional adaptation.

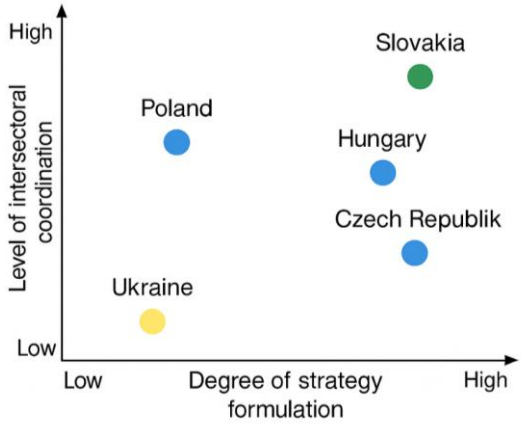

Figure 1. Typology of the Institutional Architecture of the Bioeconomy in Visegrad Group Countries and Ukraine (Based on the Level of Cross-sectoral Coordination and Degree of Strategic Formalisation)

The figure is based on the authors' interpretation of country positioning along two key indicators of institutional design.

Figure 1 presents a typological model of the institutional architecture of the bioeconomy in the Visegrad Group countries and Ukraine, using two dimensions: the level of cross-sectoral coordination (Y-axis) and the degree of strategic formalisation (X-axis). Ukraine is positioned in the lower-left quadrant, reflecting both a low level of coordination and the absence of an approved bioeconomy strategy. According to Vivien et al. [23], such institutional deficiencies may expose bioeconomy agendas to the risk of being "captured" by dominant industrial or agri-business interests in the absence of proper regulatory safeguards. In this context, Ukraine's weak coordination mechanisms raise concerns about the potential implementation of the bioeconomy in a sectorally biased manner, without adherence to sustainability principles.

In contrast, Slovakia displays both high strategic clarity and well-developed coordination mechanisms. Poland, Hungary, and Czechia occupy intermediate positions: Poland demonstrates moderate coordination with relatively limited formal strategic frameworks, while Hungary and Czechia

show higher degrees of strategic formalisation but vary in terms of institutional integration. This typological mapping enables the identification of structural asymmetries in institutional arrangements and highlights potential directions for aligning Ukraine's bioeconomy governance with European practices.

To further deepen the comparative institutional analysis, Table 2 summarises selected best practices from Visegrad countries that exhibit high potential for transferability to Ukraine's policy context, considering the country's institutional preconditions and systemic challenges.

Table 2. Opportunities for Implementing Institutional Practices from Visegrad Group Countries in Ukraine's Bioeconomy Policy

Country	Institutional Practice	Feasibility of Implementation in Ukraine
Slovakia	Bioeconomy cluster and national hub	Possible implementation via the existing network of agri-innovation hubs and academic centres
Poland	GOZ Roadmap integrating bioeconomy goals into circular economy policy	Adaptable within the framework of the draft Ukrainian Circular Economy Strategy
Czechia	Tripartite platform: academia – business – government	Formation of a consultative council or intersectoral expert platform under the Ministry of Education or Ministry of Agrarian Policy
Hungary	Full participation in BIOEAST and national coordination structures	Activation of participation by transitioning from observer to full membership

Table 2 identifies four donor countries (Slovakia, Poland, Czechia, and Hungary) and presents two key analytical dimensions: "Institutional Practice" and "Feasibility of Implementation in Ukraine." Slovakia's cluster-hub model ensures coordinated interaction among the state, business, and academia and can be replicated in Ukraine using existing agri-biotechnology clusters. Poland offers a model of bioeconomy integration into the circular economy roadmap (GOZ), which is compatible with the ongoing development of Ukraine's Circular Economy Strategy. Czechia's national platform for bioeconomy connects academic, industrial, and governmental actors, facilitating policy coordination, knowledge transfer, and intersectoral cooperation [24]. Hungary illustrates the benefits of active participation in the BIOEAST platform and SCAR structures; for Ukraine, transitioning from observer to full member status in BIOEAST would open access to regional knowledge exchange, joint research initiatives, and dedicated bioeconomy funding [25].

In Visegrad countries, the implementation of the BIOEAST Strategic Research and Innovation Agenda (SRIA) has catalysed institutional development, including the establishment of interministerial platforms, investment in research, and hub formation. As such, this table outlines a practical roadmap for institutional adaptation in Ukraine that could reinforce both formal and informal dimensions of its emerging bioeconomy policy framework.

The revealed differences in institutional architectures can be interpreted through the lens of institutional economics. As North [2; 26] emphasizes, formal institutions (strategies, regulations, coordination bodies) only partially explain cross-country variation; rather, informal rules of interaction (institutional routines, intersectoral trust, path-dependent trajectories) shape development outcomes. In Ukraine's case, an institutional void – the absence of stable norms for stakeholder interaction – hinders the operationalization of even formally adopted frameworks. In contrast, the Visegrad countries have gradually institutionalized their bioeconomy governance through mechanisms of normative and mimetic isomorphism [27], facilitating the diffusion of cluster governance models, strategies, and monitoring systems. This underscores the necessity of addressing not only technical but also deeply institutional factors when adapting international policy models to the Ukrainian context.

Comparative analysis highlights both convergences and divergences in bioeconomy governance architectures. A shared feature is the fragmented nature of formal strategies, often embedded in adjacent policies. However, a key difference lies in the presence of interministerial coordination mechanisms, clusters, platforms, and thematic working groups in the V4 countries – ensuring both vertical and horizontal policy alignment. While academic institutions in the Visegrad countries actively shape public policy, Ukrainian science currently operates in parallel, lacking structured knowledge transfer mechanisms

into policymaking.

Therefore, practices suitable for adaptation in Ukraine include Slovakia's development of a bioeconomy cluster and national hub; Poland's integration of bioeconomy objectives into circular economy roadmaps and monitoring frameworks; Hungary's regional engagement through BIOEAST; and Czechia's conceptualisation of bioeconomy as an intersectoral public policy. Collectively, these examples illustrate the real-world application of institutional economics principles – namely, polycentricity, adaptability, coordination efficiency, and stakeholder inclusion – crucial for the effective establishment of bioeconomy governance in Ukraine.

Conclusions and Discussion.

This study has conducted a qualitative institutional analysis of the bioeconomy policy architecture in Ukraine and the Visegrad Group countries, grounded in the theoretical paradigm of institutional economics and based on official strategic documents and relevant academic sources from 2015 to 2025. The comparative assessment revealed significant differences in the degree of strategic formalization, intensity of intersectoral coordination, and stakeholder involvement in the policy-making process. The typological analysis showed that Slovakia demonstrates the most advanced model of institutional architecture, combining strategic planning with effective multi-actor governance. Poland and Hungary exhibit a high level of coordination, albeit with varying degrees of strategic formalization. Czechia demonstrates a moderate level of institutional development, while Ukraine, despite several institutional initiatives, remains at an early stage of bioeconomy policy development, characterized by fragmented coordination and the absence of an approved national strategy.

The findings confirm that an effective institutional architecture for the bioeconomy requires the synchronization of formal elements (strategies, legislation, regulations) with informal coordination mechanisms (platforms, networks, clusters). Such a combination not only provides the normative foundation but also facilitates the dynamic adaptation of policies to stakeholder needs and the evolving challenges of sustainable development. Based on the analysis of Visegrad Group practices, the study proposes a roadmap for Ukraine's institutional adaptation, which includes: the establishment of a coordination platform under the Ministry of Agrarian Policy or the Ministry of Education; integration of bioeconomy objectives into the national circular economy strategy; development of cluster-hub models; and active participation in the BIOEAST initiative as a full member.

Future research should focus on the formalization of institutional assessment frameworks for bioeconomy policy using indicator-based models, as well as an in-depth analysis of the relationship between institutional capacity and the effectiveness of target programme implementation in such domains as agri-bioeconomy, renewable energy, and biotechnology. An important direction also lies in the development of mechanisms for multi-level policy coordination (national–regional–local levels), taking into account the polycentric nature of governance in the context of Ukraine's European integration trajectory.

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