European, National and Regional Policy on the Bioeconomy: Implications for Agricultural and Land-use Practice and Policy Recommendations for Ireland

Introduction

This report explores European, national and regional policy on the bioeconomy in the context of Ireland. It explores these issues in relation to agricultural and land-use practice and provides policy recommendations based on the various approaches Ireland and Europe has taken in relation to its bioeconomy strategy. First, the context of bioeconomy policy in Ireland is discussed, then the nation's research, development and innovation approach will be explored, followed by a discussion regarding the collaboration approach, governance approach, and finally the economic, environmental and social sustainability approach. These approaches are the most common amongst all European countries. Finally, respective approaches are explored in respect to the key challenges emerging in relation to each respective approach and associated policy recommendations are proposed in order to address these challenges.

The European Context

In 2012 the European Commission (EC) introduced its first bioeconomy strategy and action plan. The strategy established an expansive setting for the bioeconomy whereby it was conceived as, "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy; [with] its sectors and industries hav[ing] strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge", (European Commission, 2012; 9). In 2018 the strategy was updated and its definition further expanded to include, "all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass including organic waste), their functions and principles", (European Commission, 2018; 4). *A Bioeconomy for Europe* (European Commission, 2012) describes the integration of the bioeconomy and rural development as facilitating sustainable development and as a decentralised model of industry. *A sustainable Bioeconomy for Europe* (European Commission, 2018; 27) builds on this aspiration, describing the bioeconomy as a chance for rural areas to be revitalised, whereby bioeconomy development and rural development are combined in such a way that the farmer, as primary producer, advances development, and where bio-based value chains in rural space are

customised to the producer. The 2018 strategy document (European Commission, 2018) reflects the recommendations set out in the European Commission's (2017a) *Expert Group Report* where developing the bioeconomy is perceived in terms of new economic opportunities for rural areas.

These policy initiatives have encouraged nations throughout Europe to develop their own strategic development for the bioeconomy. Nevertheless, such national and regional policy is heavily influenced by the EU context, and although respective nations and regions may differ in the degree of focus applied to each approach, most EU countries follow an analogous template when it comes to agriculture and land use and their approach to bioeconomy strategy, i.e. in short they follow, to varying extents, the following interrelated approaches: 1) the research, development and innovation approach (perhaps the most popular); 2) the collaboration approach; 3) the governance approach; and 4) the economic, environmental and social sustainability approach (perhaps the least developed). In the Irish context, key bioeconomy policy documents include the *Bioeconomy Action Plan* (Department of Environment, Climate and Communications, 2022), the *National Policy Statement on the Bioeconomy* (Government of Ireland, 2018), and the *Bioeconomy Implementation Group First Progress Report* (Department of Environment, Climate and Communications & Department of Agriculture, Food and Marine, 2019), with bioeconomy strategy forming part of wider strategic development on a national and regional basis. Table 1 outlines the most important national and regional policy documents relating to bioeconomy development in Ireland at the current time.

Table 1: National and Regional Policy relating to the Bioeconomy in Ireland

Policy Document	Administration	Date
Bioeconomy Action Plan	Environment, Climate and Communications	2022
National Policy Statement Bioeconomy	Government of Ireland	2018
Bioeconomy Implementation Group	Environment, Climate and Communications & Agriculture, Food and Marine	2019
Climate Action Plan 2024	Government of Ireland	2024
National Development Plan 2021-2030	Public Expenditure and Reform	2021
National Planning Framework	Government of Ireland	2018
Food Wise 2025	Agriculture, Food and Marine	2018
Action Plan for Rural Development	Rural and Community Development	2018
CAP Strategic Plan 2023-2027	Government of Ireland	2022
Regional Spatial & Economic Strategy	Eastern & Midland Regional Assembly	2020
Regional Spatial and Economic Strategy	Southern Regional Assembly	2020
Regional Spatial and Economic Strategy	Northern & Western Regional Assembly	2020

It should be noted that bioeconomy strategy is only briefly outlined in relation to the *National Development Plan 2021-2030*, the *National Planning Framework*, the *Regional Spatial & Economic Strategy - Eastern & Midland Regional Assembly*, the *Regional Spatial and Economic Strategy - Southern Regional Assembly*, and the *Regional Spatial and Economic Strategy - Northern & Western Regional Assembly*. The all-encompassing nature of the bioeconomy means that it is an incredibly complex and challenging strategy in terms of policy formation and implementation. This is because co-operation and organisation needs to occur on multiple scales and sectors that would have traditionally operated on an independent basis. In terms of the primary sector, strategies must be aligned across a range of disparate industries including agriculture, food, forestry, marine, chemical, material, and energy (Devaney and Henchion, 2018). Furthermore, a multitude of different stakeholders with conflicting and competing interests are required to work together in order to identify which development opportunities should be pursued, and how resources should be distributed so that the demands for local, regional, and global food, feed, and fibre requirements are met in a sustainable manner (Devaney et al., 2017; Lewandowski, 2015). The task of articulating such complexity in policy, where strategies must be developed across a diverse range of policy spheres, is therefore inherently difficult. The following discusses Europe and Ireland's five main policy approaches to bioeconomy development before finally outlining the key challenges and proposed associated policy recommendations in order to address such challenges.

The Research, Development and Innovation Approach

In an attempt to disentangle the complexity of bioeconomy development for the policy landscape of Europe, a number of national and regional strategies have emphasised the importance of research, development and innovation. Such strategies focus on generating collaborative networks between various stakeholders representing government, academics, and industry partners (Diakosavvas and Frezal, 2019). Such networks are seen as key to developing a sustainable bioeconomy through establishing centres of excellence created to ensure the ongoing engagement and co-operation of stakeholders (Bioökonomierat, 2018). Ireland in particular focuses on a research, development and innovation approach. The approach is one of seven pillars within the *Bioeconomy Action Plan* (Department of the Environment, Climate and Communications Ireland, 2022), the others including governance, nature, climate and circular, agriculture, forestry and the marine, industry and enterprise, and knowledge and skills. Examples of the research, development and innovation approach in Irish policy are outlined in Table 2:

Table 2: The Research, Development and Innovation Approach in Irish Policy

Bioeconomy Action Plan
"Impact 2030, Ireland's Research and Innovation Strategy positions research and innovation at the heart of addressing Ireland's societal, economic and environmental challenges. Consistent with Impact 2030, this Pillar will outline actions to generating and advancing research, development and innovation in the bioeconomy including to enhance, apply and scale-up biological knowledge and bioeconomy solutions. Research, development, and innovation have been a cornerstone of the Irish Bioeconomy policy development to date and will continue to be vital" (Department of Environment, Climate and Communications, 2022; 13).
National Policy Statement Bioeconomy
"A significant and very recent demonstration of the Government's commitment in this area has been its majority funding through Science Foundation Ireland of the Bioeconomy Research Centre which the Taoiseach launched in September 2017. The purpose of the centre is to enable the transition to the bioeconomy through scientific research that will develop new products and technologies and stimulate rural development. Government has provided through Science Foundation Ireland funding of €14.2 million for a Bioeconomy Research Centre (Beacon) which will explore how to convert marine resources and the residues produced during food production into higher value products. This will be a fundamental catalyst in the future development of the bioeconomy in Ireland" (Government of Ireland, 2018; 13).
Bioeconomy Implementation Group
"The Government has already demonstrated its commitment to the bioeconomy more broadly through investment: by Science Foundation Ireland in the BEACON Bioeconomy Research Centre and other Research Centres focused on agri-digitalisation, bioenergy and the microbiome; and by Enterprise Ireland in the National Bioeconomy Campus in Lisheen, Co. Tipperary, other innovation clusters including the Marine Innovation Park, Páirc na Mara in Connemara, the BioConnect Innovation Centre in Co. Monaghan and Technology Centres focused on meat, dairy processing and food for health" (Department of Environment, Climate and Communications & Agriculture, Food and Marine, 2019; 3).
National Development Plan 2021-2030
"Research, development and innovation capacity is central to sustaining and building competitiveness in international markets. Therefore, focus on maintaining and improving standards of research is critical" (Department of Public Expenditure and Reform, 2021; 97).
Action Plan for Rural Development
"The Bioeconomy Implementation Group (BIG) was established in 2018 on foot of the National Policy Statement on the Bioeconomy and is in the process of publishing a draft report. The Bioeconomy has the potential to contribute to decarbonisation, sustainable growth and job creation in agriculture, fisheries, forestry and technological sectors, with an emphasis on job creation in rural areas" (Department of Rural and Community Development, 2018; 11).

CAP Strategic Plan 2023-2027
"Circular Bioeconomy Cluster: This initiative is supported to Enterprise Ireland's Regional Technology Clustering Fund and aims to improve collaboration between researchers, technology providers and industry to accelerate the transition to a low-carbon and circular bioeconomy. Bio-Connect Innovation Centre: This initiative is supported to Enterprise Ireland's Regional Economic Development Fund. The centre will encourage and assist research activities undertaken by firms that use the centre's resources by forming partnerships with academic institutions. The ultimate objective is to encourage the development and retention of highly skilled jobs in the region by conducting innovative bioeconomy research" (Government of Ireland, 2022; 42-43).
Regional Spatial & Economic Strategy - Eastern & Midland Regional Assembly
"EU and National Funds will support Research and Innovation outputs that address cross-cutting challenges and opportunities in the bioeconomy, including the teaming up of regions in bioeconomy-related Smart Specialisation partnerships. The Department of Agriculture, Food and the Marine and SEAI are also supporting a number of bioeconomy related projects including Agri Bio Circular Economy, led by UCD - ABC Economy, develops new sustainable value chains for the circular bioeconomy in Ireland by maximising value and minimising environmental impacts through cascading of biomass for production of biobased products and energy" (Eastern & Midland Regional Assembly, 2020; 56).

* No bioeconomy approaches discussed in this document are specifically mentioned in the context of the *National Development Plan*; National *Planning Framework*, *Food Wise 2025*, the *Regional Spatial and Economic Strategy - Southern Regional Assembly*, and the *Regional Spatial and Economic Strategy - Northern & Western Regional Assembly*. In such documentation, the bioeconomy is described very briefly and in a general sense.

Current bioeconomy policy in Ireland prioritises the role of research and development organisations such as the National Bioeconomy Research Centre *BiOrbic* (former *BEACON*) and the *Irish Bioeconomy Foundation*. This reflects the more academically orientated, science-based perspective Ireland has taken in developing the bioeconomy thus far (Kirs et al., 2022). Projects such as *BioÉire*, emphasising the potential for value-chain opportunities in the bioeconomy further exemplify the strategy whereby development of the bioeconomy is led by academics (see Devaney and Henchion, 2016). In fact, results emerging from the *BioÉire* project have been integrated into policy development procedures in Ireland. For example, *BioÉire* findings played a significant role in the Ireland's *National Policy Statement on the Bioeconomy* (Devaney and Henchion, 2018). Hence, the role of research, development and innovation is intrinsically intertwined with bioeconomy policy in Ireland.

In recent years considerable effort has been made to strengthen the links between research and industry in Ireland. More generally, initiatives such as *Food for Health Ireland* were designed to facilitate networks between researchers and industry partners whereby food is envisioned to be developed, manufactured, and marketed in a collaborative process (Devaney and Henchion, 2017). In respect to the bioeconomy specifically, approximately seven research institutes have been established in Ireland as of March 2023 that focus, not only on research and development of the Irish bioeconomy,

but also on establishing collaborative networks between researchers and industry partners. These include the *Agriculture and Bioeconomy Research Centre* in Galway, the *Bioconnect Innovation Centre* in Monaghan, the *BiOrbic Bioeconomy Research Centre* in Dublin, the *Circular Bioeconomy Cluster* in Kerry, the Irish Bioeconomy Foundation in Tipperary, *Nua na Mara Marine Innovation Development Centre* in Connemara, and *Shannon ABC Applied Biotechnology Centre* in Limerick.

Figure 1 below illustrates the geographical distribution of the seven bioeconomy research institutions in Ireland.

Figure 1: Geographical Distribution Bioeconomy Research Institutions in Ireland

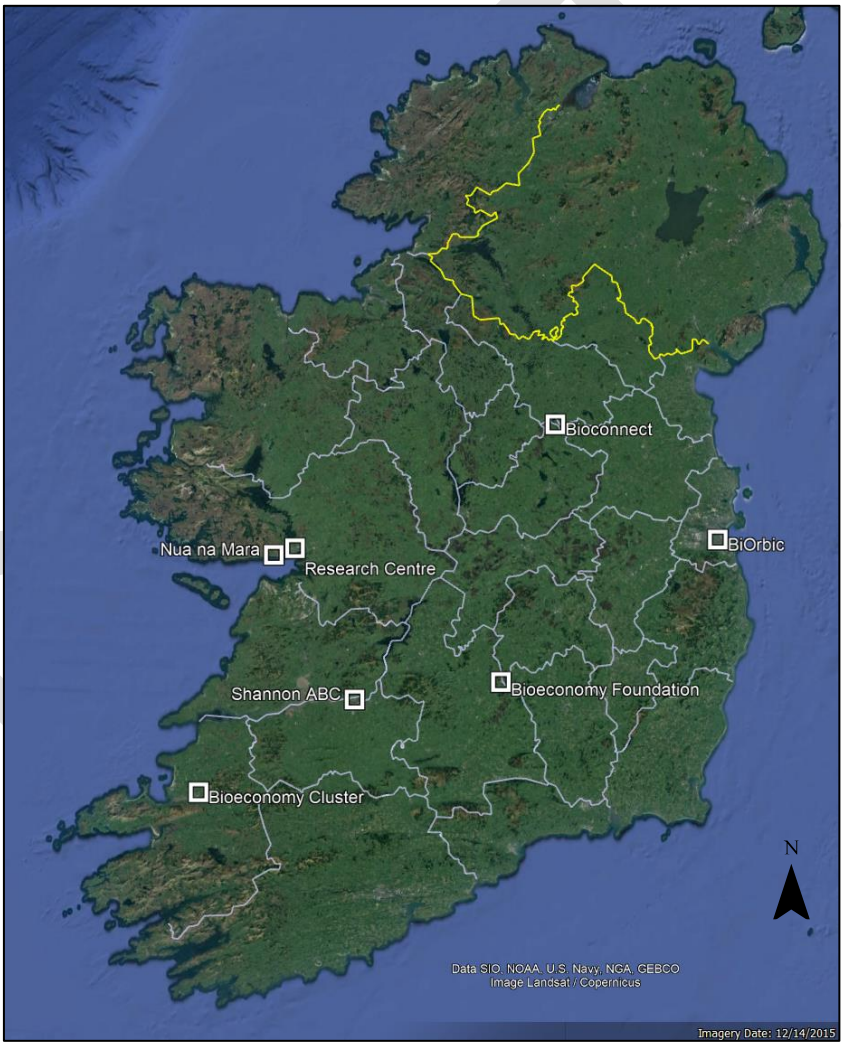

Figure 1 shows a reasonably good distribution of bioeconomy research institutes in Ireland. If further institutions are to be established they may wish to be located in areas such as the North-West serving counties such as Donegal, Mayo, Sligo and Roscommon, and areas to the South, serving counties such as Cork, Wexford and Waterford.

The various research institutes mentioned above have varying degrees of collaboration with various enterprise. The extent to which this collaboration is successful is beyond the scope of this report. What seems to be a more urgent point of discussion relates to the apparent absence in networks between research institutions and farmers, as well as farmer associations, reflecting a wider issue, both in Ireland and Europe, regarding the current direction of bioeconomy policy. This apparent lack of collaboration between research institute and farmer and farmer representative organisations is striking if one considers that Ireland is well represented by such groups, which include the *Irish Farmers' Association* (*IFA*), the *National Rural Network*, *Agriland*, *Glenmore Farming Group*, *Social Farming Ireland*, the *Irish Organic Association*, and the *Irish Farm Films Producers Group*. This reflect the fact that, as previously mentioned, Ireland's approach to bioeconomy development is primarily led by academics as opposed to other interest groups such as farmers. Indeed, like wider European policy (see Ramcilovic-Suominen and Pülzl, 2018), Irish policy is perhaps overly focused on the research, development and innovation dimension, which results in a striking absence regarding the role of the farmer in bioeconomy development. Since agriculture and the production of food, fisheries and forestry are the chief contributors to the Irish bioeconomy, it is imperative that primary producers are, not only included, but are amongst the leaders in the development of the bioeconomy in Ireland, particularly in terms of conflict resolution strategies. It is also essential that Irish policy reflects this. A social network analysis by Harrahill et al. (2023) reached similar conclusions regarding the absence of primary producers, although the study was not focused on research institutions in particular, taking a more general approach. As such, Harrahill et al. (2023) concluded that government, semi-state agencies, and research institutions form the essence of the bioeconomy social network in Ireland. The study also emphasised that, along with primary producers, private enterprises were not central players in the social network of the bioeconomy (Harrahill et al., 2023). The study suggests that this deficit could potentially be mitigated by including intermediary actors who could potentially help excluded groups access the social network of the Irish bioeconomy, or by interacting with such groups in a support role aimed to enable currently excluded groups to become more influential (Harrahill et al., 2023).

Similar concerns have been raised by the European farmer and European agri-cooperative group *Copa-Cogeca*, an organisation representing over 22 million farmers (*Copa*)[1] and the General Confederation of Agricultural Cooperatives (*Cogeca*) who represent agri-food, forestry and fishery cooperatives in Europe. Numerous agricultural associations, including *Copa-Cogeca*, have been consistently expressing their concerns regarding the current focus of European bioeconomy policy,

[1] To which the IFA is a member with Time Cullinan of the IFA serving as fourth vice president of the association (see https://copa-cogeca.eu/about-copa).

advocating the need for policies to extend their priorities beyond, what many consider, an excessively exclusive attention towards research and development (Copa-Cogeca et al., 2018). Sustainable forms of biomass production are of particular importance for these agricultural bodies, viewing this aspect as the foundation of bioeconomy value chains in Europe (Lühmann, 2019). Because of these reasons *Copa-Cogeca* and similar organisations view it as an urgent requirement that primary producers are more integrally included in processes of decision-making involving the development of bioeconomy policy. Such inclusion would entail primary producers being involved in stimulating and advancing the mobilisation of ancillary biomass and encouraging the demand for bio-based commodities and raw materials (Lühmann, 2019). According to Copa-Cogeca, this can be achieved through the establishment of incentives like the preferential management of bio-based commodities in respect to tax break incentives and public procurement (Copa-Cogeca et al., 2018). Such organisations also recommend that governments should take a much more market-orientated approach than is currently taken (Copa, 2018), and consider it essential that bioeconomy strategy is much more integrated into the Common Agricultural Policy (CAP) as well as other policy arenas such as cohesion policy, regional policy and forestry policy across the EU (Lühmann, 2019). More prevalently, agricultural organisations across Europe argue that bioeconomy policy is not focused enough on rural development. In general, organisations like Copa-Cogeca consider that the development of bioeconomy policy should be used to, not only generate new and different ways to produce and process biomass but should also be designed to resolve the long-standing and engrained structural problems present in many areas across the EU (Lühmann, 2019). Such structural problems include the necessity to modernise agriculture, to generate employment in rural areas, as well as long-standing issues related to generational renewal in respect to farming systems (Copa-Cogeca et al., 2018). In essence, prominent agricultural organisation across the EU, and Copa-Cogeca in particular, consider it a necessity that EU bioeconomy policy develop beyond its overly focused concentration on research, development and innovation and become more focused as a modernising policy for rural areas in Europe and the agricultural businesses contained therein (Lühmann, 2019).

Beyond the urgent requirement for farmer and farmer association participation, there is also a need for public consultation in policy development on the bioeconomy. In Ireland, one observes a very strong reliance on international discourse and international practice when compared to domestic policy paradigms (Kirs, 2021). The agricultural development agency *Teagasc* has been at the forefront of leading bioeconomy policy in Ireland, which has intimately shaped such policy as previously outlined. As Ireland's application of bioeconomy policy development is primarily a research, development and innovation approach, as previously argued, *Teagasc* has been successful in leading this academically-orientated strategy. However, this approach is arguably too focused on international

examples, international benchmarks, as well as relying almost exclusively on international experts (Kirs et al., 2022; see Teagasc, 2016; Teagasc 2008; Kelleher et al., 2019). Although the utilisation of international exemplars regarding bioeconomy policy is, of course, essential, it should also include national examples, national benchmarks, and national experts that can provide the essential contextual elements required for successful and sustainable implementation of the bioeconomy in different contexts. Focus on the international *is* logical to an extent since, as a small and open economy, and as part of the EU, Ireland is strongly influenced by EU policy, particularly in relation to the transition to a green economy (EIO, 2017). However, the legitimisation protocols involved in such policy development have had a long-standing tradition of participatory and public consultation at the local scale, which is absent in current bioeconomy policy development in Ireland.

The Collaboration Approach

Similar to the previous discussion regarding Ireland's priority for research, development and innovation which focused on the network integration between research institutions and governing, research, and industry partners, it is important to discuss Ireland's more general collaboration approach in respect to policy implementation. Since the mid-2010s in Ireland, various coordination organisations across industry and amongst different stakeholders have been established to provide stronger policy coherence between various sectoral strategies for the bioeconomy as well as relevant policy measures (Kirs et al., 2022); for example, the Irish Interdepartmental Group on the Bioeconomy, which is presided over by senior officials from all relevant government departments, business sectors, and academic institutions (Kelleher et al., 2019; Bahn-Walkowiak and Wilts 2017). Furthermore, in late 2016 an inter-ministerial working group was formed, administered by the Department of *An Taoiseach*, its primary goals include balancing activities connected to the bioeconomy and identifying chances for a national policy approach. Examples of Ireland's collaboration approach in bioeconomy policy are outlined in Table 3:

Table 3: The Collaboration Approach in Irish Policy

Bioeconomy Action Plan
"Bioeconomy development by its very nature needs highly collaborative endeavours, requiring participation, expertise, and investment on the part of multiple actors including government, the private sector, and civil society. A key factor for success is achieving effective co-operation among these multiple, diverse participants. Bringing together multiple actors to make complementary investments raises challenges and requires appropriate approaches. This Pillar will link to the Industry & Enterprise Pillar and the Knowledge & Skills Pillar to ensure that funding pathways exist to move from research, development, and innovation to

commercialisation, including how to best harness national and EU funding" (Department of Environment, Climate and Communications, 2022; 13).

National Policy Statement Bioeconomy

"This National Policy Statement is a further step towards our ambition to develop the bioeconomy. It has been prepared by my Department and is the outcome of extensive consultation. It outlines the major challenges in expanding the bioeconomy. Among these are promoting greater coherence between the many sectors of the bioeconomy; strengthening the development of promising bio-based products and growing the relevant markets for them; and accessing funding available at EU level as well as leveraging private investment. These matters can only be progressed by co-operation and collaboration between the public service, industry and the research institutes. The Government has mandated an implementation group jointly chaired by the Departments of Agriculture, Food and Marine and Communications, Climate Action and Environment to take forward a number of major actions, in close collaboration with bioeconomy industries and other partners, and report back to Government within a year" (Government of Ireland, 2018; 2-3).

Bioeconomy Implementation Group

"The Government established the Bioeconomy Implementation Group to advance the seven key actions identified in the policy statement on the bioeconomy…[One of these key actions is intended to] Encourage the translation of research into real world applications through promoting collaboration between research institutions (academia) and industry through the use of pilots/demonstrations at the model demonstrator facilities (Lisheen site, the Marine Research Cluster in Connemara):

- DAFM & SEAI co-funded two projects that are assessing the available biomass, value chain development, valorisation & market based opportunities and socio-economic impact through engagement with key regional and rural stakeholders in Tipperary & Monaghan including examining key principles of circularity & cascading use in real-time;
- DAFM co-funded Biorefinery Glas, through the CAP measure EIP-AGRI, which is one of the first bioeconomy initiatives in Europe which looks at moving farmers further up the bioeconomy value chain; becoming bio-processors, rather than simply suppliers of low-cost biomass in co-operation with Dairy Processors, Co-operatives and Research Performing Organisations.
- Engaged with the NTMA, EIB and private investors to examine national and EU financing options and opportunities.
- Ensured bioeconomy is in scope in current national research (DAFM, EPA, and SEAI) and innovation (Project 2040 – DTIF) funding calls.
- Promoted and supported engagement in the LIFE EU co-funding opportunity.
- On-going contact with the bioeconomy related innovation clusters based in Lisheen, Connemara and Monaghan with regular meetings ongoing with the BEACON Bioeconomy Research Centre and the Irish Bioeconomy Foundation.
- Supported the Department of Business, Enterprise and Innovation mapping and analysis report of Circular Economy & Bioeconomy enterprise opportunities.

- Benchmarked the implementation groups approach for bioeconomy policy development against OECD key messages for systems innovation".

(Department of Environment, Climate and Communications & Agriculture, Food and Marine, 2019; 15-17).

* The collaboration approach is not specifically mentioned in the context of the *Action Plan for Rural Development*, the CAP *Strategic Plan 2023-2027* and the *Regional Spatial and Economic Strategy - Eastern & Midland Regional Assembly*.

However, in order to create stronger cross-sectoral coherence in policy, it may be prudent to promote even greater coordination and collaboration between the various actors involved in the bioeconomy transition process (Kelleher et al., 2019). This may be even more pertinent considering Ireland's dependence on the sectoral approach to bioeconomy development. Recently, a strategy to promote stakeholder engagement was attempted in the form of the establishment of the *Bioeconomy Forum*, which has been referenced previously. Furthermore, there has also been particular attention on expanding communication and co-operation between key industry partners (The Government of Ireland, 2019). However, despite such developments, there remains a need for more coordination between policy arenas, and particularly across industry and across value chains. This includes a multifaceted coordination mechanism operating between policy and financial incentive and funding schemes (Kelleher et al., 2019). This remains a major concern in Ireland despite its wide-ranging framework of alternative mechanisms designed for increased coordination (Kelleher et al., 2019). Although Irish policy considers the development of the bioeconomy as a fundamental strategy for advancing the economy and ensuring sustainable growth, this is not possible without a strong and internationally coordinated governance system (Dietz et al., 2018), which is currently deficient in Irish and EU policy. In this regard it is important to note that international bureaucracy has become progressively fractured and polycentric in recent years (Carlisle and Gruby, 2019), creating additional intricacies and possible barriers to international co-operation in response to developing the bioeconomy in a sustainable manner (Held and Hervey, 2011).

The Governance Approach

The governance approach refers to the institutionalisation of bioeconomy development. For bioeconomy policy, innovative governance is required to eliminate competitive disadvantages because markets alone cannot achieve this (Gawel et al., 2019). This is necessary to eliminate fossil fuel consumption and to tighten economic, environmental and social sustainability demands (Gawel et al., 2019). Hence, the bioeconomy needs, not only creative technology, but most importantly, political solutions to encourage change in consumer habits and the utilisation of waste and recycled materials, whilst at the same time considering the potential rebound effects inherent with such

developments (Keil, 2015; Santarius; 2014). As previously mentioned, the governance approach is one of seven pillars within the *Bioeconomy Action Plan* (Department of the Environment, Climate and Communications Ireland, 2022). An example of Ireland's governance approach in policy is outlined in Table 4:

Table 4: The Governance Approach in Irish Policy

Bioeconomy Action Plan
"It is envisaged that the Governance pillar will address key issues which impact across all other Pillars such as networking, awareness raising and policy, sectoral and regulatory coherence. This Pillar will also address how we communicate the bioeconomy and its policies across various sectors, wider society and with stakeholders. It will seek to grapple with issues such as how the Bioeconomy interacts with our legal, planning, and regulatory system, and how Government disseminates scientific expertise into policymaking decisions" (Department of Environment, Climate and Communications, 2022; 12-13).

* The governance approach to the bioeconomy is not specifically mentioned in any other policy document relating to the bioeconomy.

As may be indicated in Table 4, it seems prudent to expand upon the governance approach to the bioeconomy in Irish policy. It is essential that the expansion of the circular flow mechanism of the bioeconomy is explored in conjunction with dialogue concerning sustainable bioeconomy development in order to mitigate the burdens and obstacles faced by the ecosystems that contain biomass resource (Leal Filho, 2018). However, there is a requirement for innovative technological, organisational, and product solutions in order to expand resource efficiency and to create a closely entwined cycle of materials (German Bioeconomy Council, 2015; Carus et al., 2014; Arnold et al., 2009). Furthermore, it is particularly crucial to analyse the extent to which current agricultural, environmental, and forestry trade policies need to be modified so that sustainability is maintained and secured (Gawel et al., 2019). Like most EU Member States (MS), Irish national and regional policy has endorsed the objective of growing and advancing bioeconomy development and is prepared to offer all-encompassing political support in order accomplish this objective (Dietz et al., 2018). However, the political management of conflict and competing objectives in bioeconomy development has not received the same level of attention (Dietz et al., 2018), though it is both inevitable and vitally important to address such issues. Fundamentally, a paramount challenge in creating a successful system of sustainable bioeconomy governance relates to the recognition and capable political management of competing objectives in the bioeconomy (Dietz et al., 2018). Prospectively, it appears to be the impending shortage of sustainably grown feedstocks for bio-based goods and services that stands as the main challenge for furthering the growth of the bioeconomy in Ireland, and this is as a result of the limited supply and disorganised and ineffectual use of biomass and arable land at the current time (Lewandowski, 2015). This dynamic has the potential to increase consumer concerns

regarding the sustainability of bioeconomy resource inputs while also resulting in increased prices for biomass commodities and the land on which biomass production takes place (Gawel et al., 2019). Such developments could simultaneously place the economic viability of the bioeconomy, the ecological sustainability of the bioeconomy, and the social acceptance of the bioeconomy at risk (Gawel et al., 2019). Furthermore, pressure on scarce biomass and land resources may increase due to the anticipated growth in the demand for bio-based produce (Gawel et al., 2019). As a result, conflicts between multiple sustainability objectives, such as the security of food and energy supply, land use conflicts, and sustainable land use are inevitable if not addressed (Gawel et al., 2019). At the current time, in order to manage conflict and the risks associated with the bioeconomy, Ireland relies heavily on soft regulatory measures, which include global value chains that operate on a self-regulatory basis, achieved through a combination of private standards as well as certification administration (Dietz et al., 2018). This needs to change as a matter of urgency for achieving favourable outcome for bioeconomy development nationally and internationally.

Such issues are primarily related to a lack of land use governance in respect to competition and trade-off regulation. Competition and trade-off regulation in respect to land use is not specifically mentioned in any current policy on the bioeconomy in Ireland. However, the inevitable displacement of traditional land use activities in favour of biomass production, and the competition and trade-off between food and non-food *within* biomass production, are major challenges for bioeconomy policy in Ireland as elsewhere in Europe. The utilisation of marginal land can, in some ways, address the former challenge (Singh et al., 2021), while the ability to assess resource efficiency can potentially address the latter challenge (Panoutsou et al., 2020). Moreover, in dealing with such challenges it is important to ensure that land utilised for non-food biomass production does not result in soil degradation or deforestation (Bosch et al., 2015), and that biomass production is at least as financially viable as previous production-related activities. It is critical that such contingencies are included in the strategic planning of bioeconomy development in Irish policy. Other related issues concern the need for a common definition of marginal land type and the requirement to evaluate the economic viability of land for biomass production, which does not currently exist in Irish or European policy (Singh et al., 2020).

Without a common definition of marginal land there is a danger that certain land use types may be underutilised or not used at all (Mellor et al., 2021). For example, landfill sites have been proposed as potential locations of biomass energy and as replacements for gas power stations (McKendry, 2002), with numerous studies highlighting the potential for renewable energy technologies to be located in such areas (Waite, 2017; Evans et al., 2009; Mosey et al., 2007). Mellor et al. (2021) propose the following preliminary definition for marginal land, that is, “any identifiable

land area, whether originally agricultural or non-agricultural, including those in urban areas, which is currently unused or underutilised due to economic, environmental or social factors, but which is suitable for temporary or longer-term use for sustainable energy production" (Mellor et al., 2021; 5). In evaluating the economic viability of land for biomass production, Sallustio et al. (2018) propose an easily replicable methodology consisting of a spatial analysis using the CORINE (COoRdination for the Information on the Environment) database within a GIS environment in order to qualify respective agricultural land types in terms of productive potential. The requirement to both define and economically classify marginal land for biomass production is essential for an efficient and successful development of the bioeconomy, and should be implemented in future iterations of regional, national, and pan-European bioeconomy policy.

The Approach to Economic, Environmental and Social Sustainability

It is certainly clear that Irish policy recognises the critical role that science, technology, and innovation plays in bioeconomy developing. However, in order to optimise the success and sustainability of the bioeconomy, much more is required. In this respect it is important that policy place more focus on resource sustainability and the socioeconomic dimension of the bioeconomy transition (Gawel et al., 2019). Within the *Bioeconomy Action Plan* (Department of Environment, Climate and Communications, 2022) sustainability is one of four principles stated to underpin the bioeconomy, along with the cascading principle, the precautionary principle, and the food first principle. *A sustainable economy and society* is also one of four strategic policy objectives for the bioeconomy, along with decarbonisation of the economy, jobs and competitiveness, and regional prosperity. However, whilst there is some detail in the *Bioeconomy Action Plan* (Department of Environment, Climate and Communications, 2022) regarding environmental sustainability, and even though the concept of sustainability is referred to in the majority of Irish bioeconomy policy, the term sustainability is usually only described in a vague sense, with little description of what sustainability actually means for the bioeconomy (Gawel et al., 2019), and what the bioeconomy means holistically in all dimensions of economic, environmental and social sustainability. Examples of Ireland's economic, environmental and social sustainability approach to the bioeconomy in policy are outlined in Table 5:

Table 5: The Economic, Environmental and Social Sustainability Approach in Irish Policy

Bioeconomy Action Plan
"Bioeconomy allows economic and social value to be added to biological resources providing sustainable solutions (including information, products, processes, and services) in and across all economic sectors in a sustainable, renewable, and circular manner. (Department of Environment, Climate and Communications, 2022; 4). Sustainability Principle: Environmental sustainability is an integral, core principle of the bioeconomy and products developed must be sustainable. Feasibility assessments should include environmental and social feasibility. The amount of biomaterial extracted should not have a negative impact on our biological resources; it should not exceed the capacity of the environment to replenish itself; and should cause no lasting damage to an environment. This should be regarded from a holistic view, which takes all biomass into account, including that in the soil. Activity in the bioeconomy should not degrade resilience or biodiversity in the ecosystem (Department of Environment, Climate and Communications, 2022; 11). Sustainable economy and society - Growing the bioeconomy can put Ireland's economy on a more sustainable footing by encouraging the efficient use and re-use of resources and materials to a much greater extent than hitherto" (Department of Environment, Climate and Communications, 2022; 12).
National Policy Statement Bioeconomy
"An important objective of the bioeconomy is to move Ireland beyond simply a target compliance and carbon mitigation focus to integrating sustainable economic development into our economic model as we transition to a low carbon and circular economy. The bioeconomy should promote circularity through solutions and innovations that reuse and recycle materials, maximising resource efficiency through the use of unavoidable wastes and environmental sustainability" (Government of Ireland, 2018; 10).
Bioeconomy Implementation Group
"Renewing and strengthening the industrial base through adoption, scaling up and commercialisation of small, pilot and large-scale biorefineries has the potential to lead to the creation of high quality green jobs in rural, coastal and urban areas. This can be achieved through developing sustainable biobased products, value chains and business models using resources from agriculture, forestry, and marine, biowaste including wastewater and novel bio-resources for biorefining purposes. Bioeconomy development will have a high focus on: the development of carbon neutral land use; providing for modernised primary production incorporating digitalisation and circularity; furthering the protection of the environment and regenerating and restoring healthy ecosystems and enhancing biodiversity; and also the development of urban circular bioeconomy activities" (Department of Environment, Climate and Communications & Agriculture, Food and Marine, 2019; 5).
CAP Strategic Plan 2023-2027
"Innovative approaches for a bio-rural region for sustainable, integrated and participatory territorial development which builds around the environmental, social and economic dimensions of sustainability focusing on agri-food and circular bioeconomy development" (Government of Ireland, 2022; 569).
Regional Spatial & Economic Strategy - Eastern & Midland Regional Assembly

"A sustainable bioeconomy is the renewable segment of the circular economy. It can turn bio-waste, residues and discards into valuable resources and significantly cut food waste. Realising this potential requires investment and implementing systemic changes that cut across different sectors (agriculture, forestry, fisheries, aquaculture, food, biobased industry)" (Eastern & Midland Regional Assembly, 2020; 56).

* The economic, environmental and social sustainability approach to the bioeconomy is not specifically mentioned in the context of the *Action Plan for Rural Development*.

As discussed previously, Ireland's main strategy towards the bioeconomy is focused on research and development, particularly as a way to drive bioeconomy transition and in order to strengthen the competitiveness of Ireland's bioeconomy by way of subsidies (Dietz et al., 2018). Additionally, Ireland promotes location policies for bioeconomy industries, with the focus on enhancing the general conditions for bioeconomy industries (Devaney and Henchion, 2017). Ireland's aim is also to increase public acceptance of the bioeconomy through education, capacity and awareness campaigns as well as other initiatives (Dietz et al., 2018). Irish policy demonstrates a recognition around discourse related to sustainability issues associated with the production of the first biofuels, is concerned about the adverse effects on land and water resources that the operation of the bioeconomy may engender, as well as concerns over global food security issues (McDonagh et al., 2017). Nevertheless, other concerns, which are certainly of equal importance, including the potential impact of the bioeconomy on poverty, inequality, the risks to public health, and the effects on the climate, currently play an insignificant role in Irish policy compared to the other concerns previously mentioned (Dietz et al., 2018). This is related to the fact that, like wider European policy (see Ramcilovic-Suominen and Pülzl, 2018), Ireland's bioeconomy policy is overly focused on industry, which, as previously discussed, neglects the role of primary producers such as farmers. Because of this, there is less attention on the management of sustainable resources, with the vast majority of attention focused on increasing and enhancing the efficiency of biomass production (Antar et al., 2021). This focus is based on the industrial centred bioeconomy policy of the EU, whereby bioeconomy policy emphasises competition, innovation, and economic expansion, but is fundamentally deficient in that it lacks any kind of thorough plan to outline a strategy for the actual implementation of a sustainable bioeconomy (Gawel et al., 2019). Similarly, obligatory sustainability assessment tools, for the most part, refer to the protection of land, for example, in respect to assessing greenhouse gas emissions and ecological conservation legislation (Gawel et al., 2019). However, such assessment tools do not include the socioeconomic dimension of sustainability, which is imperative; for example, social issues associated with land and land rights (see Fritsche and Iriarte, 2014) or social issues associated with the biomass production process (see Siebert et al., 2018). A sustainable bioeconomy can only be accomplished if the three pillars of sustainability are account for, and which include economic viability, environmental protection, and social equity (Gawel et al., 2019).

Key Challenges and associated Policy Recommendations

Based on the foregoing discussion, and in relation to the five main approaches taken to bioeconomy strategy in Ireland, and in the wider European context, the following Table outlines the key challenges and associated policy recommendations, which will be discussed in further detail in due course.

Table 6: Key Challenges and Policy Recommendations for Approaches to Bioeconomy Strategy in Ireland and Europe

Research, Development and Innovation Approach	
Key Challenges	
1) Development of bioeconomy is led exclusively by academics but should include primary producers. 2) Primary producers are less involved in decision-making. 3) Bioeconomy policy should be more focused on rural development.	4) There is a need for public consultation in policy development. 5) Policy approach should also include national examples, national benchmarks, and national experts.
Policy Recommendations	
1) Primary producers should be more included and arguably lead bioeconomy development. This could be done by including intermediary actors who could potentially help excluded groups access the social network of the bioeconomy, or by interacting with such groups in a support role aimed to enable such groups to become more influential (Harrahill et al., 2023). **2) Primary producers should be more involved in decision-making.** This would entail primary producers being involved in stimulating and advancing the mobilisation of ancillary biomass, encouraging the demand for bio-based commodities and raw materials (Lühmann, 2019). This can be achieved through the establishment of incentives like the preferential management of bio-based	**3) Bioeconomy policy should be more focused as a modernising policy for rural areas and the agricultural businesses contained therein** (Lühmann, 2019). **4) Policy development on the bioeconomy should include public consultation.** This process could be based on legitimisation protocols involved in other policy development in Ireland which have had a long-standing tradition of participatory and public consultation at the local scale. **5) The approach of Irish policy should also include national examples, national benchmarks, and national experts.** This can provide the contextual elements required for a successful and sustainable bioeconomy development in national contexts.

commodities in respect to tax break incentives and public procurement (Copa-Cogeca et al., 2018).

Collaboration Approach

Key Challenges

1) There is a need for more expansive collaboration and coordination between different actors.
2) There is a need for a mechanism operating between policy and financial incentive and funding schemes

3) It is not possible to develop the bioeconomy in national contexts without a strong and internationally coordinated governance system.

Policy Recommendations

1) A stronger cross-sectoral coherence in policy is recommended. This would promote greater coordination and collaboration between the various actors involved in the bioeconomy transition process (Kelleher et al., 2019).

2) A multifaceted coordination mechanism should be created. This would operate between policy and financial incentive and funding schemes (Kelleher et al., 2019).

3) Ireland should contribute to developing an internationally coordinated governance system (Dietz et al., 2018). International fragmentation has the potential to be mitigated spatially at the regional level, where international co-operation can potentially operate inter-locally and sub-nationally (e.g. Asheim et al., 2006; van Lanngenhove, 2003). Regional bureaucracy is thought to have the capacity to operate at an intermediate level whereby the local is connected to the international (Bößner et al., 2021). Besides regional international governance co-operation, there are also more practical forms of co-operation whereby insight is garnered through the application of policy and/or technology at the regional scale before it is applied more broadly and internationally (Bößner et al., 2021). The fact that regional institutions *do* currently operate, suggests that regional and inter-regional networks can be potential drivers of international co-operation.

Governance Approach

Key Challenge

1) Consumer habits and behaviour towards the utilisation of waste and recycle materials must change.

2) Agricultural, environmental, and forestry trade policies need to be modified.

3) It must be ascertained how prospective conflicts and risks associated with the bioeconomy are to be managed.

4) The potential displacement of traditional land use activities for biomass production.

5) Land used for non-food biomass production may result in soil degradation or deforestation.

6) The potential for competition and trade-off between food and non-food biomass production.

Policy Recommendations

1) Political solutions are needed to encourage change in consumer habits and the utilisation of waste and recycled materials. The potential rebound effects inherent in such developments should also be taken into account (Keil, 2015; Santarius; 2014).

2) Analysis is required in order to measure the extent to which current agricultural, environmental, and forestry trade policies need to be modified. This is necessary so that sustainability is maintained and secured (Gawel et al., 2019).

3) A capable political management of competing objectives within the bioeconomy must be established (Dietz et al., 2018). In order to manage conflict and the risks associated with the bioeconomy, Ireland relies heavily on soft regulatory measures, which include global value chains that operate on a self-regulatory basis achieved through a combination of private standards as well as certification administration (Dietz et al., 2018). This needs to change as a matter of urgency for optimal bioeconomy development nationally and internationally.

4) A clear definition of marginal land to be described in order to avoid underutilisation of all suitable land types. For example, the following definition could be used, "any identifiable land area, whether originally agricultural or non-agricultural, including those in urban areas, which is currently unused or underutilised due to economic, environmental or social factors, but which is suitable for temporary or longer-term use for sustainable energy production" (Mellor et al., 2021; 5).

5) Soil quality should be assessed, and deforestation should not occur and should therefore be monitored. Farms producing biomass should be assessed routinely in respect to the quality and health of their soil. This would require an evaluation of practices in respect to soil organic matter, soil erosion, and nitrate leaching (Poppe et al., 2016).

6) The economic potential of land intended for biomass production (including marginal land) should be evaluated. In order to evaluate agricultural land in terms of productive potential, a spatial analysis using the CORINE (COoRdination for the Information on the Environment) database within a GIS environment should be applied.

Economic, Environmental and Social Sustainability Approach	
Key Challenge	
1) How sustainability relates to the bioeconomy needs to be fully articulated within policy.	2) The potential impact of the bioeconomy on poverty, inequality, public health and climate impacts are not considered.
Policy Recommendations	
1) Details on how the bioeconomy is related to the UN's Sustainable Development Goals (SDGs) should be provided in policy documents. The focus of bioeconomy policy in Ireland is based on the industrial-centred bioeconomy policy of the EU, whereby policy emphasises competition, innovation, and economic expansion, but is fundamentally deficient in that it lacks any kind of thorough plan to outline a strategy for the actual implementation of a sustainable bioeconomy development (Gawel et al., 2019) **2) Irish policy needs to provide a strategy for the potential effects of the bioeconomy transition in relation to poverty, inequality, public health and the climate.**	

As outlined in Table 6, the research, development and innovation approach pursued in Ireland and many European countries is associated with five key challenges, these are: 1) the development of the bioeconomy in Ireland is exclusively led by academics as opposed to other important groups such as primary producers; 2) primary producers are less involved in bioeconomy development decision-making; 3) bioeconomy policy is less concerned with rural development and there requires more focus on modernising policies for rural areas and the agricultural businesses contained therein; 4) there is a need for public consultation in policy development on the bioeconomy; and 5) Ireland's approach is too focused on international examples, international benchmarks, as well as relying almost exclusively on international experts. Hence, it should also include national examples, national benchmarks, and national experts. In respect to such challenges, the following policy recommendations are advocated: 1) primary producers should be more included and arguably lead bioeconomy development in Ireland. This could be done by including intermediary actors who could potentially help excluded groups access the social network of the Irish bioeconomy, or by interacting with such groups in a support role designed to enable such actors to become more influential (Harrahill et al., 2023); 2) primary producers should be more involved in decision-making. This would entail primary producers being involved in stimulating and advancing the mobilisation of ancillary biomass, and encouraging the demand for bio-based commodities and raw materials (Lühmann, 2019). This can be achieved through the establishment of incentives like the preferential management of bio-based commodities in respect

to tax break incentives and public procurement (Copa-Cogeca et al., 2018); 3) Bioeconomy policy should develop beyond its overly focused concentration on research, development and innovation and become more focused as a modernising policy for rural areas and the agricultural businesses contained therein (Lühmann, 2019); 4) Policy development on the bioeconomy should include public consultation. This process can be based on legitimisation protocols involved in other policy development in Ireland which have had a long-standing tradition of participatory and public consultation at the local scale; 5) Although the utilisation of international exemplars regarding bioeconomy policy is essential, bioeconomy policy should also be influenced by national examples, national benchmarks, and national experts that can provide the contextual elements required for a successful and sustainable bioeconomy development in national contexts.

In relation to the collaboration approach, Table 6 outlines the three fundamental challenges, which are: 1) the need for more expansive collaboration and coordination between different actors; 2) the need for a mechanism operating between policy and financial incentive and funding schemes; and 3) the deficiency in developing the bioeconomy in Ireland due to a lack of a strong and internationally coordinated governance systems due to fractured and polycentric international governance (Carlisle and Gruby, 2019), which create barriers to international co-operation (Held and Hervey, 2011). In respect to such challenges, the following policy recommendations are advocated: 1) stronger cross-sectoral coherence in policy is required in order to promote greater coordination and collaboration between the various actors involved in the bioeconomy transition process (Kelleher et al., 2019); 2) a multifaceted coordination mechanism should be created to operate between policy and financial incentive and funding schemes (Kelleher et al., 2019); and 3) Ireland, and other EU nations, should contribute to developing an internationally coordinated governance system (Dietz et al., 2018). International fragmentation has the potential to be mitigated spatially at the regional level, where international co-operation can potentially operate inter-locally and sub-nationally (e.g. Asheim et al., 2006; van Lanngenhove, 2003). Regional bureaucracy is thought to have the capacity to operate at an intermediate level whereby the local is connected to the international (Bößner et al., 2021). Besides regional international governance co-operation, there are also more practical forms of co-operation whereby insight is garnered through the application of policy and/or technology at the regional scale before it is applied more broadly and internationally (Bößner et al., 2021). The fact that regional institutions *do* currently operate, e.g. the Union of South American Nations (Dabène, 2016), the Economic Community of Central African States (Piabuo and Tieguhong, 2017), the South African Development Community (Mlambo, 2020), the Southern Common Market (Hummel and Lohaus, 2016), the South Asian Association for Regional Co-operation (Shaheen, 2013), the African Community

of West African States (Bolanos, 2016; Gowen, 1985), not to mention the EU, suggests that regional and inter-regional networks can be drivers of international co-operation instead of state governance.

In relation to the governance approach, Table 6 describes six key challenges, which are: 1) consumer habits and behaviour towards the utilisation of waste and recycle materials must change; 2) agricultural, environmental, and forestry trade policies need to be modified in order to maintain sustainability; 3) it must be ascertained how the prospective conflicts and risks associated with the bioeconomy are to be managed; 4) the potential displacement of traditional land use activities; 5) the danger that land used for non-food biomass production results in soil degradation or deforestation; and 6) the potential competition and trade-off between food and non-food biomass production. In response to such challenges, the following policy recommendations are advocated: 1) political solutions are needed to encourage change in consumer habits and the utilisation of waste and recycled materials, whilst considering the potential rebound effects inherent in such developments are taken into account (Keil, 2015; Santarius; 2014); 2) analysis is required in order to measure the extent to which current agricultural, environmental, and forestry trade policies need to be modified so that sustainability is maintained and secured (Gawel et al., 2019); 3) a capable political management of competing objectives within the bioeconomy must be established (Dietz et al., 2018). Conflict and the risks associated with the bioeconomy are based on soft regulatory measures in Ireland and include global value chains operating on a self-regulatory basis through private standards and certification administration (Dietz et al., 2018); 4) a clear definition of marginal land should be applied in order to avoid underutilisation of all suitable land types. For example, the following definition could be used, “any identifiable land area, whether originally agricultural or non-agricultural, including those in urban areas, which is currently unused or underutilised due to economic, environmental or social factors, but which is suitable for temporary or longer-term use for sustainable energy production” (Mellor et al., 2021; 5); 5) soil quality should be assessed, and deforestation should not occur and should therefore be monitored. Farms producing biomass should be assessed routinely in respect to the quality and health of their soil. This would require an evaluation of practices in respect to soil organic matter, soil erosion, and nitrate leaching (Poppe et al., 2016); and 6) the economic potential of land intended for biomass production (including marginal land) should be evaluated. In order to evaluate agricultural land in terms of productive potential, a spatial analysis using the CORINE (COoRdination for the Information on the Environment) database within a GIS environment should be applied.

Finally, in relation to the economic, environmental and social sustainability approach, Table 6 outlines two key challenges, which are: 1) how sustainability relates to the bioeconomy needs to be fully articulated within policy and particularly in relation to ecological sustainability, resource

sustainability, and socioeconomic sustainability; and 2) the potential impact of the bioeconomy on poverty, inequality, public health and climate impacts are not considered in Irish and wider European policy. In respect to such challenges, the following policy recommendations are advocated: 1) details on how the bioeconomy is related to the UN's Sustainable Development Goals (SDGs) should be provided in policy documents. The focus of bioeconomy policy in Ireland is based on the industrial-centred bioeconomy policy of the EU, whereby bioeconomy policy emphasises competition, innovation, and economic expansion, but is fundamentally deficient in that it lacks any kind of thorough plan to outline a strategy for the actual implementation of a sustainable bioeconomy development (Gawel et al., 2019); and 2) Irish policy needs to provide a strategy for the potential effects of the bioeconomy transition on poverty, inequality, public health and the climate.

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