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Teagasc submission made in response to the Discussion document for the preparation of a National Policy Statement on the Bioeconomy Issued by Economic Division, Dept. of the Taoiseach, July 2017.

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Executive Summary

The bioeconomy accounts for a 13% share of world trade, and 18.6 million jobs and €2.2 trillion turnover within the EU. It offers Ireland significant economic benefits, an opportunity to create additional natural bio-value, to address issues such as climate change, food and water security, soil degradation, and rural development, and to reduce dependence on fossil fuels. Cutting across multiple natural resource sectors and industries, and situated in a particularly complex policy environment, its development calls for an integrated policy which the proposed national policy statement supports.

The vision upon which such a statement is based will have significant implications for Ireland's most important indigenous industry, i.e. the agrifood industry, as well as other important sectors such as marine and forestry. In harmony with the emerging narrative at national level, Teagasc advocates a vision that is broadly bio-resource based (as opposed to a bio-technology or bio-ecology vision), whereby value is created from the conversion and upgrading of bio-resources, while allowing innovative and novel technologies be applied to bio-based resources in a sustainable manner. A bio-resource vision also implies an emphasis on the optimisation of land use and a spatial focus on rural/peripheral regions. Such a vision is consistent with positioning the bioeconomy within the Action Plan for Jobs and the Rural Development Action Plan. It also situates Teagasc centrally within the bioeconomy.

The bioeconomy is not inherently sustainable. Principles such as circularity and cascading are proposed at EU level to support the development of a sustainable, circular bioeconomy. However guiding principles for biomass use, biomass demand and the organisation of research and innovation are required in relation to bioeconomy strategy implementation. These need to be established to facilitate translation of the national policy statement into effective sectoral strategies.

Teagasc recognises its specific role in supporting the sustainable production and use of biomass through research, education, advice and training. It also acknowledges the socio-technical transformation that the bioeconomy implies and ensures that research is not limited to the natural sciences but is multi-disciplinary and includes social and economic sciences and study of consumer and citizen perspectives. Teagasc additionally sees a leadership and development role for itself and has already undertaken this role through introducing renewable heat technologies to heat its building and the construction of an anaerobic digester which uses animal slurry and grass to fuel a 150kWe CHP plant.

The evolution of the bioeconomy in Ireland will require critical reflexivity of the policy mix that impacts on it to ensure optimal exploitation of opportunities and mitigation of tensions and conflicts. Teagasc therefore recommends the continued operation of the government inter-departmental group on the bioeconomy to ensure such policy coordination and reflexivity. It also advocates a multi-level governance approach to connect across local, regional and national scales as well as departments and sectors. The establishment of an independent bioeconomy advisory committee, with the German Bioeconomy Council proposed as an exemplar, is recommended. The need to establish a parallel stakeholder forum should also be considered given the democratic deficit in bioeconomy policy reported elsewhere. Teagasc is keen to work with various stakeholders to develop and support the implementation of principles and guidelines that will form part of a national bioeconomy strategy.

The Bioeconomy: Ireland in a Global Context

Introduction

This document is Teagasc's response to the "Discussion Document for the Preparation of a National Policy Statement on the Bioeconomy" issued by the Department of the Taoiseach's Economic Division in July 2017. It recognises the potential significance of the bioeconomy to Ireland, offers some policy and strategic insights from other countries, and identifies Teagasc's role in supporting the development of the bioeconomy in Ireland.

It is particularly appropriate for Teagasc to make such a submission given that its mission specifically mentions the bioeconomy: "To support science-based innovation in the agri-food sector and wider bioeconomy so as to underpin profitability, competitiveness and sustainability" (Teagasc, 2017). As the Irish agriculture and food development authority, established under the Agriculture (Research, Training and Advice) Act in 1988, Teagasc fulfils this mission by providing integrated research, advisory and training services to the agriculture and food industry and rural communities. It has the following strategic goals:

1. To improve the competitiveness of agriculture, food and the wider bioeconomy
2. Support sustainable farming and the environment
3. Encourage diversification of the rural economy and enhance the quality of life in rural areas
4. Enhance organisational capability and deliver value for money.

This submission was prepared by the Teagasc Bioeconomy Working Group (TBWG), a cross-programme, inter-disciplinary group of Teagasc research and knowledge transfer staff, which was established to support the Teagasc-led BioÉire research project. BioÉire (2014-2017) was funded by Department of Agriculture, Food and the Marine (DAFM) to provide a knowledge base to support the development of a national strategy on the bioeconomy. The research results and outputs from BioÉire and the knowledge and expertise of the TBWG combine with the results of a collaborative stakeholder workshop co-hosted by the Department of the Taoiseach and Teagasc in February 2017 to inform this submission.

The Policy Context

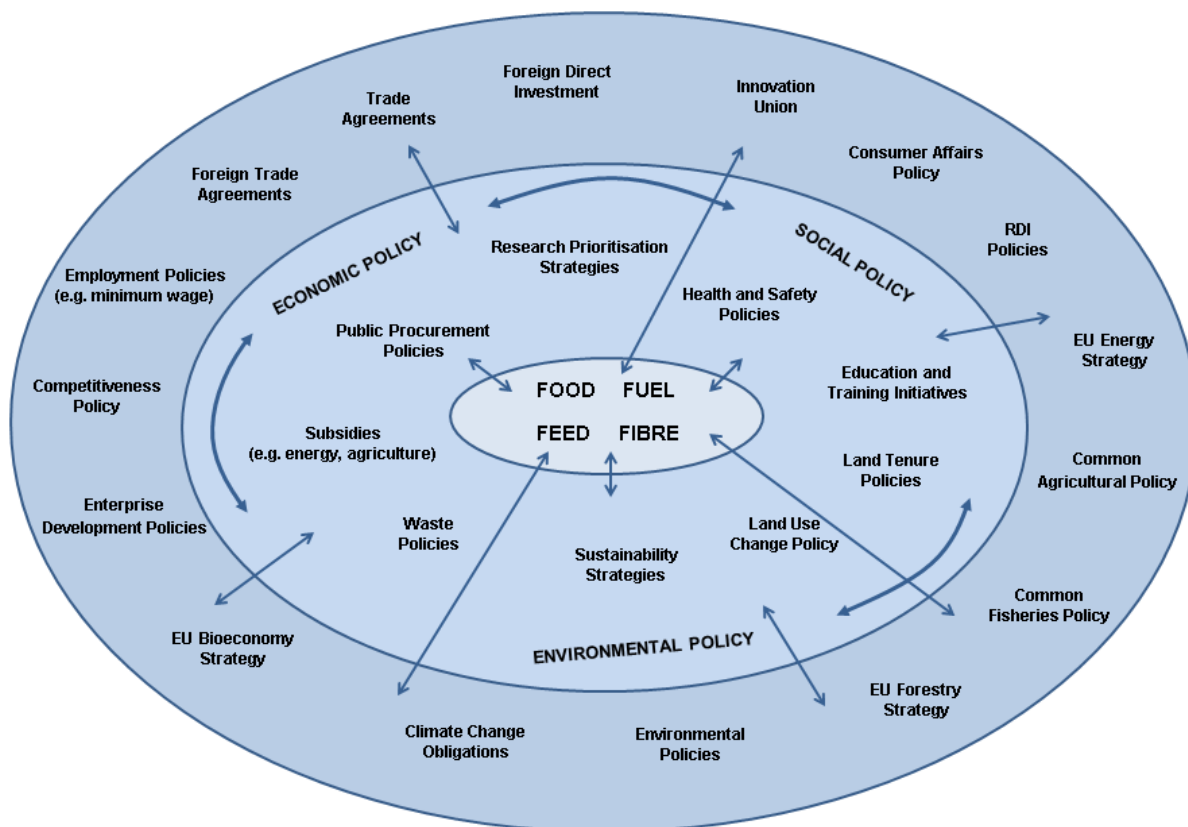
The bioeconomy is a significant area of world trade; it accounted for 13% of world trade, which is equivalent to \$2 trillion of global exports stemming from agriculture and forestry, food, bioenergy, biotechnology and green chemistry in 2014 (El-Chichakli et al, 2016). Recent figures show that it accounted for 18.6 million jobs and €2.2 trillion turnover in the European Union (EU) (Ronzon et al., 2017). Indeed a recent study by Grealis and O'Donoghue (2015) showed that the propensity of some bioeconomy sectors, such as agriculture and marine, to source inputs domestically resulted in higher economic and regional impacts, when compared with other manufacturing sectors that rely on imported inputs. These economic benefits combined with the potential of the bioeconomy to create additional natural bio-value (e.g. biodiversity preservation and wider public goods) and to address grand societal challenges such as climate change, food and water security, and soil degradation, and reduce dependence on fossil fuels, has stimulated the development of bioeconomy policies in many countries and regions. There are many national bioeconomy policies currently at different stages of development and new policies emerging on an on-going basis. Countries with strong and

established biotechnology (e.g. India, Malaysia) and biofuel (e.g. Brazil) policies have focused their bioeconomy policies in these arenas. However countries without these historical legacies have the opportunity to develop more integrated policies (e.g. Spain and France) that position to the bioeconomy so as to shift the focus from the “limits of growth” to “new growth possibilities” (Meyer, 2017). **Ireland is fortunate to be in the position to be able to develop an integrated policy and the proposed national policy statement on the bioeconomy is a clear signal to facilitate the development of such holistic thinking.**

The need for leadership and coordination by a body such as the Department of the Taoiseach is evident when one considers the clear linkages and potential conflicts between a national bioeconomy strategy with sectorial- (e.g. agriculture, forestry) and thematic, cross-sectorial- based strategies (e.g. related to research and innovation, energy, and waste management) as well as multilevel economic, social and environmental policies, at national, EU and global level. Indeed **the bioeconomy has been described as “one of the most politically complex areas facing agri-food and rural resource sectors”** (Devaney et al, 2017, p41). Strategies and white papers such as *FoodWise 2025, Forests, Products and People; Ireland’s Forest Policy, Harvesting Our Ocean Wealth, Ireland’s Transition to a Low Carbon Energy Future, Climate Action at National Level, Draft Bioenergy Plan, Irish Rural Development Plan, Irish Seafood Programme 2014-2020, and A Resource Opportunity: Waste Management in Ireland* are relevant at national level. Meanwhile, among others, the *Circular Economy Strategy, Food 2030, EU Forest Strategy: For Forests and the Forest-based Sector, Innovation Union* and *A Resource Efficient Europe* clearly hold relevance at EU level while *The Next Production Revolution* (OECD), *the COP Paris Agreement* (UN) and *Transforming our world: the 2030 Agenda for Sustainable Development* (UN) are relevant at global level. The complexity that exists in this policy arena is illustrated in Figure 1 (taken from Devaney and Henchion, 2017a).

Teagasc concurs with the Standing Committee on Agricultural Research (SCAR) Bioeconomy Strategic Working Group recommendation¹ that bioeconomy policy should crosscut a series of other valid concepts and highlight the links to, and potential synergies with, other policies. Therefore, **the development of a national policy statement is very much welcomed by Teagasc and is seen to provide a horizontal policy that crosscuts related policies. It is particularly appropriate that the Department of the Taoiseach, as a ‘horizontal’ department is the lead actor in this endeavour.** Indeed, as evidenced internationally, the lead actor has a strong influence on the direction of national bioeconomy development and in particular the targets for research funding (often the source of technological and social bioeconomy innovation) (see Table 1). Leadership roles by science and innovation ministries for example can emphasise biotechnology whereas leadership by agricultural ministries tend to highlight renewable resources. A more integrated policy is likely to emerge with the Irish configuration of leadership by the Department of the Taoiseach in collaboration with the other government departments.

¹ Rauchen, S, 16th June 2017



Source: Devaney and Henchion, 2017a

Figure 1 Irish bioeconomy policy illustration

Developing a bioeconomy strategy

While a bioeconomy strategy has already been developed at EU level, **many countries within the EU already have their own national strategies which have been based on their bespoke natural resources, infrastructure, research capabilities, historical legacies and markets.** Ireland has strong foundations on which to build, including those deriving from an abundant, natural, terrestrial and maritime resource base, a well-respected and innovative agriculture and food industry, a well-developed, industry- and internationally-connected academic research network, status as a “major regional innovator” (Lin et al, 2010, p161), and a growing number of dynamic chemical, pharmaceutical, energy and material industries (Devaney and Henchion, 2017a).

Many considerations must be examined before developing a strategy for Ireland as there are significant challenges when performing such an exercise including:

- **Potential conflicts of interest.** Economic, social and environmental objectives may not align nationally and/or internationally, e.g. there may be tensions between food security and environmental safeguards, between economic growth and climate change, and between economic development and regional and rural development processes. Economic and environmental trade-offs and conflicts are unavoidable in the bioeconomy according to Devaney

and Henchion (2017a) resulting in a need to make decisions regarding efficient and fair use of scarce, albeit renewable, biological resources.

- **Potential conflicts between sectors.** Bioresources will be required for food, feed, fibre, and fuel; conflicting demands mean that resources will need to be allocated across these areas in a sustainable and socially just manner. Meyer (2017) compares EU policy support for bioenergy and biofuels with biomaterials and reports perceptions about a “non-level playing field” that arise due to higher prices and difficulties in accessing biomass for higher value added applications such as biobased chemicals and materials in comparison to bioenergy and biofuels. He adds that fossil fuel prices and production costs of competing petrochemicals have a very significant impact on the development of biobased chemicals and materials.
- **Unintended/unforeseen consequences.** This can arise with any policy development and highlights the need for forward looking and modelling tools to identify such consequences where possible.

The development of a national bioeconomy strategy also raises the following key questions:

1. Where should we focus our efforts to create a stronger, more diverse, resilient and sustainable bioeconomy in Ireland?
2. Who should influence the decision?
3. How can we ensure our capabilities are such that we are producers and developers of high value, sustainable bioproducts?

Research undertaken as part of the BioÉire² project, which was based on expert stakeholder input, identified priority value chains for the short to medium term in Ireland, and has provided some guidance with respect to answering such questions. Outcomes from the BioÉire project highlighted an overall strong preference for value chains where inputs involved processing and by-product side streams to complement existing agriculture, food, forestry and bioenergy chains. The top value chains identified included:

- *the use of 2nd generation feedstock for the production of biochemicals;*
- *dairy processing sidestreams for sports nutrition products;*
- *horticultural by-product for biocompostable packaging;*
- *marine discard for functional food and feed applications;*
- *agricultural and food waste for bioenergy production;*
- *seaweed use for food and healthcare applications; and*
- *forestry residues for decentralised heat generation.*

² DAFM-funded, Teagasc-led

Table 1: Bioeconomy Strategies in the G7, 2015

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

Source: German Bioeconomy Council, 2015

Some preliminary feasibility work has been done³ on these prioritised value chains however more in-depth feasibility assessment is required across technical, economic, social and environmental standpoints. Furthermore, **there is now a need to identify and consider longer term value chains, and indeed, more interconnected value webs** (Devaney and Henchion, under review and Lewandoski, 2015). Identification of such chains should consider our natural resource base⁴ and the opportunities to commercialise research funded by EU and national sources. In this regard, it is also important to note that new chains will emerge in the future as more is known about certain products e.g. dairy processing sidestreams contain many components and at present only a small percentage have been investigated in any meaningful way. Furthermore, it requires an overarching policy framework to encourage collaboration amongst the varying stakeholders and “to connect up biological resource sectors and existing ideas and innovation for optimum value chain development and governance” (Devaney and Henchion, 2017a, p220). It is however not a simple task with questions to be raised in terms of how biorefining should be progressed and consideration of alternative strategies that may be pursued in the development of biochemicals, bioenergy and other biomaterials. The identification of six competing biorefining concepts⁵ by Meyer (2017) highlights the complexity. He showed that most countries support several biorefinery concepts in parallel, which may lead to a risk of mis-investment.

³ https://www.teagasc.ie/media/website/publications/2017/BioEire-Feasibility-Analyis-Report_Devaney-et-al-2017.pdf

⁴ A situational analysis is available at <https://www.teagasc.ie/media/website/publications/2017/WP1-Deliverable---Final-Jan-2017.pdf>

⁵ Sugar and starch biorefinery, plant oil and algae lipid biorefinery, lignocellulose biorefinery, green fibre/green juice biorefinery, synthesis gas biorefinery and biogas biorefinery.

Having learnt from the varying approaches and levels of stakeholder engagement evident in the development of other national strategies (Overbeek et al., 2016) it becomes clear that public, private and civil society stakeholders need to align for holistic bioeconomy development (Devaney et al, 2017). In keeping with this philosophy for stakeholder engagement, a Delphi approach, involving experts from a range of backgrounds was undertaken as part of the BioÉire project to identify the prioritised value chains for Ireland (see Appendix 1 for a profile of respondents). **This Delphi exercise effectively complements the application of good governance principles at government level, which is evident through the establishment of an interdepartmental group on the bioeconomy, the holding of “a consultative seminar on the bioeconomy, with key stakeholders including the development agencies and the private sector” as promised in the Action Plan for Rural Development and the current invitation for public submissions by the Department of the Taoiseach.** It should be noted that while public consultation is being undertaken, **Meyer (2017) identified a “democratic deficit” in bioeconomy policy**, reporting that responses to public consultations in an international context were predominantly from representatives of research and industry with contributions from civil society actors being the exception. **He identified four arguments for broader societal debate and involvement of societal stakeholders including the democratic imperative, the benefits of engaging opinion formers, the engagement of potentially resistant actors (and thus the identification of potential barriers) and the development of positive consumer perceptions of biobased products.** The importance of engaging with consumers and customers is particularly highlighted by O’Reilly (2017) following a review of market-making issues in the bioeconomy.

A bioeconomy vision

While prioritised value chains have been identified, what may not yet be clear is what the vision for Ireland should be in relation to the bioeconomy. **A recent review of the literature (Bugge et al, 2016) proposed three different ‘ideal’ visions of the bioeconomy:**

- **A bio-technology vision**, which highlights biotechnology research and its application in different sectors;
- **A bio-resource vision**, with a focus on the development of new value chains that process and upgrade biological raw material; and
- **A bio-ecology vision** which highlights sustainability and ecological processes.

These visions are not mutually exclusive and overlap. For example, while biotechnology is a “constitutive element” of the bio-technology vision, it can also be regarded as a key innovation in the other visions (Meyer, 2017). Nonetheless categorisations are useful as **they have different foci and have different implications for value creation, drivers and mediators of innovation and spatial focus** (see Table 2). As can be deduced from Table 2, they also implicitly convey differing views on land use, the role of agriculture and agricultural intensification. Such a deduction can be extrapolated to also draw implications for the use of marine resources and the role of forestry. The first two visions emphasise the technological dimension and the role of research, development and innovation (RDI) in a globalised context; the latter however gives prominence to regional dimensions and the potential of circular and integrated processes and systems. The prominence of technology in the first two visions could imply a ‘business as usual’ trajectory and a lack of consideration of fundamental and sweeping changes in agriculture and food production and consumption. It also

could mean that strategies that follow such a vision give limited attention to changing consumer behaviour and reducing the demand for biobased products as a mechanism to transition to a more sustainable economy. The bio-ecology vision has developed in response to criticisms of bioeconomy strategies and also to provide a fundamental alternative to the dominance of industrialised agriculture (Meyer, 2017). Producers have a key role in this latter vision as providers of quality food and managers of the ecosystem rather than just commodity producers. However, a limitation of this vision is that it tends not to include biobased chemicals and products. Different actors tend to be associated with these different visions, e.g. the European Commission is associated with the bio-resources vision in particular, the OECD with the biotechnology vision and the European Technology Platform TP Organics with the bio-ecology vision (Bugge et al, 2016).

The narrative in Ireland (as evidenced by the nature of government funding calls, funded research centres (e.g. BEACON), the outcomes of the collaborative Department of the Taoiseach/Teagasc workshop in February 2017⁶ and results from the BioÉire project⁷) seems to echo the bio-resource focus of the European Commission. Such a vision is also consistent with our national agri-food (FoodWise 2025), marine (Our Ocean Wealth) and forestry strategies (Forests, Product and People), the National Mitigation Plan and significant national programmes such as Origin Green. It is also consistent with positioning the bioeconomy within the Rural Development Action Plan. While it is in harmony with national economic growth objectives, consistency with the Action Plan for Jobs will require jobs to come from economic growth in traditional sectors of the bioeconomy. The reason for this is that the number of jobs in the EU bioeconomy generally is declining (a decline of 10.5% or 2.2 million between 2008 and 2014⁸ (Ronzon et al, 2017)); a different trend in Ireland will require a focus on sectors that are more labour intensive. These sectors are agriculture and marine based bioeconomy sectors as they employ relatively more people per unit of output than some other sectors (Grealis and O'Donoghue, 2015). The adoption of a bio-resource vision positions Teagasc centrally within the bioeconomy given its focus on land use and improved land productivity as well as research in the marine space. It also has far-reaching implications for how Teagasc, and other research performing organisations, engage in the innovation system, highlighting the importance of research in multiple fields, inter and trans-disciplinarity, and cross-sectorial activity.

A decision on whether to continue with this narrative or not has implications for whether a narrow or broad definition of the bioeconomy is presented within the proposed policy statement. A bio-technology vision results in a narrow definition and places the commercialisation of biotechnology and scientific findings from life sciences centre stage. Biomass as a resource does not have a central role and new applications such as personalised medicine and biomedicine are included as part of the bioeconomy. Economic relevance in this framing stems from its high innovation potential (Meyer, 2017). In contrast, a bio-resource vision provides for a broader definition, which may include some or all of the following: agriculture, forestry, food, timber, chemical, pharmaceutical and energy industries (Meyer, 2017). The inclusion of traditional sectors such as agriculture and food increases the economic relevance of the bioeconomy for Ireland, and changes the spatial focus to achieve greater relevance for rural/peripheral regions (an important

⁶ https://www.teagasc.ie/media/website/publications/2017/MHenchion_Beyond-BioEire.pdf

⁷ Value-chains considered as having the most potential for Ireland in the short to medium term emphasised co/by and side streams from processing in the agricultural, food, forestry, horticulture and marine sectors.

⁸ Turnover increased by 7% or €140 billion in the same period.

consideration for rural development here). The bio-ecology vision has a similar spatial focus (i.e. rural and peripheral regions) and is primarily concerned with sustainability, promoting biodiversity, providing ecosystem services, and emphasises “a circular and self-sustained production mode”.

Some combination of more than one vision, centred on a bio-resources vision, is likely to be appropriate for Ireland.

Table 2: Key characteristics of the bioeconomy visions

	Bio-technology vision	Bio-Resource Vision	Bio-Ecology Vision
<i>Aims & objectives</i>	Economic growth & job creation	Economic growth & sustainability	Sustainability; biodiversity, conservation of ecosystems, avoiding soil degradation
<i>Value creation</i>	Application of biotechnology, commercialisation of research & technology	Conversion and upgrading of bio-resources (process oriented)	Development of integrated production systems, and high-quality products with territorial identity
<i>Drivers & mediators of innovation</i>	R&D, patents, TTOs, Research councils and funders (Science push, linear model)	Interdisciplinary, optimisation of land use, include degraded land in the production of biofuels, use and availability of bio-resources, waste management, engineering, science & market (interactive & networked production mode)	Identification of favourable organic agro-ecological practices, ethics, risk, transdisciplinary sustainability, ecological interactions, re-use & recycling of waste, land use (circular & self-sustained production mode)
<i>Spatial focus</i>	Global clusters/central regions	Rural/peripheral regions	Rural/peripheral regions

Source: Bugge et al, 2016

The narrative at EU level is increasingly linking “sustainability” with the “bioeconomy” as there is growing recognition that “bio” does not intrinsically mean sustainable. Much research for example examines the environmental sustainability of using biowaste streams on agricultural land and indeed examines the health and water quality impacts arising from the land application of these products e.g. Peyton et al. (2016). Christian Patemann⁹ talks about the “sustainable circular bioeconomy” and SCAR state that the definition of the bioeconomy should more clearly emphasise “the sustainability of the production systems (land-based, aquaculture and fisheries), including waster use”¹⁰. This evolving narrative sits well with Ireland’s agri-food sector’s focus on sustainability and its promotion (through Origin Green) as well as narratives concerning the sustainable management of forests and fisheries. Principals of circularity (which focus on the rebuilding of capital and enhanced utilisation of waste, by-product and co-product from production and processing streams), and cascading (whereby biomass is sequentially used as often as possible to create materials before being used for heat and energy) help to enhance to sustainability of the bioeconomy (Mahro and Timm, 2007). They may however shift the bioeconomy toward a focus on biochemical, biopolymers and bioplastics

⁹ Former Director European Commission, often called “Father” of the European Bioeconomy

¹⁰ Rauschen, S., 16th June 2017 “BSW policy brief on the review of the Bioeconomy Strategy”, presentation on behalf of SCAR

away from lower value bioenergy opportunities (Babu et al, 2013). This does not mean that bioenergy does not have a role in the Irish bioeconomy; it still has a very important role but it would instead be framed as using residual animal and crop waste streams to produce bioenergy. It may not be possible, nor indeed desirable, to be prescriptive about how to implement principles of circularity and cascading in particular in the national policy statement. The current research funding by DAFM calls for a socio-technical study which should be support teasing these issues out in a national bioeconomy strategy.

Moving from Vision to Strategy

Meyer (2017) proposed **guiding principles that are required in relation to bioeconomy strategy implementation** under the headings of (1) biomass use (including biomass from primary production as well as processing co-, side- and waste-streams) and (2) the organisation of research and innovation.

1. **Supply and use of biomass:** sustainability is identified as a key element and guiding principle. The bioeconomy is not inherently sustainable (GBS, 2015) however provided it is implemented well the bioeconomy may simultaneously address economic, social and environmental challenges providing jobs, regional development and improved environmental credentials. Sustainability from the perspective of primary production of biomass encompasses sustainable use of natural resources, sustainable agricultural production (including agricultural technologies such as precision farming) and evaluation and improvement of production systems in terms of sustainability. Aside from circularity and cascading, Meyer (2017) identifies priority for food, prevention of land use conflicts, priority for residual and waste biomass, cascading and coupled use; and consideration of ecological and socio-impacts as additional complementary principles to achieve sustainability. This point is particularly relevant as the EU will shortly introduce sustainability criteria for biomass¹¹. In future, energy generated from biomass can only be counted towards future renewable energy requirements if the biomass meets EU sustainability criteria.
2. **Organisation of research and innovation:** Analysis of various bioeconomy strategies internationally led Meyer (2017) to identify seven guiding principles for the organisation of research and innovation. These are: systematic view, coherent policy framework, interdisciplinary research, international cooperation, integration of actors, education and training and improvement of framing conditions.

We would argue that **demand for biomass should be considered as a guiding principle separately to biomass supply and use** so that the demand side gets the focus that is required for a more sustainable future. Significant initiatives will be required to support market development, consumer trust-building and regulation (Devaney and Henchion, 2017a) relating to public procurement, public engagement and the development of standards and certification schemes and labels (including developing standardised sustainability assessment methodologies for biobased products and food production systems).

Analysis of different bioeconomy strategies by Meyer (2017) pointed out that strategies vary in the extent to which they envisage biobased resources replace fossil based resources – from an

¹¹ https://ec.europa.eu/energy/sites/ener/files/documents/1_en_impact_assessment_part4_v4_418.pdf

unspecified biobased economy to the conversion to an economy based on renewable resources. Regardless of the level of specification, he also concludes that the strategies he analysed are clear in their understanding of the disruptive nature of the bioeconomy and that it involves “*a far reaching and comprehensive societal transformation process that much be accompanied by social, economic, political and ecological research*” (p9). Embracing the bioeconomy will mean disruptive technological change with transformative shifts in systems of production and consumption, including new technologies, practices, values, beliefs, configurations of actor groups, networks and policies (Darnhofer, 2015).

Role for Teagasc

Teagasc recognises and acknowledges the important role of the bioeconomy in Ireland in relation to the sustainable production and use of biomass within the bioeconomy (including employment generated), the potential of the bioeconomy to contribute to rural and regional development and its contribution to mitigating the impact of climate change. Teagasc acknowledges the importance of the bioeconomy to the extent that it is specifically mentioned in its mission statement¹².

Teagasc has, and continues to, undertake research, and provide advice, education, and training of relevance to the development of the bioeconomy. On the research side, examples include work on valorising meat and marine co-processing streams, valorising organic residues, processing waste streams and biosolids, developing technologies to produce biofuels and bioenergy, as well as data collection through the National Farm Survey to facilitate sustainability measurement. More recently, it is involved in projects that specifically mention the bioeconomy such as BioÉire (DAFM funded), CASA (EU funded), AgriChemWhey (H2020, BBI JU funded) and BEACON (SFI funded). In recognition of the socio-technical transformation that is required, and in keeping with SCAR’s views (Mathijs et al, 2015), **research not only covers the natural sciences but also social and economic sciences including consumer behaviour and attitudes, and impact assessment and monitoring.** Teagasc’s current major knowledge transfer programme Grass10¹³ aims to increase grass production and utilisation to promote sustainable grassland excellence for Irish livestock; the success of this programme will potentially allow Ireland to produce substantial amounts of grass above Ireland’s requirements for milk and meat production, providing a significant feedstock for alternative uses. **Teagasc has also provided leadership by introducing renewable energy technologies to heat its buildings and provides a demonstrator facility through its recently installed anaerobic digester at its centre in Grange, Co. Meath.** This plant uses animal slurry and grass to produce biogas to provide fuel for a 150kWe CHP plant. The heat is used for feedstock heating and space heating of buildings at Grange with electricity supplied to the national grid.

Teagasc’s role in supporting the development of the bioeconomy in Ireland was the focus of an internal workshop held by Teagasc in Oakpark in July 2017 in anticipation of this open consultation by the Department of the Taoiseach. Members of the Teagasc bioeconomy working group (TBWG) facilitated by Dr Maeve Henchion, Dr Laura Devaney and Dr Áine Regan discussed the needs of Teagasc stakeholders in supporting the development of the bioeconomy as well as what success would look like if Teagasc fulfilled its remit in responding to those needs.

¹² To support science-based innovation in the agrifood sector and wider bioeconomy so as to underpin profitability, competitiveness and sustainability

¹³ <https://www.teagasc.ie/news--events/news/2017/teagasc-grass10-campaign.php>

The main messages from this workshop were:

- There is a significant role for Teagasc in how the bioeconomy develops. At this stage in the development of the bioeconomy, it has a role in providing knowledge and information for a wide range of stakeholders so as to raise awareness of potential opportunities and provide information to support decision making in the pursuit of such opportunities.
- Teagasc clearly has knowledge transfer and research roles in relation to the Irish bioeconomy but it also has a leadership/advocacy/developmental role. It has a particular role in identifying and verifying biomass inputs, conversion technologies, markets and bioeconomy business models that capture value and economic, environmental and social impacts across scales.
- In fulfilling its role, there is a strong need for a continued partnership approach with other agencies and actors, with a potential need to strengthen relationships in some sectors (e.g. biochemical).

While Teagasc has a mission in relation to the bioeconomy, an overarching perspective may not yet be present within the organisation, reflecting a lack of a clear vision at national level. Success for Teagasc in relation to the bioeconomy will require the bioeconomy to become mainstream within Teagasc activities, the establishment of strategic partnerships and the development of human capital within the organisation. **With a clear bioeconomy policy statement from the Department of the Taoiseach the language, research and innovation needs and priorities of the bioeconomy can be articulated, further framing the research, training and advisory activities of Teagasc and the national and international funding available in this space. Teagasc is a particularly apt organisation to respond to demands of the burgeoning bioeconomy, boasting direct lines, contact and influence with farmers, SMEs and leading food industries (e.g. through farmer discussion groups and collaborative industry research) and with decades of experience and expertise across agriculture, food, forestry and marine arenas; all pivotal sub-sectors of the Irish bioeconomy.**

Conclusions

There are challenges in bringing the bioeconomy into reality. Meyer (2017) identifies 5 major stumbling blocks which need to be considered in the national policy statement:

1. The risk of disappointment as ambitious promises are difficult to achieve
2. Impedance as a result of pursuit of alternative routes to a low carbon economy
3. Persistent conflicts between different biomass uses (due to and resulting in unstable policy shifts)
4. New societal conflicts if principles of efficiency gain, circularity, cascading use, residue use and sustainability certification are insufficient to ensure a sustainable supply of biomass
5. Compromise as a result of continuing to ignore on-going societal debates on agriculture and food.

The “master narrative” (Levidow et al, 2013) of the bioeconomy is still in flux and is open for very different interpretations. The interpretation assigned to it in Ireland will have significant implications for prioritisation and resource allocation decisions, (e.g. decisions on strategic investments in R&D). The development of a policy statement by the Irish Government will provide a very useful “soft

border” by providing a definition and thus focus to the development of the bioeconomy in Ireland. This clearly needs to be consistent with the definition of the bioeconomy at EU level which is under review along with the review of the EU bioeconomy strategy. Teagasc, through its involvement with SCAR (and through the CASA project) will work to support this consistency of definition into the future.

A vision based on bio-resources is in keeping with Ireland’s clean, green image and with the image of “Ireland as the food island”. It is also consistent with more spatially diverse economic development, through economic growth and jobs being created in traditional industries and biomass production, processing and marketing sectors. If sustainably implemented, it is in harmony with objectives related to combatting climate change. **It is not in conflict with Ireland being at the forefront technologically** as biotechnology will still be a facilitator of the bioeconomy and other technologies will also need to be developed if the drive towards sustainable intensification is to be maintained. This points to the need for economy, science and society to be involved and to be represented. **Elements of the bio-ecology vision are also complementary to such a vision given the need for sustainable biomass production (and Teagasc’s role therein).**

Ultimately implementation of the bioeconomy in Ireland will mean that a range of different policies will interact to affect the extent to which policy goals related to the bioeconomy will be realised. In addition to seeking to align sectorial policies (e.g. agri-food, forestry, etc.), policy instruments designed to have other, but potentially complementary, policy goals can and will be deployed to support the development of the bioeconomy (e.g. procurement, regulation, education, etc.). **There will be a need to bring a critical reflexivity to this diverse policy mix to ensure optimal exploitation of opportunities and mitigation of tensions and conflicts. Teagasc recommends the continued operation of the government inter-departmental group to ensure such policy coordination and reflexivity.**

One of the final conclusions from BioÉire was that “as the definition and policy direction for the Irish bioeconomy is established, there is a need for a systematic deliberation of all options available backed by a coherent and objective evidence base” (Devaney and Henchion, 2017b, p4). While Teagasc very much welcomes the leadership provided by the Department of the Taoiseach and the intergovernmental group, **a multi-level governance approach is required** (Devaney et al, 2017) with authority allocated “upward, downward and sideways from central state” (Hooghe and Marks, 2003, p233), consistent with McGloughlin and Sweeney’s (2012) argument regarding governance for climate change adaption in Ireland and the need for vertical and horizontal integration to connect across local, regional and national scales as well as departments and sectors. Therefore, **Teagasc recommends the establishment of an independent bioeconomy advisory committee akin to the German Bioeconomy Council.** As well as providing policy makers with access to a range of experts and stakeholders (including academics, NGOs, civil society actors, industry representatives, consumer representatives, policy makers, policy enactors) to help develop a national bioeconomy strategy, such a council could also engage in scientific and political dialogue, publish position papers, promote the bioeconomy vision to a wider society (Devaney and Henchion, 2017a) and monitor, track and measure its implementation. **The need to establish a parallel stakeholder forum should also be considered given the democratic deficit in bioeconomy policy** referred to above.

Teagasc is keen to work with various stakeholders to develop and support the implementation of principles and guidelines that will form part of a national bioeconomy strategy. Its core remit commits us to continue to ensure the sustainable supply and use of biomass, and to provide the evidence base for the development of sustainability criteria related to the bioeconomy. It is also in a unique position to develop and implement guiding principles in relation to the organisation of research and innovation including connecting researchers with industry, working across sectors within Ireland, connecting with policy makers at EU and national level and partnering with others to deliver education and training at different levels.

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Appendix 1: BioÉire Delphi - Respondent Profile, Round 1 and Round 2

Experts	Responses Round 1 n (%)	Responses Round 2 n (%)
Industry	28 (37%)	12 (23%)
Research	19 (25%)	17 (32%)
Representative Body	8 (11%)	4 (8%)
Policy	7 (9%)	6 (11%)
Support Organisation	3 (4%)	4 (8%)
Producer	2 (3%)	4 (7%)
Other*	8 (11%)	6 (11%)
<i>Total</i>	<i>75 (100%)</i>	<i>53 (100%)</i>

*The 'other' category included consultants, academics, regulatory actors and international organisations