BiOrbic Bioeconomy SFI Research Centre
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Dear Bioeconomy Action Plan Consultation Group,

BiOrbic, Bioeconomy SFI Research Centre welcomes this Bioeconomy Implementation Discussion and Consultation process and the opportunity to put forward our views.

Tremendous progress has been made since the publication of the National Policy Statement on the Bioeconomy which has coincided with BiOrbic's development. We are delighted to have worked with the relevant government Departments during this time and supported the national consultative structure.

In that time we have focused our efforts to advance a sustainable circular bioeconomy in Ireland by delivering a comprehensive research, innovation and public engagement programme. We have consolidated a previously dispersed academic landscape (in terms of the bioeconomy) and have orientated researchers, industry and others to the bioeconomy. By the end of our phase 1 programme, we will have trained a cohort of 60+ future bioeconomy leaders.

To date, we have delivered 187 bioeconomy peer reviewed publications, have partnered or coordinated 32 international consortia focused on bioeconomy and have secured €49m in research funding from national and international sources since 2018.

BiOrbic has engaged a wide range of audiences within the bioeconomy, including industry, primary producers, rural communities and young people. Examples of engagment targeting young people to pick one audience include our Environmental Innovators programme (in partnership with Agri Aware) for transition year students and will soon launch the Generation Glas Programme with Foróige to support young people to co-create Ireland's future. We co-founded Bioeconomy Ireland Day in 2018 which has since expanded to an annual week celebrating Ireland's circular bioeconomy. Furthermore, we are developing the world's first climate neutral dairy farm with our partner Carbery through the BiOrbic-led Farm Zero C project. Significant investments and resources have been harnessed to develop and structure BiOrbic as a key national bioeconomy resource.

We look forward to working closely with all partners to implement the Bioeconomy Action Plan and have outlined our responses to the questions posed below.

1. Are you satisfied the outlined Pillars represent the structure of the Irish bioeconomy?

Bioeconomy is a very broad area and covers many sectors. Multiple definitions have been used in various documents and it would be helpful to have a single national definition that is used consistently across key stakeholders.

Capturing and categorising key pillars of the bioeconomy under the term "bioeconomy" is a difficult task. Interconnectedness across all the pillars is critical and should not be considered to be only the

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focus of the Governance Pillar as outlined. For example, the Research, Development & Innovation Pillar is also directly connected to each of the other pillars also.

How each pillar will function will be the key to success. Pillars should bot be considered in isolation from each other, e.g. nature pillar and agriculture, marine and forestry pillar.

An important area missing from the pillars is "technology development and scale up". Perhaps this is intended to be covered under the pillars referenced, however, it is an area of such critical importance that it merits its own pillar. This will also ensure focus.

The word "biorefinery" does not appear at all in the document and given the importance of biorefineries in the processing of biomass and job creation, its inclusion across the document is critical.

The concept of "feedstock" does not feature prominently in the discussion document.. The distinction between primary feedstock (where most impacts happen) and secondary feedstock (e.g., wasted food) should be clear.

The 'sustainability' and 'precautionary' principles are noted in the Policy Statement (2018), but the sustainability principle needs stronger prominence in the Action Plan. Caution must also be given that the precautionary principle does not overly prevent appropriate and rapid action as required.

I am not sure if the above belongs in this part of the response.

2. Are there specific key performance indicators and/or targets the bioeconomy should be setting out to achieve to measure its implementation?

Ireland must increase its commitment to the bioeconomy in order to meet its stated objective of becoming a global leader in the bioeconomy. This commitment can be focused through KPIs.

The Circular Bioeconomy Outlook Study 2030–2050 in support of Climate Action, Sustainable Food and Biobased Systems referenced in the discussion document sets out a number of KPI targets to 2030 for the bioeconomy which BiOrbic fully supports (see table 6.1 of Outlook Study Report).

Additional suggested KPIs for this Action Plan:

- Establish a bioeconomy knowledge hub
- Develop a national bioeconomy strategy to ensure an all government and all sector approach to bioeconomy development. This will provide focus to ensure impending national climate targets are met.

Research should be linked closely to support these national KPIs and EU targets.

1. Increase resilience of the bioeconomy through supporting the restoration of nature.
   - 10% of farms dedicated to high quality habitats (Nature restoration plan EU)
   - Protecting 30% of EU land and 30% of EU sea area (Nature restoration plan EU)
2. Research and demonstrate how to achieve climate neutral operational systems to help meet and go beyond Government and EU and national targets.
   - GHG - 55% reduction by 2030 (Green deal EU, Bioeconomy strategy EU)
   - Net Zero by 2050 through reductions in emissions and C-sequestration (Green deal EU)

- Fertiliser – 20% reduction by 2030 (Farm to fork strategy EU, CAP)
- Pesticides – 50% reduction by 2030 (Farm to fork strategy EU, CAP)

3. Increase resource efficiency by targeting the biggest waste challenges globally to achieve and exceed EU and national targets.
   - Food waste – 3rd biggest GHG emitter globally – 50% decrease in retail & consumer food waste by 2030 (including re-distribution of food) (Green deal EU)
   - Plastic waste – 55% recycling rate of plastics by 2030 (Circular economy action plan EU)
   - CO_2 – While there are no target for the use of biogenic CO_2, is it identified in the SIRA as a "very promising feedstock" (SIRA 2017)
4. Design circularity in the bioeconomy (Bioeconomy strategy EU)
   - Move beyond simply 'removing the fossil' or achieving a theoretical 'net zero' economy, to creating a genuinely circular system that is optimised for circularity and not for individual technological innovations and reduces overall pressure on limited land resources.
5. Create a pathway to carbon neutral energy production and consumption in the bioeconomy (Green deal EU, Bioeconomy strategy EU).
6. Use the power of digitisation to increase the efficiency of the bioeconomy (Circular economy action plan and Bioeconomy strategy EU)
7. Translation of knowledge generated within BiOrbic into practice to support a transition to a climate neutral circular bioeconomy through education and public engagement, demo farms, scale up of technology at pilot scale facilities, collaboration with industry, licensing technology to industry and support for evidence based policy development.

3. What other key issues should the Governance Pillar deal with?

The Governance Pillar is critical to ensuring coherence of the Action Plan. This pillar should incorporate existing work and efforts already underway to deliver many of the objectives highlighted. For example, 'addressing how we communicate the bioeconomy and its policies across various sectors, wider society and with stakeholders' is a core objective of BiOrbic. The Centre has a comprehensive education and public engagement programme in place to support this action. The development of a knowledge hub can be a KPI action covered under this pillar. In addition, the Irish Bioeconomy Foundation and Circular Bioeconomy South West run many networking events.

Emerging from the Bioeconomy Forum report, two important focus areas of added value for the Governance Pillar are

1. Regulatory coherence
2. Engagement with the legal and planning systems.

While investment and access to finance is highlighted under the Industry and Enterprise Pillar, we suggest that the Governance Pillar should consider this too with a view to establishing a national circular bioeconomy investment fund similar to the ECBF.

The precautionary principle should not be used to protect what is already there simply because it is.

The EU is working to develop improved circular bioeconomy certification, which should build on eco-labelling and ISO life cycle methods. There will be a need to have governance structures in place to regulate this in a national context and systems in place to get industry ready. This approach will consider a future situation rather than current situation.

A broader consideration is if limits under climate laws can be explicitly linked to bioeconomy actions?

4. What key issues should the Research, Development & Innovation Pillar deal with?

The Research, Development & Innovation Pillar is fundamental to achieving the objectives of the Bioeconomy Action Plan. This pillar connects extensively to each of the other pillars highlighted and those suggested by us. It forms the base knowledge input to the bioeconomy innovation eco-system, providing ideas, knowledge, expertise, creativity and innovation, driving technology development, stimulating industry advancement, supporting primary producers, training future bioeconomy leaders, developing entrepreneurs as well as informing policy by engaging with communities and citizens.

While facilitated under the Impact 2030, Ireland's Research and Innovation Strategy document, it is important that the Bioeconomy Action Plan specifically calls out the continued need for a dedicated national bioeconomy research centre of scale that is multi institutional.

The Research, Development & Innovation Pillar should contribute to delivering on a range of ambitious national and EU targets to protect natural ecosystems and reduce GHG emissions, biodiversity loss, and soil, water and air pollution to support Ireland's transition to a Climate Neutral Circular Bioeconomy, transitioning rapidly from the current linear fossil-based economy. This pillar should also move beyond simply 'removing fossil' or achieving a theoretical 'net zero' economy, to creating a genuinely circular system that is optimised for circularity and not for individual technological innovations and reduce overall pressure on limited land resources.

The following research issues should be specifically dealt with by this pillar:

1. Increase resilience of the bioeconomy through supporting the restoration of nature.
2. Research and demonstrate how to achieve climate neutral operational systems to help meet and go beyond Government and EU and national targets.
3. Increase resource efficiency by targeting the biggest waste challenges globally to achieve and exceed EU and national targets.
4. Design circularity in the bioeconomy, including a readiness framework.
5. Create a pathway to carbon neutral energy production and consumption in the bioeconomy.
6. Use the power of digitalisation to increase the efficiency of the bioeconomy.
7. Translation of knowledge generated within BiOrbic into practice to support a transition to a climate neutral circular bioeconomy.

5. How could the RD&I bioeconomy approach be best structured to support the enhancement, application and scaling-up of biological knowledge and bioeconomy solutions?

A clear, focused and coordinated approach is needed to advance at the rapid rate required to meet the national climate targets referenced in the discussion document. The RD&I bioeconomy approach requires a consolidated centre and platform for bioeconomy research to be visible and accessible to all relevant stakeholders. As stated in the response to the previous question, it is critical that the Bioeconomy Action Plan specifically calls out the continued need for a dedicated, bioeconomy-focused, national bioeconomy research centre.

BiOrbic has provided depth and scale to Ireland's bioeconomy, connecting researchers from across twelve research performing organisations, industry, policy makers, primary producers, communities and citizens.

It is critical that a specific bioeconomy-focused national research centre is fully supported and maintained. While many excellent research projects are funded at academic institutions around the country, these are generally grouped and categorised by the source of funding or funding body which can create silos of research. This can lead to fragmentation of knowledge, duplication of effort and confusion for external stakeholders.

A formal coordination mechanism linking all bioeconomy research across Irish research performing organisations will maximise the impact of this research and set Ireland apart internationally.This mechanism could also define guiding pronciples for bioeconomy projects. BiOrbic is currently advancing the development of a 'knowledge hub' or 'National Circular Bioeconomy Research & Innovation Platform' which will provide a platform for bioeconomy research across the entire research system. This will be established during the period of the Action Plan including a medium to long term plan to scale the hub. The Centre is working with other national and local partners and stakeholders to link in knowledge, networks and stakeholders.

The 'knowledge hub' will run in parallel with BiOrbic's core SFI research programme. The Centre's work to date (2018 -2023) will provide the base knowledge to establish the hub. The hub will be scaled to include all other circular bioeconomy research following initial setup. It will orient the knowledge and information available for relevant stakeholders in the bioeconomy, so that it is visible and available in a format that is accessible for that audience (e.g. industry, primary producers, policy makers, young people, communities, etc). Clustering bioeconomy research in this structured way will reduce the current over reliance on a small group of high performing individuals.

Research within the hub will be consolidated under key functions as follows.

- **Healthy Ecosystems** including recovering biodiversity, natural capital and nature-based solutions.

- **Climate Neutral Operational Systems** including climate neutral forest bioeconomy, marine bioeconomy and agriculture (animal and plant).

- **Valorisation of waste resources** including prevention of waste (e.g. plastic and food) and valorisation unavoidable post-consumer and processing sides streams.

- **Bioeconomy systems** including circular bioeconomy design, digitising the bioeconomy, and powering the bioeconomy.

- **Enabling actions** including LCA, economic social and policy for the bioeconomy, co-creation, education and public engagement, training and infrastructure and scale up.

In a broader sense, clearly defined innovation pathways, supports and funding are needed. A focused innovation programme based on bioeconomy principles e.g. EI immersive needs call is an example of what could be funded through BiOrbic and delivered through all RPOs involved.

6. What key issues should the Nature, Climate & Circular Pillar deal with?

This is a critical pillar for the successful implementation of the Bioeconomy Action Plan. However, the way it is currently described is too broad and covers too many areas. Consequently, it risks being the 'everything else' pillar.

The topics focused on in the R,D & I pillar should mirror priorities in this and other operational pillars. Indeed to be effective, the areas covered within this pillar also need to be connected to the actioned within the agriculture and marine pillar.

We suggest a reframing of operational systems pillars (Nature, Climate & Circular Pillar and the Agriculture, Forestry & the Marine Pillar) as below.

- **Healthy Ecosystems** including recovering biodiversity, natural capital and nature-based solutions

- **Climate Neutral Operational Systems** including climate neutral forest bioeconomy, marine bioeconomy and agriculture (animal and plant) – as proposed.

- **Valorisation of waste resources** including prevention, elimination and minimisation of waste (e.g. plastic and food) and valorisation unavoidable post-consumer and processing sides streams. Waste avoidance should the first principle, followed then by intensifiaciton, reuse, repurposing, recycling, recovery and reprocessing to create circularity.
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- **Bioeconomy systems** including circular bioeconomy design, digitising the bioeconomy, and powering the bioeconomy. It is critical that the Bioeconomy Action Plan seeks to formally align bioeconomy policy and circular economy policy, recognising that bioeconomy forms one half of the circular economy.

In addition to this reframing, we reiterate the critical importance of alignment and cross over between all pillars, so that for example actions underway in the R,D& I pillar work hand in hand with objectives under this pillar.

7. What key issues concerning consumption patterns need to be examined to close the gap between sustainable supply of biological resources and demand?

Current economic models and a "business-as-usual" approach have become incompatible with a prosperous and safe future for humanity. We remain reliant on fossil fuels for food, industry, and infrastructure, with most societies relying on economic growth driven by a take, make, consume and dispose model.

Demand for non fossil-derived products can place a pressure on natural resources, even if the whole process becomes more eco-efficient as a result of the shift (i.e., less impact per unit output). It is necessary to break the link between economic growth and resource depletion and to recognize the biosphere does more than simply provide physical commodities. The Governance Pillar should

consider (with relevant government departments) a review of the fossil fuel subsidy as the price points are not on a level playing field but the price of renewable and bio products is concurrently cited as a reason not to advancemore rapidly.

To achieve a truly sustainable, circular bioeconomy is to embrace all elements of circularity including eco-design of products, use of processes, and services that drive integrated systemic thinking, targeting sustainable production and consumption of renewable biological materials and prioritizing maintenance and enhancement of natural capital. It is necessary to move from a theoretical combining of bioeconomy and circular economy to a framework of concepts and metrics that allow stakeholders to plan for a sustainable circular bioeconomy. (Ref https://link.springer.com/article/10.1007/s43615-022-00180-y)

Biomass quantities, flows, potential uses (including ecosystem services) and the potential for competition for biomass and factors impacting future biomass production and demand should be supported in order to build models for biomass preservation and use efficiency (e.g. building on INFORMBIO).

8. What key issues should the Agriculture, Food & the Marine Pillar deal with?

This pillar will cover the operational areas of the bioeconomy. Careful consideration needs to be provided to the needs and pressures on primary producers. As outlined in the discussion document, the bioeconomy has the potential to generate an equitable distribution of prosperity across a wider population, but to achieve this, the transition must be just. The overarching description of the pillar in the description is comprehensive. Again, coherence across pillars is absolutely essential to achieve the objectives. The Agriculture, Food and the Marine Pillar must actively link to the Natural Capital Pillar (a proposed replacement pillar), the R,D&I pillar, the Communities Pillar, Knowledge and Training Pillar and the Governance Pillar.

The following issues should be addressed by this pillar.

Climate Neutral Forestry

- Develop a state-of-the-art holistic sustainability assessment framework to inform strategic climate policy.
- Develop integrated routes for the conversion of wood-derived waste lignocellulose (cellulose, hemicellulose and lignin) to at least three products of value.
- Apply future-looking life cycle assessment and economic modelling to evaluate wood value chains to provide a pathway for net zero GHG emissions from forestry.
- Assess the behavioural and organisation mechanisms to re-ignite the afforestation programme to enable future supplies for timber and to achieve carbon sequestration objectives.
- Explore with industry partners the technological, economic and environmental implications of carbon sequestration through carbon capture and storage (BECCS) technologies using GHGs arising from the production of forest based products.

Climate Neutral Marine

- Primary production of macroalgae including wild populations and cultivated strains.
- Determination of grazing rates of consumers (e.g., molluscan grazers) on algal species and associated shifts in metabolic scaling.

- Bivalve (e.g., mussels, oysters, clams) survival, growth, condition, and resistance to other disturbances.
- Predation rates (of crab, whelk, etc.) on bivalves and their indirect effects on phytoplankton production.
- Test experimentally whether cultivated seaweed can protect calcifying organisms from the effects of predicted ocean acidification and warming.
- Identify how native Irish seaweeds respond to environmental conditions and the presence of competitors and grazers in terms of their biochemical profile and suitability for harvesting for bioresources.
- Test new methods of manipulating the plasticity of algal biochemical profiles in responses to stimulants.
- Quantify the potential of seaweed farms to mitigate impacts of climate change e.g. storm surges.

Climate Neutral Agriculture

Animal Agriculture

- (Re)Integration of cropping and livestock systems.
- Replacement of chemical inputs into livestock production systems with biobased solutions.
- Development of methane and nitrogen emission mitigation strategies that are applicable in both housed and pasture-based livestock production system, without the need to alter (shift towards high level cereal grain feeding) ruminant production systems through identification of novel mitigating agents, targeted timing of mitigation and novel delivery systems.
- Optimisation of sward/grassland seed mixtures, establishment methods, seed treatment and fertilisation strategies to optimise sward yield and quality, while minimising chemical inputs and maintaining or increasing output.

Plant based agriculture including protein

- Diversification of food, feed and pharmaceutical cropping systems to underpin the bioeconomy.
- Driving improvements in agricultural practices that increase the efficiency and climate profile of Irish cropping systems.
- Development of digital and biological solutions that enable more efficient and tailored use of chemical crop inputs.
- Development of digital solutions that ensure transparency in our food and feed systems to include field and process-based interventions using in their production.
- Extension of the use of grass and crop residues in a circular bioeconomy. Using grass biorefining and anaerobic digestion of grass to yield protein, energy and valuable intermediates such as volatile fatty acids.
- Human intervention studies to validate the nutritional value of Irish plant protein.
- Life cycle analysis of exemplar plant protein production systems.

9. What key issues should the Communities Pillar deal with?

It is indicated in the discussion document that this pillar will seek to complement national operational activities. As with other pillars, duplication of effort or cross activity must be avoided and local initiatives operating under a national umbrella is desirable.

An inclusive approach must be adopted to include the expertise, perspectives and innovations of public groups across the society in order to ensure it is practical, relevant and just.

This pillar should include i) **Public Awareness** - Dissemination and education activities aiming to stimulate a national conversation around a sustainable, circular bioeconomy, ii) **Public Participation** - Building knowledge and skills that give public groups the confidence and capacity to move beyond awareness and implement sustainable, circular actions in their communities and iii) **Public Collaboration** - Longer-term partnerships empowering public groups to co-design our bioeconomy, ensuring it is more practical, relevant and just.

We view the voice of communities as important as other stakeholders, e.g. industry.

10. Are local and regional policies ensuring the consideration of bioeconomy opportunities are in scope, and are coordinated approaches on such services in place at regional assembly and local authority level?

Each local authority should have a bioeconomy action plan reflecting the national action plan. Investment at local level should be part of this plan. Tipperary County Council have strongly engaged with the Irish Bioeconomy Foundation in order to develop the National Bioeconomy Campus at Lisheen, but a lot more could have been achieved if a formal "Bioeconomy Development Officer" position was created and that officer had been given a dedicated budget, a mandate (action plan) and the power to develop the bioeconomy by the local authority with other stakeholders. This can be developed further for regional development through local authority collaboration to share and co-invest resources. Furthermore, Ireland needs to build a number of deep demonstrators, commercial biorefineries and sustainable demo farms. Local and regional policies need to be developed in order to make this a reality.

11. What key issues should the Industry & Enterprise Pillar deal with?

The pillar description included in the discussion document focuses heavily on industry emissions and use of carbon by industry. While this is important, a fundamental shift to biocircularity is needed whereby industry products and processes are designed with circularity in mind from the outset. This will be difficult and supports will be needed to facilitate this shift. Industry should be supported to collaborate with the R,D & I Pillar for example through collaborative projects with BiOrbic. Key to this is coherence and coordination within the research and academic world which tends to be fragmented if left uncoordinated, including at a funding level. The bioeconomy innovation platform can support this by adding the essential level of coordination needed to make industry-academic engagement as accessible as possible.

This relationship can be further strengthened through close collaboration between BiOrbic and the Irish Bioeconomy Foundation linking industry and enterprise with the innovation eco-system. Pathways from research to scale up are needed which will shortly be enhanced by developments at the National Bioeconomy Campus in Lisheen, Co. Tipperary.

As suggested previously, the investment mechanism included in this pillar also needs to be considered and actioned by the Governance Pillar (including proposal to develop Irish ECBF).

As flagged, encouraging entrepreneurship within the bioeconomy will add new ideas and energy. Existing supports and programmes to support this, e.g. BiOrbic's training and commercialisation initiatives to support entrepreneurs and develop spin out companies from our research. BiOrbic is working with the EIT-funded Ri-Ecolab entrepreneurship training programme which fosters a novel way of performing research to generate immediate commercialisation in the form of spin outs. Spin out generation is at the forefront of the desired outputs for this training initiative and researchers work directly with university research support offices and Technology Transfer Offices to navigate the pathway to commercialisation and incorporation.

Other actions include Linking the INFORMBIO project which is aimed at understanding the available bioresources and value chains which can best contribute to Ireland's 2050 climate neutrality targeting to the bioeconomy knowledge hub.

Clear bioeconomy Innovation pathways need to be supported and collaboration for circulatity should be rewarded.

12. What lead market initiatives could support entrepreneurship, development, innovation and the commercialisation of bio-based products, processes, information, and services?

- The Bioeconomy Action Plan can be a stimulus for bioeconomy development. Investment from Government and industry can flow from it. We see the significant level of investment by European countries in research and development in the bioeconomy, but Ireland is lagging behind here and significant investment is needed for Ireland to catch up. The Irish Bioeconomy Foundation is very well placed to lead on supporting entrepreneurship. Access to finance will be key here.

- Financial development to develop biorefineries.

- Cost benefit analysis of having e.g. 50% of Irish GDP from bio-based (non-fossil) resources

- Bridge financing for early stage scale up companies and in a wider context a structured pipeline from readiness level 1 to 9 with clear targets, goals and requirements. New spin outs are emerging in the bioeconomy (e.g. three spins outs 2018-2022 in BiOrbic alone).

13. Due to the requirement for capital and operational investment what innovations aimed at financing infrastructures and technical and economic evaluation of innovation are necessary to scale up the bioeconomy?

This is an area where an innovative, proactive and forward thinking approach can really differentiate Ireland and signify intent to practically achieve climate targets set out. Discussion with NTMA and private investors should continue with a view to establishing an Irish bioeconomy specific investment fund similar to the ECBF. This will need to initially be underpinned by public investment to reduce burden of risk on private investors. We have previously suggested that special zones for bioeconmy investment could be set up to stimulate investment. Lisheen could be the IFSC of the bioeconomy.

The Irish Bioeconomy Foundation are the Coordinators of the Bioeconomy Ventures project which has developed a European wide platform to match Entrepreneurs and Investors in the Bioeconomy. Workshops have been delivered across the EU over the last 2 years and they are perfectly placed to leverage the connections made and experienced gained to deliver the much required structures that will aid to bridge what is known as 'The valley of death' between R & D and commercialisation.

While investment and access to finance is highlighted under the Industry and Enterprise Pillar, it is suggested that the Governance Pillar should consider this too with a view to establishing the fund mentioned.

In a wider sense a balance in subsidies given to fossil based innovation would have a major impact.

14. What key issues should the Knowledge & Skills Pillar deal with?

As highlighted in the discussion document, talent is the key to our future prosperity and an educated and skilled workforce will support the growth and acceleration of Ireland's bioeconomy, including biobased industries.

Significant strides have been made in this area since the publication of the bioeconomy statement in 2018. BiOrbic will have trained over 60 postgraduate and postdoctoral researchers at the end of its phase 1 programme and this will double during its phase 2 cycle to 2030. This is the largest single cohort of bioeconomy specialists ever developed in Ireland. All BiOrbic researchers receive a base level of bioeconomy training and it is suggested that via the knowledge hub and bioeconomy innovation platform, this can be replicated (with consideration to practicalities).

As described, the knowledge hub also has the potential to support training initiatives and knowledge sharing opportunities for different stakeholders in the bioeconomy, besides researchers.

Structured partnership and engagement with young people in and outside of schools is also essential and initiatives such as BiObic's Generation Glas (in partnership with Foróige), Environmental Innovators (in partnership with AgriAware) and the BioBeo project led by UCD should be supported and encouraged through additional contributions.

Continued professional development for people in the workforce should continue to be developed and expanded. Support should also continue for the Postgraduate Diploma in Bioeconomy with Business.

This pillar should also consider scalability (of bioeconomy). An ambitious view is needed so that the entire population need to be reached. Big message, big plan, big action.

15. Can the regional skills and regional enterprise approaches better support bioeconomy development?

Yes, but only if they operate within and contribute to an overarching national framework. Stand-alone ad hoc initiatives, may fulfil a short-term local need, but to deliver in the given timeframe, strong national level coordination and support is needed. The knowledge hub can also play a role in supporting such initiatives. As stated for Q14, continued professional development is critical and this

can be operated locally and regionally. Co-ordinating this to an action plan for bioeconomy development (Q10) is also critical.

16. An important part of developing the bioeconomy is to determine the most appropriate practices, treatments, technologies, logistics and business models to valorise ecosystem services, primary and secondary biomass resources. What role do advisory systems play in addressing this challenge?

As outlined in response to question 5, the knowledge hub will play an important role in supporting the sharing of practices, treatments, technologies, logistics and business models to valorise ecosystem services, primary and secondary biomass resources. The knowledge hub will be established in the near term and an initial focus will be to examine how to grow the hub and its network in a sustainable (finance) and practical manner. While Teagasc support services can help farmers, a wider support mechanism is needed outside of Teagasc to support the very large number of stakeholders in the bioeconomy. Advisory systems must be consistent across all aspects of the bioeconomy and should not be separated into operational only areas (e.g. agriculture must must with nature).

17. Are there any further Pillars/Issues which this Action Plan should address?

As suggested in the response to Nature, Climate and Circular Pillar, we suggest a re-working of the operational pillars (Nature, Climate & Circular Pillar and Agriculture, Forestry & the Marine Pillar) to the following: **Healthy Ecosystems**, **Climate Neutral Operational Systems, Valorisation of Waste Resources**, (including prevention of waste) and **Bioeconomy Systems** including circular bioeconomy design.

We also suggest the addition of a new pillar, **Infrastructure and Technology Development and Deployment** to ensure a focus on this critical area. This pillar could also include the establishment of bioeconomy demonstrators. As part of this, it will be vital to link with international bio-economy research partners to share best practice of existing efforts and innovation gaps, for example to commercialise biobased products. BiOrbic has a number of such partnership at a national level, for example with Bulgarian and Costa Rica and is also supporting a climate neutral dairy farming initiative with the Government of Rwanda.

Another major initiative is led by India and the Netherlands under the mission innovation programme along with Canada, Brazil, UK, EU, Nova Institute and IEA to exchange knowledge and challenges in implementing innovative solutions for the production of various biobased products (http://mission-innovation.net/missions/integrated-biorefineries-mission/). The mission's objective is to develop and demonstrate innovative solutions to accelerate the commercialisation of integrated biorefineries, with a target of replacing 10% fossil-based fuels, chemicals and materials by 2030.

18. Indicate what the top five priorities for action in the bioeconomy over the next three years should be?

1. A unifying platform (knowledge hub) that coordinates research and innovation for Ireland.

2. Deep demonstrators like Farm Zero C to include a wider range of contexts in the bioeconomy.
3. Investment in scale up facilities and projects, including by government
4. The creation of a public private partnership fund for the bioeconomy, to de-risk bioeconomy investment
5. Alignment of bioeconomy and circular economy policies recognising that bioeconomy is one half of the circular economy.