1. **What gaps do you see in the Department's current research and innovation activities? How should we address those gaps in the Department Research and Innovation Strategy?**

The Department's R&I initiative is disjointed across various interest areas from basic ground-breaking research to innovation and implementation. Part of this is because research funding is pivoted through a myriad of agencies with different and specific views and many of those views cannot be viewed as independent (e.g. funding from the SEAI centres on delivery of established sustainable energy goals not looking at wider issues such as emerging energy generation). Funding calls can be overly focussed depending on what a funder postulates as being important and relevant rather than what might be developing in the research ecosystem (e.g. the EPA calls are extremely narrow and poorly focussed on basic research; the SFI Challenge funding is heavily centred on innovation).

The main critique of the DECC research strategy is that much of the focus for Irish research is renewable/low footprint energy. Whilst a necessity, most research suggests that renewable/low footprint energy will only meet 45% of our climate goals. There needs to be research conducted on areas that can deliver for the net-zero, 2050 goals.

In terms of gaps there are several key points:

- There is little funding for fundamental environmental research – key laboratory work programmes are missing at looking for innovative solutions, looking for measuring impacts for potential solutions and where we can add innovative solutions for application.
- Irish policy talks about a circular economy, but this is underfunded. Research as to where this can have maximum value (e.g. is biodiesel a priority?) through to how we develop solutions for implementation of an Irish circular economy is extremely limited. A specific example might be how we are going to implement new research and future solutions for the recycling of plastic has never received significant funding. We have problems with the recycling of all plastics, a focus might be tyres.
- How sustainability and circularity are measured has been very poorly funded. E.g. the use of life cycle assessment is widespread, but it is widely recognised it must be improved to be compliant with a move towards circularity. We have few tools geared towards Ireland users and lack of detailed assessment.
- A focus might be sustainable and circular construction. Only limited work has been funded in terms of timber, concrete/cement, building methods and innovative building products such as insulation. Forestry research isa priority and particularly its role in emission abatement and as a sustainable material for exploitation.
- We are not focussing on research in terms of industry requirements. What is needed is funding research that allows Ireland to be a world leader in sustainable industry sectors. What research is conducted focuses on energy solutions which is important in terms of 2030 goals, but the industry elements are needed for net-zero by 2050. An example is the proposed EU Net-zero Industry Act, and we have no meaningful research or innovation funding in many of the areas in that act.

Potential solutions include:

- Increased research funding across all levels and from near to long term research.
- Reduced reliance on consultations by companies towards engagement with academics.
- Funding research aimed at developing a talent pipeline of trained personnel in critical areas.

- Targeted funding for increased PhD and MSc numbers.
- Proving significant funding to SFI/IRC for fundamental research calls.

2. **What actions can the department take to identify future trends in the areas under our remit?**

The main action is to distribute funding for core activities NOT linked to the Department. By distributing research funding by Department agencies such as EPA, SEAI, GIS, ESB etc. that are invested in near term, specific research agendas. Funding through these agencies ensures that the likelihood of finding truly disruptive science-based solutions and innovation is limited. By having a policy led approach where research is funded that meets the policy needs is flawed. Research needs to be evolved that informs policy making. E.g. it is difficult to see how Ireland could develop solutions for direct air capture of CO2 (DAC) or DAC to chemicals which could disruptively impact de-fossilisation in Ireland in the current system. There also needs to be industry input to where their needs lie. This will help competitiveness as well as identifying research topics. E.g., Ireland is a leading manufacturer of silicon chips, however the sustainability of this industry is emerging as a significant climate problem. How can this industry change, how might Ireland meet this challenge?

One positive measure Ireland could take is identifying critical solution needs not e.g. just measuring the size of the problem. Bringing leading researchers in areas such as materials science, energy science, plastics, construction materials in academia and industry as well as actors from organizations outside DECC such as Enterprise Ireland, IDA would help evolve a solution-led approach to distribution of funding as well as identifying clear funding priorities. No-conventional voices need to be heard. In parallel to the climate led advice, the formation of an environmental-solution board might be important.

3. **Are there specific thematic areas relevant to the Department's remit which you would like to see more research and innovation activity in? How can this be achieved?**

Ireland has the lowest level of circularity in Europe. This results from few targeted actions on areas of high impact (initiatives such as coffee cups and deposit-return schemes will make little impact on emissions), lack of research funding, no identification or priorities and poor infrastructural support (e.g. making recycling effective in Ireland). There is also lack of cohesion across research, users, solution providers such as waste management companies or recycling companies, industry which needs to be addressed. The challenges need to be identified, solutions evolved, and policy enacted. We often do not have the depth of information needed to make good decisions. In particular, research around the following is urgently needed:

- How significant are our problems and can they be properly and meaningfully addressed? E.g. what plastic waste and types do we produce and what is its end-of-life? What are the critical materials to be addressed?
- What are the challenges? I.e. why aren't we more circular, is this lack of domestic solutions or poor policy? Is policy properly linked to standards, regulation and enforcement?
- What are the potential benefits of meeting the challenges? Is this an opportunity for revenue generation, rural development, better employment etc.? We have a relatively small amount of quantifiable data and there is little funding for research in this space.
- What are the proposed ways forward and are they meaningful? E.g. can the bioeconomy produce a real solution? Because we have low level of assessment, many decisions are based on 'feeling' rather than fact.

- What are the potential solutions be them social, technical or environmental? Can we develop technologies that are truly disruptive and lead to both domestic and international exploitation opportunities? We need to fund ground-breaking ideas related to Irish problems not 'me too' research based on other international needs.
- What level of public and private investment is needed? A circular economy needs a kick start in terms of identifying what would bring progress and funding necessary infrastructure at regional and national levels.

4. **Have you views on the impact of disruptive technologies such as AI, Quantum and 6G as part of the digital transformation agenda and the implications of these technologies for the Department?**

All of these are potentially important for future and present generations. New IT solutions can impact the world by evolving solutions that enable greater sustainability. E.g. autonomous driving might allow more efficient use of private transport. They might allow more efficient manufacturing and so minimising climate impacts. They will probably lead to improved design of goods, products and services as well as ever more efficient supply chains. However, they need to be balanced against direct climate impacts. The ICT industry is expected to contribute > 30% of all emissions by 2050. It is unknown if the benefits outweigh the costs. The benefit-cost analysis is uncertain, and this might be a research focus.

These emerging technologies might enable proper measurement and assessment of impacts. Life cycle assessment analysis is far from perfect and used widely to assess ecological impacts. However, both data for assessment and the calculations are time intensive. Using AI for data mining, developing data libraries, carrying out multi scenario testing and assessing quality of the analysis could deliver marked increases in reliability and hence developing robust policy decisions. The role of these methods might prove invaluable.

These are significant conflicts. Part of the current climate problems have been the result of mass production and mass consumerism. That has led to product development that fund new sales, e.g. a new cell phone every 6 months. Questions have to be addressed such as whether 6G and other ICT developments really needed and likely to be sustainable?

5. **How can the Department better communicate its research and innovation needs?**

As above, funding streams outside the direct remit of parts of the Department and identified by independent (i.e. non-Department directly or indirectly employed team members) is required. This could be done by proving funding in current EI, SFI, IRC funding streams. It is also worth considering an independent funding body for environmentally led research. Diversion of funding into non-DECC bodies might provide a broader, less influenced research funding landscape but clearly minimises the visibility of DECC. The challenges of climate, ecosystem resilience, circular materials, sustainable/renewable materials are so important and so challenging that the funding across these areas needs to be very significant and perhaps match all areas of research combined. A dedicated funding organisation distributing 500 million Euro of funding is warranted.

Another very visible activity might be an Irish Research Centre for Environmental Solutions. We do have centres looking at individual areas, but nothing spans the complete needs. It might be virtual

or have a dedicated facility. It would have visibility and in terms of having a solution focus would be differentiated from many centres in other countries.

There needs to be greater engaged research particularly at school level. Involving school children in research engages them and their family. Similarly, there may be opportunities for work with older people through e.g. men sheds organizations. Funding geared towards this should be earmarked. Grant funding for research might include co-funding of engaged research projects.

6. **How can the Department work more effectively to source evidence from the national research and innovation community to support its work in policy development, policy implementation, and the uptake of new technologies?**

The first solution must be to identify areas of interest where advice is needed and then bring experts together through formation of boards, national meetings, research forum etc. Many existing networks exist. White paper calls can be useful in eliciting responses. There is the possibility of Department-academia exchanges and sabbaticals (similar to an SFI scheme that exists). The bioeconomy area is probably exemplar in creating a dynamic between policy makers and the research community. This may be related to particularly talented Departmental staff such as [redacted] whose expertise and commitment drive the interactions. A key need is to create a positive environment for dialogue.

We also need to develop the ecosystem to build and bring in research expertise. There is a paucity of academic leaders in critical spaces such as the circular economy, recycling, measurement and assessment, systems thinking, technological solutions (direct air capture, green chemical synthesis, de-fossilization strategies). These are areas that have historically been of relatively low priority and subject to research underfunding. There must be new university and research centre positions created, infrastructure funded and delivered. A recruitment drive for targeted professors should be seen as important. The funding must be linked to increased graduate training and numbers (PhDs and masters) to increase expertise for recruitment into academic and commercial positions to fill skill gaps.

7. **How can the Department engage more effectively with all stakeholders in the national research and innovation system? If you are responding on behalf of an organisation, please state how the Department could more effectively engage with your organisation.**

The clear development of a DECC research agenda and funding with perhaps the creation of a funding organisation would help engagement. Creating an active, well-funded eco-system in ways outlined here would form the foundation needed. The creation of expert boards would help coalesce various elements in the ecosystem. One of the notable elements of the Irish research landscape is that funders have no significant engagement with research leaders in development of funding priorities. This contrasts the structure of funding organisations in say the US, Finland, Germany and UK where academic and industrial advisors and boards help direct the work of the funder. The opportunity to create a lean funding organisation for DECC with advice from researchers would make a significant contribution to improving engagement.

In terms of my own organization as an example, AMBER, the SFI Centre for Advanced Materials and BioEngineering, more direct contact is needed. Sustainability of materials and materials science is central to our manufacturing industry and a focus of the centre. We lead not only research but also in the development of standards at ISO and EU level. We work closely with companies in developing new, sustainable materials and processes. We have a large proportion of funding at EU and national

level for developing the science of sustainable materials. We are very active at European level in development of the Advanced Materials Initiative, 2030 which is heavily focussed on policy for sustainable material developments and have driven the inclusion of focusses on the circular economy and measurement and assessment. However, we have had very little engagement with DECC despite efforts. DECC needs to create its own detailed knowledge of the ecosystem and who does what and how it might advantage the objectives of the Department. There is an opportunity to involve existing centres by co-funding with SFI such as creating new interest areas that align research goals and thrusts. This should be explored particularly where work could be funded between existing centres, e.g. AMBER + MAREI + BIOORBIC. This may be a more viable approach than creating a dedicated research centre.

8. **Should the Department seek to grow its capacity to carry out in-house research? If yes, how can this be achieved?**

The answer is yes and outlined above in question 6. If the environment is a research priority, very significant increases in funding are needed. Working with the current eco-system to bring the best of our scientists (technical and social), economists, industrialists together with a shared mission to meet the climate and ecosystem emergencies should be a priority. Creating a DECC funded centre should be seen as a necessity. It should be emphasised that this will require research across a number of disciplines. There remains siloing of researchers in e.g. climate, the environment, chemistry, materials science, business and economics, political science etc. A centre should prioritise the need of truly transdisciplinary work.

There are examples of Government led or funded centres which might be considered. In the area of the circular economy, the centre at Cambridge is world-leading and helping evolve UK policy. It combines world-leading economists and scientists to evolve and test solutions.

https://www.jbs.cam.ac.uk/faculty-research/centres/circular-economy/

This is a more distributed model for a centre based on a number of universities and organisations which might also be considered.

https://www.closedlooppartners.com/the-center/

However, we would think there is a case that instead of following we lead the development of such a centre.

9. **Are there examples internationally of Government strategies on research and innovation in climate, communications / digital, circular economy, cyber security, energy or environment that we should examine? If so, can you provide details?**

It should be taken as a truism that a circular approach to the use and end-of-life of products, components and materials is a critical tool in the pathway to sustainability. Until we decouple from extraction of materials (especially fossil fuels) and waste production, we will not have a sustainable manufacturing sector. As such it is the priority for funding. WRAP in the UK has provided clear evidence of a circular approach to meeting climate goals.

https://wrap.org.uk/taking-action/climate-change/circular-economy

The UK has led the development of dedicated funding to transition towards a circular economy:

https://www.ukri.org/news/national-circular-economy-research-programme-launches/

It includes all stakeholders from science, environmental, societal, industrial and economics and develops solutions for implementation and informing policy. The multi-disciplinary and trans-disciplinary nature of the research is a requirement. It has a budget of 30 million Euro which is recognised as an underfunding already. Some researchers believe this to be an order of magnitude too low.

The UK has probably pioneered dedicated funding in this area and whilst funding is low, it still represents sound policy in this space,

10. **Are there any other matters you wish to raise in relation to the development of the research and innovation strategy?**

The main aim of Government is to provide SIGNIFCANT funding for research and innovation and then onward implementation. It should consist of elements that include:

- Examining needs and funding research for the 2030-2050 climate goals outside of renewable energy with a focus on industry and difficult to meet targets.
- A broad fundamental research program that would help generate new expertise and trained people to help change thinking in UK. It should be solution focussed and have a transdisciplinary nature.
- Focus on developing innovative solutions in collaboration and partnership with industry particularly our existing large companies. There are dangers of ignoring this research focus and impacting inward investment and even de-anchoring existing companies.
- There needs to be a link to innovation funds aimed at translating laboratory research to implementation. A clear need in industry funding and support. Significant investment funds are needed.