AMBER

A World Leading SFI Research Centre

Science Foundation Ireland For what's next

Advancing ——Materials for Impact

Pre-Budget Submission 2024

ambercentre.ie
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HOST INSTITUTION

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

PARTNER INSTITUTIONS

CRANN, RCSI, UCC, Tyndall, DCU, University of Limerick, TUS, University College Dublin

FUNDED BY:

Science Foundation Ireland For what's next

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Background

Established in 2013, AMBER is the Science Foundation Ireland (SFI) Research Centre for Advanced Materials and BioEngineering Research hosted by Trinity College, University of Dublin, with researchers in 8 additional partner institution around Ireland: RCSI, UCC, Tyndall, DCU, University of Galway, University of Limerick, TUS and UCD.

The AMBER mission is to drive excellence in materials science research for the benefit of people, planet and prosperity enabling a sustainable future through innovating materials technologies that support a healthy planet.

The Centre's strategy reflects the three main pillars:

I. World-class materials innovation resulting from the excellence of our research which underpins everything we do,
II. Partnership and engagement with industry not only on collaborative research, but also to contribute to the ethos of the centre in terms of governance & strategy, emerging research challenges and researcher development, and
III. Impact with a focus on ensuring efficient translation of our research for economic, environmental, health and societal impacts.

We are at the forefront of driving advances in materials science and bioengineering and translating research excellence into new discoveries and devices. Our research develops technology to address industrial and global challenges from novel data processing and memory applications, energy storage and energy-efficient devices, regenerative medicine, and drug delivery systems through to plastics sustainability and supporting key national targets such as our zero-carbon 2050 target.

AMBER delivers a unique, integrated capability for materials research to accelerate innovation:

- Brings together Irelands leading researchers across nine higher education institutions.
- Provides access to advanced facilities.
- Provides a gateway to significant European funding.
- Has a team of professional supports to scope, build, and ensure completion of projects to the highest standards, with IP and knowledge transfer capability.

Research and Innovation Bill 2023

Within the Research and Innovation Bill research infrastructure is only mentioned in relation to consultation with the Higher Education Authority (HEA) under an explanatory note[1] which calls for consultation on annual plans where there is overlap in areas such as research talent and research infrastructure. There is an opportunity with this legislation and establishment of a new research agency to give it a mandate for oversight of research infrastructure in the country. There should be a scheduled and ongoing review of infrastructure on the island as funded by the new agency, this can prevent wastage and degrading of the equipment and provide for real-time analysis of funding needed on an annual basis to ensure that Ireland's research infrastructure is adequate to facilitate our research goals and ensure that Ireland is at the forefront of research technology and innovation.

National Investment in Research and Development

As per the figure below from Eurostat Ireland's GBARD has decreased in the last 10 years from .43% of GDP to .2%. Given the challenges that Government and indeed society wish to see succeed as part of initiatives such as IMPACT 2030 spending on Research and Development must increase in the 2024 Budget. Science Foundation Ireland (SFI) in 2017 as per figures available, accounted for 23.4 percent (€173.3 million) of total Government spending on R&D.[2]

Science Foundation Ireland is due to be merged with the Irish Research Council (IRC) as part of the Research and Innovation Bill 2023 however given that it accounts for almost a quarter of the funding allocated to Research and Development a greater budget is needed for the new Research and Innovation body as it will contend with a larger remit and impending national and international challenges.

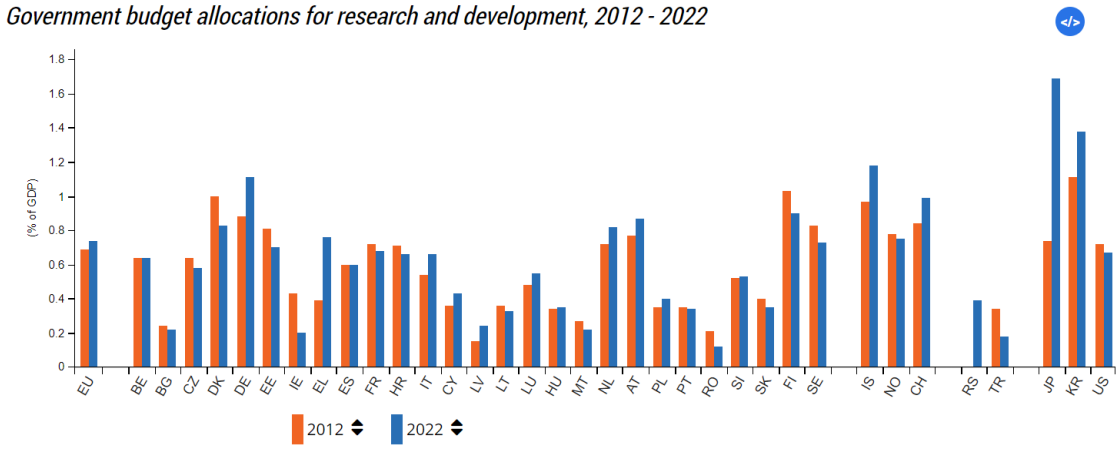


Fig1 Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_budget_allocations_for_R%26D_(GBARD)&oldid=573250

[1] General Scheme of Research and Innovation Bill2023, Pg 80, Explanatory Note 1(b), accessed August 2023, https://www.gov.ie/pdf/?file=https://assets.gov.ie/252172/8dcd8849-6bae-45d4-9739-fb627ec7dc1d.pdf#page=null

[2] Spending Review 2019 Analysis of Science Foundation Ireland Research Grants ROBERT KEOGH AND NIALL HICKEY DEPARTMENT OF PUBLIC EXPENDITURE AND REFORM IGEES UNIT AND DBEI VOTE accessed at https://assets.gov.ie/25647/b041ef6d714c4414ac0cbe0eaf329795.pdf

Skills & Development

PhD Supports

PhD students perform many teaching and learning support functions within universities and renumeration for this varies not only between institutions but also within individual institutions and faculties. A standard framework applicable to all PhD and master's researchers to ensure a consistent policy for payment for these activities across all colleges, and subjects would ensure greater transparency and fairness. Some concerns that AMBER has regarding current PhD structures and supports include:

- There is an urgent need to increase PhD stipends to a value of €25,000 to €30,000 (tax free) in line with our high cost of living. This should be implemented across all funding agencies, to ensure pay equality within and across organisations. This also needs to be monitored year on year for necessary adjustments to track with inflation growth to ensure that this issue is not repeated. The current stipend of €19K does not provide a liveable income for students with the current cost of living. This is particularly true for students studying away from home including non-Irish students and students coming from disadvantaged backgrounds. This limits the numbers applying for studentships, particularly affecting our ability to attract good students from abroad. Student stipends are not competitive against other countries. By way of comparison, in Germany, the average stipend is €24,500, in France €27,000 and in the Netherlands €38,400.
- The lack of both stipend and research funding makes Ireland uncompetitive internationally. Bringing in the best of the world raises standards in Irish research providers. Whilst the number of people enquiring about positions available has increased, the numbers taking positions has halved in the last 3 years. This has reduced competition and poorer quality students are being recruited.
- PhDs provide some teaching (for undergraduates) in schools and departments. This is vital to the universities and is valuable experience and learning for the PhD students. The classic role of laboratory demonstrator is well known to most PhD students. A decrease in the number of PhD students has ramifications for the organisation and effectiveness of teaching, increasing the ratio of PhD student: undergraduate student will result in a poorer experience for all concerned.
- Advanced industry sectors such as MedTech, semiconductor, pharmaceutical and other sectors, rely on PhD recruitment to develop the industry leaders of the future. Decreasing numbers and quality has a cumulative effect. In the semiconductor industry, about 1/3 of all PhD recruits are from foreign countries. While incoming talent is to be welcomed, it leaves industry with recruitment shortages. If Ireland is to be seen as a centre of excellence with a mobile talent pool, both the number and quality of students need to be increased.

The Independent report on supports for the PhD researchers in Ireland was published by Minister Simon Harris in late June 2023. In the report, the Co-Chairs recommend an increased stipend level, with an

optimum target of €25,000[3]. This recommendation is far off the necessary increase required to facilitate a basic standard of living for PhD researchers. As has been widely reported[4] the Low Pay Commission has recommended to Government a 12% increase in the minimum wage in Budget 2024 which would bring the minimum wage to €12.70 an hour from January 2024 which is equivalent to €25,095 based on a 38-hour working week, so the recommendation of Minister Harris' Report will see PhD researchers fall below the minimum wage once again.

In contrast the minimum wage in Latvia is €620 per month[5] with proposed legislation due this Autumn PhD students will be given state salaries of €1000 per month in addition to an obligation on Universities in Latvia to match based on involvement in research projects[6]. The aim of this legislation and increase in salary is to increase conditions for PhD students and also to ensure that they are engaged with Research and Development from the beginning of their studies.

[3] https://www.gov.ie/pdf/?file=https://assets.gov.ie/261655/13774a0b-e8c9-4956-bb62-336250ad6038.pdf#page=null

[4] https://www.rte.ie/news/2023/0718/1395164-minimum-wage/

[5] https://www.lm.gov.lv/en/minimum-monthly-wage?utm_source=https%3A%2F%2Fwww.google.com%2F

[6] https://sciencebusiness.net/news/universities/latvia-overhaul-phds-and-academic-careers

STEM Education

AMBER as a world class scientific research centre relies on STEM educated individuals to conduct the highest quality materials science and engineering research. We believe that excellent, relevant and up to date Primary & Secondary level STEM education is a vital foundation for the development of current and future materials scientists, engineers and researchers. Ireland has had success in developing a highly educated populace through policy and its delivery at primary, secondary and tertiary levels. However there remains shortages of highly educated STEM school leavers for industry and academia. There also remains a lack of gender diversity with engineering subjects in particular remaining male dominated. Gender balance is manifest in senior industry and university positions.

Ireland has a technology-based manufacturing economy with materials science and engineering at its heart. To maintain our international success and our economy we must improve STEM education, its uptake, its quality and its diversity. It is also imperative to adapt our STEM education to ensure our preparedness as a society for future developments. As the world enters an era where the elements of society and industry must be sustainable, our education must reflect a need for all its citizens to embrace change and to provide STEM trained school leavers and graduates the expertise to drive our economy forward whilst protecting the planet.

Resourcing of STEM Education

Industry and Education have engaged in mapping out requirements for future literacy in STEM subject areas including availability of teachers within subject areas, but this is being done on a piecemeal basis. For example, the recent University of Galway Report 'Capacity for, access to, and participation in computer science education in Ireland'[7] commissioned with the support of Google found that in the area of computer science only 16% of schools are offering the subject to senior cycle pupils and the majority of teachers are giving classes, without Teaching Council accreditation to do so. Lead Author of this report Dr Cornelia Connolly, said the findings showed a significant volume of work was needed to ensure that all students had the opportunity to develop essential computer and coding skills, subjects that needed to be viewed as a "foundational competence for all" and that computing education be introduced at an earlier age so that students' technical use and understanding correspond with their high level of access to phones and smart technology.

The findings of this Report are an example of the primary and secondary level education system being ill equipped to meet current and future standards in the delivery of fundamental STEM education. SOLAS' Skills and Labour Market Research Unit (SLMRU) as part of its remit to 'provide a data gathering, analytical and research resource to identify skills needs and support the work of the National Skills Council' should be tasked with reporting on STEM, mapping future input needs as regards workforce and education and reviewing on a 5-year basis and in conjunction with IMPACT 2030 targets.

Provision of STEM Education

There currently exists a plethora of optional and additional CPD courses for educators in primary and secondary level education including some of which the AMBER Centre itself has devised and engaged with. This includes a suite of 6 dedicated lesson plans and resources for teachers for ages 4 through to

[7] Connolly, Cornelia, & Kirwan, Colette. (2023). Capacity for, access to, and participation in computer science education in Ireland. Galway, Ireland: University of Galway, https://doi.org/10.13025/bccm-2c38

transition year. This resource[8] was developed by AMBER with the aim of improving teachers and their students' content knowledge of material science, understanding of materials science and society relationships, build awareness of materials science and STEM careers and develop students' sense of science identity (being a scientist) facilitating the teaching of science with other subject areas in an integrated manner.

The programmes integrate other value learning pillars focusing on integration of science lessons with literacy, drama, and design and make, developing children's skills in working scientifically, while also meeting literacy and drama objectives. The modules provide teachers with a framework to build a narrative with young learners, with the express objective of developing oral language skills, cooperation, art, design, and STEM learning. Our resources are developed with and for teachers and teacher educators, to ensure they are age appropriate, based on sound pedagogical practice.

Examples of AMBER's engagement and outreach to Primary level school children and educators:

• Primary resources developed including Materials Now and NanoWOW2![9]

  - The NanoWOW! Programme launched in 2014 and was developed for children between ages 10-12 years old, but it is also suitable for older and younger children.
  - NanoWOW! includes short educational videos hosted by AMBER scientists to introduce the properties of materials, the concepts of scale and surface area, exploration of graphene one of the first nanomaterials to be found (and one that is inside a pencil!), discussion of where nanoscience could take us in the future, and how we are using nature to inspire new nanomaterials to solve common problems.
  - Each lesson has a combination of downloadable resources which include background information for parents and teachers, and details of experiments and learning activities for children.

- AMBER collaborated with Education Support Centres across the country and STEAM in Junior Cycle throughout February and March 2022 to deliver 18 professional development workshops for over 200 primary and post primary teachers. These workshops were based on the content from our AMBER spiral learning programme. AMBER again participated in 2023 with the STEAM project.[10] A focus for us has been sustainability with materials developed on the circular economy and plastics and helping students and teachers meet the needs of the 'Education for Sustainability Programme'.
- Primary online hands-on materials science workshops were delivered to over 750 primary school students in May and June of 2022. Materials for experiments were posted out to schools in advance of the workshops. DEIS and rural schools were given priority for places on this programme.
- Amy Fahy, AMBER's Training and Outreach Manager presented a paper titled 'Leadership in STEM,' at the International Academy of Management Conference Presentation, Seattle, August 2022. This

[8] https://ambercentre.ie/engage/schools/overview/

[9] https://www.youtube.com/watch?v=CGn1mFwXXvo

[10] 'The vision of STE(A)M in Junior Cycle is to "Provide Junior Cycle teachers with rich STE(A)M professional learning experiences in keeping with national and international best standards, which will allow for interdisciplinary responses to societal challenges in subject specific and cross curricular contexts".'
https://www.jct.ie/steAm/steAm

paper explores the perceptions of Irish primary school principals on leadership in STEM, and highlights the importance of specialist teacher instruction, i.e., school-scientist collaborations.

The above initiatives have served to engage greater and more diverse and disadvantaged primary and secondary level students and educators. However, this piece meal basis of STEM engagement and CPD for educators should be prioritized by the Department of Education in Curriculum. Teachers engaging in STEM education should be adequately resourced, prepared, certified and targets for teacher recruitment should include the prioritization of STEM qualifications. The Department of Education should as a first step ensure STEM has a structured place in both primary and secondary level curriculum and that subjects such as sustainability are properly treated within STEM programme. STEM programmes should be delivered with consistent quality across the school network. Secondly engagement with Boards of Management to ensure that schools are resourcing teaching staff and infrastructure to facilitate STEM teaching and that where feasible local schools are sharing resources and infrastructure to offer subjects to all students in a catchment area. Historically it was not uncommon for schools in Local Authority Areas to link up to provide a physics or chemistry class for example to students from various schools within one school that has labs and accredited staff to teach.

Supporting & Retaining Research Talent

PhD researchers currently engaged in STEM subjects are the future of teaching and the various hi-tech industries in Ireland. They are our future industry leaders and the vital element in maintaining and developing Ireland's technological economy. Identifying, harnessing and supporting this talent source now can only seek to future proof Ireland in its ambitions to continue to be a world class leader in research, development and innovation and be an attractive location and talent pool for companies seeking to engage in such industries. However, without adequate supports and funding, this vital supply of talent into the future is at imminent risk of drying up.

As AMBER and many other parties have identified in recent PhD support consultations there is a barrier to entry into STEM at third level currently. Barriers exist in the form of Economic viability and affordability. The current stipend of €19K does not provide a liveable income for students with the current cost of living. This is particularly true for students studying away from home including non-Irish students and students coming from disadvantaged backgrounds. This limits numbers applying for studentships particularly affecting our ability to attract good students from abroad. Student stipends are not competitive against other countries. By way of comparison, in Germany, the average stipend is €24,500, in France €27,000 and in the Netherlands €38,400.

The chronic lack of funding also results in PhD students being left with no option other than to engage in additional out of hours part-time work in other sectors which does not contribute to their studies. This inevitably entails out of hours and weekend work on top of existing hours committed to PhD work and study which can lead to fatigue. If this does not lead to burn out it can impact upon both the quality and duration of their research. The relatively low numbers of PhD opportunities mean that students can be isolated from the support of their peers. These issues have a demotivating effect leading to higher dropout rates.

Major investment in both the numbers and quality of PhD research is urgently required. Per capita we educate less PhD students than our competitors such as the UK, US, Germany, Netherlands, Asian nations etc. and numbers of PhD registrations have dropped considerably in the last 10 years. Research

and funding within STEM should also be broad and not solely reliant or linked to industry or competitive grant funding. Indeed, the recently announced Spanish pilot of flexible open-ended funding for researchers[11] which will provide researchers with stable funding for four years to explore new ideas and build capacity, without being tied to specific projects. This provides an opportunity for researchers to explore new ideas without the time constraints of applying for or seeking national or EU grants, which can only serve to improve quality of research and science and compliment traditional funding models.

Industry & Workplace Engagement

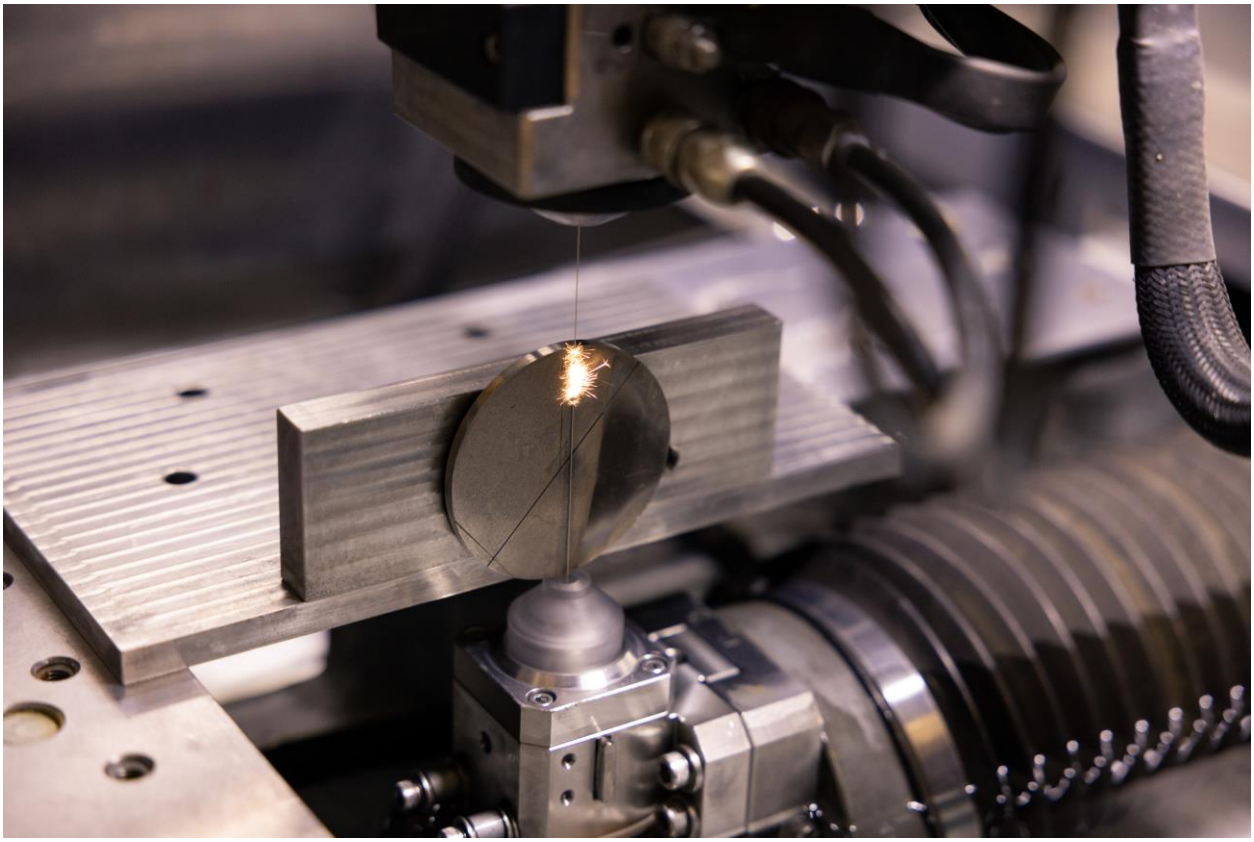
Continuing and ongoing engagement with industries and workplaces within the STEM sector is needed whilst developing and monitoring STEM education and resourcing. It must be acknowledged that whilst reviews of PhD funding are ongoing, research centres such as AMBER are essentially employers (and a significant one) of the STEM workforce, be they post-doctoral researchers, PhDs, investigators or other. The opportunity to contribute to this roundtable should be a first step for ongoing engagement between research centres such as AMBER and the Oireachtas. As a research Centre AMBER is uniquely positioned at the coal face of third level STEM education and the intersection of industry. It is the aim of AMBER and research centres who are dealing in real time with the deficit in personnel qualified in STEM nationally, to contribute to solutions to futureproof Ireland's STEM education.

Steps must be taken to safeguard the future of STEM as a significant industry in Ireland, employer and contributor to the national exchequer. Education requirements need to be addressed to meet demands for highly qualified school and college leavers and the evolving needs of students to meet expectations in areas such as sustainability. Mapping exercises of teaching resources and future workforce are greatly needed and should be conducted regularly in line with IMPACT 2030 and to reflect the ever-changing technology and science landscape. With adequate data from mapping and forecasting the focus should be investment to ensure a resilient workforce, which can adapt to changing market needs. Finally, the prioritization of STEM education as part of the national curriculum will ensure that research and innovation is facilitated to focus of finding solutions for the benefit of people, planet and prosperity.

Infrastructure

We welcome the plan for the Higher Education Authority to develop an infrastructure investment framework to develop projects compatible for the re-allocation of National Development Plan (NDP) underspends. Provision of funds for basic, essential infrastructure is a high priority if Ireland to achieve the ambition of IMPACT 2030 and to remain internationally competitive as a location for research talent and investment. As highlighted in last year's Indecon report, significant proportions of essential research infrastructure are no longer viable due to obsolescence and an inability to fund maintenance contracts and support. We would welcome the opportunity to engage with the HEA on the developing of a future strategy for the sustainable management of infrastructure which balances both responsible management of resources with the needs of an internationally competitive research environment.

[11] https://sciencebusiness.net/news/International-news/spain-pilot-flexible-open-ended-funding-researchers



National Training Fund

The National Training Fund Act 2000 states the levy on employers is for the purpose of funding the development of and raising of skills amongst those in, or seeking, employment. There is currently a significant surplus in the National Training Fund (NTF) that by 2025 is projected to rise to between €1.4 billion and €1.9 billion. Whilst the current exchequer surplus has not yet been earmarked and debates continue regarding reserving that surplus for a rainy-day fund, in contrast as per the 2000 Act, the National Training Fund has a clearly defined purpose to support development and raising of skills. The 1% employers contribute from their payroll (increased several times via the Budget between 2018 – 2020) which has led to the surplus should be strategically allocated with a focus on upskilling through research infrastructure investment. Immediate and ongoing/ annual allocation of NTF surplus to this area should be committed to in Budget 2024.

The National Training Fund Advisory Group (NTFAG) was established in 2019 following the Indecon Independent Review. However, the current membership (listed below) of the group lacks an educational representative to give perspective outside of DFHERIS or a similar semi-state. Two educational representatives must be added, one from the Irish Universities Association (IUA) and an additional member from the wider educational sphere appointed via by open competition.

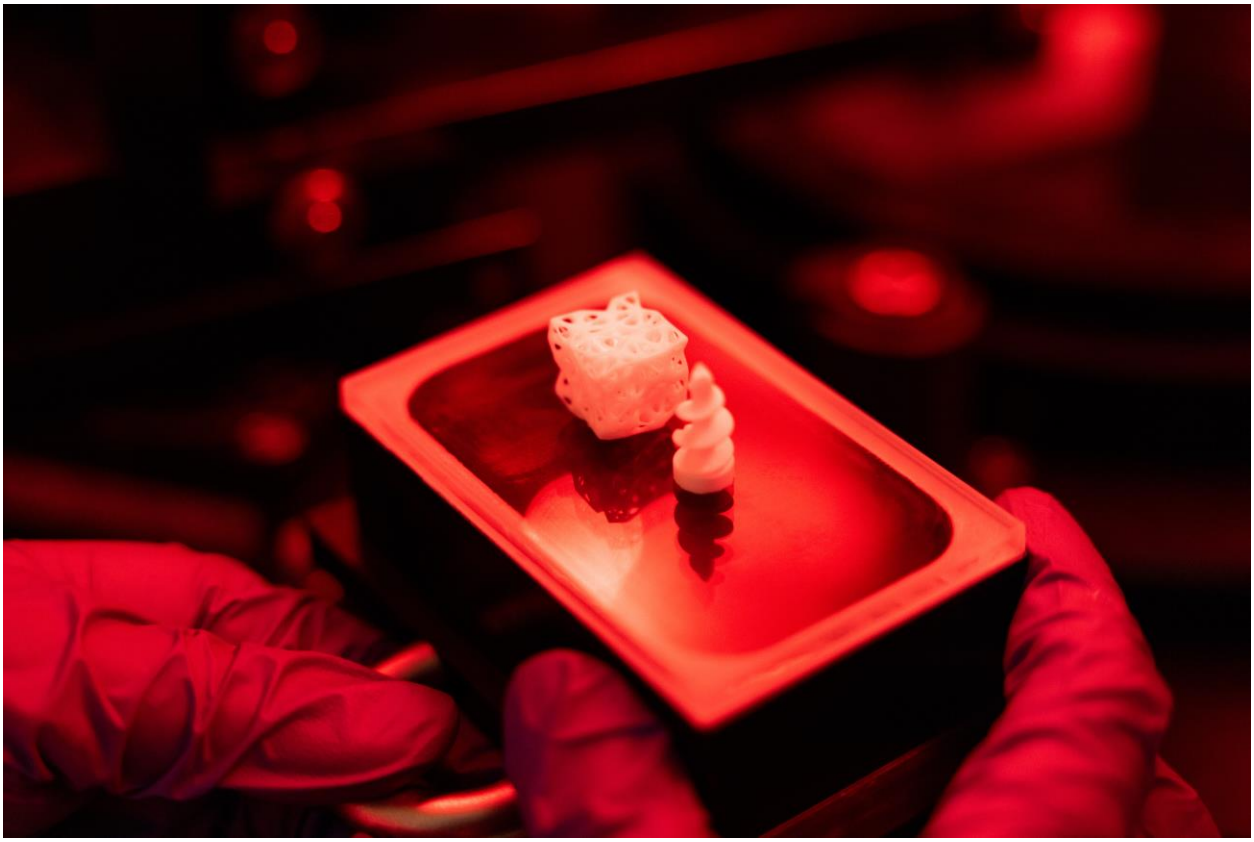
NTFAG Membership

- ISME
- IBEC
- Chambers Ireland
- Construction Industry Federation
- Irish Exporters Association
- Irish Hotels Federation
- American Chamber of Commerce Ireland
- SOLAS
- Skillnet Ireland
- The Wheel
- Higher Education Authority
- Department of Business, Enterprise and Innovation
- Department of Social Protection
- Department of Further and Higher Education, Research, Innovation and Science

https://data.oireachtas.ie/ie/oireachtas/parliamentaryBudgetOffice/2023/2023-06-20_an-overview-of-the-national-training-fund-ntf_en.pdf

Action:

- Inclusion of 2 education representatives on the National Training Fund Advisory Board
- Commitment of allocation of current and future NTF surplus to maintaining research infrastructure



Science Forum

Whilst the establishment of a National Science Advice Forum and Government Science Advisor are welcome initiatives there still exists an opportunity for the Science and Research community to engage with legislators in a broader way. Looking at existing forums such as the Hospitality and Tourism Forum[12], the Retail Forum[13] and the Responsible Business Forum[14] a similar Science and Innovation forum should be established with an inter-departmental membership at Government level due to the place of science and research within all aspects of societal challenges, including health, construction, business and enterprise, education, environment and more. The proposed makeup of the remaining members to include Deans of Research in Universities and TUs, Directors of SFI Research Centres, with a number of positions open for academics of various disciplines within Science and Research. The aim of the group being to discuss and plan for challenges facing the country that can be facilitated by the Science and Research community, how best to support the sector to ensure a stable economy inclusive of FDI and wider European and Global challenges.

[12] https://www.gov.ie/en/news/43de4-hospitality-and-tourism-forum/

[13] https://enterprise.gov.ie/en/publications/retail-forum-membership.html

[14] https://www.gov.ie/en/press-release/5a343-minister-calleary-hosts-inaugural-meeting-of-the-responsible-business-forum/

The economy, circularity, and sustainability

The linear economy of take, make, use, dispose and the development of mass production and consumerism to drive economies has led to the decimation of our natural environment. Since the 1940s we have decreased the amount of wild spaces on the planet by 50% (thereby decreasing biodiversity in the land and sea by the same amount), raised global temperatures by 1.5C and threatened the existence of many species. As a result of the increased standard of living, technological and medical advances, life expectancy and modern healthcare that the linear economy has brought, the human population has risen towards and will exceed more than 10 billion.

The use of fossil fuels have driven climate change which is now accelerating due to factors such as decreased tree coverage, melting icecaps, rising ocean temperatures, the increased % of arable land vs 'wild' land due to human habitation and farming to feed our peoples. Fossil fuels have largely sustained our development as a source of energy and the materials we build out technologies from. Fossil fuels are the basis of the petrochemical industry and sectors such as construction (cement, iron, insulation…), plastics, metals, ceramics whether used in associated combustion or as raw materials. Switching from fossil fuel energy to sustainable energy (solar, wind, geothermal hydro) is no longer enough to change the arc of climate change; our industries and technologies need radical change if we are to reverse the damage humankind have imposed on the planet by moving to net-zero economies. This will also not be enough, we must develop lifestyles, industries and farming to reverse the changes and decrease our reliance on our natural resources.

A key contribution to decreasing our reliance and impact on the environment is the concept of a circular economy[15]. Recent work by the UN suggests that a circular approach could reduce CO_2 emissions by over 40%[1]. In an ideal circular economy, materials are maintained in repeated use-cycles so that their use can be decoupled from extraction and from end of use waste production. This circular approach reduces our reliance on the environment allowing re-wilding environments particularly those that are extremely sensitive. Whilst decoupling production and use of critical materials, including fossil fuel resources, from extraction has obvious advantages (e.g. maintaining plastic through repeated use cycles decreases plastic manufacture through fossil fuels and the effects of plastic waste), the circular economy must not substitute current resources at the expense of renewables such as timber and other biomass. In this way all resources in a circular economy must be carefully managed to ensure sustainability such that natural capital is maintained and increased. Whilst the circular economy is often seen as existing within the Technosphere, the true value of a circular economy is its interaction with and improvement of the biosphere.

EU policy has recognised the importance of the circular economy by developing a circular economy action plan[16]. This is a raft of legislation introducing key features of a circular approach to developing a more sustainable EU Policy across the union. The CEAP has a key focus of increasing recycling and reuse. Ireland has signed up to the CEAP but lags behind its EU partners with the lowest level of circularity in

[15] https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change#:~:text=Studies%20show%20us%20that%2C%20through,by%2040%20percent%20by%202050

[16] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

the union (<2% in 2021)[17]. The National Circular Economy Action Plan has a broad reach aiming at reducing waste and increasing circularity at a domestic level. However, many of the measures have very limited impact (e.g. the 'coffee cup levy' which will have limited effect). Measures such as the roll out of deposit-return schemes have been delayed and other measures such as decreasing industry waste require private industry to implement measures rather than direct Government policy (e.g. asking waste companies to regulate disposal). Failed policy is reflected in poor plastic packaging recycling figures and over reliance on incineration to reduce waste.

The circular economy is much broader than simply targeting waste and recycling and needs firm policy to reduce reliance on resource extraction and thereby reduce environmental impacts. Specific actions include:

- Increased recycling of plastic, metal, and other material waste into high value products. Research and policy to reduce down-cycling of resources is a priority. The aim to recycle through multiple use cycles without degradation.
- Natural resource dependence must be reduced, and these must be properly managed with a view of improving environmental benefits including biodiversity.
- Managed and sustainable natural resources must be used to develop advanced materials for use across all industry sectors. A key focus must be sustainable construction materials.
- Developing recovery methods so that products, components, and constituent materials can be reused. This might extend to reuse of semiconductors in similar or different products.
- Design of products (including reconstruction) allowing recovery, reuse and extended use of products, components, and constituent materials.
- Design for ease of repair embracing the concept of 'right to repair'.
- Development of methods for measurement of circularity and sustainability so that the most sustainable approaches can be used.

Oireachtas Friends of Science & Technology Group

As outlined above, announcements by Minister Harris of the establishment of various Science Fora in the coming months such as Government Science Advisor and the National Science Advice Forum and the Research and Innovation Policy Advisory Forum are welcome. The structure of the Fora are however prescriptive in both their purposes and objectives as outlined below and rightfully so.

National Science Advice Forum

- "to provide cross-sectoral and multi-disciplinary science advice to the government".

[17] 1. https://www.circularity-gap.world/#:~:text=The%20Circularity%20Gap%20Reporting%20Initiative%20highlights%20the%20urgent%20need%20to,action%20to%20accelerate%20that%20transition

- "will assist in informing responses to complex and challenging policy issues like climate change, food sustainability, artificial intelligence, cybersecurity and emerging technologies and to needs identified by ministers and government departments".[18]

Research and Innovation Policy Advisory Forum

- "objective is to inform and support national research and innovation policy"[19]

Consideration should be given to maintaining the Oireachtas Friends of Science & Technology Group which should exist alongside the proposed Fora and provide for more informal engagement between all legislators, both Government parties, Opposition, Seanad and indeed support staff and advisors of Leinster House. The Group which has an informal standing in the Oireachtas was established by Mary Harney in 2002 as the 'Friends of Science' cross party Oireachtas Group and is now the Oireachtas Friends of Science & Technology with Deputy Denis Naughten TD as convenor.

Understandably due to COVID briefings and meeting of the group and those from the Science and Technology sector were sporadic[20] and it is notable that the current convenor Deputy Naughten will not contest the next General Election putting the Group at risk of falling by the wayside. This Group can provide a vital information exchange between industry, research and politicians and should be maintained.

National Science Centre

Whilst news of the upcoming National Children's Science Centre coming in 2025[21] is welcome consideration should also be given to exploring a National Science Centre. Initiatives such as Science Week which is inclusive of all levels of understanding, ages and backgrounds are a fantastic way to engage the public in the everyday science that we utilise and helps our society to function, however a couple of weeks in the year is not sufficient.

The closing of the Science Gallery in Dublin should not be the end of engagement of the public in Science and Science Communication. The Science Gallery provided an invaluable opportunity for research and science to be accessible and inclusive and was a great success from that perspective. Mismanagement of the business end of the gallery should not lead to a reluctance by Government Departments to establish a new national centre for the public to engage in science.

[18] https://www.gov.ie/en/press-release/f343c-national-science-advice-forum-and-government-science-advisor/
[19] https://www.gov.ie/en/press-release/c6f16-minister-harris-establishes-new-research-and-innovation-policy-advisory-forum-and-issues-call-for-members/
[20] https://www.oireachtas.ie/en/search/?searchType=newsArticles&q=friends+of+science
[21] https://www.nationalchildrenssciencecentre.ie/

The rise of misinformation particularly in the area of the health sciences following COVID should spur on greater and more transparent engagement in science with the public and a science gallery or museum for all ages is a first step for this. A vacuum of reliable information will only be filled by misinformation.

Europe

Net-Zero Industry Act

when it comes to the climate, it is pertinent to outline, why Net Zero? To my mind the United Nations summarises it best, "The science shows clearly that in order to avert the worst impacts of climate change and preserve a liveable planet, global temperature increase needs to be limited to 1.5°C above pre-industrial levels. Currently, the Earth is already about 1.1°C warmer than it was in the late 1800s, and emissions continue to rise. To keep global warming to no more than 1.5°C – as called for in the Paris Agreement – emissions need to be reduced by 45% by 2030 and reach net zero by 2050". Recent IPCC (Intergovernmental Panel on Climate Change) data suggests that the 1.5°C target is very likely to be missed without accelerating actions. Of particular relevance is Ireland's missed 2020 target goals (a targeted 20% cut of 12.2 million tonnes of carbon dioxide, or 25% of our 2020 target) despite several COVID19 related lockdowns limiting transport. In 2021 our emissions increased by more than 5% on 2020 figures. Of particular relevance today is the stark fact that in 2021 emissions from energy generation increased by 17.6% on 2020 figures largely due to an increase in coal use (+245% increase) and a decrease in renewable energy for electricity generation (EPA data).

Because of these stark facts, AMBER generally welcomes the Net-Zero Industry Act however before this EU legislation progresses there are distinct issues with the current proposal that must be addressed. The

first is that this act focuses on building a strong and resilient renewable energy solution (materials and products) supply industry in the EU with technologies being manufactured in the region. This becomes somewhat unclear in the proposal and the challenges are under-estimated.

You will have read our submission which outlines several such issues, but for the purpose of this initial discussion we will briefly outline the main issues as we would see them.

Technologies identified with the Act are comprehensive, including.

1. Solar photovoltaic and solar thermal technologies,
2. Onshore wind and offshore renewable technologies
3. Batteries / storage technologies
4. Heat pumps and geothermal energy technologies
5. Electrolysers and fuel cells
6. Sustainable biogas/biomethane technologies
7. Carbon capture and storage (CCS) technologies
8. Grid technologies

However, these technologies should be prioritised (particularly in Ireland), i.e. where can investment provide the quickest and most extensive contribution to emission reduction? Where can we develop industry opportunities around material, component, and product manufacture?

A *summary is required of each technology in terms of:*

A. stage of development and ease of deployment,
B. its estimated importance as a contribution to energy demands and
C. the research that is needed.

Independent assessment of the technologies should be seen as an important parallel activity.

Pillars 1 and 2 of the Act both mention technologies for CO_2 abatement which is not explicitly related to renewable energy production. We recognize that all forms of renewable energy are not carbon neutral requiring carbon intensive materials and technologies with downstream impacts in material end-of-life, disposal and raw material depletion. Both CO_2 capture and storage as these Pillars mention, is a vital consideration for climate change reversal however it would be our recommendation that CO_2 be legislated for separate to this Act. In the near-term, it does not offer a solution to direct energy emissions and is unlikely to make fossil fuel energies sustainable.

Regarding Pillar 4 and the need for enhancing the workforce. We welcome the recognition that a 'new' highly trained and educated work force is needed but we have reservations around the required education and training being carried out through as of yet poorly detailed Net-zero Academies. A focus on delivering training from current suppliers should be prioritised.

Pillar 5 is of direct relevance to research providers in Ireland and Europe. Many of the proposed technologies are early stage, low TRL and practical solutions at demonstration and even laboratory levels. How might research priorities be identified and how might they interface to the Net-zero academies? We need much closer links to innovation actions, policies and funding in this space.

We will also point out that there are barriers to this policy, many of the critical raw materials are from outside the EU, there are supply chain challenges in terms of existing channels for integrated circuits, materials including plastics/adhesives/metals as well as components and products. We would also see issues because the downstream effects of these technologies have not been considered including the circularity of materials and components and their end-of-life.

We would also emphasise that this act should not be seen as a route to climate compliance. Energy is about one third of Ireland's greenhouse gas emissions. This act focusses on electricity supply, but electricity cannot meet the energy demands for all industry sectors. The act is based on EU policies driving towards 70 and 80% of all electricity generation through non-fossil sources by 2030 and 2050 respectively. This could result in a 70% decrease in energy related emissions by 2050 but this now emphasises the critical need for changes in industry, agriculture and construction.

Critical Raw Materials Act

In March 2023, the European Commission published the Critical Raw Materials Act, which seeks to secure diversified, affordable, and sustainable supplies of critical raw materials in the EU.

Critical Raw Materials (CRMs) are defined as 'those raw materials which are economically and strategically important for the European economy but have a high-risk associated with their supply.' They are found in items as diverse as washing machines, mobile phones, construction tools, car parts, airplanes, and satellites.

These materials are classified as CRM not because they are scarce, but because they are critically important to key economic sectors; they have a high-supply chain risk due to their concentration in particular countries; and there is a lack of alternatives due to their unique properties.

Critical raw materials are of high economic importance for Europe while being also highly vulnerable to supply disruptions. Today, Europe relies heavily on imports, often from a single third country, and recent crises have underlined EU strategic dependencies. The European Commission believes that without joint and timely action, a well-functioning single market, resiliency and competitiveness, European industries, and EU efforts to meet its climate and digital objectives could be at risk.

The proposal for a Critical Raw Materials Act is a comprehensive response to these challenges. Building on the strength of the single market, the Act will ensure that the EU can rely on strong, resilient, and sustainable value chains for critical raw materials.

In line with the Green Deal Industrial Plan, the Critical Raw Materials Act comes out alongside the Commission's proposal for a Net Zero Industry Act, which aims to scale up the manufacture of key carbon-neutral technologies for clean energy supply chains.

The Critical Materials Act identifies a list of strategic raw materials, which are crucial to technologies important to Europe's green and digital ambitions and for defence and space applications, while being subject to potential supply risks in the future. The Regulation embeds both the critical and strategic raw

materials list in EU law. It sets clear benchmarks for domestic capacities along the strategic raw material supply chain and to diversify EU supply by 2030:

- At least 10% of the EU's annual consumption for extraction.
- At least 40% of the EU's annual consumption for processing.
- At least 15% of the EU's annual consumption for recycling.
- No more than 65% of the EU's annual consumption from a single third country.

The European Commission aims to strengthen the uptake and deployment of breakthrough technologies in critical raw materials. Furthermore, it is intended that the establishment of a large-scale skills partnership on critical raw materials and of a Raw Materials Academy will promote skills relevant to the workforce in critical raw materials supply chains. Externally, the Global Gateway will be used as a vehicle to assist partner countries in developing their own extraction and processing capacities, including skills development. Investing in research, innovation, and skills will be essential.

Horizon Europe

It was a welcome announcement regarding the UK's re-entrance to the Horizon Europe programme allowing researchers to participate as of January 2024 on par with their counterparts in EU member states.[22] It is imperative that for the future of programmes such as the All-Island research projects and the co-centres for research and innovation announced in October last year[23] that there is consistent and cohesive engagement of UK researchers with European research and innovation funding and calls so that wider European challenges such as health, security, climate, energy and environment have focused and engagement for the benefit of the entire continent.

We would also echo many European colleagues concerns regarding Horizon Europe's primary focus on higher technology readiness levels at the expense of funding for basic research. It is hoped that the Commissioner-designate (at time of writing) for Research and Innovation Iliana Ivanova MEP will follow through with her promise to further develop appropriate research infrastructures within Horizon Europe.

Regarding the initial Budget shortfall of approx. €34 Billion in the first two years we welcome Commissioner-designate's promise to seek out additional funding so as to ensure in the months that follow a larger percentage than 30% of high-quality proposals are funded.[24]

[22] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4374

[23] https://www.gov.ie/en/press-release/cefe0-ministers-harris-ghani-and-poots-announce-joint-investment-in-co-centres-for-research-and-innovation/

[24] https://sciencebusiness.net/sites/default/files/inline-files/en-ivanova-written-questions-and-answers.pdf , Pg 6

MEPs Engagement on Science & Research

Consideration must also be given by all Irish Political Parties seeking to put forward candidates in the upcoming European Elections in June 2024 and indeed potential candidates themselves that Ireland has arguably a limited engagement and representation on the applicable Science and Research Committees. It is welcome that 2 Irish MEPs are members of the Committee on Industry, Research and Energy (ITRE) Ciarán Cuffe and Seán Kelly[25] and 4 members of the Committee on the Environment, Public Health and Food Safety (ENVI) Grace O'Sullivan, Mick Wallace, Deirdre Clune and Billy Kelleher[26] however given the ENVI recently voted on the Critical Raw Materials Act it would be wise especially given Irelands position as a Science and Technology business hub within Europe for better representation at such committees.

The limited number of Irish MEPs on the aforementioned science linked committees has resulted in Ireland having no MEP on the European Parliament Panel for the Future of Science and Technology (STOA) for example, in contrast there are 3 MEPs from Italy and 4 from Spain on the Panel[27].

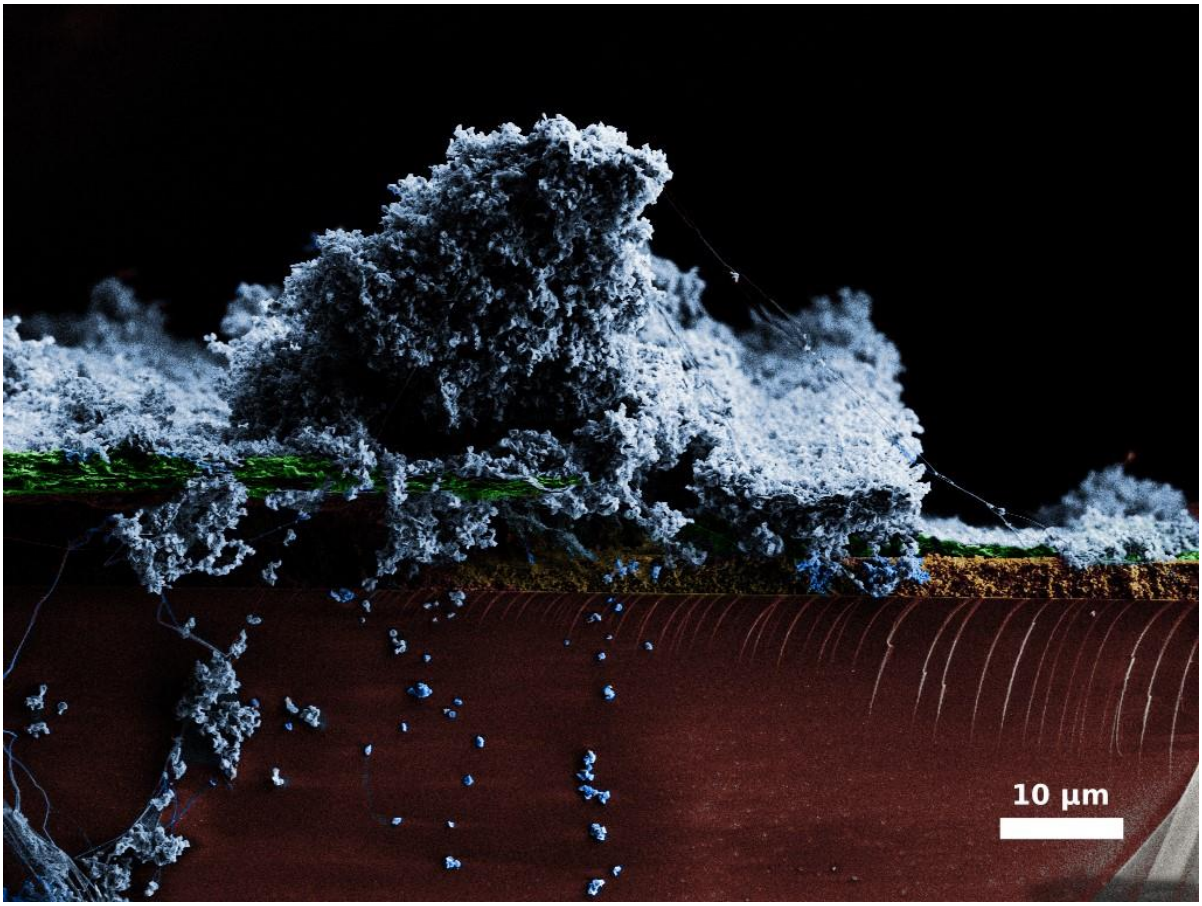


Image Credit: AMBER PhD Javier Gutierrez Gonzalez - A shimmering MXene Wave on a Teflon Surface

[25] https://www.europarl.europa.eu/committees/en/itre/home/members
[26] https://www.europarl.europa.eu/committees/en/envi/home/members
[27] https://www.europarl.europa.eu/stoa/en/home/members