BIOECONOMY YOUTH VISION

EU BIOECONOMY YOUTH AMBASSADORS

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Executive Summary

Scientists have clearly shown the impact of humanity's actions on the ecosystems on which we depend. We are already witnessing the collapse of biodiversity, the shattering of climate records, and a significant reduction in food security, three key priorities of the EU Bioeconomy Strategy. Such problems should be alarming not only for young people but for everybody. Young people are typically the ones trying to drive the transformative change that scientists are telling us we need, yet are significantly underrepresented in positions of power, reducing their ability to raise concerns. Therefore, those in influential positions have a responsibility to be courageous, think in the long term, and act in consideration of the impacts (*e.g.* economical, societal, environmental) that we are already beginning to face.

The EU Bioeconomy Youth Ambassadors (BYAs) were selected by the European Commission in 2022 to represent the voice of the youth within bioeconomy, at the local, national, and European levels. Knowing that bioeconomy does not stand alone, since it is indeed nested within broader economic, social, political, and scientific systems, this document aims to declare our vision on how to shape the bioeconomy concept & upcoming EU and national bioeconomy policies to align them with our shared mission of tackling climate change and protecting nature.

This document addresses the bioeconomy at different levels in terms of geographic boundaries, economic models, technology relevance, educational systems, and citizen engagement, being aware of differential priorities, and the need for coordinated political action from various sides. As young people witnessing a worrying future, we ask policymakers to show courage, take a systems lens, listen to the scientists, and remember that their decisions will impact not only the distant future of all life on Earth but also the lives of most of us on earth today and all the elements that support it.

Our vision for future bioeconomy policies is clustered into five main key messages as listed below. Each section is then detailed with our demands for specific topics, aiming to provide strong guidance to policymakers.

1. Involvement of Youth: From spotlight into decision-making
2. Cultivating inclusive debate: Bridging gaps in bioeconomy education
3. Rethinking economics: From infinite to post growth
4. Responsible use of bio-based resources: From exploitation to valorisation
5. Assessing the Bioeconomy: True burdens and benefits

We, as EU BYAs of the European Commission, believe that bioeconomy has the potential to allow a change from the current unsustainable systems paradigm, towards a system that supports our mission of tackling climate change and protecting nature. This document has been officially presented during the Bioeconomy Changemakers Festival (Brussels, March 2024), with different satellite events throughout Europe. It was drafted by the EU BYAs and reviewed with fruitful insights by youth organisations, together with representatives from the satellite events.

Disclaimer

This document was developed by the EU Bioeconomy Youth Ambassadors with input from other young people, youth organisations mentioned in the acknowledgements and some satellite events of the Bioeconomy Changemakers Festival who wished to comment. The views expressed therein are those of the authors and do not necessarily reflect the official opinion of the European Commission or the opinion of other satellite events or youth organisations.

Introduction

We, the EU Bioeconomy Youth Ambassadors[1], stand as torchbearers of a greener tomorrow and stewards of a future sculpted by sustainability's tenets. Since our inception, we have pledged to actively confront our shared environmental predicament. The year 2023 has been a pivotal moment, with Berkeley Earth's analysis measuring the global mean temperature as 1.54 °C above the average temperature from 1850-1900, with October soaring over 1.7 °C. Climate scientists have already publicly stated that the 1.5 °C limit is "deader than a doornail" predicting we will permanently surpass 1.5 °C of warming within this decade[2].

We are on the brink, or perhaps have already crossed, several irreversible tipping points, having now breached six of the nine planetary boundaries[3] that we rely on for a liveable biosphere, with trends seemingly only moving in one direction. It is obvious we need radical systems change to address the causes of our predicament. However, it is becoming ever clearer that it is very difficult to achieve this without meaningful inclusion of young people as stakeholders in the decision-making process. Those that the system most benefits (in the short-term) are unfortunately proving unlikely to be the ones to change it, despite what we now obviously require to sustain life on Earth as we know it.

Our mission transcends mere acknowledgment of the climate crisis. We address the core issue of ecological overshoot, fuelled by relentless economic growth. Our focus is on the bioeconomy, an innovative approach linking diverse sectors, championing circularity and sustainable management of bio-based resources. This approach aims to reconcile our economic systems within their ecological confines while meeting everyone's needs. This method is not just about mitigating climate change; it's about protecting nature and adopting a systemic viewpoint to confront and adapt to challenges ranging from food security to biodiversity loss. Bioeconomy offers paths to embed sustainability across industries, enabling a more holistic and effective response to ecological challenges. It empowers us to reconsider our role in the web of life, and our relationship with nature, emphasising renewable raw materials and sustainable practices that can coexist with environmental conservation and human prosperity.

Bioeconomy is often mentioned as the solution to the polycrisis, namely our complex situation where multiple global crises are interconnected and interact in ways that amplify their collective impact, significantly worsening humanity's prospects compared to the effects of each crisis in isolation. While the bioeconomy is a useful concept to address our interconnected problems, if the bioeconomy is to be a holistic solution, there are many aspects to first consider. This document aims to address many of them, and provide a youth perspective on how to create the conditions necessary for a more sustainable bioeconomy. Bioeconomy is a crucial part of the portfolio of solutions available to mitigate and adapt to the polycrisis we are living through. At the same time it needs to adapt and evolve accordingly, with the help of technologies, wisdom, and strategies sourced from the past, the present and the future and from a variety of cultures and origins. This inclusive approach should not be confined to the European Union alone but should also extend globally, embracing diverse perspectives and knowledge systems, without turning a blind eye to what scientists claim to be the root cause of our environmental problems, ecological overshoot[4] as a result of our relentless pursuit of economic growth.

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[1] *Meet our Bioeconomy Youth Ambassadors!* Research and innovation, European Commission (2022)

[2] Gloria Dickie, *Global warming will reach 1.5C threshold this decade - report*, Reuters (2023)

[3] *Planetary boundaries*, Stockholm resilience, Stockholm University (2023)

[4] William J, Ripple WJ *et al*. *The 2023 state of the climate report: Entering uncharted territory*, BioScience, Volume 73, Issue 12, (2023)

Through this document, we underscore the pivotal role of bioeconomy in bridging the gap between current systems and more sustainable and circular models. Our commitment is to promote understanding and adoption of bioeconomy principles, underscoring their potential to revolutionise our approach to resource exploitation and environmental stewardship. We invite others to join us in this endeavour, recognizing that the transition towards a sustainable future requires a collective effort, innovative thought, bravery, and prioritisation of ecosystem preservation. As Bioeconomy Youth Ambassadors, we are dedicated to actively participating in shaping a world where the bioeconomy is central to our collective environmental strategy and way of life.

Bioeconomy Vision

We believe that bioeconomy is a holistic solution for mitigating and adapting to our predicament. Bioeconomy has myriad definitions and typically refers to the share of the economy based on biological resources. The concept “bioeconomy '' in the EU typically refers to the “sustainable” use of “renewable” biological resources (biomass) from land and sea, like crops, forests, fish, animals and microorganisms to produce things such as food, feed, textiles, chemicals, wood, energy and ecological services.[5] While this definition is a good starting point, we believe it must be elaborated on to reflect our reality and ensure that it reflects our mission of mitigating and adapting to climate change and protecting nature as part of a just-transition.

Our vision for bioeconomy is a harmonious system that emphasises interconnectedness between its parts and supports the well-being of all life. It seeks to encourage the sustainable use and regeneration of our planet's resources, minimising consumption within ecological limits and embracing a circular approach to the use of feedstocks.

At its core, bioeconomy is an expression of our collective responsibility towards all life, including past, present, and future generations. It represents a commitment to a more equitable sharing of our planet’s resources, ensuring that the needs of all are met without compromising the ability of others, present or future, to meet their own.

This approach to bioeconomy is not just about efficient resource management; it is a profound reimagining of our relationship with the natural world, guided by the wisdom that transcends disciplinary boundaries. It is a path that acknowledges our interdependence with all forms of life, fostering a sustainable and just world for all inhabitants, now and in the times to come.

To reflect this, we define bioeconomy as: “A holistic approach to achieving a resilient, circular, bio-based economy through a just-transition that consciously aims to reduce economic throughput within our planet’s regenerative capacity.”

[5] *Bioeconomy*, Research and Innovation, European Commission (last checked February 2024)

Key message 1

Involvement of Youth: From spotlight into decision-making

Collaboration through diversified engagement practices and emotional narratives should be encouraged

A substantial enhancement of youth involvement in the EU is required. In Europe, over 50% of the population is over the age of 44, with the average age of a member of the European Parliament (MEP) being above 50[6]. Similar trends can be seen across sectors and institutions meaning young people are locked out of the decision-making process at the point in history that we most need to be included. In any system, diversity breeds resilience, something that our societies and institutions seem to lack in the face of the challenges we face today. The youth discourse must transcend mere rhetoric, underscoring the necessity for authentic partnerships with the youth. Streamlining existing initiatives is imperative, ensuring their efficacy and inclusive design. Youth engagement must shift from a symbolic gesture towards a substantial tool shaping the future. Aligned with scientific tenets, the youth's messages merit sincere consideration. The call is not for feigned inclusion but for the dismantling of barriers, facilitating genuine involvement. The era of 'youth-washing' needs to conclude, ushering in an era of authentic partnership. The prevailing mindset must shift from contemplation of 'future generations' to a recognition of the immediate urgency for actionable measures. The youth is not here merely for display; they aspire to occupy a substantive role in the decision-making echelons, engaging in supporting and more importantly promoting policies that can have a significant impact on shaping future regulations and incentives. To truly cultivate widespread interest and participation in bioeconomy, engagement practices need to be diversified and reach young individuals who may not be in this sector. Traditional, jargon heavy communication fails to resonate with the younger generation, who seek a more personal and emotional narrative. Similarly, existing institutional initiatives leave youth sceptical and disinterested. To resonate with the daily lives and concerns of young people, approaches outside traditional channels rooted in accessibility, relatability, and inclusivity are needed.

Indifference and disconnection of youth in the decision-making processes should be addressed to foster trust

While sporadic attention may be directed toward the youth, the locus of substantial decision-making remains elusive. Youth engagement initiatives exist[7], but suffer from under-utilisation or inadequate dissemination, and lack a critical element - trust. Indeed, numerous individuals are grappling with sentiments of neglect and detachment from the EU and its institutions, with these people being identified as the "Switched Off."[8] Trust is fostered by being transparent about the decision-making processes and the impact of youth contributions via clear communication of how their input is considered, valued, and implemented. This transparency establishes a foundation of trust to tackle the unprecedented levels of youth indifference towards and disconnection from governing bodies. On the other hand, it is pivotal to push formalisation processes (in terms of recognition) of youth groups, to give more accountability and trust to these individuals.

[6] *The share of elderly people continues to increase*, Eurostat (2024)
[7] *Youth engagement at the EESC*, European Economic and Social Committee (2023)
[8] *How to light up Switched Off young people disconnected from the EU*, ICF (2023)

Implement Youth Advisory Boards and Mentorship Programs following a deliberative democracy approach

The creation of formal youth advisory boards within bioeconomy organisations and institutions is a form of youth inclusion that can address the knowledge transfer gaps and give to youth the experience needed in the decision-making processes. Additionally, these boards can offer insights, creativity, recommendations, and critical perspectives. The creation of mentorship programs that connect experienced bioeconomy professionals with youth can further foster knowledge transfer and opportunities for intergenerational guidance and collaboration. This should be also encouraged at public level including internship programs within the Governmental Bodies in the EU, that engage young people to take part in bioeconomy-related programs.

In the context of bioeconomy, deliberative democracy offers a platform for enhancing youth involvement. This approach shifts decision-making from traditional electoral processes to inclusive, respectful community dialogues. It emphasises engaging youth directly in bioeconomic debates, valuing their unique perspectives and insights. Deliberative democracy helps balance power dynamics, allowing for a deeper understanding of challenges, especially from the youth's viewpoint. Governments and stakeholders should adopt these practices to ensure youth participation in shaping bioeconomic policies. This commitment to incorporating young voices will bolster policy legitimacy, promote transparency, and foster a shared responsibility for a sustainable, equitable bioeconomy.

Key message 2

Cultivating inclusive debate: Bridging gaps in bioeconomy education

Bioeconomy education should improve its interdisciplinary and inclusive approach

Bioeconomy education should break traditional boundaries, becoming interdisciplinary and inclusive across primary, secondary, and tertiary sectors as well as across other stakeholders (politicians, artists, professors, etc) and genders. Indeed, it is crucial to broaden the scope of bioeconomy education beyond the science-driven disciplines. Incorporating fields like arts, literature, policy, history, and philosophy into the curriculum can enrich understanding and encourage innovative approaches towards the development of solutions and dissemination strategies. This amplifies engagement and creates a positive feedback loop. At the same time, to ensure an inclusive debate on the topic, the voices of various stakeholders should be equally heard. A holistic approach to bioeconomy education, inclusive of diverse disciplines and generations, paves the way for a more sustainable and adaptable society. This will equip individuals with the tools to address complex challenges while harnessing the full potential of bioeconomy for the benefit of present and future generations, both at European and global levels.

Life cycle and systems thinking should start earlier in the educational system

At the heart of sustainable living is the fundamental concept of systems thinking, emphasising the intricate connections and interdependencies within our world. Introducing this notion to children at a young age holds paramount importance in shaping their understanding of how every action ripples through the interconnected web of life. Encouraging youngsters to comprehend the significance of systems thinking unveils the impact of their choices on the environment, society, and the economy. This helps to promote that sustainable options are seen as an added value and not as something that

is not affordable. Educational policies should therefore embrace and promote life-cycle-thinking from the earliest stages of learning. Integrating these concepts into educational curricula spanning from primary schools up to universities empowers future generations to make informed decisions and choices. By cultivating an understanding of life cycle processes and systems thinking, young minds are equipped to navigate complex challenges and contribute to sustainable practices. These educated individuals will not only shape a more sustainable future but will also influence policies and practices, ensuring a more interconnected, sustainable, and harmonious world for generations to come. Additionally, teachers must be trained on how to introduce these concepts and evidence-based studies to children and young pupils since they have insight into which educational processes and systems are needed to prepare pupils and young students for new challenges.

Academic education should develop trained young talents to strengthen the bio-based sector
Aligning academia communication with the bio-based sectors while harmonising requisite skill sets stands as a pivotal endeavour. Competencies such as practical proficiency, problem-solving ability, and a strong collaborative ethos should be promoted in academia in order to meet the demands of the bio-based industries. Another important step is to create a strong bridge between academia and industry. Some actions involving paid internships, collaborative partnerships, and mentorship programs serve as catalysts in enriching students' experiences, effectively bridging the gap between theoretical knowledge and hands-on industry exposure. Additionally, we envision the creation of an open-access Bioeconomy Knowledge Sharing Platform serving as a hub where researchers, policymakers, and industry converge to share research findings, case studies, and breakthrough technologies. Moreover, the platform should provide workshops and training programs, fostering hands-on learning experiences and nurturing collaborative relationships among stakeholders worldwide.

Educational programs targeting sustainable consumer behaviour should be implemented at a systemic level
The bioeconomy necessitates a societal shift towards sustainable consumer behaviour, aligning with nature's limits and individual needs. Prioritising sustainability, resource conservation, and equitable resource access is crucial. In the EU, the current material consumption per person stands at 14.5 tonnes annually[9], with half ending up as waste in landfills[10]. A comprehensive plan of action is needed, however one suggestion would be for the EU to adopt successful models like Austria and Germany's 'Voluntary Social or Ecological Year,' creating 'Voluntary Environmental Years' at the European level. These programs engage youth in environmental initiatives, fostering intergenerational dialogue and nurturing bioeconomy understanding. Cross-border opportunities prepare the next generation for bioeconomy challenges while financial incentives make this path appealing and equip them for a bioeconomy-oriented future. Similarly this approach should be applied to other fields related to bioeconomy, such as food and nutrition literacy, to foster biodiversity on the plate, which in turn will help to develop a more resilient food sector.

Science communication and dissemination should be embraced as part of bioeconomy strategies
Engagement of stakeholders is fundamental in bioeconomy, since its interdisciplinary nature and the involvement of different actors, such as the general audience, scientists, policymakers, and industries.

[9] *EU's domestic material consumption remained stable in 2022*, Eurostat (2023)
[10] Nico Schmidt, Wojciech Cieśla, *Europe's circular economy is leaking*, Investigate Europe (2023)

In this context, being able to communicate the several aspects of bioeconomy is crucial to allow the understanding of the relevance of such topics in our current world. Therefore, future EU and national strategies should include dissemination plans and projects that include young scientists, like the EU Bioeconomy Youth Ambassador program partially is, and several EU-funded projects that are disseminating knowledge on bioeconomy. To further expand the reach of such communication, several media should be considered, especially social media platforms, able to engage not only with the younger generation but with individuals of all ages. EU official online platforms (*e.g.* social media, website) already involve professional communicators to provide momentum for specific issues: bioeconomy should be one of those as well. In addition, since scientists are required to be involved in outreach activities as well, bioeconomy education systems should embrace science communication provided they receive proper training, to be able to become reference points in bioeconomy storytelling side-by-side with science communication professionals.

Key message 3

Rethinking economics: From infinite to post growth

Addressing the root cause of our predicament: Ecological Overshoot

Our current economic system, centred around infinite, exponential growth as measured by GDP, is tightly interwoven with the pressing social and ecological challenges our planet confronts. These challenges are emblematic of anthropogenic ecological overshoot, characterised by unsustainable consumption of natural resources and the generation of entropic waste surpassing the Earth's capacity to regenerate and absorb. Global GDP exhibits a nearly perfect correlation with both energy consumption and resource extraction[11], which are the primary drivers of the two core planetary boundaries, global warming, and biodiversity loss. Our economy therefore mostly works by converting nature into GDP using fossil fuels, and due to our expansionary monetary and economic systems, must do so at an ever-accelerating rate to survive. This underscores the root cause of our environmental predicament.

No meaningful decoupling has happened, with even the most successful decoupling countries in terms of emissions requiring more than 220 years to reduce emissions in line with the Paris Agreement at current rates, emitting 27 times their fair share in the process[12]. The very first recommendation in the State of the Climate Report 2023[13] states: "Economic growth, as it is conventionally pursued, is unlikely to allow us to achieve our social, climate, and biodiversity goals. The fundamental challenge lies in the difficulty of decoupling economic growth from harmful environmental impacts".

Moving towards the 'Doughnut' through bioeconomy is necessary

For over five decades, we have been in a state of ecological overshoot, living on borrowed time from future generations and pushing humanity towards a precipice, having now crossed six of the nine boundaries that preserve a liveable planet. Furthermore, the wealthiest 1% has captured over 50% of new wealth since 2013[14], indicating that most environmental degradation stems from excessive

[11] Haberl Helmut, *et al. A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: synthesizing the insights.* Environmental research letters 15.6 (2020): 065003.

[12] Jefim Vogel, Jason Hickel, *Is green growth happening? An empirical analysis of achieved versus Paris-compliant CO2–GDP decoupling in high-income countries*, The Lancet (2023)

[13] Ripple JW, *et al.*, *The 2023 state of the climate report: Entering uncharted territory*, BioScience (2023)

[14] *Survival of the Richest - How we must tax the super-rich now to fight inequality*, Oxfram (2023)

accumulation by the few, and only leads to widening inequality rather than societal well-being. As claimed in The State of the Climate report, we therefore need to change our economy to a system that supports meeting basic needs for all people instead of excessive consumption by the wealthy[15]. The global economy has experienced an average annual growth rate of 5.6% since 2000, resulting in GDP soaring from $33.8 trillion in 2000 to over $105 trillion in 2023. If this trend continues, the economy could expand 232-fold by the century's end[16]. This trajectory, given its close association with energy and resource use, is clearly unsustainable. Therefore, unless we are to address our ever-growing, oversized economy and the excess consumption of the wealthiest members of society, there is no point in discussing sustainability. We must go to the root cause of our issue and decide that now is finally the time to scale down our economic activities and make peace with nature before this decision is made for us. The Bioeconomy concept, as described by Nicholas Georgescu-Roegen[17] and elaborated in our vision, can play a key role in trying to reconcile our economic system within planetary boundaries, ease the transition towards a post-growth economy, and move towards a new economic paradigm that champions ecological and social welfare, such as Kate Raworth's Doughnut[18], where she describes the "safe and just space for humanity, where no one falls short on life's essentials (from food and housing to healthcare and political voice), while ensuring that collectively we do not overshoot our pressure on Earth's life-supporting systems, on which we fundamentally depend – such as a stable climate, fertile soils, and a protective ozone layer."

Reducing energy consumption is needed to achieve a sustainable bioeconomy

Bioeconomy is often described as an alternative to a fossil-fuel based economy. At our current rate of resource and energy consumption, even with a dramatic scale-up of "renewable energy" or bio-based materials, it is impossible for us to move away from fossil fuels, which due to scarcity alone, we will need to do in the near future anyway. Economic activity relies heavily on finite fossil fuels, which still provide over 80% of total global energy and inevitably produce waste, including heat, and pollution, following the laws of thermodynamics. "Renewable energy" sources have inherent limitations in their availability and energy yield. In our expansionist economic system, renewable energy has not replaced fossil fuels at all, but instead, merely added to them, causing problems elsewhere, such as habitat destruction, pollution and child slavery. Therefore, as the economy expands, our negative impacts on the environment intensify. Recognizing that we have been living beyond the Earth's carrying capacity for over 50 years and continue accelerating toward environmental collapse and resource and energy scarcity, it is evident that some form of economic contraction or "degrowth" is inevitable, whether we choose this or not. The way degrowth unfolds is a critical question. Structured degrowth, with a prioritisation of localised, community initiatives, allows for greater resiliency and a more controlled transition, while chaotic degrowth, in the pursuit of growth, could lead to severe disruptions, mass suffering, and the total collapse of our life-supporting systems. Policymakers must therefore aim at reducing total energy use and smooth the transition to a post-growth economy that by choice or natural limitations, is coming soon. In doing so, they must ensure sufficiency for all, particularly in food, water, energy, and shelter, while curbing excessive consumption by the wealthiest 10% and

[15] O'Neill DW, *et al. A good life for all within planetary boundaries*. Nature Sustainability 1: 88–95 (2018)
[16] Dyvik EH, *Global GDP - Statistics & Facts*, Statista (2023)
[17] Schlegel R., *et al. Review: Four Reviews of Nicholas Georgescu-Roegen: "The Entropy Law and the Economic Process"* Journal of Economic Issues Vol. 7, No. 3,, pp. 475-499 (1973)
[18] *About Doughnut Economics*, Doughnut Economics Action Lab (2024)

deliberately scaling down destructive industries through legislation and taxation, namely fossil fuels, the automotive, fashion, aviation and meat & dairy industries.

The EU should financially support bioeconomy startups

Access to funding remains a challenge for bioeconomy start-ups, especially for early stages of innovation and valley of death (TRL 5)[19]- the level where technology needs to be validated in an industrially relevant environment. Even if EU funding initiatives play an important role in fostering innovation in Europe, bioeconomy startups face specific problems (*e.g.* expensive rent of equipment, validation of pilot scale production, intellectual property), which may not be fully addressed within the framework of existing EU funding initiatives. There is a lack of targeted funding for entrepreneurs, who want to transfer scientific knowledge to commercial application. The European Commission should create a map of bioeconomy funding opportunities on their official website, considering TRL level, existing EU funding opportunities, timelines, funding conditions, pros/ cons, and place it on the official EC website. The creation of a map should involve stakeholders (*e.g.* start-ups/businesses, universities, VCs, bank representatives), and different Directorate-generals. As an outcome, funding gaps could be identified which are not allowed to pass the valley of death or transfer scientific knowledge to the market. Beyond funding opportunities, the European Commission should financially support business incubators and accelerator spaces to provide access to mentorship, networking opportunities, and workspaces. There should also be more empowering initiatives for women-entrepreneurs. In addition, matchmaking spaces dedicated to youth-led start-ups are necessary to boost innovation and job creation.

Key message 4

Responsible use of bio-based resources: From exploitation to valorization

Biomass use should be conscious, considering highest value applications and cascading principles

Biorefineries are defined as the sustainable processing of biomass into a range of marketable biobased products and bioenergy/ biofuels[20]. At the same time, biomass and land are limited resources and edible crops and deforestation are not viable nor sustainable options for the production of bioenergy, biomaterials, and bio-based products in general. Therefore, a tiered system should be implemented, compliant with cascading principles, that prioritises the highest value applications (*e.g.* bio-pharmaceuticals and fine chemicals), followed by mid-tier applications (*e.g.* biomaterials, bioplastics), and then lower value applications (*e.g.* biofuels and bioenergy). Especially for the low-tier products, bioprocesses based on residual biomasses should be promoted, to valorise side streams and reduce waste. Biofoundry, defined as an integrated facility that combines biological, chemical biology, and engineering biology systems and tools with automation, therefore becomes a fundamental concept to attract young professionals. To further promote research and development in the field of biorefineries, based on microbial cell factories or not, technology transfer between academia and

[19] Kampers LFC, *et al.*, *Navigating the Valley of Death: Perceptions of Industry and Academia on Production Platforms and Opportunities in Biotechnology*, EFB Bioeconomy Journal, Volume 2 (2022)

[20] IEA Bioenergy Task42. *Sustainable and synergetic processing of biomass into marketable food & feed ingredients, chemicals, materials and energy (fuels, power, heat)*. IEA Bioenergy. 66 (2014)

industries should be pursued, by encouraging public-private partnerships to fund research and development in cutting-edge biomass applications.

Shift towards plant-based diets and significant reduction meat and dairy consumption should be implemented

In addressing the urgent need for sustainable and resilient food systems, policymakers should prioritise a transformative shift toward nutritious and affordable plant-based diets, markedly reducing meat and dairy production in the EU. A significant portion of EU farmland (71%) is currently allocated to livestock production, accompanied by 63% of arable land dedicated to feed production.[21] This has led to a consequential impact on greenhouse gas emissions, constituting 11% of total EU emissions[22], underscoring the urgency for change. The overconsumption of meat and dairy in the EU adversely affects climate, the environment, and public health. The imperative shift away from livestock agriculture is crucial in addressing vulnerabilities in the global food system and countering climate change and restoring our ecosystems. Embracing plant-based diets is vital for emission reduction. Studies indicate that a noteworthy decrease in meat, dairy, and egg consumption within the EU could lead to a 25-40% reduction in agricultural greenhouse gas emissions[23]. This transition not only frees up valuable land for more calorie-efficient food production but also supports rewilding initiatives, promoting enhanced biodiversity and systemic resilience. Reducing reliance on livestock production in the EU presents a scientifically grounded and practical strategy with significant potential to combat climate change.

EU food systems need to become resilient to confront climate challenges and ensure lasting security

As we look toward a Europe in a post-tipping point world, embracing resilience as the guiding principle is imperative for a sustainable and secure future. Food systems have already been jeopardised by the challenges of climate change, posing threats to public health and impacting security and peace. Therefore, such systems need to embrace resiliency, from different points of view. Regarding biodiversity, there are currently four plants, namely wheat, rice, maize, and soybeans, that account for 67%[24], with a handful of countries, primarily located outside the EU, being the main exporters. This limited diversity in crops and sources of food supply poses a significant risk to the global food system[25]. The EU should therefore engage an integrated approach to develop a more resilient and decentralised food system, for example by encouraging the adoption of modern biotechnological tools, encouraging domestic production of basic foods, agro-ecological principles[26], freeing up land resources, and shifting away from the current emphasis on livestock farming. This integrated approach not only addresses climate change but also preserves biodiversity and enhances food security, while supporting local markets presenting a triple win for our planet. A resilient agricultural system, able to adapt to

[21] Willett W, *et al.*, *Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems*, The Lancet (2019)

[22] European Environmental Agency, *Annual European Union greenhouse gas inventory 1990–2020 and inventory report 2022*, EEA/PUBL/2022/023

[23] Bellarby, J, *et al. Livestock greenhouse gas emissions and mitigation potential in Europe.* Global change biology 19.1 (2013): 3-18.

[24] Kumar L., et al. *Chapter 4 - Climate change and future of agri-food production*, Future Foods, Academic Press, (2022)

[25] Nicholson, C.C., Emery, B.F. & Niles, M.T. *Global relationships between crop diversity and nutritional stability*. Nat Commun 12, 5310 (2021).

[26] *The 10 elements of agroecology - Guiding the transition to sustainable food and agricultural systems*, FAO (2019)

ongoing polycrises, not only guarantees food security but also emerges as an attractive prospect for the involvement of the younger generation in the primary sector.

Biotechnology should be embraced and recognized as a group of key technologies in bioeconomy
During the State of the European Union (SOTEU) 2023, Ursula von der Leyen emphasised biotechnology and biomanufacturing as key priorities for 2024. In 2023 the United States published bold goals for their own biotechnology and biomanufacturing sectors[27]. Nevertheless, biotechnology is rarely mentioned in EU bioeconomy policies and documents, despite its relevance and potential in multidisciplinary fields. Indeed, biotechnology should be incorporated in the EU Bioeconomy Strategy[28], and national strategies as well, to unlock the potential of bioeconomy to open new job opportunities for young students specialising in the various sectors of biotechnology (*e.g.* industrial, plant, health, genomics, environment). At the same time, the EU should review and update regulations to promote biotechnology in Europe, for example by the development of biorefineries and biofoundries based on cells (animal, vegetal, microbial) able to transform biomasses into valuable compounds (*e.g.* biomaterials, pharmaceuticals), following cascading principles. The valorisation of innovative technologies such as trans/cisgenesis, gene editing, New Genomic Techniques (NGTs) and synthetic biology should be openly discussed, while stressing the relevance of GMOs and recombinant molecules (*e.g.* enzymes) and addressing the scepticism and fear mongering present in Europe towards such technologies. Focusing on the food market might expand the available sector portfolio, helping the transition towards resilience systems and diversification of food production. Besides, we advocate for a responsible use of biotechnologies taking into consideration its environmental, social and economic impact, and also the bioethical issues related to it.

Subsidies should tilt towards sustainable innovations rather than harmful industries
Subsidies that help maintain environmentally detrimental practices in sectors such as agriculture, fisheries, forestry, and energy should be ended. On top of this, fossil fuel subsidies, known for perpetuating environmental degradation and hindering the transition to sustainable energy sources, need to be targeted for a phased reduction and cessation. Redirecting these funds towards bioeconomy initiatives aims to accelerate the shift to sustainable energy and materials, fostering a more resilient and ecologically conscious global economy. Simultaneously, subsidies in the meat and dairy sectors, notorious for contributing to environmental degradation, deforestation, and climate change, should be reallocated instead to other sectors. The objective is to reshape these subsidies to promote sustainable agricultural practices, reduce environmental impacts, and encourage a transition towards plant-based or alternative proteins. In this context, precision fermentation and cultivated (lab-grown) meat are innovative options to be considered for the European market. More and more of these products will likely file applications to EFSA, together with other innovative food, increasing the need for evidence based communication from European institutions to citizens and national governments, as a possible role of these products in the dietary transition. Otherwise, Europe will miss out on significant investments and goals to reduce meat and dairy consumption, even if the EU invests in infrastructure and has many talents capable of creating new food alternatives.

[27] *Bold Goals for U.S. Biotechnology and Biomanufacturing Harnessing Research and Development To Further Societal Goals*, The White House Washington (2023)
[28] *Adoption of the bioeconomy strategy progress report*, Directorate-General for Research and Innovation, European Commission

Farming should be a viable and attractive career choice for young people

Only 11% of all farm holdings in the EU are run by farmers under the age of 40, out of which young female farmers represent only 3%[29]. Sustainability in the agricultural sector requires both generational renewal and increased gender diversity because young people tend to bring innovation into farms. In order to achieve this, awareness campaigns should be run to highlight the economic relevance of farming. Start-up incubators and mentorship campaigns could be created to empower young people (especially women) to pursue their careers in agriculture. Success is considered as one of the most common ways to enter farming activities for young people[30] From a policy perspective, there should be more attention for young people, who are not farm successors. However, there are still financial barriers for young, landless people to access expensive land. Establishing a network of shared lands, gardens, experimental farms, communities, and young influencers campaigns, backed by financial support could solve the challenge of how to attract young people to agriculture.

Sustainable forestry should be implemented at national and European level

Forests, vital for planetary health and biodiversity, are pivotal in combating climate change. The 2030 EU Forest Strategy[31], aligned with the EU Biodiversity Strategy and the European Green Deal, aims to enhance the quantity and quality of EU forests. This involves improving forest protection, restoration, soil quality improvement, and resilience, ensuring sustainable use of forest resources, and promoting non-wood forest-based bioeconomy sectors like ecotourism. Therefore we need the EU to consider sustainable forestry as a cornerstone of any future bioeconomy strategy. Intensified efforts in sustainable forestry are needed, including increasing research and innovation investments, implementing an inclusive EU forest governance framework, and ensuring the enforcement of EU regulations. Engaging and empowering youth in sustainable forestry initiatives is crucial to fostering long-term resilience and sustainability in forest management. At the same time, forest resources should be exploited in a conscious way, by preserving biodiversity, promoting sustainable timber manufacturing, diversifying forests so that they are more resilient to changes in temperature and pests that affect them, addressing cascading principles, and leaving bioenergy as an option only when unavoidable or in specific situations.

Key message 5

Assessing the Bioeconomy: True burdens and benefits

Bioeconomy should be an all-encompassing concept, addressing the interests of all stakeholders

The bioeconomy is a crucial piece in a highly connected puzzle of economic and societal changes needed to face the climate crisis, preserve biodiversity, and ensure justice and equality on a European and global level. To achieve a holistic bioeconomy, the EU should expand its focus from economic to socio-cultural and environmental objectives, considering the diverse interests of all affected and the interdependencies of the EU with other regions. Bioeconomy policies must acknowledge the social conflicts and tensions that may arise due to this transition, considering that the transition is not confined to the EU alone, since it has far-reaching and interlinked impacts on other regions of the world. As the EU shifts its focus towards bioeconomic practices, it is crucial to consider how these

[29] Young farmers, Directora-General for Agriculture and rural development, European Commission

[30] Sutherland, LA. *Who do we want our 'new generation' of farmers to be? The need for demographic reform in European agriculture*. Agric Econ 11, 3 (2023)

[31] *New EU Forest Strategy for 2030*, European Commission (2021)

changes might affect global markets, trade dynamics, and resource distribution, as well as the inequalities that it may be associated with. Inequalities should be addressed with an intersectional approach and an inclusive consideration of all the dimensions that can represent barriers or added values, such as gender, social and economic status, education and age. There are trade-offs, and it must be made explicit how subsidies will help those who are on the losing side of the coin, both now and in the long term.

Holistic sustainability assessment should be inherent in allocating subsidies and funding

When developing incentives-based programs, holistic and forward-looking sustainability assessment methodologies should be used to evaluate the footprint (burdens) and handprint (benefits) of established and upcoming technologies. Sustainability assessment methodologies are available but lack standardisation and are rarely applied properly by policymakers. Policies should support the fundamental development of comprehensive and robust methodologies to assess the sustainability of bio-based systems at various levels of technology development. The EU should promote the use and standardisation of proper methodologies (*e.g.* Life Cycle Sustainability Assessment - LCSA) by for example expanding the Product Environmental Footprint (PEF) initiative to cover all bioeconomy sectors and broadening its scope to include socio-economic benefits and trade-offs. Besides burdens, the holistic sustainability assessment should include the potential benefits of sustainable agricultural practices, which contribute to more resilient and environmentally friendly food production systems (*e.g.* by integration of ecosystem service assessment - ESA).

Environmental, social, and economic costs must be included in financial decision-making

An economic model is needed that integrates environmental, social, and economic costs into financial decision-making, ensuring that the full impact on the biosphere is taken into account. A standardised framework for true cost accounting should be developed and implemented in collaboration with economic experts, ecologists, and social scientists. This framework should encompass metrics that evaluate environmental degradation, ecosystem services, social implications, and long-term economic consequences. The EU should support the development and promote workshops, courses, and resources to train governments, businesses, and financial institutions in applying the full-cost accounting model. Incentives, such as tax breaks or grants, should be provided to national and local governments, companies, and institutions that promote, adopt, and implement full-cost accounting. This could also involve penalties or disincentives for entities that continue with practices causing significant unaccounted harm to the environment and society. Finally, businesses and governments should be mandated to publicly disclose their full-cost accounting evaluations, fostering transparency and holding entities accountable to their stakeholders and the broader public. To this extent, gender gap in decision-making and sustainability assessment should be tackled promoting a more diversity-oriented process to include all the actors and points of view. In fact, from an environmental point of view, women are those most affected by climate change and the loss of biodiversity, so we have to support them and boost a more sustainable approach based on the society, to have a more social-oriented method.

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[32] Bioeconomy Changemakers Festival, The research and innovation community platform, European Commission