GLOBAL BIOECONOMY SUMMIT 2026

Bioeconomy for socio-economic transformation and climate action

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IACGB Communiqué 2026

International Advisory Council on Global Bioeconomy

Summary

The IACGB Communique 2026 is the next in a series of Communiques by the International Advisory Council on Global Bioeconomy (IACGB) associated with Global Bioeconomy Summits (GBS) since 2015. On this occasion, the Summit was held on 20-21 October 2026 in Dublin, Ireland, with co-hosting by the Government of Ireland.

In the past 10 years, there has been significant growth in bioeconomy activity globally. The bioeconomy is widely accepted as a pathway for socio-economic transformation, including providing solutions for climate change mitigation and adaptation. The bioeconomy has been advancing in ways that positively impact society and industry and contribute to the Climate Action needed for 2050 targets.

Bioeconomy in a nutshell

The bioeconomy is the production, utilisation, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes and services) within and across all economic sectors and enable a transformation to a sustainable economy. The bioeconomy is not a static notion, and its meaning is continually evolving (https://www.iacgb.net/)

However, while the number of national, regional, and local bioeconomy strategies, policies, roadmaps and action plans have increased to over 100 and significant business entities have included bioeconomy solutions in their future strategies, there is still a long way to go to achieve a fully bio-based socio-economic transformation at global scale.

Successes along the way have included:

- the number of dedicated bioeconomy strategies has increased widely – at regional, national, subregional, and local/city/state levels globally;
- technologies and applications relating to the bioeconomy have exponentially increased;
- several globally recognised bodies (pan-national) have released formal bioeconomy commentaries on future needs and challenges (eg WEF, Chatham House, G20, FAO, UNEP);
- CO_2 is used as feedstock in commercial-scale facilities where carbon from CO_2 is converted into various compounds; e.g., protein for animal feed and human nutrition;
- urban bioeconomy, design of “sustainable city ecosystems” and greening of buildings and transport are introducing bioeconomy practices into everyday life;
- timber and bio-composites as construction materials have the potential to transform cities into carbon sinks;
- new biopharmaceutical and life sciences techniques, including gene editing, are causing a revolution in medicine.

Challenges moving ahead include:

- the world is more fragmented in political and economic interests and there is a loss of unity globally with respect to political dynamics and climate action;
- biodiversity loss, including agro-biodiversity, and its impact on communities, environmental degradation, agrifood systems, and the global economy is increasing;
- adoption of bio-based solutions has slowed, and fossil-based reliance is retained;
- subsidies and benefits/penalties are distributed very unevenly between fossil and bio-based products;

- the science-based opportunities of bioeconomy for developing new materials, bio-manufacturing, bio-pharma, and construction are underinvested in;
- lack of standardised assessment of benefits of bio-based solutions and/or regulatory fragmentation is hindering market access and growth;
- social and economic inequality has grown within most countries.

The **urgency of immediate transformation** is ever more visible through reported temperature and weather extremes. Examples include all-time highs in temperature across the globe, droughts accompanied by enormous and numerous wildfires, heat-caused deaths especially in urban areas, flooding, landslides and alarmingly high temperatures of oceans, lakes and rivers.

This Global Bioeconomy Summit 2026 focused on discussing and showcasing the evolution of bioeconomy activity. These included global bioeconomy-based successes; bioeconomy solutions for a planet in crisis; scaling bio-based solutions through policy, markets and metrics; and visions for the bioeconomy in 2040.

Recommendations for the way ahead:

We recognise and stress that the bioeconomy is a key element of socio-economic change.

The IACGB recommends focusing actions on these following points to grow sustainable and net-zero economies governed by biological principles. These actions will aid creating regenerative cycles that enhance natural capital and developing circular economies while respecting planetary boundaries**.**

- **Use bio-based solutions to help solve global crises**
- **Integrate bioeconomy post-2030 into global frameworks of policy and industry strategies**
- **Promote bio-based scientific breakthroughs and innovation**
- **Build long-term collaborative partnerships and networks to deploy innovative bio-based solutions**
- **Ensure intergenerational equity, societal engagement and education**

Introduction - What is a bioeconomy?

The global community is currently facing a critical juncture. The interlinked challenges of climate change, accelerated biodiversity loss, food insecurity, and enduring geopolitical conflicts necessitate an urgent, comprehensive restructuring of our economic systems. The current model is no longer viable in its reliance on fossil fuels, which are finite, and results in the depletion of natural capital and the compromise of the biosphere.

The bioeconomy, which is the sustainable production, utilisation, conservation, and regeneration of biological resources, along with the associated scientific, technological, and innovative practices, has evolved beyond the status of a mere alternative sector[1]. This transformation is a profound and far-reaching phenomenon, with the capacity to drive fundamental changes across various sectors, redefine consumer behaviours, and revitalise ecosystem health. The transition to a global bioeconomy has the potential to offer unprecedented pathways to achieve climate neutrality, safeguard global health, ensure food security, create bioenergy and biomaterials, and stimulate growth and socio-economic development across all hemispheres.

Section 1 – GBS from 2015 to 2026 – a celebration!

With the UN climate change 2050 pact and an OECD early consideration of a bio-based economy[2] , Germany set up the first **Global Bioeconomy Summit** in 2015[3]. This was organised in Berlin under the patronage of the German Chancellor, and the first Communiqué was issued on the state of the Global Bioeconomy.

The Summit enabled a meeting place to discuss new developments and celebrate successes in bioeconomy solutions. Alongside the Summit a global advisory group – the IACGB was created and were the authors of the first Communiqué.

Since then, four Communiqués, with a Youth Communiqué following establishment of the Youth Champions Group, have been issued. These have a consistent evolving commentary on the state of the bioeconomy, what is needed next, and what might the future bring. Early issues included establishing dialogues with key players, promoting global capacity in bioeconomy and including bioeconomy in global fora. In 2020, three overarching contributions by bioeconomy for the planet and its people were stated for the first time: health and wellbeing (especially topical during COVID); science and technology breakthroughs; climate action, ecosystems and biodiversity protection. The 2020 meeting included over 3000 people globally in an online meeting due to COVID restrictions. The 2024 meeting was the first time a Summit was held outside Germany - in Kenya- with a second now held in 2026 in Ireland.

- The Global Bioeconomy Summit (GBS) Communiqués show the transition of the bioeconomy from a niche scientific concept into a macroeconomic framework. The 2015 and 2018 Summits established the perspective of the bioeconomy as a contributor to sustainable development and inclusive transformation. They emphasised building a foundational definition of the

[1] https://www.iacgb.net/; Ecuru, MacRae and Lang, 2022: https://www.nature.com/articles/d41586-022-03405-0

[2] OECD 2004: https://web-archive-storage.oecd.org/aemint-web-archive-prod/web-archive/de/de14afc27ed0f40089f3d4030da0b72329ec8cbbf2297ed8cde1db3f334a5230.pdf

[3] https://gbs2024.org/

bioeconomy, focusing heavily on innovation and technology pushes, engineering biology, and creating alternative bio-based substitutes for fossil fuels.

- Prompted by the COVID-19 pandemic and accelerating climate pressures, the GBS 2020 IACGB Communiqué shifted towards a "building back better" narrative. It explicitly linked the bioeconomy to planetary health, social equity, and economic recovery.

- The early documents established a three-pronged vision: (i) science and innovation: leveraging biotechnology, digitisation, and automated screening to create sustainable bio-manufacturing pipelines; (ii) climate and ecosystems: positioning the bioeconomy as a critical driver for carbon neutrality and biodiversity preservation; (iii) inclusivity: expanding the focus to include rural transformation, indigenous knowledge, and smallholder farmers, ensuring that the shift away from fossil fuels should not widen the global wealth gap.

- Milestones in 10 years (according to our Communiqués and beyond):

    - 2015-2018 - Bioeconomy as a substitution system: replacing fossil fuels with first-generation biofuels (corn, sugarcane). This concept was revised in later years to acknowledge bioenergy and biofuels as a niche opportunity. Bioeconomy was aligned with the UN Sustainable Development Goals (SDG) goals and recognised as a core element of sustainable development and inclusive transformation.

    - 2019-2023 - Bioeconomy as a circular system: utilisation of agricultural and industrial waste as a key strategy in the elimination of the 'food versus fuel' conflict. The CRISPR gene-editing technology revolutionises agriculture and microbial biomanufacturing. In the COVID-19 pandemic, bioeconomy became critical not only in prevention (hand sanitisation), but also in treatment (vaccines, herbals for immune boosting), and in the resilience of supply chains (food, biofertiliser, etc).

    - 2024-2026 – Bioeconomy as a catalyst for decentralised manufacturing. Biodiversity monetisation and global policy harmonisation are focal policy aspects. The G20 High-Level Principles on Bioeconomy are adopted. Bioeconomy is considered a social services system. The concept of “socio-bioeconomy”, developed at the Federal University of Pará during the early 2020s and a central feature of Plan Bio Pará[4], was introduced at the GBS2024 in Kenya[5], the G20 Initiative on Bioeconomy in Brazil[6], and the Bioeconomy Challenge at COP30 of the UNFCCC[7]. This includes the concept of Access and Benefit Sharing, providing a fair model of joint economic success. Decentralised and modular biomanufacturing allowed local communities to convert agricultural waste into their own organic fertilisers and off-grid biogases, creating localised wealth. The Bioeconomy Youth Champions had their debut Communiqué[8], demonstrating enablement of the next generation.

    - 2026 – Bioeconomy as a stimulus for socio-economic transformation: The economic costs of biodiversity loss are being delineated, with these costs representing an active macro-

[4] https://opsaa.iica.int/en/initiative-1859-plan-bio-para

[5] https://gbs2024.org/

[6] https://www.gov.br/g20/en/tracks/sherpa-track/bioeconomy-initiative

[7] https://bioeconomychallenge.org/

[8] https://www.iacgb.net/youth

financial threat. According to the World Economic Forum[9], more than half of global GDP (approximately $58 trillion) is moderately or highly dependent on natural systems. Economic simulation models further show that unchecked biodiversity loss is projected to reduce global GDP by 2.3% by 2030[10]. The rise of regional wars has also highlighted the value in ensuring greater locally grown (distributed) food and manufacturing using new bio-based tools, techniques and resources. It has also illustrated the dangers in dependence on fossil materials for economic wealth and growth, many of which have various forms of subsidy and limited areas of production globally, often amid geopolitical conflict.

As time has passed the recommendations have been reflected in the rise of bioeconomy and its significance in local and global economic and societal activities.

Exemplars of change in the past 10 years include:

- There has been an exponential increase in technologies and applications relating to the bioeconomy, both those still in development and those already embedded through commercial or political intervention.
- There has also been a large increase in the number of dedicated bioeconomy strategies – at regional, national, subregional, and local/city/state levels globally. These articulate governmental, industrial and environmental initiatives related to the bioeconomy and its applications and needs.
- The EU continues to play an important role in bioeconomy activities globally, but regional strengths are also in Latin America, Africa (especially East and Southern Africa) and Asia/Pacific (especially China and Japan); with North America (an early lead, especially in biotechnologies) continuing strongly in the private sector, with the government recently removing policy activity.
- There are now some globally recognised measurement systems to prove claims of Bio-origin as well as proof of sustainable production and end-of-life claims; though they are not consistently used yet.
- There are several globally recognised bodies (pan-national) that have released formal bioeconomy commentaries over the past 3 – 4 years on future needs and challenges (eg WEF, Chatham House, G20, FAO, UNEP, etc)
- Best practice examples include:
    - **Circularity**: The implementation of "cascading biomass use" models, where biological materials are prioritised for high-value applications (pharmaceuticals, biomaterials) before being recycled into bioenergy or organic soil amendments.
    - **Agri-Food and Bio-based Innovation Hubs**: Regional programs like BioInnovate Africa and the Biostar project have successfully scaled regional bioprocesses. Similarly, biofuel developments in LATAM, especially Brazil, are being successfully scaled into biorefineries. Such initiatives transform agricultural processing waste (such as coffee husks, cassava peels, and wastewater) into organic fertilisers, animal feed, and off-grid bioenergy, boosting rural incomes while minimising pollution.
    - **Biotechnology and Engineering Biology** (mostly in technology-driven bioeconomies such as China, Singapore, Japan, EU, UK, US): Biomanufacturing of chemicals and pharmaceuticals,

[9] https://www.weforum.org/stories/global-risks/governing-environmental-risk-era-geopolitical-instability/

[10] https://openknowledge.worldbank.org/entities/publication/fcc11682-c752-51c4-a59f-0ab5cd40dc6f

gene and genome editing systems for plant breeding. Microbial fermentation is changing the resource used for many products, such as those in the flavour and fragrance industries. There is considerable potential to expand biomanufacturing across sectors and to apply the associated learnings much more widely.

- **CO_2 as feedstock**: Commercial-scale facilities are utilising gas-fermentation technology (such as Solar Foods and LanzaTech) to capture industrial emissions and direct them into bioreactors where microorganisms convert carbon from CO_2 or CO into various compounds; eg protein, which is used as animal feed and for human nutrition, or making various substitutes for fossil chemicals.
- **Urban bioeconomy**: Waste to biogas and other biomaterials, and design of "sustainable city ecosystems" and greening of buildings and transport (such as Kashiwa-no-ha, Tianjin Eco-city, Abu Dhabi, Barcelona, Curitiba, Stuttgart, Singapore)
- **Construction**: Timber and bio-composites are used for buildings and are structurally used for buildings up to 39 floors (eg Atlassian in Sydney and Ascent in Milwaukee) and have the potential to transform cities into carbon sinks.
- **Textiles:** Clothes derived from sustainable natural resources, such as farm produce, food processing by-products and organic waste, offer an alternative to conventional synthetic materials made from fossil fuels and natural fibres such as cotton.

Section 2 – Challenges remain

Despite the accomplishments, the socio-economic transition continues to be accompanied by significant challenges. Some are ongoing from previous years, but others have worsened. While there is still a lack of clarity on language and understanding of what a bioeconomy is, there is still uneven treatment and dependence by governments on current embedded fossil systems versus new bio-based solutions. Significant economic disruptions from wars and erratic political decision-makers pose novel challenges for the bio-based transition. Further, the **speed of climate change consequences is startling**.

As the time gets shorter to address the global agreement on 2050 - i.e. for the post-SDG agenda several critical aspects need to be worked on, and measures need to be implemented NOW.

The fragmentation of **markets, standards and regulations** has become more visible as the number and diversity of stakeholders in business strategies and governmental policies is increasing. There are divergent global rules on biosecurity, genetic innovations, and bio-based content verification. This leads to a slow-down of trade and a delayed market entry for bio-innovations. International trade codes can be harmonised, and carbon accounting can be standardised.

Economic and scaling barriers hinder a fast and broad market access and widespread market share. Scaling barriers are often **financial barriers**, as scaling requires large and long-term financing. Today's investments are not sufficient.

Immature supply chains and high capital costs hinder wider market entry of biobased products and services. Startups struggle to survive the "valley of death" due to a lack of dedicated de-risking finance, and a lack of understanding of the length of time it takes to change supply chains in the market (i.e. often 20 – 30 years is needed for bioproducts to become embedded into the market as a real choice). Public procurement measures like the "bio-preferred" programme in the USA can pave the way for bio-based innovations. Specific financial vehicles that utilise public capital, sovereign wealth funds, or

multilateral development banks can be established to cover the "first loss" piece of a project, thus enabling private pension funds, infrastructure equity, and commercial loans to safely invest.

Manufacturing is a limiting factor still, while **cross-sectoral products** and activities appear to be increasing. There is considerable potential to expand production and apply the associated learnings much more widely. One example is the rapid growth in cost effectiveness of some bioplastics (especially in packaging) and the rise of 3D printing using biomaterials as a manufacturing solution. Microbial fermentation is changing the resource used for many products, eg growth in the flavour and fragrance industries over the past 25 years, and more recently in biopharma.

Severe economic barriers are also set up by persisting **subsidies** for fossil fuels and fossil-based materials which hinder a level playing field for bio-based goods and processes. “Fossil industries” have benefited from over a century of optimised infrastructure, direct and indirect subsidies and externalised environmental costs. They have become deeply entrenched. In contrast, bio-based alternatives - such as aviation biofuels (SAF), biosuccinic acid, biofertilisers, – are generally not subsidised and they often hit a scaling wall. While still ensuring feedstock sourcing stays within regenerative limits, subsidy reform and carbon feedstock standards could significantly change the game.

The impacts of climate change are being manifested faster than anticipated. Droughts as well as floods, weather extremes such as excessive heat and storms are endangering food and feed supply, are impacting healthy livelihoods and biodiverse environments. Bio-based solutions will have to demonstrate how they help to mitigate consequences on a large scale. Bioeconomy and bio-based processes need to adapt to the significant changes. Bioeconomy solutions to capture CO_2 and reduce emissions need to scale faster and in time to impact the growing wildfires, the consequences of biodiversity loss, flooding or sea-level rise, and the faster rise in urban and oceanic temperatures. The lack of shared international standards limits the development of Carbon markets and the investment in natural based bio-based solutions.

There still is a lack of **consistency in bioeconomy language** – while the IACGB has a well-recognised definition of a bioeconomy, multiple words can and are being used locally and internationally to indicate what is essentially “bioeconomy in practise”. These are words like “green”, “circular”, “sustainable”, “cleantech”, “environmental”, “regenerative”, “biodegradable”, “agroecology” – all fit within the definition of bioeconomy and need to be reconciled with the bioeconomy narrative. This includes better communication with society in general, and a dialogue on what bioeconomy means – both globally and on the local and regional level - , why it is needed and what “change” means on the personal and community level. **Education** on the bioeconomy in many different forms and levels is urgently needed (as mentioned in the past and in the IACGB Youth Communiqué) and must be grown both formally and informally with society and the community.

Harmonised measurement systems will need to be negotiated to track bioeconomy benefits. At COP30, Brazil initiated the Bioeconomy Challenge. This is a call for proposals to enable a consistent global assessment system and the data from it to track the Global Goal on Adaptation. This needs to inform the next steps for globally consistent perspectives on the benefits of a bioeconomy and bioeconomy systems for addressing climate change by 2050. The bioeconomy should have greater prominence in the post-2030 global sustainable development agenda.

Section 3 – How bioeconomy can shape the future and accelerate socioeconomic change

A central road to success in the bioeconomy is to support and encourage socioeconomic change. These are the **key areas** in which the bioeconomy can and will provide solutions (often new manufacturing and materials) to foster change:

Food – Food security and food quality are stressed by the increased demand of a growing world population, by weather and climate changes, by pests and by reduced soil and marine quality and sustainability.

Bioeconomy provides multiple potential value and revenue streams. Solutions include employing regenerative agriculture techniques that lead to better soil, pest and water management. AI-assisted crop management reduces and customises water and nutrient requirements. Gene editing and other biotechnology techniques considerably accelerate breeding and enhance breeding success for drought- and pest-resistant varieties and microbiomes. Microbial precision fermentation uses alternative carbon sources from waste and air (CO_2) to produce protein for feed and food. Insect farming using food waste as a feed stock eliminates the pressure on soy feedstocks and their wide applications.

Health – Health is a basic human need. Many nations recognise health and prevention as a national objective or a fundamental right. WHO lists several key threats to health; among these are outbreaks of vaccine-preventable diseases like measles and diphtheria, increasing reports of drug-resistant pathogens, growing rates of obesity and physical inactivity, and the health impacts of environmental pollution and climate change.

Bioeconomy is crucial in managing and positively influencing such health issues. For these solutions, the use of indigenous knowledge as well as the application of modern technologies play rapidly evolving roles. Examples include the development of modern vaccines (protein-based, RNA-based), of cancer therapeutics (antibodies based), of diabetes and weight control drugs (insulins, GLP-1 molecules), as well as traditional extractives and modern antibiotics.

Environment – A growing global population, industrialisation based on fossil sources, intensive agriculture and urbanisation have all endangered the environment, put stress on biodiversity and induced massive contamination of oceans, air and soils.

Bio-based solutions are necessary and can be effective in mitigating the negative consequences and minimising further risks in the future. Examples include:

- Redesigning **urban** environments and promoting cross-talk between food, fuel, water, oceans, forests, environmental nurture, cities and towns, and solutions from indigenous sources. All need to include 100-year planning.
- **Microbiomes** which maintain or restore diversity and functionality in soils, plants, animals, and humans. Interventions with a positive effect on the environment include probiotics, biofertilisers, or bioremediation.
- **Reducing carbon emissions from fossil sources** by replacing fossil carbon with renewable carbon in production across sectors; capturing carbon by microbial production, designing cascading

biorefineries. Pastures, urban parks and forest plantations can contribute carbon sequestration leading to climate change mitigation.

Society and economy – Education and job creation through advanced biomanufacturing increases economic resilience and reduces the reliance on (imported) fossil-based products. Bioeconomy has the capacity to redistribute economic activity from centralised fossil-fuel hubs to rural and regional communities, and to contribute to socio-economic change. Nations with high biodiversity can shift from being mere exporters of biomass to becoming partners that own the intellectual property and proactively establish domestic processing hubs to ensure the localisation of wealth generation.

Inadequate financing of and investing into science today still hinders development and job creation in many nations. Bioeconomy solutions need to be implemented in everyday life so that all people can see and believe they add value and hence embrace them. Narratives, experiences and evidence need to be developed at the community level, in political fora, business and economic bodies, always adapted to various parts of the world and different communities, and always including youth. Bioeconomy has the potential to reduce inequalities (especially gender and generational ones), increase fairness, inclusivity and equity, and create positive outlooks towards the future.

Global cooperation - The bioeconomy must be incorporated into both national economic policy-making and industrial strategy frameworks in a formal and direct manner. To fully articulate the benefits of a transition to a bioeconomy, including its successes and its potential to benefit people and the planet, there needs to be closer collaboration between bioeconomy initiatives around the world. It will be critical to join forces at decisive moments and take effective action on the major policy agendas that will define the coming decades. This is urgent now as the post-SDG framework for the period after 2030 is being prepared.

A bioeconomy that speaks with one voice can claim its place within the new framework; but fragmented voices will not be heard. The successful formation of a Global Bioeconomy Partnership, led by the IACGB, will enable consistency, understanding of developments, and issues and ways to address these both globally and locally.

Section 4 – Recommendations for the way ahead

We recognise and stress that the bioeconomy is a key element of socio-economic change.

The IACGB recommends focusing actions on these following points to achieve net-zero economies governed by biological principles, creating regenerative cycles that enhance natural capital and develop circular economies, by 2035**.**

- **Use bio-based solutions to help solve global crises:**
  Appropriately brought to market, a bioeconomy can deliver significant emissions reductions for meeting Paris Agreement targets and bioeconomy tools and principles properly applied can alleviate food insecurity and stop biodiversity loss. It requires inclusive participation and needs to operate sustainably, ensuring extraction never outpaces regeneration and stays within planetary boundaries. New employment prospects for youth will come through innovations in the bioeconomy and enabling communities. This includes building technical capacity, supporting value-adding activities and strengthening supply chains in different regions.

- **Integrate bioeconomy post-2030 into global frameworks of policy and industry strategies:**
  Global collaboration is required to take effective action on the major policy agendas (e.g., post-2030 SDGs, UNFCCC, CBS, and UNCCCD COPs, G20 and G7) that will define the coming decades. International scientific, societal and policy collaboration and knowledge sharing are needed to address shared challenges. A Vision for 2040 was developed at GBS2026 and is published in an Annex.

- **Promote bio-based scientific breakthroughs and innovation:**
  Key innovations from biotechnology, chemistry, engineering, digital technology, responsible use of AI, and convergence of multiple technologies across sectors are accelerating bioeconomic development opportunities. Development of the new bio-based industries requires the education and training of specialist workforces. There will be a need for new educational courses at various technical levels. In many cultures, this includes the use and application of indigenous knowledge.

- **Build long-term collaborative partnerships and networks to deploy innovative bio-based solutions globally:**
  Bioeconomy developments by their very nature are highly collaborative endeavours, requiring transformative coalitions. We are committed to building a Global Bioeconomy Partnership Platform during the coming years to facilitate bioeconomy progress. Over the next decade, the traditional funding models of government grants, leading to angel and VC funding, will still apply - but new funding models will need to be developed. We plan to strengthen capabilities to advise governments, development banks, NGOs, e.t.c. on formulating specific financial instruments, including blended finance strategies and impact-investment funds, to mitigate risks for private capital entry into the bioeconomy.

- **Ensure intergenerational equity, societal engagement and education:**
  The bioeconomy will not become embedded in our future without strong education and engagement with all parts of society. This will be critical to create a future planet where generations can live harmoniously with their environment.

Bioeconomy is significantly impacted by some breakthrough technologies

1. Engineering Biology: Over the last 25+ years, genetic modification/engineering biology/synthetic biology principles have been applied in increasing activity to a range of fields including: diagnostics, therapeutics, crops and soil, commodity and specialty chemicals, innovative foods, bioremediation, bioenergy, and biomaterials.

Research has progressed rapidly to a point where industrial translation is now a key component of the field worldwide. The traditional industrial model uses fossil-based feedstocks and synthetic chemistry in industrial processes, leading to current products. The new industrial model comprises bio-based feedstocks (carbon as a gas or biomass) utilising the new biological tools in industrial processes, leading to both substitute and totally new products. It is anticipated that by 2035 many products currently based on the use of fossil fuels will be replaced by the new, sustainable and biobased industrial processes. A recent analysis of the Synthetic Biology Market[11] showed it was USD 21.12 Billion in 2025 and projected to grow to USD 105.04 Billion by 2035 (a CAGR of 17.4%). To achieve this prediction a global acceptance and new partnerships will be required. For example, there are estimated to be around 1000 new start-ups and SMEs in the US, 200 in the UK and 500 in China.

Another forward-looking application is to mimic the photosynthetic system from plants to create synthetic manufactured metabolic structures to capture CO_2 and sunlight energy directly, creating energy and various other bioproducts.

With food resources, marker assisted breeding and genome and gene editing technologies have been introduced into agriculture within the past 40 years. While their potential is still very much untapped, the tools will be needed for rapid development of climate resistant food crops and greater productivity.

In a world of rapid climate-related changes in water supply and higher temperatures these technologies and approaches are needed more than ever. While the herbicide tolerance segment currently captures the highest market share, the abiotic stress tolerance (drought, heat, salinity) segment is expected to grow significantly in the next decade. Gene edited crops like maize, soybean, cotton have been the primary crops on the market, but the fruit and vegetable segment is already growing rapidly and will be significant in the next ten years. Gene editing will also be significant in modifying soil microbes as well as in precision medicine, especially in treatment for genetic diseases that often result from point mutations, e.g., sickle cell anaemia and beta thalassemia.

2. The rise of AI: Digitalisation and AI will bring cross-sectoral innovations. In biology, generative AI and Large Language Models (LLMs) are predicting protein structures and enabling the customised design of novel enzymes and synthetic pathways. Using AI technologies responsibly and considering biosafety concerns will be a key provision.

By 2035 AI-driven metabolic engineering will have designed novel microorganisms that can digest complex agricultural waste, produce specialised novel chemical blocks, and synthesize personalised drugs. AI is driving precision farming, crop resilience, advanced fermentation and sustainable food systems in agriculture[12]. Through such innovations, the bioeconomy enables industries to decouple economic growth from fossil resource consumption and is shifting farming away from traditional scheduling and towards real-time, data-driven biological management.

Engineering and computer science are increasingly integrated and applied in engineering biology, using the Design, Build, Test and Learn (DBTL) paradigm (coupled to the design cycle). The next decade will see the increasing integration and widespread use of AI/ML techniques -integrated into biorefineries that use extensive automation. The design of bio-based products will increasingly rely on moving away from human-based design systems to the use of generative biology that employs LLMs.

As all these applications and technologies are heavily dependent on energy and water, (bioeconomy) solutions will need to be devised for sustainable and future focussed options.

3. Advanced manufacturing: With the production of materials, chemicals and pharmaceuticals from biomass rather than from fossil resources, the structure of production will change as well, especially with adoption of green chemistry and sustainable engineering principles.

In the next few years, the focus will be on **scaling and biomanufacturing**. This, in turn, will rely on several factors. Principal among these are facilities (e.g. Biorefineries and Precision fermentation facilities – mobile and fixed), together with new funding and financing models to support company growth. The next decade will see the increasing

[11] Synthetic Biology Market (2026-2033): Biotechnology Research team; Grandview Research Ltd; 150pp June 2026; ID: 978-1-68038-182-5.
[12] AI4AI, https://initiatives.weforum.org/ai4ai/home

integration and widespread use of AI/ML techniques -integrated into biorefineries and precision fermentation facilities while using extensive automation.

Progressing existing initiatives to build the new industry will require a worldwide infrastructure of distributed facilities, possibly supported by a standardised information infrastructure. New technical standards and metrics to achieve interoperability for a wide range of biobased raw materials, equipment and software will be needed. The development of such infrastructures and standards will facilitate distributed biodesign and biomanufacturing (both nationally and internationally). A structure based on local biomass supply will remove the need for long supply chains, leading to small decentralised local biomanufacturing capabilities as an alternative to centralised manufacturing facilities and systems.

Advanced biorefineries decouple the production of chemicals and energy from primary land use. They may utilise non-food feedstocks, such as agricultural residues and municipal solid waste, or industrial carbon dioxide emissions routed directly into microbial bioreactors to yield biomaterials. Examples include biopolymers, bioplastics, biobased concrete and other construction materials, biobased fibres for textiles, novel food and feed.

Achieving industrial growth will require new funding models to provide a facilities infrastructure which is affordable for growing companies[13],[14]. Over the next decade the traditional funding models of government grants, leading to angel and VC funding, will still apply – but we can also expect the development of new financing models[15],[16],[17]. Prominent examples currently under development and implementation include blended finance mechanisms and capital market tools like green bonds and sustainability-linked bonds. Public-private partnership (PPP) models for operating shared pilot facilities and demonstration equipment are also active.

4. Novel Materials: Modern societies depend on materials, chemicals and manufactured products for housing, mobility, communication, healthcare and everyday consumption. Today, these are generally derived from finite fossil resources, contributing significantly to greenhouse gas emissions, waste generation and resource dependency. Advances in biotechnology, biomanufacturing and biorefining are transforming biological resources. Examples include:

- **Biobased materials and chemicals** such as bioplastics, biobased solvents, surfactants and specialty chemicals that can replace fossil-derived products in packaging, consumer goods and industrial applications.
- **Sustainable construction materials** including engineered wood products, biocomposites and novel biomaterials that reduce the carbon footprint of buildings and infrastructure while storing biogenic carbon over long periods.
- **Advanced textile and consumer products** derived from biomass, microbial fermentation or cultivated biological systems, providing renewable alternatives for clothing, personal care products and household goods.
- **Precision fermentation and industrial biotechnology** enabling the production of ingredients, polymers, enzymes and functional materials with improved resource efficiency and reduced environmental impacts.
- **Circular biorefineries and renewable carbon systems** that convert biomass, waste streams and captured carbon into fuels, chemicals and materials through cascading use approaches, maximising resource efficiency and minimising waste.

[13] https://www.biomade.org/
[14] https://www.bbeu.org/
[15] https://www.esgtoday.com/forbion-raises-e200-million-for-biotechnology-focused-sustainability-solutions-fund/
[16] https://www.tpg.com/platforms/impact/rise-climate
[17] https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-linked-bond-principles-slbp/