Financing a Sustainable Global Bioeconomy

September 2024

WORLD bioeconomy FORUM

NATURE FINANCE

Financing a Sustainable Global Bioeconomy

September 2024

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About
Financing a Sustainable Global Bioeconomy

Financing a Sustainable Global Bioeconomy provides the results of a pioneering landscape analysis of the current and prospective interplay between finance and the bioeconomy.

The substantive context is the keystone role that the bioeconomy needs to play in shaping an equitable, nature positive, low carbon global economy.

Financing a Sustainable Global Bioeconomy's institutional context is the leadership taken by Brazil in establishing the *G20 Initiative on Bioeconomy* in its G20 Presidency and hopefully South Africa's G20 Presidency in 2025, the prioritisation of finance and the bioeconomy by the Colombian Presidency of the forthcoming Conference of the Parties of the Convention on Biological Diversity (COP16), and the place of the bioeconomy in building international collaborative action on climate, grounded in the Conference of the Parties on climate change under the Brazilian Presidency in 2025 (COP30).

Financing a Sustainable Global Bioeconomy is the initial product of a collaboration between NatureFinance and the World Bioeconomy Forum. It draws on the extensive work of both organisations and draws on the wealth of knowledge and practical experience of many of its partners.

Financing a Sustainable Bioeconomy builds on two key pieces of work contributed to the Brazilian G20 Presidency, *The Global Bioeconomy – Preliminary Stocktake of G20 Strategies and Practices* prepared by NatureFinance and the Center for Sustainability Studies of Fundação Getulio Vargas on behalf of a coalition of twenty Brazilian-based civil and business organizations and coalitions, and the *G20 High-Level Principles of the Bioeconomy – a Roadmap for Action*, as well as the final report of the High-level Taskforce on Nature Markets, *Making Nature Markets Work*, released at the Amazon Summit in Belem, Brazil, in August 2023.

Related material can be downloaded at:
https://www.naturefinance.net/resources-tools/
https://www.naturemarkets.net/publications
https://wcbef.com/online-store/

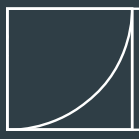
About NATURE FINANCE

NatureFinance is a Swiss-based, international not-for-profit organisation dedicated to aligning global finance with more equitable, nature positive outcomes.

We work to make nature count in global finance and the global economy. NatureFinance is active in advancing the use of data to disclose and manage nature related risks, developing impactful and equitable nature markets, and advancing financial innovation in the areas of sovereign debt and nature positive investment. We develop tools to help financial actors better assess and align their investments with nature positive outcomes and push for stronger costs and consequences where finance is failing to address nature liabilities.

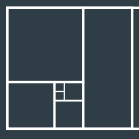
What do we do?

NatureFinance's work is underpinned by four cross-cutting pathways to impact:



Policy and regulatory: we work to shape the enabling frameworks for nature finance and nature positive, equitable markets.

Market development: we work to create an ecosystem of investable, nature-related ventures with the potential to shape nature positive markets.



Engagement and advocacy: we work to build coalitions of practice, public engagement, and communication, supporting civil society development and actions around aligning finance with nature positive, equitable outcomes.

Innovation and incubation activities: we work to accelerate nature-positive outcomes at scale through seeding and supporting new efforts like our Sustainability Linked Debt Hub (SSDH).

Additional information about the work of NatureFinance can be reviewed on www.naturefinance.net

Our use of Fibonacci sequence imagery is inspired by the association of this unique ratio with the maintenance of balance, and its appearance everywhere in nature- from the arrangement of leaves on a stem to atoms, uncurling ferns, hurricanes and celestial bodies.

About WORLD bioeconomy FORUM

The World Bioeconomy Forum is a global platform dedicated to bringing together stakeholders in the circular bioeconomy to share ideas and promote bio-based solutions. Our focus spans across bioresources, biotechnology, and bioecology visions, fostering a collaborative environment for sustainable innovation.

OUR COMMITMENT

We are fully committed to sustainability in all aspects of our work and firmly believe in the reality of climate change. Recognizing that there is no one-size-fits-all approach to the bioeconomy, we utilize our unique Four-Pillar Structure to evaluate and advance the status of the circular bioeconomy.

THE FOUR-PILLAR STRUCTURE

Our operations and activities are based on the Four-Pillar Structure, which provides a comprehensive framework for our initiatives:

The Bioeconomy:
People, Planet, Policies

Corporate Leaders and
the Financial World

Bioproducts around us

Looking to the Future

This structure allows us to effectively assess and drive progress across the entire bioeconomy sector. By leveraging these pillars, we aim to facilitate holistic and impactful bioeconomic developments, contributing to climate change mitigation and promoting a sustainable future.

Additional information about the work of the World Bioeconomy Forum can be reviewed on https://wcbef.com/

Acknowledgments

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As part of our on-going engagement in Brazil with the G20, we acknowledge with appreciation the collective leadership of the coalition of organizations of which NatureFinance is a member that have supported the Brazilian G20 Presidency in advancing the bioeconomy agenda, comprising of the Alana Institute, Amazon Concertation, Amazon Environmental Research Institute (IPAM), Arapyaú Institute, Brazil Climate, Forests and Agriculture Coalition, Brazilian Business Council for Sustainable Development (CEBDS), Brazilian Center for International Relations (CEBRI), Brazilian Federation of Banks (FEBRABAN), Brazilian Tree Industry (IBÁ), CDP Latin America, Climate Policy Initiative (CPI), Conservation International (CI), Dom Cabral Foundation (FDC), Igarapé Institute, Insper Agro Global, Institute for Climate and Society (iCS), Interstate Consortium for Sustainable Development of the Legal Amazon, Natura&Co, The Nature Conservancy (TNC), and the World Wide Fund for Nature (WWF).

Finally, thanks to those who have provided financial support in making this work possible, including the Children's Investment Fund Foundation (CIFF), Instituto Clima e Sociedade (iCS), and the MAVA Foundation.

Notwithstanding the importance of the many acknowledged contributions, all errors and omissions are those of the individual and institutional authors.

List of Abbreviations

AfCFTA	African Continental Free Trade Area
ASEAN	Association of Southeast Asian Nations
AU	African Union
BCG	Bio-circular Green Economy
BIC	Bio-based Industries Consortium
CAGR	Compound Annual Growth Rate
CBD	Convention on Biological Diversity
CBE-JU	Circular Bio-based Europe Joint Undertaking
CEN	European Committee for Standardization
CIFF	Children's Investment Fund Foundation
COP16	16th Conference of the Parties of the Convention on Biological Diversity
COP29	29th Conference of the Parties on Climate Change
COP30	30th Conference of the Parties on Climate Change
EFSI	European Fund for Strategic Investments
EIB	European Investment Bank
ESG	Environmental, Social, and Governance
EU	European Union
FIC	Finance in Common
FMP	Financial Market Perceptions
FOAK	First of a Kind
FONAFIFO	National Forestry Financing Fund
G20	The Group of Twenty
GDP	Gross Domestic Product
GIB	G20 Initiative on Bioeconomy
GREEN	Global Renewable Energy Efficiency Network
IAPB	International Advisory Panel on Biodiversity Credits
ICMA	International Capital Markets Association
IIF	International Institute of Finance
IOSCO	International Organization of Securities Commissions
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
ISSB	International Sustainability Standards Board
iCS	Instituto Clima e Sociedade
MAVA	MAVA Foundation
mRNA	messenger RNA
MCTIC	Ministry of Science, Technology, Innovations, and Communications
MEC	Ministry of Education
NBS	Nature-Based Solutions
NBSAPs	National Biodiversity Strategies and Action Plans
NDCs	Nationally Determined Contributions
NGFS	Network of Central Banks and Supervisors on Greening the Financial System
PES	Payments for Ecosystem Services
PPP	Public-Private Partnership
RAITs	Regenerative Agriculture Investment Trusts
R&D	Research and Development
SDGs	Sustainable Development Goals
SFWG	Sustainable Finance Working Group
TNFD	Taskforce on Nature-related Financial Risks
UNCTAD	United Nations Trade and Development
USDA	United States Department of Agriculture
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Preface

In 2024, Brazil embarked on an unprecedented initiative to strengthen sustainable development, social inclusion, the fight against climate change and the generation of decent employment in international financial discussions. Inspired by the potential of the bioeconomy as a catalyst that propels the economy towards a sustainable path and integrates nature into economic development, Brazil introduced the G20 Initiative on Bioeconomy (GIB) as a key element of its presidency. We are convinced that the bioeconomy is a departure from the traditional linear economy, a new productive paradigm which affords science, technology, innovation and traditional knowledge the same respect.

We suggested to our partners at G20 a methodology that prioritises dialogue and the exchange of experiences. We recognised early on that unlocking the full potential of the bioeconomy requires robust policy frameworks and extensive international collaboration. Today, G20 countries are actively debating and converging on a set of High-Level Principles for the Bioeconomy that will set a paradigm shift in our approach to economic growth, environmental protection, and social equity.

The report Financing a Sustainable Global Bioeconomy, proposed at the request of Brazil as an independent input to support the debate, is a stout contribution to a core set of questions that can help improve our global economy. How big is the Bioeconomy? What are the innovative approaches to finance the bioeconomy? What are the main levers and obstacles? How to overcome them? How to promote prosperity while ensuring equity and environmental integrity? Those are some of the elements examined in the report that encourage further debate, research and engagement by governments, academia, private sector and civil society.

Understanding the role of finance and the instruments available to stimulate the bioeconomy is fundamental to driving forward a bioeconomy that is positive for climate, nature and people.

The Brazilian Presidency of the G20 extends its heartfelt gratitude to the group of 22 organizations: Alana Institute, Amazon Concertation, Amazon Environmental Research Institute (IPAM), Arapyaú Institute, Brazil Climate, Forests and Agriculture Coalition, Brazilian Business Council for Sustainable Development (CEBDS), Brazilian Center for International Relations (CEBRI), Brazilian Federation of Banks (FEBRABAN), Brazilian Tree Industry (IBÁ), CDP Latin America, Climate Policy Initiative (CPI), Conservation International (CI), Dom Cabral Foundation (FDC), Getulio Vargas Foundation (FGV), Igarapé Institute, Insper Agro Global, Institute for Climate and Society (iCS), Interstate Consortium for Sustainable Development of the Legal Amazon, Natura&Co, NatureFinance, The Nature Conservancy (TNC), and the World Wide Fund for Nature (WWF) that have been actively contributing to the Initiative on Bioeconomy. This group provided invaluable insights and disseminated the GIB work in several public debates, articles in the media, and research pieces throughout the process.

This document is a valuable contribution that deserves broad circulation to enrich the global dialogue on the bioeconomy.

Ambassador André Corrêa do Lago
Vice-Minister for Climate, Energy and Environment of the Ministry of External Relations and Co-leader of the G20 Initiative on Bioeconomy (GIB).

Executive Summary

The global bioeconomy is a cornerstone in the transition to a more equitable, low-carbon and climate-resilient, nature-positive economy. The changing world is resetting our appreciation of how an equitable and sustainable bioeconomy can play a pivotal role in sustainable development. The clean tech revolution has provided one viable pathway, especially for decarbonisation. The bioeconomy provides the complementary basis through which we can secure an equitable, sustainable use of nature, particularly biodiversity, a pre-condition to a just-transition to sustainable development.

What's needed is to turn the vision of an equitable, sustainable bioeconomy into practice. At its core, it is about how we use biological resources in sustainable ways that advance an equitable global economy. The bioeconomy holds cultural value, immense economic potential for significant job creation and economic growth. Beyond such quantitative potential, efforts must support the development of socio-bioeconomies that are localised and sustain cultural diversity embodied by the role of Indigenous Peoples and Local Communities, including farmers, in stewarding the world's biodiversity.

The global bioeconomy is a cornerstone in the transition to a more equitable, low-carbon and climate-resilient, nature-positive economy. The changing world is resetting our appreciation of how an equitable and sustainable bioeconomy can play a pivotal role in sustainable development.

The bioeconomy is already large and rapidly growing. Today's global bioeconomy is estimated to be valued at US$4-5 trillion, with growth potential to US$30 trillion by 2050. Despite significant data gaps and weaknesses, there is clear evidence of key growth drivers including climate, environmental and health concerns, increasingly embodied in market preferences and regulatory developments. National and regional bioeconomy strategies from countries such as Namibia and South Africa to Mexico and Brazil, and from India and China to Japan, the EU and the US, signal governments' commitments to harnessing this potential.

The bioeconomy has to be collectively imagined, developed, and governed – and of course financed. The bioeconomy is a spectrum of bio-based enterprises and markets, ranging from local and regional socio-bioeconomies to the businesses, sectors and economies that blend biodiversity and technologies – from biochemicals and bioplastics through to diverse applications of biogenetics. It is essential that this spectrum be considered as a whole. After all, we all share the same biodiversity resources which have to serve many purposes. We need a commonly agreed approach to managing the nexus between economic and livelihood priorities, and increasingly fragile biodiversity.

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Brazil has raised the policy bar in encouraging international cooperation in advancing an equitable, sustainable bioeconomy through the G20. The G20 Initiative on Bioeconomy is an exemplary recognition of the need for collective action. Notably, it seeks to converge on a set of high-level principles that can inform policy making and market development. Such principles will focus on the normative dimensions, such as social equity, livelihoods and sustainable prosperity, and the need for the bioeconomy to address nature and climate goals. Moreover, they are likely to highlight the need to ground the bioeconomy in good science, and to secure common definitions, accounting and metrics, as well as enabling trade rules and financing arrangements and flows.

Bioeconomy financing challenges can be considerable and have diverse roots. Private investor interest in the socio-bioeconomy can be constrained, for example, by limited scale and restricted commercial rights over traditional knowledge. Nature-intensive bioeconomy enterprises, such as certified bio-products including food, chemicals and plastics, face unfavorable market conditions, often made worse by perverse fossil fuel and environmental subsidies. The higher-tech bioeconomy, especially early-stage businesses, often need risk capital, often blended with public funding support, which is only available in some parts of the world, restricting opportunities in many parts of the Global South.

Failing to act collectively, and ambitiously, in developing an equitable, sustainable bioeconomy into a major part of the global economy will result in the continued destruction of nature and associated negative climate and social equity outcomes.

Financing the bioeconomy is entirely possible, drawing on a wealth of existing financial instruments. Beyond conventional commercial financing channels, there are a host of existing 'sustainable finance' instruments that can be deployed in financing the bioeconomy. Nature credits, for example, including carbon and biodiversity credits, can both augment revenues and provide long-term income security that de-risks and lowers the costs of capital. Sustainability-linked financing instruments, likewise, especially in corporate and sovereign debt markets, can further reduce the cost of capital, attracting both impact investors and those betting on the potential of bio-products in tomorrow's, more sustainability-focused markets. Blended, public-private instruments have an important role to play, highlighting the importance of development finance institutions in advancing the bioeconomy in low to middle-income countries.

Financing the bioeconomy is entirely possible, drawing on a wealth of existing financial instruments. Beyond conventional commercial financing channels, there are a host of existing 'sustainable finance' instruments that can be deployed in financing the bioeconomy.

Investors will be more attracted to the bioeconomy where governments and regional bodies have put in place integrated bioeconomy strategies and associated executable plans. Less likely to work are isolated bioeconomy funds, high-level bioeconomy strategies lacking market buy in or execution capability, and public support for new bioeconomy enterprises and sectors absent of links to enabling trade policy. What's needed is an 'integrated' approach that for example, connects enterprise and market development with growing public awareness, suitable infrastructure, and enabling fiscal arrangements, education and research institutions and capabilities.

National and regional strategies and actions have to be complemented by international cooperation. International cooperation is essential for scaling the positive impacts of the bioeconomy and mitigating its risks. There is much that can be done at the national and regional levels, as witnessed by the growing number of sophisticated bioeconomy strategies. While national and regional actions are crucial, they must be complemented by global efforts to ensure a sustainable and equitable bioeconomy. The following priorities are critical for this endeavour:

1

PRINCIPLES

We cannot afford to allow the emergence of a 'buccaneering' bioeconomy - there is a need to converge on what public interest outcomes the bioeconomy needs to align with, an approach exemplified by the high-level principles being advanced by the G20 under Brazil's Presidency.

2

MEASURING PROGRESS

The lack of common measurement standards and related data makes it hard to measure, or more importantly guide progress. This is not just a matter of measuring its breadth and size but ensuring a common 'operating system' rooted in the science of natural capital accounting and building out through financial accounting to asset valuation and investment decisions.

3

STRATEGIES AND PLANS

Strategies and plans, including core economic and industrial strategies. In in many cases, these are linked to the development and enforcement of land tenure rights and other mechanisms to secure the rights, roles and rewards for nature's stewards, largely Indigenous Peoples and Local Communities, including farmers.

4

FINANCING

Principles, measurement, strategies and trading conditions need to be locked into a range of largely existing financing instruments, raising investor awareness, mitigating risks, and opening the way to effective collaboration, in combination with action to reduce, offset, or repurpose perverse environmental and fossil fuel subsidies.

5

PRICING NATURE

To accelerate on-going efforts to increase the price of nature in the global economy which will increase investor interest in the sustainable bioeconomy, through improved risk analysis, explicit pricing, regulatory developments including action by financial regulators such as enhanced application of anti-money laundering rules in addressing nature crimes.

6

TRADE RULES

Financing is less likely to flow unless the right enabling trade and associated investment rules are in place to encourage principles-aligned bioeconomy-related trade. This can and should be advanced in regional, as well as bilateral and international agreements, with the associated need to address the distorting effects of perverse subsidies, as well as industrial subsidies that can have the effect of restricting low and middle-income countries to move up the bioeconomy value chain.

7

KNOWLEDGE AND CAPABILITIES

There is a need to overcome the current lack of systematic analysis of the bioeconomy, in part by overcoming current shortfalls in data, especially to inform the development of robust bioeconomy strategies and plans as well as providing investors with much-needed information to support investment decisions.

Broader international policy orchestration is required to ensure effective and timely efforts. The G20 is the obvious platform to take on a broad international coordination role, given its thematic coverage, convening power and signalling influence. Brazil has begun this journey during its Presidency and there is a compelling logic to extending Brazil's efforts into future G20 Presidencies, notably the South African in 2025, and US in 2026. Complementing this, there is a need for the imperative to rapidly expand an equitable, sustainable bioeconomy in the deliberations of other key regional and international platforms, including the UN Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC). The imminent CBD COP16 in Colombia, and UNFCCC COP30 in Brazil in 2025, offer timely opportunities to prioritise this important topic.

1

Objectives and Approach

The global bioeconomy needs to be one keystone in advancing an equitable, climate-resilient, nature positive prosperity in the broader transition to sustainable development. Failing to act ambitiously in growing this part of the global economy will result in the continued destruction of nature and associated negative climate and social equity outcomes.

Financing a Sustainable Global Bioeconomy **explores the opportunities and challenges associated with accelerated financing the bioeconomy.** Its context is a growing recognition of the potential of the global bioeconomy to contribute to addressing climate, nature and equity goals, as well as the challenges and risks associated with its development.

This growing recognition is exemplified by Brazil's decision to establish the G20 Initiative on Bioeconomy (GIB) as part of its G20 Presidency, the prioritisation of finance and the bioeconomy set out by the Colombian Presidency of the forthcoming Conference of the Parties of the Convention on Biological Diversity (COP16), and hopefully the continued place of the bioeconomy in key policy platforms going forward, including the G20 under South Africa's Presidency and COP30 chaired by Brazil, both in 2025.

The Global Biodiversity Framework, as adopted at COP15 in Montreal in 2022, has accelerated the appreciation of the role of nature as an enabler of sustainable prosperity, and highlighted the importance of building an investable landscape at the nexus of economic development and biodiversity conservation and restoration.

Building and raising awareness of this investment landscape is all the more important in a world facing growing climate disruption as we move beyond the target limits set out in the Paris Agreement. It is in such a world that robust strategies are needed to create jobs, and tackle poverty, food security, and equity challenges.[1]

Financing a Sustainable Global Bioeconomy **is the fruit of a collaboration between NatureFinance and the World Bioeconomy Forum.** It builds on extensive work, including the A Status of the Global Bioeconomy[2] prepared by the World Bioeconomy Forum, and an initial piece contributed to the Brazilian G20 Presidency, *The Global Bioeconomy – Preliminary Stocktake of G20 Strategies and Practices*,[3] prepared by NatureFinance and the Center for Sustainability Studies of Fundação Getulio Vargas on behalf of a coalition of nineteen Brazilian-based civil and business organizations and coalitions. Moreover, it builds on the work of the high-level Taskforce on Nature Markets, summarized in its final report, *Making Nature Markets Work*,[4] released at the Amazon Summit in Belem, Brazil, in August 2023.

Financing a Sustainable Global Bioeconomy **maps the current financing and related instruments and mechanisms that are pivotal in advancing an equitable, sustainable bio-based economy.** There is a wealth of research on the related topics of nature finance, including financing aspects of the circular economy, nature-based solutions and, more recently, nature markets. However, there has to date been little written comprehensively on the topic of 'financing the bioeconomy', and even less that is framed by nature, climate and equity goals.

This paper seeks to bring together what is known, and to highlight what needs to be better understood on the topic, drawing tentative conclusions based on available data, recognising that it is incomplete and fragmented, and often poor quality. Notwithstanding these limitations, this report hopefully offers insights and helps to points the way forward in advancing financing for a truly sustainable bioeconomy. Moreover, we trust that it will also catalyse further research, including the generation of new data sets, allowing for more detailed analysis and evidence-based investment and policy decisions.

2

What is the Bioeconomy?

The bioeconomy is rapidly growing, with the World Bioeconomy Forum predicting that it could increase six-fold by 2050 to US$30 trillion from its current estimated size of US$4-5 trillion.[5] Major economies including Brazil, China, the EU, India, South Africa, and the USA have ambitious bioeconomy plans, many with specific growth targets. Clearly, the bioeconomy is becoming of increasing economic significance.

The bioeconomy is rapidly growing, with the World Bioeconomy Forum predicting that it could increase six-fold by 2050 to US$30 trillion from its current estimated size of US$4-5 trillion.

Yet despite the term being in use for two decades, it remains contested what exactly it includes and by implication, does not include. The scope of the bioeconomy is understood differently between countries and regions. There is no single, agreed definition of the bioeconomy. Most generally, it concerns the use of biomass in economic activities. But such a broad framing has its limitations since 100% of the global economy is ultimately 100% dependent on nature, as highlighted in the Taskforce on Nature Markets.[6]

One of the early definitions appeared in 2004 in an OECD report which defined the bioeconomy as

"...leveraging renewable biological resources, efficient bioprocesses, and eco-industrial clusters to generate sustainable bioproducts, employment, and income".[7]

Here it becomes clear that the bioeconomy in principle embraces the need to use biomass in a sustainable manner. Moreover, in referring to employment and income, this and other definitions point out the need to impact positively on people.

Although the bioeconomy is therefore generally underpinned by sustainability and equity objectives, these normative aspects are in practice under-specified and rarely subject to robust oversight. Regarding the science, there remain challenges in agreeing common measures of 'sustainable biodiversity' let alone the impacts on biodiversity from diverse human activities, all of this notwithstanding considerable efforts to land a common approach to understanding and measuring 'nature positive' outcomes, such as through the Nature Positive Initiative.[8]

Likewise, if not more so, there are concerns about the impact on people from a bioeconomy acceleration. This brings into focus the distribution of economic rewards between peoples and nations, and the matter of rights and cultural diversity, especially for Indigenous Peoples and rural communities, alongside broader societal outcomes including poverty and social inequality. Many socio-bioeconomy activities remain in the informal economy. This critical omission, if left unaddressed, risks reinforcing historic patterns of inequality at many levels, Along with that, lies the risk of undermining the vitality of what is often referred to as the *socio-bioeconomy* which embraces the nexus between sustaining biodiversity and social, cultural and economic autonomy.

This broader perspective on biodiversity is captured in the concept of a 'socio-bioeconomy' that acknowledges the intricate ties between biodiversity and socio-cultural systems. It advocates for sustainable production chains, the protection of genetic heritage, valuing traditional community knowledge, job creation and income generation. This approach also positions itself as a strategy for climate change adaptation. Applied to the Amazon context, the socio-bioeconomy offers opportunities for generating innovative products while promoting sustainable economic growth and preserving biological, cultural, and social diversity.

In practice, the socio-bioeconomy should involve activities that conserve and restore ecosystems, promote diverse and integrated agroecological practices, protect human and territorial rights, add local value to Amazonian products, and integrate scientific knowledge with Indigenous and local knowledge. It specifically excludes activities leading to deforestation, environmental degradation, reduced river connectivity, monoculture, and increased social inequality.

The bioeconomy is distinct from, but has close links with, other bio-concepts and frameworks. Notably, there is a complementarity with the increasingly significant and broadly used notion of 'nature-based solutions,[9] also included as an element of the Brazilian G20 Presidency, notwithstanding the latter's more limited focus on economic activities and markets.[10] Similarly, the bioeconomy echoes many of the goals and concepts behind the circular economy[11] with the bioeconomy focused more on biodiversity conservation and restoration. And finally, the bioeconomy fits into the broader 'green economy' framing[12] as well as being an integral part of the Sustainable Development Goals.

The G20 under Brazil's Presidency is expected to agree on a set of high-level principles intended to catalyze a more equitable, sustainable development of the global bioeconomy. Brazil's G20 Initiative on Bioeconomy has been established with the goal of securing of advancing a global economy in ways that deliver more equitable, sustainable outcomes. Core to advancing this goal is the intention to agree on a principles-based framework global that establishes a clearer basis for policy interventions aligned to sustainable development objectives, including through international cooperation in areas such as economic subsidies, trade policies and financial regulation.

These principles are under discussion at the time of preparing this paper and are likely to include specific reference to jobs, equity and anti-poverty considerations, and climate and nature goals. In this way, the bioeconomy is becoming a key lens and market process through which national and international policy goals can be addressed. Turning the principles into practice would then be the critical next step, which can be supported by continuing to focus on the bioeconomy during South Africa's G20 Presidency and Brazil's COP30 Presidency. Likewise, these efforts can be integrated into other key platforms encouraging ambitious action on sustainable development, including for example the *Finance in Common* platform for public development banks, the BRICS group of nations, and platforms advancing actions by central banks and financial supervisors.

Scoping of the bioeconomy ranges from local, small scale, traditional production practices through to large-scale, transnational, and includes technology intensive, economic activities. The *G20 Global Bioeconomy – Preliminary Stocktake of G20 Strategies and Practices* highlights the wide spectrum of frames adopted by governments and researchers. Varied perspectives co-exist between and within countries. For example, some view the Amazon's bioeconomy as primarily encompassing traditional and small-scale regenerative production practices embedded within a broader, inter-dependent social and cultural context (the socio-bioeconomy).[13] Others include commercial organic and regenerative farming and wider land-use, and advanced bioeconomy agricultural produce such as biofuels and bioplastics.

Such variations also sometimes differ on whether and how equity and sustainability factors are taken into account. Thailand has chosen to use both the local and transnational approaches together, promoting the artisanal or community-based model through the work of the *Biodiversity-based Economy Development Office*, as well as a large-scale approach through its *Bio-circular Green Economy* (BCG) model.[14] In 2022 the underlying approach was adopted by the *Asia-Pacific Economic Cooperation* (APEC) as the *Bangkok Goals on Bio-Circular-Green* (BCG) *Economy*.[15]

The *G20 Global Bioeconomy* paper identified five common themes emerging from the literature, national and regional strategies and evidence from practice, summarised in Exhibit 1.

Exhibit 1 | **G20 Global Bioeconomy Stock take - Emerging Cross Cutting Action Agenda**[16]

1

BIOECONOMY INTEGRATION INTO ECONOMIC, INDUSTRIAL AND GREEN GROWTH PLANS

Exploring the ways in which G20 members have integrated bioeconomy elements into national, regional and sector plans would enable learning how the bioeconomy fits into wider development planning and policies.

2

LIVELIHOODS AND EQUITY OUTCOMES AND OPPORTUNITIES

Deepening shared understanding of the livelihoods and equity dimensions and opportunities of bioeconomy development experiences and associated policy options, particularly for the most vulnerable populations such as small-scale farmers, Indigenous Peoples and Local Communities (IPLC) and others.

3

BIOECONOMY-ENABLING FINANCE

Understanding how developments in sustainable finance could broadly or specifically support bioeconomy developments, drawing from and informing the work of the G20 Sustainable Finance Working Group.

4

FACILITATING BIOTRADE

Better understanding the evolving importance of 'biotrade' arising from the development of a global bioeconomy would allow the consideration of enabling policies, regulations, and incentives.

5

BIOECONOMY MEASUREMENT

Sharing experience on the methodologies, indicators, and data sources for measuring the bioeconomy would enable greater understanding of the dynamics of the bioeconomy, its potential, and also the usefulness in diverse contexts of enabling policies and strategies.

These themes broadly reflect many of the ensuing G20 discussions and have informed the development of principles expressing normative and technical characteristics of the bioeconomy. Whilst these discussions are on-going, such high-level principles are illustrated in Exhibit 2.

Exhibit 2 | **Illustrative Focus of G20 High-Level Principles on the Bioeconomy[17]**

Integrated Approach	Bioeconomy activities and strategies should be designed with an integrated approach that promotes sustainable development in its three dimensions (social, economic, and environmental).
Climate Goal	The bioeconomy should contribute to limiting global warming and climate resilience, informed by the latest science in light of different national circumstances.
Local, National and Regional Context	Bioeconomy approaches should be developed and implemented in accordance with local, national, and regional contexts.
International Cooperation	International cooperation on bioeconomy should address global challenges, leverage complementary strengths, and promote knowledge sharing and capacity building.
Joint Methodologies	Transparent criteria and methodologies should be jointly developed to ensure and monitor the sustainability of bioeconomy activities throughout the whole value chain.
Scientific Basis	Science, technological development, and traditional knowledge are paramount for the bioeconomy, and its risks should be assessed on a scientific basis.
Equitable Sharing	Bioeconomy actors must commit to the conservation and sustainable use of biodiversity and ensure the fair and equitable sharing of benefits arising from the use of genetic resources and associated traditional knowledge.
Ecosystems	The bioeconomy should contribute to the restoration and regeneration of productive ecosystems and promote sustainable use of resources.
Social Equity	The bioeconomy should be inclusive and prioritize social equity, uphold the rights of all people including Indigenous peoples and local communities, and promote gender equality.
Policy Support and Fair Trade	Bioeconomy initiatives should be backed by robust policy frameworks that fosters equitable and transparent trade practices. These frameworks should encourage sustainable business operations, create employment opportunities, promote local economic growth, and actively engage the private sector.

Source: Adapted from NatureFinance, 2024

Here we have built on classical approaches explaining the bioeconomy. Usefully, discussions about the bioeconomy have typically been broken up into three interlocking themes:

- Research, Development and innovation (Biotechnology)
- Sustainable Use of Biodiversity (Bioresources)
- Bioeconomy as an Enabler of Sustainable Development (Bioecology)

Whilst drawing on this tradition, in this paper we have found it useful to introduce the concept of a bioeconomy spectrum that has three inter-dependent key segments:

NATURE INTENSIVE BIOECONOMY

The Nature Intensive Bioeconomy includes the primary production and utilization of biological resources such as agriculture, forestry, and fisheries. It emphasizes the direct use of natural resources to produce food, fibre, building materials, energy and fuel using traditional practices. This Nature Intensive Bioeconomy is characterised by extensive production systems, large quantities of standardized commodity products, significant asset values and economic activities, and mature industries with established supply chains and value chains. This segment also encompasses the concept of socio-bioeconomy, which is widely accepted throughout the Amazonian region.

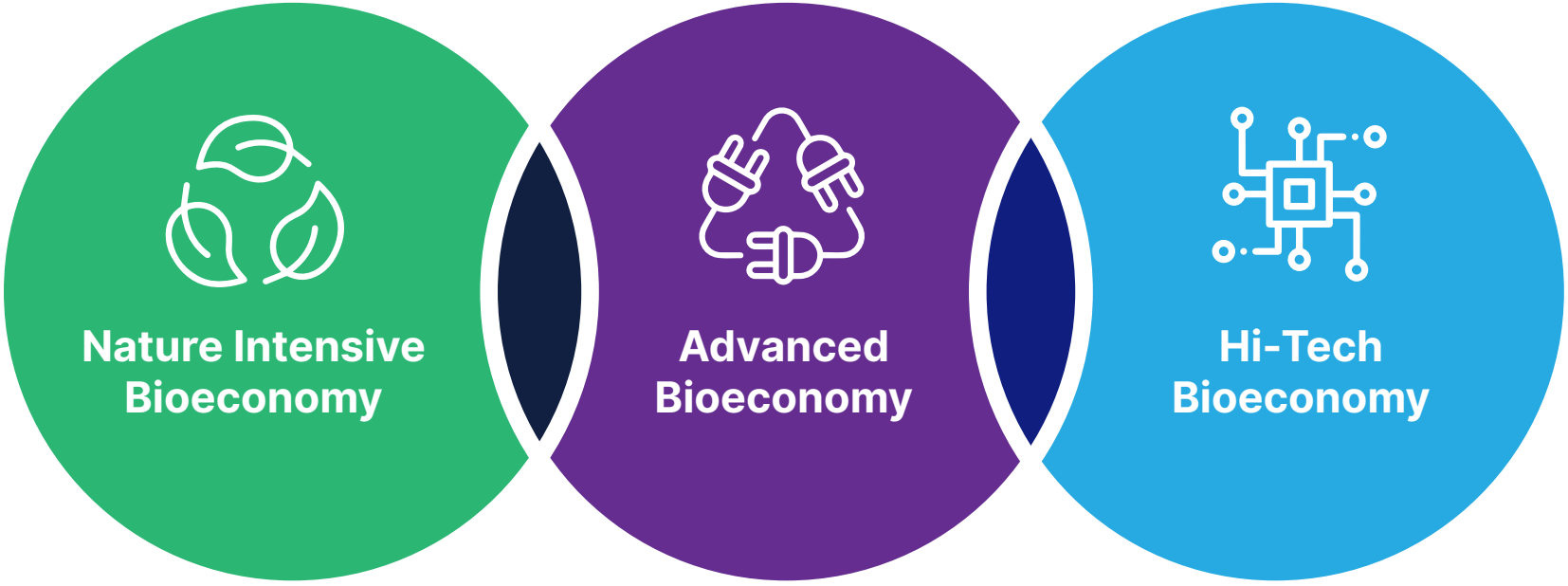
ADVANCED BIOECONOMY

The Advanced Bioeconomy builds upon the Nature Intensive Bioeconomy by integrating modern scientific knowledge and technological advancements to improve efficiency and sustainability. It focuses on renewable energy and fuels from biological sources, biorefineries based on forestry and agricultural produce, and sustainable farming and forestry systems. This core bioeconomy is characterized by the growing production of conventional and advanced bioproducts, continuous innovation, and increasing private investment driven by supportive policies and rising market demand for sustainable, renewable, recyclable, and naturally decomposable materials in society.

HIGH-TECH BIOECONOMY

The High-Tech Bioeconomy represents the cutting-edge intersection of biology, technology, and innovation. It leverages advanced technologies like synthetic biology, genomics, and bioinformatics to create novel products and services. This economy is characterized by specialized, high-value outputs, substantial investments in research and development, and a strong focus on innovation. It will also include new technologies like remote sensing, artificial intelligence, and geospatial modelling tools to revolutionize land management for both economic efficiency and positive social and environmental impacts. In many instances, this segment minimises the continued use of biological resources, such as in the cases of synthetic biogenetics for pharmaceutical products and lab-grown protein and vertical farming, offering opportunities for reducing pressure on biodiversity.

Evolving Bioeconomy



The proposed spectrum accommodates the wide range of scope definitions used whilst still distinguishing between them in ways that allow for distinct policies to be developed and applied, as demonstrated in Exhibit 3 below.

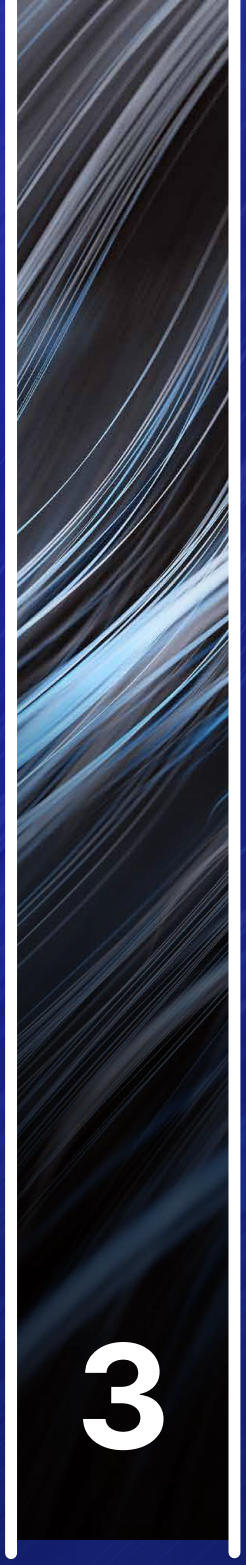
Exhibit 3 | **Strategic Spectrum of the Bioeconomy**

	Nature Intensive Bioeconomy	Advanced Bioeconomy	Hi-Tech Bioeconomy
Explanation	The **Nature Intensive Bioeconomy** refers to an economic system that utilizes biological resources, processes, and principles to produce goods and services. It encompasses various sectors including **agriculture, forestry, fisheries, food and bioenergy**. The goal of the bioeconomy is to create sustainable economic growth, while reducing environmental impact and dependency on fossil fuels.	The **Advanced Bioeconomy** represents an evolution from traditional bioeconomic practices, focusing on the use of **innovative technologies and advanced biological processes to create value-added products.** It aims to address environmental and economic challenges by providing sustainable alternatives to fossil-based products and enhancing the efficiency and sustainability of production processes.	The **High-Tech Bioeconomy** refers to the segment of the bioeconomy focused on producing **high-value, specialized, and often technologically sophisticated bioproducts.** These products are characterized by their advanced functionalities, innovation, and higher market value compared to traditional bio-based or commodity goods.
Volumes	High, established volumes	Growing volumes as technology and market demand drive increased production.	Production in the **high-tech bioeconomy focuses on quality, precision, and specialized applications**, often resulting in lower but more valuable outputs.
Products including consumer preferences and cultural norms	Large quantity of goods – **in the main unprocessed nature products** for established markets, although growing context and impact-based differentiation	**Advanced bioproducts** (biofuels, biochemicals. biomaterials etc.) using other techniques than biotechnology and biomanufacturing	**High-Tech Bioeconomy products, driven by biotechnology and biomanufacturing**, include enhanced crops with superior nutrition and climate adaptability, high-performance bioplastics, bio-based nanomaterials, and custom organisms for industrial use.
Stage and level of investments	At a mature stage, with significant investments already made and is closely linked to traditional industries such as agriculture, forestry, and fisheries, although specific projects like forest restoration and socio-bioeconomy initiatives may still face considerable financing challenges.	At an evolving stage, characterized by continuous innovation and the development of new technologies. Investments are increasing as both public and private sectors recognize the potential for returns and environmental benefits.	At a dynamic evolving stage, attracting investments in R&D. The focus is on innovation, with funding from both public and private sectors to support cutting-edge biotechnology and biomanufacturing projects.
Location and associated comparative advantages	The bioeconomy has a prevalence across continents, benefiting from consolidated industrial value chains that provide comparative advantages in production and distribution.	Primarily driven by, located and benefiting more technologically advanced countries characterized by a greater access to technology, investment capital, and regulatory frameworks that support sustainable innovation.	Predominantly driven by technologically advanced regions with strong research infrastructure. These regions benefit from robust IPRs (intellectual property rights), a skilled workforce, and a supportive regulatory environment that fosters innovation and commercialization.
Policy and regulative context	Government policies on land use, sustainable practices, notably land tenure challenges	Policies on renewable energy, sustainable agriculture and forestry	Regulations on new technologies, Intellectual Property protection
Competitiveness now and into the future	Currently competitive and is expected to maintain or enhance its competitiveness in the future due to its established infrastructure and continued advancements in biotechnology and sustainable practices.	Poised to become increasingly competitive due to its focus on sustainability, resource efficiency, and the development of added-value products. Expected to play a critical role in transitioning to a low-carbon economy and addressing global challenges such as climate change and resource scarcity.	Highly competitive due to its focus on innovation and technological leadership. Expected to grow significantly as demand for specialized, sustainable, and high-performance bioproducts increases.

The proposed three-way segmentation, considered in more detail in Exhibit 3, does not necessarily imply a preference order or development ladder, but instead serves to highlight different aspects and applications within the bioeconomy, especially from a financing perspective. That said, from an equity perspective, it is critical to recognize that many low and middle-income countries are currently clustered most heavily in the core nature intensive bioeconomy segment, which often offers the least economic value and maximum vulnerability to climate change of all three segments.

The proposed three-way segmentation does not necessarily imply a preference order or development ladder, but instead serves to highlight different aspects and applications within the bioeconomy, especially from a financing perspective.

Investing in more technologically sophisticated and climate-resilient bio-economy strategies may prove attractive to some countries in increasing the economic development benefits from biodiversity resources and increasing investment in biodiversity whilst reducing dependency on biodiversity in the context of growing climate-related disruption. At the same time, in addition to the challenges for many developing countries to shift to the more technologically intensive end of the bioeconomy spectrum, doing so may increase the risks of accelerated overuse of biodiversity or damage to long-standing socio-economic systems of nature's stewards, including Indigenous Peoples and Local Communities.



3

How Big is the Bioeconomy

There are no robust, comprehensive measures of the size of the bioeconomy. Those estimates of the size of the current bioeconomy that do exist are beset by the diversity of definitions and are complicated and often undermined by data challenges. Sizing exercises using the broadest definitions of the bioeconomy such as "use of biological resources in economic activities" deliver very large numbers given that authoritative estimates indicate that more than half of the global economy is considered 'highly dependent' on biodiversity.[18] Such estimates, however, include activities that are not sustainable, for example non-regenerative commercial agriculture and fishing. At the other end of the spectrum, researchers who view the bioeconomy as including only economic activities that are small scale and embedded in traditional practices and communities, so closer often to a 'socio-bioeconomy' perspective, offer far lower estimates of the bioeconomy's direct economic value whilst emphasizing the broader, non-monetarised benefits, including the sustainable management of biodiversity and the strengthening of cultural diversity and land and other rights.

Similarly, there are disputes within the three broad segments, as well as between them. Few would challenge the inclusion in the second, "advanced bioeconomy" segment of kelp cultivation, which supports carbon sequestration as a co-benefit in producing a range of products from pure alginate and alginate rich pulp for use in textiles, cosmetics, and bio-packaging. Yet there would be more debate as to whether to include food production systems such as lab-grown protein[19] and 'controlled environment agriculture' (often referred to as "vertical farming"), which are principally characterized as making 'less' rather than 'sustainable' use of biomass.

Biopharmaceuticals, likewise, may use synthesised or digitally sequenced biogenetic resources, leading both to ambiguity regarding which elements of the products' market value to include, and growing concern as to who is benefiting from the commercialization of biogenetic resources.[20] All this to say that much more work needs to be done to better classify what kinds of activities are collectively considered a part of the sustainable bioeconomy, with bespoke concerns and challenges arising within each of the three bioeconomy segments.

The implications of this lack of robust, comparable data are significant, notably making policy interventions more difficult. The good news is that the extent and quality of economy-related nature data is increasing rapidly, along with emergence of related disclosure standards, such as the work of the Taskforce on Nature-related Financial Disclosure (TNFD) and the work of the International Sustainability Standards Board (ISSB). These developments will over time not only directly better inform businesses in their investment decisions, but also inform policies, regulations and standards advancing a more equitable, sustainable bioeconomy.

Notwithstanding data limits, some tentative conclusions can be offered:

BIOTECHNOLOGY

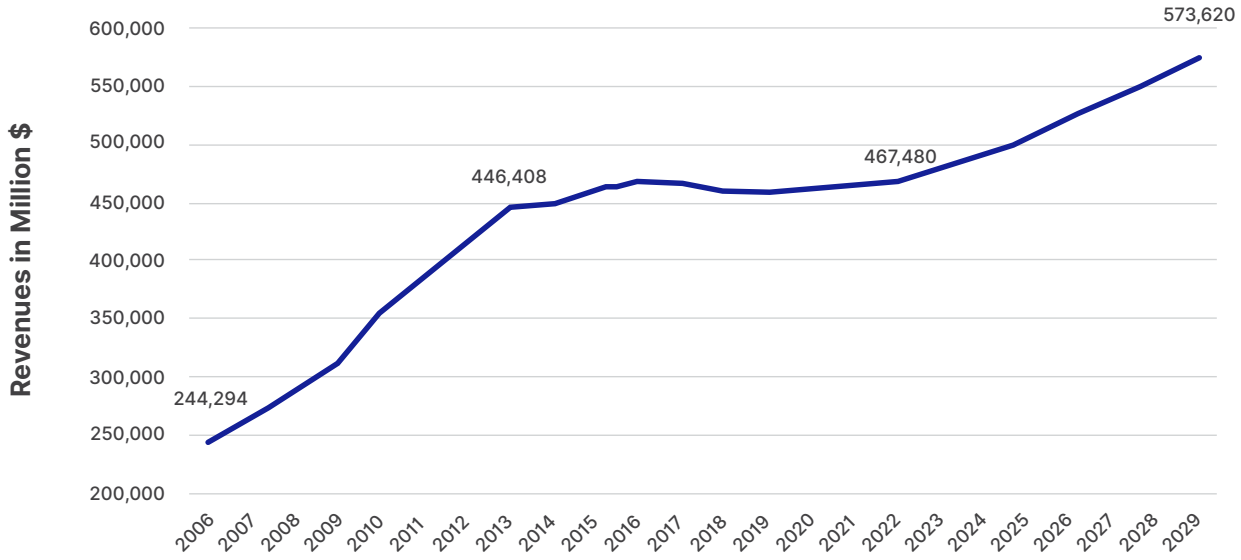
There is reasonably good quality data about the revenues associated with 'biotechnology' sectors, broadly including the third and much of the second segment, as summarised in Exhibit 4, but with little information about the impact of these activities on people and the planet.

Likewise, a more disaggregated view on the likely growth of these sectors can be provided, summarised in Exhibit 5. The implications of this growth for the use of biological resources cannot be derived from this data. However, by way of illustration,

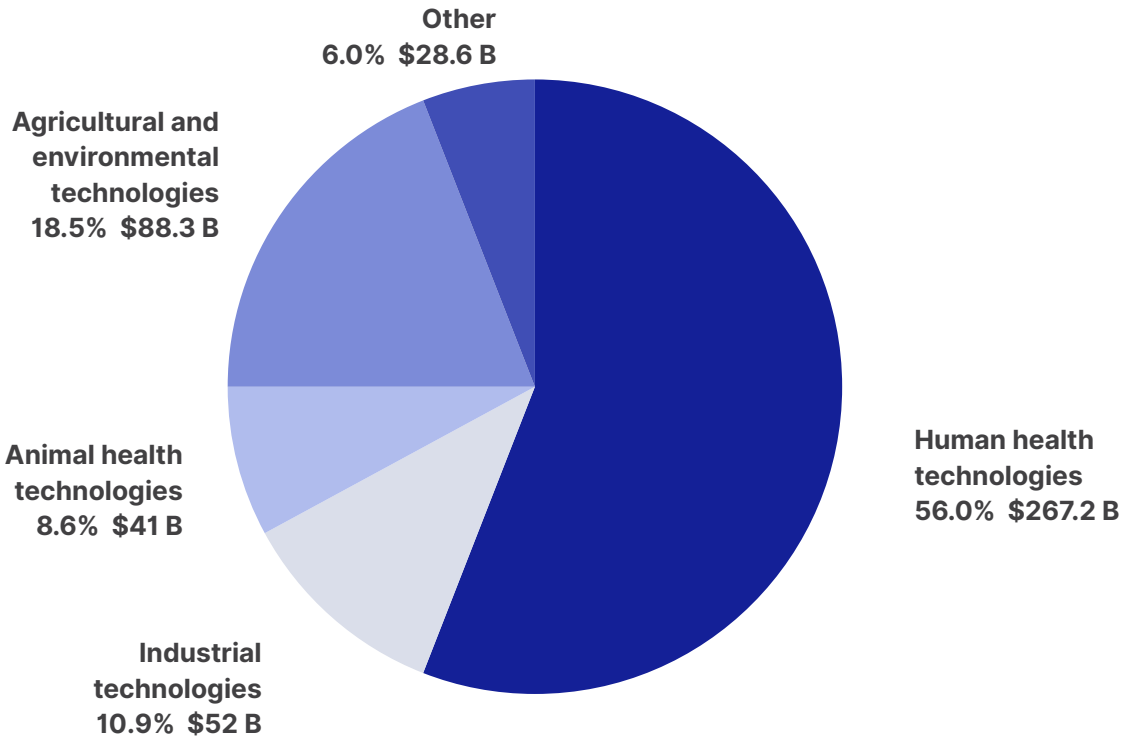
- High Compound Annual Growth Rate (CAGR) of 18.8% for bioplastics probably indicates strong market potential driven by increasing demand for eco-friendly materials and innovations in biopolymer technologies.

- Moreover, the 9.4% CAGR predicted for bioenergy and the 8.6% CAGR for biochemicals seeks to take account of increasingly stringent environmental regulations and incentives to promote sustainable practices, which may drive higher growth rates in sectors such as bioenergy and biochemicals.

Exhibit 4 | **Global Actual and Projected Biotechnology Revenues: 2006-2029**[21]



BIOTECHNOLOGY REVENUES BY SECTOR (2023)



Source: IBISWorld (2023)[22]

Exhibit 5 | **Global Actual and Projected Advanced and High-Tech Biotechnology Revenue**

Market Value Billion USD	2023 Advanced Bioeconomy	2023 High-Tech Bioeconomy	2024 - 30 Growth predictions (CAGR)
Agriculture[23]			7,7
Forestry[24]			8,4
Aquaculture and Fisheries[25i]			AQ 4,5 / FI 4,9
Foraged products[26i]			4,2
Berries[27]			3,7
Mushrooms[28]			9,2
Nutraceuticals markets[29]	415		10,9
Bioenergy[30]	271		9,4
Biofuels	120[31]		11,3[32]
Biochemicals[33]	76		8,6
Biomaterials[34]	178		15,6
Bio-based fibre markets[35]	57		8,8
Bioplastics[36]	97		18,8
Biocosmetics		22[37]	5,1[38]
Biopharmaceuticals		284[39]	11,3[40]
Biotechnology		477,1[41]	13,96[42]

NATURE INTENSIVE BIOECONOMY

There is of course a lot of data on the scale of the economic activities underpinning this segment, covering global agriculture, fisheries and other soft commodities such as forest products. Predicted growth rates of upwards of 8% per annum may reflects an expectation of a growing, higher-priced market for healthy and more nature and climate-friendly products, driven both by consumer preferences and emerging climate and nature related regulations.
Market conditions also play a critical role in the sustainability and growth of the bioeconomy. The forestry sector, with a predicted CAGR of 8.4%, may experience fluctuations based on timber demand, conservation efforts, and international trade policies. Sustainable forestry practices are essential to balance economic growth with conservation goals. Similarly, the aquaculture and fisheries sector's growth rates (AQ 4.5% / FI 4.9%) are influenced by regulations to prevent overfishing, aquaculture technology advancements, and shifts in consumer preferences towards sustainable seafood.

The implications of this on equity and food poverty, however, are unclear from available data. If these trends result in increasing producer incomes, they could positively impact inequality and levels of poverty. On the other hand, the gains from increased prices are more likely under current market conditions to be largely captured by intermediaries in the food value chain. Moreover, the increase in the cost of nutrition could negatively impact inequality and food poverty, as one recent study involving quantitative simulations of these dynamics commissioned by NatureFinance illustrates.[43]

One of the most significant economic benefits of the bioeconomy is its potential for job creation. When considering job creation, we have considered not only the direct jobs created but also the indirect (such as the supply chains) as well as the induced (employment related such as food establishments supporting a biorefinery) job benefits. For example, the most recent report by the US Department of Agriculture (USDA) indicated that in the United States that for the Biobased Products industry, for every direct job - an additional 2.4(indirect + induced) jobs were created.[44] The sector encompasses a wide range of industries including agriculture, bio-manufacturing, and research and development. Jobs in the bioeconomy are often high-skilled and located in rural areas, providing economic opportunities in regions that might otherwise struggle with employment. For instance, the development of bio-based products requires expertise in fields such as genetic engineering, chemistry, and environmental science.

One of the most significant economic benefits of the bioeconomy is its potential for job creation. When considering job creation, we have considered not only the direct jobs created but also the indirect (such as the supply chains) as well as the induced (employment related such as food establishments supporting a biorefinery) job benefits.

Notwithstanding data limitations and the implied lack of a window to the impacts on biodiversity and the direct and indirect impacts on equity and poverty, Exhibit 6 offers a summary of some of the available data on job creation for selected bioeconomy sectors across the three-way strategic segmentation.

Exhibit 6 | **Bioeconomy Global Job Creation for Selected Sectors (Global)**

	Nature Intensive Bioeconomy	Advanced Bioeconomy	High-Tech Bioeconomy	Employment, No. of people (million, 20144)
Agriculture	1 100[45]			976,7
Forestry	33[46]			16,7
Aquaculture and Fisheries	62[47]			45,6
Foraged products	N.A.			
Berries	N.A.			
Mushrooms	N.A.			
Nutraceuticals markets		N.A.		0,577
Bioenergy		67[48]		7,7
Biofuels		2,4[49]		3,101
Biochemicals		N.A.		14,827
Biomaterials		N.A.		NA
Bio-based fibre markets		N.A.		49,855
Bioplastics		0,23[50]		N.A.
Biocosmetics			N.A.	N.A.
Biopharmaceuticals			5[51]	N.A.
Biotechnology			1[52]	
# of people (million)	**1 195**	**69,63**	**6**	

4

Financing Challenges

Financing of the bioeconomy today involves a diverse mix of sources and mechanisms, each contributing to the development and growth of this sector. The diversity and breadth of bioeconomy value chains from smallholder farmers; agribusiness, forestry, and fisheries/aquaculture; primary processing businesses; and a range of emerging high technology and climate/nature finance opportunities means that the whole spectrum of sources and channels are represented in current financing of the bioeconomy.

Catalysing investment in the bioeconomy faces diverse challenges as a function of specific enterprise features such as relevant technology maturity, location, and policy and market contexts. Investing in the bioeconomy presents unique opportunities, but also comes with a set of financial challenges. Understanding these challenges is crucial for devising strategies that can mitigate risks and enhance the viability of bioeconomy investments. Challenges include technological, policy and regulatory risks, market competition including from entrenched unsustainable industries, creating conditions that support both intensification of biological production systems as well as enhanced conservation of biodiversity and positive benefits to Indigenous Peoples and rural economies.

Financing challenges vary considerably between the three-part spectrum of the bioeconomy, as summarised in Exhibit 7 with highlights below:

Exhibit 7 | **Financial Challenges for the Bioeconomy**

	Nature Intensive Bioeconomy	Advanced Bioeconomy	Hi-Tech Bioeconomy
High R&D costs	Low	Moderate/high	High
Scalability	Easy	Long lasting	Moderate
Market volatility	Moderate/high	Moderate/high	Moderate
Consumer acceptance	Low	High	High
Regulatory uncertainty	Moderate	Moderate/high	Biosafety/Biosecurity related challenge
Compliance costs	Moderate	Moderate/high	Low
High Initial Investment	Depends on application	Often	Moderate
Long Payback Periods	Moderate	High	High
Access to Capital	Moderate	High	High
Loan quarantees	Moderate	High	High
Insurance	Moderate to high	High	High, but spezillised
Feedstock availability	Regional	Regional	Low
Logistic and infrastructure	Being well-established	Developing	Advanced and specizilised
Biodiversity impact	Moderate	Low to moderate	Low
Equity and inclusion	Moderate	High	High
Return on investment	Steady	High	High but variable
Performance metrics	Clear	Clear but evolving	Advanced and specific

Nature Intensive Bioeconomy

Covering core nature-based products and services, there are in general, low- to- moderate technology risks and likewise low- to- moderate associated R&D requirements and capex intensive investment needs. Similarly, there is low- to- moderate risks concerning consumer preferences, and indeed the upside development of nature and climate-friendly consumer habits at the higher end of the income spectrum.

Set against this are growing physical risks associated with biodiversity degradation and water scarcity, increased risks associated with extreme weather events, and growing policy and broader transition risks linked to the crystallisation of nature and climate risks and impacts into rules and decision making, including financial regulations and trade rules.

Advanced Bioeconomy

Covering everything from bioplastics and biofuel to kelp-based textiles and insect-based waste management, there are more significant technology risks and on-going R&D requirements, uncertain retail and business user preferences with the latter linked closely to future policy and regulatory developments, and often extended payback periods with significant uncertainties linked to price disadvantages associated in turn with existing perverse subsidies, scaling challenges and high-cost early stage technology cost curves.

Hi-Tech Bioeconomy

Covering high-tech bio-industries for example in pharmaceuticals, nano organisms, and advanced nutrition products, technology risks necessitate extensive R&D pipelines and networked technological capabilities, with high regulatory risks notwithstanding relatively low end-user preferences, and again long, uncertain pay back periods associated with the need for scale often involving multi-product and even multi-sector application.

Location counts in determining investment attractiveness. The physical, institutional, and jurisdictional location of the potential investment is critical in determining investment attractiveness.

Most generally, location counts given the ***availability and cost of feed for livestock or aquaculture***. This could and should benefit nature-rich developing countries but does not always do so. Examples include food for livestock or fish if portable, i.e. for 'sustainably grown salmon', or if demand for feed leads to perverse effects such as land grabs and associated evictions and price rises.

Location also counts in terms of ***human and institutional capabilities***, especially for high-tech opportunities that need to benefit from an ecosystem of adequately staffed and equipped research labs, education facilities and critical supply chains such as reliable energy and clean water.

Financial conditions influence locational attractiveness.

• Most obviously, access to affordable and diverse forms of capital, for early-stage investment is key - especially for all-important scaling stage prior to becoming attractive to institutional investors.

• Beyond this is the critical role of public finance which is scarce in fiscally constrained – especially low and middle income – countries, despite the growing entrepreneurial side of international development finance.

• Moreover, for many low and middle-income countries, the cost of capital is high, independent of the merits of the specific investment, whether because of substantiated or perceived sovereign risk.

Policy and regulatory factors provide a strong locational preference driver. For the Nature Intensive Bioeconomy, this often concerns agricultural subsidies and credit lines, sometimes sustaining small farming and at times linked to nature and climate goals. As for the Advanced Bioeconomy this can include trade restrictions and tariffs of various kinds. For this latter segment and the High-Tech Bioeconomy segment, there are R&D subsidies, investment-linked public support and links through to product regulation, including go-to-market approvals.

Once again, low and middle-income countries tend to offer weak positive policy and regulatory incentives, although exceptions include Brazil, Malaysia, and South Africa, all of which have active bioeconomy strategies. Domestic regulatory approval is relevant, but often carries little or no weight in extending market access to other countries, and trade policies and subsidies in combination tend to make it harder for low to middle income countries to develop commercially viable internationally traded, technology advanced bioproducts.

Exhibit 8 | Financial Market Perceptions of the European Bioeconomy Investment Landscape

1 **The key drivers of investor interest and investment in the bioeconomy are its sustainable features and large future growth potential**

2 **Investors perceive investments into the bioeconomy as very risky, including:**

a. Information asymmetry and technology risks, steering private capital towards more mature projects.

b. Perceived instability of the market and fluctuating demand for products. Off-take agreements play a crucial role in mitigating this risk.

c. Regulation and market and demand framework conditions can be important drivers but can also present the biggest risks and challenges.

d. Projects require a significant investment volume whilst generating unstable revenues and cash flows.

3 **Investors identify two major funding gaps**

a. Scaling-up from pilot to demonstration

b. Moving from demonstration to flagship/first-of-a-kind (FOAK) and industrial-scale projects.

4 **Public financial instruments are key, and their catalytic impact could be enhanced**

a. Bioeconomy strategies are a key trigger for providing public finance.

b. Grants dominate the form of public support, while access to innovative financial instruments is limited.

c. Initiatives focus primarily on supporting the R&D phase and less support is available for commercialization.

d. Public funding mostly to the bio-energy (including bio-fuels) and agricultural sectors, with less support for value-added product development.

5 **Financial sector recommendations (to the EU), included:**

a. Establish an effective, stable and supportive regulatory framework.

b. Develop new risk-sharing financial instrument, potentially taking the form of a thematic investment platform.

c. Reinforce awareness of public investment instruments (e.g. InnovFin and the European Fund for Strategic Investments (EFSI).

d. Explore the creation of an information exchange and knowledge sharing platform to facilitate relationships between project promoters, industry experts, public authorities and financial market participants.

Adapted from "Access-to-Finance Conditions for Investments in Bio-Based Industries and the Blue Economy," European Investment Bank, 2022.

Notwithstanding the importance of taking careful account of the diversity of contexts and bioeconomy aspects, there are some broadly common patterns in how the financial community sees the challenges of investing in the bioeconomy. This is illustrated in Exhibit 8, a summary of the results of a survey of EU-focused investors . While recognizing the focus on the advanced and high- tech parts of the bioeconomy, many of the perspectives surfaced by the survey would resonate with would-be investors in the equivalent bioeconomies in low to middle income and certainly upper middle countries.

That said, investor perceptions about many low and middle-income countries do differ in key ways from those expressed in the survey about the EU bioeconomy. These perceptions include higher political, regulatory, and currency risks; concerns about the lack of an enabling knowledge ecosystem; a more pronounced lack of supportive public financing; and greater concerns about local demand conditions in non-traded bioproducts.

Taken together, the development and ultimately geopolitical risk is that the bioeconomy will play an uneven role in the broader transition to sustainable development. Ironically, this might leave behind those very communities and nations that have done the most to preserve the world's dwindling biodiversity in the face of continued, under-priced, overuse. Moreover, such unevenness in opportunity and outcome could worsen in the face of the unevenly distributed impacts of a world operating at temperature levels well in excess of the UN agreed ceiling of 1.5C above pre-industrial levels.

Inequitable outcomes in advancing and benefiting from the bioeconomy are also likely to be unsustainable, both because of the resourcing constraints it imposes on nature's stewards, and the likelihood of a geopolitical backlash with economic consequences. Brazil's leadership in advancing international cooperation in the more ambitious and equitable advance of the bioeconomy through its G20 Presidency illustrates actions urgently needed to ensure that these macro risks do not materialise.

5

Financing the Bioeconomy

This landscape review has identified a wide diversity of bioeconomy financing instruments and channels. Diversity in financing approaches is unsurprising given the wide range of enterprises and sectors encompassed by the bioeconomy. This diversity is highlighted in Exhibit 6 and illustrated below for each of the three strategic segments.

In a Nature Intensive Bioeconomy, sectors such as agriculture, forestry, marine resources, and fisheries operate with established finance, markets, and supply chains, often receiving significant subsidies. Bank lending, often involving concessionary financing advanced through public financing institutions, typifies smaller enterprises which may also earn carbon finance as an adjunct, in this segment. In wealthier countries, concessionary support often comes in the form of straightforward subsidies, such as through the European Union's Common Agricultural Policy (CAP) that supports farmers with direct payments and rural development funds. Increasingly, these subsidies are linked to sustainability outcomes, such as the Government of Japan's direct subsidies to the fisheries sector to support sustainable marine resource management and maintain rural fishing communities.

Innovative financing mechanisms such as markets or payments for ecosystem services (PES) are also gaining traction. PES schemes provide financial incentives to landowners and resource managers for maintaining and enhancing ecosystem services like climate change mitigation, biodiversity conservation and restoration, or freshwater regulation thus integrating nature conservation with economic benefits.

For example, Costa Rica's National PES program, managed by the National Forestry Financing Fund (FONAFIFO) and supported by international development assistance, incentivizes landowners to engage in conservation activities such as forest conservation, reforestation, and agroforestry. Such schemes can become a core element of rural incomes – for 60% participants in the Costa Rica PES, for example, associated payments amount to constitute over 50% of their annual income. Other initiatives in development include the Tropical Forest Forever Facility currently being promoted by Brazil as part of its G20 Presidency.[54]

A further example is the Moringa Fund, which is an impact investment fund that provides equity and quasi-equity instruments to large-scale agroforestry projects in Latin America and Sub-Saharan Africa.[55] One of its primary goals is to promote sustainable land use, generate environmental and social impacts, and achieve predictable returns for investors. The Fund targets operations with a proven potential for high environmental and social impact, in regions with rich biodiversity.

The Fund has been instrumental in restoring 25,000 hectares of land, creating 9,000 jobs, and positively impacting 20,000 farmers. These activities include sustainable agroforestry practices, which integrate local communities' traditional knowledge and promote biodiversity conservation.

The Fund's blended finance structure includes investments from various impact investors and development finance institutions. For instance, it received over €20 million in senior equity from FONPRODE (Spanish Development Promotion Fund), €12 million in investment-stage grants from the Global Environment Facility (GEF), and substantial equity investments from institutions like the African Development Bank (AfDB) and the Development Bank of Latin America (CAF).

Exhibit 9 | Bioeconomy Financing Instruments and Practices

	Nature Intensive Bioeconomy	Advanced Bioeconomy	Hi-Tech Bioeconomy
Venture capital	Early-stage funding for startups in agriculture, forestry, and fisheries.	Funding for innovative biotechnologies and bio-based product startups.	Capital for cutting-edge biotech and synthetic biology startups.
Private equity	Investment in established nature-based enterprises aiming for expansion.	Investments to scale up bio-based technology firms.	Investments in high-tech bioeconomy firms for growth and development.
Public equity	Funding through stock markets for companies in agriculture and forestry.	Stock market investments in advanced bioeconomy companies.	Market investments in advanced biotech companies.
Green bonds	Debt instruments to finance eco-friendly agricultural and forestry projects.	Financing for sustainable bioenergy and bioproducts.	Funding for sustainable biotech and genomic projects.
Sustainability-linked loans	Loans with interest rates linked to sustainability performance.	Loans with rates tied to sustainability goals in bioeconomy projects.	Loans linked to achieving high-tech sustainability targets.
Public-Private Partnerships (PPPs)	Collaborative projects to enhance natural resource management.	Collaborations to build biorefineries and bioenergy plants.	Collaborations for developing high-tech bio-manufacturing infrastructure.
Grants and subsidies	Government financial support for sustainable practices.	Government funds supporting bio-based research and development.	Government support for research in high-tech bioeconomy fields.
Carbon credits	Financial incentives for reducing carbon emissions through sustainable practices.	Incentives for bioenergy projects reducing greenhouse gas emissions.	Financial incentives for reducing emissions through high-tech solutions.
Biodiversity credits	Payments for maintaining or enhancing biodiversity in agriculture and forestry.	Financial rewards for projects enhancing biodiversity.	Payments for enhancing biodiversity through biotech innovations.
Standardized carbon accounting	Methods to measure and report carbon sequestration in natural resources.	Techniques for measuring carbon impact in bio-based processes.	Advanced methods for tracking carbon impact in biotech.
Certification schemes	Programs verifying sustainable practices in agriculture and forestry.	Standards ensuring sustainability in bio-based product manufacturing.	Verification of sustainable practices in high-tech biomanufacturing.
Crowdfunding platforms	Public investment opportunities in small-scale nature-based projects.	Public funding sources for bio-based technology initiatives.	Public investment opportunities in high-tech biotech projects.
Impact investment funds	Investments aiming for both financial returns and environmental benefits.	Investments targeting financial returns and environmental benefits.	Investments focused on financial and environmental outcomes in biotech.
First-loss capital	Risk mitigation funds for high-risk nature-based projects.	Risk-sharing funds for innovative bio-based technologies.	Funds to mitigate risk in cutting-edge biotechnologies.
Guarantees	Financial assurances to reduce investment risk.	Financial backing to lower risks in bioenergy and bioproduct investments.	Financial assurances to support high-tech biotech investments.
Long guarantees	Extended financial assurances for long-term projects.	Long-term financial support for sustainable bio-based projects.	Extended financial backing for long-term high-tech bioeconomy projects.
Infrastructure investments	Funding for essential facilities and logistics in natural resource management.	Funding for facilities supporting bio-based production.	Funding for state-of-the-art facilities in biotech and synthetic biology.
Advance purchase agreements	Agreements for pre-purchasing nature-based products to secure future supply and stimulate the market.	Commitments to purchase bio-based products to ensure market stability and encourage production.	Pre-purchase agreements for high-tech biotech products to ensure market viability and stimulate innovation.

Carbon and most recently biodiversity credit markets have emerged as additional forms of Payment for Ecosystem Services (PES). Voluntary carbon offsets have proved to be contentious, with major groups speaking out against their extensive use, including most recently the UN Secretary General's taskforce on climate finance.[56] Despite concerns, however, many see these markets as important current and future sources of finance to invest in nature, climate resilience and more broadly sustainable development.

Such markets are widely dispersed across different countries, from nature-rich, smallholder focused countries in sub-Saharan Africa[57] through to new nature credit markets emerging in Latin America, Europe, and Australasia.[58] Biocredit markets come in many shapes and forms, including bio-enhanced carbon, inset credits (productivity enhancing investing through supply chains), voluntary 'contributions' through biocredit markets, and local and international offset markets.[59] There is significant concern among some stakeholders about the potential risks of internationally traded biocredit markets. These concerns stem from fundamental concerns about 'equivalence' in seeking to offset damage to one ecosystem with investments in another. Beyond this, there are concerns over the lack of clear rules, standardization, and reliable data, as well as fears of greenwashing and the negative impacts on local communities and biodiversity.

Significant global efforts are underway to develop innovative approaches to ensure the impact, integrity, and equity of biocredits, including through the International Advisory Panel on Biodiversity Credits (IAPB) established in June 2023 to catalyse improved biodiversity outcomes through the development of high integrity biocredit markets.[60] These initiatives hold substantial promise for enhancing the potential financing in this area, ensuring that biocredits not only generate financial returns but also adhere to high standards of environmental and social responsibility.

However, in a world breaching temperature beyond 1.5 degrees Celsius above pre-industrial levels, several critical risks must be considered for financing the Nature Intensive Bioeconomy. These include rising insurance rates, escalating subsidy costs, and the nature of degraded landscapes, all of which can place significant strain on financial and natural resources.

The increasing frequency and severity of climate-related events may lead to higher insurance premiums, making it more costly for enterprises to manage risks. Moreover, the growing financial burden of subsidies required to support these sectors could become unsustainable for governments.

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Degraded landscapes, as a consequence of climate change, can undermine the productivity and viability of natural resource-based industries, necessitating more substantial investments in restoration and adaptation measures. Addressing these risks will be essential to ensuring the long-term sustainability and resilience of the Nature Intensive Bioeconomy.

Exhibit 10 | Blended Finance for Sustainable Production Systems in SE Asia

New Forests Asia established the Tropical Asia Forest Fund II in 2023, which is a blended fund making direct investments in forestry plantations and wood processing, as well as conservation and community development projects. The fund's finance structure combines institutional investors with concessional capital to allow higher sustainability aspirations in the fund and the integration of climate finance in the returns to investors.

The fund is structured with Class A investors who seek an appropriate risk adjusted return for private investments in Southeast Asia and Class B investors who are willing to take a lower return in exchange for increased environmental and community impacts from the fund investments. The two sources of capital are blended together in the fund, but an amount equal to half of the Class B funding is earmarked for a suite of environmental and community benefit activities that are set out in the fund documentation—such as restoration projects, community agroforestry initiatives and community-based conservation efforts. These impact activities do not need to generate a return on investment.

Investments generating carbon offsets are sold under a long-term offtake agreement with two of the investors, reducing the risk associated with carbon-related cash flows. The returns are differentiated between the two investor classes. All investors receive a 2% preferred return, then the Class A investors receive a preferred return until they have achieved a 10% rate of return, and then the excess returns over 10% are distributed pari passu i.e. on equal footing between all investors.

Initial investments have included a peatlands restoration and community livelihood investment in Southern Thailand and a forestry and wood processing investment in Laos.

These type of investment structures can facilitate the creation of sustainable landscapes balancing conservation and production, sustainable livelihoods and access to technology and know-how from international investors.

Source: Green Finance Institute, 2024. "Tropical Asia Forest Fund." https://hive.greenfinanceinstitute.com/gfihive/case-studies/tropical-asia-forest-fund-2/.

The Advanced Bioeconomy is characterised by the integration of innovative technologies and innovative business models. This sector is witnessing a surge in venture capital and private equity investments, particularly in start-ups focused on biotechnology, biofuels, and bio-based materials. Governments are also playing a pivotal role by establishing innovation funds and providing targeted subsidies to support research and development in Advanced Bioeconomy fields.

Public-private partnerships are crucial in this phase, enabling the commercialisation of new technologies and facilitating the scaling up of production processes. The European Union's Horizon 2020 program, which funds research and innovation projects across Europe, is an example of how public funding can drive advancements in the bioeconomy. Similarly, national initiatives in countries like the United States, Canada, and Brazil are fostering innovation through supportive policies and substantial financial commitments.

The High-Tech Bioeconomy is propelled by countries and regions with strong technological capabilities and substantial venture capital-related financial resources. Financing in the High-Tech Bioeconomy is centred on venture capital, corporate investments and strategic alliances between technology companies and research institutions. The focus is on high-impact areas such as medical biotechnology, industrial bioprocesses, and high-value bio-based products.

In summary, the bioeconomy, like many evolving economic sectors, is financed through a variety of public and private investments, each playing a crucial role in different stages of development. The current trajectory of global bioeconomy development demonstrates that there are many of the same equity dynamics we see in the larger "dirty" global economy. That's in terms of raw material extraction and limited value-added opportunities and related investment happening in lower-and middle-income countries. With all that said, there are some bright spots and tremendous interest and emerging leadership from a growing cohort of countries.

6

Accelerating Financing of the Bioeconomy

Accelerating the financing of the bioeconomy requires a multi-faceted approach that includes traditional investment vehicles and instruments, innovative financial instruments, supportive policies, and international cooperation, underpinned by the convergence of principles and definitions and improved bases for measuring arising performance, especially set against policy goals such as decent jobs, social equity, rights and cultural integrity, climate resilience, and nature conservation and restoration.

Recognising both the potential of the bioeconomy and associated challenges including financing, growing numbers of governments and regional bodies worldwide are developing bioeconomy strategies. Amplifying the investor perceptions summarised in the EU-sponsored survey, the number one priority in accelerating investment flows to the bioeconomy was to establish clear national and regional strategies. Such strategies needed to drive coherent enabling policy and regulatory coherence and a measurable basis for advancing targeted public support. Many of today's bioeconomy strategies are summarised in the World Bioeconomy Forum's *Status of the Global Bioeconomy*[61] and the *Global Bioeconomy – Stocktake of G20-Members Strategies and Practices*,[62] and include:

China's National Development and Reform Commission unveiled a new plan to spur the bioeconomy during the 14th Five-Year Plan period (2021-25), with a strong focus on meeting "rising domestic demand for healthcare and better lives, foster high-quality economic development, prevent and control biosecurity risks and modernize China's system and capacity for governance during the period".[63]

The **EU's bioeconomy plan**, like others, has a strong focus on competitiveness and jobs, but has more explicit links to the continent's natural resource and climate goals, referring to the goals of "managing natural resources sustainably," "reducing dependence on non-renewable, unsustainable resources" and contributing to "limit and adapt to climate change".[64]

India's five-year bioeconomy development plan,[65] likewise, seeks an ambitious growth pathway, with targeted growth of 50% over the three-year period to 2025, highlighting focus areas including "biopharma, bio-services, agri biotech, industrial biotech, and bioinformatics through public-private partnership".[66]

Japan has recently published its second update of the 2019 national bioeconomy strategy, with considerable expectations of market growth and with a strong focus on links to AI, digitalisation, along with an expected strong regional dimension across South-East Asia.[67]

South Africa's bioeconomy strategy,[68] currently under revision, like Brazil's more recent Ecological Transformation Plan[69] also points to significant biotechnology opportunities but place greater emphasis on the links that need to be made between the bioeconomy and nature conservation and restoration, anti-poverty strategies, indigenous rights, and community development.

The **US White House** has recently issued a de-facto bioeconomy strategy, notwithstanding the country's general aversion to explicit economic and industrial strategies, with a strong focus on biotechnology/biomanufacturing and addressing climate goals, transitioning the food system, and meeting the next generation of health needs.[70]

Beyond such explicit targeting of the bioeconomy, many other policies, and regulatory developments impact investor appetite for the bioeconomy. For example, sustainable bioeconomy investment options will tend to become more attractive through:

- Crystallising nature-related risks into business decisions resulting the widespread adoption of risk disclosure reporting standards such as the Taskforce on Nature-related Financial Risks (TNFD) .
- Carbon markets that improve return to businesses and can demonstrate incorporation of nature-based carbon sequestration through the more effective stewardship of biodiversity.
- Green taxonomies that inform and shape investment behaviour, increasingly policy incentivised, notably championed by the EU and now common practice across more and more countries .
- Trade-related policies that impose penalties on core nature-intensive bioeconomy products if they cannot prove their production is deforestation-free
- Reversing perverse environmental and fossil fuel subsidies, and even better repurposing such subsidies to support enterprises that can contribute to the equitable, sustainable bioeconomy.

Without such strategies and associated plans in place, financing becomes a greater challenge, not least because the likelihood of the success of individual entities is significantly diminished. Such strategies allow for the development of much needed clusters that foster collaboration among businesses, research institutions, and government entities. These clusters facilitate the all-important sharing of knowledge, resources, and infrastructure, leading to innovative solutions and accelerated advancements in bio-based technologies. Creating such clusters, especially where a continuous technology dynamic is required, offers the important benefit of avoiding the high risks and low development leverage that comes from investing in a single, often isolated, entity. This is all the more important for countries seeking to move beyond a Nature Intensive Bioeconomy to capture the economic and broader benefits at the nexus of biodiversity and technology.

Coherent biodiversity-focused economic and industrial strategies allow for smart collaborative platforms to be established to realise the 'competitive cluster' potential, highlighted above, often including specific financing mechanisms, for example:

Amazonian Socio-Bioeconomy is not a single initiative but rather a broad vision now involving many Indigenous Peoples and Local Communities working alongside local and international civil and expert organisations, businesses, and commercial and development finance institutions. Whilst having a focus on enterprise and livelihood in common with other bioeconomy strategies around the world, it has a specific focus on forest conservation and restoration, territorial planning and law enforcement, and people-centred processes and plans.[71]

BioInnovate Africa illustrates such an approach, focusing on harnessing bio-based technologies to address socio-economic challenges in Eastern Africa.[72] The organization supports scientists and innovators in developing sustainable solutions across agriculture, health, and industry. Their projects include developing biofuels, creating biodegradable packaging, and enhancing food security through improved agricultural practices. BioInnovate Africa aims to foster a bioeconomy that promotes regional collaboration, innovation, and economic growth with sustainability.

Empresa Brasileira de Pesquisa e Inovação Industrial is a Brazilian organization dedicated to fostering industrial research and innovation. Operating under the Ministry of Science, Technology, Innovations, and Communications (MCTIC), the Ministry of Education (MEC), and the Ministry of Economy, it provides financial resources and technical expertise to help industries develop innovative products and processes in strategic areas such as biotechnology, information and communication technology, energy, and advanced manufacturing.[73] The organization operates through accredited research units across Brazil, which collaborate with companies to execute R&D projects.[74]

The **Circular Bio-based Europe Joint Undertaking (CBE-JU)**,[75] exemplifying a successful public-private partnership (PPP) model, crucial for financing the bioeconomy. CBE-JU is a collaboration between the European Union and the Bio-based Industries Consortium (BIC) and aims to harness €2 billion over the period 2021-2031 to drive innovation and sustainability in the bio-based sector. By combining public and private resources, CBE-JU supports projects that transform bio-based feedstock into innovative products, thereby reducing dependence on fossil fuels and promoting environmental sustainability.[76]

The **mRNA tech hub** located at Afrigen, Cape Town, South Africa exemplifies South-South collaboration on urgent shared priorities, utilizing a collective intelligence approach to intellectual property (IP).[77] This initiative is enabling regions in the Global South to leapfrog technological advancements typically dominated by the Global North, where large pharmaceutical companies often withhold proprietary knowledge. Such models underscore the potential for developing regions to advance by sharing knowledge and resources, thereby contributing to a more equitable and sustainable global bioeconomy.

Exhibit 11 | Accelerator Bioeconomy Financing Instruments

	Nature Intensive Bioeconomy	Advanced Bioeconomy	Hi-Tech Bioeconomy
Sustainable Development Goal (SDG)-Linked Bonds Bonds specifically designed to fund projects that contribute directly to achieving the UN SDGs, particularly those related to climate actions.	Fund reforestation projects and sustainable agriculture initiatives to meet UN SDGs on climate action and life on land	Invest in large-scale biorefineries that convert agricultural waste into biofuels, biochemical and biomaterials contributing to clean energy goals.	Support the development of bioplastics and advanced bioenergy systems, achieving SDGs related to industry innovation and climate action.
Green and blue bonds expansion Enhanced versions of green bonds (focused on environmental projects) and blue bonds (focused on ocean and water-related projects) with stricter sustainability criteria and impact reporting.	Issue bonds to finance the restoration of wetlands and marine ecosystems with strict sustainability criteria.	Use green bonds to support bioeconomy projects that harness agricultural and forest biomass, ensuring rigorous impact reporting.	Fund high-tech projects like ocean-based carbon capture and storage systems with blue bonds, ensuring high sustainability standards.
Blockchain-enabled carbon and biodiversity credits Utilizing blockchain technology to create transparent, secure, and traceable carbon and biodiversity credit trading systems.	Implement blockchain for transparent carbon credits in reforestation and biodiversity conservation projects.	Use blockchain to trade carbon credits from bioproducts that sequester carbon during production.	Ensure transparent trading of carbon and biodiversity credits for projects like bioplastics and advanced ecosystem restoration technologies.
Environmental impact bonds Pay-for-success bonds where returns are linked to the achievement of specific environmental outcomes, such as carbon reduction, water purification, or biodiversity restoration	Link returns to outcomes such as increased forest cover or improved water quality from conservation projects.	Tie bond returns to successful bioproducts that reduce greenhouse gas emissions and enhance soil health.	Link returns to measurable reductions in pollution or increases in renewable energy production from high-tech bioeconomy projects.
Nature-Based Solutions (NBS) funds Investment funds dedicated to projects that use nature-based solutions to address environmental challenges, such as reforestation, wetland restoration, and sustainable agriculture.	Fund projects like reforestation, wetland restoration, and sustainable agriculture that use natural processes.	Invest in bio-based solutions that improve soil health and increase crop yields using natural inputs.	Support high-tech solutions that leverage natural processes, such as advanced algae-based biofuels and bioremediation technologies.
Circular economy financing platforms Digital platforms that facilitate investments in circular economy projects, enabling recycling, reuse, and resource efficiency initiatives.	Finance projects focused on composting and organic waste recycling to improve soil health and reduce landfill use.	Support the recycling of bioproducts and the reuse of agricultural residues in bio-based manufacturing processes.	Invest in technologies that enable the recycling and repurposing of bioplastic materials, reducing waste and resource consumption.
Impact-linked finance Financing mechanisms where the cost of capital is linked to the social and environmental impacts of the funded projects, with better impacts leading to more favorable financing terms.	Provide financing with favorable terms for projects that demonstrate significant positive environmental impacts, like biodiversity restoration.	Offer better financing rates for bioproducts that achieve substantial environmental benefits, such as reducing carbon footprints.	Link financing terms to the environmental performance of high-tech bioeconomy projects, like advanced bioenergy systems and bioplastics.
Regenerative agriculture investment trusts (RAITs) Trusts that pool investor capital to purchase and manage farmland using regenerative agriculture practices.	Pool capital to purchase and manage farmland using regenerative practices that restore soil health and biodiversity.	Invest in farms that use bio-based inputs and sustainable practices to enhance productivity and environmental health.	Fund high-tech agricultural projects that integrate precision farming technologies with regenerative practices for improved sustainability.
Bioeconomy insurance products Specialized insurance products that protect bioeconomy investments against specific risks such as crop failure, pest infestations, and extreme weather events.	Provide insurance against risks like crop failure or pest infestations for projects using nature-based solutions.	Offer specialized insurance for bioproduct investments, covering risks related to production and market fluctuations.	Develop insurance products for high-tech bioeconomy projects, protecting against risks like technological failures or extreme weather events.
Climate adaptation funds Funds specifically targeted at financing projects that enhance the resilience of ecosystems and communities to climate change impacts.	Finance projects that build resilience in ecosystems and communities to climate impacts, such as mangrove restoration.	Support bio-based solutions that enhance climate resilience, like drought-resistant crops and soil health improvement.	Invest in advanced technologies that help communities and ecosystems adapt to climate change, such as precision climate-smart agriculture.
Bioeconomy crowdfunding platforms Platforms that enable small-scale investors to fund bioeconomy projects, democratizing investment and increasing public engagement in sustainable initiatives.	Enable small-scale investors to support community-led conservation and sustainable agriculture projects.	Democratize investment in bioproduct startups that use bio-based processes to create sustainable materials.	Crowdfund innovative high-tech bioeconomy projects, allowing the public to participate in the growth of sustainable industries like bioplastics and advanced biofuels

There are a diverse set of financial actors who are key to advancing financing for the bioeconomy, including the development finance community. Public spending, amounting to around 30% of global expenditure is key to advancing the bioeconomy,[79] as reflected in every national and regional bioeconomy strategy. For low-income countries in particular, and for middle income countries, this percentage is far lower, making development finance of great importance in advancing investments and innovative financing solutions. There are around 530 so-called 'Public Development Banks' (including MDBs, sovereign funds and other publicly owned, managed, and directed financial institutions) from about 154 countries – which manage approximately US$23 trillion in assets and make about US$2.5 trillion in annual investments.[80]

> The **Inter-American Development Bank (IDB)**, a leader amongst MDBs in addressing nature-related risks and opportunities, is championing the prospects of the bioeconomy. Together with the Igarapé Institute, it has examined the bioeconomy of eight Amazonian countries and showcased opportunities to create sustainable economic alternatives for the almost 50 million people living in the region.[81]

> The **African Development Bank (AfDB)** has historically focused on one of the bioeconomy's sister concepts, the 'circular economy', and has recently highlighted related opportunities to increase GDP in Africa by 2.2% and generate eleven million jobs. [82]

> The **Asian Infrastructure Investment Bank (AIIB)**, as an infrastructure financing institution, has focused on what it terms 'nature as infrastructure.' Its flagship report of the same name in 2023, highlighted the growing investment opportunities in approaching nature as the enabling infrastructure that can support vibrant, climate resilient economies, including the provision of basic feedstock into nature positive enterprises. [83]

Despite such leadership, most development finance institutions remain wary, or unaware of, the immediate and longer-term livelihood and development opportunities of the bioeconomy. Their growing engagement as a community in the biodiversity agenda is a good step forward, notably their joint commitment at COP15 in Montreal to track and report on their nature positive financing.[84] However, a next step would be to follow the path taken by the IDB in developing full bioeconomy strategies and support their sovereign clients in doing the same.

Bioeconomy strategies need to reflect climate and nature goals. As some of the existing national and regional strategies highlight, the bioeconomy can contribute directly to achieving key policy goals, including employment, social equity, and food security goals, as well as nature and climate imperatives. Integration with key strategic frameworks and commitments is therefore essential, such as climate-focused Nationally Determined Contributions (NDCs) and nature-focused National Biodiversity Strategies and Action Plans (NBSAPs), both of which are intended to map the linkages between climate and nature goals and financing needs and investment planning.[85]

Nature and climate realities themselves are changing, with huge implications that are too often not reflected in policy-driven economic and industrial strategies and associated financing ambitions and plans. The challenge is to consider the implications of the world moving beyond the Paris Agreement target of 1.5C temperature rise above pre-industrial levels, with growing expectations that it will move beyond 2C and far more in some parts of the world.[86] Whilst all efforts need to be made to restrict these temperature rises, there is an increasingly urgent need to plan for a far more disrupted future.[87]

For many low and middle-income countries, especially those closer to 'hot spots' of climate change, economic and industrial strategies will need to factor in the impact of climate on nature, and the flow through to food security and employment, in particular. Bioeconomy strategies need to contribute to conserving and restoring all, but especially economically productive, biodiversity.

At the same time, strategies and plans cannot depend on sustaining much of today's biodiversity resources. Whilst most must be made of the synergies between regenerative farming and biodiversity conservation and restoration, bioeconomy solutions also have an important role to play in reducing dependency on increasingly fragile natural systems. Reduced dependency can of course take many forms. Key to any meaningful strategy is to increase the price of biodiversity in ways that reduce over-use and bring in more revenue that can at least in part be used to invest in less nature intensive industries and livelihood opportunities. Such opportunities in fact will often lie within the more technologically advanced parts of the bioeconomy, so continuing to leverage nature-rich resources but in ways that add more economic value and reduce dependency.

One example of this is the all-important sphere of food production and security. With soil nutrition declining in the face of climate change and with more extreme weather events, climate resilient, nature-use light, soilless food production like lab-grown protein and Controlled Environment Agriculture (more commonly referred to as 'vertical farming') may transition from being a marginal 'nice to have' in producing high value products for wealthier consumers, to at least one basis on which food security more broadly across the population can be secured.

For renewables, the policy-based financing innovation was the 'feed in tariff,' deployed at scale initially in Germany and then adopted across the world.[88] It provided a standardized basis for spreading the addition costs, de-risking investments, and so lowering the cost of capital with associated economic benefits to the end users. The feed-in-tariff, notwithstanding its limits, has arguably been one of the most important innovative financial mechanisms to support the transition towards a low carbon world.

Like many parts of the bioeconomy, the current cost of nutrition produced through these capex intensive approaches remains well above prevailing market levels, especially in low and middle-income countries. Bringing down these costs is partly a matter of moving down the cost curve as the technologies mature and scale increases. However, much like renewables a decade or more ago, this is not possible without early-stage policy-based, financing support.

Now, there is an equivalent needed to catalyze investment in climate resilient, low nature-risk, capex intensive food production, a topic of on-going research by NatureFinance and partners including the FAIRR Foundation.[89] Such an instrument's design may vary between locations and technologies and over time but are likely to include a similar set of building blocks, including for example carbon and biodiversity credits, performance-based debt, and tax credits.

In summary, bioeconomy financing can benefit from the last decade's innovative financing developments and practices. Although bioeconomy financing challenges have some specific features, considerable progress can be made in overcoming them by drawing on the wealth of advances made over the last decade in areas. For example, bioeconomy financing can draw on the experience of blended finance, performance-based financing, and the development of public interest credit markets, as well as the underlying growth of impact investing. Such instruments and markets need to be considered in tandem with supportive policy and regulatory action, such as so-called 'double materiality' reporting standards, green investment taxonomies, and increasingly assertive amplifying action by central banks and financial supervisors.

Opportunities for **blended instruments** has received considerable attention, and there are literally tens if not hundreds of thousands of examples of practical approaches. The long-standing Blended Finance Taskforce provides an exceptional clearing house for methods, use cases and networks.[90] The G20 Sustainable Finance Working Group (SFWG) under Brazil's Presidency, in particular, has focused on the application of blended financing approaches to financing nature-based solutions including many examples of investing in base nature market enterprises.[91]

Performance based financing has come into its own in recent years and holds considerable potential to support investing in the bioeconomy. Of particular relevance is the evolution of performance-based sovereign financing, as sovereign risk pricing usually sets a floor on the cost of capital for any investments in that jurisdiction, with international cooperation in this space now well-advanced through the NatureFinance-hosted Sustainability-linked Sovereign Debt Hub.[92]

Nature and climate performance -linked sovereign debt issuance and the related so-called debt for nature swaps have provided the highest profile examples of reductions in the cost of capital in return for demonstrable performance returns, including stand-alone deals with Chile and Uruguay as well as credit-enhanced debt for nature swaps with Ecuador, Belize, and others. These developments are especially relevant for low to middle income countries facing high costs of capital. Such performance instruments can of course be tuned to bioeconomy and related policy goals.

Nature credit markets – both carbon and biodiversity focused, in effect a subset of performance-based financing – if effectively designed and governed, can make a significant contribution. Such markets are intended to go beyond channelling much needed funds into nature conservation and restoration in incentivising through price effects less carbon intensive and nature destructive activity – tipping investor interest towards tomorrow's low carbon, nature positive businesses and sectors. Beyond this, long-term credit offtake agreements can create a stable revenue stream into the future, effectively de-risking investments and reducing the cost of capital.

Especially effective and scaling are credit markets linked to so-called 'comply or compensate arrangements, whether established by sovereigns, financing institutions or down supply chains. Colombia, for example, requires companies to pay compensation for any damage to nature, which has resulted in the development of a voluntary biocredit market to channel such funds into long term, locally-engaged, nature restoration programmes.[93] Similar initiatives are now in place in Australia[94] and the UK,[95] with the most recent development of a comparable approach at the sub-national level in Parana in Brazil.[96]

Trade rules can provide another mechanism for making the bioeconomy more attractive to private investors. Yet such rules can have unintended, or intended, distributional effects that do not promote the equitable distribution of economic benefits. Europe's trade-linked zero deforestation rules may protect biodiversity, for example, but impose the associated costs on the businesses and economies of nature-rich, often developing nations. Similarly for other trade rules such as carbon border adjustment tariffs. Critical in all these cases is for effective international cooperation in seeking to promote a sustainable bioeconomy whilst ensuring a more equitable distribution of the arising opportunities and rewards.

For low- and middle-income countries, establishing agreements on subsidies and incentives for sustainable bioeconomy goods and services is crucial, as this remains an emerging area. Harmonizing rules and standards around bio-waste management can also facilitate regional integration. Regional trade agreements, such as the African Continental Free Trade Area (AfCFTA), which currently focus on industrialization with minimal environmental considerations, need to incorporate the sustainable bioeconomy into their frameworks. Effective international cooperation is essential to promote a sustainable bioeconomy while ensuring equitable distribution of opportunities and benefits.

Exhibit 12 | Trade Arrangements Can Incentivize Bioeconomy Financing

The development of new markets is crucial for financing the bioeconomy, as it directly impacts the economic viability of bioeconomy investments. International markets for many bio-based products are still in their infancy, requiring coordinated efforts to develop. This includes the creation of product standards and certifications, such as those developed by the European Committee for Standardization (CEN) for bio-based products. Trade agreements can also play a role in promoting bioeconomy trade, as seen in the EU-Mercosur trade agreement, which includes provisions on cooperation in biotechnology and the promotion of trade in bio-based products.

Export promotion initiatives, like the US Department of Agriculture's BioPreferred Program, can increase the global market share of bio-based products. Current subsidies that support unsustainable practices in agriculture, forestry, and energy sectors pose significant obstacles to the bioeconomy. Redirecting these subsidies towards sustainable bio-based initiatives can drive substantial progress. For example, subsidies could be reallocated to support the development of bio-refineries, the cultivation of biomass crops, and research in bio-based technologies. This reallocation would not only promote environmental sustainability but also attract private investment by de-risking bioeconomy projects and improving their financial viability.

Ensuring equity and inclusion in global bioeconomy trade is crucial for sustainable development and can impact financing flows. Developing fair trade standards for novel bio-based products could ensure a more equitable distribution of benefits. For instance, the Union for Ethical BioTrade provides a certification system for ethically sourced bio-based ingredients. Facilitating technology transfer to developing countries can enable them to move up the value chain in bioeconomy trade, as exemplified by platforms like WIPO GREEN, which promotes the transfer of green technologies. Supporting small-scale producers in accessing international markets, such as through UNCTAD's BioTrade Initiative, can promote more inclusive bioeconomy trade. These equity considerations are increasingly important for investors, particularly those focused on impact investing or adhering to ESG criteria and can influence the availability and terms of financing for bioeconomy projects in different regions.

Conclusions and Recommendations

The global bioeconomy is a cornerstone in the transition to a more equitable, low-carbon and climate-resilient, nature-positive economy. The changing world around is resetting our appreciation of an equitable and sustainable bioeconomy's pivotal role in sustainable development. The clean tech revolution has provided one viable pathway, especially for decarbonisation. The bioeconomy provides the complementary basis through which we can secure an equitable, sustainable use of nature, particularly biodiversity, a pre-condition to a just transition to sustainable development.

We need to turn the vision of an equitable, sustainable bioeconomy into practice. At its core, it is about how we use biological resources in sustainable ways that advance an equitable global economy. The bioeconomy holds immense economic potential for significant job creation and economic growth. Beyond such quantitative potential, efforts must support the development of socio-bioeconomies that are localised and sustain cultural diversity embodied by the role of Indigenous Peoples and Local Communities, including farmers, in stewarding the world's biodiversity.

The bioeconomy is already large and rapidly growing. Today's global bioeconomy is estimated to be valued at US$4-5 trillion, with growth potential to US$30 trillion by 2050. Despite significant data gaps and weaknesses, there is clear evidence of key growth drivers including climate, environmental and health concerns, increasingly embodied in market preferences and regulatory developments. National and regional bioeconomy strategies from Namibia and South Africa to Mexico and Brazil, and from India and China to Japan, the EU, and the US, to signal government's commitments to harnessing this potential.

The bioeconomy extends across a wide but interconnected landscape of peoples and economies. The bioeconomy has many shapes and forms, lying along a spectrum from locally-embedded nature intensive economies to the nexus of biodiversity and advanced technologies, and so involving actors ranging from small farmers through to multi-billion-dollar, high-tech businesses. Too often considered as inhabiting different worlds, there are practical reasons for considering this as a connected, dynamic spectrum.

The bioeconomy extends across a wide but interconnected landscape of peoples and economies. The bioeconomy has many shapes and forms, lying along a spectrum from locally-embedded nature intensive economies to the nexus of biodiversity and advanced technologies, and so involving actors ranging from small farmers through to multi-billion-dollar, high-tech businesses.

> Firstly, there exists one finite biodiversity that has to serve many purposes, and is not currently doing so in a sustainable, or equitable, manner.

> Secondly, we all have to respect and sustain nature's stewards, who are in the main the world's Indigenous Peoples, local communities, and farmers.

> Thirdly, we need make collective decisions about how to use biodiversity most effectively, rather than leaving it to those with most buying and political power.

> And fourthly, to make this all possible, we need to have and use similar concepts, definitions and ways of measuring progress, or its lack thereof.

The bioeconomy, in short, has to be consciously and collectively imagined, developed, and governed – and of course financed. **Financing the bioeconomy is entirely possible, drawing on a wealth of existing financial instruments.**

Beyond conventional commercial financing channels, there are a host of existing 'sustainable finance' instruments that can be deployed in financing the bioeconomy. Nature credits, for example, including carbon and biodiversity credits, can both augment revenues and provide long term income security that de-risks and lowers the costs of capital.

Financing the bioeconomy is entirely possible drawing on a wealth of financial instruments alongside complementary policy and regulatory developments set within an integrated approach to developing the bioeconomy. An 'integrated' approach, often said but rarely done well in practice, is a pre-condition for success in scaling the bioeconomy as a route to addressing social equity, jobs, and nature and climate goals, especially in a world increasingly disrupted by climate change impacts.

Investors will be more attracted to the bioeconomy where governments and regional bodies have put in place integrated bioeconomy strategies and associated executable plans. Less likely to work are isolated bioeconomy funds, high-level bioeconomy strategies lacking market buy in or execution capability, and public support for new bioeconomy enterprises and sectors absent of links to enabling trade policy. Needed is an 'integrated' approach that for example connects enterprise and market development with growing public awareness, suitable infrastructure, and enabling fiscal arrangements, education and research institutions and capabilities.

National and regional strategies and actions have to be complemented by international cooperation. There is much that can be done at the national and regional levels, as witnessed by the growing number of sophisticated bioeconomy strategies. While national and regional actions are crucial, they must be complemented by global efforts to ensure a sustainable and equitable bioeconomy. International cooperation is essential for scaling the positive impacts of the bioeconomy and mitigating its risks. The following priorities are critical for such cooperation:

1

PRINCIPLES

We cannot afford to allow the emergence of a 'buccaneering' bioeconomy - there is a need to converge on what public interest outcomes the bioeconomy needs to align with, an approach exemplified by the high-level principles being advanced by the G20 under Brazil's Presidency.

2

MEASURING PROGRESS

The lack of common measurement standards and related data makes it hard to measure or more importantly guide progress. This is not just a matter of measuring its breadth and size but ensuring a common 'operating system' rooted in the science of natural capital accounting and building out through financial accounting to asset valuation and investment decisions.

3

STRATEGIES AND PLANS

Strategies and plans, including core economic and industrial strategies but in many cases linked to the development and enforcement of land tenure rights and other mechanisms to secure the rights, roles, and rewards for nature's stewards, largely Indigenous Peoples and local communities, including farmers.

4

FINANCING

Principles, measurement, strategies, and trading conditions need to be locked into a range of largely existing financing instruments, raising investor awareness, mitigating risks, and opening the way to effective collaboration, in combination with action to reduce, offset, or repurpose perverse environmental and fossil fuel subsidies.

5

PRICING NATURE

Needed is to accelerate on-going efforts to increase the price of nature in the global economy which will increase investor interest in the sustainable bioeconomy, through improved risk analysis, explicit pricing, regulatory developments including action by financial regulators such as enhanced application of anti-money laundering rules in addressing nature crimes.

6

TRADE RULES

Financing is less likely to flow unless the right enabling trade and associated investment rules are in place to encourage principles-aligned bioeconomy-related trade, which can and should be advanced in regional as well as bilateral and international agreements, with the associated need to address the distorting effects of perverse subsidies as well as industrial subsidies that can have the effect of restricting low and middle-income countries of moving up the bioeconomy value chain.

7

KNOWLEDGE AND CAPABILITIES

There is a need to overcome the current lack of systematic analysis of the bioeconomy, in part by overcoming current shortfalls in data, especially to inform the development of robust bioeconomy strategies and plans as well as providing investors with much-needed information to support investment decisions.

Broader international policy orchestration is required to ensure effective and timely efforts. There are multiple channels through which regional international cooperation in these and other relevant areas can be progressed. Actions should be framed by the key UN Conventions whose mandates are relevant to the bioeconomy, notably the UN Convention on Biological Diversity and the United Nations Framework Convention on Climate Change need to embrace the importance of advancing an equitable, sustainable bioeconomy and enabling financing. The good news is that such developments are already in progress. The Colombian Presidency of CBD COP16 has made both biodiversity and financing a priority, recognizing that the bioeconomy is emerging as an alternative to the unsustainable economic models that have caused biodiversity loss in tropical countries. Brazil, having championed the bioeconomy during its G20 Presidency, is likely to take it forward as it takes on the Presidency role of the UNFCCC COP30.

Regional action can and should complement these developments. For example, just as the EU has advanced its bioeconomy plan largely through a regional approach, so too can the AU advance regional progress on the African continent, drawing in key regional bodies such as the African Development Bank, as well as drawing the bioeconomy into key continental agreements, such as the African Continental Free Trade Agreement. The Association of Southeast Asian Nations (ASEAN), similarly, would be a suitable venue for building on its embrace of the Bangkok Principles on the bioeconomy in 2022 in advancing practical collaboration on the bioeconomy and associated financing under the Malaysian Presidency in 2025.

Some agenda items can be advanced with the help of specialized agencies. For example, UNCTAD and the WTO clearly have a role to play in advancing more effective bio-trade arrangements. Multiple actors are working on pieces of the measurement agenda, too often with a research and mapping objective rather than a broader market and policy use in mind and could usefully be convened and re-focused by key policy platforms, such as the G20. Many actors, including the UNDP, has advanced proposals for repurposing perverse environmental and fossil fuel subsidies in pursuit of a just transition to a nature positive, low carbon, climate resilient economy.

On financing, the landscape of actors is rich in expertise but fragmented. The ‘nature finance’ community has in the main ignored the more high-tech aspects of the nature investment landscape, but has much to offer, for example, in advancing the natural capital accounting to asset valuation stack. The related standards bodies and associated communities of practice all have a role to play, from the International Sustainability Standards Board (ISSB) to the financial market standards organisations such as International Organization of Securities Commissions (IOSCO) and regulatory networks such as the Network of Central Banks and Supervisors on Greening the Financial System (NGFS). Key financial sector associations such as the International Institute of Finance (IIF) and the International Capital Markets Association (ICMA) need to be centrally involved, as well as specialist finance-facing platforms such as the Finance in Common (FIC) association of public development banks.

With so many actors needing to be involved, there is a need for international orchestration to avoid fragmentation, duplication, lowering of ambition, or simply inertia setting in. The G20 is the obvious platform to take on this role, given its thematic coverage, convening power, and signaling influence. Brazil has begun this journey during its Presidency most visibly through the G20 Initiative on Bioeconomy,[97] but the bioeconomy in different guises is present across other parts of the G20, including the Sustainable Finance Working Group and the Taskforce for the Global Mobilization against Climate Change, as well as being relevant to many other workstreams, for example on trade, infrastructure and centrally reform of the global financial and economic architecture. There is a compelling logic to extending Brazil's efforts into future G20 Presidencies, notably the South African in 2025 and American in 2026.

Other international cooperation platforms should also take on the bioeconomy alongside the continued leadership of the G20 on the bioeconomy. Most immediately is the forthcoming Conference of the Parties (COP16) of the Convention on Biological Diversity (CBD) and subsequent work of the CBD. Fortunately, the current Colombian Chair has already prioritised both the bioeconomy and finance for the upcoming meeting in Colombia in late 2024, opening the way for this to become a core part of the finance mobilization and alignment agendas. Likewise, for the UN Climate Change Conference, both the upcoming COP29 in Baku, and the Brazil led COP30 during 2025. Given Brazil's forthcoming leadership, there is an obvious opportunity to join the dots with the work it has progressed during its G20 Presidency, with a particular focus on the climate-bioeconomy nexus.

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WORLD bioeconomy FORUM

NATURE FINANCE