# Growing a Sustainable Bioeconomy Through Trade and International Cooperation

Input paper for the G20 Initiative on Bioeconomy (GIB)

September 2025

NATURE FINANCE

G20 SOUTH AFRICA 2025

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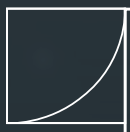

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Our use of Fibonacci sequence imagery is inspired by the association of this unique ratio with the maintenance of balance, and its appearance everywhere in nature- from the arrangement of leaves on a stem to atoms, uncurling ferns, hurricanes and celestial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

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This report was authored by Indekhwa Joy Anangwe,[1] Julie McCarthy[1] and Mark Halle[1] with contributions from Fiona Napier,[1] Isobel Cohen,[1] and Monique Atouguia.[1] Editorial assistance by Roberta Zandonai,[1] design and layout by Natan Aquino.[1]

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Any errors or omissions remain the sole responsibility of the authors.

1 NatureFinance

2 Stockholm Environment Institute (SEI)

3 International Centre for Trade and Sustainable Development (ICTSD - Geneva)

4 United Nations Trade & Development (UNCTAD)

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# Foreword

The global economy stands at a critical inflection point. Confronted by climate change, biodiversity loss, and resource scarcity, traditional economic models rooted in fossil-fuel-based models and linear resource extraction are no longer fit for purpose. The bioeconomy, based by definition in renewable biological resources, offers a transformative path toward sustainable products, services, and inclusive prosperity. It reimagines global trade as a driver of environmental restoration rather than degradation.

Under South Africa's G20 Presidency, we have championed the transition from Brazil's aspirational bioeconomy principles into implementation: the G20 Initiative on Bioeconomy (GIB) seeks actionable mechanisms and policy frameworks that can deliver real-world impact. Trade is central: we view sustainable trade not only as the vehicle for bioeconomy development but as its ultimate destination, creating equitable market pathways for bio-based innovation.

South Africa's leadership is both strategic and personal. As a biodiversity-rich nation with strong agricultural and growing biotech capabilities, we understand the promise and complexity of building a competitive bioeconomy. Bioeconomy success demands more than natural resources, it also requires local investment, expanding skills and capacities, coordinated policy, global partnerships, and regional cooperation. Crucially, sustainable trade frameworks must ensure that bioeconomy benefits reach all nations, especially those in the Global South where biodiversity is abundant but economic opportunity remains limited.

The bioeconomy is not just an environmental and social necessity, it is a $30 trillion economic opportunity. Current trade structures often perpetuate extractive dynamics; reversing this through sustainable trade policy is essential for global economic justice. This paper outlines a roadmap for G20 action, including policy integration, infrastructure development, standards harmonization, and financial realignment to scale the bioeconomy inclusively.

The urgency of our planetary crises demands bold leadership. Through GIB, the G20 can set global precedents for how trade supports both development and environmental stewardship. The transition to a nature-positive economy will be inevitable. The question is whether we will lead it strategically, or be forced to reactively adapt. Under South Africa's presidency, we choose to lead.

**Ben Durham**
Chief Director: Bio Innovation
Department of Science, Technology and Innovation, South Africa

# Acronyms and Abbreviations

| | |
|---|---|
| ACEA | African Circular Economy Alliance |
| ACEF | Africa Circular Economy Facility |
| AfCFTA | African Continental Free Trade Area |
| AfDB | African Development Bank |
| APEC | Asia-Pacific Economic Cooperation |
| BASF | Baden Aniline and Soda Factory |
| BCG | Bio-Circular-Green |
| BEPS | Base Erosion and Profit Shifting |
| CARICOM | Caribbean Community |
| CBAM | Carbon Border Adjustment Mechanism |
| CBD | Convention on Biological Diversity |
| CBE JU | Circular Bio-based Europe Joint Undertaking |
| CCPs | Core Carbon Principles |
| CEF | Connecting Europe Facility |
| CELAC | Community of Latin American and Caribbean States |
| CEPA | Comprehensive Economic Partnership Agreement |
| CRISPR | Clustered Regularly Interspaced Short Palindromic Repeats |
| CTE | Committee on Trade and Environment |
| DSI | Digital Sequence Information |
| E3F | Export Finance for Future |
| ECA | Export Credit Agencies |
| EEA-32 | European Economic Area |
| EGA | Environmental Goods Agreement |
| EPA | Economic Partnership Agreement |
| ESG | Environmental, Social, and Governance |
| ETS | Emissions Trading Schemes |
| EU | European Union |
| EU BIC | European Union Biobased Industries Consortium |
| EUDR | European Union Deforestation Regulation |
| FAO | Food and Agriculture Organization |
| FDI | Foreign Direct Investment |
| FRC | Forest Risk Commodities |
| FTA | Free Trade Agreement |
| GCF | Green Climate Fund |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gases |
| GIB | G20 Initiative on Bioeconomy |
| GII | G20 Global Infrastructure and Investment |
| HLPs | High Level Principles on the Bioeconomy |
| ICVCM | Integrity Council for the Voluntary Carbon Market |
| IDB | Inter-American Development Bank |
| IFPRI | International Food Policy Research Institute |
| IGOs | Intergovernmental Organizations |
| IMO | International Maritime Organisation |
| IPBES | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| IPCC | Intergovernmental Panel on Climate Change |
| IPLCs | Indigenous Peoples and Local Communities |
| IRA | Inflation Reduction Act |

| | |
|---|---|
| ISEAL | International Social and Environmental Accreditation and Labelling |
| ISO | International Organization for Standardization |
| ITC | International Trade Centre |
| JETPs | Just Energy Transition Partnerships |
| LCA | Lifecycle Assessment |
| MDBs | Multilateral Development Banks |
| mRNA | messenger Ribonucleic Acid |
| MRV | Monitoring, Reporting, and Verification |
| MSMEs | Medium, Small and Micro-Enterprise |
| NAPs | National Adaptation Plans |
| NBSAPs | National Biodiversity Strategies and Action Plans |
| NDCs | Nationally Determined Contributions |
| ODEPA | Oficina de Estudios y Políticas Agrarias |
| OECD | Organisation for Economic Co-operation and Development |
| PDBs | Public Development Banks |
| PES | Payment for Ecosystem Services |
| PPP | Public Private Partnership |
| RIO | Regulatory Innovation Office |
| R&D | Research & Development |
| SAMRC | South African Medical Research Council |
| SDGs | Sustainable Development Goals |
| SMEP | Sustainable Manufacturing and Environmental Pollution Programme |
| TESS | Forum on Trade, Environment and SDGs |
| TIWG | Trade and Investment Working Group |
| SFWG | Sustainable Finance Working Group |
| UK | United Kingdom |
| UKIPO | United Kingdom Intellectual Property Office |
| UN | United Nations |
| UNCTAD | United Nations Trade & Development |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| USA | United States of America |
| VSS | Voluntary Sustainability Standards |
| WEF | World Economic Forum |
| WHO | World Health Organisation |
| WTO | World Trade Organization |

# Executive Summary

**The global bioeconomy, valued at US$4 trillion and projected to reach US$30 trillion by 2050,[1] represents a critical pathway for sustainable economic transformation amid escalating resource extraction pressures and climate challenges.** The bioeconomy, broadly defined as using renewable biological resources to generate sustainable products, services, employment, and income, encompasses everything from bio-based materials and fuels to biotechnology applications and ecosystem services.[2] Alongside the transition to renewable energy, and building on the application of technology, the bioeconomy offers a vast opportunity landscape of innovation and commercial potential that extends well beyond basic "nature" finance for landscape conservation and restoration. The bioeconomy, in essence, represents the ecological counterpart to the renewable energy transition, and together they constitute the full just green transition agenda essential for achieving global climate goals.

**Biodiversity-based trade represents 17.16% of total global trade, representing 7.02% of total global GDP.[3] Moving beyond niche markets, the bioeconomy is projected to reach a global value of US$ 8 trillion by 2030, spanning industries from food and agriculture to advanced materials, pharmaceuticals, and bioenergy.** This scale of growth places the bioeconomy on par with today's digital economy in terms of economic potential, positioning it not only as a tool for sustainability but as a mainstream driver of competitiveness, jobs, and trade. **Unlike single-sector transitions, the bioeconomy cuts across multiple industries. This creates entry points for a wide range of investors, from venture capital and impact funds to infrastructure and institutional investors seeking long-term stable returns.**

Bio-based goods are often the only viable alternative to greenhouse gas-intensive products in many sectors. In a context where global supply chains must be massively and urgently decarbonised to support a resilient and liveable planet, the bioeconomy transition carries both inevitability and unprecedented opportunity. **The bioeconomy can contribute up to one-third of the emissions reductions needed to limit global warming to 1.5°C**, while simultaneously delivering adaptation and resilience benefits through nature-based solutions that strengthen ecosystem services and community livelihoods.[4] **For emerging and developing countries, this offers an opportunity to leapfrog and develop industries and economies fit for the future.**

The bioeconomy is a hugely under-valued potential contributor to climate mitigation, adaptation and increasing resilience. It can provide bio-based sustainable alternatives to carbon-intensive products, drive regenerative agricultural practices and create circular forest and agricultural economies that help extend soil health and productivity, and prevent deforestation and land conversion. It can also support scientific developments and products such as synthetic biology, genomics and bioinformatics, as well as encompass service-based activities such as tourism and gastronomy. The larger and more sustainably it develops, the more the bioeconomy benefits nature, climate, and inclusive and resilient socio-economic development.

Bio-based solutions offer significant potential across **climate mitigation, adaptation, and economic resilience strategies. The bioeconomy serves as both a climate action tool and an economic resilience strategy**, helping countries adapt to changing environmental conditions while reducing emissions. The bioeconomy can contribute to NDCs through **carbon sequestration in agricultural and forestry systems,**[5] **emissions reduction through bio-based alternatives to fossil fuel products, development of sustainable aviation and maritime fuels**, and implementation of **nature-based solutions for climate adaptation and economic diversification**.

Confronted with the imperative to move away from fossil fuels, reduce material extraction and combat biodiversity loss, **a growing number of countries are exploring options to harness trade and trade-related policies to encourage more sustainable economic models and benefit from the opportunities offered by the bioeconomy**. These include establishing sustainability requirements for products entering the market; introducing mandatory due diligence requirements for imports; providing preferential market access for sustainably produced goods; banning products directly linked to illegal deforestation;[6] removing environmentally harmful subsidies; or providing payments for ecosystem services and trade-related capacity building that supports sustainable production patterns. **The critical distinction lies in whether the bioeconomy is designed to be regenerative, circular, and inclusive, or whether it mimics fossil-era models that prioritize short-term profit over long-term resilience. In this sense, the bioeconomy can either accelerate sustainability transitions or deepen ecological and social risks.**

**Achieving the bioeconomy's potential requires leveraging comparative advantages and cooperation at regional and international levels, particularly for emerging market and developing economies.** Like renewable energy development, the bioeconomy requires massive strategic R&D, industrial policy, tax and procurement incentives to compete with incumbent, lower-cost technologies and create new economies of scale. We are only at the beginning of the innovation curve in many bioeconomy areas, requiring intentional strategy development, policy enabling, and regional and global cooperation to harness its potential.

**Most current trade frameworks historically and systematically disadvantage bio-based products by bundling them with fossil fuel counterparts and subjecting them to conventional regulations without equivalent support structures.** The absence of harmonized international standards creates significant trade barriers that impede market access and increase compliance costs for exporters. Meanwhile, fossil fuel subsidies, currently US$1.1 trillion globally,[7] still represent a significant portion compared to the US$2.2 trillion[8] allocated to clean energy investments. However, emerging mechanisms signal growing policy alignment. Frameworks such as the EU's Carbon Border Adjustment Mechanism (CBAM), are helping to create competitive advantages for low-carbon bio-based alternatives across key sectors including cement, steel, aluminium, fertilizers, and hydrogen.[9]

**Realising bioeconomy potential requires coordinated action across national, regional, and international levels.** At the national level, governments can establish foundational policies including biotechnology investment and technology transfer partnerships (as demonstrated by G20 members like South Africa, China, India, Brazil, the US, and UK), tariff reductions[10] on bio-based technologies, and capacity building for bioeconomy businesses to meet emerging international standards. Regional cooperation mechanisms can develop integrated supply chains linking biomass rich countries with technologically advanced neighbours, harmonise standards, create duty-free trade in bio-based products like organic fertilizers and bio-packaging, and establish joint financing facilities. **Frameworks like the African Continental Free Trade Area (AfCFTA) further present opportunities to incorporate bioeconomy-specific clauses promoting sustainable bio-product development and trade across continents.** International coordination through forums like the G20 can establish global standards and mutual recognition frameworks that accelerate market access and investment flows.

Under South Africa's G20 Presidency, the G20 Initiative on Bioeconomy (GIB) builds on high level bioeconomy principles[11] established during Brazil's presidency to operationalize concrete trade mechanisms for sustainable economic transformation. **This G20 bioeconomy effort recognizes that achieving climate goals requires not just renewable energy deployment but comprehensive economic transformation that leverages nature's productive capacity.** Strategic priorities and pathways to scaling the bioeconomy for the G20 should include:

1

### Policy Integration

Link bioeconomy strategies with circular economy policies and national climate commitments, establishing clear regulatory distinctions between bio-based and fossil fuel products.

2

### Trade Infrastructure

Create preferential trading arrangements for bio-based products across member states and coalitions of the willing, including the establishment of specialized customs facilities with digital verification systems.

3

### Regional Cooperation

Strengthen technology transfer mechanisms, and create joint financing facilities for cross-border bioeconomy projects and initiatives such as the proposed Bioeconomy Financing Hub for Africa and the EU Test Farms Programme.

4

### Data and Standards Harmonisation and Interoperability

Establish comprehensive data and standards harmonisation frameworks that create interoperable systems for measuring, reporting, and verifying bioeconomy activities across G20 countries. This includes harmonized international standards through mechanisms such as the Codex Alimentarius,[12] while also building national capacity in Digital Sequence Information (DSI) to ensure that biodiversity-rich countries can participate meaningfully in global bioeconomy value chains.

5

### Financial Realignment

As part of the transition process, immediately make bioeconomy goods and services eligible for the same subsidies as environmentally harmful fossil fuel-based counterparts. Gradually start reducing fossil fuel subsidies, while separately making the case through regular budget processes for increased allocation toward bioeconomy development and the prioritisation of bio-based solutions in public procurement to create stable demand and signal market shifts.

6

### Market Incentives

Deploy strategic financial, regulatory, tax, behavioural and supply chain incentives to strengthen demand signals and accelerate market transformation.[13] These time-limited incentives provide technologists with the opportunity to develop product-market fit, ensuring emerging bioeconomy technologies can drive business performance long after incentives phase out.

While the bioeconomy offers numerous opportunities, success will require robust inter-ministerial coordination between finance, environment, agriculture, economic planning and trade ministries. **Priority actions include establishing a G20 bioeconomy inter-ministerial working group and developing mutual recognition frameworks for bio-based products that can move faster than traditional multilateral processes.** The bioeconomy represents both an environmental imperative and a significant economic opportunity. Aligning trade policies with sustainability goals offers G20 nations an opportunity to accelerate the transition to resilient, nature-positive economies while creating the policy precedents and market conditions necessary for global bioeconomy scaling.

# Introduction and Context

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# The Global Bioeconomy Landscape

The global bioeconomy continues to emerge and evolve as a transformative economic force, representing one of the fastest-growing sectors in the modern economy. According to the World Bioeconomy Forum, **the bioeconomy refers to the production, utilisation, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions within and across all economic sectors and enable a transformation to a sustainable economy.**[14]

**Valued at US$4 trillion, the bioeconomy leverages biological resources and processes across three interconnected spectrums: nature-intensive, advanced, and high-tech to create sustainable economic value through innovative biological alternatives to fossil-based systems, delivering everything from traditional bio-based goods to sophisticated, high-value bioproducts that address global sustainability challenges.**[15] Though distinct, the bioeconomy has close links with and complements other bio-concepts and frameworks including the nature-based solutions, the circular economy and the green economy.

**Figure 1** **Strategic Spectrum of the Bioeconomy**[16]

### Nature Intensive Bioeconomy

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.

### Advanced Bioeconomy

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.

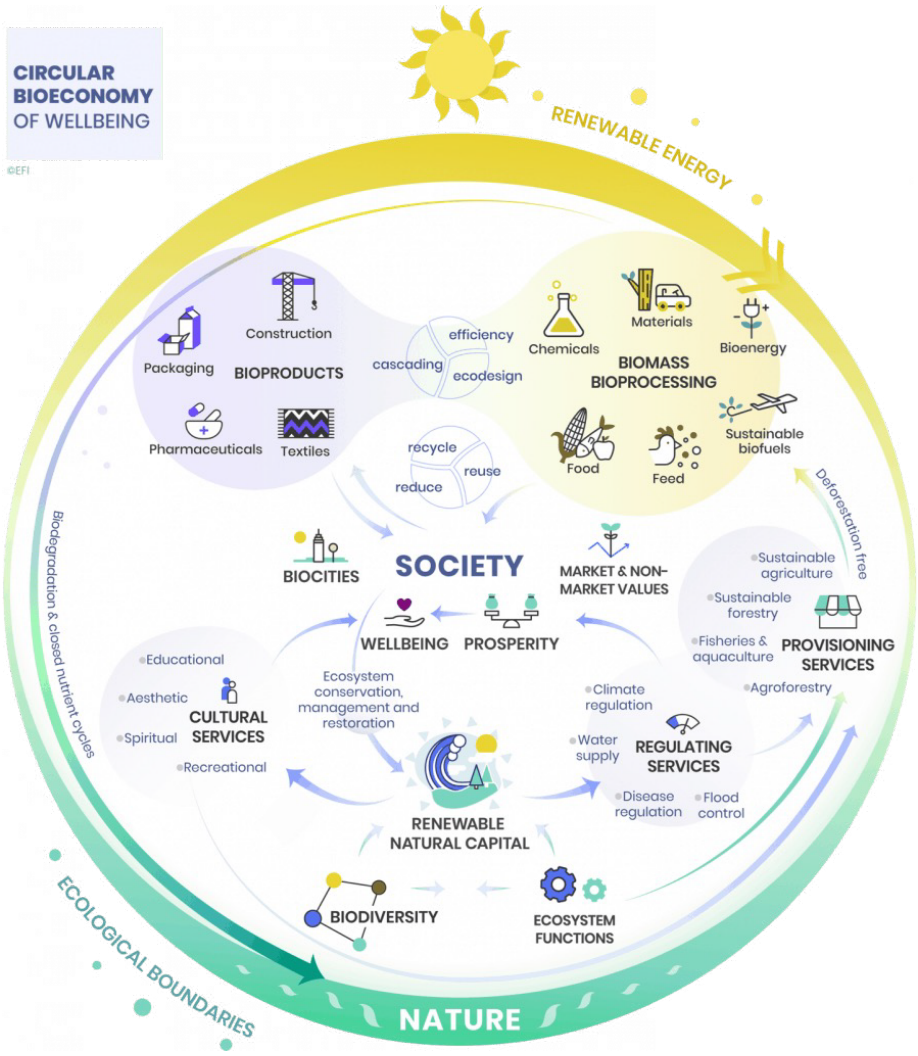
### Hi-Tech Bioeconomy

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.

While the bioeconomy has the potential to drive green growth, improve resource efficiency, and create new industries, it is not automatically sustainable. Its impacts depend on how biological resources are managed and how value chains are designed. A sustainable bioeconomy is one that works within ecological limits, regenerates resources, and distributes benefits equitably.[17] It also emphasises circularity by turning waste into inputs, promotes low-carbon solutions that substitute fossil-based products, and supports innovations that reduce land, water, and chemical use. Social inclusion is also a key element, ensuring that farmers, local communities, and small enterprises capture value from new opportunities. For example, producing bioenergy from agricultural residues rather than expanding land for biofuel crops both avoids deforestation and provides farmers with additional income streams.

Today, biodiversity underpins a wide range of products and services used by our societies and forms the growing foundation of a more sustainable economy. **Approximately US$ 44 trillion of economic value generation—over half the world's total GDP, is currently moderately or highly dependent on nature and its services.[18] Biodiversity and healthy ecosystems also provide livelihoods for 4.3 billion people, particularly the most vulnerable and economically disadvantaged[19] and play a critical role in fostering climate resilient development given their roles in climate change mitigation and adaptation.[20]**

**Figure 2** **The Circular Bioeconomy**

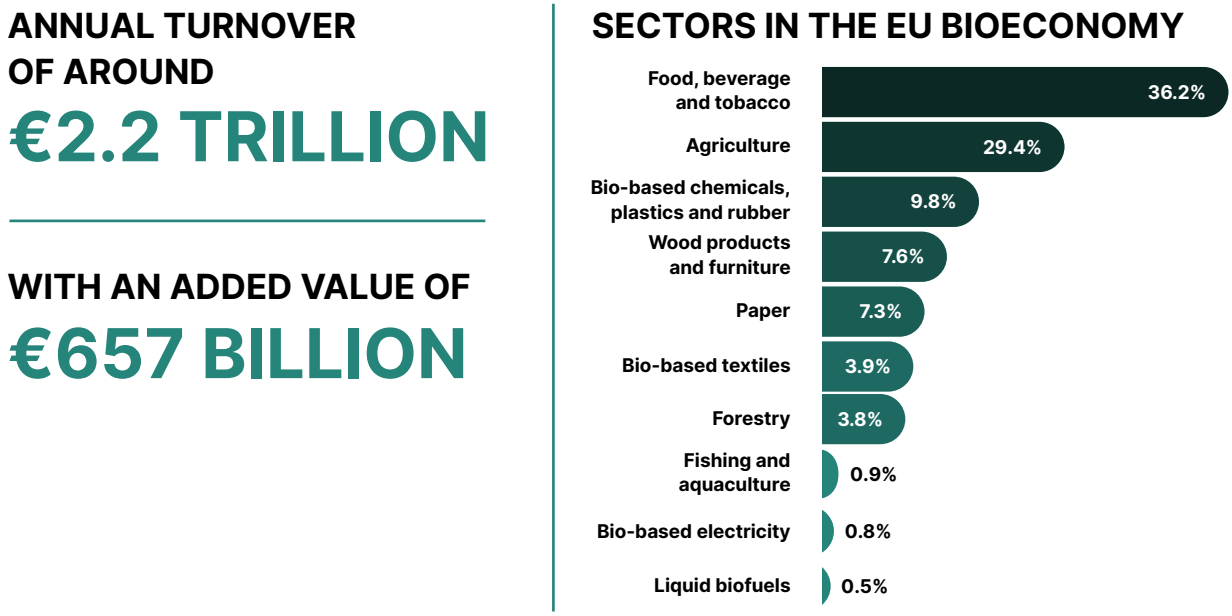



**Source:** Circular Bioeconomy Alliance[21]

By contrast, an unsustainable bioeconomy replicates extractive models of the past and arises when biological resources are overharvested, when bio-based industries drive land-use conflicts, or when biodiversity-rich ecosystems are converted into monocultures. Practices such as large-scale palm oil expansion or indiscriminate logging, even when labelled "bio-based," undermine ecological integrity, worsen inequality, and threaten long-term resource security. In these cases, the bioeconomy becomes part of the problem rather than the solution. **The critical distinction lies in whether the bioeconomy is designed to be regenerative, circular, and inclusive, or whether it mimics fossil-era models that prioritize short-term profit over long-term resilience. In this sense, the bioeconomy can either accelerate sustainability transitions or deepen ecological and social risks.**

The bioeconomy is projected to grow exponentially to US$30 trillion by 2050, representing approximately a third of the global economic value.[22] The bioeconomy's current valuation reflects its diverse portfolio of established and emerging sectors across different countries as reflected below:

**Figure 3** **Overview of the EU Bioeconomy[23]**




**Source:** https://open-research-europe.ec.europa.eu/articles/5-163/v1

**Figure 4** Overview of the Brazilian Bioeconomy[24]

THE BIOECONOMY IN BRAZIL COULD GENERATE AN ANNUAL REVENUE OF

**US$284 BILLION**

BY 2050

AREAS OF HIGH POTENTIAL

- Bioenergy
- Biochemicals and biofuels
- Alternative proteins

**≈ 57%**

OF BRAZIL'S CURRENT INDUSTRIAL SECTOR BY 2050

**Figure 5** Overview of the US Bioeconomy

IN THE UNITED STATES THE BIOECONOMY IS VALUED AT

**US$959.2 BILLION**

ACCOUNTING FOR

**5.1%**

OF GDP

$402.5B DIRECT

**556.7**

INDIRECT & INDUCED

KEY SUB-SECTORS

- Biomanufacturing
- Biofuels
- Bio-based chemicals
- Advanced materials
- Biotech-based food ingredients
- Algae-based materials

**Source:** World Bio Market Insights

**Note:** Due to the varying valuation methods and definitions of the bioeconomy, the 2016 figures represented above represent the most comprehensive valuation covering both direct and indirect aspects of the US Bioeconomy[25]

# The Bioeconomy Opportunity, A Global Growth Frontier

In recent years, **the way in which 'nature' is understood by key economic and financial actors has been rapidly evolving.** Alongside long-standing calls for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources," as reflected in the 1992 Convention on Biological Diversity (CBD), there is a growing emphasis on restoration and regeneration of nature, on 'nature-based solutions', and more systemically on the concept of 'nature economies', where nature is increasingly valued and traded. This evolving perspective among economic and financial actors is reshaping how nature is integrated into growth strategies, investment portfolios, and trade systems.

**This evolution is positioning the bioeconomy as a diverse economic system capable of generating employment, driving economic growth, and simultaneously advancing net-zero emissions targets while protecting and enhancing natural capital.** International trade and trade policies have a vital role to play in this transition.

Under Brazil's leadership during its 2024 G20 Presidency, the G20 Initiative on Bioeconomy (GIB) was launched to foster a shared understanding of the bioeconomy among G20 members and to accelerate its development as a sustainable, nature-based solution to global challenges like climate change and poverty. As part of its work, and following intensive deliberations by member countries, in December 2024 the G20 adopted a set of High Level Principles on the Bioeconomy (HLPs).[26] South Africa, through its GIB engagement, is now prioritizing the implementation of these principles to align national efforts with global best practices, and has placed particular focus on **High-Level Principle 7, which emphasizes the need for robust and coherent policy frameworks that foster trade for bioeconomy products and services while ensuring sustainable business models, decent job creation, local value creation, and meaningful private sector and civil society participation.** South Africa has also prioritized advancing implementation of **HLP 9 which promotes international collaboration to address global challenges by leveraging complementary strengths, innovation, and entrepreneurship while promoting financing, capacity building, and sharing of best practices.**

These initiatives have particular urgency, given that according to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), achieving global biodiversity objectives and sustainable development necessitates urgent transformative, systems-level changes across various domains, improving not only the sustainability of economic sectors but also how they function globally through trade. **In the absence of effective regulations, policies and frameworks, international trade spurred by global demand and rapidly evolving consumption patterns will contribute to exacerbate biodiversity loss, the degradation of ecosystems, and acceleration of the climate crisis. At the same time, trade and trade-related policies can play a key role in promoting biodiversity conservation, sustainable use and restoration, while supporting the emergence of an equitable and sustainable global bioeconomy that fosters economic growth, creates jobs, and enhances livelihoods.**

**Moving beyond niche markets, the bioeconomy is projected to reach a global value of USD 8 trillion by 2030, spanning industries from food and agriculture to advanced materials, pharmaceuticals, and bioenergy.** This scale of growth places the bioeconomy on par with today's digital economy in terms of economic potential, positioning it not only as a tool for sustainability but as a mainstream driver of competitiveness, jobs, and trade. **Unlike single-sector transitions, the bioeconomy cuts across multiple industries. This creates entry points for a wide range of investors, from venture capital and impact funds to infrastructure and institutional investors seeking long-term stable returns.**

Financing constraints in the bioeconomy should be seen not as barriers, but as catalysts for innovation and investment. The capital requirements are diverse: **patient capital** is needed for early-stage biotechnology research; **infrastructure financing** is essential for biorefineries, logistics, and cold chains; and **innovative financial products** such as green bonds, blended finance, and sustainability-linked loans can help channel mainstream capital into bio-based industries. **For investors seeking growth sectors aligned with climate and sustainability mandates, the bioeconomy offers a largely untapped frontier.**

**The bioeconomy is reshaping global trade by creating demand for sustainable feedstocks, certified bio-based products, and advanced biomaterials.** Countries that invest early in bioeconomy infrastructure and standards can secure leadership positions in **high-value export markets** such as biopharmaceuticals, sustainable textiles, bioplastics, and alternative proteins. **This shift diversifies economies away from fossil dependency, strengthens supply chain resilience, and opens pathways for green industrialisation.**

**Globally, the bioeconomy has the potential to generate tens of millions of new jobs across rural and urban economies.** These include farming and feedstock production, industrial and processing jobs, scientific and technical roles, and digital service jobs linked to certification and monitoring. **Unlike fossil-based industries, the bioeconomy's growth is inherently more inclusive, connecting rural communities with global markets and offering new opportunities for women and young entrepreneurs.**

**As investors and consumers increasingly demand low-carbon and sustainable products, the bioeconomy aligns directly with global megatrends including the net-zero transition, circular economy strategies, and the surge in ESG-driven capital.** Additionally, financial markets are actively seeking credible green opportunities; positioning the bioeconomy as investable provides a pathway to mobilise both public and private capital at scale.

**The coming decade is critical. Countries and regions that invest now in bioeconomy infrastructure, governance, and innovation ecosystems will shape the rules, standards, and markets of the future.** For governments, this means embedding the bioeconomy in industrial and trade strategies. For investors, it means recognising that financing bio-based solutions is not just about impact, it is about positioning portfolios in a sector with high growth, resilience, and long-term competitiveness.

# Global Bioeconomy Strategies in Context

Growth trajectories vary significantly across different bioeconomy segments, with some sectors experiencing double-digit annual expansion rates. **The growth arises from several converging factors** such as increasing environmental regulations for instance on carbon pricing and chemical safety, sustainable finance frameworks like the EU Taxonomy redirecting capital flows, renewable energy mandates driving biofuel demand, corporate sustainability commitments, technological breakthroughs in areas like synthetic biology and biotechnology, and growing consumer demand for sustainable alternatives to traditional products. **These market dynamics suggest that current valuations represent only the beginning of the bioeconomy's economic potential.**

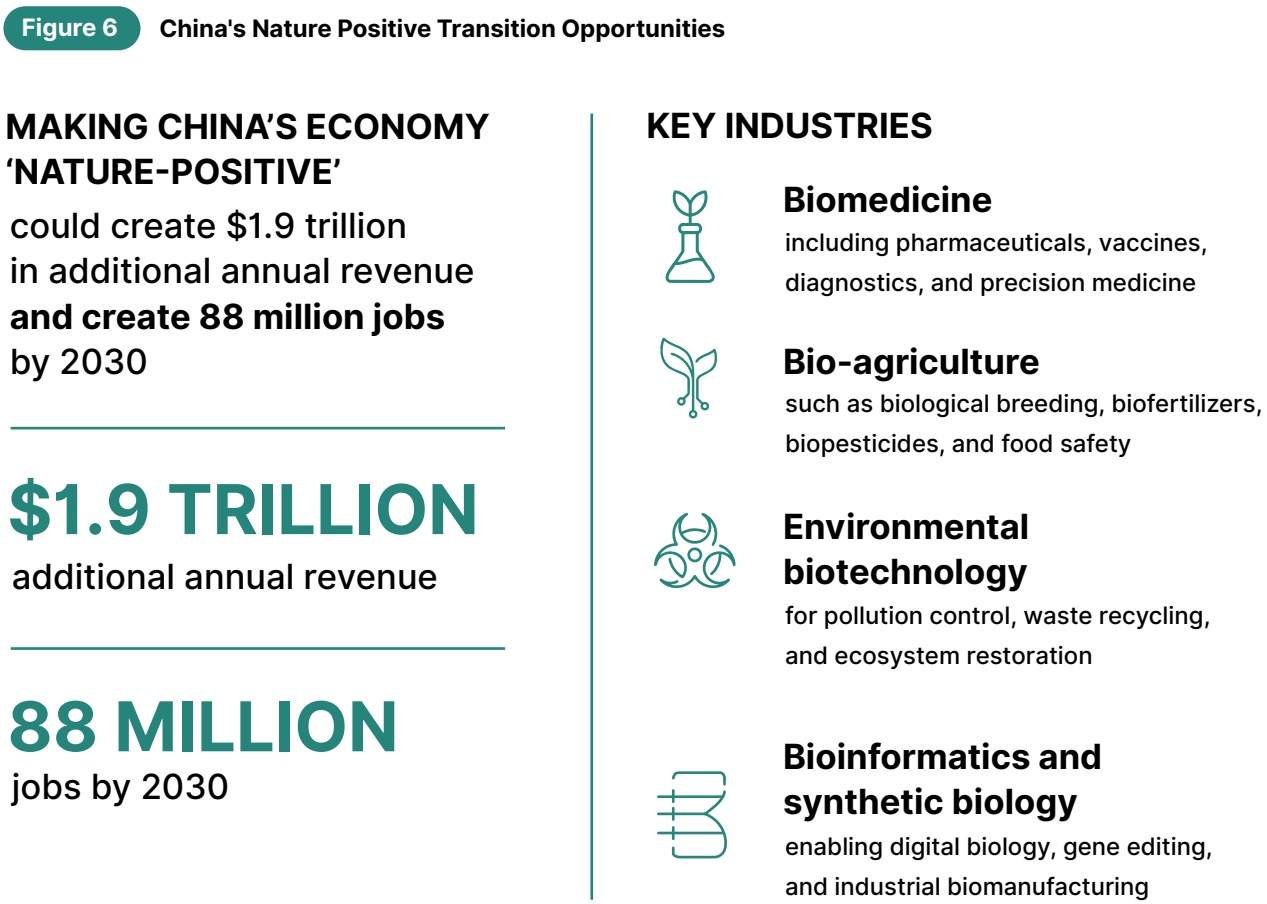
Over 50 nations,[27] including Eswatini, Namibia, the East Africa Community, the European Union, the United States, China, India, and South Africa, have sustainable strategies based on the bioeconomy, reflecting the global recognition of its strategic importance with the European Union leading in bioeconomy policy coordination and implementation. Deployment of regional bioeconomy strategies has accelerated following the launch of the revised EU Bioeconomy strategy in 2018, with countries like the UK, Germany, Finland, France, Kenya and Sweden developing comprehensive national frameworks and sector strategies that integrate environmental sustainability with economic development.

**The United States has historically maintained technological leadership through substantial federal investments in biotechnology research and development, robust venture capital ecosystems, and supportive regulatory frameworks for innovation. While robust venture capital ecosystems and supportive regulatory frameworks remain, the strategic direction for federal biotechnology investments is currently in transition.** Though there is growing competition[28] from other players like the EU and China, presently, American bioeconomy strength lies particularly in biopharmaceuticals, agricultural biotechnology, and emerging synthetic biology applications.

**China, on the other hand is rapidly emerging as a major bioeconomy player, leveraging large-scale manufacturing capabilities, government-directed investments, and growing domestic markets.** China's bioeconomy development focuses on biomanufacturing, traditional medicine modernization, and agricultural biotechnology applications. Other significant players include the **UK in biotechnology in life sciences,[29] India in biopharmaceuticals production, Brazil in biofuels and agricultural biotechnology, Canada in forestry-based bioeconomy, South Africa[30] in health, agriculture, bio-based chemicals, biomaterials and bioenergy and the environment, and Japan in high-value biotechnology applications.** While bioeconomy development is uneven across AU member states, there is growing interest in regional strategies, **particularly in sustainable agriculture, biodiversity-based innovation, and bioenergy.**

The bioeconomy is far broader than is typically recognised including blue economy initiatives, bio-based construction materials, nature credits, regenerative agriculture, and sustainable textiles. This implies there is much more significant untapped potential across diverse sectors and geographies.

**Figure 6** China's Nature Positive Transition Opportunities




The bioeconomy represents a significant economic opportunity that is already generating substantial value for early adopters yet remains largely untapped globally. Although over 50 nations have developed bioeconomy strategies whether regionally or nationally, **these vary dramatically in scope and ambition, from conservation-focused approaches in developing economies to commercialisation-driven frameworks in more industrialised nations.** This diversity in strategic approaches reflects both the bioeconomy's adaptability to different national contexts and the nascent stage of global development. With the field extending far beyond traditional biotechnology into areas like blue economy initiatives, bio-based materials, and nature credits, most countries are only beginning to recognize the full transformative potential of this economic paradigm. This early-stage recognition presents both an opportunity for strategic positioning and a risk of being left behind as the bioeconomy accelerates globally.

# Trade and Cooperation Imperatives

The economic significance of the bioeconomy shift is already evident in current trade patterns.[31] **Biodiversity-based trade represents a substantial share of global commerce,** with significant variations across countries reflecting different resource endowments, processing capabilities, and market positioning strategies.

**Figure 7** 2023 Share of biodiversity-based trade to global trade

## BIODIVERSITY-BASED TRADE AT A GLANCE - 2023

**17.16%**
of total global trade

**$3.68 TRILLION**
Trade Value

**7.02%**
Share of Global GDP

## AREAS OF HIGH POTENTIAL

- Aviation
- Biochemicals
- Bio-based textiles
- Bio-contruction materials
- Bio-based textiles

**Figure 8** Overview of biodiversity-based products in select countries

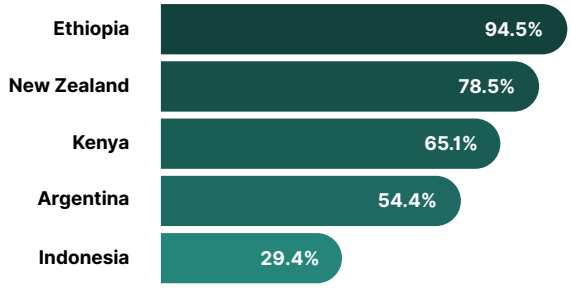
## TOP EXPORTERS OF BIODIVERSITY-BASED PRODUCTS

**US$318 BILLION**
USA

**US$304 BILLION**
China

**US$288 BILLION**
Germany

## SHARE OF BIODIVERSITY-BASED PRODUCTS IN TOTAL




## TRADE IN BIODIVERSITY-BASED PRODUCTS AS % GDP

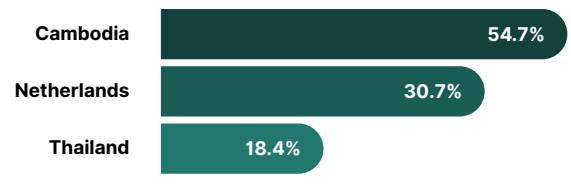


**Figure 9** Overview of G20 Bioeconomy (2023)

# G20 BIOECONOMY TRADE OVERVIEW

### OVERVIEW

**15.7%** of total trade

**US$2.04** trillion (51% of GDP)

### CURRENT SECTORS

Agricultural commodities
Forestry products
Traditional biofuels

### EMERGING SECTORS

Bio-based chemicals • Advanced materials

### BIGGEST BIOECONOMY GROWTH SEGMENTS

Bio-based chemicals and materials
**US$142 BILLION**

Agricultural biotechnology
**US$45 BILLION**

### G20 COUNTRIES WITH HIGHEST SHARE OF BIOTRADE TO TOTAL EXPORTS

Argentina 54.4%
Canada 49.5%
Indonesia 29.4%

### PROJECTED GORWTH IN BIOFUELS (GLOBAL DEMAND)

2023 — +30% — 2028

### LEADERS IN BIOFUELS TRADE

USA • BRAZIL • EUROPE • SOUTHEAST ASIA

### PRODUCTS AND COUNTRIES LEADING

FOOD AND BEVERAGES
EUROPEAN UNION
PHARMACEUTICALS
CHINA, INDIA, BRAZIL
CROP PROTECTION

### G20 COUNTRIES WITH HIGHEST SHARE OF BIOTRADE TO GDP

Italy 14.2%
Germany 12.3%
France 11.1%

Given this substantial economic footprint, **trade and industrial policy become critical levers for economic growth and regional integration.** While market size limitations and resource distribution asymmetries create scaling challenges that often require international engagement, **the bioeconomy also serves as a powerful regional development and national resilience strategy, particularly for food sovereignty and climate resilience, mitigation and adaptation.**

Successful bioeconomy development calls for multi-scale value chain approaches that combine regional cooperation for resource sharing with national capacity building for strategic sectors like food security and renewable energy. **Innovation cycles in bioeconomy sectors are capital-intensive and time-consuming, often requiring 10-15 years from research to commercial application.** This makes international market access essential to spread development costs across larger customer bases and justify these extended development timelines.

Strategic regional and international partnerships serve as critical mechanisms for accelerating bioeconomy development through technology transfer and knowledge sharing. **Technology transfer partnerships are already demonstrating impact. Examples include collaboration between Sweden and Kenya and the UK and Kenya involving bioeconomy R&D collaboration, and the EU's Test Farms programme[32] that links agricultural startups with farmers and testing-land.** These partnerships enable rapid diffusion of innovations across borders while reducing global development timelines and costs.

**Joint research initiatives pool international expertise and resources,** tackling complex challenges that exceed individual countries' capabilities. These collaborations leverage complementary strengths where developed countries provide advanced biotechnology capabilities and established regulatory frameworks, while developing nations offer abundant biomass resources, lower production costs, and growing domestic markets.

Knowledge sharing mechanisms, including technical assistance programs, capacity building initiatives, and regulatory harmonization efforts, further help to standardize bioeconomy practices internationally. **This standardization reduces market entry barriers, facilitates trade, and ensures safety and sustainability standards are maintained across global supply chains.** To emphasise, regional supply chain development discussed in detail below, is a key lever to advancing sustainable bioeconomy growth and cooperation.

## Critical Importance of Regional and Global Supply Chains for Bio-based Products

**Bio-based products often require sophisticated global supply chains** that integrate agricultural production, biotechnology processing, specialized logistics, and end-market distribution. However, complexity varies significantly across the bioeconomy spectrum. While regenerative agriculture or aquaculture products may have relatively straightforward supply chains, complexity increases substantially as greater value addition occurs through biotechnology processing, pharmaceutical applications, or advanced bio-manufacturing processes. These supply chains involving living systems, time-sensitive materials, and stringent quality control requirements and can be more complex than traditional manufacturing. **Supply chain resilience therefore becomes critical for bioeconomy success, as disruptions can compromise product quality, safety, and availability.**

**Regional supply chain development offers critical advantages for bioeconomy growth,** particularly in contexts like Africa where maximizing local value addition from abundant biomass resources can drive economic development and increase resilience to global trade disruptions. The optimal approach could emphasise building production and processing capacity within regions, even when end consumers are global, to capture maximum value addition locally.

**This requires robust regional trade collaboration,** enabling countries with substantial biomass resources but limited processing infrastructure to partner with more technologically advanced regional neighbours that possess the refining and manufacturing capabilities. Global supply chains and technology transfer also play important roles, enabling bioeconomy companies to source optimal raw materials, access specialized processing capabilities, and reach diverse end markets efficiently.

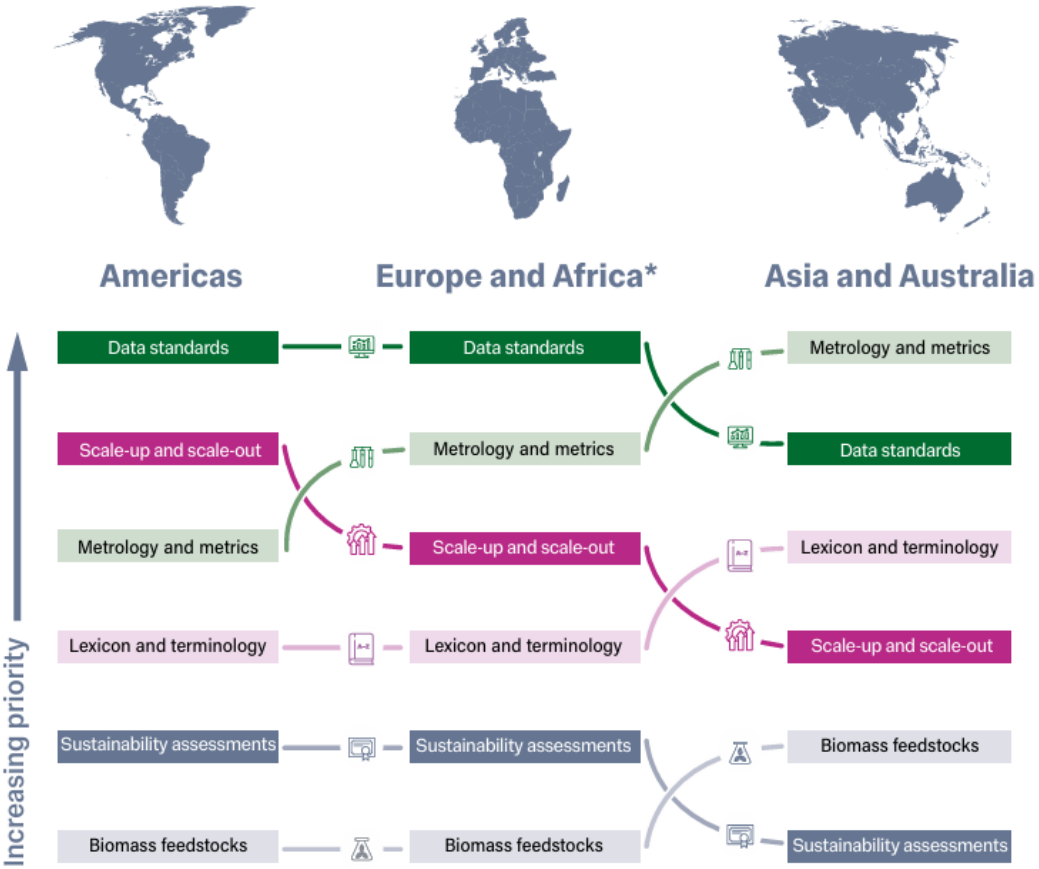
**Regional integration provides additional resilience by reducing dependence on distant suppliers and creating redundant supply pathways.** The integration of digital technologies, blockchain tracking, and international standards can enable transparent, traceable supply chains that meet increasingly stringent sustainability and safety requirements demanded by consumers and regulators worldwide while supporting both regional value addition and global market participation.

## Sustainability Data, Standards and Metrics

**Traceability and supply chain transparency requirements are expanding rapidly, driven by consumer demands and regulatory requirements.** However, different countries and regions are implementing varying traceability standards, data requirements, and verification processes. **These differences not only constrain both investment flows and legitimate trade development, but they also create compliance challenges for global supply chains and may favour vertically integrated companies over smaller, specialized producers.**

According to the World Economic Forum, although the worldwide bioeconomy is booming, there still exists a need to establish technical standards and metrics to enable continued innovation and scale-up of the sector.[33] This metrics challenge represents both a significant barrier and a strategic opportunity that requires inclusive collaboration across member states and leveraging of existing initiatives. There are ongoing efforts to address this challenge. The joint Task Force on Engineering Biology Metrics and Technical Standards for the Global Bioeconomy[34] has convened several regional engagements to identify specific areas for development, both technical and non-technical towards continued scale-up.[35]

**Priority order of key areas recommended for standards and metric development**




Key technical areas are displayed as ranked by region, with highest priority areas at the top. This ranking is the result of responses to a survey inviting all workshop participants to identify the priority order as they see relevant to their region. Priority could be resultant from a combination of factors, such as the need for standardization coupled with technology readiness. Lower ranking may not therefore imply lesser importance.
* No African stakeholders were able to attend the workshop in person; views discussed were those of European stakeholders only. For consistency throughout the report, the workshop continues to be referred to as "Europe and Africa".

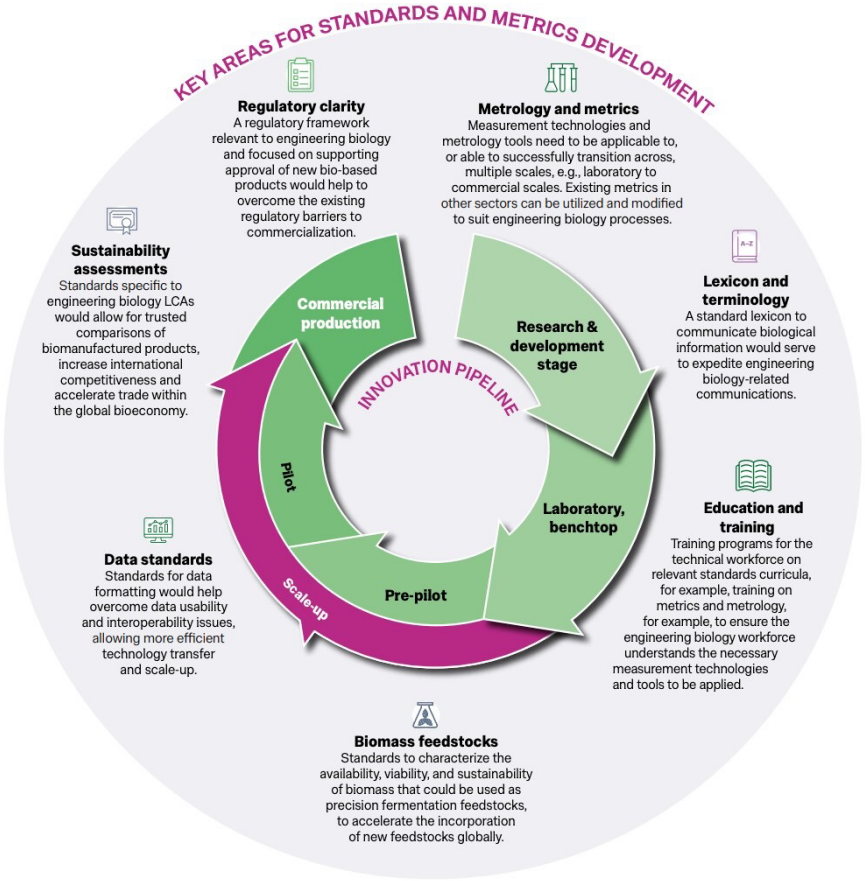
**Source:** Imperial College London
https://www.imperial.ac.uk/media/imperial-college/medicine/infectious-disease/Standards-and-metrics-for-the-bioeconomy_EMBARGO-until-070524.pdf

The experience of leading bioeconomy nations demonstrates that meaningful measurement requires intentional collaboration between government agencies, private sector players, research institutions, and communities, particularly in terms of what can be distinguished as sustainable. **South Africa's and Germany's approaches to realizing bioeconomy potential illustrate this collaborative imperative. Without inclusive approaches across member states, fragmented data emerges that fails to capture the bioeconomy's true territorial impact and, crucially, fails to attract the investment needed for scale.**

Science-based metrics further serve as critical infrastructure for legitimate bioeconomy trade and investment, but only when developed collaboratively and where possible, built upon existing frameworks. **Through initiatives like the Bioeconomy Finance Hub being co-developed by NatureFinance, The African Natural Capital Alliance and FSD Africa,** robust metrics frameworks are emerging not just as measurement tools but as investment enablers that must be inclusive and collaborative to succeed.

**The opportunity lies in positioning data and metrics as competitive advantages that truly unlock legitimate bioeconomy trade and investment across all member states, regardless of their current capacity levels.** The way towards a sustainable, competitive and fair bioeconomy lies in enhanced coordination and cooperation across stakeholders in developing metrics and standards.

**Figure 11** **Enabling Bioeconomy Scale-up Across Value Chains**




**Source:** The World Economic Forum

**The integration of sustainability metrics into bioeconomy development must serve both measurement and mobilisation of capital in ways that are inclusive, collaborative, and leverage existing frameworks.** Success requires moving beyond fragmented national approaches toward coordinated international standards that enable transparent, comparable assessment of bioeconomy activities while supporting legitimate trade and investment flows across all participating nations.

# Trade Flows and Market Access

NATURE FINANCE

G20 SOUTH AFRICA 2025

# Identification of High-Potential Product Categories for Export Growth

**The bioeconomy encompasses key sectors of global significance for decarbonization and climate action that offer broad export potential.** However, specific high-potential product categories vary considerably for different countries based on their unique characteristics, resource endowments, technological capabilities, and market positioning. While certain bioeconomy product categories demonstrate exceptional export growth potential based on market dynamics, technological readiness, and global demand trends, **successful export strategies must align with national comparative advantages.** Advanced biofuels, including sustainable aviation fuels and marine biofuels, represent the highest-growth potential category, driven by international decarbonization commitments and sectoral regulations. The International Maritime Organization's carbon intensity reduction requirements and aviation industry net-zero targets create substantial market opportunities for countries capable of producing certified sustainable fuels.

**The EU's CBAM,[36] which began its transitional phase in October 2023 and will be fully implemented by 2026, further amplifies these opportunities by creating competitive advantages for low-carbon bio-based alternatives over high-carbon conventional products.** CBAM covers sectors including cement, iron and steel, aluminium, fertilizers, electricity, and hydrogen, with potential expansion to other carbon-intensive sectors, creating significant market incentives for bioeconomy producers who can demonstrate lower carbon footprints through verified sustainability credentials.[36]

**Bio-based chemicals and polymers offer significant export potential,** particularly for countries with competitive feedstock access and processing capabilities. Specialty chemicals, including bio-based solvents, surfactants, and polymer additives, command premium prices and face growing demand from industries seeking sustainable alternatives. The global shift toward circular economy principles and plastic waste reduction creates expanding markets for bio-based polymer alternatives for bioplastics and other applications from packaging, at industrial and retail levels, as well as across pharma- and nutraceuticals.

**Biotechnology products, including enzymes, probiotics, and bioactive compounds, represent high-value export opportunities with strong intellectual property protections.** These products serve diverse end markets including food and beverages, pharmaceuticals, cosmetics, and industrial applications. Countries with strong research capabilities and regulatory frameworks can develop competitive advantages in these knowledge-intensive sectors.

**Agricultural biotechnology and precision agriculture technologies also offers substantial economic potential, particularly for developing countries seeking to enhance food security and agricultural productivity.** Digital agriculture platforms, biotechnology-enhanced seeds, and sustainable crop protection products address global challenges while creating valuable export opportunities for more technologically advanced countries.

The transition from traditional agricultural models to bioeconomy applications, however, **faces significant challenges, as illustrated by South Africa's sugar industry. This sector could serve as a prime candidate to supply petrochemical alternatives through biorefinery development, but is still experiencing bottlenecks in shifting from traditional business model and competing with cheaper alternatives - especially fossil fuel.** This transition imperative underscores that realising bioeconomy potential requires a holistic set of government interventions, including but not limited to trade policy, encompassing regulatory frameworks, investment incentives, and infrastructure development.

# Regulatory and Standards Landscape

## Divergent National Standards Creating Trade Barriers

The absence of harmonized international standards for bio-based products creates significant trade barriers that impede market access and increase compliance costs for exporters. National regulatory frameworks often reflect domestic priorities, technological capabilities, and political considerations rather than internationally agreed standards. These divergences create complex compliance requirements that disproportionately burden smaller companies and developing country exporters.

Bioplastics regulations exemplify these challenges, with different countries applying varying definitions, testing requirements, and certification processes. The European Union currently has no sustainability criteria that apply to bio-based plastics, while having harmonized standards for industrially compostable packaging and specific agricultural applications.[38] Palm oil-based bioplastics illustrate this challenge.[39] Bio-based palm oil production has been and continues to be a major driver of deforestation of some of the world's most biodiverse forests. The manufacturing of bioplastics also involves energy-intensive processes, which contribute to greenhouse gas emissions and environmental pollution.[40] Meanwhile, the United States employs different testing protocols and labelling requirements including in some cases at state level, creating parallel compliance systems that increase market entry costs and complexity.

Safety and environmental standards present additional harmonization challenges, particularly for novel bio-based products with limited regulatory precedents. Countries often apply precautionary principles differently, resulting in varying approval timelines and requirements. Biowaste processing regulations vary dramatically across jurisdictions—some countries classify certain organic waste streams as hazardous materials requiring extensive treatment protocols, while others permit direct agricultural application, creating compliance complexity for companies operating across borders. These inconsistencies create regulatory arbitrage opportunities where companies may relocate production or research activities to more favourable regulatory environments, distorting global trade patterns and investment flows.

Food safety regulations for biotechnology products demonstrate particularly complex harmonisation challenges. Different countries apply varying approaches to genetically modified organisms, novel food ingredients, and biotechnology-derived additives. Indigenous medicinal plants provide an example. South Africa has recently banned the commercial sale of hemp-based food and cosmetic products, citing concerns around safety, environmental pollution, and regulatory inconsistencies.[41] However, it is simultaneously formalising the practice of traditional healing through national registration systems. China on the other hand has developed comprehensive regulatory frameworks that enable sustainable commercialisation of traditional medicine while ensuring safety and sustainability standards.[42] These differences create substantial trade barriers, with some countries prohibiting imports of products approved in other jurisdictions, fragmenting global markets and increasing consumer confusion.

## Certification and Sustainability Requirements Across Markets

**Sustainability certification requirements are becoming increasingly important trade determinants, but lack of mutual recognition creates significant market access barriers.** Multiple certification schemes operate in parallel, each with different standards, testing requirements, and verification processes. Companies seeking global market access must often obtain multiple certifications which often increases costs and complexity while potentially creating conflicting requirements.

Biodegradable materials require compliance with specific international standards,[43] along with biodegradability and ecotoxicity requirements. **However, these standards are not universally recognized, with some countries maintaining additional or alternative requirements. This fragmentation creates uncertainty for producers and increases compliance costs, particularly for smaller companies with limited regulatory expertise.** Climate change compounds the complexity of biodegradable material performance. As global temperatures exceed 1.5°C warming thresholds, the efficacy of bio-based products becomes increasingly unpredictable—biofuels demonstrate reduced efficiency under elevated temperatures, while bioplastics may experience altered decomposition timelines in changing soil and marine environments, potentially undermining their intended environmental benefits.

**Carbon footprint and lifecycle assessment (LCA) requirements are becoming standard for many bioeconomy products, but methodological differences create trade complications.** While international standards[44] and specific guidelines in the bioplastics sector exist,[45] heterogeneity in LCA approaches and assumptions persist. These methodological differences can result in products receiving different sustainability ratings depending on the assessment framework used, creating potential trade disputes and market confusion.

The proliferation of distinct regulatory frameworks compounds these challenges. The EU Deforestation Regulation (EUDR),[46] which applies to seven key commodities including cattle, cocoa, coffee, oil palm, rubber, soya and wood requires companies to prove their supply chains are deforestation-free through specific due diligence processes. Meanwhile, the CBAM demands carbon intensity calculations for imports of cement, iron, steel, aluminium, fertilizers, electricity, and hydrogen. The EU Green Taxonomy establishes its own technical screening criteria for sustainable activities, while the UK is developing a parallel Nature Taxonomy with different biodiversity metrics and disclosure requirements.

**Countries need to work towards developing mutual recognition agreements for LCA methodologies, creating standardized databases for emission factors and impact assessments, and establishing a global digital platform for sharing verified sustainability data, but most critically, ensuring emissions and nature-related metrics and standards are harmonised together, not in silos.** Most immediately, the G20 and multilateral trade organisations should facilitate pilot programs that demonstrate interoperability between existing frameworks for instance, beginning with high-trade-volume commodities covered by EUDR, while incentivizing convergence through preferential trade arrangements for countries adopting harmonized standards. Additionally, capacity-building initiatives must support developing countries in implementing these standards, ensuring that sustainability requirements enhance rather than hinder equitable global trade.

## Intellectual Property Considerations in Biotechnology Transfer

**Intellectual property frameworks significantly influence bioeconomy trade patterns, particularly for high-value biotechnology products and processes.** Patent protections vary considerably across jurisdictions, creating complex landscapes for technology transfer and trade. Developing countries often face challenges accessing patented biotechnology innovations, while developed countries aim to safeguard their research investments and maintain competitive advantages.

Biotechnology patents present unique challenges due to their technical complexity, broad potential applications, and long development timelines. The resulting patent thickets, where multiple overlapping patents cover related technologies, can create barriers to innovation and trade. These complexities are particularly challenging for developing countries with limited patent examination capabilities and legal expertise.

Traditional knowledge and genetic resource rights create additional intellectual property complications for bioeconomy trade. Many bio-based products derive from genetic resources or traditional knowledge originating in developing countries, raising questions about benefit-sharing and access rights. International frameworks like the Nagoya Protocol attempt to address these issues, but implementation remains inconsistent and contentious.

**Technology transfer mechanisms, including licensing agreements, joint ventures, and collaborative research arrangements, are critical for bioeconomy development but face significant intellectual property challenges.** Developing countries often lack the technical capacity to absorb and implement advanced biotechnology, while developed countries may hesitate to transfer sensitive technologies without adequate intellectual property protections.

The WHO's mRNA Technology Transfer Programme demonstrates how strategic multilateral coordination can overcome these barriers. The programme, centred at Afrigen in South Africa with partners including Biovac and the South African Medical Research Council (SAMRC), has successfully transferred mRNA vaccine technology to 15 manufacturing partners across middle-income countries.[47] The initiative has transferred knowledge to facilities in countries including Bangladesh, Serbia, Brazil, and Argentina, proving that with dedicated support, intellectual property sharing, and capacity-building investments, developing countries can rapidly absorb and implement sophisticated biotechnologies.

The emergence of Digital Sequence Information (DSI) frameworks[48] also represents a significant development in bioeconomy traceability infrastructure, directly addressing many of the challenges outlined above. As negotiations advance under the UNCBD, DSI systems are being designed with the ambition to create standardised mechanisms for tracking genetic resources and associated traditional knowledge throughout global value chains. This infrastructure aims to establish transparent benefit-sharing arrangements while providing the digital backbone for compliance with access and benefit-sharing obligations.

However, the implementation of DSI frameworks faces substantial technical and governance challenges, including the need for interoperable databases, standardised sequence identification protocols, and mechanisms for tracking commercialization across complex multi-jurisdictional supply chains. The success of DSI infrastructure will largely depend on achieving consensus on technical standards and ensuring that developing countries, which are often the primary sources of genetic resources, have the technological capacity to participate meaningfully in these digital systems. This creates both an opportunity to address current traceability gaps and a risk of further marginalizing countries with limited digital infrastructure capabilities.

## Technology Transfer as High-Value Trade - The WHO mRNA Technology Transfer Programme

Technology transfer represents one of the highest-value forms of international trade, yet it remains underutilized in bioeconomy strategies. The WHO mRNA Technology Transfer Programme demonstrates how strategic knowledge sharing can simultaneously build industrial capacity, enhance global health security, and create new economic opportunities for developing nations.

Launched in 2021 during the COVID-19 pandemic, the WHO mRNA Technology Transfer Programme aims to build resilience and strengthen local vaccine research, development and manufacturing capacity in different regions of the world, especially those areas that could not access COVID-19 vaccines in a timely way. The first technology transfer was completed in September 2024 to Biovac, with 3 additional partners receiving technology in 2024. The programme facilitates that countries and partners participating acquire know-how for mRNA vaccines production, helping LMICs establish mRNA manufacturing locally with comprehensive services including technical expertise, regulatory support, and manufacturing guidance.

The mRNA programme's approach offers a template for technology transfer in other bioeconomy sectors:

• For Digital Sequence Information (DSI): Currently, debates around DSI focus on benefit-sharing mechanisms such as a percentage of profits from commercial products or a 1% levy on retail value of DSI-reliant products. DSI is key to scientific advancement and technological innovation in medicine, food security, green energy production, and biodiversity conservation. Technology transfer hubs could help developing countries build capacity to utilize their own genetic resources rather than simply providing raw biological material.

• For Coalitions of the Willing: Countries with rich biodiversity could form technology transfer consortiums, like the mRNA hub model, to:

- Develop in-country biotechnology capacity
- Process genetic resources locally rather than exporting raw materials
- Capture value-added manufacturing and R&D activities
- Build South-South technology partnerships

Technology transfer creates reciprocal value: recipient countries gain industrial capacity and technological sovereignty, while source countries/organizations maintain engagement in growing markets and build long-term partnerships. Recent breakthroughs in DSI benefit-sharing at CBD COP16 demonstrate growing international recognition of the need to share benefits from using nature's genetic information. This model could transform how developing countries participate in the bioeconomy - from raw material exporters to technology-enabled value-added producers, creating jobs, building capabilities, and retaining more economic benefits domestically.

The mRNA Technology Transfer Programme shows that strategic knowledge sharing, supported by appropriate international frameworks, can democratize access to high-value technologies while creating sustainable economic opportunities for all participants.

# Infrastructure and Logistics Challenges and Opportunities

## Cold Chain and Specialized Transport Requirements

**Bio-based products, like other new industries, often require specialized logistics infrastructure that differs significantly from traditional manufacturing and agricultural supply chains.** Temperature-sensitive products, including many biotechnology products, vaccines, and biological materials, require sophisticated cold chain management throughout the entire supply chain. These requirements create substantial infrastructure investments and operational complexities that can limit market access for countries with inadequate logistics capabilities.

Investments in cold chain infrastructure requirements can vary significantly across bioeconomy sectors. Pharmaceutical biotechnology products may require ultra-low temperature storage and transport, while agricultural biotechnology products might need standard refrigeration. However, these infrastructure investments can be foundational for a number of industries from agriculture to health industries, creating efficiencies and support for existing and new industries. These investments will also position those early movers and early market movers, especially in the context of a rapidly warming world.

To this point, there are some geographic precedents that demonstrate rapid scalability across multiple sectors and regions. Agricultural bioeconomy investments reveal significant potential. In India, the Ministry of Food Processing Industries estimates that a significant portion of food loss is due to inadequate cold chain infrastructure.[49] To address this, the government has fully exempted central excise duty for cold storage installations and allows 100% FDI with a minimum investment of US$100 million, spurring private sector engagement.

Similarly, Chile has developed a cold chain system for exporting fresh fruit to China, including sensor-based verification systems for in-transit cold treatment. This system helps meet phytosanitary requirements and reduces customs delays. Additionally, the Chilean Ministry of Agriculture and ODEPA (Oficina de Estudios y Políticas Agrarias) have coordinated with Chinese authorities to expand the cold treatment verification system to all Chinese ports. This initiative is part of Chile's broader strategy to streamline agricultural exports and improve logistics efficiency.[50]

Specialised transport requirements extend beyond temperature control to include contamination prevention, regulatory compliance, and traceability systems. Bio-based products may require dedicated transport equipment, specialized handling procedures, and extensive documentation. These requirements could create barriers for smaller logistics providers and may limit service availability in developing countries or remote regions.

International transport regulations for bio-based products involve multiple regulatory frameworks, including dangerous goods regulations, customs requirements, and health and safety standards. These regulations vary by country and product category, creating complex compliance requirements that require specialised expertise and may limit shipping options or increase costs.

**Multilateral and regional development banks (MDBs and PDBs) represent critical but underutilised instruments for addressing these infrastructure gaps.** MDB leaders have agreed to deepen collaboration to encourage private sector investment in vital infrastructure needed to support sustainable and inclusive economic growth, yet cold chain infrastructure remains marginal in most of their portfolios. **Given their expertise in cross-border infrastructure financing, climate adaptation investments, and resilience building, MDBs and PDBs should prioritise specialised logistics infrastructure** as essential climate-resilient development infrastructure. This aligns with their broader mandates and addresses a critical barrier to bioeconomy market access and global supply chain resilience.

## Port Facilities and Processing Capabilities

Port infrastructure plays a critical role in bioeconomy trade, but many facilities lack the specialized capabilities required for bio-based products. Temperature-controlled storage, contamination prevention systems, and rapid customs clearance procedures are essential for many bioeconomy products but are not available at all ports. This infrastructure gap limits shipping options and may create supply chain bottlenecks.

**Processing capabilities at ports and logistics hubs can provide significant competitive advantages for bioeconomy trade.**[51] Value-added processing, including packaging, labelling, quality testing, and regulatory compliance verification, can be performed at logistics facilities to reduce costs and improve market access. The Netherlands and Singapore are showing leadership in this space with the countries recently signing a Cooperation Agreement to further strengthen their efforts on the Rotterdam-Singapore Green and Digital Shipping Corridor.[52]

However, these capabilities require substantial investments and specialised expertise that may not be available in all locations. Mombasa (Kenya), East Africa's largest port handling significant agricultural exports, has strong potential to become a regional bioeconomy hub, especially for agricultural biotechnology. However, realizing this potential requires substantial investment in cold storage facilities, accredited quality testing laboratories, and regulatory compliance infrastructure. Similarly, other major emerging market ports - South Africa's Durban (Africa's busiest container port), Brazil's Santos (Latin America's largest port), and India's Mumbai/JNPT (handling 70% of India's containerized cargo) - possess the scale and regional connectivity to serve as bioeconomy processing hubs but would need targeted investments in specialized processing facilities, certification capabilities, and regulatory infrastructure to fully capitalize on bioeconomy trade opportunities.

Customs and regulatory procedures at ports present additional challenges for bioeconomy trade. **Many bio-based products require specialised inspections, documentation, and clearance procedures that standard customs facilities may not be equipped to handle.** Delays in customs clearance can be particularly problematic for time-sensitive products, potentially compromising product quality or market access.

Port security and biosecurity requirements are increasingly important for bioeconomy trade, particularly for products containing living organisms or genetic materials. These requirements may involve specialized screening procedures, documentation requirements, and facility certifications that create additional costs and complexity for exporters and logistics providers.

## Digital Infrastructure for Traceability and Compliance

Digital infrastructure is becoming essential for bioeconomy trade, enabling traceability, compliance verification, and supply chain management. Blockchain technology, Internet of Things sensors, and digital documentation systems provide capabilities for tracking products throughout global supply chains, verifying sustainability claims, and ensuring regulatory compliance. However, digital infrastructure requirements create challenges for countries and companies with limited technological capabilities.

Traceability systems for bioeconomy products must track complex information including raw material sources, processing methods, transportation conditions, and regulatory compliance. These systems require standardized data formats, interoperable platforms, and secure data sharing mechanisms. The lack of international standards for bioeconomy traceability creates challenges for global supply chain integration and may limit market access for companies unable to meet varying requirements.

Compliance verification systems increasingly rely on digital platforms to manage regulatory requirements, certification processes, and documentation. These systems require sophisticated data management capabilities and integration with multiple regulatory frameworks. Countries and companies with limited digital infrastructure may face challenges accessing global markets that require digital compliance verification. Data sovereignty and privacy concerns create additional challenges for digital bioeconomy infrastructure. Different countries have varying requirements for data storage, processing, and sharing that may conflict with global supply chain needs. These regulatory differences can create compliance challenges and may limit the effectiveness of international traceability and compliance systems.

These challenges call for coordinated multilateral action across several dimensions. G20 member countries could consider establishing a minimum viable standard that developing countries can implement cost-effectively, with pathways for enhancement as capacity grows. This graduated system would ensure basic compliance capabilities are universally accessible while allowing for advanced features in more developed markets.

**MDBs should also prioritise digital infrastructure for bioeconomy compliance as a development imperative,** creating dedicated funding mechanisms for blockchain platforms, IoT sensor networks, and digital documentation systems through regional digital infrastructure hubs serving multiple countries. **Innovative public-private partnership models should be established where technology providers partner with public institutions to build and maintain digital infrastructure, with costs shared based on usage and benefits realized, ensuring sustainability while respecting data sovereignty through, for instance, federated database systems that enable global verification while maintaining national control over sensitive information.**

# Financing Infrastructure and Innovation for Bioeconomy Trade

## Bridging Critical Financing Gaps

The development of bioeconomy trade infrastructure and capabilities requires significant capital investment across multiple scales and stages. **Unlike traditional trade sectors, bioeconomy development demands simultaneous investment in research infrastructure, manufacturing capacity, supply chain networks, and regulatory systems. This complexity creates both financing challenges and untapped investment opportunities across multiple asset classes and investor types.** According to NatureFinance report on financing 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.[53]

The bioeconomy innovation pipeline requires patient capital for basic research, proof-of-concept studies, and technology development. Most developers of bio-based solutions often face the "valley of death", the gap between pilot projects and commercialisation. More than this, bioeconomy industries are often disrupting existing well subsided and established fossil fuel incumbents, which are cheaper and easier to produce and embedded in existing supply chains and market structures. Overcoming this structural barrier will require the coordinated efforts taken in growing renewable markets – requiring intentional government and industrial policy, incentives and enabling environments to allow nascent industries to compete and grow with well-established industries.

**Interventions must address intersecting challenges that compound financing difficulties.** Technology and capability gaps in emerging economies limit local participation in high-value bioeconomy segments, forcing countries to remain in low-value commodity production. Preferential tax and subsidy regimes for incumbent fossil fuel industries distort investment signals, making bioeconomy alternatives appear less competitive than they would under neutral policy conditions. Regulatory uncertainty around novel bio-based products increases perceived investment risks, deterring risk-averse institutional investors from participating. Meanwhile, limited track records for bioeconomy projects complicate risk assessment for traditional lenders, who lack historical data to evaluate project viability and returns.

These financing constraints have profound implications for **economic transformation and job creation.** Countries that cannot bridge the valley of death remain trapped in low-value commodity production, exporting raw biological materials rather than developing value-added manufacturing capabilities. This perpetuates economic dependence and limits opportunities for dignified, high-skilled employment in emerging bioeconomy sectors. The role development finance can play in developing new industries, particularly in the bioeconomy with IPLCs is evidenced by efforts by the Inter-American Development Bank's Amazon Bioeconomy Fund.[54]

## Diversified Financing Architecture for Bioeconomy Trade

A diversified financing architecture is essential to unlock the full potential of bioeconomy trade. This framework integrates public finance, blended finance, private sector investment, and innovative mechanisms to support infrastructure development and value chain expansion across bioeconomy sectors.

### 1. Public Finance and Development Banks

**Multilateral Development Banks (MDBs)** represent the most scalable financing mechanism for bioeconomy infrastructure. The World Bank's recent commitment to increase climate financing to 45% of its portfolio creates opportunities for bioeconomy project integration. Similarly, regional development banks can leverage their local knowledge and risk appetite to support bioeconomy industrialization. Key investment opportunities include:

- **Biorefinery infrastructure** connecting agricultural regions to processing facilities
- **Cold chain and logistics networks** for bio-based products with limited shelf life
- **Shared manufacturing facilities** serving multiple bioeconomy enterprises
- **Research and testing infrastructure** supporting product certification and quality assurance

**National development finance institutions** can also provide patient capital for domestic bioeconomy development, particularly in middle-income countries where commercial financing gaps are most acute. Countries like Brazil, India, and South Africa have successfully used development banks to support biofuels industrialization.

### 2. Blended Finance and Risk Mitigation

**Blended finance mechanisms are powerful tools for unlocking private sector investment in the bioeconomy. By addressing specific risk factors that deter commercial lenders, blended finance can significantly increase the flow of capital.** The OECD estimates that properly structured blended finance can mobilize three to four dollars of private investment for every dollar of public funding.

Effective risk mitigation strategies include first-loss guarantees for bioeconomy project financing, especially for novel technologies that lack a proven track record. Currency hedging facilities can protect investors from exchange rate volatility in emerging markets, while regulatory insurance can safeguard projects against policy changes that threaten their viability. Offtake agreements, which provide revenue certainty for bioeconomy producers, are another critical tool for de-risking investments. Climate finance mechanisms such as the Green Climate Fund are increasingly recognizing bioeconomy projects as eligible investments. This creates new opportunities for countries to access concessional financing for bioeconomy infrastructure development, particularly in sectors with strong climate mitigation and adaptation benefits.

**3. Private Sector Investment Vehicles**

Institutional investors are showing growing interest in bioeconomy sectors, driven by ESG mandates and the need for portfolio diversification. Pension funds, sovereign wealth funds, and insurance companies collectively manage over $100 trillion in assets, and are increasingly allocating capital to sustainable infrastructure and natural climate solutions. Investment opportunities span the entire bioeconomy value chain. In primary production, sustainable forestry and agroforestry operations generate certified biomass, while algae cultivation facilities produce high-value compounds and biofuels. Waste-to-resource processing facilities convert agricultural residues into valuable inputs, and marine biotechnology operations develop products derived from ocean resources.

In processing and manufacturing, integrated biorefineries produce multiple products from single feedstock streams, while fermentation facilities generate bio-based chemicals, pharmaceuticals, and materials. Advanced materials manufacturing uses bio-based inputs, and food technology facilities develop alternative proteins and functional ingredients.

Digital and service infrastructure also presents significant investment potential. Platforms for sustainability certification and traceability, biotechnology research and testing facilities, supply chain management systems, and carbon accounting technologies all support the growth and efficiency of bioeconomy enterprises. Corporate venture capital from established companies such as Unilever, Nestlé, and BASF provides not only financing but also market access for bioeconomy innovations. These firms have launched dedicated investment programs to support the development and commercialisation of bio-based products and technologies.

**4. Innovative Financing Mechanisms**

Innovative financing mechanisms offer additional revenue streams and incentives for bioeconomy projects. Carbon markets, for example, can enhance project returns for sustainable agroforestry for example by 10 to 20 percent through the sale of high-quality carbon credits. The voluntary carbon market reached $2 billion in 2023, with growing demand for nature-based and bioeconomy solutions that deliver measurable climate benefits. Payment for ecosystem services (PES) mechanisms can also finance bioeconomy infrastructure that generates environmental co-benefits. Costa Rica's forest conservation program, which is funded through fuel taxes, demonstrates how countries can create sustainable financing models that support both bioeconomy development and environmental objectives. Supply chain finance is another promising avenue. By providing working capital to producers and buyers, it can accelerate bioeconomy trade. Increasingly, large corporations offer preferential financing terms to suppliers who meet sustainability criteria, enabling bioeconomy enterprises to access cheaper capital and scale their operations more effectively.

Overall, the bioeconomy represents a multi-trillion dollar investment opportunity that remains largely untapped by mainstream financial markets. Countries that successfully bridge the valley of death between demonstration and commercial scale and provide the necessary policy enabling environment and incentives will capture disproportionate economic benefits, including high-value manufacturing, dignified employment, and export competitiveness.

# Market Access Restrictions

## Tariff and Non-tariff Barriers Specific to Bio-products

Bioeconomy products face complex tariff structures that often disadvantage bio-based alternatives compared to conventional products. A critical structural issue has emerged where bio-based products are typically bundled with their fossil fuel counterparts (such as bioplastics with plastics, or biofuels with fossil fuels) in trade classifications and regulations. This bundling means that bio-based products are penalised by restrictions and regulations designed for conventional products but do not benefit from the advantages that traditional industries receive, such as subsidies and industry body support structures.

Tariff escalation further discourages developing economies from exporting value-added goods, hindering industrialisation by applying higher tariffs on finished goods than on raw materials or intermediate inputs. This practice particularly affects bioeconomy exporters seeking to develop value-added bio-based products rather than simply exporting raw biomass.

Classification issues create additional tariff complications for bio-based products. Novel bio-based materials may not fit established tariff categories, leading to classification disputes that create uncertainty and potential for discriminatory treatment, such as bioplastics being classified and regulated in the same category as fossil-fuel based plastics. Customs authorities' limited familiarity with bioeconomy products can result in inappropriate classifications that impose higher tariffs than intended or create trade delays while classification issues are resolved.

Non-tariff barriers present even greater challenges for bioeconomy trade. Technical barriers to trade, including product standards, testing requirements, and certification procedures, often discriminate against bio-based alternatives through bias toward established conventional, synthetic or fossil-fuel products. Safety and environmental regulations, for example border regulations around seed, plant and food, may impose higher standards on bio-based products while grandfathering existing conventional alternatives, creating systematic disadvantages for sustainable alternatives.

Phytosanitary and sanitary measures create challenges for bioeconomy products that incorporate biological materials or organisms. These measures, while legitimate for protecting human, animal, and plant health, can be applied in discriminatory ways that favour domestic products or create unnecessary barriers to trade. The complexity of bioeconomy supply chains, which may involve multiple countries and processing steps, compounds these challenges by requiring compliance with multiple regulatory frameworks.

## Protectionist Policies Favouring Traditional Industries

Government policies often systematically favour traditional industries through subsidies, tax preferences, and regulatory frameworks developed over decades to support “conventional” sectors that are often more environmentally harmful than bio-based alternatives and where systemic shifts are urgently needed. These embedded advantages create competitive disadvantages for bioeconomy alternatives that lack equivalent support systems. The structural problem of bio-based products being bundled with conventional alternatives means they face the regulatory burdens of traditional industries without accessing the same subsidies and support mechanisms that make conventional products artificially competitive.

Fossil fuel subsidies, for example, artificially reduce the costs of petroleum-based products, making bio-based alternatives less competitive despite their environmental benefits. Industrial policy frameworks frequently prioritise existing industries over emerging sectors, directing government support toward established companies and technologies rather than innovative bioeconomy alternatives. These policies may include preferential lending, research and development support, infrastructure investments, and workforce development programs that systematically exclude or under weigh bioeconomy sectors.

To level the playing field, governments can adopt strategic industrial policies that include:

1. **Green public procurement to create demand for bio-based products**
2. **Tax incentives for sustainable inputs and production methods**
3. **Dedicated R&D funding for bioeconomy innovation**
4. **Inclusion of bio-based sectors in national industrial strategies**

This is particularly exemplified by industries in crisis due to their catastrophic environmental and human health impact, such as fossil fuel based plastics, where a range of bio-based alternatives now exist but cannot compete on price or economies of scale given decades of industry lobbying, subsidies and supply chain control, preventing a level playing field for new bioplastics industries.

Trade policy mechanisms often reflect these domestic biases, with countries maintaining higher trade barriers for products that compete with protected domestic industries. Agricultural policies may favour traditional crops and production methods over bioeconomy applications, limiting domestic feedstock development and creating trade barriers for bio-based imports. Many protectionist approaches limit countries' ability to reduce dependency on costly and environmentally destructive inputs like synthetic fertilizers and proprietary seeds. Transitioning to biofertilizers and regenerative agriculture requires upfront investment but can enhance resilience, sovereignty, and farmer incomes. Farmers can benefit not only from food production but also from biomass sales, carbon credits, and exploit ecosystem service markets.

Political economy factors reinforce these protectionist tendencies, as established industries typically have greater political influence and lobbying capabilities than emerging bioeconomy sectors. Traditional industries' economic significance, employment levels, and political connections enable them to maintain favourable policies even when bioeconomy alternatives offer superior environmental or economic benefits.

## Limited Access to Government Procurement Markets

Government procurement markets represent substantial opportunities for bioeconomy products, particularly in countries with strong public sector purchasing power and sustainability mandates. However, bioeconomy companies often face systematic barriers to accessing these markets due to procurement procedures designed for conventional products and suppliers.

Overcoming Procurement Barriers: Successful examples from other sectors showing how procurement reform can unlock market access for emerging industries include:

- Feed-in tariffs in the renewable energy sector guaranteed long-term purchase prices for clean electricity, enabling early-stage technologies to scale despite higher initial costs.
- The U.S. Inflation Reduction Act (IRA) includes provisions for federal procurement of electric vehicles and clean technologies, creating guaranteed demand and market certainty for sustainable alternatives.

Procurement specifications frequently lean towards established products and suppliers through requirements that inadvertently exclude bioeconomy alternatives. Technical specifications may reference conventional materials or performance standards that bio-based products cannot meet, even when alternative specifications would provide equivalent or superior performance. Qualification requirements may favour large, established companies with extensive track records over innovative bioeconomy startups.

Price-focused procurement approaches often disadvantage bioeconomy products that may have higher upfront costs but provide lifecycle benefits through durability, environmental performance, or reduced maintenance requirements. Government procurement systems often lack mechanisms for evaluating total cost of ownership or environmental benefits, systematically favouring lowest-bid conventional alternatives, limiting the benefits of trade liberalisation for sustainable alternatives.

## Limited Financing Mechanisms for Bioeconomy Ventures

Bioeconomy ventures often face unique financing challenges that limit their ability to scale operations and access international markets. The sector's long development timelines, regulatory uncertainties, and novel technologies create risk profiles that traditional financing sources may not understand or accept.

Venture capital and private equity investors may lack expertise in bioeconomy sectors, leading to systematic and uninformed underinvestment in promising technologies and companies. The sector's technical complexity and regulatory requirements can deter investors who prefer more familiar technology sectors with established market dynamics and shorter commercialization timelines.

The bioeconomy further continues to be plagued by the premium burden. Banking systems often lack appropriate financial products for bioeconomy ventures, particularly in developing countries where financial markets may be less sophisticated. Traditional lending criteria may not accommodate bioeconomy projects' unique characteristics, including long payback periods, biological risks, and regulatory uncertainties.

International development finance institutions and multilateral banks have historically focused on traditional sectors and may lack specialised expertise or appropriate financing instruments for bioeconomy projects. While some institutions are developing bioeconomy financing capabilities, gaps remain in available financing options, particularly for mid-stage companies seeking growth capital. Similarly, export credit agencies and trade finance institutions may also lack appropriate products for bioeconomy trade, particularly for innovative products with limited trade history or uncertain regulatory status. These financing gaps can limit companies' ability to access international markets and scale their operations globally.

# Capacity and Knowledge Constraints

## Technology Gaps Between Developed and Developing Nations

The bioeconomy is a hugely under-valued potential contributor to climate mitigation, adaptation and increasing resilience. It can provide bio-based sustainable alternatives to carbon-intensive products, drive regenerative agricultural practices and create circular forest and agricultural economies that help extend soil health and productivity, and prevent deforestation and land conversion. It can also support scientific developments and products such as synthetic biology, genomics and bioinformatics, as well as encompass service-based activities such as tourism and gastronomy. The larger and more sustainably it develops, the more the bioeconomy benefits nature, climate, and inclusive and resilient socio-economic development.

Bio-based goods are often the only viable alternative to greenhouse gas-intensive products in many sectors. In a context where global supply chains must be massively and urgently decarbonised to support a resilient and liveable planet, the bioeconomy transition carries both inevitability and unprecedented opportunity. **The bioeconomy can contribute up to one-third of the emissions reductions needed to limit global warming to 1.5°C,** while simultaneously delivering adaptation and resilience benefits through nature-based solutions that strengthen ecosystem services and community livelihoods.[55] **For emerging and developing countries, this offers an opportunity to leapfrog and develop industries and economies fit for the future.**

**Significant technological disparities between developed and developing countries create structural barriers to bioeconomy trade expansion.** Advanced bioeconomy technologies, such as synthetic biology, precision fermentation, and sophisticated biorefining processes, require substantial research and development investments, specialized equipment, and technical expertise that are concentrated in developed countries. For example, precision fermentation used in producing alternative proteins (like lab-grown dairy or meat) is advancing rapidly in the U.S. and Europe, while many developing countries lack the bioreactors, skilled personnel, and regulatory frameworks to adopt these technologies.[56] Similarly, bioplastics production in Southeast Asia is often limited to raw feedstock supply (e.g., cassava or sugarcane), while value-added processing occurs in developed countries, reinforcing dependency dynamics.[57]

**These technology gaps create dependency relationships where developing countries serve primarily as raw material suppliers while developed countries capture value-added processing and manufacturing activities.** This pattern perpetuates economic inequalities and limits developing countries' ability to participate fully in global bioeconomy value chains, reducing overall trade potential and economic benefits.

**Intellectual property barriers compound these technology gaps by limiting developing countries' access to patented bioeconomy innovations.** Patent protection systems may restrict technology transfer and licensing arrangements, particularly for breakthrough technologies with significant commercial potential. For instance, patents on CRISPR-based gene editing or proprietary microbial strains used in fermentation can restrict licensing and delay technology diffusion, especially where legal and technical IP capacity is limited.[58] These restrictions can delay technology diffusion and limit developing countries' ability to build domestic bioeconomy capabilities.

Infrastructure deficits in developing countries create additional constraints on technology adoption and bioeconomy development. Advanced bioeconomy technologies often require specialised infrastructure, including reliable electricity, sophisticated laboratories, cold storage facilities, and digital connectivity, that may be limited in developing countries. In many sub-Saharan African countries, for example, cold storage capacity is less than 10% of demand, limiting the viability of temperature-sensitive bio-based products.[59] Similarly, limited broadband access in rural areas hinders the deployment of digital bioeconomy platforms, such as blockchain-based traceability or AI-driven crop optimization. These infrastructure gaps increase the costs and complexity of technology transfer while limiting operational effectiveness.

## Technical Expertise Development

**The bioeconomy's multidisciplinary nature requires expertise spanning biotechnology, engineering, environmental science, regulatory affairs, and business development, often at scale and with the ability to coordinate and work together.** Developing this combination of skills, able to collaborate toward scaling the bioeconomy requires intentional interministerial coordination, as well as an industrial policy aligned with other national policies, including trade, development, bioeconomy and circular economy policies. This can range from educational system reform to accommodate interdisciplinary programs; professional development opportunities for bioeconomy expertise and regulatory expertise.

# Leveraging Trade and Trade-related Policy Measures to Promote a Sustainable Bioeconomy

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# Market Access Restrictions

The challenges hereto outlined not withstanding, trade as a bridge between policy, regulation and markets, can be used innovatively and effectively to lever and grow the bioeconomy at national, regional and international levels. Governments attempting to promote the sustainable bioeconomy have a range of trade and trade-related policy measures at their disposal. These can be broadly organized under two categories, namely **measures encouraging production and trade aligned with a sustainable bioeconomy and measures designed to discourage production and trade preventing the transition to a sustainable bioeconomy.** Under the first approach, trade and trade-related policy tools can be harnessed to provide positive incentives to shift production and consumption towards more sustainable pattern as evidenced by Canada's Greener Homes Initiative.[60]

The second category focuses on **removing perverse incentives that encourage unsustainable practices or applying market-correcting measures to internalize some of the negative environmental and social externalities associated with the production and trade of goods.** The measures themselves can take several forms including (i) **price and market-based measures,** (ii) **support measures and other economic incentives** (iii) **regulatory measures of a voluntary or mandatory nature.** Using this typology originally developed by the WTO's environment database, the following sections provide a short description of these different measures. Table 12 below shows illustrative examples under each category.

A critical challenge remains, however, in the integration of these trade measures with the broader architecture of nature and climate transition finance and policy. Despite the proliferation of Nationally Determined Contributions (NDCs), National Biodiversity Strategies and Action Plans (NBSAPs), country platforms for green investment, and green taxonomies designed to channel climate finance, remarkably little coordination exists between these frameworks and bioeconomy trade measures. This disconnect represents a significant opportunity that can still be exploited. **NBSAPs and NDCs typically focus on domestic mitigation and adaptation strategies with limited consideration of how trade policy can accelerate bioeconomy transitions,** while green taxonomies (such as the EU Taxonomy Regulation or emerging frameworks in Asia) establish sustainability criteria that could be harmonized with trade measures to create coherent market signals.

Similarly, country platforms established under initiatives like the Just Energy Transition Partnerships (JETPs) concentrate on energy sector transformation with minimal attention to how bioeconomy trade policies could support broader decarbonisation goals. **For example,biocement can be a huge driver of decarbonisation in the construction sector, a major emissions offender, but biocement requires renewable energy to be sustainable.** Countries with abundant biomass and infrastructure capacity to potentially support biocement or biosteel production could integrate these opportunities into their JETPs, creating synergies between renewable energy development and bio-based industrial applications. This fragmentation undermines the effectiveness of both nature and climate finance mechanisms and trade measures, as they operate in parallel rather than reinforcing each other toward common sustainability objectives. **Integrating these frameworks would create more powerful incentives for sustainable bioeconomy development while ensuring that trade measures align with national climate commitments and international finance flows.**

# Price and Market-based Measures

Price and market-based measures include border measures such as import or export quotas and tariffs, trade remedies such as safeguard measures or anti-dumping duties, and also internal taxes applicable to both imported and domestically produced goods. Measures such as border carbon adjustments designed to prevent carbon leakage also fall under this category.

Overall, the use of tariff barriers applied exclusively to imported products to internalize environmental or social costs remains highly controversial under the multilateral trade rule setting, if equivalent taxes are not applied to domestic producers. In this respect, a less discriminatory approach would be to impose an internal tax to both imported and domestic goods that do not comply with certain environmental requirements. As illustrated by recent initiatives to impose border carbon adjustments, price and market-based instrument can also charge an amount on imports based on their embedded carbon emission that is equivalent to the one paid by domestic producers under national or regional Emissions Trading Schemes (ETS).

Border measures can also be used to restrict trade in products having negative environmental or health effects in the consuming country such as certain chemicals or pesticides. To the extent that import restrictions are implemented in conjunction with restrictions on domestic production or consumption, such measures would generally not violate international trade laws. Alternatively, governments can provide more favourable market access concessions on products complying with specific sustainability requirements by reducing import tariffs or granting tariff preferences to products that have a sustainability certification. For example, the Swiss-Indonesian Comprehensive Economic Partnership Agreement (CEPA),[61] which entered into force in 2021, provides for reduced tariffs on sustainably produced Indonesian palm oil by 40% within a fixed quota.

## Support Measures and Other Economic Incentives

Perhaps the most obvious and well documented approach is to remove perverse economic incentives, such as environmentally harmful subsidies. After hitting record levels of more than $ 1 trillion in 2022, governments continued to heavily subsidies the use of fossil fuels, in 2023 **spending $620 billion, an amount significantly above the $70 billion that was spent on support for consumer-facing clean energy investments.**[62] Such support contributes to lowering prices, increasing consumption and making fossil fuels artificially more competitive compared to alternatives such as renewables. According to the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report, removing fossil fuel subsidies could reduce GHG emissions by up to 10% by 2030 while improving public revenue and macroeconomic performance.

While reforming fossil fuel subsidies is a critical enabler for scaling sustainable trade and unlocking the full potential of the bioeconomy, such reforms must be carefully designed to avoid adverse distributional impact on the most economically vulnerable groups.[63] In fossil fuel-dependent economies, subsidy removal can disproportionately affect energy-poor households and communities reliant on extractive industries, triggering political resistance and undermining public support for climate-aligned trade reforms. To ensure political feasibility and social equity, G20 members should consider redistributing revenue saved from subsidy reform toward targeted support for vulnerable populations and sectors. This may include direct cash transfers, energy access programs, or transition support for workers in fossil fuel-intensive regions. For developing economies with significant oil and gas reserves, subsidy reform must be framed not as a loss of economic assets, but as a strategic reallocation toward future-proof industries such as bio-based manufacturing, regenerative agriculture, and sustainable transport where trade competitiveness can be enhanced.

Integrating these just transition measures into broader bioeconomy trade strategies will help mitigate resistance, build coalitions for reform, and ensure that the shift toward sustainable trade is inclusive, equitable, and politically durable.

**Given the historic challenges in directly dislodging harmful subsidies, another pragmatic approach could involve initially making sustainable products eligible for equivalent or enhanced subsidies rather than eliminating existing support for conventional alternatives,** noting the transitionary nature of removing these existing subsidies. This subsidies for good in the presence of subsidies for bad strategy has proven transformative in renewable energy. For example, feed-in tariffs and production tax credits helped scale solar and wind energy without removing fossil fuel support. In 2023, the EU allocated €354 billion in energy subsidies, with a growing share directed toward renewables, energy efficiency, and clean hydrogen, while still maintaining some fossil fuel support.[64] In addition, the Modernisation Fund, financed through the EU Emissions Trading System (ETS), supports investments in renewable energy, energy storage, and clean mobility infrastructure in 13 lower-income EU member states.[65] Similarly, the United States' Inflation Reduction Act (IRA) of 2022 represents the largest climate investment in US history, allocating approximately $370 billion in clean energy incentives and tax credits over ten years, while existing fossil fuel subsidies largely remain in place. However, as of 2025, the IRA faces implementation challenges.

Similarly, out of the almost $540 billion spent annually on net support to individual agricultural producers in 88 countries, between 2013 and 2018, the FAO, UNDP and UNEP estimate that two-thirds can be considered price distorting and potentially harmful to the environment.[66] Such support measures remain highly concentrated among a handful of large countries and mostly benefit temperate products.[67] In this context, there has been growing calls for reforming or repurposing them towards additional and more sustainable practices. This may include payments for ecosystem services or direct payments to maintain a diversified set of crops, conserve permanent grassland, or devote a share of arable land to ecological practices. For example, the Costa Rican Forestry Law introduced in 1996, includes a Payment for Ecosystem Services (PES) Program, to promote forest and biodiversity conservation funded through a carbon tax on fossil fuels, creating a direct link between carbon pricing and forest conservation.[68]

**According to the World Bank and IFPRI, repurposing a portion of government spending on agriculture each year from subsidies to investment in developing and disseminating green innovations or technologies for crops and livestock that are both productivity-enhancing and emissions-efficient could reduce overall emissions from agriculture by more than 40%.[69]** Meanwhile, millions of hectares of land could be restored to natural habitats. Redirecting about $70 billion a year—equivalent to 1% of global agricultural output—would also yield a net benefit of over $2 trillion in 20 years.[70]

Other types of economic incentives can be provided through government procurement rules encouraging public purchases of sustainably produced products or limiting purchases of goods with high environmental footprints. For example, China, the United States, Korea, Finland, Japan, Thailand, the European Union, Brazil, Ecuador, and Argentina have already established sustainable public procurement programmes, sometimes combined with the use of ecolabelling schemes, which have contributed to fostering sustainable consumption and production.[71] Government can also encourage innovation or the diffusion of environmentally sound technologies through intellectual property rights, for example by fast tracking the granting of patents on environmentally sound technologies or encouraging technology transfer through favourable licensing arrangements with third countries. This is the case of the 'Green Channel' scheme of the UK Intellectual Property Office (UKIPO), which allows the examination of patent applications relating to environmentally friendly inventions to be accelerated.[72]

Finally, governments can use export credit agencies (ECA) as a tool to foster a sustainable and nature positive bioeconomy. Such agencies play a significant role in global energy financing, providing guarantees and loans that help de-risk large infrastructure projects, including both fossil fuel and renewable energy developments. There's a growing movement to phase out public finance for fossil fuel projects and shift resources towards renewable energy. For example, Export Finance for Future (E3F), an initiative launched by seven countries at ministerial level in April 2021, aims to align public export finance with climate goals by increasing support for sustainable and climate-friendly projects and accelerate the progressive phasing out of fossil-fuel related projects.[73]

# Regulatory measures

A third type of instruments relates to regulatory measures in the form of technical regulations, standards or conformity assessment procedures imposing specific environmental requirements on producers. Examples include both product related requirements such as food safety standards (e.g., maximum pesticides residue limits) and production related requirements, for example on the use of nutrients or airborne pollutants, wildlife and habitats protection, or animal welfare prescriptions. An example of such regulatory measures is the South Korea's Act on the Sustainable Use of Timbers. The regulation, which applies to both domestic and imported timber and timber products aims to promote the trade of legally harvested timber. Other examples include mandatory due diligence requirements such as the EUDR, changes to the United Kingdom's Environment Act and proposed regulations for the use of forest risk commodities (FRC) in commercial activities in the UK.

However, from the recent South Africa – EU example, it should be noted that while some of these measures open up some opportunities for the bioeconomy, they **have also become a source of tension in low- and middle-income countries who worry that these approaches unfairly place the burden of transition to a post carbon and a nature positive economy on poor nature-rich commodity exporting countries that lack affordable access to relevant technologies and finance, or do not have the fiscal space and resources to support large-scale economic transformation.**

Beyond mandatory requirements, regulatory measures, encouraging sustainable production and trade can also be achieved using voluntary sustainability initiatives promoting different social and environmental objectives. These usually include a range of sustainability requirements pursued through standards or codes of conduct, but also mechanisms to ensure compliance, and capacity-building and supporting services to producers such as training or impact monitoring.[74] The ITC standards map identifies more than 350 voluntary sustainability standards (VSS).[75]

While some are developed by governments or international organizations, the majority emerged from the private sector and civil society. In the context of highly fragmented international supply chains, VSS help firms meet their social and environmental goals, either to avoid reputational damage or gain marketing advantages. They also increasingly fill a regulatory vacuum left by the inability of governmental initiatives to regulate on sustainability issues. Although voluntary in nature, these schemes can sometimes become de facto conditions to access certain segments of the markets. They are also increasingly integrated into various government policy instruments, including due diligence regulations, FTAs, public procurement policies, or export promotion strategies as way to demonstrate compliance with governments requirements.[76] For example, Mexico and Ecuador recognise VSSs within their national public procurement strategies to verify the sustainability of forest products.[77]

However, VSS is not without challenges. While VSS can enable producers to receive higher prices, administrative costs associated with certification, compliance or conformity assessment procedures can be prohibitive and exclude producers in developing countries, especially smallholders. **Many voluntary standards lack scientific rigor, allow selective compliance, and enable companies to claim sustainability credentials while continuing harmful practices elsewhere in their operations.** The voluntary nature means that participation is often driven more by marketing considerations than genuine environmental commitment, leading to 'greenwashing' rather than substantive change. Furthermore, the proliferation of competing standards creates confusion and allows companies to 'shop' for the least demanding certifications

**Voluntary carbon markets have long been criticised as an example of a failed VSS mechanism because of inconsistent methodologies, questionable credit quality, and limited environmental integrity.** Significant reforms are however underway, largely through the Integrity Council for the Voluntary Carbon Market (ICVCM) which has introduced Core Carbon Principles (CCPs), a global benchmark for high-integrity carbon credits.[78] Countries including the US, UK, and Singapore have endorsed the CCPs, integrating them into emerging regulatory frameworks.[79]

There is also a shortage of accredited auditors or conformity assessment facilities in most developing countries, which increases the costs of audits and certification.[80] Finally, it is often difficult for producers to distinguish reliable, credible, or effective VSS from ineffective ones.[81] Some initiatives are underway to help reduce private standards fragmentation, ensure that they are based on sound science, and are non-discriminatory and interoperable. These include, for example, the WTO TBT Agreement Code of Good Practice. The International Organization for Standardization (ISO) has also developed ‘meta-standards’ in areas such as transparency and accountability. The non-governmental International Social and Environmental Accreditation and Labelling (ISEAL) Alliance also codifies best practice for the design and implementation of social and environmental standards initiatives an provides a globally recognised framework, defining practices for effective and credible sustainability systems.[82]

**Figure 12** **Preliminary Mapping of Trade and Trade Related Tools for a Sustainable Bioeconomy**

| Typology of trade policy instruments and examples | | Encouraging/incentivizing production and trade aligned with a sustainable bioeconomy | Discouraging production and trade *not* aligned with a sustainable bioeconomy |
|---|---|---|---|
| **Market-based measures** | Import/export quotas | • Removing trade barriers on the import/export of nature positive and sustainable bio-based goods, services & technologies<br>• Conditioning or providing market access concessions to comply with sustainability requirements (e.g., using tariff rate quotas or trade preferences) | • Import/export restrictions on goods, services and technologies undermining the sustainable bioeconomy or GBF<br>• Import/export bans on harmful pesticides and hazardous chemicals |
| | Import/export duties & tariffs | | |
| | Trade remedies including anti-dumping, countervailing duties, safeguards | • Prohibiting the use of trade remedies on nature positive/sustainably produced bio-based goods | |
| | Internal taxes | | • Taxes internalising negative environmental externalities in production |
| | Border tax adjustments & other market instruments | | • Applying measures to prevent ileakage (e.g., border adjustment measures) |
| **Support measures & other economic incentives** | Subsidies including:<br>• Grants and direct payments<br>• Income or price support<br>• Loans & financing support<br>• Tax concessions<br>• Non-monetary support | • Environmental payments or payments for ecosystem services<br>• Subsidies, grants and tax incentives for bio-based innovation, research and development | • Removing subsidies to the production, transformation, and/or consumption of fossil fuels<br>• Removing subsidies encouraging the production, consumption or trade in goods, services and technologies undermining the sustainable bioeconomy |
| | Government procurement | • Green government procurement rules encouraging public purchase of sustainable bio-based or nature-positive products and services | • Green government procurement rules limiting public purchases of goods, services and technologies undermining the sustainable bioeconomy |
| | Intellectual property rights | • Fast tracking the granting of patents on technologies and innovation for sustainable bioeconomy products<br>• Technology transfer & licensing agreements fostering the diffusion of sustainable bio-based technologies | |
| | Investment and investment facilitation | • Facilitate investment in sustainable bioeconomy sectors/projects | • Discourage investment that undermines sustainable bioeconomy |
| | Export credit/guarantees | • Facilitate the granting of export credit/guarantee and trade financing for sustainable bio-based products | • Removing export credit, guarantees and financing provided to fossil fuel or carbon-intensive trade and investment |
| **Regulatory requirements** | Bans/prohibitions | | • Import/export bans or licensing requirements on goods, services and technologies undermining the sustainable bioeconomy |
| | Import/export licensing | | |
| | • Technical regulations<br>• Standards<br>• Conformity assessment procedures<br>• Risk assessment<br>• Labelling//transparency requirements | • Mandatory environmental requirements, compliance with which assures market access or a green premium<br>• Voluntary sustainability standards developed by governments and/or non state actors (including labelling, transparency, traceability schemes) | • Mandatory environmental requirements/targets (e.g., airborne pollutants, wildlife and habitats protection, animal welfare, energy efficiency).<br>• Mandatory due diligence (e.g. deforestation free supply chains, CSR), labelling or transparency requirements that aim to discourage or restrict trade in cases of non-compliance |

**Note:** This overview does not aim to depict the relative relevance, merits, or scale of potential impacts of the various trade policy instruments

TESS Forum on Trade, Environment, & the SDGs

# Strategic Opportunities Through Regional and International Cooperation

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Many of the measures highlighted in this policy brief can, for the most part, be pursued autonomously however, **their effectiveness would be significantly enhanced through coordinated international action.** While some bioeconomy trade measures may comply with existing World Trade Organization (WTO) laws when designed as good faith environmental policies that do not discriminate arbitrarily between countries where the same conditions prevail, this applies to only a small minority of cases. More importantly, **without coordination, countries risk creating a patchwork of unaligned policies that may conflict or dilute global impact.**

**The GIB represents a critical emerging framework for addressing these coordination challenges.** Building on the High Level Principles developed during Brazil's presidency, the GIB recognises trade facilitation as a core priority for 2025, with ongoing discussions focusing on issues such as harmonised standards, mutual recognition frameworks, and preferential trading arrangements for bio-based products. **The GIB's emphasis on operationalising concrete implementation mechanisms including through trade positions it as the primary vehicle for coordinating G20 bioeconomy trade policy development,** offering a dedicated platform that other international initiatives currently lack.

**Cooperative approaches can also avoid the free rider problem and alleviate concerns of loss of competitiveness** because of autonomous reforms. This is particularly the case of measures aimed at r**emoving perverse incentives such as environmentally harmful subsidies or fostering trade in biodiversity-based products. In a similar vein, ensuring that environmental regulations, standards, or conformity assessment procedures are applied in a way that ensures interoperability across jurisdictions** (e.g., through harmonization, equivalences, or mutual recognition) and minimise trade frictions will send a strong coherent signal to exporters. More broadly, in a globalized world economy dominated by highly integrated supply chains, **addressing transboundary environmental challenges such as climate change, biodiversity loss, or pollution increasingly requires coherent policy approaches across jurisdictions.**

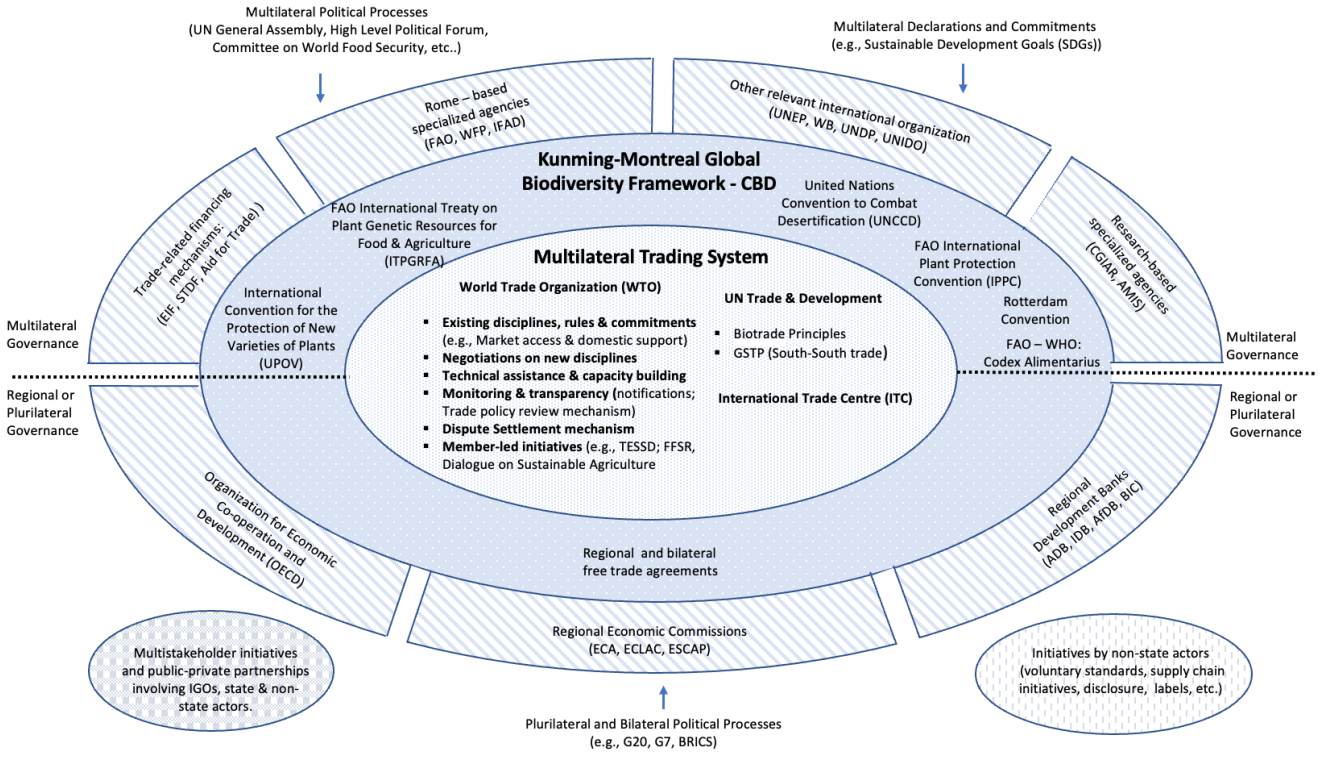
Some of the most promising immediate pathways include **utilising the G20 Global Infrastructure and Investment (GII) framework to prioritise bioeconomy infrastructure projects that create regional value chains and trade corridors.** The OECD's trade and environment initiatives also provide established mechanisms for developing harmonized standards and mutual recognition agreements that can be immediately applied to bioeconomy products. **Regional frameworks like the African Continental Free Trade Area (AfCFTA) and the EU-Africa trade partnership further offer concrete opportunities to embed bioeconomy provisions in existing trade negotiations, technology transfer and joint investment in bioeconomy sectors.**

At the higher political level, cooperation on trade and the sustainable bioeconomy is informed by a range of declarations and commitments, including the 2030 Sustainable Development Goals (SDGs) and the Kunming Montreal Global Biodiversity Framework. Other international political processes such as the G20 also contribute to giving broad political guidance. These high-level commitments and declarations are then advanced and operationalized through a range of international or regional institutions with relevance to and influence over trade such as regional banks, economic commissions, specialized UN agencies, bilateral and regional trade agreements and dedicated financing mechanism. Simultaneously, members should focus on **retrofitting existing trade agreements and regional partnerships with bioeconomy provisions that create binding commitments for market access, technology transfer, and sustainable supply chain development.** Multi-stakeholder initiatives including public-private partnerships, or sectoral initiatives involving IGOs, governments and non-state actors also provide critical venues for cooperation. A detailed brief into international corporation pathways is further discussed below:

# Multilateral Framework Development

In practice, there is no single forum to discuss cooperation on trade and the bioeconomy. Figure 2 provides a broad overview of international processes relevant to such nexus. At the heart of the global trade system are the WTO, UN Trade and Development (UNCTAD) and the International Trade Centre (ITC). These institutions provide a forum for transparency, rulemaking and dispute settlement. They also provide a multilateral space to raise specific trade concerns, share experiences and good practices, and address potential trade frictions in a pre-emptive, non-litigious, and cooperative manner. Institutions such as the WTO, UNCTAD and ITC also play a critical role in generating analysis and data as well as technical assistance and capacity building.

**Figure 13** **Preliminary mapping of international processes relevant to trade and the sustainable bioeconomy**




**Source:** TESS' elaboration

**Note:** This mapping is intended to be illustrative not comprehensive and does not aim to depict the relative relevance or influence of the various processes and institutions.

## Strengthening WTO Provisions for Environmental Goods and Services

The World Trade Organization's Environmental Goods Agreement (EGA)[83] negotiations which collapsed in 2016[84] could still provide a crucial foundation for bioeconomy development. Eighteen participants representing 46 WTO members engaged in negotiations sought to eliminate tariffs on environment-related products, including those that generate clean and renewable energy, improve energy and resource efficiency, control air pollution, manage waste, treat wastewater, and monitor environmental quality.[85] The product list included renewable and clean energy technologies, water and waste treatment products, air pollution control technologies, and environmental monitoring and assessment equipment, with lower tariffs expected to lead to lower prices that can help support emerging green industries (World Bank, 2024).

While the WTO remains the cornerstone of the multilateral trading system, **current negotiations on key issues including dispute settlement reform, agricultural trade, and environmental goods face complex challenges are stuck for an indefinite period.** This context, **creates opportunities for complementary approaches to advance bioeconomy trade through regional frameworks, bilateral agreements, and initiatives like the G20's GIB.** Rather than waiting for comprehensive multilateral solutions, **G20 members can demonstrate leadership by developing innovative trade mechanisms that align with WTO principles while creating momentum for broader international adoption.**

That said, incremental progress is still possible. The WTO's Committee on Trade and Environment (CTE) continues to provide a platform for dialogue. In addition, the WTO, the Secretariat of the Convention on Biological Diversity (CBD), the Food and Agriculture Organization (FAO), UN Trade and Development (UNCTAD), do recognise the bioeconomy potential through the "Trade for Bioeconomy" initiative, which explores pathways to promoting sustainable and inclusive bioeconomy development through trade policy action. The WTO's fifth Trade and Environment Week in October 2024 featured a high-level event on "Trade for Clean Energy Transition for All," demonstrating growing institutional commitment to environmental trade facilitation.[86] Ultimately, while the WTO remains a critical institution for global trade governance, advancing the bioeconomy will require a multi-track strategy that includes but is not limited to WTO reform. Countries should simultaneously pursue plurilateral or regional agreements focused on environmental goods and services or embed bioeconomy-related provisions into bilateral trade deals.

## Regional Trade Agreement Provisions Supporting Bioeconomy

Regional trade agreements offer more flexible frameworks and pragmatic pathways in the near to medium term for advancing bioeconomy cooperation among willing parties. For instance, The APEC Environmental Goods List[87] provides a model for regional approaches to environmental goods liberalization, while newer agreements increasingly incorporate specific provisions for bio-based products and sustainable technologies. The Africa Continental Free Trade Area is an important opportunity to align the continent towards sustainable trade practices. Key aspects should include harmonising regulatory frameworks starting at local levels, encouraging frameworks that facilitate trade in certified bioproducts, and creating certainty around international policies and standards to enhance market access and encourage innovation.

**Several regional groupings are already developing bioeconomy strategies with significant trade implications, for example: The Southern African Development Community (SADC) is exploring regional bioeconomy frameworks to support agro-processing, bioenergy, and biotechnology innovation, the Caribbean Community (CARICOM) has initiated discussions on a regional bioeconomy strategy focused on marine resources, sustainable agriculture, and climate resilience while the EU-MERCOSUR and EU-Africa partnerships increasingly include sustainability chapters that could be leveraged to promote bio-based trade.** These regional frameworks can serve as testing grounds for broader multilateral approaches while addressing specific regional bioeconomy development needs. They also offer a pragmatic path forward in a fragmented global trade environment, allowing like-minded countries to pilot innovative trade and sustainability linkages that could later inform global norms.

# Technology Transfer Mechanisms

## Public-Private Partnerships for Biotechnology Sharing

Effective bioeconomy scaling requires innovative partnership models that combine public sector resources with private sector innovation capabilities. With strong acknowledgement from the G20 members that private sector facilitation is fundamental to advancing national bioeconomies, particularly through enhanced PPP ecosystems that include collaboration with higher education institutions, these partnerships should thus focus on developing shared research facilities, co-financing demonstration projects, and creating intellectual property frameworks that encourage technology sharing while protecting commercial interests. Priority areas include making biotechnology accessible across sectors, boosting circularity and sustainability through artificial intelligence and synthetic biology applications, and ensuring skills development and innovation support targets small and medium enterprises.

## International Research Collaborations and Joint Ventures

Cross-border research collaborations can also help to accelerate bioeconomy development through the pooling of expertise, resources, and market access opportunities. Entry points include bilateral and multilateral research agreements, joint funding programs for bioeconomy research, shared infrastructure development for biotechnology research and testing, and researcher exchange programs. These collaborations should prioritise developing countries' participation to ensure equitable access to bioeconomy benefits.

## Capacity Building Programs

Comprehensive capacity building programs should address multiple dimensions of bioeconomy development, including technical skills development for biotechnology applications, regulatory framework development and implementation, market access and trade facilitation training, and entrepreneurship support for bioeconomy startups. Critical considerations include ensuring biosafety and biotechnology frameworks are robust foundations for bioeconomy development, engaging rural economies effectively in bioeconomy initiatives, and maintaining focus on decent jobs and sustainable trade practices. International development agencies, multilateral banks, and bilateral cooperation programs should prioritize bioeconomy capacity building as a key component of sustainable development assistance, with particular emphasis on making agricultural, forestry, and bioresource sectors more competitive through enhanced regulatory frameworks

# Sustainable Development Alignment

## Circular Economy Principles in International Trade Frameworks

According to the WEF, the circular economy is a critical catalyst to addressing the planetary triple crisis of environment, climate and biodiversity.[88] Integrating circular economy principles into international trade frameworks however requires developing trade rules that support product life extension, waste reduction, and resource efficiency, creating certification systems for circular products that facilitate international trade, establishing trade finance mechanisms that prioritize circular economy projects, and implementing extended producer responsibility frameworks that work across borders.

G20 members have repeatedly emphasised the critical importance of strengthening links between bio and circular economies, with some establishing dedicated circular bioeconomy alliances to drive policy integration.[89] This bio and circular economy integration should leverage trade mechanisms for enhanced collaboration while maintaining strict policy coherence across sectors. The focus must remain on boosting circularity and sustainability outcomes, recognising that inclusivity should be a core pillar of bioeconomy implementation alongside cooperative approaches that ensure fair participation across all stakeholders.

## Integration with UN Sustainable Development Goals

The circular economy, which involves making economies less wasteful and less resource-intensive while contributing to human development and well-being, could hold the key to accelerating SDG delivery.[90] The ISO and UNDP international guidelines for businesses and organizations to accelerate urgent progress on the SDGs also provide practical frameworks for bioeconomy alignment with sustainable development objectives.[91]

National frameworks also play a crucial role in bioeconomy development, with the bioeconomy serving as an opportune convergence point for the three Rio Conventions (biodiversity, climate change, and desertification). Essential elements include establishing national forums for bioeconomy development, linking finance to social goals and ensuring equitable benefit sharing, and maintaining policy coherence across governmental departments. Overall, while in numerous cases the bioeconomy directly contributes to multiple SDGs, it should also be clear that bioeconomy development is not automatically sustainable and must be explicitly linked to nature conservation and sustainability outcomes.

## Climate Change Resilience, Mitigation and Adaptation Through Bio-Based Solutions

Bio-based solutions offer significant potential across **climate mitigation, adaptation, and economic resilience strategies. The bioeconomy serves as both a climate action tool and an economic resilience strategy,** helping countries adapt to changing environmental conditions while reducing emissions. The Bioeconomy can contribute to NDCs through **carbon sequestration in agricultural and forestry systems,**[92] **emissions reduction through bio-based alternatives to fossil fuel products, development of sustainable aviation and maritime fuels,** and implementation of **nature-based solutions for climate adaptation and economic diversification.**

**Landscape and ecosystem restoration represents a particularly powerful intersection of biodiversity conservation and climate action.** According to UNEP, nature-based solutions can deliver emission reductions and removals of over 40% of the mitigation needed to limit global warming to 1.5°C.[93] **Large-scale ecosystem restoration projects demonstrate both climate and biodiversity benefits:** peatland restoration can sequester significant carbon while supporting unique biodiversity, while reforestation initiatives create wildlife corridors that enhance ecosystem resilience. In Indonesia, mangrove restoration projects have shown a return on investment of up to 10:1, **combining carbon sequestration, flood protection, and livelihood support.**[94] **These multi-benefit approaches highlight how bioeconomy strategies can simultaneously address climate change, biodiversity loss, and economic development challenges.** International cooperation should therefore prioritise sharing best practices for quantifying and verifying climate benefits from bioeconomy activities.

However, realizing this potential requires addressing the complex interactions between bioeconomy development and climate impacts. As detailed in the Inter-American Development Bank and Nature Finance bioeconomy-climate nexus analysis, **the relationship between bioeconomy solutions and climate change is bidirectional and dynamic.** While bio-based products offer mitigation benefits under current climate conditions, **their effectiveness may be compromised as global temperatures rise beyond 1.5°C.** Biofuels become less efficient at higher temperatures, bioplastics may not decompose according to expected timelines in altered environmental conditions, and agricultural productivity for bioeconomy feedstocks faces increasing climate stress. **This creates an urgency around scaling bioeconomy solutions rapidly while they remain maximally effective** and underscores the need for **climate-adaptive bioeconomy strategies that account for changing environmental conditions.**

**International cooperation should prioritise sharing best practices for quantifying and verifying climate benefits from bioeconomy activities,** while also developing frameworks that account for climate change impacts on bioeconomy performance. This includes creating **standardised methodologies for measuring carbon sequestration and emissions reductions,** establishing **monitoring systems that track bioeconomy climate effectiveness over time,** and developing **adaptive management approaches that can adjust bioeconomy strategies as climate conditions change. Emphasis should be placed on ecosystem restoration approaches that deliver co-benefits for biodiversity conservation, climate resilience, and sustainable economic development.**

# G20 Policy Recommendations

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The bioeconomy offers integrative approaches to today's interlinked global crises of climate change, biodiversity loss, food insecurity, and economic inequality. **An inclusive and innovation-driven bioeconomy can provide a nexus of solutions to climate mitigation, resilience and adaptation, biodiversity conservation, and sustainable development.** The 2023 data on biodiversity-based product trade demonstrates significant development opportunities for G20 members in expanding sustainable bioeconomy markets.

As G20 economies seek pathways toward resilient and inclusive growth, **trade and investment policy can play a pivotal role in unlocking the full potential of a just and nature-positive bioeconomic transition.** This transition entails moving decisively away from fossil-based systems toward high-tech, circular, and bio-based value chains.

**Yet current global trade structures and investment flows fail to reflect and leverage this potential. This misalignment largely occurs because existing trade frameworks were designed for fossil-fuel based economies and lack the specialised infrastructure, standards, and incentives necessary to support bio-based value chains.** For instance, Africa, despite its rich natural assets, captures less than 10% of the value generated from biomass due to limited processing capacity, fragmented certification systems, and preferential access barriers that favour processed imports over local value addition. **Addressing these structural barriers requires coordinated policy action to redesign trade frameworks that can capture and distribute bioeconomy value more equitably.**

The G20 members have expressed interest in working to reshape trade and investment rules to equitably scale a sustainable bioeconomy, harnessing its power to support both planetary health and shared prosperity despite current geopolitical tensions and varying national priorities around trade policy.

The following recommendations emerge from the second meeting of the South African G20 Global Bioeconomy Initiative (GIB) 2025 discussions on sustainable trade and the bioeconomy. **They are designed to advance High Level Principle 7, which calls for policy frameworks that promote trade in bioeconomy products and services, ensure supportive market conditions, foster sustainable business models, create decent jobs, stimulate local value creation, and boost private-sector participation.** The recommendations can be grouped along 7 themes, as per the GIB engagements:

1. **Policy integration and harmonisation**
2. **Institutional coordination and governance**
3. **Trade infrastructure and market access**
4. **Financial incentives and subsidy reform**
5. **Regional cooperation and implementation mechanisms**
6. **Climate-resilient trade transformation**
7. **Data and Standards Harmonisation and Interoperability**

## 1 Policy Integration and Harmonisation

**Maximising existing trade framework opportunities - G20 nations should prioritise integrated policy approaches** that align national bioeconomy strategies with circular economy policies, just transition frameworks, and existing climate and biodiversity commitments such as Nationally Determined Contributions (NDCs) and National Biodiversity Strategies and Action Plans (NBSAPs). This alignment is essential to advancing G20 Bioeconomy High-Level Principle 7. Recent research demonstrates actionable pathways for policymakers, including the need to align and integrate national circular economy and bioeconomy policies, with practical recommendations to help scale circular bioeconomy models, particularly in the Global South.[95]

**Establishing clear regulatory distinctions between bio-based and fossil fuel-based products,** which will enable clearer measurements, regulations and incentives for bio-based products. Such distinctions will also better enable trade classifications and standards which prioritise bio-based products that can demonstrate verifiable lifecycle benefits such as reduced carbon emissions, biodegradability, and sustainably sourced inputs. While the UK's Regulatory Innovation Office (RIO), may not fully capture the breadth of the G20's diversity given its narrower focus on Engineering Biology within a national context it nonetheless offers a valuable illustration of how targeted regulatory innovation can help address regulatory bottlenecks and support innovation in bio-based sectors.

To scale these efforts globally, **G20 countries should work toward the creation of a Bioeconomy Mutual Recognition Framework.** This framework would be a shared system for recognizing sustainability certifications and establishing common criteria for legitimate, sustainability produced bio-based products, processes and services. Together with efforts to harmonise sustainability standards across G20 members, such increased interoperability would reduce trade friction and regulatory fragmentation, increase market predictability, and unlock new opportunities for investment, economic growth, and job creation in the bioeconomy.

**G20 countries should leverage existing multilateral trade mechanisms and established frameworks, such as the Agreements of the WTO,** which directly enable and shape biodiversity-related measures[96] to create enabling policy environments for sustainable bio-based goods and services. Additionally, the G20 can **leverage bilateral and regional free trade agreements** as vehicles for promoting bioeconomy development. For example, the EU–Kenya Economic Partnership Agreement (EPA), the most ambitious EU trade deal with a developing country to date, provides duty-free access to products derived from the sustainable use of natural resources, including botanicals, plant extracts, and agro-products, aligning closely with bioeconomy and sustainability objectives. These agreements offer greater flexibility than multilateral frameworks and can establish precedents for interpreting existing WTO rules in bioeconomy-friendly ways.

G20 countries should undertake national (or regional) assessments across two interconnected domains to identify priority areas for policy intervention and investment:

- **Trade policy frameworks that support sustainable bio-based products and services,** including sustainable agricultural exports, sustainable trade initiatives, especially those highlighting the use of maritime and aviation biofuels and natural non-plastic substitutes such as natural fibres and marine-based materials like seaweed. They also include innovative biotechnology products, carbon-trapping biochar, and alternative proteins.
- **Bioeconomy resource endowments and expertise, low carbon bio-based industries and innovation capabilities.**

**G20 countries should consider more strategic investment in robust monitoring, reporting, and verification (MRV) systems for bioeconomy goods and services,** which reduce operational costs for bioeconomy enterprises while improving market confidence through transparent sustainability metrics. These systems should be designed to minimise compliance burdens on enterprises, particularly small, micro and medium-sized businesses, while providing credible assurance about sustainability claims. Harmonised international standards and mutual recognition agreements can reduce duplicated reporting requirements and facilitate cross-border trade in certified bio-based products. Developing countries will require enhanced technical and financial support to build these capacities.

**Undertake regulatory reforms to update and harmonise standards governing the cross-border movement of high-value bio-based goods and services** including waste-derived products, botanicals, biofertilizers, bio packaging, and bioenergy. This should include aligning sustainability certification schemes, customs classifications, and phytosanitary rules to reduce trade frictions, enable technology diffusion, and support the development of regional value chains in the bioeconomy. These reforms should promote locally anchored best practices, build institutional capacity, and encourage simple, interoperable frameworks that facilitate trade and technology cooperation while minimising transaction costs.

## 2 Cross-Ministerial and Coordination Alignment for Implementation

Scaling the bioeconomy requires strong coordination across government ministries especially those of finance, environment, trade, economic planning, agriculture, and energy. **G20 countries must align financial policies, investment plans, and trade regulations to create a clear and consistent policy environment that supports sustainable bio-based growth.** This coordination should include mechanisms to manage and align commercial incentives and environmental goals, such as ensuring that trade finance instruments incorporate sustainability criteria and that export promotion agencies prioritise bio-based products that meet environmental standards. Transitional policies are also needed to support the shift away from fossil fuel-based products and toward more circular and sustainable nature-based solutions

As a first step, **G20 members should establish a G20 Inter-Ministerial Working Group on the Bioeconomy to replace the current G20 Global Bioeconomy Initiative.** This group would guide policy alignment across countries and develop shared approaches to bioeconomy development, including transitional policy design, investment-ready hubs, and region-specific innovation zones, similar to recent EU efforts. This working group can operate within existing G20 structures while providing the coordination necessary to ensure national bioeconomy strategies contribute meaningfully to trade, climate, and economic goals.Without such coordination, national bioeconomy strategies risk remaining fragmented and may fall short of contributing meaningfully to trade, climate, and economic goals. Key to its success will be ensuring that ministers of finance are engaged alongside other relevant line ministries (e.g. energy, science and technology, agriculture, environment) to engage the bioeconomy as a cross-cutting economic growth and development approach, rather than a siloed sector.

## 3 Trade Infrastructure and Market Access

As part of a larger commitment to decarbonising the global economy and supporting more sustainable economic development the **G20 should establish a Bioeconomy Trade Alliance.** This alliance would be a coalition of willing countries that can move faster than traditional multilateral processes to create preferential trading arrangements for bio-based products, building on successful precedents in regional trade innovation. The G20 and OECD Inclusive Framework on Base Erosion and Profit Shifting (BEPS) provides a relevant precedent for this kind of alliance.

**The establishment of bioeconomy trade facilitation hubs at major ports and border crosses** will be necessary infrastructure to rapidly grow the bioeconomy at scale. These hubs—near-term capital-intensive investment that can deliver long term global rewards—must ultimately include specialised customs facilities and testing laboratories for bio-based products.

Such "hard" infrastructure should be paired with the rapid development of **digital trade platforms that connect domestic bioeconomy producers with global buyers and demand,** while providing robust verification systems for sustainability claims.

**National standard setting agencies and accreditation bodies must also be enlisted at scale to support product quality assurance, biosafety, and cross-border compliance,** alongside investments in training customs and trade officials on bioeconomy product classifications and sustainability standards. This includes considering establishing bioeconomy trade facilitation desks within export promotion agencies. Multi-lateral development banks, export credit agencies, national and regional development banks and relevant UN agencies all have a key role to play in driving these efforts around bioeconomy trade facilitation. In particular, Medium, Small and Micro-Enterprise (MSMEs) and cooperatives will require support meeting international certification and traceability requirements.

## 4 Financial Incentives and Subsidy Reform

Unlocking trade opportunities in the sustainable bioeconomy can be achieved by leveraging strategic incentives and financial tools such as **public procurement policies, industrial strategies, tax incentives, and export credit instruments** to support higher-value, circular, and nature-positive bio-based products and services. Public procurement represents a particularly powerful driver of bioeconomy development, enabling governments to prioritise economically viable bio-based alternatives to fossil fuels and synthetic agricultural products while creating stable demand signals for emerging industries. Successful examples demonstrate the potential of coordinated procurement strategies, such as:

- The proposed multistakeholder initiative in East Africa supported by the Global Alliance for the Future of Food, aims to utilise public procurement through school feeding to generate demand for locally produced, organic food stuffs.
- Ongoing discussions in Indonesia exploring Green Public Procurement to support domestic sustainable agriculture sectors.
- The US' BioPreferred Program exemplifies systemic implementation, introducing mandatory public purchasing requirements for national agencies and their contactors of bio-based as opposed to fossil-fuel based products, as well as encouraging bio-based labelling.

G20 members are encouraged to **review and repurpose existing subsidies to promote trade in sustainable bioeconomy sectors, while phasing out incentives that reinforce fossil-based or nature-degrading value chains.** This includes the critical need to repurpose harmful agricultural subsidies that currently incentivize unsustainable practices and limit the development of nature-positive farming systems essential to bioeconomy growth. The substantial disparity between fossil fuel subsidies ($620 billion in emerging and developing economies spent in 2023) and consumer-facing clean energy investments ($70 billion)97 highlights the substantial opportunity for subsidy reform to accelerate bioeconomy development while reducing fiscal inefficiencies. Effective subsidy reform should emphasize positive incentives that encourage bioeconomy adoption while ensuring support mechanisms promote genuine sustainability outcomes rather than bio-based alternatives that could prove environmentally detrimental **such as biofuels that drive deforestation, bio-based plastics that lack proper end-of-life management, or monoculture biomass production that reduces biodiversity.** As examples like Germany's Feed-In Tariff and the U.S. Inflation Reduction Act demonstrate, countries can begin creating incentives for sustainable development even in the continued presence of harmful subsidies.

## 5 Regional Cooperation and Implementation Mechanisms

In line with High-Level Principle 9 and given the urgency of climate action and the competitiveness of emerging bioeconomy sectors, **G20 members should establish formal regional coordination platforms that support joint action while ensuring fair and inclusive distribution of benefits.** These mechanisms can help countries pool resources, share knowledge, and develop coordinated markets that create scale, attract investment, and expand market access in ways that individual countries cannot achieve alone.

Likewise, they should facilitate technology transfer, harmonise sustainability standards and certification systems, and support joint financing facilities for cross-border projects. A dual-track implementation model is essential for combining bottom-up, community-led initiatives with top-down policy and investment frameworks. Regional approaches should also prioritise incentives that remove trade barriers, unlock new markets, and ensure that local value creation, decent work, and equity are embedded in bioeconomy development strategies. Recognising that trade liberalization can potentially undermine local employment and value creation, successful regional frameworks require careful sequencing of reforms and complementary policies that build local capacity while gradually opening markets

Recent examples demonstrate the potential of such approaches. Initiatives like the African Circular Economy Alliance (ACEA) and the Africa Circular Economy Facility (ACEF), supported by the African Development Bank, have emerged as key platforms for integrating circular economy principles into regional trade agreements, such as the African Continental Free Trade Area (AfCFTA). Similarly, the Asia-Pacific Economic Cooperation's (APEC) adoption of the Bangkok Goals on the Bio-Circular-Green (BCG) economy underscores regional commitments toward harmonized circular economy standards and sustainable trade policies. In Europe, the EU bio-based Industries Consortium (BIC) and Circular Bio-based Europe (CBE JU) represent successful public-private partnerships funding large-scale biorefinery projects and technology platforms. Meanwhile, the Community of Latin American and Caribbean States (CELAC) bioeconomy working group is advancing regional coordination on bioeconomy development strategies.

## 6 Climate-Resilient Trade Transformation

**The bioeconomy presents unprecedented opportunities to make trade more sustainable if properly leveraged,** particularly in sectors where few sustainable alternatives currently exist. Transport and construction alone account for over 36% of total $CO_2$ emissions in the European Economic Area (EEA-32) region, making them strategic entry points for climate-smart trade reform.[98] Bio-based alternatives in these areas can build on existing environmental exceptions in trade rules while establishing new precedents for climate-friendly trade policies. This presents an opportunity to leverage trade mechanisms to build climate-resilient development pathways that connect bioeconomy advancement with broader just transition and climate adaptation strategies.

To operationalize this, **the G20 should strengthen existing platforms and initiatives particularly the G20 Trade and Investment Working Group (TIWG), the G20 Sustainable Finance Working Group (SFWG), and UNCTAD's BioTrade Initiative and the Sustainable Manufacturing and Environmental Pollution (SMEP) Programme** to facilitate bioeconomy cooperation through enhanced information sharing, coordinated research and development investments, and aligned policy approaches that maximize each country's comparative advantages while ensuring equitable benefit distribution across regions.

Additionally, **G20 countries should integrate bioeconomy strategies as central components of their National Adaptation Plans (NAPs) under the UNFCCC framework, ensuring that climate adaptation efforts leverage bio-based solutions for building resilience across sectors, particularly in agriculture, forestry, and coastal management.**

## 7 Data and Standards Harmonisation and Interoperability

Without standardised data frameworks and mutual recognition agreements, G20 members cannot effectively leverage trade mechanisms to scale bioeconomy solutions or create the transparent market conditions necessary to attract private sector investment at the scale required for meaningful impact. The absence of harmonised data collection methods and standardised metrics across G20 nations is a critical barrier to expanding bioeconomy trade. Inconsistent definitions, measurement protocols, and certification systems fragment markets, undermines investor confidence and limits cross-border commerce. These disparities, especially around how countries classify bio-based products, measure sustainability impacts, and verify carbon removal claims lead to high transaction costs and regulatory uncertainty, impeding the development of integrated global bioeconomy value chains.

To address this, **the G20 should establish comprehensive data and standards harmonisation frameworks that create interoperable systems for measuring, reporting, and verifying bioeconomy activities across member countries.** This should **build upon the Bioeconomy Mutual Recognition Framework referenced in policy integration efforts,** creating shared systems for recognizing sustainability certifications and establishing common criteria for authentic bio-based products. The framework should mandate data-sharing protocols that support real-time monitoring of bioeconomy trade flows, sustainability outcomes, and market development trends. This transparency is essential for evidence-based policymaking and building investor confidence. Furthermore, harmonised standards must cover the full spectrum of bioeconomy activities i.e. from feedstock production and processing to product certification and end-of-life management, ensuring that trade facilitation aligns with environmental objectives.

As a first step, **members should establish a G20 Bioeconomy Data Consortium that creates standardised definitions, measurement protocols, and reporting frameworks for bio-based products across all member countries.** The consortium must include technical working groups with representatives from trade, environment, and standards agencies from each member country, operating through existing G20 institutional mechanisms while providing specialised bioeconomy expertise. Relevant precedents include the G20 Global Infrastructure hub, which centralizes data on global infrastructure investment needs, project pipelines and best practices, and the G20's Data Gaps Initiative, which has fostered the creation of monitoring frameworks and platforms to track gaps in financial data, systemic risks, and shadow banking.

# Overview of Pain Points and Potential Implementation Pathways

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| Intervention Area | Challenges | Proposed Solutions | Potential Implementation Partners and Frameworks |
|---|---|---|---|
| **Policy Integration and Harmonization** | • Divergent sustainability standards and bio-based product classifications across G20 create trade barriers and unpredictable market conditions for bioeconomy enterprises. | • Establish a **G20 Bioeconomy Mutual Recognition Framework** with shared safety standards, clear bio-vs-fossil distinctions, and expedited approval pathways. | • G20 inter-ministerial WG (trade, environment, finance, agriculture, planning)<br>• G20 Sustainable Finance WG<br>• G20 Trade and Investment WG |
| **Institutional Coordination and Governance** | • Lack of coordination across government ministries (e.g. finance, environment, trade, economic planning, agriculture, energy)<br>• Fragmented policy approaches undermining bioeconomy development | • Establish a **G20 bioeconomy inter-ministerial working group** to co-ordinate policies across members, share experience and develop pathways for bioeconomy development. | • G20 inter-ministerial WG (trade, environment, finance, agriculture, planning) |
| **Trade Infrastructure and Market Access** | • Fragmented or underutilised trade arrangements<br>• Limited infrastructure at ports and borders for bio-based products<br>• Limited connection between domestic producers and global buyers with sustainability verification<br>• Insufficient knowledge of bioeconomy products among trade officials | • Establish a **G20 Bioeconomy Trade Alliance,** a coalition of willing countries for preferential trading arrangements in bio-based trade.<br>• Invest in government-funded programmes or inter-country exchange programmes for bioeconomy education, reskilling and R&D<br>• Leverage the **G20 Global Infrastructure and Investment** (GII) framework to prioritise bioeconomy infrastructure projects that create regional value chains and trade corridors. | • G20 inter-ministerial WG (trade, environment, finance, agriculture, planning)<br>• G20 Sustainable Finance WG<br>• G20 Trade and Investment WG<br>• UN Trade & Development (BioTrade Programme and Sustainable Manufacturing and Environmental Pollution (SMEP) Programme)<br>• AfCFTA<br>• EU BIOBec Project – EU Horizon 2020<br>• G20 GII |
| **Financial Incentives and Subsidy Reform** | • Lack of coordinated government purchasing power for bio-based products.<br>• Misaligned tax systems do not support bio-based product development | • **Align public procurement policies, tax incentives and industrial policy** to prioritise economically viable bio-based alternatives, creating stable demand signals.<br>• Review and repurpose existing subsidies to promote sustainable bioeconomy sectors while phasing out fossil-based incentives. | • G20 Energy Transitions WG<br>• IMF Fossil Fuel Subsidy Reform initiatives<br>• OECD subsidy tracking mechanisms<br>• G20 Public Procurement WG |

| | | | |
|---|---|---|---|
| **Regional Cooperation and Implementation Mechanisms** | • Lack of structured regional cooperation for bioeconomy development.<br>• Limited knowledge sharing and technology transfer between countries | • Establish **formal regional coordination platforms** for joint action with fair benefit distribution.<br>• Facilitate **technology transfer and harmonise** sustainability standards/certification systems.<br>• Support joint financing facilities for cross-border bioeconomy projects drawing on successful models such as the Green Climate Fund's Amazon Bioeconomy Fund[99] and the EU's Connecting Europe Facility (CEF).[100] | • G20 inter-ministerial WG (trade, environment, finance, agriculture, planning)<br>• G20 Digital Economy Task Force<br>• G20 Sustainable Finance WG<br>• G20 Trade and Investment WG<br>• UN Trade & Development<br>• G20 Infrastructure WG<br>• Multilateral Development Banks coordination<br>• Green Climate Fund |
| **Climate-Resilient Trade Transformation** | • Fragmented existing initiatives limiting bioeconomy cooperation.<br>• Disconnected bioeconomy and climate adaptation strategies. | • Strengthen G20 TIWG, SFWG, and UNCTAD's BioTrade Initiative for enhanced information sharing and coordinated R&D investments.<br>• Incorporate bioeconomy approaches in national adaptation plans. | • G20 inter-ministerial WG (trade, environment, finance, agriculture, planning)<br>• G20 Sustainable Finance WG<br>• G20 Trade and Investment WG<br>• UN Trade & Development |
| **Data and Standards Harmonisation and Interoperability** | • The absence of harmonised data collection methods and standardised metrics across G20 nations is a critical barrier to expanding bioeconomy trade.<br>• Inconsistent definitions, measurement protocols, and certification systems fragmenting markets. | • Establish a **G20 Bioeconomy Data Consortium** that creates standardised definitions, measurement protocols, and reporting frameworks for bio-based products across all member countries. | • OECD trade and environment initiatives<br>• AfCFTA<br>• The Africa-EU trade partnership<br>• G20 inter-ministerial WG (trade, environment, finance, agriculture, planning)<br>• G20 Trade and Investment WG<br>• UN Trade & Development |

[i] International Standards Harmonisation Through ISO and Codex Alimentarius

The International Organization for Standardisation (ISO) has developed comprehensive circular economy standards that directly support bioeconomy development. Notably, these three ISO standards provide a comprehensive toolkit for circular economy implementation: ISO 59004 (Vocabulary, principles and guidance ), ISO 59010 (Guidance on business model transition ), and ISO 59020 (Measuring and assessing circularity performance ). These standards play a key role in helping companies design products that prioritize durability, reusability, upgradability, and repairability—key principles that build consumer confidence in shared, recycled, repaired, or upcycled goods and promote collaborative practices .

In addition, the ISO/UNDP PAS 53002:2024 Guidelines for contributing to the UN Sustainable Development Goals complement existing standards such as ISO 14001 (environmental management ) and ISO 22000 (food safety management), working together with ISO's circular economy standards to enhance organizational sustainability (ISO, 2024). Codex Alimentarius standards play a crucial role in facilitating trade in bio-based food products by establishing internationally recognized safety and quality standards that reduce trade barriers and build consumer confidence.

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