

Towards a sustainable bioeconomy in Latin America and the Caribbean

Elements for
a regional vision

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Summary

The document serves as a frame of reference to guide the development of national strategies for bioeconomy development. We propose a strategic framework based on four pillars: a) the 2030 Agenda; b) the Paris Agreement on Climate Change and individual country commitments expressed in their nationally determined contributions; c) social inclusion and territorial development; and d) innovation and productive diversification for decarbonization. The document identifies key structural factors for the development of bioeconomy strategies, with the common goal of moving towards sustainability. The document also identifies limitations, needs, opportunities and precautions to consider in the development of such strategies. Adequate knowledge of available biological resources, related scientific and technological capabilities and market potential and consumer acceptance of new bioeconomy products are required to tap the full potential offered by the bioeconomy. Still, the development of an inclusive, sustainable and competitive bioeconomy can be hindered by several factors, including the lack of adequate regulatory frameworks, contradictory regulatory frameworks, insufficient coordination of existing technical and technological capabilities, market entry restrictions for bioeconomy-related small businesses, and lack of funds to enhance the creation of innovative business enterprises. Finally, we highlight the importance of international and intra-regional cooperation for the development of the bioeconomy, in particular, the facilitating and supportive role that regional technical and financial cooperation agencies can play.

Introduction

The conference *New perspectives in the knowledge-based bio-economy*¹ (Brussels, Belgium, 15-16 September 2005) and the publication of *In Route to the Knowledge-Based Bio-Economy*,² presented at the conference of the same name³ held in Cologne, Germany, on 30 May 2007, are recognised as key milestones for promoting the elaboration of policies and strategies for the development of the bioeconomy. Since then, policy documents have been published by the OECD⁴ and the European Union⁵ and strategies have been developed, regionally, by the European Union⁶ nationally, in developed⁷ and emerging countries,⁸ and subnationally.⁹

In Latin America and the Caribbean (LAC), the elaboration of policy frameworks for the development of the bioeconomy is underway in several countries, at various stages of progress. However, unlike the European Union, there is no agreed regional vision on the bioeconomy, which could serve as a reference framework to guide the development of national policies and strategies. This document seeks to fill this gap.

The preparation of this document was agreed at the workshop *Cooperation and Knowledge Exchange on Public Policies for the Bioeconomy*, held at ECLAC headquarters in Santiago, Chile, on 26 and 27 June 2018, with financial support from German Cooperation. The document was prepared by ECLAC on the basis of: a) the inputs from that workshop, in which professionals from institutions involved in the elaboration of strategic frameworks for the development of the bioeconomy in

¹ New perspectives in the knowledge-based bio-economy (organizada por la Dirección General de Investigación de la Unión Europea, en colaboración con la Presidencia británica del Directorio de la Unión Europea).

² In Route to the Knowledge-Based Bio-Economy (conocido como el Documento de Colonia – The Cologne Paper).

³ Organised by the German Presidency of the Council of the European Union.

⁴ The Bioeconomy to 2030: designing a policy Agenda (OECD, 2009).

⁵ The European Bioeconomy in 2030 (European Commission, 2010).

⁶ Innovating for Sustainable Growth: A Bioeconomy for Europe (European Commission, 2012)

⁷ For example, Germany (2013), Spain (2016), United States (2012), France (2017), Finland (2014), Italy (2018), Norway (2016).

⁸ For example, Malaysia (2013), South Africa (2013) and Thailand (2017).

⁹ In several Canadian provinces (e.g. Alberta, Ontario) and German states (e.g. North Rhine-Westphalia, Bavaria), in the Province of Buenos Aires in Argentina, Andalusia in Spain and in the region of Flanders in Belgium, among others.

Argentina, Brazil, Colombia, Costa Rica, Ecuador and Uruguay participated; and b) the concept note prepared for the *Global Bioeconomy Summit 2018*, based on the results of the *Regional Bioeconomy Seminar Latin America and the Caribbean 2018*, held at ECLAC on 24 and 25 January 2018, organized by ECLAC as part of the ECLAC-France Work Programme, with the collaboration of the German Cooperation and the FAO Regional Office.

The document is part of a process that has as background:

- i. Two bi-regional projects Latin America - European Union, for the strengthening of science and technology, financed by the European Union: ALCUE-KBBE (Knowledge-Based Bio-Economy), between 2011 and 2013; and ALCUE-NET, between 2013 and 2016 (Hodson, 2017).
- ii. These projects aimed at building a regional vision for the bioeconomy, followed by roadmaps and action plans to strategically harness the region's strengths. Both projects contributed to building capacity and awareness about the potential of the bioeconomy in the region, through expert meetings and national and regional workshops, as well as to identifying pathways for the development of bioeconomics of regional interest.
- iii. The International Conference Latin America and the Caribbean - Bioeconomy 2015,¹⁰ held on 7 and 8 October 2015, at ECLAC headquarters (Santiago, Chile), jointly organized by ECLAC and ALCUE-NET, with the participation of representatives of Latin American and European countries and South Africa.
- iv. The Regional Seminar Bioeconomy in Latin America and the Caribbean 2018,¹¹ held at ECLAC on 24 and 25 January 2018, organized by ECLAC as part of the ECLAC-France Work Programme, with the collaboration of the German Cooperation and the FAO Regional Office (Rodríguez, 2018).
- v. The document prepared for the workshop Bioeconomy of World Regions: Latin America & Caribbean¹² (Henry, Rodríguez and Trigo, 2018), held on 20 April 2018 in Berlin, Germany, as part of the Global Bioeconomy Summit 2018 (GBS 2018) programme, as well as the Communiqué¹³ and report of the event.¹⁴ (see Annex A).
- vi. Several documents prepared by ECLAC on the bioeconomy (Rodríguez et al. 2017; Aramendis et al. 2018; Rodríguez et al. 2018).

¹⁰ http://conferencias.cepal.org/Conferencia_bioeconomia/.

¹¹ http://conferencias.cepal.org/bioeconomia_AL/.

¹² <http://gbs2018.com/workshops/bioeconomy-of-world-regions-lac/>.

¹³ http://gbs2018.com/fileadmin/gbs2018/Downloads/GBS_2018_Communique.pdf.

¹⁴ http://gbs2018.com/fileadmin/gbs2018/GBS_2018_Report_web.pdf.

I. Elements for a regional vision of the bioeconomy in Latin America and the Caribbean

A. What is the bioeconomy?

Given the diversity of national situations, it is not considered appropriate to propose a definition of bioeconomy with the intention that it be accepted by all countries. However, and in line with the GBS Communiqué 2018, it is recognized that the bioeconomy can be defined from a global perspective, as "*the production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes and services in all economic sectors aiming toward a sustainable economy*" (GBS, 2018). Bioeconomy, in practice, is a dynamic and complex process of social transformation, which requires a long-term policy perspective; countries can define their bioeconomies based on their own national realities and capacities, as well as their programmatic elements.

B. A bioeconomy for Latin America and the Caribbean

A regional vision on bioeconomy in Latin America and the Caribbean could be built on the following four pillars (diagram 1):

- (i) Promote sustainable development, taking Agenda 2030 as a frame of reference;
- (ii) Promote climate action, taking as a frame of reference the Paris Agreement and the proposals of the countries in their nationally determined contributions (NDCs);
- (iii) Promote social inclusion (e.g. family farming, youth and women, indigenous peoples) and the reduction of territorial development gaps within countries;
- (iv) Promote innovation processes that contribute to the diversification of economies and generate new value chains, especially those that contribute to regional development, are in high-growth market segments, or offer opportunities to young people and women.

Diagram 1
Strategic framework for the development of national bioeconomy strategies in Latin America and the Caribbean



Source: ECLAC.

C. Structural factors and the development of the bioeconomy in Latin America

A regional vision of the bioeconomy in LAC could contemplate - at least - the following structural factors:

- **Latin America is a mega biodiverse region:** a) several mega biodiverse countries are located in the Amazon Basin and in Mesoamerica; b) there is a great variety of unique ecosystems, such as desert zones (northern Chile and southern Peru) and semi-desert zones (Catinga, Brazil), Patagonia (southern Chile and Argentina); the humid pampas (southern Brazil, Uruguay and Argentina) and dry pampas (Argentina), and the Pantanal (Brazil, Bolivia and Paraguay); and c) marine ecosystems, many still little known, both in the Pacific and Atlantic oceans and in the Caribbean Sea. Therefore, in LAC, the sustainable productive use of biodiversity represents both potential and a challenge for the development of the bioeconomy.
- **A high potential for biomass production** (availability of land, adequate soils and water) that: (a) has allowed the consolidation of many production chains in traditional areas of food (human and animal food), fibre and forestry sectors, and bioenergy, in which there is still room to increase value addition (e.g. through transformation at source); (b) can be enhanced to encourage productive diversification through the production of biomasses for advanced non-conventional uses, e.g. energy crops for bioenergy production and specialised crops for the production of biomolecules (plants such as bioreactors) for applications in the food, chemical and pharmaceutical industries, among others.
- **The availability of large quantities of waste biomass** generated in biologically based primary sectors (crops, livestock, fisheries and aquaculture and forestry), are considered pollution and problematic in the linear view of the economy. However, these elements are resources in the circular view of the bioeconomy are valuable for new value chains. Examples include the production of energy, bioplastics and other biomaterials, the recovery of proteins and enzymes for industrial use, and others.

- The bioeconomy is a space where **the dichotomy between agriculture and industry as alternative models of development disappears**; The bioeconomy raises the need for new relationships between agriculture and food, and new links to industry, in which new technological concepts and new value networks are generated.
- The bioeconomy can contribute to **meeting the challenges of productive diversification and structural change** associated with the economic dependence of primary commodity-producing sectors (agriculture, mining, fossil resources) and the instability associated with price volatility.

D. The bioeconomy and the articulation of relevant policy frameworks

A regional bioeconomy vision should also recognize the following elements, with the aim of fostering a big push towards sustainability:

- The bioeconomy provides an adequate framework for the integration of policies for climate action, within the framework of the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC); to advance in the fulfillment of the commitments established by the countries in their Nationally Determined Contributions (NDCs).
- The bioeconomy is an adequate framework for the harmonization of policies required for the implementation of the 2030 Agenda, considering in an integrated manner the SDGs in the social, environmental and economic fields. For example, in structuring a solid framework to guide the implementation of the SDGs, integrating objectives of sustainable management of biodiversity, food security and sustainability in agriculture (SDGs relevant for the sustainable intensification of agricultural production and the need to reconcile food production and conservation objectives).
- The bioeconomy provides an adequate framework for the application of integrative policy frameworks based on systemic concepts, such as those related to the Water - Energy - Food Nexus and the Sustainable Food System.
- The bioeconomy is a suitable framework for integrating regional-national and national-global policies, public and private actions, institutional silos and economic sectors, as well as national territories and landscapes. This includes initiatives for the industrialization of agriculture and the addition of value to biomass at source; the promotion of reindustrialization based on biological resources; the articulation of private sector, government agencies and society organizations; and the articulation of policies oriented to the development of territories and regions.
- The bioeconomy promote coherence with related national strategies that are already being implemented in each country, seeking to reinforce what is already being implemented, and at the same time, opening new public policy options that complement the initiatives implemented by ministries, universities and technical institutes, citizen organizations and private companies. This implies a special effort to strengthen the links between the ministries of Science and Technology, Agriculture, Environment, Energy, Education and Economy, as well as other public and private organizations.

E. The bioeconomy as a framework for transit towards sustainability

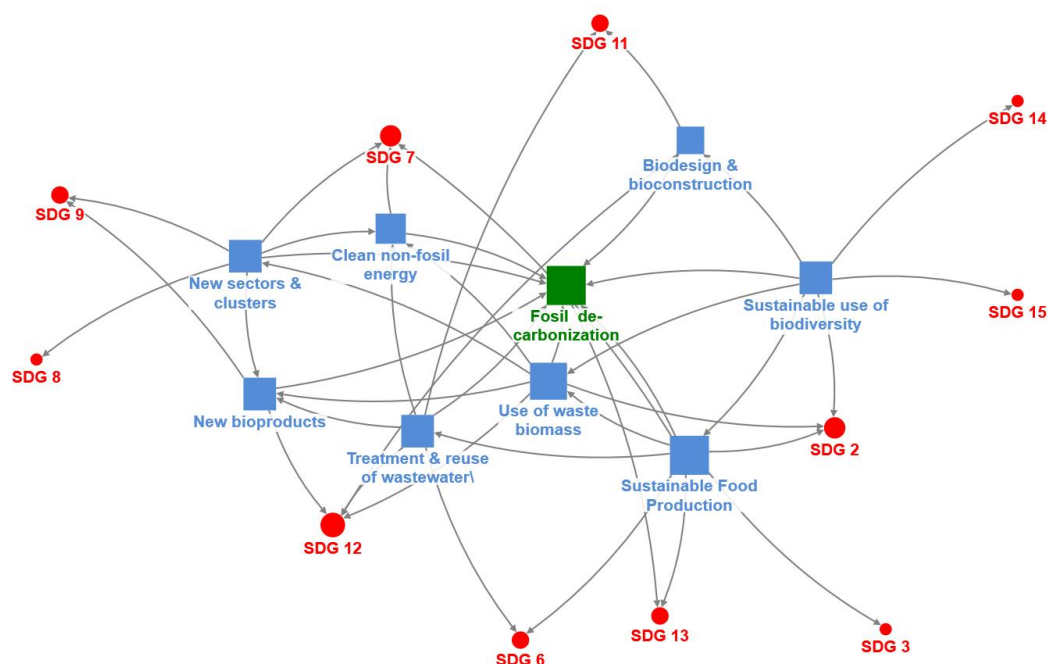
1. The bioeconomy and 2030 Agenda

The bioeconomy provides a conceptual framework for the development of strategies focused on addressing the social challenges and sustainable development concerns contemplated in the 2030 Development Agenda for Sustainable Development:

- The bioeconomy is based on biological resources; therefore, **it is a real alternative for fossil decarbonization of the economy** and can play a fundamental role in climate action, in line with Sustainable Development Goal (SDG) No. 13 (combating climate change) and established commitments in the Paris Agreement
- The bioeconomy is related to the **sustainable production of healthy foods and the sustainable intensification of agricultural production**; therefore, it can contribute to SDG No. 2 (through sustainable food production), SDG No. 3 (healthy lives) and SDG No. 15 (protection of terrestrial ecosystems).
- The bioeconomy promotes **new production models** (e.g. biorefineries, bioindustry) that enable the development of **new products** that can be used as inputs by other sectors (e.g. biomaterials for construction, bioinputs for agriculture, enzymes for industry), to substitute petrochemical products (e.g. bioenergy, biofertilizers, bioplastics), or to satisfy **new consumer demands** (e.g. functional foods, biocosmetics). Therefore, in addition to its contribution to ODS No. 2 (sustainable food production), the bioeconomy can also be instrumental in achieving ODS No. 7 (sustainable energy accessible to all), ODS No. 8 (new sources of decent work and sustainable economic development) and ODS No. 9 (industry and innovation).
- The bioeconomy **promotes circular economy production systems**, through the productive use of waste biomass derived from production and consumption processes; therefore, the bioeconomy can contribute to the achievement of SDG No. 12 (responsible production and consumption) and SDG No. 11 (sustainable cities and communities).
- An innovative element of the bioeconomy is the possibility of **developing products, processes and systems by replicating processes and systems observed in nature**. This can lead to the development of new value chains consistent with ODS No. 9 (industry and innovation), ODS No. 14 (sustainable use of marine biodiversity) and ODS No. 15 (sustainable use of terrestrial biodiversity).
- The bioeconomy also encompasses the development of **bioremediation alternatives to address environmental pollution problems**, for example, for the recovery of degraded or contaminated soils and for the treatment of drinking water and wastewater; therefore, it offers alternatives to support ODS No. 6 (clean water and sanitation for all) and ODS No. 15 (regarding the prevention of soil degradation).

In summary, the bioeconomy is a growth strategy based on emissions decoupling, given the central role it has in climate action, in particular, as a strategy to move to a post-fossil post-resource economy (diagram 2).

Diagram 2
Bioeconomy and Agenda 2030
Illustration



Source: Rodriguez, Mondaini & Hitschfeld (2017).

2. The bioeconomy and a big environmental push

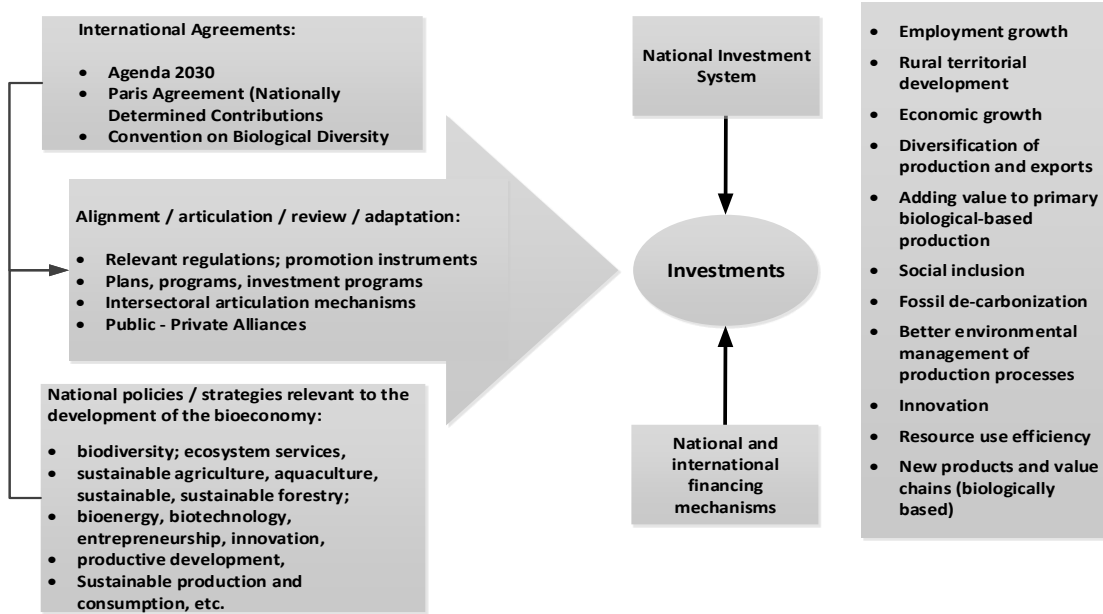
ECLAC has proposed that the region should generate a Big Environmental Push (BEP) from the coordinated reorientation of policies, regulations, and investments, in order to face current sustainability challenges. This should have an impact on economic growth, job creation and the development of production chains, reducing the environmental footprint and achieving the maintenance and recovery of the productive capacity of natural capital. All these impacts are consistent with the objectives to which a sustainable bioeconomy should aspire (ECLAC, 2016).

A related concept proposed by ECLAC is that of progressive structural change (ECLAC, 2016), which is defined as a transformation process characterized by three elements: (a) it is oriented towards activities and productive processes that are intensive in learning and innovation; (b) it promotes links with rapidly expanding markets; and (c) it should facilitate production and employment increases.

The bioeconomy provides an adequate framework for the development of policies aimed at supporting a progressive structural change based on a BEP, in Latin America and the Caribbean. The elements included in the general definition of the bioeconomy and the structural factors proposed for the articulation of a regional vision of it are inherent to a process of structural change oriented towards sustainability, since: a) biological resources are the basis for development of new productive activities and value chains intensive in knowledge and in the application of new technologies (especially those in which biological sciences converge with chemistry, physics, nanotechnology, engineering, robotics, cognitive sciences and of the information); b) the bioeconomy produces goods and services that are located in rapidly expanding market segments (for example, bioplastics, biomaterials, agricultural bio-inputs, biopharmaceuticals and biocosmetics, bioremediation systems, biodiagnostic and biomonitoring services, among others); and c) the new activities allow to increase production and employment, since many of them are based on the use of biological resources with territorial

specificities, which provide alternatives for productive diversification and the aggregation of value in rural areas, especially in the agricultural and agroindustrial sectors.

Diagram 3
Bioeconomy and a Big Environmental Push
Ilustración



Source: ECLAC.

II. Limitations, needs, opportunities and precautions for the development of the bioeconomy in Latin America and the Caribbean

A. Limitations

1. Regulatory barriers

There are various types of regulatory barriers that limit the development of the bioeconomy in the region. Among the most relevant are the following:

- Absence of regulatory frameworks, especially in areas where progress in knowledge and application of new technologies is faster (e.g. biotechnological applications such as New Breeding Techniques and CRISPR-Cas and developments in the field of synthetic biology);
- Complexity of national regulatory processes (e.g. access to genetic resources for research and development, protection of traditional seeds and plants);
- Weak capacities to comply with regulations in target markets for bioeconomy products and/or lack of awareness of such requirements (e.g. new food products, biopharmaceuticals and biocosmetics);
- Incompatibility of regulations between conventional products and similar bioproducts (e.g. bioenergy, biopharmaceuticals, bioremediation, biomaterials);
- Lack of harmonization in classification criteria for new products bioeconomy products (e.g. functional foods and superfoods, biopharmaceuticals, agricultural bioinputs, industrial enzymes); and
- Difficulty in enforcing existing regulations (e.g., regulations on biofuel-fossil fuel blends).

2. Barriers that limit market access

There are also barriers to the development of new markets and to access to existing markets; for example, sanitary and phytosanitary measures, technical barriers to trade, pre-shipment inspections and other formalities, as well as weaknesses in intellectual property issues. Some of these barriers limit the possibilities of biodiversity valorization, for example, the absence of traceability schemes for products related to biodiversity and the lack of homologated standards between exporting and importing countries.

Of particular importance are the barriers in the field of biotechnological products and processes, which can be grouped into four categories: a) analytical barriers or lack of technical and scientific studies to comply with regulations in destination countries; b) logistical barriers, related to obtaining export certifications, labels and seals (e.g. certified laboratories, certification of good manufacturing practices); c) economic barriers, due to the high cost involved in complying with the requirements of seals or certification schemes; and d) perception barriers, due to the producer's need to demonstrate to end consumers that the product is harmless and safe.

3. Capabilities in science and technology, innovation and human resources

The development of the bioeconomy requires new knowledge to take advantage of the potential of biological resources and advance the implicit challenge in the concept of the bioeconomy, which is producing more with less. But new knowledge will be insufficient if it is not put into practice effectively to transform existing production patterns, and without appropriate innovative behavior by relevant economic actors. A successful transition to the bioeconomy will require an intensive effort in the development of human resources, as well as better mechanisms for social participation. Biological-based processes require a new technological base, which in turn demands a reorganization of scientific skills for research and development. They also require changes in production and management levels, since development strategies based on biological resources are generally much more knowledge-intensive than development routes based on natural resources of fossil origin.

4. Financing limitations

The lack of funding resources is a constraint on innovation in Latin America, especially in new areas such as the bioeconomy. Available public funds are scarce and generally limited to financing the initial phases of research and development; the venture capital market is incipient in most countries; and there is no widespread culture of private sector investment in innovation. However, there are some mechanisms that have been developed for other purposes, with their own specificities, focus and rules of access, that have the potential to support bioeconomy-related entrepreneurship in the region, including public funds in national development agencies, national and regional private funds, mixed public-private funds, and regional and global international cooperation funds

5. Insufficient knowledge about opportunities and benefits of the bioeconomy

The bioeconomy promotes a change in the predominant development paradigm, which is based on the use of fossil resources. This new paradigm is based on the production, use and conservation of biological resources, to provide information, products, processes and services to all economic sectors, with the purpose of moving towards a sustainable economy. However, more knowledge of the multiple benefits and possible risks of the bioeconomy is required, at all relevant levels:

- Among policy-makers and in the development community, for the responses that a sustainable bioeconomy can provide to the broad aspirations and needs of society, given the linkages between society and many relevant SDGs, including poverty reduction, food security, access to water and energy, sustainable innovation, and sustainable production and consumption.
- Among the business community, for the opportunities and economic benefits in the development of new products and production processes and new businesses and value chains

to, on the one hand, meet a growing demand for more environmentally friendly products and forms of production, and on the other hand, create new quality jobs and new markets.

- Among citizens, to generate confidence about the safety of consumption of bioeconomy products (e.g., biopharmaceuticals, biocosmetics) and awareness about the benefits of accessing products with a lower fossil footprint (e.g., bioplastics).

B. Needs

In order to face the limitations, it is necessary to develop actions in the areas of policies and regulations, research and development, innovation and promotion of entrepreneurship, valorization of biological resources and market access and development, communication, awareness and participation, and information, monitoring and evaluation.

1. Public policies and regulations

In the development of national bioeconomy strategies, it is important to:

- Recognize territorial and landscape specificities, to increase benefit distribution.
- Articulate the national, regional and local levels, through well-designed processes to encourage the participation of all relevant actors, to allow for the identification of relevant regional needs, strategic vocations of the territories and the design of policy instruments supported by stakeholders, as well as the reinforcement of existing policy devices. The transition to the bioeconomy must respond to both local and national development needs.
- Adjust or develop relevant formal education programs, technical training and use of ICT and digital technologies, aimed at developing capacities to overcome trade and regulatory barriers that may limit the development of the bioeconomy, as well as to reconcile current regulations and / or the issuance of new ones.
- Wider dissemination of innovative and successful startups and productive bioeconomy ventures, in order to attract society's attention to the bioeconomy and its potential to diversify the economy and articulate new value chains.
- Develop mechanisms to support and engage relevant stakeholders through policy design, including venture capitalists, investors and regulators.
- Systematize information on financing mechanisms related to innovation and make it available to interested and potential bio-innovators.
- Generate participation processes, as well as education and dissemination programs so that society begins to interact with the bioeconomy and the impacts it generates.

2. Research and development

The relevance of promoting regional collaboration around a set of issues that have been identified from the ALCUE-KBBE and ALCUE-NET initiatives and in the ALC 2018 Regional Bioeconomy Seminar is recognized, namely:

- Biodiversity issues: a) detection of new bioactive metabolites and enzymes from terrestrial and marine microorganisms for industrial use, according to market demands; b) development of integrated databases with easy access for interested parties, on native organisms and their functionalities; c) review of bioprospecting programs carried out at the national level, together with the updating of environmental and biodiversity laws/policies, with the objective of identifying bottlenecks and challenges for the development of viable and novel strategies for the protection, knowledge and sustainable use of biodiversity.

- Eco-intensification issues: biological processing of agricultural and agroindustrial waste
- Biotechnology issues: design and selection of multipurpose crops.
- Bio-refinery and bioproducts issues: a) agro-industrial and urban waste valorization at biomass processing and consumption sites; b) fractionation and valorization of residual biomass for high value intermediate and/or final biological products; c) lignocellulosic bio-refinery platform to produce high value biological base products, especially in the forest sector.
- Transversal actions. Support for the development of the bioeconomy and circular economy model (circular bioeconomy), including appropriate market measures and policies for new bio-based products, services and jobs.
- Facilitating actions. Development of know-how for Intellectual Property (IP) management and improvement of science-industry communication and integration.

The need for greater multilateral and intersectoral collaboration in bioeconomy research and development projects with common goals is also recognized, in order to encourage better use of national public funds and support knowledge transfer, as highlighted in the statement of the Second Global Bioeconomy Summit,¹⁵ Berlin 2018 (2nd Global Bioeconomy Summit). The relevance of the issues proposed in that communiqué is recognized, in particular:

- Sustainable sources of protein for human and animal nutrition;
- Healthy diets, including sustainable production and access to food and the promotion of behavioural change;
- Health, food and environmental applications developed from microorganisms;
- Bioenergy as part of the energy matrix;
- Sustainable soil and water management;
- Conservation and regeneration of ecosystems;
- Conceptualization and realization of bio-cities;
- The development of sustainable materials, especially to face the crisis of pollution caused by plastics;
- The development of approaches to minimize food losses; and
- Measuring and monitoring the impact of bioeconomics.

Many of the above developments require an adequate knowledge of the availability of biological resources (e.g. types, volumes and distribution). The evaluation of the use of such resources should be made according to the scientific and technological capabilities of each country. There are several megadiverse countries in the region, but not all of them have the science and technology infrastructures (e.g. biotechnologies) necessary to take advantage of the full potential of this diversity. Similarly, there are countries with greater science and technology capabilities, where the most immediate opportunities are in domains of less sophisticated technologies; for example, in the use of residual biomass from agriculture and agro-industry to generate energy. This opens up great opportunities for regional cooperation that should be taken advantage of.

¹⁵ International Advisory Council del Global Bioeconomy Summit 2018. Communiqué Global Bioeconomy Summit 2018: Innovation in the Global Bioeconomy for Sustainable and Inclusive Transformation and Wellbeing. Berlin, 20 April 2018.

3. Innovation and entrepreneurship

In order to promote innovation and encourage entrepreneurship, the elaboration of national bioeconomy strategies its is considered relevant to:

- Develop innovative instruments to facilitate interaction between new bioeconomy ventures and universities or research centers, especially to promote bio-entrepreneurship among young people.
- Design financial and non-financial instruments to help new bioenterprises reach the global bioeconomy market and improve their capacities to respond and adapt to rapid technological change.
- Promote public-private and regional-multilateral collaboration to strengthen the national infrastructures required to meet the requirements for bioproducts in importing countries, either in terms of infrastructures (e.g. laboratories) or quality certifications (e.g. good manufacturing practices, USDA, USFDA, EU certifications).
- Foster a culture of entrepreneurship that values freedom of creation and innovation and does not punish failure.

It is recognised that start-ups and SMEs are often pioneers and drivers of innovation in the bioeconomy and therefore need greater access to capital and markets. It is therefore important to improve knowledge on how these companies can grow and integrate into the global value chains of the bioeconomy and how public policies can contribute to leveling the conditions in the market, paying special attention to the needs of young innovators and in areas of intensive application of advanced knowledge.

4. Valuation of biological resources, access to existing markets and development of new markets

To promote the valorization of biological resources, develop new markets and facilitate access to existing markets, in the development of national bioeconomy strategies it is relevant to:

- Quantify and value in economic, social and environmental terms the potential of bioproducts and the paths for the development of the bioeconomy vis-à-vis their fossil counterparts. In particular, the development of the bioeconomy must consider the conditions under which competition with mature industries based on fossil resources (e.g., energy, plastics, synthetic textiles) takes place, in the absence of a price on carbon.
- Design and disseminate tools to help academia and the private sector deal with regulatory and trade barriers, both to import complex biological components and to export bioproducts.
- Recognize the importance of incentives for the private sector, financing and infrastructure; of the predictability of incentives and conditions of market access; and of an adequate knowledge of the regulatory requirements at different levels, as well as the development of appropriate regulations, when necessary.
- Recognize that advances in the bioeconomy, especially at the level of research and development and innovation, depend on the availability and reliability of assessments of the potential benefits and risks of new technologies, especially those that may be more controversial, as well as on the compatibility of regulatory procedures.

- Balance potential trade-offs between routes for the development of the bioeconomy based on sophisticated products vs. immediate opportunities with great potential for performance and impact (for example, agrobiodiversity and use of agricultural waste).
- Develop a strategic vision of where to invest in the short, medium and long term, especially in countries with diverse biomasses.

5. Communication, dialogue and visibility

The change in the development paradigm that promotes the bioeconomy requires proper communication, highlighting its potential and its economic, social and environmental benefits. Therefore, in the development of national strategies for the development of the bioeconomy in the region it is important to consider the implementation of mechanisms for communication, coordination and political dialogue with the different social actors. The image of the bioeconomy needs to be strengthened in public awareness as an innovative and transformative solution to the great challenges of our time. Public-private and private-private collaboration is essential to sensitize consumers about the safety and sustainability of bioproducts, as well as to create demand and markets for them. It is also important to use existing bodies, such as chambers of commerce and industry and association and technology transfer offices, to promote collaborative networking, share best business practices and, in general, educate and communicate the opportunities that the bioeconomy offers, as well as its possible risks.

6. Information, monitoring and evaluation

The development of national bio-economy strategies is complex and demanding. Therefore, the creation of mechanisms and forums whereby countries can share relevant knowledge and experiences on how to monitor implementation progress, and in general on how to measure the impact of public policy policies and interventions that support the development of the bioeconomy is highly valued. Regional cooperation agencies can collaborate in the articulation of such forums and networks.

In the development of impact assessment systems it is important to take into account existing standardized statistical frameworks, such as national accounting systems (including the development of environmental satellite accounts), the development of observatories (e.g. environmental observatories), as well as ongoing initiatives for the development of indicators for monitoring SDG targets.

In the region, there are initiatives for the development of information relevant to the bioeconomy that can be strengthened through greater cooperation among countries. For example, the development of adaptation indicators in Uruguay; the development of environmental accounts on water, forests, energy and expenditure on environmental protection in Costa Rica; and the development of registers of plant species for medicinal use or with bioenergy potential, in Colombia. There are also proposals for national initiatives to prepare flow of materials and ecosystem service accounts in Costa Rica and for a bio-economy satellite account in Colombia.

The assessment of the economic importance of the bioeconomy is fundamental, but it is an area in which experience is limited, even in developed countries, and there are no universally accepted methodological frameworks to determine, for example, its contribution in terms of value added, employment and exports. As a new development paradigm, the bioeconomy generates new products, processes, sectors and value chains, for which no classifiers have been developed in the current statistical systems (for example, classifiers for bioeconomy products). Greater international and regional collaboration is important to fill these gaps.

C. Opportunities

1. Legal and policy frameworks are in place

Many countries in the region already have policies and public institutions relevant to the development of the bioeconomy, in areas such as science, technology and innovation; climate change; sustainable agriculture, livestock and aquaculture; forestry and biodiversity; biotechnology; bioenergy; and the use of residual biomass (Rodríguez et al., 2017). Many of these policies have evolved over time, in response to different national and international political contexts. The elaboration of bioeconomy strategies in the countries of the region, therefore, must start from the identification and articulation of existing initiatives, together with the development of dialogue processes with the private sector and other relevant actors in society. Achieving consensus and stakeholder support for a long-term process is a critical element in the formulation of national policies for the bioeconomy.

Developing policies for the bioeconomy also requires aligning relevant incentives that already exist in many countries, especially those aimed at promoting innovation and entrepreneurship; for example, in national science, technology and innovation funds, sectoral funds, environmental service payment schemes and public, private, mixed public-private, regional and global funds.

Achieving coherence between the objectives and goals of existing public policies, coordinating interventions within the framework of those policies, developing an adequate timetable for this, rationalizing regulations vis-à-vis the development of knowledge and technology, and aligning incentives and investments in public goods, among others, are recognized as key factors in the formulation of bioeconomy strategies in LAC.

2. Pathways for the development of the bioeconomy have been identified

Given the diversity of resources and capacities, we cannot speak of a generic bioeconomy for Latin America. However, the work carried out by the ALCUE-KBBE and ALCUE Net Projects in the identification of pathways for the development of the bioeconomy in the region is valued and we consider that pathways identified provide a relevant general framework for the development of “bioeconomies” adapted to the specific conditions of each country. These pathways are:

- Use of biodiversity resources, including scenarios in which the distinctive feature is the valorization (domestication, transformation, links to markets, etc.) of biodiversity; for example, the recovery of traditional seeds, the discovery of functional traits related to specific sectors and uses, the development of new products through innovative transformations, and the development of markets for local products, among others.
- Ecosystem services, including the processes through which the environment produces resources used by humans, such as air, water, food and materials. Due to the special nature of the relationship between natural resources and social and economic activities under a bioeconomy approach, the ecosystem perspective must be a crucial component of any strategy to foster a sustainable bioeconomy.
- Biotechnology applications (products, tools and processes), through the cultivation of industrial tissues, selection assisted by markers in culture and breeding of animals, plants and improved seeds, molecular diagnosis, improvement of animal reproduction through molecular techniques, modified enzymes, microorganisms and yeasts, etc. Also included in this pathway are applications in the management of natural resources, food, fibers and chemical industries, as well as in the supply of energy.
- Bioenergy - bioproducts; biorefineries - circular economy. The bioenergy sector seeks to replace fossil fuels, through the full use of biomass, including waste biomass. Ethanol,

biodiesel, biogas and bioelectricity plants, as well as different biomanufacturing activities related to the production of bioproducts, are examples.

- Ecoinintensification in agriculture. This relates to agricultural practices aimed at improving the environmental performance of agricultural activities (e.g. precision farming, direct seeding, agroecology) without sacrificing, and even increasing current levels of production/productivity.
- Efficiency of agrifood value chains. This includes activities that reduce post-harvest losses and food waste at any level that may occur.

D. Precautions

Building the bioeconomy is a process that will leave losers (e.g. in the fossil fuel economy) and winners (e.g. actors in new value chains based on biodiversity and waste use) and each country must manage the balance. Countries (individually or multilaterally) will have to decide how to include the environmental dimension and internalize costs and externalities in any national or international decision taken in this regard.

A relevant consideration is the balance of objectives, especially in the context of Agenda 2030. For example, concerns can be raised about competition in the use of land to produce biomass for food or bioenergy. Given productivity gaps with respect to land and water availability and scientific and technological capabilities, the region should be able to develop its bioeconomy, while strengthening its contributions to the world's food security. Economic circularity should be a key element in achieving such convergence, not only for environmental reasons, but also on economic grounds.

The bioeconomy offers an alternative to address territorial and sectoral inequalities that affect most countries (for example, agriculture versus industry, commercial agriculture versus family, rural versus urban agriculture). The challenge is how to "redesign" visions and policies to ensure that this happens differently than it was in the past: not as a dichotomous choice between agriculture and industry, as alternative routes for economic and social progress, but as a complex system of agricultural and industrial input-output relationships that mutually reinforce each other to move forward on a more sustainable development path.

The key to this is how to articulate the gradient of options for the development of bioeconomics, from the most basic pathways of using biomass, to the most knowledge-intensive options, taking advantage of progress in biological sciences and technologies (e.g. biotechnology, synthetic biology, omics, green chemistry) and convergence with other related rapidly evolving fields (e.g. nanotechnology, digital technologies, robotics, cognitive sciences, artificial intelligence).

It is also important to note that the application of research and development advances in areas relevant to the bioeconomy depends on the availability and reliability of expert assessments, the quality of processes for societal participation, and the compatibility of regulatory procedures. This mainly relates to R&D standards, processes for evaluating and regulating new technologies, certification and labelling systems, as well as intellectual property laws. Multilateral and intersectoral collaboration in these areas is important to keep up with the speed of development, foster mutual learning and provide balanced and sound assessments and information that policy-makers and citizens consider reliable, particularly on the potential benefits and risks of new technologies relevant to the bioeconomy (e.g. artificial intelligence, nanotechnology, CRISPR-Cas, synthetic biology). Standards and good business practices are vital for the creation and development of markets for bioeconomy products, processes and services.

III. The development and implementation of national policies and strategies for bioeconomy-based development

A. The strategy development process

In general, the process for developing a national bioeconomy policy or strategy can contemplate a set of 8 elements (see diagram 4), the application of which may differ between countries.

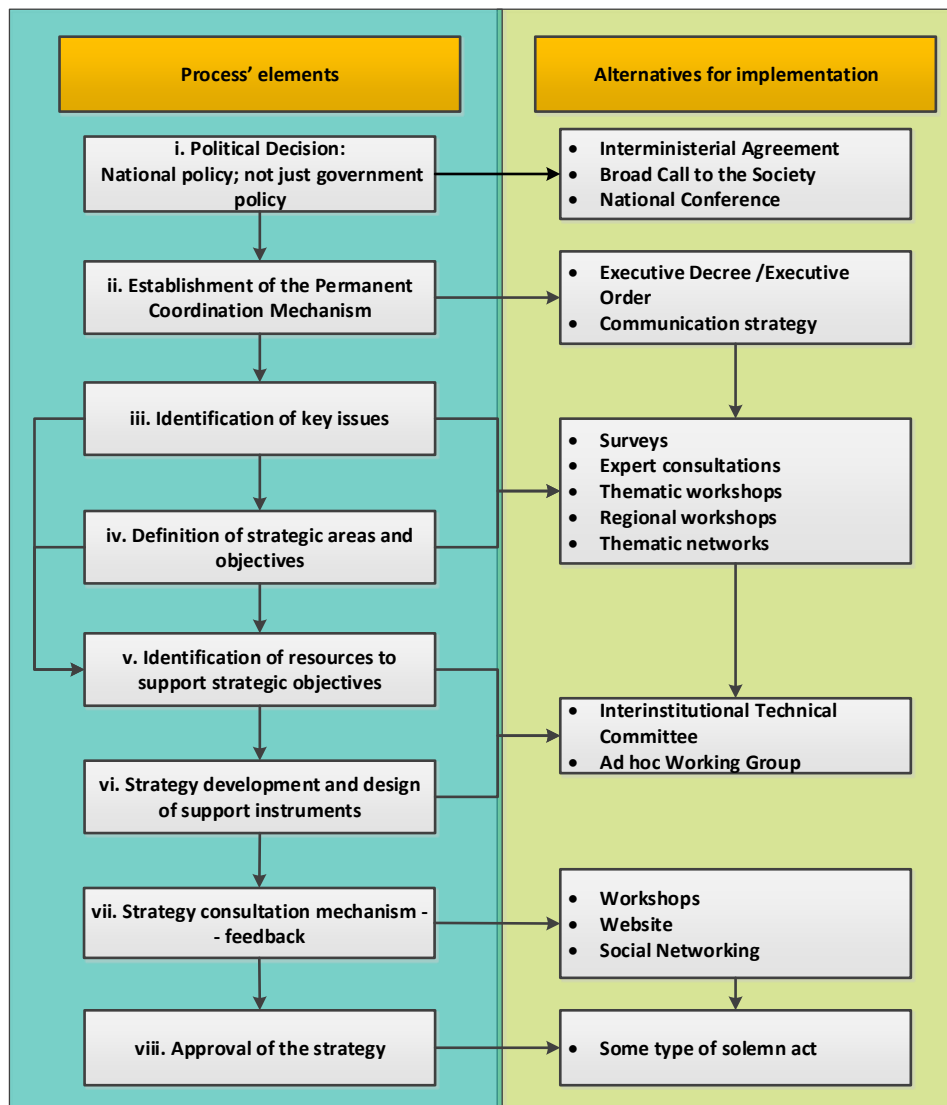
These elements include:

- (i) Establishment of some type of political agreement, which may be between public institutions or also involve other sectors of society, with the aim of generating consensus on the fact that it is a policy decision that goes beyond government terms.
- (ii) Establishment of a permanent coordination mechanism for the formulation and management of the bioeconomy strategy. The possibility of establishing an advisory group with national or international experts may also be considered.
- (iii) Determination of the key issues under which strategic actions will be directed.
- (iv) Definition of strategic areas and objectives and consideration of regional specificities.
- (v) Identification of the means to support the objectives.
- (vi) Strategy development and design of support instruments.
- (vii) Consultation and feedback process.
- (viii) Strategy approval.

Elements *i* and *ii* are essentially political in nature and are fundamental to generating trust, ownership and commitment among all sectors of society. To address elements *iii* - *v* the process may include holding a national conference as a kick-off activity, as well as surveys, focus groups and expert

consultations, support from thematic networks, regional workshops and meetings, and other types of working groups, from which written inputs can be derived. Element *vi* relates to the drafting of the strategy itself (i.e. document preparation), an activity that can be entrusted to an Interinstitutional Technical Committee or an ad hoc Working Group. Once the strategy has been developed, it should be subject to some clearly established process of consultation and feedback over a reasonable period of time. Finally, the strategy needs official approval.

Diagram 4
Elements of the process for developing national bioeconomy strategies
Illustration



Fuente: Based on Aramendis, Rodríguez and Krieger (2018).

B. Implementation

A bioeconomy strategy should include at least three elements:

- (i) The establishment of a system of governance that defines the roles and responsibilities of the entities involved;
- (ii) The definition of a model that ensures the economic and financial sustainability of the process and makes viable the purpose of reaching the market with the innovations of the bioeconomy; and

A system of communication, coordination and political dialogue with the different social actors (depending on what is stated in section III.B.5).

At least three elements are also considered relevant in the establishment of the governance system:

- (i) The integration of institutions, in particular the ministries involved in the national bioeconomy strategy;
- (ii) Horizontal integration with other relevant sectors, such as logistics, transport and telecommunications;
- (iii) The articulation of national and regional development policies.

The exchange of experiences on how to address these issues is fundamental, as is the role of regional cooperation agencies, supporting the development of this type of activities.

IV. Cooperation for the development of the bioeconomy in Latin America and the Caribbean

Most of the advances related to the bioeconomy in the region have been at the country level. This applies to both business and scientific developments, as well as to policy development. The few regional activities related to science have mostly been part of research programs supported by the European Union. Since 2012, these projects provided the European Union with information on research topics in high-priority bioeconomy issues (for example, new raw materials, biorefineries, waste streams, bioproducts) to be included in the research calls for the Framework Program 7 (FP7) and Horizon 2020 (H2020). The result has been that a greater number of research teams from LAC countries have partnered with European laboratories dedicated to bioeconomy research; however, similar collaborative efforts within the region do not exist.

The evidence of adverse market access conditions, lack of bioeconomy awareness and capacity constraints, among others, calls for a concerted intra-regional collaborative effort. One mechanism for timely collaboration is that of regional networks. The regional organizations (for example, ECLAC, CIAT, FAO and IICA) have offers that together can encompass policies and strategies, research, innovation, dissemination of knowledge and development of capacities relevant to supporting the development of bioeconomics in the region.

In that regard:

- The Economic Commission for Latin America and the Caribbean (ECLAC) is a highly recognized regional organization of the United Nations, with extensive experience in organizing policy dialogues, through conferences, technical workshops and expert group meetings, as well as sponsoring training workshops, symposiums and seminars, and executing technical cooperation projects. ECLAC's mandate includes helping to give a regional perspective to global problems and forums and to introduce global concerns at the regional and subregional levels. ECLAC is also a reference organization in the region for the organization and systematization of statistical information and has experience in the

organization of regional observatories (e.g., gender, broadband, among others). ECLAC has assumed regional leadership in the field of bioeconomy, reflected in the holding of the 2015 LAC Regional Bioeconomy Conference (in conjunction with ALCUE Net), the 2018 LAC Regional Bioeconomy Workshop (with the support of French Cooperation, German Cooperation and FAO/RLC), as well as several publications¹⁶ and the creation of a digital platform for the exchange of information.

- The International Center for Tropical Agriculture (CIAT), one of the CGIAR centers with presence in the region and global projection, is recognized for the quality and impact of the collaborative research it conducts to improve agricultural productivity and natural resource management in tropical and developing countries. Among its relevant initiatives for bioeconomics, the CIAT BioSciences Regional Platform stands out as a means to improve the capacity of the countries of Central America and the Andean Region to use advanced biosciences in the development and transfer of effective technological options for the further development and consolidation of their bioeconomies. This platform has two components: a) training activities (short-term); and b) research and support services, aimed at providing scientists in national research institutions (public and private) with access to advanced infrastructure and advice in support of their research efforts.
- The Food and Agriculture Organization of the United Nations (FAO) is a specialized agency of the United Nations system that directs international efforts to eradicate hunger, serves both developed and developing countries, acts as a forum where all nations meet as equals to negotiate agreements and discuss policies, and is a recognized source of knowledge and information and assists developing and transition countries to modernize and improve their agricultural, forestry and fisheries activities in order to ensure good nutrition for all. FAO has played a leading role in coordinating the International Sustainable Bioeconomy Working Group (ISBWG), with the support of the German government, which is working on the development of guiding principles for measuring the impacts and performance of bioeconomics at international, national, regional and sub-national levels. These activities are of great relevance to countries in the region that are in the initial stages of developing bioeconomy strategies and that could be extended in the region through the Subregional Office for Latin America.
- The Inter-American Institute for Cooperation on Agriculture (IICA) is a regional institution of the Inter-American System, with more than 70 years of experience in agriculture and rural development. In its Medium-Term Plan (2018-2022), IICA has included a Bioeconomy and Productive Development Program, the initial emphasis of which will be the identification of opportunities and policy needs and technical assistance for the development of bioeconomy policies in the area of agriculture at the country level.
- There are three development banks in the region that could make a significant contribution to financing the bioeconomy: The Inter-American Development Bank (IDB), the Latin American Development Bank (CAF) and the Central American Bank for Economic Integration (CABEI).

In summary, there is a great opportunity for regional technical and financial cooperation agencies to play leadership and/or facilitation roles. It is important to articulate the activities of these organizations in support of the bioeconomy, so as not to disperse attention from the scarce capacities available to the countries of the region, creating the necessary conditions to foster greater economies of scale and efficiency in collaboration.

¹⁶ Rodríguez et al. (2017), Aramendiz et al. (2018), Rodríguez (2018), Rodríguez (2018).

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Annexes

Annex 1

Communiqué Global Bioeconomy Summit 2018 Innovation in the Global Bioeconomy for Sustainable and Inclusive Transformation and Wellbeing

Executive Summary of Recommendations ¹⁷

The International Advisory Council (IAC) of the GBS₂₀₁₈ re-emphasizes the recommendations from GBS₂₀₁₅ and recognizes that a **surge in international policy collaboration and dialogue is needed** to achieve sustainable bioeconomy and leave no one behind. The GBS₂₀₁₈ defines a set of **14 themes of global relevance for bioeconomy research and policy agendas**. While some of these key themes relate to discussions continued from GBS₂₀₁₅, others are newly **emerging topics**, specifically: a) the links between climate change, health impacts and bioeconomy, b) digitization and converging technologies in the bioeconomy c) communication and trust in transformative sciences & technologies, d) interdisciplinary education and training at all levels in bioeconomy, e) biodiversity as a resource and foundation for bioeconomy, f) sea and ocean bioeconomy g) innovative ways of financing and h) bioeconomy in the cities or “biocities”.¹⁸

GBS₂₀₁₅ identified the key role of bioeconomy as a transformative strategy for advancing SDGs. Practically all of the bioeconomy policy strategies adopted since GBS₂₀₁₅ address the UN Agenda 2030 and seek to contribute to a number of SDGs.¹⁹ **However, the bioeconomy is yet to be appropriately included in international fora on innovation, climate, biodiversity and sustainable development policy.** Bioeconomy promotes distinct features of interest to several SDGs, including knowledge-based growth and jobs, the renewability of resources, resilience of ecosystems, circularity, as well as efficiency and value-orientation. Biobased solutions frequently provide innovative or unique benefits, which facilitate sustainable consumption.

In view of the noted diversity of bioeconomy in countries around the world, we may define bioeconomy from a global perspective in rather general terms. The definition is partly vision and partly reality, by saying ‘bioeconomy is the production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable economy’. Bioeconomy is a dynamic and complex societal transformation process, which demands a long-term policy perspective; countries are welcome to define their bioeconomies, as any definition also has programmatic elements.

With a view to the grand societal challenges, we call urgently for an increase in multilateral dialogue and collaboration in:

- bioeconomy R&D, in particular sustainability and global change research,
- governance,
- capacity building.

¹⁷ This first part of the document summarizes the key messages of the Communiqué of the Global Bioeconomy Summit 2018 (GBS₂₀₁₈). The second part presents the full version of the Communiqué. In an Annex, stock is taken on the progress made on the measures proposed at the Global Bioeconomy Summit 2015 (GBS₂₀₁₅).

¹⁸ Bio-cities or bioprincipled cities have been identified as future flagship project of bioeconomy in the Delphi Study of the GBS₂₀₁₅. Available at <http://biooekonomierat.de/fileadmin/Publikationen/berichte/Delphi-Study.pdf>.

¹⁹ German Bioeconomy Council. (2018). Bioeconomy Policy Part III: Update Report of National Strategies around the World. Available at <http://gbs2018.com/resources/>.

With respect to effectiveness, international policy collaboration in the bioeconomy will need to become more formally structured maybe even institutionalized. The IAC as an informal platform composed of leading bioeconomy experts should be strengthened and continued beyond GBS2018. **We recommend exploring options for the design and establishment of an international mechanism for knowledge exchange and coordination on global bioeconomy.** It should involve the stakeholders of the GBS and interested United Nations Organizations.

In line with our policy recommendations, the mechanism would need to contribute to the following:

- organization of **a structured exchange of policies and practices** among the global bioeconomy community on the key themes identified by the GBS2018
- provision of a state-of-the art knowledge base for bioeconomy policy and governance, specifically of evidence-based information and assessments that are considered trustworthy by all stakeholders.
- a competent and significant bioeconomy voice in global policy fora related to innovation, sustainable development, biodiversity and in particular the Paris Agreement, providing a holistic perspective and considering the interdependencies between individual SDGs in the bioeconomy.
- facilitation of multilateral collaboration programs in bioeconomy R&D and capacity building as well as governance oriented on common goals.

Aim and Purpose

This communiqué of the second Global Bioeconomy Summit, held in Berlin from 18 to 20 April 2018, was developed in a collaborative effort by the International Advisory Council (IAC)²⁰ and tabled at the Summit. We, a community of international experts and stakeholders from all hemispheres, met in Berlin to review the state of bioeconomy in different parts of the world and to identify opportunities for accelerated transition to sustainable bioeconomy. We build on the work and recommendations of the International Advisory Council, published in the Communiqué of the GBS2015 conference.

Re-visiting the Proposed Measures of GBS2015: Summarized Stock-taking

The GBS2015 resulted in mutual learning and recognition of a broad diversity in bioeconomy strategies and programs around the globe. Despite this diversity, the participants clearly **shared the vision of a sustainable bioeconomy in which humanity lives with respect for nature, and where the economy benefits society and protects planet and local environments.**

In view of the noted diversity of bioeconomy in countries around the world, we may **define bioeconomy** from a global perspective in rather general terms. The definition is partly vision and partly reality, by saying 'bioeconomy is the production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes and services in all economic sectors aiming toward a sustainable economy'. Bioeconomy is a dynamic and complex societal transformation process, countries are welcome to define their bioeconomies, as any definition also has programmatic elements.

²⁰ The members of the International Advisory Council (IAC) are listed at the end of this Communiqué.

The GBS2015 recognized three key areas of action for achieving sustainable bioeconomy - (i) promoting innovative as well as proven technologies,²¹ (ii) establishing good governance and (iii) strengthening international dialogue.

Consequently, the IAC of the GBS2015 agreed on seven measures to promote the development of sustainable bioeconomy across the globe. A number of activities and initiatives unfolded regarding these measures over the past two and a half years. These are briefly summarized here and are presented in greater detail and including many examples in the Annex of this document:

- To establish an international forum for bioeconomy as an informal network to foster strategic dialogue with policy-makers, private sector, civil society and scientists, including foresight and think-tank-oriented activities. In addition, a shared understanding of sustainable bioeconomy, and monitoring and reviewing progress at an international level should be part of its agenda.
 - >> A dedicated initiative was taken by UN FAO with an international working group to develop sustainable bioeconomy guidelines and facilitate bioeconomy dialogue globally; the BioFuture Platform was launched during COP22 facilitating global policy cooperation among 20 countries for a low-carbon bioeconomy; an International Bioeconomy Forum for long-term R&D collaboration among global players in the bioeconomy was established in November 2017 by the EU; many more regional and national events were held than ever before. The establishment of a central forum for bioeconomy policy is however still missing and no mechanism to approach such a structure can be identified up to this moment.
- To explore opportunities for long-term international research and development collaboration to advance biobased technologies, processes and products in selected innovation areas, building on key themes identified at the GBS2015 in Berlin.
 - >> Research activities accelerated in and between hemispheres. Global programs were however not started in the promising fields identified during GBS2015.
- To initiate a dialogue among stakeholders regarding the knowledge, skills and competencies, which will be crucial for implementing the bioeconomy, and to promote mutual capacity building efforts.
 - >> Bioeconomy higher education initiatives expanded in many countries, including at BSc and MSc levels at new and significant scale. A steady forum to exchange experiences and proven practices, such as curricula and standards, is however still missing.
- To build up dialogue with civil society and the interested publics to render bioeconomy a venture based on a widely shared vision of a sustainable future; innovative ways of communication with the public must be identified and developed, based on principles of transparency, openness and evidence.
 - >> Extensive stakeholder dialogues were held by governments as well as business and civil society organizations, mostly at national and regional levels. However, new participatory and evidence-based ways to communicate bioeconomy are needed in view of rising concerns and decreasing trust in transformative science and technologies.
- To include bioeconomy topics into ongoing discussions on how to achieve the Sustainable Development Goals at international and national levels.

²¹ Improvement efforts relate to applying state-of-the-art practices and proven technologies. Innovation efforts relate to scientific and technological breakthroughs, to social innovations (new forms of collaboration and of doing things) and to institutional and policy innovations. The bioeconomy is a very interesting field where such technological, social and policy innovations emerge and develop. The GBS2018 discusses promising avenues, risks and challenges of worldwide improvement and innovation efforts.

>> On this measure, GBS2015 contributed to a breakthrough in that there is now a broad understanding that bioeconomy is needed to achieve the SDGs. The global sustainability governing organizations such as those related to climate change and biodiversity have however yet to comprehensively embrace bioeconomy and define meaningful measures.

- To exploit synergies from collaboration at regional level, in particular by coordination of smart regional innovation strategies.

>> Most new action in bioeconomy emerged at national and even subnational levels in promising clusters. Coordination and cooperation increasingly occur across the science and business communities involved in these clusters or centers. Synergies from policy coordination among governments and public authorities however remain underexploited.

- To hold the next Global Bioeconomy Summit in two years, and to maintain the IAC until then as an informal mechanism for international coordination and cooperation activities, incl. facilitating the above-mentioned international forum.

>> This measure was fully taken: an expanded IAC was formed and provided leadership for the GBS2018.

It is reassuring to be able to state that there has been significant progress in implementing the seven agreed measures from the last Summit. However, further action is still needed to achieve the goals of sustainable bioeconomy.

Sustainable Bioeconomy: Global Agenda Setting

Considering the dynamics and the recent developments described in the above stock-taking (see details and examples in the Annex), the members of the IAC emphasize that the policy agenda and recommendations from 2015 are still valid and of high relevance.

We note that bioeconomy development globally is and will be driven by three broad forces:

- societal aspirations and good governance for sustainable development and for improved health and wellbeing,
- needs and opportunities of valorization and protection of biological resources, including residues, in the traditional bioeconomy core-sectors linked to agriculture, forestry, fishery, water management food and bioenergy,
- scientific breakthroughs in biological, digital and other technology fields, expanding the frontiers of innovation possibilities.

The structure of the GBS2018 program and the recommendations are built around these drivers. The GBS2018 defines a **set of globally relevant key themes for bioeconomy research and policy agendas**. The themes were elaborated in a bottom-up and demand driven process guided by the IAC and subject to an open call for workshop proposals. The call resulted in nearly 50 workshop proposals. In order to foster international perspectives and collaboration already in the preparatory phase, the proposals were merged into 14 co-organized workshops and clustered into 4 tracks.

GBS2018 Workshop tracks and topics (key themes)

Bioeconomy of World Regions (intra- and inter-regional collaboration)

- Africa
- Asia
- Latin America and the Caribbean
- Europe and North America

Industry

- Bioeconomy Financing – Bringing Innovation to Market
- Bioenergy and Biorefineries – Innovation and Futures
- Biobased Innovations in Manufacturing
- The Great Convergence – Digitalization, Biologicalization and the Future of Manufacturing

Innovation and Environment

- Biodiversity for a Sustainable and Thriving Bioeconomy
- Blue Growth: Seizing Opportunities for a Sustainable Future
- Bioeconomy, Health and Climate Change.

Policy

- Measuring and Monitoring the Bioeconomy – What, Where and How?
- Transformative Science and Communication
- Cooperation in Education and Training at all levels for the Bioeconomy

Los resultados de los 14 talleres se publicaron en un informe detallado²². Todos los temas del taller se beneficiarían del seguimiento después del GBS2018 por parte de los presidentes²³ y las redes que se han formado alrededor de ellos durante la preparación y desarrollo del GBS2018. Los temas podrían servir como un núcleo para futuras colaboraciones y proyectos conjuntos en bioeconomía.

Recommendations for Strategic Directions

In response to the drivers of global bioeconomy development, we propose a set of recommendations for international bioeconomy policy.

a) Bioeconomy to respond to societal aspirations for sustainable development

In the past years, the damages to the environment resulting from unsustainable resources use have become even more visible and tangible globally. We recognize a growing societal awareness of the bundle of impacts, such as climate change, degrading ecosystems and soils, pollution of air and water, health risks and scarcity of resources, such as water..

Sustainable bioeconomy can help respond to societal aspirations and needs through its links to several relevant SDGs including poverty reduction, food security, access to water, energy and

²² Available at https://gbs2018.com/fileadmin/gbs2018/GBS_2018_Report_web.pdf.

²³ Joachim von Braun y Christine Lang.

education, and sustainable innovation, production and consumption. Bioeconomy policy needs to respond faster and better to the demands and aspirations of citizens and to environmental needs.

Countries therefore need to define how a transition to bioeconomy should respond to local and national development needs. This will require long term planning and prioritization, investment in R&D, human capacity, S&T infrastructures, entrepreneurial capacity and innovation facilitating structures. However, many countries with rich biodiversity have not yet defined and agreed on how they should take advantage of locally, regionally and globally emerging bioeconomies. Global fora such as the GBS2015 and GBS2018, supporting national bioeconomy strategy and policy agenda development – together with global networking - are therefore crucial in this regard.

Specific recommendations for international policy:

- Science, technology and experience provide the knowledge base for bioeconomy policy regarding interdependencies with sustainable development. International measuring and monitoring efforts are required to understand and address the impact of bioeconomy developments, specifically on climate change, food security, health, and nature conservation. Tapping into big international initiatives such as Future Earth/Belmont Forum, Global Environment Facility or the Mission Innovation would provide additional funds for complex sustainability research in the bioeconomy. International scientific assessments are also required to develop options for bio-based sustainable lifestyles. **Public R&D support and international collaboration are required to establish and maintain a state-of-the art knowledge base for bioeconomy policy and governance.**
- Bioeconomy opportunities in the medical and pharmaceutical fields and in the health sector have to become integrated in bioeconomy policy strategies. Furthermore, health risks resulting from air pollution have emerged as a key sustainability issues. In this respect, potential health impacts of the bioeconomy need to be better understood and communicated. **We recommend addressing health aspects of bioeconomy more directly and to integrate them in the international environment, climate and health policy agendas.**
- The development of national bioeconomy strategies is complex and challenging. **Mechanisms and fora where countries can share knowledge and experiences in the development of strategies** and how to **monitor the impact** of policies and interventions in support of bioeconomy development are therefore important.

b) Bioeconomy to be based on the needs and opportunities of better valorization and protection of bio-resources related to agriculture, forestry, fishery and bioenergy

Valorization is not only understood in monetary terms (mostly resulting from desirable product qualities and valuable benefits) but includes the intrinsic values of biodiversity and ecological functions. In the sectors of agriculture, forestry and fishery and those of food, biochemicals, biomaterials and bioenergy production, bioeconomy policies and programs should generally recognize and value the functionality and quality of biological resources instead of considering them as quantitative “biomass”. Furthermore, high amounts of losses and organic waste are still generated across international agri-food, forestry and fishery supply chains, which could be either avoided or better used for the benefit of people and the environment.

Such improvements on the consumption and production side are of global importance and vital for resource efficiency. With a view to countries with an important share of smallholder production, the successful implementation of agricultural development strategies that ensure food and nutritional security is one of the most important challenges of the 21st century. Connecting the smallholder farmers to markets, value chains and agro-processing opportunities is an important tool in elevating

agricultural productivity, decreasing poverty and improving rural livelihoods, and a central task in a modern bioeconomy.

Specific recommendations for international policy:

- Knowledge transfer for achieving the SDGs is urgent. **Supporting the promotion of proven and broadly accepted good practices** in the production and the sustainable management of relevant natural resources as well as ensuring an inclusive decision-making process in that respect will significantly contribute to using biological resources more efficiently and for the benefit of society and the planet.
- **Bioeconomy policy needs to set the framework that stimulates sustainable resources use in bioeconomy value-networks.** Given the close inter-linkages between water, energy and food, a water-energy-food nexus approach is needed to address the tradeoffs and synergies in their production and/or use. Responsible production, circular approaches and the functionality-oriented use of resources should be part and parcel of bioeconomy approaches that need to be more widely applied in the primary sector. Policy agendas need to promote rural and coastal areas development by motivating new value-networks between agriculture, forestry, fisheries and bio-based industries. The participation of women and youth in the development of new bio-businesses should be encouraged to broaden their economic and social impact. An example are food packaging materials made from biobased materials, e.g. from agri-food residues, instead of fossil-based plastics.

c) **Bioeconomy fostered by knowledge, science and innovation**

A key driver of bioeconomy innovation is the rapid development in the life sciences, in combination with digitization, and the convergence of key technologies in applications. Promising innovations have for example been developed from genomics, applying big data analysis, and artificial intelligence as well as bio-, neuro- and nanotechnology. Such high-tech applications provide huge potential in the various areas of bioeconomy and for sustainable development. They typically require only small amounts of biomass, but are of transformative nature, i.e., they contribute to the establishment of novel and more connected industries and markets.

Yet, the developments in biotechnology and related high-tech areas are dominated by a few innovation hubs globally, while many countries rich in bio-resources are lacking critical S&T investment to participate in technological developments. In many emerging economies, an absence of technology and business incubation mechanisms that move bioscience innovations from R&D along the innovation chain to markets is a barrier for making use of S&T to optimize the use and add value to bioresources.

Consequently, policy actions and S&T investments of the public sector are needed to broaden the innovation agenda and to stimulate fair innovation sharing and to close science and knowledge gaps in the global bioeconomy. Also, active bioeconomy-related industrial policies should initially be considered, and experiences shared. The principles of fair, rule-based and free trade will remain important as stimulus for international competition and cooperation across bioeconomy value-chains.

Furthermore, trust and confidence in evidence-based technology assessments have been declining at a worrying pace in general, and especially in industrialized countries. Governments and policy makers will need to find more suitable formats for the dialogue among societal stakeholders on how to manage and effectively monitor the application of new technologies.

Specific recommendations for international:

- Digitization in combination with the scientific and technological advances in bioeconomy promise solutions for many societal challenges. Public R&D funding is important for initial development stages of most bioeconomy innovations. Public R&D partnerships between more

and less advanced countries, especially assisting in the translation of R&D into marketable applications, are key to improve the chances that the benefits of the bioeconomy innovations also reach smallholder farmers, resource poor communities and a broader set of market actors. Incentivizing private innovation investments should complement these efforts.

- **In order to leverage public funds and to support knowledge transfer, more multilateral and cross-sectoral collaboration in bioeconomy R&D projects with common goals are recommended.** As topics worthy of such transnational R&D and converging technology projects in the bioeconomy we propose:
 - Sustainable sources of protein for human and animal nutrition
 - Healthy diets including sustainable production, affordability, and behavioral change
 - Health, food and environmental applications developed from microorganisms (including microbiome-based solutions)
 - Bioenergy in the renewable energy mix
 - Sustainable soil and water management
 - Nature conservation and regeneration of the ecosystems
 - Conceptualizing and realization of bio-cities ²⁴
 - Sustainable materials, specifically addressing the plastics pollution crises ²⁵
 - Measuring and monitoring of bioeconomy impact
 - Bioeconomy approaches to minimize food loss & waste.
- The application of advances in bioeconomy R&D depends also on the **availability and trustworthiness of expert assessments and the compatibility of regulatory procedures.**²⁶This relates to standards in R&D, to the assessment and regulatory processes for technologies, to certification and labeling systems as well as to intellectual property law. Multilateral and cross-sectoral collaboration on the above is recommended to keep up with the speed of development, to foster mutual learning and to provide balanced and solid assessments and information that are considered trustworthy by politicians and citizens. Standards and good business practices are also vital for market creation and development.
- Startup companies and small businesses are often the pioneers and drivers of bioeconomy innovation, however they need access to capital and markets. Policy and business stakeholders need to understand how these businesses can grow to medium-sized companies and be better integrated in bioeconomy value chains and how **policy should support the development of level-playing fields for bioeconomy innovators worldwide**, paying special attention to the needs of young bio-entrepreneurs. Policy also needs to encourage and initiate new ways of financing, which correspond to the more longer-term and complex nature of bioeconomy innovation.

²⁴ Bio-cities or bioprincipled cities have been identified as future flagship project of bioeconomy in the Delphi Study of the GBS2015, available at <http://bioekonomierat.de/fileadmin/Publikationen/berichte/Delphi-Study.pdf>.

²⁵ Relates to the pollution of rivers, oceans, lakes as well as land soils with plastic particles. Plastic waste needs to be avoided, at least it should be recycled or become biodegradable. Problematic are especially single use plastics in all sorts of packaging and fast-moving consumer goods like clothes, shoes, toys, cosmetics, etc. Equally critical is the plastic abrasion resulting from product use such as car tires, textile washing, etc.

²⁶ Artificial intelligence and biotechnology have for example been rated as the most promising but also most risky technologies in a survey among top managers (see WEF 2017).

d) **Good governance to support sustainable bioeconomy development**

The Communiqué of the GBS2015 highlighted in one section the key areas of good governance for the bioeconomy and recommended three sets of measures related to governance, specifically to leading an international policy and stakeholder dialogue, to promoting societal participation and to establishing linkages with sustainable development policy. The Annex to this Communiqué presents actions developed since then regarding these measures. While such efforts are laudable, so far, they have still been fragmented and lack strategic planning and implementation.

Specific recommendations for international policy:

- To establish the international forum called for by GBS2015 as a global platform mechanism to contribute to an organized and continued international dialogue on bioeconomy policy, providing a counterpart for international sustainable development and climate policy fora. Options for the design of this platform mechanism, including stakeholder participation and public engagement should be explored at and after the GBS2018.

In sum, the IAC of the Global Bioeconomy Summit 2018 calls for an increase in multilateral and cross-sectoral collaboration and coordination on bioeconomy R&D, governance as well as in capacity building to ensure “Sustainable Bioeconomy For All”.

Stock-taking of Progress since GBS2015

The 1st Global Bioeconomy Summit was held in November 2015. It was initiated by the Bioeconomy Council of the German federal government in order to **create an evolving multi-stakeholder platform aimed at addressing the policy issues related to global bioeconomy development**. For the first time, bioeconomy policy stakeholders from more about 80 countries were brought together to discuss opportunities, perspectives and risks of bioeconomy development with a view to sustainability. The summit resulted in mutual learning and recognition of a broad diversity in bioeconomy strategies and programs around the globe. Despite this diversity, the participants clearly shared a vision of a sustainable bioeconomy in which humanity lives in harmony with nature and the economy benefits society and planet. With a view to global policy, the GBS2015 Communiqué called for “a more comprehensive and shared understanding of the concept of bioeconomy, which defines biological resources holistically, and considers the challenges together with the unique features and advantages. Specifically, its potential for resilience, carbon neutrality, its renewability, circularity, re-usability and multi-functionality.” Furthermore, it highlighted key areas where international policy dialogue and cooperation were considered necessary in order to meaningfully advance the bioeconomy and to contribute to sustainable development.

Since the GBS2015, Bioeconomy has taken a steep and exciting way forward. The term “bioeconomy” has become more mainstream in policy papers and strategies globally, however with differing definitions. In parallel, we observe that new terms and wider concepts are emerging. In the European Union, synergies between the concepts of bioeconomy and circular economy are being explored. Many of the recent bioeconomy policy papers from European member countries accordingly refer to “sustainable and circular bioeconomy”. In Finland and in Canada policy papers have defined the term “forest-based bioeconomy”. In the Anglo-Saxon countries, like the UK, the US and New Zealand, but also in China bioeconomy policy papers relate more strongly to concepts of high-tech innovation, such as synthetic biology, digitization and advanced manufacturing. In the US, the term “industrialization of biology” has been coined, whereas in Germany terms like the “biologization of economy” or “biological transformation of industry” are emerging in key innovation policy papers.

A recent analysis of bioeconomy policy strategies around the world indicates that since 2015 more countries have decided to develop holistic national bioeconomy strategies than strategies related to sub-policy areas, such as biotechnology. New bioeconomy policy strategies have been adopted in

France, Ireland, Italy, Latvia, Norway, Spain and Thailand. Globally, 49 countries pursue policy strategies related to bioeconomy development, of which 15, including the European Union and the West Nordic Countries, have developed holistic or dedicated bioeconomy policy strategies, with the trend rising in the past two years. In fact, the governments in Austria, Brazil, Colombia, Ecuador, Estonia, Iceland, Japan and the United Kingdom are in the process of preparing dedicated bioeconomy strategies. And still others, like Namibia, Kenya or Iran have tasked S&T committees working on bioeconomy policy.²⁷ However, many of these strategies are not backed by concrete action plans and budgets for implementing the visions and long-term goals. An interesting approach has been adopted by the French government that published an action plan one year after its bioeconomy strategy. The plan details the implementation measures to be taken by the government and key stakeholders. Also, Thailand has issued a Bioeconomy Roadmap together with an action plan.

However, the dynamic development of bioeconomy is not restricted to national policy making. It is also reflected by the increasing number of bioeconomy-related initiatives promoted by public and private actors. Considerable bioeconomy innovation programs are underway, for example in Australia (Queensland), Argentina, Brazil, in Canada, China, in Eastern Africa, in the European Union and its member states, in India, New Zealand, South East Asia and the USA. New bioeconomy and bio-industry policy strategies have been launched in the past two years, for example in China, Italy, France, Latvia, Norway, Spain and Thailand. A number of countries are in the process of setting up such dedicated bioeconomy and bio-industry strategies, such as Argentina, Ireland, Iceland, Namibia, Japan, South Korea and the United Kingdom.

All of these activities involve public support for bioeconomy development and some form of innovation budget, which provides a new and unprecedented scope for international collaboration.

The International Advisory Council (IAC) of the Global Bioeconomy Summit 2015 proposed seven measures to promote the development of sustainable bioeconomy across the globe. A number of activities and initiatives, often involving IAC members or GBS2015 participants, are unfolding. These are briefly presented for each of the recommended measures:

Measure 1. "To establish an international forum for bioeconomy as an informal network to foster strategic dialogue with policy-makers, private sector, civil society and scientists, including foresight and think-tank- oriented activities. In addition, a shared understanding of sustainable bioeconomy, and monitoring and reviewing progress at an international level should be part of its agenda."

- We observe at least three attempts of the bioeconomy community to establish structures for a multilateral policy dialogue to foster the development of sustainable bioeconomy; the UN FAO has set up an International Working Group on Sustainable Bioeconomy to advise on the development of sustainable bioeconomy guidelines, the European Commission has initiated an International Bioeconomy Forum, for long-term R&D collaboration among global players in the bioeconomy; During COP22 in Marrakech, the BioFuture Platform was launched with 20 signatory governments seeking policy cooperation and mutual learning in the development of a low-carbon bioeconomy.
- We observe tremendous international meeting activities in the bioeconomy and related to key sustainable development challenges, such as food and energy security as well as industrial innovation and economic growth.

²⁷ German Bioeconomy Council. (2018). Bioeconomy Policy Part III: Update Report of National Strategies around the World. Available at <http://gbs2018.com/resources/>.

- However, these events are not supported by a more institutionalized and strategic approach regarding the links between bioeconomy and the SDGs. There is currently no international mechanism for bioeconomy policy and for exchanging experiences, practices and information as well as initiating or supporting joint global R&D projects.

Measure 2. “To explore opportunities for long-term international research and development collaboration to advance biobased technologies, processes and products in selected innovation areas, building on key themes identified at the Global Bioeconomy Summit in Berlin.”

- Several countries have signed bi-lateral bioeconomy R&D collaboration agreements including co-funding schemes and capacity building partnerships. Just to name a few examples: the Newton UK-China Agritech Challenge, Brazil’s joint research project calls with the UK and France and the Embrapa Labex Program for international research collaboration, the German “Bioeconomy International” R&D funding program for research collaborations e.g. with Argentina or the joint funding of bioeconomy research projects between India and Norway.
- Regional and multilateral collaboration in education and R&D have for example been initiated in the Nordic Council member countries extending to the Baltic Sea Region countries, in Eastern Africa and by the International Bioeconomy Forum (IBF). The International Bioeconomy Conference 2018 in Lodz (Poland) has established a Bioeconomy Education Platform among key European players.
- The country profiles assembled in the G20 innovation report for 2016²⁸ show that the biosciences, bio-innovation and the bioeconomy are prominently considered in the innovation agendas of the leading industrialized countries – with competitiveness and economic development as key goals. Both Germany, holding the G20 presidency in 2017, and Argentina in 2018, have set policy priorities in bioeconomy development and could propose a forum for developing partnerships and joint-initiatives.
- The newly set-up Technology Facilitation Mechanism under the UN AGENDA 2030 process brings together the stakeholders on Science, Technology and Innovation for Sustainable Development Goals. Biotechnology and bio-based innovations are expected to have a significant impact on the SDGs. It remains to be seen whether this Mechanism supports multilateral cooperation in bioeconomy capacity building and R&D.

Measure 3. “To initiate a dialogue among stakeholders regarding the knowledge, skills and competencies, which will be crucial for implementing the bioeconomy, and to promote mutual capacity building efforts.”

- Several public institutions and schools have engaged in bioeconomy education and awareness programs, for example the Federation of Danish Workers has published a brochure on the bio-based society, which is distributed to employees and in schools. Through international cooperation with other trade unions the brochure has been translated and distributed in other countries, e.g. in Germany (IG BAU).
- A number of universities have developed bioeconomy courses and even dedicated bachelor and master programs. Examples can be found in Argentina, Finland, France, Germany, Italy, Malaysia, Poland and in the US. Some initiatives have been started to make these experiences available for institutions and bodies interested in establishing education and training programs, for example in Eastern Europe and Argentina (open online lectures and courses). GBS2018 will

²⁸ OECD. (2016). G20 Innovation Report., Available at: www.oecd.org/sti/inno/G20-innovation-report-2016.pdf.

host a workshop looking at international collaboration for bioeconomy education and training. To our knowledge there has been little international dialogue on the curricula and training methods used. A global exchange platform of curricula could be considered.

- Pilot projects involving bio-based businesses and training centers do exist, for example the “BioBase4SME” network holds business workshops and professional trainings supported by bioeconomy experts involved in the BioBase North-West-Europe project. To our knowledge, such programs have not been rolled-out on a larger scale.

Measure 4. “To build up dialogue with civil society and the interested publics to render bioeconomy a venture based on a widely shared vision of a sustainable future; innovative ways of communication with the public must be identified and developed, based on principles of transparency, openness and evidence.”

- Since the GBS2015, several countries have initiated participatory bioeconomy strategy development processes involving public consultations, public conferences and stakeholder workshops, for example in Austria, Canada, the European Union, France, Germany, Ireland, Italy, the UK, Thailand, and Argentina.
- Bioeconomy policy makers also seek to better understand societal expectations. The EU Commission has for example nominated a Bioeconomy Stakeholder Panel tasked to draft a social agenda for bioeconomy (Bioeconomy Stakeholder Manifesto). In Japan, the government supports survey and communication activities to understand societal expectations related to new bio- and plant breeding technologies. In Finland, a bioeconomy exhibition travels the country to engage with the public on bioeconomy development questions. Germany funds a social sciences research program to better understand the social and cultural aspects of a transition to the bioeconomy.
- Communication and dialogue concepts have been or are being developed. For example, governments in Finland, Germany, Malaysia, the Netherlands have already gained experience with public road shows, exhibitions and citizen conferences. There is still a need for sharing of these experiences and lessons-learned. For example, an EU project (BioStep) has been funded to collect such experiences with dialogue and outreach formats for mutual learning. The final project report has been published in February 2018.

Measure 5. “To include bioeconomy topics into ongoing discussions on how to achieve the Sustainable Development Goals at international and national levels.”

- Some core issues for a sustainable Bioeconomy have firstly been addressed in discussions at COP21 in Paris, at COP22 in Marrakech and COP23 in Bonn, however, still in fragmented policy fields, such as sustainable agriculture and forestry and renewable energies. The IPCC process itself has by now hardly considered the challenges and opportunities of bioeconomy and bio-innovation to achieving the Paris climate agreement. COP24 in Katowice (Poland) will offer new opportunities for a stronger reference to bioeconomy and its contribution to achieving the Paris climate goals.
- When it comes to global policy fora, the transformative contribution of agricultural and biotechnologies as well as bio-based innovation to the sustainable development goals (SDG) were highlighted in a chapter on Technology Foresight in the 2016 Global Sustainable Development Report as well as in the 2017 report of the multi-stakeholder forum on Science, Technology and Innovation for SDG. However, international efforts and initiatives to achieve the SDGs have slowed down and need to be stepped-up considerably in the coming years.

- Policy programs with a focus on monitoring and assessing the contribution of bioeconomy to the sustainable development goals have for example started in the European Union and some of its member states, in the US, Malaysia, the Nordic Council Countries, South Korea and in Latin America. Yet, country level sustainable development strategies hardly recognize the bioeconomy as a pillar for achieving the SDGs.

Measure 6. “To exploit synergies from collaboration at regional level, in particular by coordination of smart regional innovation strategies.”

- We observe that a considerable share of bioeconomy activities seeks to exploit synergies from regional specialization approaches. Several sub-regions in the European Union have for example coupled bioeconomy development with their Research and Innovation Strategies for Smart Specialization (RIS3). For example, the Central Hungarian region, the Island of Crete (Greece) the Spanish regions of Extremadura, Galicia and the Basque country, the Haute de France region (France), Lapland (Finland), the Lodzkie region (Poland), North Denmark, the Norte region (Portugal), Olomouc and South Bohemia (Czech Republic), Upper Austria, Värmland and Skåne regions (Sweden), Weser-Ems region (Germany), West Romania and the Emilia Romagna (Italy). Sub-regional bioeconomy strategies are further promoted in Argentina, Australia, and Canada.
- Macro-regional bioeconomy collaboration with a view to harnessing synergies across borders have been initiated, for example by the Latin American Countries of the Southern Cone, the Nordic Council Countries and the Baltic Sea region as well as by regions in Eastern Europe (BioEAST) and in the Mediterranean.
- Furthermore, regional industrial clusters in different countries have begun to collaborate. For example, the EU funded “Bio Innovation Growth mega Cluster (BIG-Cluster)” is a cross-border collaboration of clusters in the Flanders region of Belgium, the Netherlands and the German state of North Rhine-Westphalia as well as the “3BI strategic partnership” involving the Cluster Biobased Delta (The Netherlands), the BioEconomy Cluster (Germany), the Cluster BioVale (UK) and the Cluster Industries & Agro-Resources IAR (France).

Measure 7. “To hold the next Global Bioeconomy Summit in two years, and to maintain the IAC until then as an informal mechanism for international coordination and cooperation activities, incl. facilitating the above-mentioned international forum.”

- The second GBS2018 is held from 18–20 April 2018 in Berlin. The International Advisory Council has been maintained and extended to reflect recent developments and changes. The members of the IAC2015 and IAC2018 initiated and contribute to many of the above-mentioned fora, platforms and working groups.

The Members of the International Advisory Council of GBS2018, serving in their personal capacity:

- Baba Yusuf Abubakar, Nigeria
- Mohammed Ait Kadi, Morocco
- Harry Baumes, United States of America
- John Bell, European Union
- Zurina Che Dir, Malaysia
- Paul Colonna, France
- Achim Dobermann, United Kingdom

- Olivier Dubois, Food and Agriculture Organization of the United Nations (UN FAO)
- Ben Durham, South Africa
- Ruben Echeverria, International Center for Tropical Agriculture (CIAT)
- Fabio Fava, Italy
- Newai Gebre-ab, Ethiopia
- Josef Glössl, Austria
- Hordur G. Kristinsson, Iceland
- Manuel Lainez, Spain
- Christine Lang, Germany
- Yin Li, China
- Mogens Lund, Norway
- Pedro Luiz Oliveira de Almeida Machado, Brazil
- Elspeth MacRae, New Zealand
- Jussi Manninen, Finland
- Murray McLaughlin, Canada
- Paulus Mungeyi, Namibia
- Ian O'Hara, Australia
- Geir Oddsson, Iceland / Nordic Council of Ministers
- Christian Patermann, Germany
- James Philp, Organization for Economic Co-operation and Development (OECD)
- Vladimir Popov, Russia
- Frank Rijsberman, Global Green Growth Institute (GGGI)
- Adrián Rodríguez, United Nations Economic Commission for Latin America and the Caribbean (UN ECLAC)
- Andrzej Siemaszko, Poland
- Renu Swarup, India
- Morakot Tanticharoen, Thailand
- Omid Tavakoli, Iran
- Eduardo Trigo, Argentina
- Masahiro Uemura, Japan
- Jan van Esch, Netherlands
- Ivar Virgin, Sweden
- Joachim von Braun, Germany
- Seung Jun Yoo, South Korea

Annex 2

Ejemplos ilustrativos de desarrollos relacionados con la bioeconomía Illustrative examples of bioeconomy-related developments

Relevant elements	Bioeconomy development routes in LAC identified by ALCUE-KBBE (Hodson,2015)						Other routes		
	Biodiversity resources	Ecosystem services	Eco-intensification	Biotechnological applications*	Biorefineries and bioenergy	Value chain efficiency	bio-manufacturing	bio-medicine, genomic medicine	Bioinformatics, computational biology
Genetic resources Micro-organisms Wild biodiversity									
Biomass Biological waste Soils Water									
Sustainable, bio-based production systems									
Sustainable agriculture, livestock, forestry, fishing and aquaculture	Genetic resources Traditional crops Microorganisms	Water, pollination, CO2 capture	Precision agriculture	Green and blue biotechnologies Genetic editing; synthetic biology; Green chemistry	Energy crops Waste recovery	Waste reduction and recovery	Building materials (e.g. wood) Products of the forestry industry	Bio-molecule production	Agriculture 4.0
Economic activities									
Agricultural raw materials (Section 01 of the ISIC)			Use of agricultural bio-inputs	Genetic improvement; Seeds and improved breeds	Economic recovery of waste				Agriculture 4.0
Forest industry: (ISIC Section 02)				Genetic improvement of forest species	Economic valuation of waste		Wood products		Forest modeling. Big data in forestry
Fishing and aquaculture: (ISIC Section 03)				Genetic improvement of aquaculture species	Economic valuation of waste				Aquaculture modeling (e.g. fisheries) Big data in aquaculture and fisheries.
Agroindustry: Sections 10-11						Economic valuation of waste			Blockchain for traceability.
Health food	Traditional foods			Biofortification;					Blockchain for traceability.
New foods	Metabolites			Proteomics Food design Proteomics					Blockchain for traceability.

Relevant elements	Bioeconomy development routes in LAC identified by ALCUE-KBBE (Hodson,2015)						Other routes		
	Biodiversity resources	Ecosystem services	Eco-intensification	Biotechnological applications*	Biorefineries and bioenergy	Value chain efficiency	bio-manufacturing	bio-medicine, genomic medicine	Bioinformatics, computational biology
Agricultural bio-inputs	Active principles	Active principles		Green biotechnology, genetic editing, synthetic biology; Green chemistry					Big data on trends in food consumption.
Bioremediation	Microorganisms (eg enzymes, bacteria)		Waste monitoring	Coffee biotechnology; green chemistry; synthetic biology					Modeling and simulation of pest and disease dynamics.
Bio-sensing	Active principles Microorganisms	Pollination	Pathogen monitoring	Biomimicry					Modeling and simulation of pest and disease dynamics.
Bioenergy					Bioelectricity Biogas Bioethanol Biodiesel Biohydrogen	Economic valuation of biogenic waste			Modeling and simulation of phenology.
Bioproducts				White biotechnology, genetic edition Green chemistry synthetic biology	Biomolecules for industrial use;		Bioplastics Biochemical industry: Biocosmetics	Biopharmaceuticals, phytopharmaceuticals	Modeling and simulation.
Intermediate chemicals				White biotechnology Green chemistry synthetic biology	Biomolecules Industrial enzymes				Modeling and simulation.
Bio-design	Biomimicry	Biomimicry	Biomimicry				Biologization of the industry. Industrialization of biology.		Modeling and simulation of complex biological systems.
Bioconstruction					Biomaterials				
Biocosmetics, biopharmaceuticals, biomedicine	Active principles			Red biotechnology; Green chemistry; Synthetic biology; Omics; Genetic edition	Biomolecules			Red biotechnology; Green chemistry; Synthetic biology; Omics; Genetic edition	Modeling and simulation.
Diagnostic services				Biotechnologies					Big data of diseases.

Relevant elements	Bioeconomy development routes in LAC identified by ALCUE-KBBE (Hodson,2015)						Other routes		
	Biodiversity resources	Ecosystem services	Eco-intensification	Biotechnological applications*	Biorefineries and bioenergy	Value chain efficiency	bio-manufacturing	bio-medicine, genomic medicine	Bioinformatics, computational biology
Bio-finance		Carbon market							Disease dynamics modeling
Biotourism		Scenic beauty							
Contributions of the bioeconomy									
CC adaptation			Climate smart agriculture	Green biotechnology; Gene Edition					Crop adaptation modeling. Modeling of complex biological systems
Mitigación CC									
Soil and water management		Carbon sinks	Climate smart agriculture Agroecology	Green biotechnology		Water use efficiency	White Biotechnology		Carbon cycle modeling
Relevant related policies									
Sector, intersectoral and transectoral policies	Biodiversity policies	Ecosystem Services Policies Climate change policies	Policies for sustainable agriculture Climate change policies in agriculture (including mitigation and adaptation) Agriculture 4.0 Policies	Policies for the development of biotechnology	Industry 4.0 Policies	Sustainable Production and Consumption Policies	Industry 4.0 Policies	Policies to promote genomic medicine.	Agriculture Policies 4.0 and Industry 4.0

Source: ECLAC

Notes: Green biotechnology refers to applications in agriculture and forestry, blue biotechnology refers to aquaculture applications, brown biotechnology refers to bioremediation, white biotechnology refers to applications in manufacturing, red biotechnology refers to applications for medicine.



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