



## Article

# The Futures of Bioeconomy in Eastern Africa

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## Abstract

*There are many good reasons, ranging from aspirations for greater ecological sustainability to inspiring practical business innovations, to imagine the future of the Bioeconomy, especially for East African countries that are still largely agrarian. To engage in such imagining this project used a structured action-learning futures methodology with the goal of exploring a Bioeconomy strategy for East Africa. The process enabled participants to engage their collective-intelligence to consider the Bioeconomy in much broader sense, integrating images of future production of bio-products into potential society wide dynamics. The participants produced a range of scenarios from ones that depicted considerable potential for the Bioeconomy with vibrant and sustainable business to other more conflict riven futures due to bio-piracy, bio-security, environmental degradation among other concerns. The key drivers of the futures were seen as conducting policies and nature of investments attracted to the sector. Some policy proposals that emerged included developing regional and national platforms to bring stakeholders together to ensure policy coherence, creating innovation platforms to drive R&D, developing outreach programs to communicate Bioeconomy prospects and stimulating demand for bio-products through mandates (e.g. ban on single use plastics) and incentives e.g. government procurement quotas.*

## Keywords

Bioeconomy Strategy, Futures, Future Literacy Laboratory (FLL), Eastern Africa

## Introduction

The exploitation of biological natural resources is a basic economic activity of humankind, providing food, shelter and energy. Perhaps the first biggest step ever made by human beings was the harnessing of agriculture some 10-12,000 years ago. While new bases of economic activity have developed based on non-biological natural economic bases e.g. minerals and fossil fuels, agriculture and forestry and fisheries constitute important economic activities. For many developing countries these form the mainstay of livelihoods, for the more industrialized countries land and water-based biological resources provide many of the basic materials that power their industries.

Over the years, developments in technologies have seen the role of biological resource-based economic sectors play a declining role in economies. The first industrial revolution saw the harnessing of fossil fuels (coal) and the steam engine<sup>2</sup> to develop new economies that are now based on the exploitation of minerals and fossil fuels. This has seen tremendous improvement in livelihoods for many countries, especially the industrialized countries (Rifkin, 2013). However, this has come at a cost. Mineral resources are not renewable and thus current consumption jeopardizes future consumption, the economies as structured have created significant pollution and especially released a tremendous amount of Greenhouse Gases (GHGs) that are causing climate change and threatening livelihoods of many. Significant biodiversity is also being lost as natural resources that are feedstock to many industries get overexploited and also higher living standards have created huge demands that cannot be sustainably met by the current economic system<sup>3</sup>. This has seen efforts to reduce the environmental footprint of current

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economic activities ranging from urging shift towards more sustainable production and consumption patterns to an outright call for rethinking the whole economic structure to make it sustainable and yet able to support high living standards. There is now a global push towards a new economic paradigm.

In line with this thinking, The East Africa countries (Ethiopia, Burundi, Kenya, Rwanda, Tanzania and Uganda and South Sudan) are keen to chart a new development trajectory. Towards this end, the countries have identified Bioeconomy as a potential pathway (BiSEA, 2020). The strategy is thus premised on the belief that a successful deployment of the Bioeconomy has also the potential to promote sustainable, bio-based economic growth, new employment opportunities, improved livelihoods, food security and wealth creation. It is, therefore, key to have a deeper understanding of potential futures of Bioeconomy and potential levers in shaping the development of relevant sectors. This paper seeks to explore these issues through a review of the literature and also through a futures exercise involving key stakeholders in the region. The next section will give a literature review of on the how Bioeconomy fits within the sustainability discussion and various approaches to developing a Bioeconomy. Subsequent sections of this paper discuss the methodology and results of the Future Literacy Laboratory (FLL) exercise to explore futures of Bioeconomy, followed by a discussion on policy implications and conclusions.

### **Towards Sustainable Development - Bioeconomy as a Pathway**

The search for a sustainable development pathway is now a top global agenda as attested by the promulgation of Sustainable Development Goals (SDGs), the Convention on Biodiversity Treaty, The Paris accord on climate change (COP21) among others. There is a clear call and global agreement on the need to shift from the current economic growth trajectory to new pathways. The key pathways that have been proposed include three interrelated pathways: (1) Green Economy (GE); (2) Circular Economy (CE); and (3) Bioeconomy (BE).

Green Economy is concerned with fostering economic growth and development pathway that is low carbon, efficient and socially inclusive. It aims to reduce pollution and increase resource efficiency while preventing loss of biodiversity and valuing ecosystem services (UNEP, 2014; OECD, 2011). The Circular Economy (CE) goal is mainly pursued by redesigning the life cycle of the 'product', to have minimal input and minimal production of system 'waste' (D'Amato et al., 2017). Similarly, the EU Circular Economy Action Plan defines a Circular Economy as one "where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized" (European Commission, 2015, p. 2). The definition of Bioeconomy is still fluid as there exist many visions of what Bioeconomy is. For example, Hausknot, Schriefl, Lauk, and Kalt (2017) and Meyer (2017) in a review of strategies identifies three broad visions: (1) a biotechnology-centred vision that has an emphasis on the use of development of biotechnology leading to economic growth, improved international competitiveness and additional jobs; (2) a bio-resource-centred one that sees Bioeconomy from the perspective of sustainable exploitation of biological resources, this vision presents Bioeconomy as an answer to sustainability challenges e.g. climate change through a structural transition to a bio-based economy.; and (3) an agro-ecological vision that is more focused on sustainable agriculture and especially utilizing agroecological techniques and methods e.g. increasing plant genetic diversity, improving nutrient recycling, enhancing biodiversity etc. with the aim of minimising the need for external inputs and to rely on ecological interaction. Brugge, Hansen, and Klitkou (2016) also made similar observations pointing out that there seems to be little consensus concerning what the Bioeconomy actually implies. All the same, a global consensus is emerging. The Global Bioeconomy Summit (GBS) gives the following definition:

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. (Global Bioeconomy Summit, 2015)<sup>4</sup>

Paşnicu, Ghența and Matei (2019) point that the objective of a Bioeconomy transition is to achieve a low-carbon innovative economy that reconciles the demands for sustainable agriculture and fisheries, food security and the sustainable use of renewable biological resources for industrial purposes while ensuring biodiversity and environmental protection. This essentially overlaps with the green economy objective making Bioeconomy an aspect of the green economy agenda. A key emphasis of Bioeconomy pathway is the efficient use of biomass by

ensuring that, at each stage of its use, the highest possible value is gained from it by leveraging the cascading principles and greater attention to the utilization of wastes (Pașnicu, Ghența, & Matei, 2019). The cascading principle seeks to ensure biomass is utilized initially for high-value applications, such as in the production of bio-based products, and then recycled and reused before being converted into an energy source (Besi & McCormick, 2015). Therefore, Bioeconomy has a significant overlap with the circular economy in terms of seeking re-use products and to utilize waste as feedstock to new processes. However, Carus (2017) makes the argument that the concept of Bioeconomy goes far beyond the circular economy, including a lot more aspects such as innovation, functionalities and properties of products compared to the singular objective of a circular economy. Similarly, Leipold, and Petit-Boix (2018) point that overall, the scope of the circular economy is extremely broad, ranging from all fossil-based to all bio-based materials.

The Bioeconomy pathway has become increasingly popular and FAO (2019) points out that over 50 countries have developed a Bioeconomy strategy. Europe has been particularly keen on developing the Bioeconomy sector. It sees Bioeconomy as key to ensuring food security; sustainable management of natural resources; reducing dependence on non-renewable resources; mitigating and adapting to climate change; creating jobs and maintaining European competitiveness (European Commission, 2012). The European Bioeconomy Strategy focuses on three areas: (1) investment in research, innovation and skills; (2) reinforcement of policy interaction; and (3) enhancement of markets and competitiveness in Bioeconomy. Member states have also developed country-level strategies. A review of key priorities of Bioeconomy strategies of 12 EU countries identifies four key pillars: (1) stimulating research and innovation, especially in the field of biotechnology; (2) promoting collaboration between industry, businesses and research institutions; (3) prioritization of optimized use of biomass through the implementation of the "cascade" principle and the use of waste residue streams; and (4) providing financial support for the development of biology-based activities (Besi & McCormick, 2015). Beyond strategy what also matters is the development of policy frameworks. Drawing from the lessons of the 12 EU member countries Besi and McCormick (2015) point that five key actions to help develop the necessary framework for the development of the Bioeconomy are (1) creating measures that aim to increase coherence between different policy sectors; (2) creating measures for facilitating the cooperation between government, research institutions and industry; (3) increasing communication to society on bio-based activities; (4) implementing measures that support the creation of new markets and the uptake of bio-based products; and (5) facilitating the development and demonstration of bio-based activities through financial and administrative support.

Creating coherence between different policy measures is a key issue for the Bioeconomy, particularly as many different policy areas influence it. However, having a coherent policy framework will require much reflection and iteration. The EU which has been at forefront of developing Bioeconomy is still grappling with this issue. Carus (2017) point out that there is still an insufficient level of coherence in many EU and national policies, especially in terms of biomass use. For example, the EU renewable energy directive, as well as some national energy policies, are incentivising the use of biomass as an energy source, whereas there is almost no political or financial support mechanism for the industrial material use of biomass.

### **Bioeconomy growth pathways**

In the European Commission's approach, Bioeconomy covers 'the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products and bioenergy', including both traditional and emerging sectors, i.e. 'agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of the chemical, biotechnological and energy industries' (European Commission, 2012). Scarlat, Dallemand, Monforti-Ferrario and Viorel (2015) in a review of the potential of Bioeconomy in Europe identifies five sectors: (1) Agriculture and food; (2) Fishes and aquaculture; (3) Forestry, (4) Bioenergy including biofuels and bio-heat/ bio-electricity and (5) Bio-based industries including bio-chemicals, bio-plastics, bio-lubricants, bio-solvents bio-surfactants, enzymes and biopharmaceuticals. A key aspect of Bioeconomy that tends not to be quantified is the production of biodiversity related ecosystems services which include clean water, fresh air, flora and fauna. Bio-economy can be sub-divided to four subsectors; (1) traditional food and feed sector; (2) bio-energy sector; (3) bio-based products sector and (4) bio-diversity dependent sectors:

- Food and Feed: Food and feed are significant sectors and indeed with agro-processing and agribusiness activities they are some of the biggest economic sectors in both developed and developing countries. For

African countries with highly underdeveloped value chains, the key concern is increasing productivity and upgrading value chains to produce a diverse range of food products. Indeed agro-processing is seen as a key pathway to the transformation of African economies (ACET, 2014; ACET, 2017).

- Bioenergy sector: For many in developing countries biomass is the key source of energy. However, this has a potentially huge cost of environmental degradation (through deforestation) and health (smoke pollution). More modern fuels (bio-fuels) have been developed through chemical processes. Indeed biofuels have a long history and technologies are well developed. They are already a key energy sector in some economies like Brazil (with sugar-cane based ethanol).
- Bio-based products: Products made from biological based resources beyond food and fuel have a long history i.e. furniture, building material, paper. However, the potential for increasing functionality of old products (e.g. stronger building materials) and developing new materials (e.g. bio-plastics) is huge.
- Biodiversity related sectors: As bio-economy is also about sustainability and conservation, a bio-economy based approach also means an improvement in biodiversity and thus ecosystem services that are key to the economy. A major beneficiary of improved biodiversity is the already very important tourism sector that has great potential for transformation (ACET, 2014).

Looking at the range of opportunities offered by Bioeconomy pathways; it is clear that this pathway is open to both advanced and developing economies. Indeed the promotion of Bioeconomy has been placed on the political agenda of more than fifty countries, including the creation of dedicated visions, strategies and action plans (FAO, 2019). Some country strategies have emphasized linkages between bioeconomy and health (e.g. biopharmaceuticals; healthy nutrition), whereas other country strategies have focused on sustainable biomass production and utilization (Global Bioeconomy Summit, 2015). All the same Meyer (2017) points out that the number of countries with an integrated Bioeconomy strategy including all facets of the Bioeconomy is restricted with Finland, Flanders, Germany and Sweden having such an integrated strategy in the EU region.

The book *'The future of food and agriculture – trends and challenges'* published by FAO (2017) points out that achieving sustainable Bioeconomy development faces many challenges especially how to address the interrelated concerns of ensuring food security, addressing climate change, sustainably managing natural resources, managing competition between different uses of biomass feedstocks and crucially guaranteeing that Bioeconomy development benefits everybody. Bioeconomy activities are also not necessarily sustainable and thus the development of an economy that is based on biological resources faces several trade-offs. (FAO, 2019). In similar vein, Meyer (2017) points to five major stumbling blocks for the further development of the Bioeconomy as: (1) the risk of disappointment because far-reaching promises of the strategies are difficult to achieve; (2) the Bioeconomy is not the only way to a low carbon economy so alternatives could impede the desired development; (3) the conflicts between the different uses of biomass for food, material and energy; (4) the broader success of new Bioeconomy value chains could trigger new societal conflicts if demand is not sufficient to ensure a sustainable supply of biomass; (5) the acceptance of Bioeconomy could be compromised if Bioeconomy policies continue to ignore the on-going societal debates on agriculture and food. As Bioeconomy develop there is thus a need to continuously monitor the relationship with sustainability. Pfau, Hagens, Dankbaar and Smits, (2014) point that a lifecycle perspective is needed in the development of the Bioeconomy to understand the implications that the activities within it may have and to minimise any negative social, economic or environmental impacts and propose employment of lifecycle assessments tools.

Thus developing a Bioeconomy strategy is not a straightforward affair. Some lessons from the foregoing literature review point to some factors that need to be considered. These include:

1. There are potentially many Bioeconomy visions and therefore need to develop an owned vision that is consistent with available resources, levels of development etc. This underscores the need for a participatory approach to develop a common vision among stakeholders.
2. Bioeconomy cuts across sectors and therefore a Bioeconomy strategy will necessarily consist of several interrelated sectoral policies. Attention will need to be paid to policy coherence.
3. As significant trade-offs are needed, Bioeconomy strategy will also need a political process to negotiate competing interests. Attention needs to be paid to political economy and in particular stakeholder participation.
4. Innovation is at the heart of Bioeconomy, innovations to make traditional activities more productive and

innovation to develop new bio-based products. Significant investment in R&D and also in skills will be needed.

5. As many products are new, significant efforts will be needed to develop markets for new bio-based products.

The next part of this paper will review a participatory process that was used to help develop a Bioeconomy vision and strategy for East Africa using futures methodology.

## **Methodology**

The session employed the Futures Literacy Labs (FLL) methodology of the UNESCO (see Miller, 2004, 2007a, 20018). FLL uses workshops to generate knowledge through ‘action research’ methods. Participants are invited, step by step, to make explicit their assumptions about the future (their ‘anticipatory assumptions’) and to become aware that there are different ways of using the future to understand how alternative assumptions about the future help to define different aspects of the present. The workshop process enables researchers to record the participant’s anticipatory assumptions and how different ideas about the future alter perceptions of the present. By the end of each workshop, participants are expected to be able to start reassessing their original assumptions and ask new questions about their current situation.

## **FLL process**

In this workshop participants followed a process that is designed to take into account the different kinds of futures that exist in the present, in our imaginations, and how these different kinds of futures are created. Participants were asked to go step-by-step through three stages of futures thinking.

### ***Session 1: Revealing assumptions***

This process seeks to ask participants about their ‘best guesses’ about future directions over the next 15-20 years or so; what they expect will happen, and what they would like to happen.

A set of trends and driving forces provided by the facilitator can help catalyze the discussion. This session needs to start by putting people at their ease by (1) reassuring them that there are no right or wrong answers; (2) encouraging them to push the bounds of their thinking; (3) giving them a clear understanding of the sequence of the futures workshop and how they fit into the process.

At the end of this first group session, the rapporteurs should be able to present a rough list of anticipatory assumptions regarding expectations and values for each group. These will be used as points of reference for Session 3 dealing with Futures Literacy.

### ***Session 2 – ‘Rigorous Imagining’***

The aim here is to equip participants with the ability to let go of simple (session 1-type) visions of future based on simple extrapolation. Participants are reminded at the beginning of this session that they are now moving on to the next phase. The Learning Intensive Society (LIS), was used as a tool to paint a new scenario (Miller, 2004, 2007b). LIS is a constructed society where industrial production is no longer the source of wealth and thus is not necessarily dominated by firms, jobs, management e.g. using a technology like 3D printer allows people to produce everything they need. Where primary source of productivity increase is learning. Where unique creation is the source of value addition. Where unique creation is local, ideas are global and tangibles are cheap. LIS is meant to give participants some words to describe the future differently— it is to help them to begin to construct new anticipatory assumptions that entertain changes in the conditions of change. The LIS is not presented as being probable or likely, nor desirable or preferable.

The ‘LIS’ model can be thought of as being constructed using variables that define key aspects of society such as exchange/value creation; learning and social connections; information and decision making. The aim is to ‘equip’ participants with this LIS model and ways of describing things that then let them specify their picture of an imaginary future. This helps participants think beyond simple extrapolation, become aware of alternative systems and to be able to describe a snapshot of a system in a very different future e.g. a health and healthcare system.

**Session 3 - Reframing**

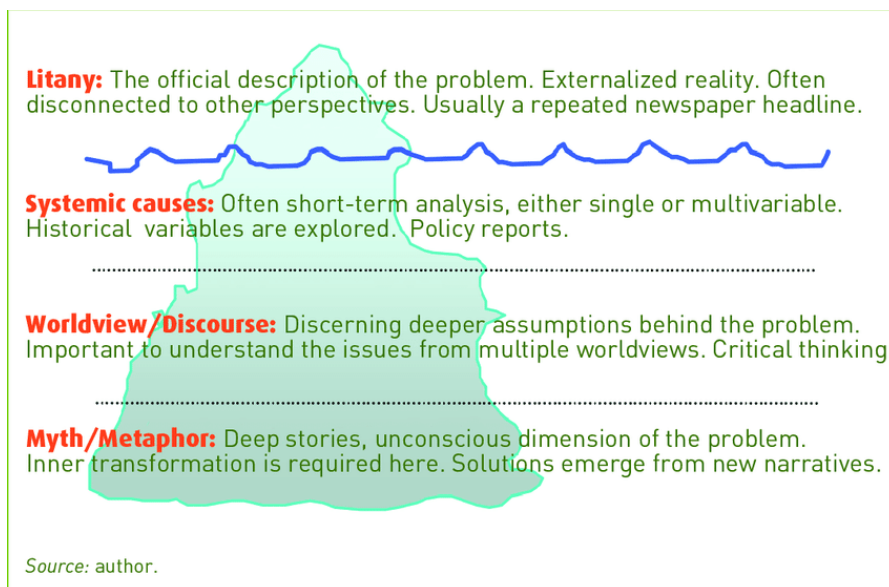
This session aims to connect the session 2 discussion and description of 2040 to the current situation. The trick is trying to spot what may be emergent trends right now – even before they’ve happened! What is it that participants are doing today in their systems that might be a new emergent trend and how might they go about spotting it? How do we get that ‘trust’ into the creative content? Who are ‘specialists’ and what do they do in 2040 and how do we know and trust that they are specialist and capable?

One way to get them to the frame of mind needed is to get them to discuss, for example, a health care system without hospitals or today’s kind of health care professional. If the future is radically different in organizational and even outcome terms, does it change how they think about some of the things that are happening today? If they see some changes in the present in a different, more emergent, more systemic way, does that provoke or inspire ideas about changes in what they do now or assumptions they make about the future?

**Causal Layered Analysis (CLA)**

Each step in the FLL utilized a the CLA approach to capture assumptions and help participants interrogate the assumption to get deeper to elaborate the parameters behind our images of the future. CLA is a tool for analysing future possibilities and alternatives to current social issues (Inayatullah, 2004). The social issue under investigation is deconstructed according to a 4 layers each deeper akin to an iceberg (see fig. 1);

1. Litany: This is the official unquestioned view of reality. The issue presented as the uncontested truth. Usually, it tends to be superficial lacking depth and can result in a sense of helplessness or apathy
2. Social level: In this layer the issues presented in terms of systemic and/or technical explanations. The data of the litany is explained and questioned at this second level
3. World View: This layer explores the deeper, more complex understanding of the issue. Deeper, unconsciously held ideological, worldview and discursive assumptions are unpacked at this level. As well as how different stakeholders construct the litany and system is explored. Providing insights into how an issue is socially constructed.
4. Myth/Metaphor: This layer explores the unconscious emotive dimensions of the issue. Deep mythical stories and social/cultural archetypes, emotional experiences and responses to the issue are explored.



**Fig. 1:** CLA Iceberg model. Source: Inayatullah (2017)

Inayatullah (2004, 2017) points out that the CLA challenge is to conduct research that moves up and down these layers of analysis and thus is inclusive of different ways of knowing. Doing this allows for the creation of authentic alternative futures and integrated transformation. CLA is concerned less with predicting a particular future and more with opening up the present and past to create alternative futures. CLA thus opens up space for the articulation of constitutive discourses, which can then be shaped as scenarios. Bishop, Dzidic and Breen (2013) notes that CLA provides a means to address not only the observed act but also the act in its social, political, historical and cultural context. Thus using CLA ensures that researchers examine not only what has happened and the social context in which action occurred, but it allows examination on the worldviews of the participants and the underlying aspects of culture. (see Inayatullah, 2004, 2017 for a detailed discussion of CLA).

The exercise used a modified 4 steps of the CLA iceberg, from the most obvious (headlines being the emerged aspect of the iceberg) to the most hidden (myths). Participants were tasked to answer the following questions:

- Level 1- Headlines: What headlines best capture them (ex: ‘scandalous inflation of the insect meat’s price’)? (They were asked to come up with at least 7 different headlines on various themes relating to the Bioeconomy e.g. some on waste management, wealth creation or on learning systems etc)
- Level 2- Actors: Who are the actors that render these probable futures possible? (Facilitators were encouraged to ask them to think about various actors who guarantee the survival of the prediction).
- Level 3- Systems: Systems (parameters for these probable futures to come to life or to survive in 2040)? (Facilitators were encouraged to make them not limit themselves to political/economic/technical/environment/socio-cultural and emphasis that systems are about the parameters for this prediction to survive, events/things that have happened. What are the systemic, organic elements that are necessary for your futures to exist?)
- Level 4- Myths: What myths are underlaid, what do they entail (narratives, taboos e.g. insects are the only healthy environment-friendly source of protein at our disposal)

### **Data collection**

Participants were divided into three groups and each session was facilitated by an experienced facilitator. Each group had a scribe who captured the deliberations of the group. Two rapporteurs/observers collected data through observation. At the end of each session, each group presented a plenary and each presentation was discussed. The discussions were captured by the rapporteurs.

### **Results**

The exercise generated many potential futures. Participants also identified actors and systems that could generate potential futures. Examining the futures proposed pointed to the key determinant of the futures as innovation and investment on the one hand and a conducive environment for Bioeconomy on the other. The potential futures were then organized along these two axes to generate potential Bioeconomy futures scenario spaces as shown in fig. 2. The scenario spaces can be categorized as:

**Strong Bioeconomy:** Where conducive policy for a Bioeconomy combines with sustainable innovations and investments. The majority of the futures generated fell in this scenario space reflecting that the group and many of them reflected the preferred futures. This can be expected as these were stakeholders who are invested in developing a strong bioeconomy for the region.

**Conflict Riven Bioeconomy:** This scenario space combines weak bio-economy conducive policies (but strong policies to support free markets) with unsustainable investment and generated the second most set of futures. These produced bad outcomes with bio-resources based conflicts as the main feature of the projected futures. Most of these fell under probable futures indicating that the stakeholders are wary of the current trajectory.

**Conflicted Bio-economy/ Unsustainable Bioeconomy:** This is where conducive policies are combined with unsustainable investments. Therefore, a bio-economy sector emerges but industries emerging are not necessarily sustainable e.g. monoculture indigenous forest. This scenario space underscores the challenge of building sustainable business models. Policies are much easier to put in place than getting the right business models (which is much harder) especially given the fact that the landscape is characterized by small firms which are also largely informal.

Out-competed Bio-economy: This scenario space where free markets policies and sustainable investment produce a world where products can outcompete bio-based products. Though not many futures or visions were generated here, the overriding theme was the emergence of the 4<sup>th</sup> industrial revolution and its potential to generate new products and indeed re-organize how society works.

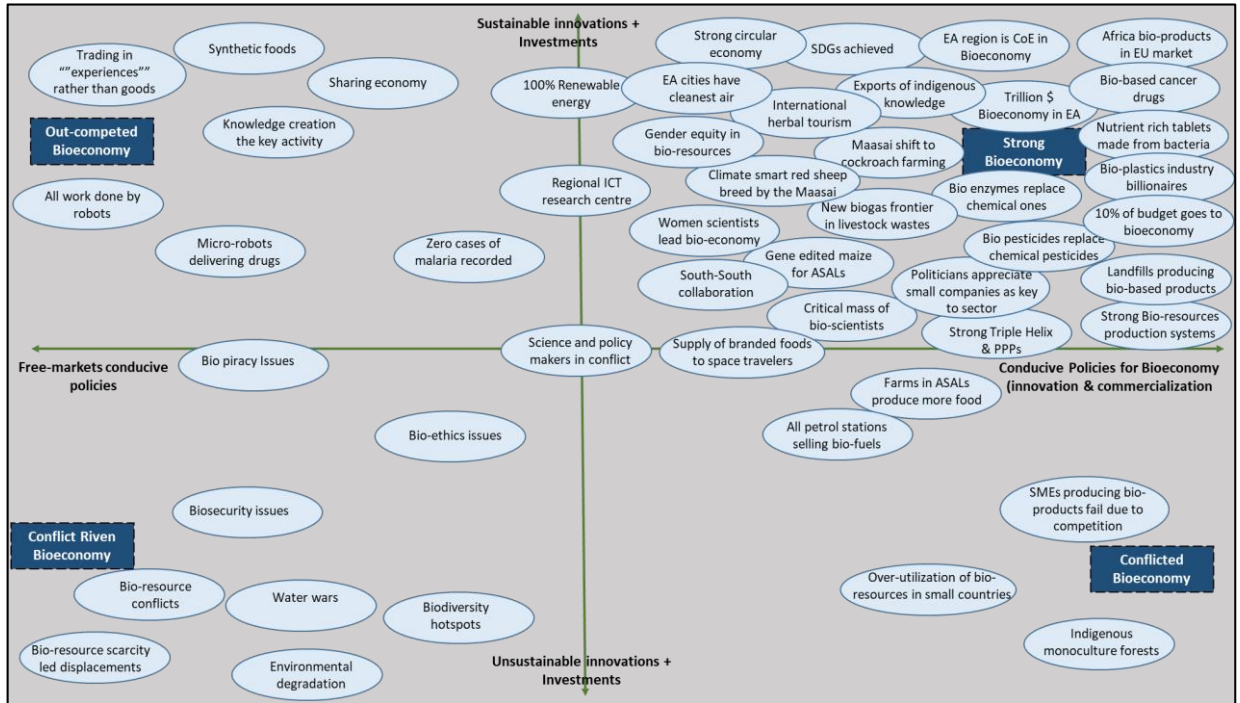


Fig. 2: Bioeconomy Scenario Space

**Policy Implications: What Will It Take to Enable a Strong Bioeconomy?**

As previously noted, there is was a strong expressed preference for a strong bio-economy with the region becoming a centre of excellence (CoE) in Bioeconomy with a vibrant Bioeconomy industrial sector producing and exporting a wide range of bio-based products and even exporting knowledge.

**Bioeconomy pathways**

The discussion also explored potential pathways beyond the traditional agriculture and agro processing that seems to be that default given the huge role that agriculture plays in the East Africa region economies. The results featured very few scenarios that were traditional agriculture focused indicating the wider lens of participants. Potential pathways for bio-based economies identified included:

- Agriculture including GMO products e.g. gene edited maize, insect farming
- Chemicals substitutes: Bio-pesticides, Bio-enzymes
- Pharmaceuticals: Medicines derived from herbal remedies
- Tourism including eco-tourism and medical (herbal) tourism
- Construction products including timber



**Box 1: Ginette's Ecosystem life**

One of the preferred Bioeconomy scenarios captured many of the elements participants considered to constitute a strong Bioeconomy future. This was a description of the self-sustaining Bioeconomy village/town. The key highlight of this town included:

- A factory that uses biogas from the animal produce. The factory produces repellents, cosmetics.
- Planted trees for soil conservation, climate change, mitigation, medicinal
- Rearing of cows for food security and biogas production.
- Because of the stability, there is more revenue generation and reaches the international level and draws the attention of the international trade partners.
- Modernized industry, gain more knowledge from the international exposure to improve life at the local level including Ginette getting empowerment.
- Improved housing (good green apartments), good packaging of milk,
- Improved infrastructure
- International university for bio-economy knowledge growth.
- A regional campus built

**Strong bioeconomy enablers**

A strong bio-based economy necessarily means that bio-based businesses are sustainable and profitable. The participants also interrogated the key enablers needed to make this a reality. The enablers as identified were grouped under four categories: Market Demand; Business Development; Financing and Human Capital. The key features under these enablers were discussed and the following emerged.

**Market demand**

Market demand is a key pre-requisite. A market must exist for there to be a bio-based industry and this requires the following:

- There is a need for a high preference for bio-based products. This requires the promotion of local bio-based products and ensuring the availability of the products;
- Consumers must have trust in the product. This will require a common understanding of the bio-economy including the standardization of bio-based products and a quality assurance framework to give consumers the needed confidence i.e. commercialization and functional regulatory system;
- Favourable procurement policies by governments e.g. green procurement, etc.

**Business development**

Fulfilling a market hinges on business development. While conducive policies are key to attract needed investment, much more is needed. The following key actions are required:

- Feasibility studies to understand the needs;
- Intellectual property frameworks that allow East Africa (EA) countries to leverage their indigenous knowledge and at the same time being able to tap knowledge from modern science;
- A strong Bioeconomy ecosystem with all actors (government, researchers, private sector, civil society) fulfilling their required roles so that viable and marketable products are developed;
- Well developed entrepreneurship capacity, effective incubation services and infrastructure is available;
- Production capacity for bio-products is well developed and necessary support systems exist including supply chains for raw materials;
- A strong triple helix network that brings universities, government and private sector together in a collaborative arrangement. This will help to build trust and shared vision;
- Ethical issues surrounding Bioeconomy are resolved and communicated;
- Political goodwill and also implementation and enforcement of relevant policies

**Financing**

A financing ecosystem that can fund all stages of development of products and viable business is key. This requires:

- Public funds especially for research and development and also start-ups. This can be supported by ring-fenced funding for bioeconomy;
- Venture capital (especially for scaling viable start-ups);
- Incentives and subsidies (to jump-start investment in production);
- Standard financing for on-going business;
- Building public-private partnerships to mobilize resources and share risk

**Human capital**

Developing requisite skills to generate bio-based products and services is key. The basic foundation is education and especially in bio-sciences. However, beyond the sciences, entrepreneurship skills and also hands-on production skills are also crucial. Having needed skills will require:

- Building know-how of bio-based products is supported by key stakeholders especially Universities and also training in schools on the production of bio-based products especially the hands-on skills;
- Bio-based curricula are developed at all levels of education and should include other technologies like robotics. This will require significant reform of the education curricula and putting in place the infrastructures for teaching Bioeconomy including Bioscience and bioinformatics labs;
- Entrepreneurship capacity is developed;
- Students have enthusiasm for the Bioeconomy and embrace a career in Bioeconomy. For this to happen, bio-based businesses need to be seen as profitable enough to justify early learning curricula.

**Towards a strong bioeconomy strategy**

Beyond the key enablers discussed above several issues were also raised that are pertinent to having the desired Bioeconomy future. This is the need to broaden perspectives on what Bioeconomy is, pay attention to political economy issues and also the issue of inclusiveness.

The discussion also pointed to the need to expand mindsets so that opportunities are not missed. The fact that agriculture and food security issues dominate the debate in the EA region means that the wider Bioeconomy topics might be missed if critical questions are not asked. It was pointed that if one carries a hammer then one will only see nails, so there is a need to put the agriculture “hammer” down. Some reflections that could help in developing this broader perspective include:

1. Food vs Feed debate can blinker thinking: Is Bioeconomy about achieving food security or about wealth creation from sustainable comparative advantage? Maybe if feedstock for industry provides better returns for some countries they can specialize and import food from other countries. Comparative advantage should be a key consideration when making choices. Regional specialization in Bioeconomy should be explored;
2. Who are the stakeholders: Currently agriculture and bio-technology sector stakeholders dominate thus limiting perspectives on opportunities. The table needs to be expanded and non-traditional stakeholders brought in including herbalists, architects, engineers, business consultants etc;
3. Bioeconomy is at heart a knowledge-based economy: Though bio-products are the final outputs the key-value addition from traditional products is the knowledge added to them. Thus, knowledge is the key commodity and we should seek to commercialize this too;
4. Bioeconomy is not a new concept: Traditional African economies were bio-based. Nature provided building materials, medicines and fuel. The Baganda made clothes from tree barks. Tree resins were used to manufacture many products including for the treatment of leather. Smelting of metals to make implements and weapons depended on inputs from nature. Thus, the proposed transition to Bioeconomy is a “Back to The Future” story. Thus, traditional knowledge is key.
5. Political economy matters: Development of a strong Bioeconomy will involve coordination of a number of sectors especially agriculture, energy, health, trade, industry and finance. Supportive policies must be made across these sectors. Development of a Bio-based economy is a long term endeavour that will take

years to realize. A long term planning horizon is needed and policy stability is key. Policy coherence and consistency (long term commitment) is extremely important. This can be challenging given that democracies mean regime changes and with this new vested interests come into play. A strong case for Bioeconomy through the compelling narrative is critical in ensuring policies survive regime changes.

6. Inclusion: The issue of inclusion was also seen as crucial and indeed in discussions, the need for women playing a leading role was emphasised. Women already play an important role in agriculture yet capture little of the benefit that comes when agriculture is upgraded. A good regulatory framework also needs to pay particular attention to inclusiveness.

Also in crafting a strategy, there is a need for caution and the following advice was given: (1) Strategy must have a priority since not all activities can be done at once. Develop ideas around a viable idea to ensure it matures; (2) Policy issues may limit some viable ideas; (3) The community may not perceive the whole idea which may lead to sabotage. We should know our Bioeconomy prospects considering the different societal changes; (4) The community may be slow to adopt new ideas and technology; (5) Political instability is also a factor especially for foreign investors; (6) The market may have an alternative (a market survey may not give the full picture); (7) Some innovations may not be accepted by the market.

### **Towards a bioeconomy policy framework**

Bioeconomy has significant potential for transforming the East Africa region through building a bio-based industry to complement the agricultural base of the economies. This will require building skills, innovating new products and business models and also attracting investments to commercialize the innovations. Policies that will be key to building a strong and sustainable Bioeconomy sector include:

- Develop regional and national Bioeconomy platforms that bring stakeholders together and help to ensure policy coherences
- Promote Bioeconomy innovation platforms that bring the research community and industry to develop research agenda, catalyse and commercialize innovations. Platforms focused on different sectors will be ideal e.g. a bio-plastics forum.
- A special fund to support R&D and commercialization of bio-based products. This can be through a carbon tax on unsustainable goods in the market.
- Position Bioeconomy with the wider SDG and Green Economy global push so that funds available from global sources for green economy e.g. Global Environmental Fund (GEF) can be leveraged to develop the Bioeconomy sector.
- Develop an outreach program to help communicate Bioeconomy opportunities, especially to students (to stimulate entrepreneurship and research), investors (to attract investments) and also to consumers to raise awareness and increase consumption
- Stimulate demand for new bio-based goods. Demand can be stimulated by shaping national public procurement policy toward bio-based products. Incentives and mandates can be leveraged. For example, the recent ban on single-use plastics in some countries in the region can be complemented by subsidized for researched and commercialization of cassava bio-plastics.

### **Conclusion**

The current economic model has seen tremendous improvement in livelihoods for many countries, especially the industrialized countries. However, this has come at a cost. Mineral resources are not renewable and thus current consumption jeopardizes future consumption, the economies as structured have created significant pollution and especially released a tremendous amount of Greenhouse Gases (GHGs) that are causing climate change and threatening livelihoods of many. Significant biodiversity is also being lost as natural resources that are feedstock to many industries get overexploited and also higher living standards have created huge demands that cannot be sustainably met by the current economic system. There is now a growing consensus globally for a shift towards more sustainable consumption and greening the economies (UNEP, 2011; OECD, 2011; FAO, 2019; European Commission, 2012) and bio-based economies that seek to sustainably exploit renewable biological resources is seen as a way forward.

Bioeconomy is now seen as a potential transformation pathway for East Africa. However, this pathway is still not very clear. From the foresight exercise, it is clear that stakeholders understand the potential dangers that current trends pose with many seeing potential conflicts emerging as biological resources become scarce. Despite this, there is huge optimism of a better future through proper exploitation of the biological resources. Many stakeholders see the potential of an industrial transformation through the production of an array of bio-based products. However, the key enablers must be in place. Markets need to be created, business need to be developed, skills need to be built and necessary financing infrastructure put in place. These are not in place and the right mix of policies and proper sequencing will be key in getting the desired bio-economy future.

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## Notes

- 1- The countries referred to are six countries in East Africa. Ethiopia, Burundi, Kenya, Rwanda, Tanzania and Uganda) including South Sudan
- 2- Though coal and steam engine were key, the 1st industrial revolution was driven by a number of innovations that when combined created a whole new economy. These were innovations in transport (the railway, business model (the factory) and communication (the telegraph). This allowed goods to be produced cheaply (steam engine + factory production system) and distributed wide(railways) and people to know about them (newspapers and telegraph) (see Rifkind, 2013)
- 3- This concern was first brought to global debate by the well-known “Limits to Growth” study by the Club of Rome (Meadows et. al., 1972) which forecasted a global crisis by around 2000 for several metals (for instance copper reserves were to be exhausted in 2008).
- 4- Some authors make a further differentiation between “Bioeconomy” and “bio-based economy”. Whilst “Bioeconomy” also includes the food and feed sector, the “bio-based economy” only comprises the sectors of bio-based materials and products (incl. pharma) as well as bioenergy / biofuels

## References

- ACET. (2014). *African transformation report- growth with DEPTH*. Accra, Ghana: African Centre for Economic Transformation (ACET).
- ACET. (2017). *Africa Transformation Report: Agriculture Powering Transformation*. Accra, Ghana: African Centre for Economic Transformation (ACET).
- Besi, M., & McCormick, K. (2015). Towards a bioeconomy in Europe: National, regional and industrial strategies. *Sustainability*, 7(8), 10461-10478. <https://doi.org/10.3390/su70810461>
- BiSEA. (2020). *The regional innovation-led bioeconomy strategy for Eastern Africa (Draft Version 1.3.)*. The Regional Drafting and the BiSEA team.
- Bishop, B. J., Dzidic, P. L., & Breen, L. J. (2013). Multiplelevel analysis as a tool for policy: An example of the use of contextualism and causal layered analysis. *Global Journal of Community Psychology Practice*, 4(2). Retrieved September 20, 2020, from <http://www.gjcpp.org/>
- Brugge, M. M., Hansen, T., & Klitkou, A. (2016). What is the bioeconomy? A review of the literature. *Sustainability*, 8(7), 1-22. <https://doi.org/10.3390/su8070691>
- Carus, M. (2017). *Bio-based economy and climate change – Important links, pitfalls and Opportunities*. The UN Food and Agriculture Organization (FAO), nova-Institut, January 2017. <http://www.nova-institut.eu>
- D'Amato, D., Droste, N., Allen, B., Kettunen, M., Lehtinen, K., Korhonen, J., Leskinen, P., Matthies, B. D., &

- Toppinen, A. (2017). Green, circular, bio economy: A comparative analysis of sustainability avenues. *Journal of Cleaner Production*, 168, 716-734.
- European Commission. (2012). *Innovating for sustainable growth: A bioeconomy for Europe*. Luxembourg: European Commission (EC) Publication Office of the European Office.
- European Commission. (2015). *Closing the loop - An EU action plan for the circular economy*. Brussels: European Commission (EC).
- FAO. (2017). *The future of food and agriculture – Trends and challenges*. Rome: Food and Agriculture Organization (FAO).
- FAO. (2019). *Towards sustainable bioeconomy guidelines*. Rome: Food and Agriculture Organization (FAO).
- Global Bioeconomy Summit. (2015). *Communiqué global bioeconomy summit 2015: Making bioeconomy work for sustainable development*. Berlin: Global Bioeconomy Summit. Retrieved from [http://gbs2015.com/fileadmin/gbs2015/Downloads/Communique\\_final.pdf](http://gbs2015.com/fileadmin/gbs2015/Downloads/Communique_final.pdf)
- Hausknost, D., Schriefl, E., Lauk, C., & Kalt, G. (2017). A Transition to Which Bioeconomy? An Exploration of Diverging Techno-Political Choices. *Sustainability*, 9(4), 669. doi:10.3390/su9040669
- Inayatullah, S. (2004). The causal layered analysis (CLA) reader. *Theory and Case Studies of an Integrative and Transformative Methodology*. pp. 1-52. Taipei: Tamkang University Press.
- Inayatullah, S. (2017). Causal Layered Analysis, Prospective and Strategic Foresight Toolbox. *Futuribles International*, 1-21.
- Leipold, S., & Petit-Boix, A. (2018). The circular economy and the bio-based sector - Perspectives of European and German stakeholders. *Journal of Cleaner Production* 201, 1125-1137.
- Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). *The limits to growth: A report for the club of rome's project on the predicament of mankind*. London, UK: Potomac-Earth Island.
- Meyer, R. (2017). Bioeconomy strategies: Contexts, visions, guiding implementation principles and resulting debates. *Sustainability*, 2017(9), 10-31. doi:10.3390/su9061031
- Miller, R. (2004). Imagining a learning intensive society. *Learning in the 21st century: Towards personalisation*, 27-74. Retrieved from [https://www.researchgate.net/publication/310803202\\_Imagining\\_a\\_Learning\\_Intensive\\_Society](https://www.researchgate.net/publication/310803202_Imagining_a_Learning_Intensive_Society)
- Miller, R. (2007a). Futures Literacy: A Hybrid Strategic Scenario Method. *Futures*, 39(4), 341–362.
- Miller, R. (2007b). *Towards a learning intensive society: The role of futures literacy*. Wales Futures Network Cardiff. [http://www.urenio.org/futurereg/files/making\\_futures\\_work/Towards-a-Learning-Intensive-Society\\_The-Role-of-Futures-Literacy.pdf](http://www.urenio.org/futurereg/files/making_futures_work/Towards-a-Learning-Intensive-Society_The-Role-of-Futures-Literacy.pdf)
- Miller, R. (2018). Futures literacy laboratories (FLL) in practice: An overview of key design and implementation issues. In Miller, R. (Ed.). *Transforming the future; Anticipation in the 21st century*. London: Routledge.
- OECD. (2011). *Towards green growth*. Paris: Organisation for Economic Cooperation and Development (OECD).
- Paşnicu, D., Ghența, M., & Matei, A. (2019). Transition to bioeconomy: Perceptions and behaviors in Central and Eastern Europe. *Amfiteatru Economic*, 21(50), 9-23. doi: 10.24818/EA/2019/50/9
- Pfau, S., Hagens, J., Dankbaar, B., & Smits, A. (2014). Visions of sustainability in bioeconomy research. *Sustainability*, 6, 1222–1249.
- Rifkin, J. (2013). *The third industrial revolution*. Palgrave MacMillan
- Scarlat, N., Dallemand, J., Monforti-Ferrario, F., & Viorel, N. V. (2015). The role of biomass and bioenergy in a future bioeconomy: Policies and facts. *Journal of Environmental Development*, 15, 3-34. doi: 10.1016/J.ENVDEV.2015.03.006
- UNEP. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication*. Retrieved from <http://www.unep.org/greeneconomy>
- UNEP. (2014). *Green economy initiative*. Retrieved from <http://www.unep.org/greeneconomy/>

