



Developing an innovation-led regional Bioeconomy
Strategy for eastern-Africa (BiSEA)

BIOECONOMY RELATED POLICIES AND INSTITUTIONS IN EASTERN AFRICA

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LIST OF ABBREVIATIONS AND ACRONYMS

ACP/EU	African, Caribbean and Pacific- European Union
ADLI	Agricultural Development Led Industrialization
AFDB	African Development Bank
AIMS	African Institute of Mathematical Science
ASAL	Semi-Arid Lands
ASDS	Agriculture Sector Development Strategy
ASSP	Agriculture Sector Strategic Plan
AU	African Union
BEST	Biomass Energy Strategy
BiSEA	Bioeconomy Strategy for Eastern Africa
CBD	Convention on Biological Diversity
CESB	Capacity Building Services and Employment Board
CIA	Central Intelligence Agency
COMESA	Common Market for Eastern and Southern Africa
CoP	Conference of Parties
COSTECH	Commission for Science and Technology
CRGE	Climate Resilient Green Economy
DNA	Deoxyribonucleic Acid
DRMFS	Disaster Risk Management and Food Security
EAC	East African Community
EARO	Ethiopia Agriculture and Research Organization
EASTECO	East African Science and Technology Commission
EDPRS	Economic Development and Poverty Reduction Strategy
EIAR	Ethiopian Institute for Agricultural Research
EMCA	Environmental Management and Coordination Act
EPRA	Energy and Petroleum Regulatory Authority
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FDRE	Federal Democratic Republic of Ethiopia
FIT	Feed in Tariffs
FYDP	Five Year Development Plan
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GHG	Greenhouse Gas
GMOs	Genetically Modified Organisms
GoK	Governement of Kenya
GoT	Government of Tanzania
GSE	Geological Survey of Ethiopia
GTP	Growth and Transformation Plan
ICT	Information Communication Technology
IDS	Industrial Development Strategy
ILRI	International Livestock Research Institute
IRDA	Industrial Research and Development Agency
IRST	Institute of Scientific and Technological Research
JBA	Japan Bio-industry Association
KALRO	Kenya Agriculture and Livestock Research Organization
KAM	Kenya Association of Manufacturers
KenGen	Kenya Electricity Generating Company Limited
KENIA	Kenya National Innovation Agency
KEPHIS	Kenya Plant and Health Inspectorate
KIC	Kigali Innovation City

LPG	Liquefied Petroleum Gas
LT	Long-term
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MAPS	Marketing and Agro Processing Strategy
MENWR	Ministry of Environment Water and Natural Resources
MINAGRI	Ministry of Agriculture
MINEACOM	Ministry of Trade, Industry and EAC Affairs
MINICOM	Ministry of Trade and Industry
MINIRENA	Ministry of Natural Resources
MoALFI	Ministry of Agriculture Livestock Fisheries and Irrigation
MoARD	Ministry of Agriculture and Rural Development
MoE	Ministry of Energy
MoEFCC	Ministry of Environment, Forest and Climate Change
MoST	Ministry of Science and Technology
MT	Medium-term
NACOSTI	National Commission for Science, Technology and Innovation
NAEB	National Agricultural Export Development Board
NAP	National Agriculture Policy
NARS	National Agricultural Research System
NBF	National Biosafety Framework
NCPD	National Council for Population and Development
NDP	National Development Plan
NEP	National Energy Policy
NIRDA	National Industrial Research and Development Agency
NRF	National Research Fund
NRIF	National Research and Innovation Fund
NSGRP	National Strategy for Growth and Reduction of Poverty
NST	National Strategies for Transformation
OECD	Organisation for Economic Co-operation and Development
OECD	Organization for Economic Cooperation and Development
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
R&D	Research and Development
RAB	Rwanda Agriculture Board
RARIs	Regional Agricultural Research Institutes
REA	Rural Electrification Authority
REF	Rural Electrification Fund
SADC	Southern African Development Community
SDGs	Global Sustainable Development Goals
SEATINI	Southern and Eastern Africa Trade Information and Negotiations Institute
SIANI	Swedish International Agricultural Network Initiative
SIDA	Swedish International Development cooperation Agency
SIDP	Sustainable Industrial Development Policy
SPTA	Strategic Plan for the Transformation of Agriculture
SSA	Sub-Saharan African
ST	Short-term
ST&I	Science, Technology and Innovation
STEM	Science Technology Engineering and Mathematics
STIP	Science, Technology and Innovation Policy
STISA 2024	Science, Technology and Innovation Strategy for Africa 2024
TDC	Tanga Development Corridor
TDV	Tanzania Development Vision
TOFo	Trees Outside Forest
TVET	Technical, Vocational Education and Training
UNCST	Uganda National Council for Science and Technology

UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
VAT	Value Added Tax
WEF	World Economic Forum
WTO	World Trade Organization
ZSGRP	Zanzibar Strategy for Growth and Reduction of Poverty

EXECUTIVE SUMMARY

Bioeconomy is one of the strategies that can be used to spur cross-sectoral growth and development in developing countries with underutilized bio-resources. Globally, some countries have developed strategies that are exclusively geared towards promoting sustainable Bioeconomy growth and development. For instance, the European Union (EU) has the EU 2020 Strategy that aims to have an innovation-led EU and a resource efficient Europe through development of a bio-based economy. Sub-Sahara African (SSA) countries though indicative of economic growth, face a myriad of challenges ranging from poverty, climate change to an accelerated population growth that puts pressure on biological resources. This calls for a renewed transformative approach towards addressing the complex developmental challenges in the region so as to ensure sustainability. The aim of the BiSEA project is to ensure a knowledge-based innovation led Bioeconomy that can inspire and catalyse the development of national Bioeconomy strategies and subsequent policies and interventions that are able to create new jobs and a sustainable bio-based and inclusive economic growth in the region. This is in line with the African Union's Agenda 2063 and most specifically the STISA 2024 as well as the current Science, Technology and Innovation Policy for East African Community (EAC).

Most specifically, this study reviewed the existing policies and strategies that are related to and or in support of the Bioeconomy development in eastern Africa to identify what has worked, what has not worked and why with a view to position the development and acceptance of Bioeconomy issues to aid sustainable development. Results show that whereas there are many existing policies related to Bioeconomy development, there is no explicit Bioeconomy policy or strategy in the region. Available policies and strategies in eastern African countries that are closely related to Bioeconomy development border mostly around Science, Technology and Innovation Policy/Strategy; Environment Policy/Strategy; Biotechnology Policy/Strategy; Agricultural Policy/Strategy; Industrial Policy/Strategy; and sometimes Energy Policy/Strategy among others. Few of these policies/strategies have made mention of a deliberate effort to harness the abundant bio-resource potentials in the region for the production of goods and services in a sustainable manner. This therefore gives impetus for the development of a standalone Bioeconomy policy/strategy in the region that will guide the application of the rich and available knowledge base in the production and utilization of goods and services from bio-resources for economic advancement across all sectors including agriculture, energy, health, environment, etc. in a sustainable manner. To achieve this, it became imperative to liaise with the relevant national bodies and agencies responsible for policy and strategy development in the region to come up with a suitable Bioeconomy strategy and or policy that will be able to drive the development of the subsector in the coming years both at the national levels as well as at the regional level.

From the interactions with the key stakeholders in the region, they are all positively disposed to having a standalone Bioeconomy policy/strategy both at the regional level to address regional issues and the national levels to address peculiar national issues and interests relating to Bioeconomy development. Besides, there exist national development agendas and visions which can provide a good enabling environment to build the Bioeconomy strategy/policy in the region. Stakeholders expressed delight that the Bioeconomy agenda is very timely considering the need to deploy existing and abundant human and bio-based resources in the region to combat the complex societal challenges of poverty, hunger, disease, climate change, unemployment, and limited access to energy resources among others in the region. To drive this agenda, they also identified various frameworks and institutions that are well positioned to champion the development and implementation of Bioeconomy strategies in the region and countries including the East African Science and Technology

Commission (EASTECO); the various national commissions/councils for science and technology in the region; ministries of agriculture, environment, health, industry and education among others.

A quick examination of the statuses of Bioeconomy related policies, strategies and institutions in the region provide a better picture of the need to harness its full potentials for sustainable development of the sector in the region.

In Ethiopia, the concept of Bioeconomy is new and does not appear in most of the existing policies and laws. Although the policies and laws address the utilization of bio-resources, renewable resources and biotechnology which are the bases of Bioeconomy, they do not explicitly address the issues involved in the context of Bioeconomy development. Some of the relevant policies and strategies include Ethiopia's development strategy focusing mainly on Agricultural Development Led Industrialization (ADLI), Rural development policy and strategy (2002), Industrial Development Strategy (2002), the national water resources management policy (1999), the Education and Training policy (1994), the Science, Technology and Innovation Policy (2012), the Ethiopian Environment Policy (1997) and the Proclamation on Access to Genetic Resources and Community Knowledge and Community Right (2006) among others.

Favourable macroeconomic factors exist for Bioeconomy development such as the two growth and transformation plans, GTP I (2010/11-2014/15) and GTP II (2015/16-2019/20), rapid economic growth, enhanced value addition and expansion of the labour markets. With regard to technological innovation and readiness, the Science, Technology and Innovation Policy of Ethiopia (2012), was pointed as a key instrument for Bioeconomy development. Other Bioeconomy support factors include the availability of skilled and trainable manpower, the existence of institutions, technology roadmaps for 24 sectors (2015-2025), a number of newly established industries and parks; the presence of a national science, technology and innovation council and a national research council and biotechnology council. The current Ethiopian education system has increased the number of public universities and other institutions of higher learning thus promoting research, higher education and training in the country. The establishment of industrial parks and the Ethiopian commodity exchange promote Bioeconomy development related infrastructure. For sustainable implementation, adoption of relevant policies and strategies is crucial. There is also the need to increase budgetary allocations for Bioeconomy related activities, promote public awareness on Bioeconomy, create a favourable business environment, and strengthen public-private partnerships and investment in the production of trained manpower among others. Additionally, creating platforms for public-private partnerships in networking on Bioeconomy issues, development of guidelines, benchmarking for developing standard operating procedures, curriculum development, preparation of science and technology roadmaps and establishment of Bioeconomy departments in institutions of higher learning becomes necessary. Other recommendations include: the development of bills, policies, strategies, acts and regulations, institutionalization of bio-economy agency/ministry, Intra and inter trade cooperation on Bioeconomy, establishment of Bioeconomy centres of excellence in institutions, establishment of a Bioeconomy university and creation of a Bioeconomy database and infrastructure.

In Uganda, Bioeconomy development is appreciated mostly in areas of biotechnology and use of biomass for energy. Concerted efforts have been made towards development of the bio energy sector through establishment of the Biomass Energy Strategy (BEST) which recognizes the importance of biomass in all sectors of the economy. Other relevant policies include the Renewable Energy Policy for Uganda (2007) and the National Biotechnology and Biosafety Policy (2008) among others. Stakeholders appreciate the capability of Bioeconomy development in addressing unemployment issues in the country as a macroeconomic indicator.

The establishment of the Ministry of Science, Technology and Innovation in 2016 and bio-ethanol production from cassava among others indicate the country's commitment to improved technological innovation. The establishment of a National Innovation Fund Framework indicates a milestone achieved in research, higher education and training. Infrastructure development is also fairly done with roads built as the major biomass transport means. Proposed policy and strategic recommendations include formulation of favourable policies, policy coherence and human resource capacity building. Besides, there is need for the assessment of the existing human resources to inform need for capacity building. Other recommendations for a Bioeconomy strategy in the country include responsible regulation on the use of biological resources, adaptation of the existing technologies, establishment of a well-coordinated legal and regulatory framework, creation of an enabling business environment, adequate political goodwill, and enhancement of international collaborations as well as increasing government budgetary allocation to Bioeconomy related sectors.

In Kenya, key structural, political and economic changes have been made aimed at promoting economic growth and development, including the promulgation of the new 2010 constitution and establishment of the devolved/county governments among others. In an effort to promote Bioeconomy growth and development, the country has frameworks such as the Strategy for developing the Bio-Diesel Industry in Kenya (2008-2012), the National Biotechnology and Development Policy (2006) among others. In a macroeconomic context, sustainable growth and development of bio-based industries and demand for bio-based products is highly dependent on enabling business environment, public private partnerships, and political stability. Technological innovations can be used as a tool to drive industrialization in different thematic areas such as health, energy and agricultural biotechnologies aimed at promoting increased productivity and bio-based products through value addition. To promote technological innovation for inclusive economic growth, the Kenyan government has put in place legal and institutional frameworks, such as the National Commission for Science, Technology and Innovation (NACOSTI), the Kenya National Innovation Agency (KENIA) and the National Research Fund (NRF) to coordinate innovation and research activities among others. To promote research, higher education and training, Kenya has increased its budgetary allocations on research and development targeting 2% of GDP by 2030. Additionally, key infrastructure investments have been made to reinforce Kenya's position in the regional power market by connecting to Ethiopia, Uganda and, in the future, Tanzania. As a sign of commitment to Bioeconomy development, various sector specific policies and strategic plans have been formulated. These include the National Energy Policy (2014) which recognizes the contribution of biomass (68%) to the energy sector in the country and the Strategy for developing the Bio-diesel Industry in Kenya (2008-2012), the National Environment Policy (2013), the National Trade Policy (2017) and the National Climate Change Response Strategy (2010) to mention but a few.

Being a signatory to the Convention on Biological Diversity (CBD), Kenya has a National Biodiversity Strategy and Action Plan 2000 whose mandate is to ensure biodiversity conservation and sustainable utilization of biological resources. Bioeconomy development is heavily reliant on presence of a favourable operating environment that encompasses fiscal policies, parliamentary acts and strategies that act as drivers for a competitive knowledge-based Bioeconomy development. Policy review and analysis indicate presence of policies, acts, legal frameworks and institutions to guide and provide a framework for Bioeconomy development in the country. Therefore, it can be recommended that for Kenya to achieve a coveted milestone in Bioeconomy development there is need to ensure coherence of the existing policies, legislations and regulatory frameworks. Effective and efficient sectoral coordination between relevant regulatory institutions involved in biomass use is a prerequisite. There is also need for explicit legal, regulatory and institutional frameworks on biomass generation, production, distribution and supply. The government should

also provide fiscal incentives for biomass production projects, plant and equipment for utilization in different areas of the economy.

In Rwanda, the concept of Bioeconomy is still in its infancy stages. With agriculture being the mainstay of the economy, it has a great potential in driving Bioeconomy development in the country. However, despite its significance, there is low use of high technology, unavailability of the necessary skills and inadequate bio-productive land. Rwanda is making some progress in Bioeconomy development, as depicted in the existing policies and development plans by the government and the private sector. From the macroeconomic point of view, various government policies are present to spur Bioeconomy development. For instance, the Made in Rwanda policy which promotes the consumption of locally made products, policy incentives such as use of fertilizer subsidy and the tax exemptions on specific agricultural inputs in the country, among others provides the enabling environment for Bioeconomy development to thrive in the country. With regards to technological innovations and readiness, the country is home to a number of technological entities such as the African Institute of Mathematical Science (AIMS), EASTECO, Kigali Innovation City and innovation hubs such as the K-Lab and Fab lab. The country also has a National research and innovation fund launched in mid-2017 dedicated to innovation and the Rwanda Development Board hosted by the Ministry of ICT and Innovation. To promote research, higher education and training, the National Commission for Science and Technology is committed to put in place a national research agenda which has a focus on developing biotechnology and building human capital through partnership and support from various stakeholders, as well as an increase in the number of training centres.

Rwanda has initiatives to develop green smart cities through the Rwanda Green City project. The country's transport system is also fairly developed indicating some commitment to infrastructure development. From the discussions, some policy and strategic recommendations were given for Bioeconomy development in the country, such as Investing in biological waste processing, formulating appropriate policies and strategies to create enabling environment, promotion of eco-tourism through conservation policies, promotion of bio bank and medical tourism through capacity building and development of infrastructure.

In Tanzania, the economy is agriculture dependent with other sectors like mining, tourism and manufacturing making significant contributions. The country's macro-economic environment for Bioeconomy development is characterized by prudent monetary policies, favourable food prices and declining fuel prices. However, the banking sector institutions are not very compliant with financing Bioeconomy and biotechnology related projects, thus a major setback. As a sign of technological innovation and readiness, the agricultural sector is well equipped with the necessary infrastructure, thus making it competitive in the region. In addition, the Commission for Science and Technology (COSTECH) has recently funded 15 innovation hubs in the country, hence a major step on Bioeconomy development. With respect to research, higher education and training, the country is more skewed towards applied research, with Gross Domestic Expenditure on Research and Development (GERD) being less than 0.5%. The level of infrastructure development in Tanzania is quite demanding, with the primary sources of energy being solar and petroleum-powered generators. The road system in the country is good so far with expected constructions in the near future.

Tanzania's commitment to Bioeconomy development is evident from the existing cross-sectoral policies and strategic plans. To create an enabling environment for Bioeconomy to thrive, there is need to promote its competitiveness through ensuring political stability and goodwill, infrastructure development, stabilizing interest rates, strengthening public private partnerships and establishment of a central coordination and

regulatory body for Bioeconomy activities. For sustainable implementation, there should be human and technological capacity development, creation of favourable business, legal and regulatory environment, increasing budgetary allocation on research and innovation and ensuring availability of an inventory of biological resources. From the discussions with stakeholders, it was recommended that for Tanzania to develop its Bioeconomy, it should venture in Bioprospecting / value addition and conserve biodiversity. It should also incentivize producers to do bioprocessing through rules and regulations and create awareness on the importance of Bioeconomy.

Burundi has not embraced the concept of Bioeconomy in its national policies and institutional frameworks. Its economy is agriculture based, contributing between 40 and 60 percent of the Gross Domestic Product (GDP). Burundi remains a Fragile State given the recurrent socio-political tensions erupting into violent conflicts, which have led to high food insecurity, poverty, and inequality. Its economic growth has relied on steady depletion of its natural resource base, and as a result, the country's natural environment has been substantially degraded. Besides, over 90% of the population depends on biomass for fuel, with minimal dependency on electricity and solar energy. As a remarkable milestone in Bioeconomy development, the country has formulated a National Biodiversity and Action Plan (2000), though faced with implementation challenges. Burundi is also a signatory of the World Heritage Convention, the African Convention on the Conservation of Nature and Natural Resources and the Bamako Convention on the Prohibition of Imports and the Control of Transboundary Movement of Hazardous Wastes (1991) among others. Other relevant policies include the Burundi vision 2025 approved in 2011, the Environmental Code of Burundi (2000) and the Growth and Poverty Reduction Strategy Paper II (2012) and the National Agriculture Strategy (2008) among others.

At the macroeconomic level, political instability, high poverty levels, continued degradation of the natural resource base and lack and/or inadequate policy and strategic background are serious impediments to Bioeconomy development in Burundi. However, as an indication of commitment to technological innovation and readiness, Burundi has met the 10% GERD/GDP for Agriculture. National Policy on Scientific Research and Technological Innovation is also being implemented. Additionally, various institutional frameworks have been established for research and development. With regard to infrastructure, Burundi relies on road systems, since the country is landlocked and has no rail system. For optimal operationalization of Bioeconomy in Burundi, government should put up projects and programs to conserve the endangered bio-resources. It should also formulate policies and strategic plans to guide the growth and development of its key sectors like agriculture. For sustainability of Bioeconomy, there is need for the government to invest more resources in infrastructure development, human resource capacity building and establishment of proper legal and regulatory frameworks.

From the policy and institutional framework review done, it is recommended that for Burundi to be in the fore front with regards to Bioeconomy development, adequate and relevant policies and strategic plans need to be formulated. There is also the need to ensure policy and institutional coherence to support and guide efficient utilization of the existing biological resources, like the biofuels. Public awareness and sensitization are also paramount to embrace biotechnologies among other aspects of Bioeconomy development. Since the country's economic instability is attributed to political instability, national cohesion is also required. In conclusion, public private partnerships should be advocated to create synergies in Bioeconomy policy development and implementation.

OVERVIEW OF GLOBAL AND REGIONAL BIOECONOMY POLICIES, STRATEGIES AND REGULATORY FRAMEWORKS

1.1 INTRODUCTION

Bioeconomy is one of the strategies that can be used to spur economic growth and development and sustainable impacts in developing countries that have underutilized biomass to drive growth in other sectors such as manufacturing and industrialization. The Japanese industrial sector for instance has established a Japan Bio-industry Association (JBA) which promotes application of biotechnology in the various industrial fields (JBA, 2020). Other regions include Europe has promoted bio-industrialisation through initiatives and platforms such as the EuropaBio which champions use of health, agriculture and industrial biotechnology among others (Europabio, 2020). Bioeconomy development in Europe is reliant on innovation and diversification into food processing, bio refinery development and biotechnology applications as a pathway to bio-based industries (EU, 2012)

The Food and Agriculture Organization (FAO), refers to Bioeconomy as “the knowledge-based production and utilization of biological resources, biological processes and principles to sustainably provide goods and services across all economic sectors” (Bracco et al, 2018). The European Union on the other hand defines Bioeconomy as "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. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge"(Biostep, 2020) whereas the Organization for Economic Cooperation and Development (2009) terms Bioeconomy as “the aggregate set of economic operations in a society that use latent value incumbent in biological products and processes to capture new growth and welfare benefits for citizens and nations”.

The concept of Bioeconomy is perceived as inclusive approach contributing to agriculture, natural resource management, and development of the blue economy, manufacturing and processing using advanced technological innovations. Global trends are pointing towards accelerated Bioeconomy development as evidenced in continued development of regional and national Bioeconomy strategies across the globe. These include the European Bioeconomy strategy which is has a focus on the circular economy, Namibia which is in the process of developing a national Bioeconomy strategy anchored on biotechnology and in recent times efforts by the Bio-resources Innovations Network for Eastern Africa Development (BioInnovate Africa) to initiate development of an Eastern Africa Bioeconomy strategy in Kenya, Ethiopia, Uganda, Tanzania, Rwanda and Burundi (Council, G.B, 2018). A positive trend notwithstanding, Bioeconomy development has received criticism on its sustainability without compromising the ability of future generations to meet their needs (UN, 1987). Among other emerging issues include the ability to produce bioenergy crops without comprising food production, world food prices and food security; and the overreliance of Bioeconomy on biological resources and their effects on environmental degradation and loss of biodiversity (Issa et. al, 2019)

The Bioeconomy to 2030: Designing a Policy Agenda, (OECD, 2009) highlights the importance of application of biological sciences in different fields such as agriculture, manufacturing and health as a solution to the increasing environmental pressure and biodiversity loss. It is also projected that about 75 % of economic contributions to the Bioeconomy growth will directly come from agriculture and bio-based industries. However, despite this significant contribution majority of the stakeholder funding is geared towards

applications in the health sector. Bioeconomy offers global, regional and national governments a platform to rethink their development strategies by offering solutions to constrained biological resources, environmental sustainability and reduce their carbon footprint. Reducing over reliance on fossil fuels has been proposed as one of the ways to grow bio-based economies while reducing greenhouse gas (GHG) emissions and mitigating climate change effects. This can however be achieved through sound policy and institutional frameworks that cuts across economic, social and environmental sustainability to promote efficient biomass production and use.

Biomass is defined as a natural substance that is derived from either living or recent living organisms (SIANI, 2020). It can be categorized into food, feed, energy sources, and raw materials (SIANI, 2020). Countries that depend on agriculture can benefit from an increased demand for biomass, especially when there are high levels of value-addition to the biomass raw product in labour-intensive processing sectors. There are many complexities such as the conflicting use of biomass for food purposes and bioenergy crops production, involved when exploring biomass-based economic growth. For many agricultural crops, the agro-processing approach is suitable in comparison to use and export of raw produce (SIANI, 2020). This method details the range of activities involved in bringing a product from its production to consumption through use of modern agro-processing techniques.

1.2 GLOBAL AND REGIONAL PERSPECTIVES ON THE BIOECONOMY

At the global level countries and governments have developed strategies that are exclusively geared towards promoting sustainable Bioeconomy growth and development. For instance, the European Union (EU) has the EU 2020 Strategy that aims to have an innovation-led EU and a resource efficient Europe through development of a bio-based economy. The strategy recognizes the need to achieve food security, mitigating and adapting to climate change effects and reducing unsustainable use of natural resources among other global challenges. Additionally, the strategy has emphasis on a knowledge-based Bioeconomy achieved through public and private investment in research and innovation in areas such as agriculture, bioenergy and bio refineries (Staffas et. al, 2013)

In the United States, the National Bioeconomy Blueprint of 2012 is a policy document that paves way for current and future Bioeconomy discourse while relying on the past policies and strategies. It is anchored on applications of genetic engineering, manipulations of biomolecules and DNA sequencing as a vehicle to drive sustainable development in health, agriculture and environment. This is in tandem with research and innovation and efficient use of bio resources. The bio-based economy significantly contributes to the growth of the American economy through job creation and manufacturing of bio-based products. Trends show that, the bio-based industry created an estimate 4.2 million jobs in 2014 and directly contributed \$393 million to the economy through value addition (Bioeconomista, 2018).

The African continent is predominantly an agriculture-based industry without an advanced manufacturing sector. A number of Bioeconomy policies have emerged in the region with countries such as Mali, Namibia, Mozambique, Kenya and Uganda among others working with regional organizations and international partners to promote Bioeconomy growth. On the forefront in such initiatives is South Africa which has developed a Bioeconomy strategy: The National Bioeconomy Strategy, 2013. The strategy has focuses on agriculture, health, industries and environmental innovation while incorporating indigenous knowledge system to conserve and maintain biodiversity (Brocco et. al, 2018). Coordination and cooperation between national and regional governments has seen increased investment from donors and development partners into Bioeconomy related

activities and projects. This has been demonstrated by the Biomass Web project in Ethiopia, Ghana, Kenya and Nigeria, which aims to increase productivity and efficiency along the value chain including producing, processing and trading biomass an initiative of the German government and a Swedish International Development cooperation Agency (SIDA) initiative in eastern Africa to promote development of bio-innovations.

Sub-Sahara Africa (SSA) countries though indicative of economic growth, face a myriad of challenges ranging from poverty, climate change to an accelerated population growth that has put pressure on biological resources. Demographical statistics of the eastern African region indicate one of a high demographic dividend and an increasing young population (c.f. Fig 1 and Table 1), with an average population growth rate of **2.81%** against 1.158% of the world and comparable to that of sub-Saharan Africa (excluding high income) of 2.7%. As a region with agriculture as its mainstay, this population growth increases demand for biomass and biobased products, signalling a requirement for the development of diversified value-added products

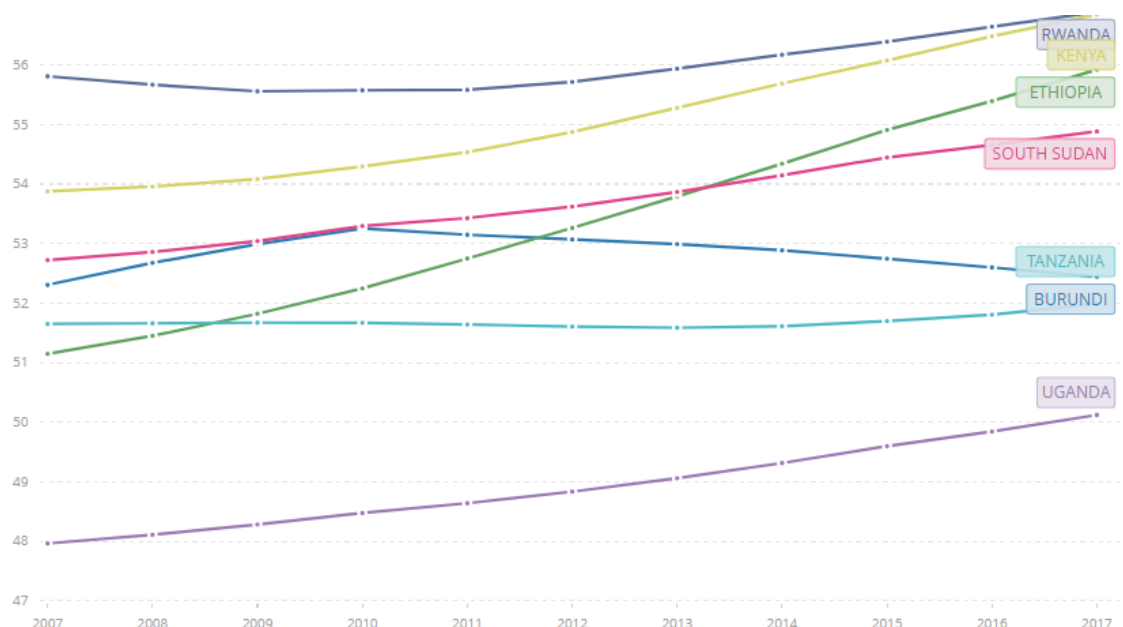


FIGURE 1: INCREASING YOUNG POPULATION (15-64 YEARS) FROM 2007-2017 IN THE EASTERN AFRICAN COUNTRIES

TABLE 1: POPULATION AND DEMOGRAPHIC STATISTICS, EASTERN AFRICAN REGION
POPULATION AND DEMOGRAPHIC STATISTICS, EASTERN AFRICAN REGION

	Population (2017)	Population Growth rate (2017)	Population ages 15-64 (% of total) (2017)
Burundi	10,864,245.00	3.18	52.44
Ethiopia	104,957,438.00	2.46	55.92
Kenya	49,699,862.00	2.52	56.85
Rwanda	12,208,407.00	2.41	56.89
South Sudan	12,575,714.00	2.78	54.89
Tanzania	57,310,019.00	3.08	51.98
Uganda	42,862,958.00	3.26	50.12

The political environment in the region has been quite stable in the recent past, with the exception of South Sudan and Burundi, which have experienced protracted and perpetual crises, causing disruption of its governance structures and livelihoods. The political systems in the country are majorly either presidential or parliamentary, with Ethiopia having a Federal government and Tanzania having a Unitary system (Table 2).

TABLE 2: CURRENT POLITICAL SYSTEMS (2018) IN THE EASTERN AFRICAN COUNTRIES.
CURRENT POLITICAL SYSTEMS (2018) IN THE EASTERN AFRICAN COUNTRIES.

Burundi	A transitional presidential representative democratic republic, whereby the President of Burundi is both head of state and head of government, and of a multi-party system	The Republic of Burundi
Ethiopia	Federal parliamentary republic, whereby the Prime Minister is the head of government	Federal Democratic Republic of Ethiopia
Kenya	A presidential representative democratic republic, whereby the President of Kenya is both head of state and head of government, and of a multi-party system in accordance with a new constitution passed in 2010.	The Republic of Kenya
Rwanda	A presidential republic, whereby the President of Rwanda is both head of state and head of government, and of a multi-party system	The Republic of Rwanda.
South Sudan	A presidential representative democratic consociation list republic, where the President of Sudan is head of state, head of government and commander-in-chief of the Sudanese Armed Forces in a multi-party system.	The Republic of South Sudan
Tanzania	A unitary presidential democratic republic, whereby the President of Tanzania is both head of state and head of government, and of a multi-party system	The United Republic of Tanzania
Uganda	A presidential republic, in which the President of Uganda is both head of state and head of government. There is a multi-party system	The Republic of Uganda

This political environment supports a growing economy, with an average growth rate of **5.44%** as of 2017, with the Federal Democratic Republic of Ethiopia having the highest GDP growth rate of 10.25% (Table 3). This growth rate has been quite steady in the last years (c.f. Fig 2). In light of the role of research and development in building a robust Bioeconomy, there lacks adequate statistics on the national expenditure in research and development (GERD), with available statistics indicating an investment of below 0.2%.

TABLE 3: GDP AND GERD FIGURES ACROSS THE EASTERN AFRICAN REGION

	GDP (current US\$) – 2017	GDP Growth (annual %) - 2017	GERD (2014)
Burundi	3,172,416.15	0.50	
Ethiopia	80,561,496.13	10.25	
Kenya	79,263,075.75	4.87	
Rwanda	9,135,454.44	6.06	
South Sudan	-	-	
Tanzania	52,090,321.00	7.10	
Uganda	25,995,031.85	3.86	0.17

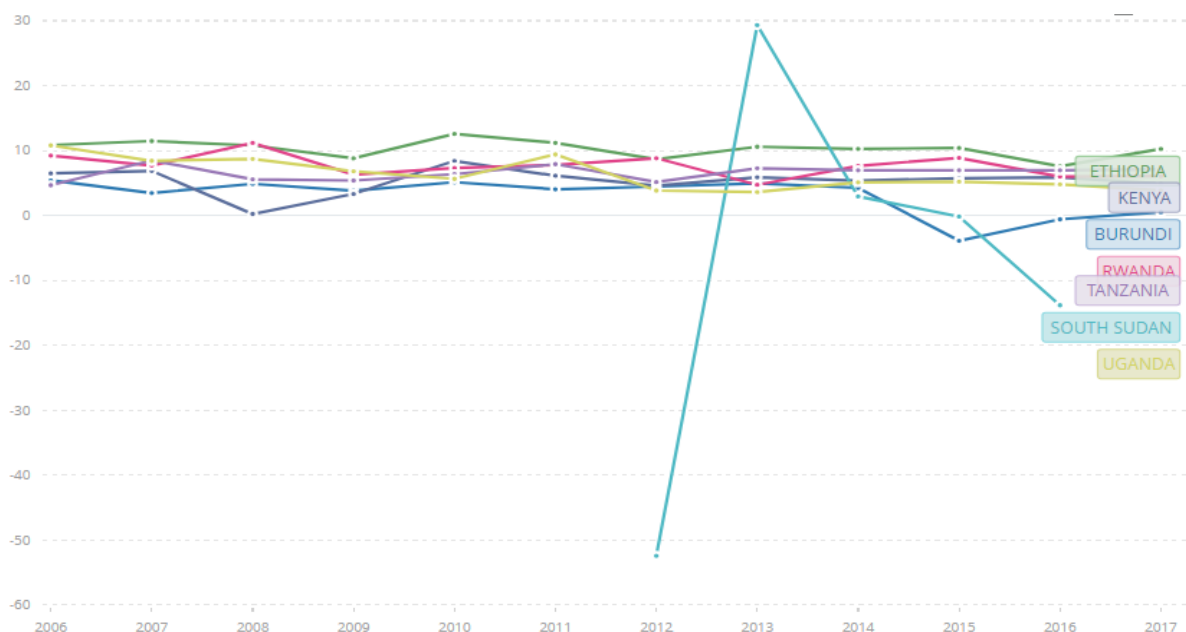


FIGURE 2: MOSTLY STEADY GDP GROWTH (ANNUAL %) FROM 2006-2017

SOURCE; WORLD BANK NATIONAL ACCOUNTS DATA, AND OECD

Of the economic growth, the core bio-based industries (agriculture, forestry and fishing) accounted for a regional average of **30.826%** of the total GDP in 2017. This further illustrates that key biomass production areas are the mainstay of the region. Tanzania has the highest rain cover in percentage of land area of **51.58%**, while Kenya has the lowest (based on available statistics) of **7.82%** (Table 4).

A growing demand for food and feed, the competing uses of natural resources and population pressure are issues that require visionary and concerted efforts by governments, donors and the private sector for sustainable growth. Modern biosciences and coupled with technological applications are providing an avenue for food production, mitigation of environmental wastes, energy production and bio based products while conserving the already existing bio diversity. However, such developments are highly interlinked with the level of innovation, the presence or absence of enabling legal and institutional frameworks, an enabling macro environment that encourage investments in the Bioeconomy, government investment in research and development and well-developed infrastructure.

TABLE 4: CONTRIBUTION OF AGRICULTURE, FORESTRY AND FISHING IN THE EASTERN AFRICAN ECONOMIES

	Agriculture, forestry, and fishing, value added (% of GDP) – 2017	Forest Cover (% of land area) – 2016
Burundi	-	10.93
Ethiopia	34.00	12.54
Kenya	34.64	7.82
Rwanda	30.96	19.73
South Sudan	-	-
Tanzania	30.13	51.58
Uganda	24.58	9.68

1.3 POLICIES AND STRATEGIES RELATED TO BIO-ECONOMY DEVELOPMENT IN THE EAST AFRICAN COMMUNITY (EAC)

The Eastern Africa region is endowed with immense bio-resources which can be utilized to spur economic growth and development in the region. All the economies in the region are primarily dependent on the existing natural resource base across different sectors for their social and economic growth. As a result, identifying and protecting those bio-resources is crucial as well as building the region's capacity to harness them for economic development. For successful bio-economy development in the region, there is need to formulate and fully implement a bio-economy policy or strategy in the region. Although the region does not have a specific bio-economy policy or strategy, there are various regional policies, strategies and regulations that cover various aspects of bio-economy development. These are described under some major bio-economy sectors below:

Agriculture

Agriculture is the mainstay of almost all economies in the Eastern African region. Its roles range from ensuring food security, source of foreign exchange to the economies, creation of employment and provision of industrial raw materials among others. It also accounts for a substantial share of the countries' GDP, hence its importance cannot be overlooked. Although the region is well endowed with natural resources for agricultural production, more often it is faced with challenges of food and nutrition insecurity coupled with high poverty levels. To guide and support this sector, various policies, strategies and regulations have been put in place.

The East African Community Food and Nutrition Security Action Plan of 2018 – 2022 aims to contribute to elimination of hunger, malnutrition and extreme poverty in the region by 2022. This is attained through improving sustainable and inclusive agricultural production, productivity and trade of crops, animals and animal resources, fisheries, aquaculture, apiculture and forest products. Moreover, it focusses on strengthening the people's resilience through promoting sustainable utilization of natural resources, environmental conservation and post-harvest value addition among others. This strategy is cognizant of the need to ensure efficient and sustainable utilization and conservation of the region's biological resources as a key driver to sustainable agricultural growth, hence expressing its support for bio-economy development.

The IGAD Regional Strategy and Implementation Plan of 2016 – 2020 provides a strategic and integrated framework for regional cooperation in the IGAD priority areas of intervention, which include agriculture, livestock, fisheries, natural resource management, environment and climate, regional economic cooperation and integration, social development, peace and security. With respect to agriculture, natural resources and environment, this plan aims to promote the attainment of food security and sustainable management of the environment and natural resources as well building the resilience to natural disasters like drought among others. To achieve this objective, it advocates for proper use, management and protection of the existing natural and biological resources within the region, thus supporting bio-economy development.

The EAC Agriculture and Rural Development Policy of 2006 intends to achieve food security in the region and improve agricultural production within the member states. This is achieved through improving the standards of nutrition by increasing output, quality and availability of food in the region, encouraging the development of new and appropriate agricultural production technologies that improve land and labor productivity as well as promoting sustainable use and management of soil, water, fisheries and forest resource in order to conserve the environment. This policy supports bio-economy development since it promotes sustainable use and

management of various biological resources like fisheries and forests in order to achieve sustainable development in the region.

The EAC Agriculture and Rural Development Strategy of 2005 – 2030 envisions a well-developed agricultural sector for sustainable agricultural economic growth and equitable development. The strategy focusses on promoting and facilitating the development, production and marketing of high quality agricultural produce thus attaining food security, eradicating poverty, increasing agricultural incomes and achieving sustainable development within the partner states. The strategic intervention employed to achieve the stated objectives include increasing the quantities and quality of agricultural production, increasing income generation through processing, value addition and marketing, supporting agro-based industrialization, promoting export of agricultural produce and conservation of natural and biological resources for economic development, thus supporting bio-economy development.

Environment and Climate

Sustainable economic growth and development of the Eastern African region is tied to the state of its environment and natural resource base. The region is faced with various environmental challenges that impede its success in attaining sustainable economic development across the member states. These include soil degradation, deforestation, overgrazing, climate change and loss of biodiversity and extinction of endangered species among others, with adverse effects on food and water security. These challenges cut across different sectors since the region is highly dependent on its natural resource base for development. Although most of the countries in the region are active members of international environmental conventions, protocols and agreements, various regional policies, strategies and regulations have been implemented.

The Fourth EAC Development Strategy of 2011 – 2016 recognizes the value of the region's productive sectors in the people's livelihoods which include agriculture, tourism and wildlife, environment and natural resources, industry and energy. This strategy plays a pivotal role in designing regional economic integration as a prerequisite to globalization through sustainable use of resources, value addition, trade and enhanced competitiveness. To ensure sustainable natural resource management, environmental conservation and mitigation of climate change impacts in the region, the strategy aims to promote and protect the indigenous/traditional knowledge associated with biological resources and natural eco-systems. In addition, the strategy focusses on harmonizing the bio-safety policies related to genetically modified organisms (GMOS), thus expressing its support for bio-economy development in the region.

The East African Regional Development Cooperation Strategy of 2011 – 2021 envisions an integrated, prosperous and resilient East African region. Its main focus is on enhancing the region's economic growth and resilience through cross sector development opportunities. This strategy recognizes that sustainable management of the environment, the natural resources and biodiversity is vital for economic growth and stability. In addition, if well managed the biological resources can provide a foundation for sustained and inclusive growth and poverty reduction in the region. Therefore, this strategy appreciates the importance of the existing biological resources and their role in regional economic development thus supporting bio-economy development.

The EAC Protocol on Environment and Natural Resource Management of 2006 gives a directive to all partner states with regard to the management of the environment and natural resources within their jurisdiction including transboundary ecosystems and natural resources including the conservation and management of biological diversity, wetlands, forests and tree resources, protection of the ozone layer, tourism development

and biosafety and biotechnology development among others. This protocol aims to promote sustainable development and utilization of environment and natural resources, foster closer cooperation for judicious, sustainable and coordinated management, conservation, protection and utilization of the environment and natural resources, and promote capacity building and environmental awareness among others, thus supporting bio-economy development.

The East African Community Climate Change Policy of 2011 is focused on addressing the adverse impacts of climate change in the region and harness any potential opportunities posed by climate change within the principle of sustainable development. This is in response to the growing concerns about the increasing threats of the negative impacts of climate change to national and regional development targets and goals. This policy is founded on three key pillars, namely; climate change adaptation, mitigation and research, which encompasses monitoring, detection, attribution and prediction. Adaptation strategies in this policy include strengthening meteorological services, risk reduction, scaling up efficient use of water and energy resources, protection of wildlife and key fragile ecosystems among others. Mitigation measures identified include reduction of greenhouse gas emission in the region across sectors. This policy supports proper utilization and protection of the region's biological resources for sustainable development, which is a key aspect of bio-economy thus expressing its support for bio-economy development.

The East African Legislative Assembly has already passed the Polythene Materials Control Bill of 2016 which will become a law if implemented fully. This will see a total ban on the production and use of single-use plastics across the member states. So far, some countries like Rwanda and Kenya are implementing this ban, while others like Tanzania are committed to start its implementation soon. This is a great milestone which creates new forms of environmentally friendly jobs, new markets and innovative production to fill the gap created by the ban. This is also a commendable achievement in the reduction of greenhouse gas emission produced during the production and degradation of these plastics. This ban is also a big achievement in reducing air and environmental pollution that end up affecting both human and animal life. Since this ban aims to substitute the use of plastics with bio-degradable materials, it offers a direct support for bio-economy development in the region.

Research and Innovation

Science, technology and innovation (ST&I) is a key driver to socio-economic development in the Eastern African region. All the countries in the region have taken the initiative to incorporate ST&I in their national development goals. The level of investment and uptake of new technologies and innovations define the competitive edge of economies and regions. At the regional level, the establishment of the East African Science and Technology Commission (EASTECO) is a show of its commitment to ST&I whose objective is to promote regional integration in the development, management and application of ST&I in the East African Community. Through this commission, the partner states will make and implement common ST&I policies and programmes. Since increased investment in the development of technology and innovation is one of the key focus areas of the EAC, EASTECO commits to achieve it through promoting and coordinating the development and use of science, technology and innovation to spur social and economic development in the region.

The EASTECO Strategic Plan of 2017/2018 – 2021/2022 comprises of a three tiered strategic framework which include strategic priorities, key initiatives and medium term targets. This strategic plan will help to strengthen scientific and technological cooperation at the EAC and create synergies between various actors of ST&I including the governments, academia, industry and scientific institutions. This makes the community's actions in ST&I more effective, facilitate better access to knowledge, economic resources and expand markets, thereby

upholding the regional and global science and technology agenda and enabling the region's researchers to work in collaboration. This strategic plan focusses on supporting the development and implementation of evidence-based regional ST&I policies and frameworks and promoting ST&I knowledge and innovation through enhancement of STEM training and education among others. This strategic plans supports bio-economy development through promoting technology and innovation as well as development of human capacity to fully embrace and utilize the new green opportunities.

The EAC Vision 2050 aims to attain transformation, value addition and growth. This gives the region's perspective in optimizing the utilization of its natural resources in a bid to narrow the gap in terms of social wellbeing and productivity. It also depicts a future for the region's individual prosperity in cohesive societies, competitive economies and strong inter-regional interactions. The vision promotes sharing of indigenous knowledge and innovative experiences across sectors as part of cross-sectoral learning and also as a way of tackling the inherent socio-economic challenges in the region. This will be done along with the immense potential for resource and technology sharing and mutual research and development efforts. This vision recognizes the role of ICT in enhancing the interaction between persons and businesses within the partner states, thus promoting full exploitation of the market and investment opportunities created by the regional integration, thus supporting bio-economy development in the region.

Trade and Industry

Regional trade in the EAC is pegged on the national trade and manufacturing environment of the partner states. This implies that the national trade policies and institutions as well as the countries' resource base are key determinants of the success in regional trade. Since promotion of regional trade is one of the key priorities of regional integration, the treaty for the establishment of the East African Community focusses on promoting self-sufficiency and balanced industrial growth, thus improving the competitiveness of the industrial sector and boost the development of indigenous entrepreneurs.

The EAC Industrialization Policy of 2012 – 2032 aims to enhance industrial production and productivity as well as accelerate the structural transformation of the region's economies in order to enable sustainable wealth creation, improved incomes and high standards of living for the people. In addition, it is focused on making structural transformation of the manufacturing sector through high value addition and product diversification based on comparative and competitive advantages of the region. This policy plays a crucial role in raising the investment levels and facilitating the creation of new backward and forward linkages across the region. It is also keen on upgrading the technological capacity of the partner states for the purposes of promoting trade within them and also promoting a more strategic integration into the world economy to ensure sustainable industrial growth. Although this policy does not explicitly support bio-economy development, its focus on promoting value addition, development of human capacity and new technologies and innovations as a pre-requisite for successful regional trade which are key components of bio-economy reveals its significance.

Bio-energy

The Eastern African region is experiencing a growing energy demand due to the increasing human population and industrialization. Though most of its member states experience energy deficits, the region has a high potential to grow modern and bio-energy sources such as solar energy, wind energy, energy from municipal solid waste, geothermal energy and biomass among others. Despite the many challenges and constraints faced in the energy sector, the region has made a significant progress over the past years with regard to energy

generation, upgrading and extending network infrastructure, expanding energy access especially in the rural areas and widening interconnectivity in the region (Kammen et al, 2015).

The Eastern Africa Power Pool (EAPP) Master Plan of 2011 aims to facilitate and secure power supply to the countries within the Eastern African region at the lowest possible cost. This is attained through pooling the energy resources within the member states and ensure optimal exploitation of the available potential in the region to meet the escalating demand (IRENA, 2013a). This master plan recognizes the potential of modern and renewable energy sources to social and economic development of the region if well utilized and managed. This master plan supports the increased production and utilization of modern, clean and renewable energy sources, thus supporting bio-economy development in the region.

The EAC Energy Security Policy Framework of 2018 intends to provide policy guidance for better understanding, measurement, monitoring, evaluation and management of energy security risks and challenges experienced in the energy sector. This framework recognizes biomass, electricity, oil and gas as the mainstay and dominant sources of energy in the region. This policy also appreciates biomass as the key source of energy in the region and therefore attempts to increase its efficiency and sustainability in production and use for socio-economic development. Additionally, it commits to balance the supply and demand side of the biomass energy thus contributing to its affordability, thus supporting bio-economy development in the region.

Pharmaceuticals

Ensuring access to proper and adequate medication is a basic requirement for human life. The pharmaceutical industry in the region is rapidly growing due to the growing population and the prevalence of infectious diseases. Although the industry is rapidly growing in the region, there has been over reliance on imported pharmaceutical products and the internal industries are operating below capacity. This implies that there is still opportunity to expand and invest more in new technologies as well conduct more research and innovation on the same. To our advantage, the region is endowed with biological resources that can be utilized to bridge that gap. To tap on the unutilized resources, some industries have ventured into herbal medicine which is gaining popularity in the region. Due to the importance and sensitivity of the sector, effective regulation is needed to ensure the quality, safety and efficacy of medicines provided to the population is not compromised.

The second EAC Regional Pharmaceutical Manufacturing Plan of Action of 2017 – 2027 is a regional roadmap towards attaining an efficient and effective regional pharmaceutical industry that can meet national, regional and international demands efficiently. The plan recognizes the contribution of local production of essential medicines towards attaining the sustainable development goal on universal health coverage in the region. In addition, local production offers a safe, accessible, effective, quality and affordable medical products in a more sustainable manner. The plan aims to increase local production to cover much of the internal needs as well as investing more on new technologies and innovations, establishing linkages between the industry and academia and also intensifying research and development on the industry. Although this plan does not explicitly support bio-economy, it prioritizes the use of locally available materials and biological resources to develop the industry. Additionally, it is keen to promote local knowledge and technologies in the industry, which are key elements of bio-economy development.

The Digital Regional East African Community Health (REACH) Initiative Strategic Plan of 2019 – 2028 envisions interconnected health systems for a healthy and prosperous East Africa. This initiative is focused on utilizing the power of digital health in the region by ensuring the presence of an enabling environment through implementation of a scaled, coordinated, transformational and innovative approaches. This plan promotes the

development and application of new technologies in the health sector as a way of ensuring its sustainability. Considering the high human population in the region, this plan promotes the use of ICT and new innovations to ensure access and effectiveness in delivery of health services. It also prioritizes increased human resource development and knowledge sharing to achieve its objectives, thus indirectly supporting bio-economy development in the region.

1.4 APPROACH

The project “Developing an Innovation- Led Bioeconomy Strategy for Eastern Africa” (BiSEA) is supported by the BioInnovate Africa Programme (www.bioinnovate-africa.org). The main objective of BiSEA is to **develop a regional innovation driven Bioeconomy strategy** shared by the countries in the Eastern Africa region. This will be done in close consultation with Science and Technology Councils/Commissions and relevant ministries and stakeholders in all six BioInnovate countries (Ethiopia, Burundi, Kenya, Rwanda, Tanzania and Uganda) and South Sudan.

The BiSEA project partners are:

1. East African Science and Technology Commission (EASTECO) - Rwanda
2. African Technology Policy Studies Network (ATPS) - Kenya
3. The Scinnovent Center - Kenya
4. Bio-Innovations (U) Ltd - Uganda
5. Stockholm Environment Institute (SEI) Africa Center - Kenya

The African Technology Policy Studies Network (ATPS) has undertaken an in-depth review of Bioeconomy related policies and regulatory frameworks in the BiSEA project countries (Burundi, Ethiopia, Kenya, Rwanda, South Sudan, Tanzania and Uganda), in collaboration with the National Working Groups (NWGs). Key components of this situational analysis include:

- An assessment of Bioeconomy related policies and regulatory frameworks. desk studies will be carried out on relevant grey literature including policy documents from the participating countries, regional policies, economic reports, relevant value chain reports and data among others with a view to understand the policy statuses, what works and what does not and why. This assessment will also analyse the links with the strategy to the broader development framework in the region, including EAC Vision 2050, AU Agenda 2063 and the SDGs.
- Identification and assessment of current governance structures, projects, initiatives etc. driving the current developments towards a modern Bioeconomy in the region.
- A review of the broader operating environment (environmental scanning), taking into account factors such as the economy key assets and stakeholder landscape and to collect statistical, demographic information and projections.

This analysis was carried out through three key actions:

1. **Internet Desk Review:** To guide the desk review, a set of guiding questions (GQs) were be established (c.f. annex 1). This involved a framework for the analysis of the key thematic areas of the Bioeconomy and their supporting thematic areas. While the key thematic areas involve the Bioeconomy related sectors supported by biomass valorisation, its supporting areas involve research, innovation, trade and industry for the Bioeconomy. We reviewed existing literature on the Bioeconomy with the main data

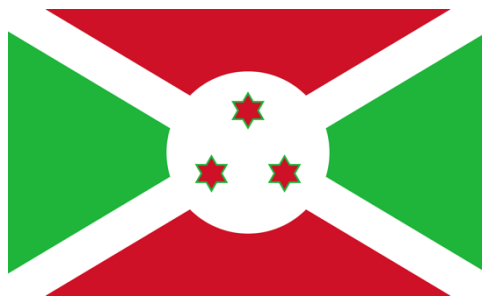
sources being publicly available government documents, such as publications from ministries, government agencies and affiliated research institutions. With the support of participants from the NWGs, we shall also review unpublished reports, articles, and presentations on national, regional and international initiatives, sector analysis and country profiles reports, strategy papers, relevant EAC Secretariat reports, studies and other relevant documentation.

2. **Key informant interviews:** Following this initial review, key informant interviews were conducted after drawing up a list of guiding questions (GQs) from the desk review. The interviewees were selected based after checking for conflict of interest and their knowledge in the Bioeconomy in the region. The interviewees will be representatives from the different sectors and preferably with interdisciplinary knowledge and experience in the Bioeconomy. The interviews will be recorded and later transcribed for analysis.
3. **Focus group discussions:** Finally, in a 1-day workshop in each of the participating countries, focus group discussions were held with the participation of 10 national representatives. This step was done to triangulate the collected data. Firstly, the groups were introduced to the general themes and perspectives sought on the general approach taken. Following this introduction, participants then discussed in a facilitated session on the specific themes of this research. Analysis will then be performed by coding out the key themes/ideas, content analysis, discourse analysis and conversation analysis.

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BURUNDI – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

2.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

2.1.1 INTRODUCTION

Burundi's broad operating environment is characterised by a largely rural economy as much as the percentage rural population has been in a stable decline through the last decades, 87% in 2018 compared to 98% in 1960 – current global percentage of rural population is at 45% (WorldBank Data). Like other eastern African countries, agriculture, forestry and fishery is the mainstay of the country, with its annual percentage growth rate oscillating between – 10 and 10% in the last five decades, despite the series of political crises and economic sanctions that the country has suffered in the same period.

The population dynamics of the country have been in the rise in the recent years following global trends with its growth rate in 2017 being at 3.18% and at 10,864,245 persons. Youth between the ages of 15-64 make up 52.44% of the total population. Despite being a largely rural area and considering the global trend of urbanisation, the population density of the country has been on a constant high, standing at 435 people per square kilometre of land area as of 2018, right after Rwanda (Fig 3). This dynamic has been attributed to the low cost of living in the country, inciting people neighbouring countries to immigrate towards the country, as they have done in Rwanda (IFAD, n.d.) .

Its current political system is that of a transitional presidential representative republic, whereby the President of the Republic of Burundi, now Pierre Nkurunziza since 2005 is both head of state and head of government. It has a multi-party system with the National Council for the Defense of Democracy – Forces of the Defense of Democracy (Conseil National Pour la Défense de la Démocratie–Forces pour la Défense de la Démocratie, CNDD–FDD)) being the ruling party. Nkurunziza's re-election in 2015 into a third term triggered political crises that saw thousands of Burundians exile majorly into neighbouring countries and hundreds of them dead.

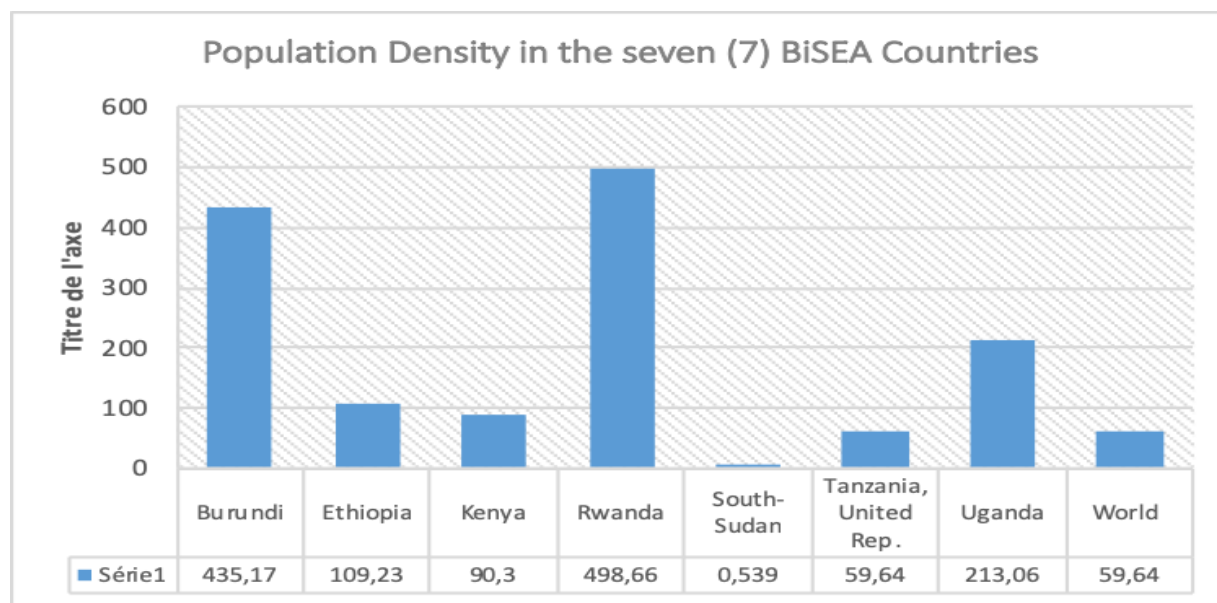


FIGURE 3: POPULATION DENSITY IN THE SEVEN (7) BISEA COUNTRIES IN 2019

SOURCE: WORLD BANK DATA

One of the poorest countries in the world with a poverty headcount ratio at \$1.90 a day (2011 PPP) percentage population standing at 71.8% in 2013 relative to the global level of 11.2% in the same year, coupled by the civil and political unrests in the country, one which lasted from 1993 to 2005 and the most recent political unrest in 2015-2018, the country has been trying to come to its feet for a long time (Republique du Burundi, 2011). One of the four (4) landlocked countries in the Community, the country is also limited in access to key infrastructure that that countries like Kenya and Tanzania enjoy, which makes it protected from the outside world.

TABLE 5: NATIONAL BIODIVERSITY INDEX IN THE SEVEN (7) BISEA COUNTRIES

Country	NBII	ex-situ collectionsII			National RDBsIII		Protected areasIV	
		NHM	Zoo	Bot	Animals	Plants	No.	Area (km ²)
Burundi	0.683	1	-	1	-	-	13	1,462
Ethiopia	0.593	1	-	1	-	-	39	186,998
Kenya	0.643	1	4	6	-	-	68	45,473
Rwanda	0.726	-	-	1	-	-	6	3,624
Sudan	0.539	2	1	1	-	-	27	122,490
Tanzania, United Rep.	0.674	5	-	3	-	-	91	264,582
Uganda	0.655	5	-	2	-	-	54	49,156

The country ranks second highest after Rwanda, among the BiSEA countries with regard to its National Biodiversity Index¹ (Table 5) (MEEATU, 2013; Republique de Burundi, 2011b). Burundi's has 10.93% of forest cover as at 2018 (World Bank Data).

On its trade balance, Burundi recorded a trade deficit of 105190.25 BIF Million in March of 2019. Balance of Trade in Burundi averaged -47168.45 BIF Million from 2000 until 2019, reaching an all-time high of -1801 BIF Million in February of 2000 and a record low of -170303.45 BIF Million in January of 2015. Its main economic exports goods consisting of coffee, tea, sugar, cotton and hides going to Germany, Pakistan, Kenya, China and Sweden primarily. Its main import products consist of capital goods, petroleum products and foodstuffs coming from Saudi Arabia, China, Uganda Belgium and Kenya (Niyangabo, 2017).

Based on the perception received through a Focus Group Discussion on the 8th of July 2018 in Bujumbura, the Bioeconomy means the sustainable valorisation of biological resources, leveraging on research to have economic gains. A word building on biology and economy, implying the use of living things for development purposes. Consideration for the environment is of prime importance as it plays into the natural and biological resource base and heritage of the country and its heritage by extension

2.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

1.1.2.1 MACROECONOMIC CONTEXT

A thriving economy requires a stable macro-economic environment. Measured by indicators such as inflation, external debts and fiscal deficits. The infrastructural environment of the country is marked primarily by the Lake Tangayika, a critical trading point, which also the second largest lakes by volume globally and the second deepest only after Lake Baikal. It allows for access to the littoral region comprising of the Democratic Republic of Congo, Tanzania and Zambia. To this effect the maritime infrastructure is a critical leverage point for the economic growth and development of the country. The country also enjoys country-wide internet fiber optic coverage, as much as the telecommunication companies have not invested much due to the relatively lower purchasing power of the population, giving limited connectivity. The export and manufacturing capacity of the country remains minimal across the region (fig 4), with the bio-based products accounting for less of their export portfolio compared to metals and chemical products for instance (fig 5) (Republique de Burundi, 2017).

¹ | NBI = National Biodiversity Index. This index is based on estimates of country richness and endemism in four terrestrial vertebrate classes and vascular plants; vertebrates and plants are ranked equally; index values range between 1.000 (maximum: Indonesia) and 0.000 (minimum: Greenland, not shown in table). The NBI includes some adjustment allowing for country size. Countries with land area less than 5,000 sq km are excluded. Overseas territories and dependencies are excluded from this column.

Valeurs des Exportations Manufacturières en milliers USD				Taux de croissance annuelle		
Pays	2007	2011	2015	2007-2011	2011-2015	2007-2015
Burundi	50,075.7	31,800.9	41,842.9	-11.0%	7.0%	-2.0%
Ethiopie	171,721.9	315,366.7	358,142.3	16.0%	3.0%	10.0%
Kenya	2,115,437.3	2,524,966.2	2,575,776.8	5.0%	0.0%	2.0%
Malawi	165,300.9	504,958.4	283,217.2	32.0%	-13.0%	7.0%
Rwanda	80,423.6	199,992.3	206,426.5	26.0%	1.0%	13.0%
Tanzanie	667,199.2	2,003,102.8	2,528,115.6	32.0%	6.0%	18.0%
Uganda	385,497.3	401,185.0	629,011.4	1.0%	12.0%	6.0%
Zambie	1,031,377.4	1,586,935.7	1,080,005.3	11.0%	-9.0%	1.0%

Source : UN COMTRADE

FIGURE 4: EXPORT VALUES MANUFACTURED IN USD AND ANNUAL GROWTH RATE IN% FOR BURUNDI AND ITS COMPARATOR COUNTRIES

N.B : Kenya* : pour le Kenya les données de 2011 et 2015 sur les exportations des produits manufacturés n'étaient pas disponibles. On a dû utiliser les données de 2010 au lieu de 2011 et celles de 2013 à la place de celles de 2015

Valeurs en milliers Usd				Taux de croissance annuelle		
Sous-secteurs	2007	2011	2015	2007-2011	2011-2015	2007-2015
Aliments,boissons et tabacs	8,722.00	3,804.00	17,444.50	-18.7%	46.3%	18.9%
Textiles	3,175.90	713.7	2,786.50	-31.1%	-1.6%	-3.2%
Bois transformés et papier	337.3	267.1	264.3	-5.7%	-3.0%	-5.9%
Metaux	4,434.91	11,201.60	3,444.90	26.1%	-3.1%	-6.1%
Produits en caoutchouc	5,926.10	2,995.50	4,455.70	-15.7%	-3.5%	-6.9%
Equipements	5,837.90	5,864.00	1,529.50	0.1%	-15.4%	-28.5%
Transport	14,893.92	1,980.40	911	-39.6%	-29.5%	-50.3%
Produits chimiques et plastiques	1,013.20	4,770.30	10,866.60	47.3%	34.5%	81.0%
Produits non spécifié	5,734.50	207.6	195.9	-56.4%	-34.4%	-57.0%
Exportations des produits manufacturés	50,075.70	31,800.90	41,842.90	-10.7%	-2.2%	-4.4%

Source : UN COMTRADE

FIGURE 5: BURUNDIAN EXPORT OF MANUFACTURED PRODUCTS BY SUB-SECTORS 2007-2015

1.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

The industrial performance of a country is directly correlated to its development levels. Burundi is the only country in the East African Community (EAC) that does not have an industrialisation strategy or policy, although the country is in the process of developing one. The lack of such a strategy affects its technological and innovation readiness. An overpopulated country, much of the population are small holder farmers. Its SMMEs are also an important employer to the population although the exact numbers are not accurately documented. There is an expressed need to not only document these, but to also put in effort to upscale the SMMEs to reach out to regional and global export markets. The standardization of products for export is esteemed to be important especially in light of the opening up of the east African and continental common markets and other aggregations, a drive that would make exportations easier. Burundi is not a member state of the African Regional Intellectual Property Organisation (ARIPO), although a signatory of the World Intellectual Property Organisation (WIPO) through the decree n°1/ 012 of 08 February 2015 (République de Burundi, 2015). While there seems to be a recognition of the role of patents efforts to have more copyright and trademarks especially for the SMMEs is important.

1.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

The Burundi Commission for Science, Technology and Innovation was set up in 2014 (De Cliff, n.d.). Unfortunately, soon after there was a resurgence of a political crisis in the country that did not allow for the commission to successfully execute its functions nor expand its outreach. The role of the commission is to orient, coordinate and regulate the various activities of scientific research and innovation for technological development in Burundi. However, to date, the Commission is esteemed understaffed and underfunded in view of their role and potential outreach. The country is yet to reach the 1% AU recommended target for STI funding.

1.1.2.4 INFRASTRUCTURE

Infrastructure is critical especially with regard to its role in the transformation and bio-synthesis of biomass to bio-based products for commercialisation. The Lake Tanganyika offers an important port and infrastructure for maritime transportation, and the Bujumbura Airport disposes of a depot of strategic use for trade. The road networks in the country are judged to be sufficient. There is an existing network of internet and telephone cables in the country, although the operators have it to be relatively expensive to allow for accessibility and reliability. With regard to electricity, the country has a dilapidated interconnected national electricity network. The installed electrical power is currently close to 90 MW, including 34 MW of national hydraulic production. The national and regional hydroelectric projects under development total an installed capacity of 196.35 MW. The total installed capacity is estimated to be at 287,141 MW in 2027. Electricity production the national level consists of hydroelectric power stations and thermal power stations which are managed by public and private institutions, including the RUZIZI I and RUZIZI II units. However, the current supply of electricity does not yet meet demand. In the next ten years, with the completion of the projects in progress, supply is estimated to be much greater than the demand, as indicated by the sectoral strategies for implementing the National Development Plan (Kuriyo, 2019; Niyangabo, 2019; Republique de Burundi, 2017).

2.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

The Republic of Burundi is a transitional presidential representative democratic republic, whereby the President of Burundi is both head of state and head of government, and of a multi-party system. The legislative arm of the government is in charge of policy making. It comprises of a senate of thirty-four members indirectly

elected by an electoral college. The legal, regulatory and administrative framework of a country determines the institutional environment in which businesses operate and how they interact with the government. This framework is an important determinant of productivity and competitiveness. Despite its political environment, Burundi remains a member of a number of international bodies which influence its national policies including the United Nations (UN), the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA) the International Energy Agency (IEA), the International Fund for Agricultural Development (IFAD), the World Intellectual Property Organisation (WIPO), the Organisation Internationale de la Francophonie (OIF), among others.

The National development plan (Plan national Développement 2018-2027) of the country is anchored on the need for different approaches and interventions for mental and structural actors of their economy, indicated as a circular economy. In line with the principles of the Bioeconomy, this strategy seeks first strengthen food self-sufficiency and diversify its export portfolio through the promotion of agro-industrial, commercial and extractive enterprises. Its second objective is to promote the development of the energy and crafts sector, the third being the development and maintenance of growth supporting infrastructure. The strategy also seeks to foster regional and international partnerships. These have been recognised as leverage points for the socio-economic transformation of the country, along 11 sectors: agriculture, energy, technology and know-how, natural resources, human capital, industrialisation, infrastructures, tourism, public-private partnerships and regional and regional integration and cooperation (Republique de Burundi, 2018).

1.2.1 AGRICULTURE

The Burundian population is predominantly rural and derives its livelihood from agriculture. However, the agricultural sector represents less than half of the wealth produced annually by the country (GDP). This is due to the low agricultural productivity consequent degradation of soils, inappropriate agricultural techniques and mainly to climatic hazards. Almost 70% of the population lives below the poverty line and 85% of households face food insecurity on a daily basis. The rate of acute malnutrition is more than 10% and the daily caloric intake per inhabitant is well below the required standards (1,650 calories against 2,250 recommended). The agricultural sector is the growth engine of the national economy, guaranteeing food security of the population. According to the ministry in charge of agriculture, 1.2 million rural families (90% of the population) are small holder farmers (0.5 ha on average per household), the increasing population presents a risk to food security (MINAGRIE, 2008; Republique de Burundi, 2018).

In Burundi, the Ministry of Agriculture and Livestock offers institutional support for the National Agriculture Strategy (Stratégie Agricole Nationale (SAN)) (ran through 2008-2015) (MINAGRIE, 2008), Programme National de Sécurité Alimentaire (PNSA) (République du Burundi, 2014) (ran through 2009-2015), and the Stratégie Nationale et Plan d'Action sur la Biodiversité (2013-2020) (MEEATU, 2013). The National Development Plan (NDP) 2018-2027 reveals that agriculture contributes 39.6% to the Gross Domestic Product (GDP) and provides 84% of jobs. It provides 95% of the food supply and is the main provider of raw materials to agro-industry. In order to boost agricultural production and reduce food deficit, the Government adopted a National Agricultural Investment Plan (PNIA) on the 2012-2017 period is divided into 16 maps Provincial Agricultural Investment (16 PPIA). Through this programme, the Burundi Fertilizer Subsidy National Program (PNSEB), a Selected Seed Grant Program, certain crop profiles (coffee, tea, cotton, rice) were reviewed and institutional reforms implemented to fit within the NDP (MEEATU, 2013; Republique de Burundi, 2018).

The NDP offers a number of recommendations for improving agricultural productivity through modern agriculture. These include the regionalization of crops, promotion of integrated family farming, agricultural mechanization, agricultural land preservation, processing of agricultural production, permanent housing, the diversification of exportable products, and management rainwater and irrigation marshes (Kuriyo, 2019)

The National Agriculture Strategy (Stratégie Agricole Nationale (SAN) sought to Increase productivity and agricultural production and development of sustainable production systems to restore, current and medium-term food before 1993 and long-term self-sufficiency obtain an annual growth above that of food supply population (3%). Its three main focuses were to: Promote chains and agribusiness with a view to develop and diversify sources of growth, the export products and those of import substitution to help increase household purchasing power and improve the financial resources of the 'State. The resources of the currency area will increase by 120 to 200 million US dollars while the rate of the population living below the poverty line will be reduced by half (from 70% to 35%) in 2015; Professionalize producers and develop private initiatives to help them defend their interests and be masters of their own development while supporting private to get involved in agricultural training, development and diversification of profitable channels; and Strengthen the management and sustainable development capacity of the agricultural sector in order to achieve our turn subsistence farming into a profitable market for agriculture and managed by professionals (MINAGRIE, 2008).

The PNIA 2012-2017 recognised Agriculture to have great potential while the population increase in the country, a rate higher than 3%, there is a great risk that the vulnerability of food insecure populations worsens and the economy regresses if adequate investments are not implemented. To this end it planned four (4) key programmes i.e. sustainable growth of food production and security, professionalization of producers and promotion of innovation, development of sub-sectors and agribusinesses, capacity building of public institutions (Republique de Burundi, 2011b).

1.2.2 ENVIRONMENT

In this analysis, environmental considerations for the Bioeconomy are within the green economy, where the economy operates with improved human and social equity, while reducing environmental and ecological scarcities. Burundi has enacted in 2000 the Environmental Code and has ratified in 2005 the Stockholm Convention on persistent organic pollutants.

The Ministry of Water, Environment, Regional Development and Urbanisation (Ministère de l'Eau, de l'Environnement, de l'Amenagement du Territoire et de l'Urbanisme (MEEATU)) oversees the Stratégie Nationale et Plan d'Action sur la Biodiversité (2013-2020), the National Strategy and Action Plan for Access to Genetic Resources in Burundi (2016) (Kuriyo, 2019), among other plans. With a forest cover of 10.93%, the country has developed codes and laws for plant protection.

Aware of the importance of safeguarding genetic resources, the Parties to the Convention on Biological Diversity (CBD) agreed to adopt, in Nagoya, Japan in October 2010, a Protocol on Access to Resources genetic and fair and equitable sharing of benefits arising from it (PN/APA). Burundi signed the Nagoya Protocol following Law No. 1/21 of 23 June 2014 (République de Burundi, 2015). With this membership, the Burundian Government, through the MEEATU is committed to take all appropriate and necessary measures to ensure the implementation of the Protocol in Burundi. Biodiversity is an important asset for Burundi, and institutional structures have been put in place to ensure its continuous documentation and management (fig 6).

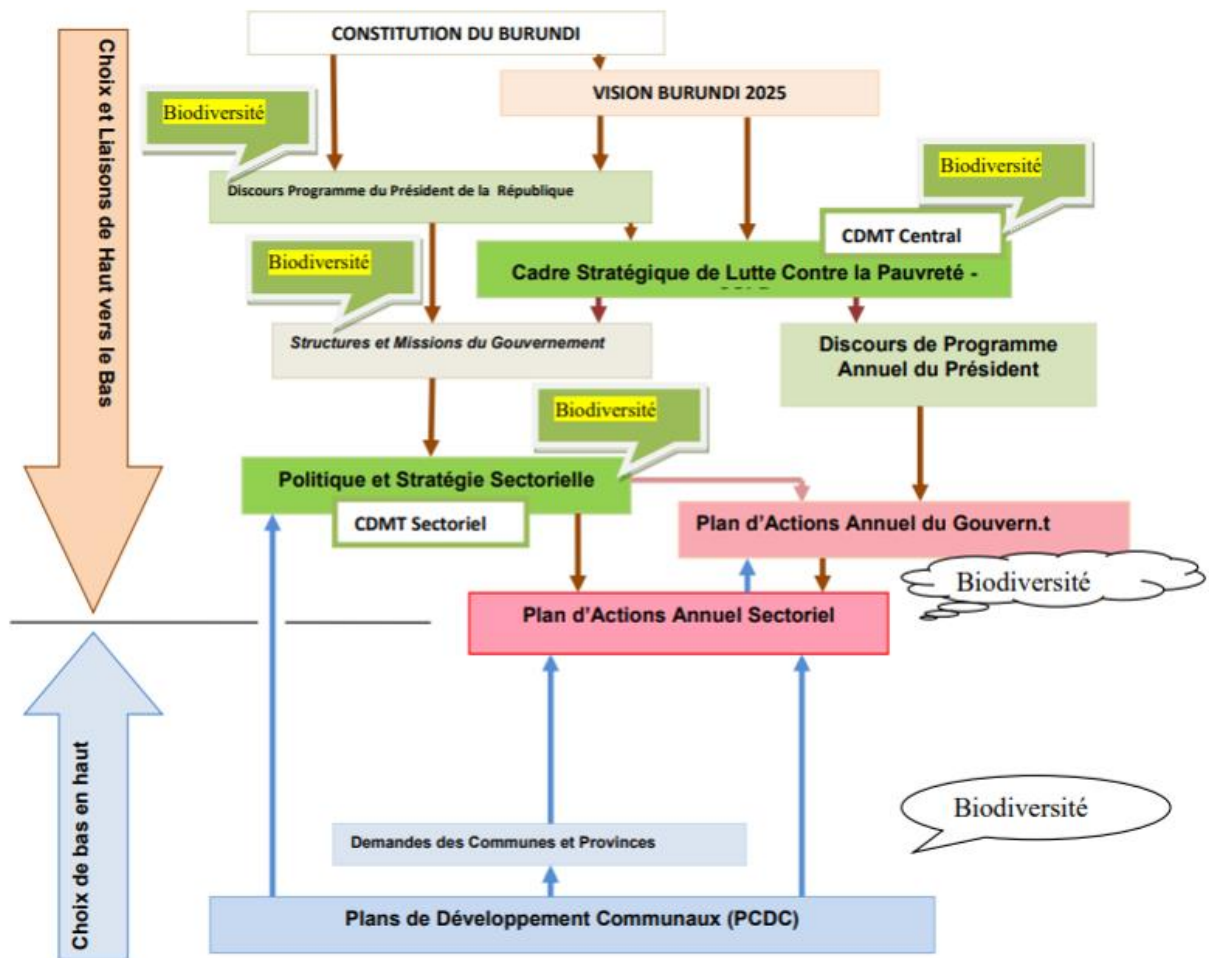


FIGURE 6: INSTITUTIONAL ORGANISATION FOR BIODIVERSITY MANAGEMENT IN BURUNDI

The National Strategy and Action Plan for Biodiversity 2013-2020 is a sectorial plan for integration of biodiversity to the highest levels of decision making. Its objectives include: 1) By 2017, all decision makers and business managers are aware of the value of biodiversity, the risks it incurs and impregnated measures and practices they need to take to conserve and use sustainably. 2) Objective 2: By 2016, the values of biodiversity are integrated into national strategies, plans and programs, sectoral and local development and fight against poverty and incorporated in the national accounts; 3) Objective 3: By 2018, incentives, including subsidies harmful to biodiversity are reduced gradually to achieve a minimum level of negative impacts, and positive incentives for the conservation and the sustainable use of biological diversity are identified, popularized and applied; and 4) Objective 4: By 2015, Burundi adopted an investment strategy and mobilization of financial resources for the effective implementation of this strategy (MEEATU, 2013)

Despite the opportunity strengths, threats already exist or may arise jeopardizing the implementation of National Strategy and Action Plan for Biodiversity 2013-2020 procedures including: the perpetuation of bio-piracy by corruption on very lucrative genetic resources; genetic resources distributed in other countries with the possibility to refuse a binding contract in favour of Burundians; and, genetic resources distributed in transboundary ecosystems with the possibility of provocation of conflicts with neighboring countries.

The Burundi 2025 vision firmly commits the country to make the protection and rational management of the environment a priority, so that Burundians live in a protected and well managed. Activities related to climate change has been particularly marked by the development and publication of the first and second national communications under the UNFCCC. In the same vein, Burundi has prepared the National Action Plan for Adaptation (NAPA). The actions identified in the NAPA covering the key sectors of the economy of Burundi. Institutionally, the Ministry of Water, Environment, Spatial Planning and Urban Development with its departments and institutions such as custom IGEBU OBPE and addresses issues related to the change climate. It has in its mission to support consultation frameworks such as: the National Commission for the Environment, the Sector Group Water, Sanitation and Environment (GSEAE) and the Country Water Partnership (CWP-Bu), the Platform national Risk Prevention and Disaster Management. In addition, the Burundi National Forest Policy (2012) has as priority areas: development and rational managements of forest resources to bring coverage forestry 20% in 2015, the valuation of forest resources and strengthening human and institutional capacities (Fonds international de développement agricole (FIDA), 2012; IFAD, n.d.).

Ongoing initiatives to support adaptation include:

- Watershed Management and Improving Climate Resilience Project (Projet d'Aménagement des Bassins Versants et l'Amélioration de la Résilience Climatique (PABVARC))
- Communication Strategy and Early Warning on Climate Change Adaptations (Stratégie de Communication et d'Alerte précoce sur les Adaptations au Changement Climatique),
- Climate Change Adaptation for Water and Soil Resources Protection Project (Adaptation au Changement Climatique pour la Protection des Ressources en Eau et Sols (ACCES)), with funding from the special energy and climate fund,
- Integration of smart agriculture in the National Agricultural Investment Program (PNIA)

1.2.3 BIOENERGY AND CLIMATE

Presently in Burundi, oil and gas products widely used in transportation and industry. Petroleum products (gasoline, diesel, heavy fuel oil, jet A1 kerosene) are an important source of energy in the economy. This in the transportation and industry. These products are fully imported, and the sector is liberalised. The challenges include the implementation of a national strategic stock fuel, fluctuating cost of oil products on the international market, the ability of the population in the use of petroleum products and gas, sufficient infrastructure storage of petroleum products, an adequate legal framework and certification of equipment and quality control of products.

Bioenergy is a key biomass consumption industry, with wood and lignocellulosic products accounting for more than 97% of the energy balance in the Economic Community of the Great Lakes Region (CEPGL), according to the 2011 Energy Policy Ministerial Letter (Republique de Burundi, 2011a). According to sector strategies, essential sources of energy include traditional sources of energy (firewood, charcoal and agricultural residues), petroleum, hydropower, solar, peat, the wind, geothermal and biogas. The potential to generate electricity is enormous, first through hydroelectric national resources, solar, geothermal resources and then biological (biomass: all plant or animal material can be converted into energy) yet to be explored or tested.

There is an existing gap between supply and demand of energy wood. Wood energy is the most used energy source. It is used in the form of coal and vegetable waste to 97, 09% by households for cooking and heating. According to the Energy Policy Letter (2011), national annual supply of wood energy could be estimated between 1.3 million and 2.9 million tonnes per year while domestic demand was estimated at 3.32 million and

4520 000 tons per year (Niyangabo, 2019). On urban waste recovery projects, a development program of municipal waste in the city of Bujumbura for the production of energy and modern fuels is evoked through a Public Private Partnership (PPP) Framework.

Around sixty collective biogas projects (schools, military camps, etc.) were put in place out in the 1990s from animal or human excrement. Following the civil war and political crisis of 1993, these projects need rehabilitation. This energy resource remains relevant to exploit. Only one site is functional at the moment and the directive to restore these projects is underway at the Directorate General for Energy (la Direction Générale d’Energie (DGE)) and its implementation by the Burundian Rural Electrification Agency (l’Agene Burundaise d’Emectirifcation Rurale (ABER)) follows its normal course. Ten sites per year from the 2020/2021 financial year will be rehabilitated, i.e seventy sites until 2027 (Niyangabo, 2017, 2019).

Still on biomass, peat is a common fuel for heating and cooking in Burundi. Peat deposits were estimated at 150 million tonnes in 1990. The exploitable deposits were valued at 57 million tonnes. Currently, peat is used as fuel for heating or cooking. The consumption of peat is in the order of 13 thousand tons per year with the possibility of increasing production. Its use for the production of electricity is also possible. However, feasibility studies could be conducted to better analyse the economic, environmental and land impacts, as well as the potential risk of depletion of available resources and competition with the use of the same resource in substitution of wood of fire.

In addition, waste sugar cane is used as electrical power source. A power plant fueled by bagasse (waste from sugar cane) exists at the Moso Sugar Company (SOSUMO), a cogeneration unit of 2 x 2 MW fueled from bagasse and running for six months. Unfortunately, this turbine is connected only to the SOSUMO plant and its administrative buildings). Otherwise, any surpluses could be linked to the Regisco network for import or export.

1.2.4 INDUSTRY AND TRADE

The other countries in the eastern African region have already implemented their industrialization policies and adopted the strategies for their implementation. However, Burundi has neither PNI nor industrialization strategy. Stakeholders acknowledge that without the development of the industrial sector, there is no development for a country. “No country in the world has developed without industrialization, which has become a must to achieve sustainable development.” It also provides for the installation of special economic zones where investors will benefit from tax advantages.

The Government of Burundi implemented in 2008 a new investment code. Consequently, the Burundi Investment Promotion Agency was created in 2009 with the aim of supporting the private sector in general and the industrial sector in particular.

A National Industrialisation Policy (Politique National d’Industrialisation (PNI)) is in the course of development. According to Emmanuel Mbonihankuye, Director General of Industry at the Ministry of Commerce, Industry and Tourism, this policy was drafted in alignment with the content of the NDP (Vision 2025) (Hacintuka, 2019). Even though the PNI has not yet been launched, there are 11 pillars that have been identified to stimulate the development of the industrial sector in general and the agro-industrial sector in particular. These include the agro-industry, the fishing sector, the mining sector, the manufacturing sector, water, energy and many others. The policy is now being discussed at the ministerial level acknowledging (Niyangabo, 2017, 2019; Republique de Burundi, 2011b, 2017; Republique du Burundi, 2015). Some of the economic situation of the country as at 2015 as being:

- Very little diversified production mainly based on a primary sector dominated by subsistence agriculture practiced on very small unprofitable farms and whose contribution to GDP is 39.60%.
- Volatile and unstable growth due, on the one hand, to dependence on an agricultural sector using poorly diversified rudimentary tools, the food component of which is poorly marketed, and on the other hand to the variability of production dependent on rainfall and the price of the main export product, coffee, which represents 70% of the country's exports.
- Very poor performance of a still fragile private sector, in which industry represents only 15.1% of GDP¹, and which is plagued by a chronic energy deficit, and a business climate unfavorable to its development, this despite the government improvements in recent years.
- A 2.3% decrease in industrial production in 2015, after an 8.9% increase in 2014 due to the declines in beverage production (-8.1%), construction (-10.1 %) and the production of electricity, gas and water (-9.8%) (CNP2015).
- The share of the value added of the industrial sector in the GDP evolving only very slowly, passing from 10% in 1971 to 15.1 %% in 2015 of which 11.7% of the GDP comes from the manufacturing sector, 0.3% of the mining sector and 3.1% of the energy sector (CNP 2015).
- An export rate (ratio of exports of manufactured products to manufacturing value added) that has not progressed much since it was 4.19% in 1972 and ended up at 6.79% in 2012 (World Bank, 2012).

Despite these many constraints that Burundi faces, its membership in community organizations (EAC and COMESA) among others offers it access to enlarged markets and, in turn, an opportunity for its industrial development.

1.2.5 RESEARCH AND INNOVATION

While there is no dedicated policy framework on biotechnology, a Bioeconomy knowledge based high technology sector, biotechnology is still actively practiced through institutions such as the Institut des Sciences Agronomiques du Burundi (ISABU) through programmes such as the Plant Production Programme (PPV). There is an ongoing project to have biosecurity laws in the country. Local and international trade are overseen through the Ministry of Commerce, Industry, Posts and Tourism, which has specific regulations on the manufacture and production of biobased products.

Burundi has seven public higher education institutions including: University of Burundi (Université du Burundi (UB)), Ecole Normale Supérieur (ENS), Higher Institute of Business Management (Institut Supérieur de Gestion des Entreprises (ISGE)), Higher Institute of Police (Institut Supérieur de Police (ISP)), Higher Institute of Military Executives (Institut Supérieur des Cadres Militaires (ISCAM)), National Institute of Public Health (Institut National de Santé Publique (INSP)) and Normal School of Administration ((Ecole Normale d'Administration (ENA)). To date, there are 20 private higher education institutes and 23 other private institutes (MESRS, n.d.).

The institutional framework of research and innovation in Burundi is set up by law and the High Commission for Science, Technology and Innovation (Haut conseil de la science, la technologie et l'innovation) which is under the presidency or under the authority of the highest republican institution constitutionally in charge of coordinating economic and social issues, the latter acting solely by delegation (fig 7).

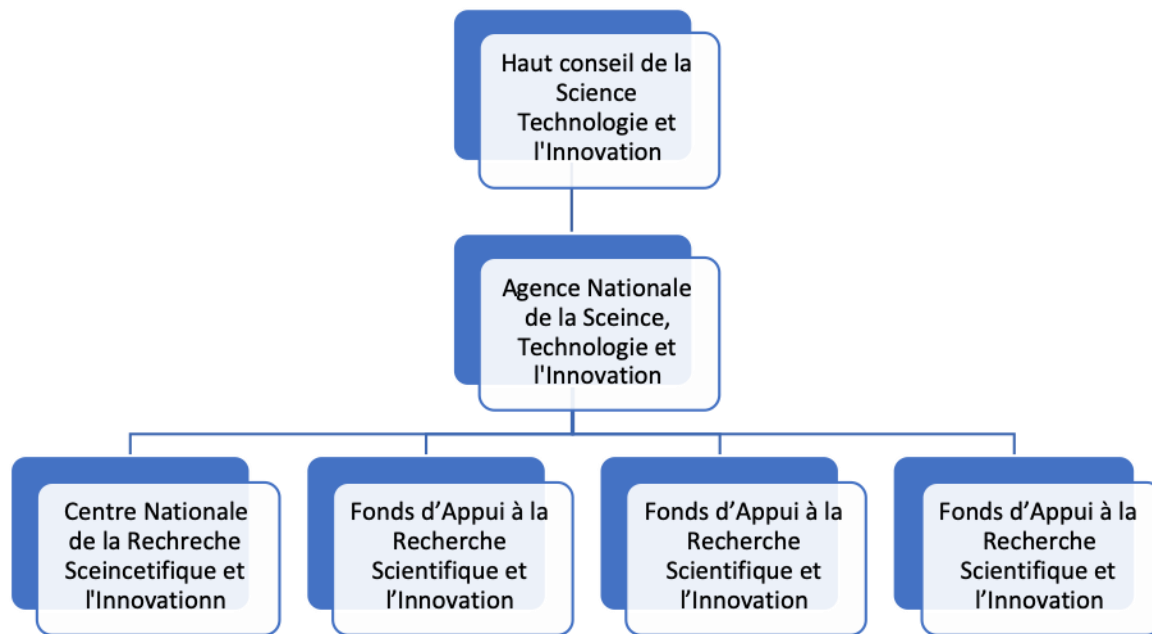


FIGURE 7: INSTITUTIONAL ORGANISATION OF RESEARCH AND INNOVATION IN BURUNDI

The Burundi strategic plan for higher education and research as steered with the UNESCO Commission sought to analysed the eight priority fields for science, technology, research and innovation (STRI) as contained in the document of National policy of scientific research and technological innovation, namely: agro-technologies food; medical sciences; energy, mining and transportation; water, desertification, and the environment; biotechnology and indigenous knowledge; materials science, engineering and industries; information and communication technologies (ICT), space and mathematical sciences, and finally; social and human sciences. For each priority area, provision is made in particular for the creation of research capacities, including sufficient human resources; strengthening the institutional framework and infrastructure; knowledge transfer, by promoting research by the private sector and civil society; regional and international cooperation and; finally, science at the service of communities (*Burundi | Organisation des Nations Unies pour l'éducation, la science et la culture*, n.d.; UNESCO, 2009).

Among the planned strategic measures: strengthening the capacity of researchers, setting up research units, coordinating with sectoral policies, creating a central campus for STRI, encouraging innovation and the creation of innovative businesses, joining international organizations, opening research establishments and promoting scientific creativity among young people.

The research and innovation sector is considered to be one that is neglected, despite its great contribution to development. Burundi has research centers. Unfortunately, their contribution to sustainable development is not yet visible, say some participants in the exchange workshop on the strategic directions of the Ministry of Higher Education and Scientific Research for the operationalization of a platform for all the development actors held on Thursday January 31, 2019 (*Burundi | Organisation des Nations Unies pour l'éducation, la science et la culture*, n.d.; UNESCO, 2009). They lament the fact that the few research projects carried out remain in the drawers instead of being exploited. On the other hand, the contribution of university professors to development in other countries is remarkable. They bring to market new products that generate income,

improve living conditions for households or protect the environment. They lament the fact that in Burundi the research professors do nothing to change the life of the communities.

TABLE 6: SUPPORTING INSTITUTIONS, LEGISLATION AND ACTS IN BURUNDI

Thematic areas	Institutional Setting	Legislations and Acts
Agriculture Agriculture Blue economy Aquaculture	Ministère de l'agriculture et de l'élevage	Stratégie Agricole Nationale (SAN) (2008-2015) Plan national d'investissement agricole (PNIA) (2012 – 2017) Plan d'intégration de la biodiversité dans le secteur de l'agriculture et de l'élevage Programme de relance et de développement du monde rural Stratégie nationale de développement de la filière riz au Burundi
Environment Forestry Biodiversity	Ministère de l'eau, de l'environnement, de l'aménagement du territoire et de l'urbanisme	Stratégie Nationale et Plan d'Action sur la Biodiversité 2013-2020 Stratégie nationale et plan d'action en matière d'accès aux ressources génétiques et de partage des avantages découlant de leur utilisation au Burundi Stratégie Nationale et Plan d'Action en matière d'Echange d'Informations sur la Biodiversité Plans sectoriels d'intégration de la biodiversité Plan Stratégique de Développement et de Renforcement des Capacités dans le domaine de la Biodiversité au Burundi Stratégie Nationale Plan Stratégique d'Investissement et de Mobilisation des ressources Financières dans le domaine de Biologie au Burundi Politique Forestière Nationale du Burundi (2012)
Climate/Energy Bioenergy Green economy	Ministère de l'énergie et des mines ;	Loi no1 /13 du 23 avril 2015 portant réorganisation du secteur de l'électricité au Burundi.
Industry and Trade Manufacture of bio-based products	Ministère des finances et de la planification du développement économique ; Ministère du commerce, de l'industrie, des postes et du tourisme Ministère des transports, des travaux publics et de l'équipement ; Agence de Promotion des Investissements du Burundi	Politique Nationale d'Industrialisation (PNI) – en train d'être développé
Research and Innovation	Ministère des télécommunications, de l'information, de la	Renforcement des capacités en politiques STI en Afrique (2008–2014), Politique nationale de la recherche scientifique et de l'innovation technologique Plan d'actions, de Stratégie et de la loi sur la science, la technologie et la recherche.

High tech including biotechnology, nanotechnology, Bioeconomy research and development Education and human resource development	communication et des relations avec le parlement ; Ministère de l'enseignement supérieur et de la recherche scientifique ; Ministère de l'enseignement de base et secondaire, de l'enseignement des métiers, de la formation professionnelle et de l'alphabétisation Ministre de la Jeunesse, des Postes et des Technologies de l'Information	Initiative africaine en matière d'indicateurs de STI du Nouveau partenariat pour le développement de l'Afrique (NEPAD).
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2.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

According to the stakeholders during the focus group discussions held at the Burundi Commission for Science Technology and Innovation in July 2019, biodiversity and biomass make up the key assets for a strong bioeconomy in the country. While the country has ratified the Nagoya Protocol and the Convention for Biological Diversity as well as set up local institutional frameworks for the management and protection of biodiversity, stakeholders still felt that much remains to be done.

The public private partnership model in the country has allowed for public participation and advancement of strategic projects. Stakeholders however feel that these efforts can be increased. A particular focus should be put on Academia Private Partnerships (APPs) to enforce the research and innovation environment in the country which is rather weak.

Agriculture and the blue Bioeconomy are they key drivers of the Burundian economy. Its proper management remains a key determinant to the country's sustainable development. In this regard, the SMME sector was esteemed to be most potent for building agriculture and aquaculture. The broad aim is firstly to rehabilitate the production tool and revitalize agricultural activity and in order to boost production and meet or exceed the best levels of before the series of political crises that have hit the country. This should be accompanied by the modernisation of the modernize the medium and long term the agricultural sector in order to transform subsistence agriculture to a market agriculture. An annual growth rate of 6% is retained. Promotion of SMMEs will contribute towards increased subsumption and transformation of biomass.

In addition, green economy, ecological organic agriculture and bio-based growth seems to be a more favourable pathway for an innovation-led Bioeconomy in the country. Genetically Modified seeds have significantly infiltrated the country predominantly through the south. However, stakeholders question the pertinence of these strategies particularly their contribution to biodiversity deterioration are worrying.

The industrial policy in development is very strategic, especially on its role in creating a more favorable business environment for industrial enterprises. From this point of view, the role of government is to substantially improve the general business climate, to adopt policies aimed at infrastructure development, training-employment adequacy, improved access to finance and creating the right conditions to attract foreign direct investment.

2.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

The overpopulation and poverty levels of Burundi make it such that there are distinct disparities between regions and social groups. The poverty level goes from 41% in Bujumbura to 86% in the province of Bubanza for instance. It is estimated that only a proportion of 5 % of the population has no food security problems. Food and financial vulnerability also remain more critical for households with low production capacities, including: households still living in camps for internally displaced people (around 100,000 people) and outside refugees (around 350,000 people); rural households with access to land but whose other factors of production were looted or destroyed during the war (repatriated and displaced during the resettlement phase); women widows and children who are now heads of households, families victims of HIV/AIDS, the elderly or disabled and the marginalized group of Batwa (these categories represent more than 10% of the population); and the many households without land or with very limited access to land and without financial resources to acquire other improved production inputs such as livestock and seeds (around 15% of the population); among others.

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Taking these factors into consideration, there is therefore need to put in place actions that will ensure sustainable implementation of the Bioeconomy across the provinces of the country and across its social classes. These were esteemed to be necessary to have a

the creation of favorable conditions to attract more investment in the sector

- A structure for the promotion and coordination of the Bioeconomy across the different levels of government. This would include a legal, regulatory and institutional environment favourable for an innovation-led Bioeconomy;
- Good human resource and a working class that is educated and sensitised to the sustainability, inclusivity issues of the country and the potential of Bioeconomy development;
- Inventorised and protected biodiversity and biomass including knowledge on these that concern the populations of the country;
- Technological capacity building that would allow SMMEs to have optimised production, transformation and valorization of the biomass in the country;
- A legal environment that would provide protection against unfair competition. The Bioeconomy in Burundi needs to be driven by a production private sector conscious of its social responsibilities;
- Budgetary allocations that are fair and sufficient for the bioeconomy. Research and innovation being key components of the Bioeconomy, the 1% AU recommended threshold should be the target.

2.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS



Policy and strategic recommendations for an innovation-led Bioeconomy in Burundi reflect observations made in components 3 and 4 as well as the aspirations articulated in the NDP Burundi 2025.

In the long term (estimated 10 years in the future) the country aspires to have an autonomy of choice for their strategic decisions. This will be fuelled in the MT through policies in STI that are have mainstreamed the Bioeconomy and the vulgarisation of the concept. To achieve this, a coordination institution is necessary in the ST.

The long-term objective was proposed to be agriculture for industrialisation.

This LT objective would be achieved the MT objective of the promotion of consumption of local and regional products. The cooperative model is esteemed not to work anymore. In the ST, the support of SMMEs is necessary to allow for transformation of biomass to bio-based products. This should be coupled with capacity building and adequate financing partnerships such as PPPs and ACPs.

Thirdly, the Bioeconomy in Burundi should be service led allowing for faster outreach to regional and global markets. This can be enhanced in the MT though setting up proper infrastructure. Financial subsidies

should be given to support the development of this infrastructure to this end. In the ST, education capacity building in ICT and the control of telecommunication operators in the country would help reach this end.

Finally, biodiversity development was forwarded as a LT recommendation. MT measures would include conservation and multiplication of these, while ST measures would include setting up an inventory of the biodiversity in the country, the selection of seed varieties in consideration of the biodiversity present and subsequent valorization of these.

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ETHIOPIA – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

3.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

3.1.1 INTRODUCTION

Just like most SSA countries, Ethiopia, located at the horn of Africa is the second most populous country in Africa with an annual growth rate of 2.1 %, with majority of the population residing in rural areas and heavily relying on agricultural production activities. The agriculture sector is the mainstay of the country's economy. It contributes to about 46% of the annual GDP, a major export contribution and a source of employment and income for the rural folks (FDRE, 2011). About 60% of the land is arid and semi-arid lands (ASAL) with over reliance on rain fed agriculture. Exposure to climate change effects, over reliance on biological resources and low agricultural productivity has exacerbated an already existing food security menace thus threatening livelihoods (ibid).

The world economic forum report depicts the country's economy as one of the fastest growing economies in sub Saharan African with an estimated annual GDP growth of 8.5% majorly driven by industrialization, manufacturing and investment in infrastructure (Gray, 2018). Major strides have been made in reducing the number living below the poverty line from an estimate 30% in 2011 to 24% in 2016 and implementation of GTP II is projected to increase GDP growth, the industrial sector and create job opportunities for a growing population (The World Bank, 2016). However, despite making commendable improvements, the country's export earnings contribution to GDP is still below par (10%) compared to a potential of 24% (World Bank 2017), the productivity of the manufacturing sector is still low (4.2% of the GDP), food security threat worsened by climate change and variability and low agricultural productivity characterized by low uptake of technology and innovation (UNDP, 2015).



TABLE 7: SUB-SAHARA AFRICA FASTEST GROWING ECONOMIES

SOURCE: IMF WORLD ECONOMIC OUTLOOK

3.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

One of the benefits of development of an innovation led Bioeconomy is a reduced GHG emission that is as a result of over dependence on fossil resources in a varied number of sectors. As such, continued use of fossil resources is projected to exacerbate an already worse climate change situation in the country. Diversification to utilization of bio resources to drive bio-based industries and eventual Bioeconomy development heavily relies on a number of factors such as technological readiness, presence or lack therefore of an enabling microenvironment, and robust infrastructure among others. A bio-based economy offers employment opportunities through its application in agriculture, energy, manufacturing and health. It offers solutions to reduce environmental degradation, promote inclusive growth while fostering sustained economic growth.

3.1.2.1 MACROECONOMIC CONTEXT

Ethiopia has in previous years experienced stable economic growth (10.3%) during the implementation of the growth and transformation plan period 2010/11-2014/15. Among other macroeconomic indicators, the country's annual GDP per capita income reached high of 691 USD in 2015 and the proportion of the population living below poverty line fell to 23%. Major sectors such as agriculture, service and industry recorded an average of 6.6%, 10.8%, 20.2% respectively. The country has experienced a fluctuating inflation with a high of 33.7% in 2012 and 13.8% in 2018 which is projected to be maintained at single digit of 8% in 2020 (Plecher, 2019). Further, domestic tax and revenue collection policies have led to an increase in domestic revenue collection from 53.9 Billion Birr to 186.6 billion Birr at the end of the GTP I period. This was made possible by institutional reforms revenue mobilization including transparency and enforcement of the rule of law.

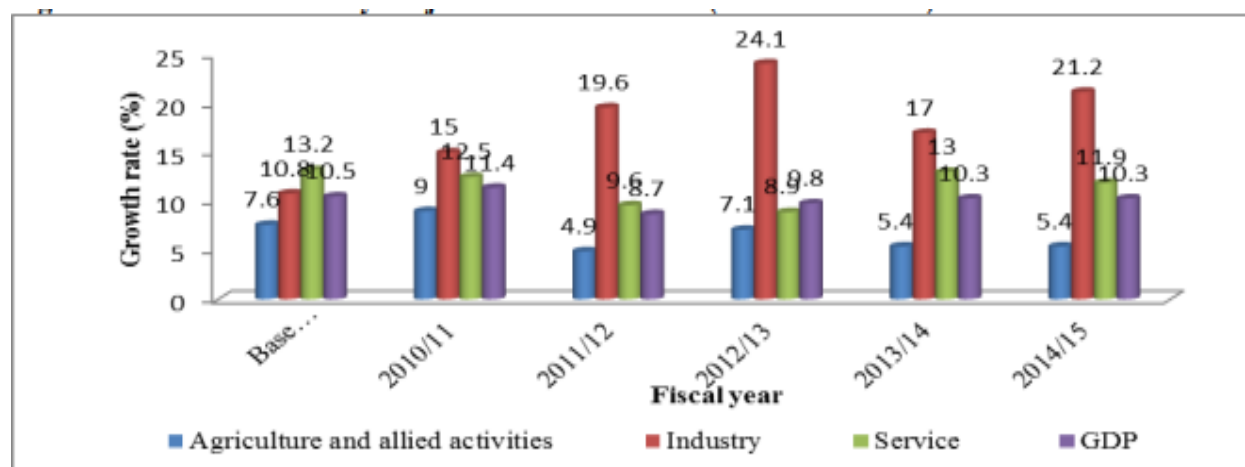


FIGURE 8: GDP GROWTH RATES BY MAJOR SECTOR IN THE GTP 1 PERIOD (2010/11-2014/15)

SOURCE: GTP II

The country has made efforts in institutionalization of prudent monetary and fiscal policies with a focus on maintaining price stability and a stable exchange rate which is a necessity for sustained economic growth and development. Fundamentally, the second GTP plan has macroeconomic objectives that are aimed at maintaining single digit inflation rate, increasing public expenditure on pro poor sectors and strengthening domestic revenue generation among others.

3.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

Technology has been lauded as panacea for sustained economic growth and industrial transformation. This has been evidenced in the 'Asian Tigers' experiences where harnessing technological capabilities has led to transformative economic growth. The country's vision of being the regions manufacturing hub and rely less on agriculture as outlined in the second GTP requires immense technological harnessing. Technology

development, dissemination and utilization have been prioritized as a major driver for industrial transformation. Universities, Research Institutes, TVET Institutions and Industries are key actors in the national innovation system, which play crucial role in technology importing, adapting and utilization. A knowledge-based Bioeconomy is dependent on use of technological innovations on biological resources. The country's investment in R&D stands at 0.61% as of 2016 which are still below the continental recommended of 1% by the African Union. According to Tigabu (2017), the bulk of the gross domestic expenditure on research (GERD) is government sourced (79%) with minimal contribution from the donor community (2%). The country's Ministry of Science and Technology (MoST) is the overall government institution whose mandate is to oversee all national research projects and activities. Additionally, the presence of the national science granting councils and existence of a national science technology and innovation (STI) policy is an indication of the significance of technological innovation in driving economic growth and development.

3.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

The linkages between higher education and economic growth have been asserted by various empirical findings which have highlighted the significance of education in accumulation of productive skills and capabilities, adoption of technology and generation of new technological innovation (Aghion et al, 2009; Holmes, 2013). Effective technology innovation, dissemination and transfer rely on the existence of skilled labour in the areas of science technology engineering and mathematics (STEM). A major challenge for the Ethiopian industry sector is a high number of recruits with skill mismatch (The Ethiopia Science and Technology Agency, 2006). Additionally, as of 2013, the country had a low number (87) of researchers per million population compared to her regional counterparts such as Kenya (318) and South Africa (818) (UNESCO, 2015). In cognizance of this, through the STI policy, the education sector seeks to transform training and higher education to one that meets the industry needs at the national, regional and global levels while positioning the country's competitiveness. The country has had policy and institutional framework to guide the education sector development such as Education and Training Policy and the Education Sector Development Strategy.

The Ethiopian science and technology landscape also features about 31 accredited public universities. Another four universities are expected to be administered by the Government, increasing the total public universities in the country to 35. Ethiopia also has 59 accredited nongovernmental universities and colleges, most of which are based in Addis Ababa. Although the majority of public universities are new, many of them undertake R&D activities. Examples of major universities that are involved in R&D and human resource development include Addis Ababa Science and Technology University (AASTU), Haramaya University (HU), Gondar University, Bahir Dar University, Mekele University, Adama Science and Technology University, Arbaminch University, Jima University and Hawasa University. There are also a number of laboratories and infrastructural agencies, which are part of the Science landscape of Ethiopia. These include: National and Regional Soil Laboratories, Regional Veterinary Laboratories, and Geological Survey of Ethiopia (GSE).

3.1.2.4 INFRASTRUCTURE

The country's infrastructure development has been prioritized in a series of medium-term plans namely the plan for accelerated and sustained development to end poverty (PASDEP) and growth and transformation plans (GTP). The federal government of Ethiopia has been pursuing industrialization through the agriculture development led industrialization (ADLI) which is a strategy that seeks to achieve economic transformation through increasing investment in agriculture. The second GTP however has a focus on industrial development with the manufacturing sector as a priority. Establishment and development of industrial parks for export processing has been identified as one of the infrastructures

necessary for accelerated growth. These include the Hawassa Industrial Park, Eastern Industrial Zone (Dukem, Bole Lemi Industrial Park, Ayka Addis) and Hujian Industrial Zone.

The country's road infrastructure has greatly improved during the implementation of the first GTP with an increase in the road network from 48,800 km in 2010 to 63,604 km in 2010 and construction of railway infrastructure which connects Addis Ababa and Djibouti has been initiated. Construction of the Grand Ethiopian Renaissance Dam (GERD) will significantly boost energy production; improve industrial productivity and overall competitiveness. Efforts to increase use of renewable energies led to increase in the number of biomass stoves distributed, construction of biogas plants and distribution of solar technologies (National Planning Commission, 2016). Additionally, use of biofuel as an alternative source of energy has been initiated by planting of biofuel crops, construction of biofuel blending facilities and ethanol production (ibid). Such efforts and investment in infrastructure are critical in production of bio-based products and overall development of the Bioeconomy in the country.

3.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

3.2.1 AGRICULTURE

The Ethiopian economy is dependent on the agriculture sector which contributes about 40% of the total GDP, a source of foreign exchange and employment to the smallholder producers (Oduya, 2016). Increasing Agricultural productivity is one of the development priorities identified in the country's development roadmap. Through the Agriculture Development Led Industrialization (ADLI) of 1995, the Ethiopian government has prioritized the agriculture sector as a driver for industrialization and subsequent economic growth and development. The strategy builds on the agriculture sector to drive industrial growth as a source of food and raw materials necessary to increase industrial productivity. In this regard, ADLI is a link between the agriculture sector and industrial development (Dube et. al, 2019). ADLI emphasizes the relevance of the sector as a source of biomass for industrial development as well as a precursor for biomass valorisation through agro processing and value addition. The agriculture sector is a source of biomass for industrial development highly emphasized in the ADLI, PASDEP and the growth and transformation plans (GTP). The PASDEP majorly focused on technological applications and potential of agricultural research in driving sectoral development, biodiversity conservation and use of agricultural biotechnology including bio fertilizer production among others (Ministry of Finance and Economic Development, 2006). The GTP II (National Planning Commission, 2016) acknowledges the significance of the sector as a source of biomass for textile and garment industry development. Further, given the endowment in livestock population in the country it has a comparative advantage in supply of feedstock for the leather industry² and as such the plan promotes value addition in the livestock sub sector. The strategic directions for the agriculture sector are keen on sustainable utilization of biological resources including efficient use of water resources for blue economy development. The Agriculture sector policy and investment framework (PIF) 2010-2020 (Ministry of Agriculture and Rural Development, 2010) outlines the identified investment priorities. The strategy has no mention of biomass although biodiversity conservation has been succinctly addressed. Increasing agricultural commercialization and agro processing, improving agricultural productivity while enhancing sustainable biological resource management and improving overall food security are the key areas addressed in the PIF.

The institutional arrangement of the Ethiopian government is a federal system of governance comprising of nine regional states and two administration units. At the national level, the MoARD has overall responsibility for agricultural and rural development policies, strategies and plans, including the

²<https://www.unido.org/sites/default/files/files/201805/4.%20Investment%20Opportunity%20in%20Manufacturing%20Industry.docx.pdf>

management of agricultural research and extension services, natural resource management, input and output marketing, disaster risk management and food security (DRMFS), and private investment support. The Bureau of Agriculture and Rural Development (BoARD) is the key counterpart of MoARD at the regional level. The decentralized institutional structure of the BoARDs reaches down to the *kebele* (lowest administrative unit) level, where there are at least three development agents working with farmers. Ethiopia has invested heavily in development of the National Agricultural Research System (NARS), including the Ethiopian Institute for Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs) and International research organizations such as International Livestock Research Institute (ILRI).

3.2.2 ENERGY

One of the strategic areas for Bioeconomy development is the energy sector. Empirical evidence indicates that total biomass fuel supply of Ethiopia is about 990 billion while about 95% of the total potential supply is from woody biomass (Guta, 2012). Key biomass-based energy strategy may largely involve innovative technological investment, which use biomass more efficiently to produce modern renewable fuels to meet energy needs in various sectors. Such technological investment requires biomass conversion to non-solid form (biogas, bioelectricity, hydrogen fuel production, bioethanol, and biodiesel) and more efficient use of solid biomass fuel using modern cooking stove technologies. These potential advantages include reduction in indoor air pollution, decreased per capita energy consumption and various other societal welfare benefits. The Ethiopia National Energy Policy 2012 (Ministry of Water and Energy, 2013) has a focus on transforming the country into a regional hub for renewable energy while driving sustainable economic growth and development. The policy recognizes the immense potential that the country has on woody biomass, wind, solar and geothermal sources. With respect to Bioeconomy development in the sector, a high percent of biomass consumption is undertaken at the household level (92); the industry uses about 2% whilst the agriculture sector has the lowest use of biomass at 1%. Bio energy utilization takes place not at a commercial level, but in small enterprises and given the potential of biomass in energy generation, the policy recognizes the significance of bio energy development for commercial use. The policy widely covers issues and benefits of bio energy and various sources of biomass such as wood, charcoal, crop-residues, livestock dung, bagasse, ethanol and biodiesel. The linkages between agriculture and bio energy production have been clearly outlined where the agriculture sector has been identified as contributor (8%) to biomass fuel supply, whilst the service sector encompassing schools, hospitals and universities heavily rely on woody biomass.

Ethanol production for blending with gasoline has been highlighted as a priority area for liquid bio fuel development in the country. Given the high livestock population in the country, the country has a high potential for biogas production from livestock waste. A national biogas program has been in place to promote biogas production through distribution of biogas digesters. To promote Bioeconomy development, the bio energy policy objectives have a focus on ensuring sustainable forest management in biomass production and utilization; promote improved bio-energy conversion technologies including agro-industrial waste for thermal and power applications, biogas from urban, livestock and poultry waste for diverse and efficient bioenergy production; and promote use of bio oil and bio diesel for household energy use among others.

The Ministry of Water Irrigation and Electricity is the national institution with a mandate to ensure development of the energy sector across the republic. This also includes protection of water resources and sustainable blue economy development. Ministry of Environment, Forest and Climate Change (MoEFCC) which is responsible for regulatory policy and decision making, environmental, climate related operations and climate change mitigation. The Ethiopia Energy Authority and the Rural Electrification Fund (REF).

3.2.3 ENVIRONMENT AND CLIMATE

The environment policy of Ethiopia (Ministry of Natural Resources Development and Environmental Protection, 1994) has a goal to 'improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs'. The policy takes into account the cross cutting environmental issues in agriculture such as use of agricultural biotechnology in an integrated manner; maintenance of biological diversity for future generational use; and use of agricultural technologies and innovation in an environmentally sustainable manner. On forest management, the policy highlights the detrimental effects of continuous use of forest products for industrial use; the need forest conservation and the importance of using agricultural practices that reduce pressure on woodland and the ecosystem. Among other priority objectives include genetic, species and ecosystem biodiversity conservation; management and conservation of the blue economy (water resources); and promote use of renewable energy in the energy sector while encouraging reduced use of fossil fuel sources.

Ethiopia's development objective is to achieve a middle-income status by the year 2025. However, such projected growth and development is expected to put pressure on biological resources and worsened by climate change effects. The climate resilient green economy (CRGE) (Federal Democratic Republic of Ethiopia, 2011) strategy was formulated to provide a green economy development pathway for the country while mitigating and adapting to climate variability. The CRGE is anchored on four sectoral pillars aimed at promoting adoption of agricultural and land use efficiency measures; increasing greenhouse gas sequestration in forestry by protecting and re-establishing forests for their economic and ecosystem services including their use as carbon stocks; deployment of renewable and clean power generation; and use of appropriate advanced technologies in industry, transport, and buildings. Although there is no mention of Bioeconomy development in the strategy, there is recognition of the need of use of biomass as a source of fuel the industrial sector and more specifically in cement production and the significance of the forestry sub sector in provision of biomass for domestic consumption and its contribution environmental degradation and climate change. The strategy has succinctly addressed the major contributions of green gas emissions and possible mitigation strategies for a climate resilient economy.

The National Biodiversity and Action Plan succinctly points out the role of biological diversity in promoting sustainable development in utilization of biological resources. Development of energy, agriculture, industry and health sector among others is reliant on availability and accessibility of biological resources. In other words, there is recognition of the use of biological agents in the manufacturing sector such as the food industry and production of pharmaceuticals and in so doing the biodiversity plan is geared towards conservation of the country's varied biological diversity for future generation use. Bioeconomy related policies and strategies in the areas of environment and climate reside in the Ministry of environment, forest and climate with close coordination efforts from other line ministries and agencies such as the Ministry of Agriculture and Natural Resources Development, the Ministry of Environment, Forest and Climate Change and the Ministry of Water, Irrigation and Energy.

3.2.4 INDUSTRY AND TRADE

The growth and transformation plan of Ethiopia seeks to drive the country into a middle-income status by 2015 with industrialization taking the lead. The country's industrialization efforts first began with the formulation of the ADLI in 1995 which was anchored on the agriculture sector as the basis for industrial sector development. The strategy succinctly points out the significance of biomass from the agriculture sector in driving industrialization. Subsequently, the formulation of an Industrial Development Strategy

(IDS) 2003 (Federal Democratic Republic of Ethiopia, 2002) was anchored on agriculture led industrialization, export promotion and development of labour-intensive industries. Though there is no direct mention of biomass and Bioeconomy related objectives in the strategy, there is recognition of the comparative advantage that the textile and garment and the meat and leather sub sectors have due to availability of cotton biomass and livestock materials for development of the aforementioned processing industries. Additionally, the strategy identifies agriculture as a source for biomass necessary for agro processing and the need to integrate industrial production and agricultural productivity. In line with this, is the emphasis on valorisation of agricultural raw materials in industrial processes to increase the share of Ethiopian products in the export markets. Biotechnology application has also been highlighted as a key strategic area that if well utilized can be used to strengthen agro- industrial links through increased productivity.

The Ethiopian Industrial Development Strategic Plan of 2013-2025 (Federal Republic of Ethiopia: Ministry of Industry, 2013) has a vision of *“Building an industrial sector with the highest manufacturing capability in Africa which is diversified, globally competitive, environmentally-friendly, and capable of significantly improving the living standards of the Ethiopian people by the year 2025”*. Just as the IDS the linkages between the agriculture sector and industrial development has been well elaborated and there is emphasis on the need for export led industrialization. Other relevant strategies in the manufacturing sector include the National strategy and plan of action for pharmaceutical manufacturing development in Ethiopia (2015–2025) (Federal Democratic Republic of Ethiopia: Ministry of Health and Ministry of Industry, 2015) which has succinctly addressed the importance of biocatalysts in pharmaceutical production. Although there is recommendation for use of biotechnology to produce high value biologicals for pharma use, the plan is sceptical of the country’s technological capacity to efficiently engage in such activities. Strategic areas for intervention include enhanced research and development to grow the bio pharmaceutical manufacturing industry; establishment of strategic technology platforms to encourage biotechnology use and enzymes for biocatalyst; and the importance of the agriculture sector as a source of biomass for agro industrial development.

3.2.5 RESEARCH AND INNOVATION

Given the country’s rich biodiversity, use of technological applications in various fields such as agriculture, health and industry are an opportunity for development of the Bioeconomy. The science technology and innovation policy of Ethiopia of 2010 (Federal Democratic Republic of Ethiopia, 2012) is focused on building competitiveness through innovation. Achievement of set objectives in the agriculture development led industrialization and the growth transformation plans which seek to transform the country’s economy through industry rely on scientific innovations. Although there is no mention of technological applications in valorisation of biomass in various thematic areas, the policy is in cognizance of the significance of innovation in promoting a green economy through treatment of industrial waste and conversion of waste into energy. Key policy objectives include; creation of an enabling intellectual property rights environment to encourage innovation, diffusion and knowledge transfer; and establishment of a national innovation system for strong federal and regional STI activities. Further, the policy identifies agriculture chemical and pharmaceutical and energy among others as priority areas that can greatly benefit from science technology and innovation applications. The significance and relevance of government research institutes has been well emphasized in driving innovation driven economic growth with recommendations on establishing necessary infrastructure such as national laboratories to promote biotechnology research activities.

To promote biotechnology activities in the country, a national biosafety framework was formulated in 2007 (Federal Democratic Republic of Ethiopia: Environmental Protection Authority, 2007) by the Environmental Protection Authority in accordance to the Cartagena Protocol on Biosafety to the Convention on Biological

Diversity. The document provides policy, regulatory and technical guidelines on undertaking biotechnology related research in the country. The document has widely addressed arising issues on handling of Genetic modified organisms, environmental protection and the need for environmental impact assessment for sustainable growth and development. The Ethiopia Agriculture and Research Organization (EARO) is the lead organization taking part in biotechnology activities.

3.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

Data collected on the allocation of the GDP towards R&D has shown that Ethiopia currently allocates only 0.27%, which will be just above a quarter of the recommended 1% by the African Union council. In effect, these dwindles the efforts that can be made towards creating a self-sustaining Bioeconomy.

Political good will to implement Bioeconomy policies and laws in different thematic areas. This includes public participation for sustainable implementation of Bioeconomy related projects and consumer awareness to encourage consumption and demand for bio-based products.

Legal frameworks are enablers for business and Ethiopia is lacking on specific policies that create an efficient space for Bioeconomy related businesses to operate. Adoption of policies should be given priority and requisite laws put in place to govern the operation of all stakeholders in the sector.

Governance is another important factor in the optimization of business. To this effect, an agency with specific inclination to development of Bioeconomy with related activities spread across relevant ministries. It should be done in such a way that there is no overlap and conflict in the dispensation of the mandate of the agency in charge. Some of the suggested actions include formation of the agency under the Ministry of Innovation and Technology, change of the Biotechnology Institute to the Bioeconomy Institute. In the new Institute (Bioeconomy Institute), biotechnology will be part of the constituent elements.



FIGURE 9: BIOECONOMY AGENCY AND SUPPORT DEPARTMENTS OR INSTITUTIONS

Presence of institutional and policy synergies between the key thematic areas is a prerequisite for Bioeconomy development. The Bioeconomy concept is a cross cutting concept which transverses various sectors such as energy, agriculture, health and industry among others. A successful Bioeconomy strategy and implementation is dependent on the presence of non-contradicting policies, laws and regulations for synergistic effects.

Human capacity building through research and training to cater for Bioeconomy industry needs. For a successful knowledge-based Bioeconomy, the country needs to invest in expert training in areas of biomedical engineering, agricultural biotechnology and other related areas.

Presence of a favourable business environment with a robust private sector will form a basis for Bioeconomy development. A knowledge-based Bioeconomy is dependent on strong public private partnerships to encourage participation of the private sector in development of modern R&D which is a necessary condition for industrial development.

A stable macro-economic environment conditioned by favourable monetary and fiscal policies to attract investment is a key determining factor in economic development.

3.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

One of the crucial steps in implementation of a bio-economic development is resource mapping. Ethiopia has biological resources that can be utilized for industrial purposes. With 32 agro-ecological zones already identified and the Dalol sink (lowest place in the world), robust with microorganisms that offer immense potential for industrial use. Availability of arable land and plenty of water favour implementation of a Bioeconomy.

Existing infrastructure also gives Ethiopia a platform to use the opportunity. Successful Implementation of a Bioeconomy strategy is dependent on the presence of infrastructure to ranging from research laboratories, road and rail transport, availability of reliable sources of energy to presence of science technology and innovation. With a developed air transport system (among the most competitive in Africa), the country can be able to access the world with products from the Bioeconomy. The ongoing road and rail projects also improve on bio-economic activities and access to raw materials and markets for finished products. The Ethiopian Government has made steps in the right direction through establishment of industrial parks to spur industrial growth.

Increased budgetary allocation towards research and development activities will contribute to capacity building and concentrating the expert pool for Bioeconomy development. Investment in infrastructure

Bioeconomy development is highly reliant on the availability and accessibility of biomass and given that the Ethiopian economy is agriculture-based economy, a surety of biomass supply without comprising agricultural production and food security is critical. Bioeconomy development is dependent on biomass production for utilization by other sectors and valorisation.

3.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS

For a start, strategy should focus on creating awareness and advocating on Bioeconomy as a short-term goal. Policies can be laid down demarcation and milestones that are expected. In the short term, focus can be made on reviewing of policies. The main deliverable at this stage would be identifying what works for the Ethiopian economy what does not and what can be done to develop a more robust policy for Ethiopia. The process will be reliant on meta data from research which can help in policy formulation.

A number of elements will spring off from the milestones in the short-term milestones. In this section, creating platforms for public private partnerships and networking on Bioeconomy forms part of the objects of concern. Ethiopia can use this time to benchmark and develop its own standard operation procedures and guidelines. An in-depth look into the academic and human resource training should be done with reviews and development strategies. Among the deliverables are science and technology roadmaps, skills assessments and curriculum development to have competitive industrial skills that will help in implementation and growth of the sector. As a crowning summation of the medium-term measures, there should be a working Bioeconomy department with support institutions.

From the department, a working agency or ministry should be functional in the long term. In addition to this, there should be bills, policies, strategies, acts and regulations in support of Bioeconomy in place to foster trade and industry in the sector. Some of the milestones visible will be intra and inter trade in the Bioeconomy spectrum, established centres of excellence in institutions, a university or academic institution with inclination to Bioeconomy, a vast database with Bioeconomy information as well as sizeable investment on infrastructure that aids in development of a thriving Bioeconomy.

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KENYA – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

4.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

4.1.1 INTRODUCTION

Kenya has an estimated population of 45.8 million in 2017 (National Council for Population and Development [NCPD], 2018), and an inter-censal population growth rate of 2.9 per cent and which is expected to reach 52 million in 2020 and about 65 million by 2030 (UNDESA, 2017). Like other eastern African economies, agriculture is the backbone of Kenya's economy, directly contributing up to 31.3% of the nation's GDP. Kenya Vision 2030 the long-term development blueprint for the country aims to transform the country into "a newly industrializing, middle-income country providing a high quality of life to all its citizens in a clean and secure environment. The development discourse for the country is anchored on three pillars: an economic pillar that seeks to achieve a 10% annual GDP growth rate, a social pillar that promotes gender equality and equitable development, and a political pillar to ensure democracy and accountability to the public. Sectoral policies and strategies are a domestication of the vision to spur economic, social and political development in a sustainable manner. Other key guiding frameworks include the Agriculture Sector Development Strategy.

The country has made key structural, political and economic changes that are aimed at promoting economic growth and development. The country's economic growth has been fluctuating over the years. According to the economic outlook report (2017), Kenya's gross domestic product (GDP) has been on an average of 5.8 % between 2013 and 2017 with a low of 4.9% in 2017. The dip in GDP was attributed to the political environment following the 2017 general elections. Future projections, however, depict a steady growth rate in 2019 that will eventually translate into a 6.0 % annually in the year 2020 as a result of recovery in the agricultural sector, political stability and an enabling business environment (ibid). Promulgation of the new constitution 2010 has led to a devolved system of government with some functions such as agriculture being undertaken by the County governments. Devolution has been lauded as one of the best outcomes of the Kenyan constitution. Devolved functions such as agriculture and health have led to investments that reach the rural communities, public participation in for mutual accountability and efficient service delivery among others.

However, the country is facing a number of challenges such as poverty, food insecurity, inequality and climate change evidenced by irregular and unpredictable rainfall, increased temperature and drought among others (Olago, 2009). The population growth rate is as high as 2.52% with an increase in the young population (56.85%). This has been further aggravated by the high unemployment rates among the youths (15-24 years) which stand at 20.1% (Hall, 2017). Projections indicate that the country is on a path that will enable her to achieve a demographic dividend (Demographic Dividend, 2020) that can be used as a tool to drive the informal sectors through application of ICT to tackle the unemployment menace. The country has the ability to becoming the region's economic powerhouse by tapping into the youthful population, promoting private sector development and increasing investment in infrastructure. Increased population growth has led to a demand for bioresources to drive economic and development. In an effort to promote

Bioeconomy growth and development, the country has frameworks such as the Strategy for developing the Bio-Diesel Industry in Kenya (2008-2012, the National Biotechnology and Development Policy 2006 among others to drive growth of Bioeconomy and increase its contribution towards the annual GDP growth while ensuring conservation of the country's biodiversity and sustainable utilization of bio resources.

The Bioeconomy was variably viewed as: i) an economy whose foundation is bio-related products, system and technologies; ii) sustainable utilisation of biological resources, of which the Kenya Wildlife Service is a key custodian of; iii) the use of research-based science and its knowledge to increase productivity in the use of bio-resources for sustainable development; iv) biotechnology, which is the technology of developing biologics; v) the process and principles that lead to the production and utilisation of bio-resources. These perspectives were then summarised as **“Processes and activities that lead to sustainable use of biological resources to create value in form of products, services and knowledge, through science, technology and innovation.”**

4.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

One of the benefits of development of an innovation led Bioeconomy is a reduced GHG emission which is as a result of over dependence on fossil resources, climate change and unsustainable use of biological resources in a varied number of sectors. Diversification to utilization of bio resources to drive bio-based industries and eventual Bioeconomy development heavily relies on a number of factors such as technological readiness, presence or lack therefore of an enabling microenvironment, and a robust infrastructure among others. A Bioeconomy offers employment opportunities through its application in agriculture, energy, manufacturing and health. It offers solutions to reduce environmental degradation, promote inclusive growth while fostering sustained economic growth.

2.1.2.1 MACROECONOMIC CONTEXT

Sustainable growth and development of bio-based industries and demand for bio-based products is highly dependent on enabling business environment, public private partnerships, and political stability. Kenya's position as a regional economic player can only be strengthened if it is able to guarantee a stable operating macro environment in terms of interest rates, a stable exchange rate and continued investment in primary sectors for a stable upward trend in GDP growth. Key sectors of the economy include agriculture, manufacturing, real estate and services. Although agriculture remains the mainstay of the economy at 30 per cent of GDP, manufacturing's share of GDP has been rising significantly over the years. At 10%, manufacturing is the second-largest contributor to GDP, with the processing of agricultural products a key factor in growth. According to the World Bank, Kenya has transitioned from low income country to lower middle income due to its continued economic performance. However, Kenya currently has a large trade deficit. Between 2011 and 2015 the country exported 5.5 million US dollars' worth of goods and services while it imported 16.4 million US dollars worth of goods and service (Hanlin, 2017). For continued long term growth and development, there is need for an enabling business environment to promote foreign direct investment (FDI). These include economic indicators such as the interest rate which is being regulated by the Banking (Amendment) Act, 2016. However, in recent times, capping of the interest rates by the Banking Act has led to a decline in lending to the private sector. Consequently, this has adverse implications in private sector investment and overall economic growth.

2.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

Given that the Kenyan economy is a primary based economy, technological innovations can be used as a tool to drive industrialisation in different thematic areas such as health, energy and agricultural biotechnologies aimed at promoting increased productivity and bio-based products through value addition. Applications of bio-innovations can lead to development of bio-degradable and renewable materials to reduce the over dependence on organic materials as pathways to the Bioeconomy. Agricultural

production and the manufacturing sectors are based on natural resources and heavily rely on low technologies. Further, advanced technological innovation can be used produce high technology bio-based products that meet regional and international trade standards. If well exploited, technological advancement is a critical tool towards a competitive knowledge-based economy not only for national growth and development but also for meeting the African Union Agenda 2063 and the Global Sustainable Development Goals (SDGs).

To promote technological innovation for inclusive economic growth, the Kenyan government has put in place legal and institutional frameworks. These include establishment of bodies and authorities such as the National Commission for Science, Technology and Innovation (NACOSTI), the Kenya National Innovation Agency (KENIA) and the National Research Fund (NRF) to coordinate innovation and research activities for inclusive benefits for all strategic thematic areas; others include efforts to develop innovation hubs and business incubation centres such as NaiLab, iHub and C4DLab a research and development centre at the University of Nairobi; science parks and special economic zones in Mombasa, Lamu and Kisumu for purposes of converting ideas, research, or prototypes into viable products and services. However, a glaring gap that has posed a challenge to utilization of new innovations and could be a bottleneck to Bioeconomy development is poor linkages between the academia, research institutions and industrial applications of bio innovations (Mwanzo, 2009). This is further aggravated by lack of a well-functioning innovation system to ensure enhanced competitiveness and links with the education and research system, the business system, the intermediate organizations, ST&I infrastructure and framework conditions in which they operate to interact dynamically.

2.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

A competitive innovation led Bioeconomy demands skills, linkages between the education system and training across sectors for a sector wide approach. Education and research development are crucial determinants of the ability to create a knowledge-based economy. Education and research system must be proactive in addressing the needs of industry to ensure effective synergy. A knowledge-led Bioeconomy requires broad technological innovation applications that for desirable and impactful outcomes extensively rely on highly qualified and skilled human resource.

Gross domestic expenditure on research and experimental development (GERD) is an indicator widely used in assessing national scientific and technological strength, and provides information on how much a country invests in R&D. Being a member of the African Union (AU), Kenya has a mandate to meet the set standard of 1% of the GDP to be investment in research by the AU's executive council. The country's budgetary allocation towards research and development activities has gradually increased from 894 million in 2013/14 financial year to 3.4 billion in 2016/17 as shown in figure 4. This was attributed to an increase in allocation towards the national research fund. To further consolidate the effort, the country's STI act has a target of 2% of GDP to be spent on research activities. However, despite such commitments, the country's expenditure on research is still below target averaging at 0.79% of GDP (Ministry of Education, 2018).

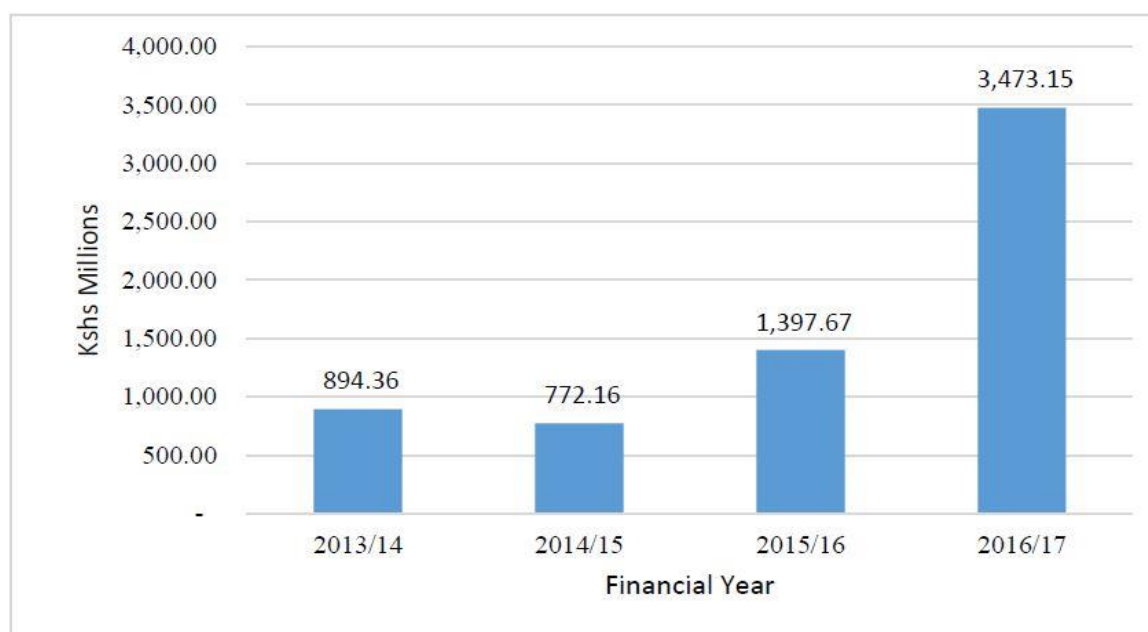


FIGURE 10: BUDGET ALLOCATION FOR R&D (2013/14- 2016/17)

SOURCE: THE NATIONAL TREASURY

Given that agriculture is the country's economic backbone, the agriculture sector receives 44.8% of the GERD followed by the medical and health sciences at 17.5% (IndexMundi, 2020). The investments made in higher education are in expectation of benefits that can be reaped by the researchers as well as enriching the growth of the country's economy. Kenya's education sector has experienced transformation and growth over the years. The country has the highest density of researchers per million inhabitants in east and central Africa and this has been attributed to a rise in number of both public and private universities (Republic of Kenya, 2012). However, with the low uptake of STEM at the tertiary levels, there exists disconnect between education and training and industry needs that are technologically aligned.

2.1.2.4 INFRASTRUCTURE

Infrastructure development plays a fundamental part in economic growth and development. In this regard, the sectoral contribution to economic growth and development cannot be over emphasized. Infrastructure development is critical to facilitating trade and industrial growths, thus spur economic growth especially in developing countries. Among the key infrastructure with huge deficit include energy, transportation and ICT. This has implications on the country's ability to optimize the recently opened regional trade blocks such as the East Africa Community (EAC) and COMESA among others.

According to the energy sector policy, Kenya's 1664 MW installed electricity generation capacity is below the required generation capacity of 6700 MW to spur sustained economic growth and development (GoK, 2015). This coupled with over reliance on hydro and thermal electricity generation poses a huge challenge as these sources of energy are prone to be affected by climate change effects and world fuel prices. Efforts have been made to boost availability through imports from regional surplus states like Ethiopia, diversification of generation sources, and modernization of transmission and distribution systems to assure usage efficiency and reliability in supply. Key infrastructure investments have been made to reinforce Kenya's position in the regional power market by connecting Kenya to Ethiopia, Uganda and, in the future, Tanzania.

Even though the supply of infrastructure has historically remained low, the government has heightened investment to a tune of 27% of the total budget (CSP, 2014 – 2018) and the number of projects started for infrastructure development especially on transport, energy, water & sanitation and environment related

drastically increased (World Bank, 2016). The Vision 2030 and the Medium-Term Plan (MTP) II identified that energy costs in Kenya are comparatively higher than those of other countries (Oxford Business Group, 2016). This translates to higher costs of doing business and hence diminished competitiveness of the economy. Diversification to foster resilience in the transport system is necessary through increased use of water- and rail-based transport. The transport system needs to be made environmentally sustainable, foster equity and assure economic efficiency.

4.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

The legal, regulatory and administrative framework of a country determines the institutional environment in which businesses operate and how they interact with the government. This framework is an important determinant of productivity and competitiveness.

4.2.1 AGRICULTURE

The Ministry of Agriculture Livestock Fisheries and Irrigation (MoALFI) is the overall state accredited body, whose mandate is to ensure continued growth and development of the agricultural sector by ensuring policy formulation to support financial, technical and an enabling regulatory and legal framework, maintain linkages with donors and supervise sector's performance to meet the overarching objectives. The agriculture sector in the country has been operating without a policy document and instead the Agriculture Sector Development Strategy 2010-2020 (ASDS) has been the guiding framework for agricultural development in the country. The ASDS recognizes the opportunities present in the agriculture sector for production of biofuels from sugarcane, maize, millet, sorghum, jatropha and other oil-bearing seeds as a source of income for small holder producers; the threat posed by population growth on bio diversity loss and poor natural resource management leading to deforestation, desertification and over exploitation of indigenous species; the potential of agricultural wastes derived from growing and first processing of raw agricultural products such as slaughter houses as alternative sources of energy such as biogas; the importance of energy as an enabler for agricultural development. The strategy seeks to provide incentives to private sector engagement in energy generation activities and investment in research and careful planning in line with the national strategy guiding production of biofuels; and biotechnology applications for increased commercialized agricultural production.

4.2.2 ENERGY

Energy generation and consumption is one of the key indicators of a country's growth and development trajectory and as such the presence and or lack therefore of enabling environment for energy sector development is critical in overall Bioeconomy development. In order to achieve the national development objectives outlined in the country's Vision 2030, the available production factors have to be utilized in an economical efficient manner. The level and intensity of commercial energy use in a country is a key indicator of economic growth and development. The National Energy Policy 2014 (GoK, 2014) recognizes the contribution of biomass (68%) to the energy sector in the country. One of the most important sources of energy for the rural households is wood biomass utilized as charcoal and firewood. The imbalance between demand and supply for wood biomass has led to overexploitation of natural resources and as such raising issues such as competing land uses between land for biomass and food production. The energy policy seeks to promote research and development on of biomass energy technologies that could reduce pressure on natural resources; collaborate with other relevant ministries and other stakeholders to grow and sustain tree cover to above 10%; and provide incentives for private sector participation in generation, exploitation, production, distribution, supply and use of biomass energy. This is aimed at use of renewable sources of energy for small and medium agro processing, heating and lighting activities in business enterprises.

Secondly the policy recognizes the importance of biofuels in form of bio-ethanol and bio-diesel, as substitute for petroleum to meet transportation needs, reduce vehicle emissions, save on foreign exchange required for petroleum importation, improve on the balance of trade, create employment, and contribute to the overall green economy. This can be achieved through establishment of facilities for biofuel blending and identifying and setting aside land for feedstock production such as jatropha. The document highlights the importance of legal, regulatory and institutional framework in promoting sustainable generation, exploitation, production, distribution, supply and use of liquid biofuels; tax holidays and duty waivers for bio-fuel production projects; and the relevance of research on the production chain and sustainability of biofuels particularly biodiesel. Other critical issues include use of biogas and energy generation from organic waste for industrial growth and promotion of the green economy.

Other relevant documents to the energy sector include: the Strategy for developing the Bio-Diesel Industry in Kenya (2008-2012) (GoK, 2012) whose mandate is to ensure blending of biodiesel in the ratio of B5 by 2012 and B10 by 2020; contribute to efforts to address global warming through substitution of petroleum fuels; diversify rural energy sources by promoting substitution of kerosene with biodiesel, and the use of decentralized energy systems and increase security of energy supply by reducing vulnerability resulting from dependence on imported fossil fuels and diversification into use of biodiesels.

Implementation of the national energy policy requires an inclusive cross sectoral approach, efficient coordination between the different stakeholders to promote synergistic effects and minimize contradicting policy formulation. The policy is guided by the Sessional Paper No. 4 on Energy of 2004 (GoK, 2004) which outlines several legislations such as the Energy Act, No.12 that seeks to amend and consolidate the law relating to energy, provide for the establishment, powers and functions of the Energy and Petroleum Regulatory Authority and the Rural Electrification Authority; the Geothermal Resources Act No. 12; the Petroleum (Exploration and Production) Act; and the Petroleum Development Fund Act.

The aforementioned legislation and acts perform regulatory functions to institutions under directly or indirectly related to the energy sector such as the Ministry of Energy (MoE); Energy and Petroleum Regulatory Authority (EPRA) Energy and Petroleum Regulatory Authority (EPRA) whose mandate is to oversee regulation of energy, tariffs, licensing and enforcement; Rural Electrification Authority (REA) that ensures mobilization of resources for rural electrification and promoting the development and use of renewable energy; and the Kenya Electricity Generating Company Limited (KenGen) which is mandated with hydro, wind, geothermal and solar energy production in the country.

4.2.3 ENVIRONMENT AND CLIMATE

Bioeconomy development heavily relies on sustainable use of natural resources to drive growth and development. Kenya's environmental resources contribute directly and indirectly to the local and national economy through revenue generation and wealth creation in productive sectors such as agriculture, fisheries, livestock, water, energy, forestry, trade, tourism and industry. Environmental degradation in Kenya directly contributes to impacts of climate change as is witnessed in the rising costs of water treatment, food imports and health services. The continuous loss of biological resources translates into loss of economic potential and options for commercial development (GoK, 2013). Though there is no mention of biomass in the National Environment Policy (2013), the policy articulates the importance of biodiversity conservation in bio-prospecting processes; acknowledges the contribution of unsustainable resources use to high carbon footprint and greenhouse gas emissions and as such the policy has a focus on promoting green economy development through a clean and healthy environment (ibid).

The National Climate Change Response Strategy was formulated as a response to the climate change effects (GoK, 2010). The strategy succinctly outlines the importance and linkages between biomass to

critical sectors of the economy such as energy; the over exploitation of forest biomass due to population pressure and the need promote alternative energy sources, energy conservation initiatives, efficient charcoal production and utilization technologies to reduce biomass consumption; use of green energy sources for reduced GHG emissions and investment in renewable biomass energy including biofuels; and investment in cogeneration of electricity from renewable biomass waste which has benefits such as improving health, lowering demand for both land filling waste and fossil fuels among others.

The Environmental Management and Coordination Act (EMCA) 1999 provides for sound management of the environment; Land Act (2012) whose mandate is to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources; National Land Commission Act 2014 which instituted the Lands Commission is mandated to identify and keep record of all public land as well as plan for its use under section 8 of the act; and the Forest Act 2005 whose purpose is to provide for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country.

Being a signatory to the Convention on Biological Diversity (CBD), Kenya has a National Biodiversity Strategy and Action Plan 2000 whose mandate is to ensure biodiversity conservation and sustainable utilization of biological resources (GoK, 2000). The Strategy emphasizes the importance of institutional capacities and linkages in implementation and enforcement of biodiversity related legislations to ensure environmental protection is upheld; the relevance of policies and legislations on management biological resources; and in situ conservation of by protection of aquatic and wetland ecosystems and protection of the ASALs to facilitate biodiversity conservation and bioprospecting are some of the key areas addressed in the document. There is cognizance of overexploitation of forest resources and unsustainable harvesting of various biodiversity products. The policy seeks to encourage use of diverse sources of energy such as biogas and varied agricultural and forest products; estimate the full value of standing forest resources in terms of biodiversity value, watershed protection, influence on climate, cultural and aesthetic value; and integrate and improve the management of forest resources by regulating access to forests and promoting benefit sharing, promoting the re-use and recycling of forest resources, encouraging the use of forest resources for ecotourism among others. The importance of agricultural biodiversity has been succinctly addressed in the document with a major focus on the need to conserve agricultural biodiversity by promoting the development and use of neglected and underutilized species through inventorying and improving quality while creating awareness among user and the sustainable agricultural production practices that conserve the ecosystem. Biotechnology and use of other technologies in manipulation of biological resources has been pointed out and a need for legislation of use of biotechnology has been emphasized.

The Ministry of Environment Water and Natural Resources, (MENWR) carries the overall mandate for natural resources management and conservation including forests, wildlife, the environment and pollution control. The Ministry of Agriculture, Livestock and Fisheries (MoALF) has responsibility over the agricultural components, and thus ensuring sustainable land management in cultivated areas, grazing lands and through all aspects of the agricultural value chains. National Environment Management Authority (NEMA) is the national regulatory agency coordinating with the decentralized entities with a responsibility of ensuring environmental standards are adhered to and protection of the environment.

4.2.4 INDUSTRY AND TRADE

Kenya's industrial sector accounts for about 10% of the total GDP (Economies Africaines, 2017) and it is characterised by various manufacturing activities such as agro processing which contributes to the largest share of industrial GDP (43%) followed by the textile sub sector at 8% (KAM, 2018). The Industrialization Policy Framework for Kenya 2012-2030 is based on Sessional Paper No. 09 of 2012 which seeks to

“Transform Kenya into a globally competitive regional industrial hub”. The industrial policy prioritizes the development of agro-processing, the medium to high technology sector such as pharmaceutical and the advanced technology sector that require broad bio and Nano technologies applications; and environmental applications such as bioremediation and biosensors and methods to reduce the environmental effects and production of biofuels. The policy acknowledges the strategic location of the country to be a regional industrial hub through utilization of biomass from the agriculture sector and the fairly skilled human capacity. However, despite agro processing being a large contributor to the manufacturing sector, the policy seeks to address issues such as low biomass valorisation which is conditioned by limited technological capability. Further, the document highlights the importance of an enabling business environment focusing on components such as political stability, a stable macro-economic environment, establishment of a favourable legal and institutional and regulatory framework, promoting value addition and physical infrastructure among others.

The National Trade Policy 2017 seeks to ‘transform Kenya into a competitive export led economy, enhance regional integration and widen participation in both domestic and international trade’. Although there no clear mention of biomass and Bioeconomy related objectives, the policy recognizes the importance of innovations and inventions for production of high value-added products that meet international standards and the critical role played by education, research and training in accessing international markets. The policy highlights the presence of several registration and licensing agencies as a cause of high transaction cost and a disincentive for business investment. To promote access to international markets, the document proposes an increase in value addition through use of modern technology and innovation, establishment of special economic zones and industrial parks and undertaking institutional reforms to facilitate trade.

4.2.5 RESEARCH AND INNOVATION

Science, Technology and Innovation Policy and Strategy 2008 ‘aims to mainstream applications of science, technology and innovation in all sectors and processes of the economy to ensure that Kenyans benefit from acquisition and utilization of available capacities and capabilities to achieve the objectives of Vision 2030’. One key priority areas of the policy are application of technological innovations in the energy sector. It acknowledges the significance of technological applications in harnessing alternative sources of energy water, wind, sun, geothermal, nuclear energy, gas, oil, coal, domestic waste and biomass so they account for a larger portion of the energy mix. It further seeks to promote biotechnology application in development of biomaterials, including polymers, metals, ceramics and composites, which are produced synthetically or biologically, for use in the efficient treatment and management of diseases with growth potential in bio-generics and molecular diagnostics for diseases, as well as vaccines for tropical diseases and advancement in the production of bio diesel to curb the rise in crude oil prices.

Establishment of the National Biotechnology and Development Policy 2006 is an indication of government acknowledgement on the importance of biotechnology in promoting economic growth through intellectual property creation to expand entrepreneurial opportunities for industrial growth, reduction of poverty, and improvement of food security, health, and environmental sustainability. The policy covers a wide range of areas such as tissue culture and micro propagation, bio pesticides and bio fertilizers, bioremediation, livestock technology, DNA marker technology, and genetic engineering. The document has identified agricultural biotechnology as a priority area which can be used to improve food security, reduce environmental degradation and accelerate agro-processing. This can be achieved through development of new plant varieties, artificial insemination techniques and development of new plant and animal diagnostic products including bio pesticides and bio fertilizers. Further, the policy is in cognizance of the importance of education in ensuring a knowledge driven and research-intensive biotechnology industry. In so doing,

the document proposes curricula review to strengthen and increase the number of biotechnology experts such as engineers, scientists and technologists.

The significance of bio-resources in industrial biotechnology applications has been succinctly addressed. Specific objectives to promote sustainable bio-resource utilization include: molecular characterization and bioprospecting for novel products for development and industrial production; focused exploitation of fauna, flora and microbes in marine and extreme habitats for novel genes for development of osmo-tolerant crops, enzymes, biopolymers, marine pollution biosensors, bioactive molecules; and the development of a centrally managed database on species in different ecosystems and the traditional knowledge associated with the species; among others. Other key policy priority areas include environmental biotechnology which highlights the importance of approval before undertaking any biotechnology; medical biotechnology which prioritizes basic and applied research in bioinformatics, molecular and cellular biology, genomics, proteomics, stem cell biology (strictly using ethically obtained stem cells only), and other new platform biotechnologies as appropriate, development of traditional herbal medicines into superior industrial therapeutic products and screening of biodiversity components for bioactive compounds for value added therapeutic products. On industry and trade, the key priority areas are the application of biotechnologies to convert the local bio resources into biofuels, fine and bulk chemicals, bioplastics, pharmaceuticals, enzymes, vitamins, bio fertilizers and food processing among others.

The governance system for ST&I consists of different institutions to coordinate and oversee implementation of an effective Kenya National Innovation System. The key institutions include, the Ministry in charge of Science, Technology and Innovation, the National Commission for Science, Technology and Innovation (NACOSTI), the Kenya National Innovation Agency (KENIA) and the National Research Fund (NRF).

TABLE 8: SUPPORTING INSTITUTIONS, LEGISLATION AND ACTS IN KENYA

Thematic area	Institutional setting	Legislations and Acts
Agriculture	Ministry of Agriculture Livestock Fisheries and Irrigation (MoALFI) Kenya Plant and Health Inspectorate (KEPHIS) Kenya Agriculture and Livestock Research Organization (KALRO) Ministry Environment and Natural Resources	Agriculture Act 1986 Agriculture and Food Authority Act 2013 The Forest Conservation and Management Bill, 2014 The Community Land Bill 2013 the Climate Change Act 2016
Energy	Ministry of Energy Energy Regulatory Commission Rural Electrification Authority Kenya Electricity Generating Company Limited	Sessional Paper No. 4 on Energy of 2004 Energy Act, No. 12 Geothermal Resources Act No. Petroleum (Exploration and Production) Act Petroleum Development Fund Act.
Environment/Energy	Ministry of Environment Water and Natural Resources, (MENWR) Ministry of Agriculture, Livestock and Fisheries National Environment Management Authority	The Mining Act of 2014 The Environmental Management and Coordination Act (EMCA) 1999 Land Act (2012) National Land Commission Act 2014 Forest Act 2005 The Forest Conservation and Management Bill, 2014 The Community Land Bill 2013
Industry and trade	Ministry of Trade, Industry and Cooperatives Kenya Bureaus of Standards Kenya Industrial Estates Kenya Industrial Property Institute	Environmental Management and Coordination Act 2006 Industrial Property Act 2001
Research and innovation	Ministry of Science, Technology and Innovation National Commission for Science, Technology and Innovation Kenya National Innovation Agency National Research Fund National Biosafety Authority	National Biosafety Act The Science Technology and Innovation Act 2013

4.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

Bioeconomy is a concept that is aimed at achieving self-sufficiency by promoting use of eco-friendly products to drive economic growth, sustainable use of biomass, efficient use of raw materials and reducing carbon footprint. Successful establishment of a Bioeconomy is heavily reliant on presence of a favourable operating environment that encompasses fiscal policies, parliamentary acts and strategies that act as drivers for a competitive knowledge-based Bioeconomy development.

Policy review and analysis on different thematic areas of the Kenyan economy indicate presence of policies to guide and provide a framework for Bioeconomy development in the country. Sustainable development requires policies and strategies that provide a guiding framework for demand and supply of bio-based products. The diverse nature of biomass utilization and its cross-cutting aspect needs a legislation framework that can harmonize the statutory mandates of existing institutions for efficient implementation of sector wide policies.

Additionally, the fragmented nature of legislations and acts on biomass utilization leads to systemic incoherence which is inhibitive. Effective and efficient sectoral coordination between relevant regulatory institutions involved in biomass use is a prerequisite for sustainable utilization of bio resources in different thematic areas.

Existence of legal, regulatory and institutional frameworks to encourage sustainable biomass utilization is a necessary condition for Bioeconomy development. This includes framework on biomass generation, production, distribution and supply.

In addition, political stability is judged to be a prerequisite for an optimised operating environment. However, this without a good political buy-in would not suffice to create a strong Bioeconomy. The question of political buy-in being an important one seeing as the country has in made several attempts to have a biotechnology policy put into place and it has been met with significant social resistance. In some instances, it has required proponents of these “avant-garde” positions to make public protests, a case example is the advocacy done by Prof Wangari Maathai to have protect the Kagura Forest from deforestation and Uhuru Park from being erected with more urban skyscrapers.

Through proper political buy-in, fiscal incentives can be provided for biomass production projects, plant and equipment for utilization in different areas of the economy. Sound fiscal instruments such as tax holiday and VAT tax exemptions will create incentives for private sector investment in biomass utilization equipment, promote production of bio-based products and overall Bioeconomy growth. For instance, the Public Private Partnership Act of 2013 provides for the participation of the private sector in the financing, construction, development, operation, or maintenance of infrastructure or development projects of the Government through concession or other contractual arrangements; the establishment of the institutions to regulate, monitor and supervise the implementation of project agreements on infrastructure or development projects and for connected purposes. Within each state department are Committees responsible for overseeing matters PPPs. The Act in addition provides specific guidelines beginning from the identification of projects warranting such kind of collaboration and ensuring that the transfer of assets at the expiry or early termination of a project agreement is consistent with the terms and conditions of the project agreement, where the project agreement involves a transfer of assets.

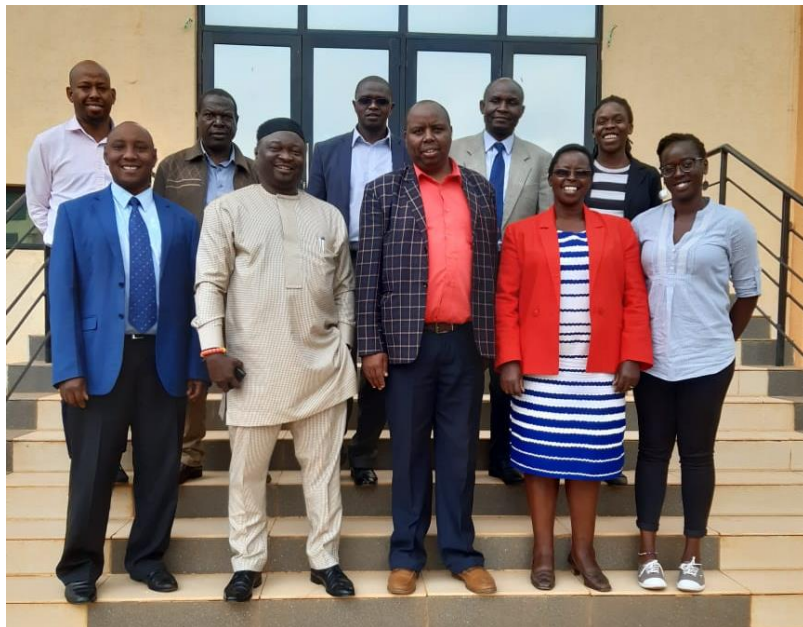
4.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

Development and institutionalization of Bioeconomy policies and strategies is highly dependent on the presence of a number of factors.

- Knowledge based human resource development is a critical component for transition and development of the Bioeconomy. Although the Kenyan government has made substantial efforts towards investment in education, research and training, there is a need to develop strategies and actions that are geared towards human resource training for innovative and competitive industrial skills. The linkages between technical skills and biomass utilization and development of industrial bio products is one if well exploited can significantly promote Bioeconomy development.
- The country is endowed with a wide range of biological resource base which form a basis for Bioeconomy promotion. Development of a Bioeconomy is reliant on the country's ability to produce raw material for industrialization and agro processing among others without necessarily leading to depletion of biological resources. It is therefore important for the country to have strategies and regulations in place on land management and use, agriculture and biodiversity conservation.
- A knowledge-based Bioeconomy is sustained by existence and formation of public private partnerships. Collaborative projects between the government and the private sector are strategic in ensuring industrial bio production, attracting funding for bio development and promoting research development and innovation.
- The linkages between infrastructure and Gross domestic product are one that strongly determines a country's economic growth. The cost of energy has impacts on the price of food and other economic activities and therefore, Kenya's energy prices significantly contribute to its position as an economic hub both locally and globally. The country's energy policy emphasizes on the importance of diversification to other renewable sources of energy including biomass to meet the domestic and industrial demand for energy. Other key infrastructural development critical to the success of Bioeconomy implementation include a good network of both road and rail transport for transportation of raw materials and value-added products, promoting regional trade; and water and sanitation.
- Bioeconomy development in Kenya highly depends on the presence of innovations and technologies both leapfrog and emerging technologies. The country being the region's innovation hub has a competitive advantage in using innovative technologies to extract biomass for the different priority areas of the Bioeconomy. It currently takes about 24 hours to register a business name and 14 days to successfully register a business, elements that are critical for innovative activities.
- The role of advocacy to drive the scientific agenda in the country is esteemed to be important, in as much as advocacy is esteemed to be useful where systems are not working. The National Commission for Science Technology and Innovation (NACOSTI) is the central organisation mandated with overseeing matters STI in the country. While the institution is well capacitated, its political power in advocating for key STI infrastructural and capacity needs seems to raise more questions than answers. While the Commission has ceded its grant allocation functions to its sister institution the National Research Fund (NRF-Kenya), the current GERD levels are approaching 1%. A recent revision of the National Research Priorities has the 2018-2022 scope align with the Presidential National Development Plan, the Big 4 Agenda. The Big 4 has BT Cotton as one of its priorities and it is esteemed that if successful, it will pave way for bolder biotechnology projects. In addition, the Big 4

Agenda presents a case for manufacturing, which will hopefully pave way for a prolific bio-based industry.

4.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS



From consultations, the policy and strategic recommendations for an innovation-led national Bioeconomy were addressed in short-term, medium-term and long-term perspectives.

On the Short-term, mainstreaming Bioeconomy in existing policies and frameworks seemed to be a priority. This is especially in consideration of the fact that there have been Bioeconomy related activities in the country, only they have not been dubbed as such. This coupled with the fact that ministries and other institutions working on the

Bioeconomy are acting more in isolation than less with bring to table the matters that require joint approaches, and Bioeconomy considerations can be included in the policies and frameworks. Secondly, there is need to create awareness and sensitise all classes of the population of what the Bioeconomy means. As this is a socio-economic project, that should be driven by the people, the understanding for instance that biotechnology is one of the driving factors of the Bioeconomy is necessary to allow for people to have a more wholistic view of the concept. One of the approaches proposed is to have a big Bioeconomy conference that will bring to table stakeholders at all levels with representation from the different counties. Ministers would be invited, and the communications made accessible to the public.

On a medium-term perspective, a national strategy can be developed which should mainstream main in-house departmental strategies: a national strategy would include global perspectives, but then allow for each ministry to pick up implementation items that they can then build on. Also, in the short term the NRF-Kenya and other funding and development agencies in the country can make sure to have the Bioeconomy as a thematic topic of research, funding projects that advance this national agenda, especially in light of its interdisciplinary nature. Going further, these can be included as themes in university curricula as full educational programmes are developed.

On the long-term perspective, full curricula can be developed to educate a critical mass that applies Bioeconomy principles in the socio-economic different areas, and a Bioeconomy Policy and Act developed, establishing relevant institutions that are dedicated to Bioeconomy research, development and innovation.

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RWANDA – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

5.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

5.1.1 INTRODUCTION

With the agriculture being the major contributor to economic growth in Rwanda, the country's overarching development plan Vision 2020 aims to transform Rwanda into knowledge based middle income economy through strategic transformations of the agriculture sector, savings and increased private sector investment (Republic of Rwanda: Ministry of Finance and Economic Planning, 2000). Agriculture has not reached its full potential and investments in climate resilient techniques for farming coupled with improvements in value chains is expected to yield significant future gains in both growth and poverty reduction. Develop and support priority sub-sectors with high potential for growth and employment including: Agro-processing, Construction, Light manufacturing, Meat and Dairy, Leather, Textiles and Garments, Horticulture, Tourism, Knowledge based services, Value addition and processing of Mining products, Creative Arts, Aviation, Logistics, and Transportation.

The country heavily relies on tourism, minerals, coffee, and tea as main sources of foreign exchange. The country's GDP growth performance has been stable averaging at 6.1% as of 2017 majorly driven by the service and agriculture sector. Being the highest GDP contributor, the agriculture sector is projected to post a good performance in food and export crops due to continuing investments to improve seeds and extend small scale irrigation whereas the manufacturing is expected to grow at 8.3% and 13.1% (**fig 11**) supported by continued investment in infrastructure.

	2014	2015	2016	2017	2018	2019	2020
GDP	7.6%	8.9%	6.0%	6.1%	7.2%	7.8%	8.0%
AGRICULTURE	7.0%	5.0%	4.0%	7.0%	5.6%	4.5%	4.3%
Food crops	9.0%	4.0%	3.0%	7.0%	7.1%	5.1%	5.1%
INDUSTRY	11.0%	9.0%	7.0%	4.0%	8.3%	13.1%	13.9%
Mining & quarrying	25.0%	-5.0%	10.0%	21.0%	20.1%	31.5%	32.9%
Manufacturing	8.0%	8.0%	7.0%	6.0%	6.1%	7.6%	8.5%
Construction	10.0%	15.0%	5.0%	-3.0%	5.2%	10.1%	8.7%
SERVICES	7.0%	10.0%	7.0%	8.0%	7.6%	7.8%	7.8%

FIGURE 11: GROSS DOMESTIC PRODUCT CONTRIBUTION PER SECTOR.

However, despite the suitable eco system, forests and fertile land, food production is still below par and the country therefore relies on food imports. Despite grappling with the effects of the genocide crisis, the country has made impeccable socio-economic development in the last decade putting it on the map as one of the

fastest growing economies in Africa. This includes an annual GDP growth rate of between 6-8 % since the year 2003; a reduction in the inflation rate; a decrease in the number of people living below the poverty line to 39% in 2015 compared to 57% in 2006; and improved maternal and child health to an estimated 70% (Ministry of health, 2015) mortality reduction in under 5 year olds in line with sustainable development goals (IndexMundi, 2019). As of 2018, the population growth stood at 2.3% with a projected decline to 2.2% in 2020 (CIA, 2020). The country is projected to achieve demographic dividend given that about 38% of the population consists of young people aged between 15-35 years whilst 40% is comprised of children between the ages of 1-14 years. This has significant economic implications as it will result in a bulge in the working population which is projected to trigger an increase in overall productivity in various sectors of the economy.

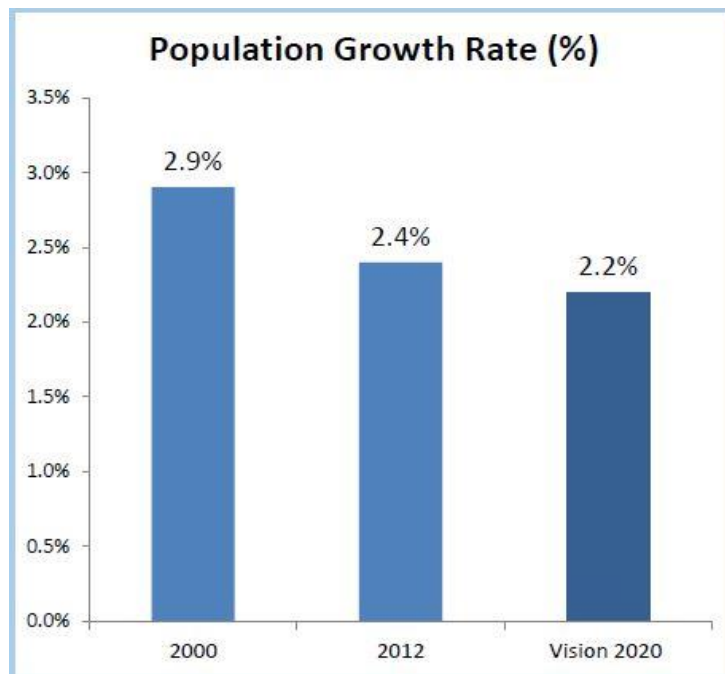


FIGURE 12: PERCENTAGE GROWTH RATE OF RWANDA'S ECONOMY

The Bioeconomy concept in Rwanda is still at its infancy level. A study by Biber-Freudenberger et.al, (2018) points out the importance of primary sectors such as agriculture in promoting Bioeconomy development. However, despite the significance of primary sector in Bioeconomy development, the documents highlight low use of high technology unavailability of the necessary skills and inadequate bio productive land as an impediment to Bioeconomy development (Biber-Freudenberger et.al, 2018). For a sustainable Bioeconomy, investment in genetics, biology, ecology, information technology, and engineering are not only a sufficient condition, but also a necessary one.

5.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

Rwanda's economy is heavily dependent on its environmental resources. Agriculture, industry, commerce and rural energy requirements place significant demands on natural resources, while the livelihoods of rural communities are shaped by their access and use of them. Accelerating growth in economic sectors will put additional pressure on non-renewable natural resources. Vision 2020 establishes that becoming a knowledge-based economy is a key development objective for Rwanda. Bioeconomy development requires innovative application of research and technology in biological sciences to produce bio-based drugs for improved human health, increase agricultural productivity through high yielding crop varieties and eventual food security.

However, critical to Bioeconomy development is the availability of biological resources to form feedstock for the different areas of the economy; presence of labour resources conditioned by investment in education and professional training for a country to be able to effectively compete for both domestically and internationally; infrastructure establishment in areas such as transport and, information communication technologies (ICT's) and knowledge resources encased in public research and innovation and providing a conducive environment for private sector involvement among others.

5.1.2.1 MACROECONOMIC CONTEXT

A favourable macro environment is a necessary condition for economic growth for any given country. Since the 1994 Rwandan genocide, the country has experienced overall political stability which forms a prerequisite for stable economic growth. The country seeks to reach a middle-income state through the National Strategies for Transformation (NST). Rwanda has made strides towards a stable GDP growth averaging at 6.1 in 2017, a low inflation which is indicative of low food prices, investment in road transport and formulation and implementation of policies to improve production while increasing exports (International Monetary Fund, 2018). Additionally, efforts to leverage regional blocks and alliances provide a platform for trade, access to infrastructure which is necessary for promotion and growth of the Bioeconomy. The government has embraced an expansionary fiscal policy to reduce poverty by improving education, infrastructure, and foreign and domestic investment. Public investment has formed the basis for economic growth characterised by external sources of financing such as grant. However, in recent times, the government seeks to promote private sector growth by instituting structural strategies to reduce the cost of energy while encouraging domestic savings (World Bank, 2019). The African Economic Outlook report (African Development Bank Group, 2020). highlights the significance of the industrial sector and manufacturing which have in recent times contributed to economic growth at 4.1% and 1.5% respectively. The government has made fiscal and monetary policies such as the made in Rwanda policy statement which is aimed at increasing the quantity of exports thus promoting growth of an export led economic growth. Further, projected economic growth is anchored on domestic revenues through domestic resource mobilization strategies and prudent borrowing.

5.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

The most developed research infrastructure is in the agriculture sector where there are noticeable achievements. The R&D infrastructure for industrial technology is very modest and needs strengthening. The most significant effort to-date concerns the high-tech sectors, with the planned development of Kigali Innovation City (KIC), for which support and funding have been pledged to an estimated \$100 million. Dubbed as the 'Silicon Valley of Africa', the KIC will be a host to world-class universities, technology companies, biotech firms, and commercial and retail real estate. The project is in line with the country's NST of transforming the country into a competitive knowledge-based economy.

The Government has launched ambitious plans for the high-tech sectors and developing Centres of Excellence in advanced technologies. However, it is important that the agro-food sector, industry and medicine and health-related sectors receive due policy attention. Vision 2020 established that developing technological research services is a primary policy element. To this end, the National Industrial Research and Development Agency (NIRDA) was established in 2013 as a department of the Ministry of Trade, Industry and EAC Affairs (MINEACOM) and to support R&D projects of economic value for industry. Some strengthening of NIRDA's R&D activities may thus be needed in order to better match development ambitions. A National Commission for Science and Technology (NCST) was established in 2012 to advise the Government on policies, legislation and regulation in the fields of science, technology, research and innovation, and to monitor the implementation of

such policies and legislation. NCST has led to establishment of the National Research and Innovation Fund (NRIF) to support and promote national science, innovation, technology, and research.

5.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

Education is fundamental to developing innovation capabilities and a knowledge-based economy. Improvement of science and technology environments in schools and developing demand-driven and relevant science and technology curricula, will require interaction with other STI stakeholders, including financial firms and industries. The Ministry of Education, recognizing the importance of leading in the practice of innovation, launched an Innovation for Education fund in 2012. The fund finances innovative pilot projects on improving children's learning. As of FY2018/19, Rwanda allocated about 11% of the total budget towards education, including tertiary education. This is below other countries in the region such as Ethiopia which allocated about 24.2% (UNICEF, 2020). To monitor the achievements of education and training efforts the Government has established a Capacity Building Services and Employment Board (CESB). It oversees the identification of training needs and gaps and coordinating an institutional and policy response. Research and development are however important for sectors such as agro-food sector and the medicine and health sector, where there is a need for integrated efforts to generate the critical mass required for technological progress. There is a need for a strong and integrated approach for developing a biomedical industry in Rwanda. This means, among other things, training a corps of biomedical engineers and engaging the private sector to invest in health care activities. A UNESCO reports indicates that the research capacity of the Rwandan education sector is still undeveloped characterized by 0.2% of enrolled PhD students (UNESCO, 2017). Despite emphasis on the importance of the education sector on economic growth and development, there lacks statistics on government expenditure on research and development activities in the country (World bank, 2019). An Institutional assessment of the Rwandan education sector shows that the ministry of Education has the overall mandate to ensure equitable access to quality education and promoting use of science technology and innovation. Other semi-autonomous agencies include the Rwanda Education Board which oversee the pre-primary, primary and secondary school programme, and the Workforce Development Authority which as a responsibility to ensure technical and vocational education and training (TVET) development among others.

5.1.2.4 INFRASTRUCTURE

The Rwandan Government has stated that one of its key goals as part of its Vision 2020 is to improve the country's infrastructure in order to bring about significant economic growth. This includes developing the country's transport links and energy supplies. Being a landlocked country, the country heavily relies on Kenya and Tanzania on infrastructural support. The energy sector in Rwanda has made significant steps to ensure availability if energy needs for industrial transformation and overall economic growth. Only about 24.5% of the total population has access to electricity with current electricity generation standing at 186 MW which is below the generation capacity of 563 MW to spur sustained economic growth (USAID, 2016). Infrastructural investment in the Economic Development and Poverty Reduction Strategy (EDPRS II) (The Republic of Rwanda, 2013) is an inclusive government strategy that takes into account dynamic factors such as population growth, biological resource depletion and other socio-economic factors that are critical in energy availability, transmission and utilization. In the EDPRS II, there was an increase energy generation (fig 8), with biomass energy generation at 0.79MhW; the number of households connected to electricity increased compared to the previous years; and government awareness campaigns on the use of improved cooking technologies under the Biomass Energy Program.

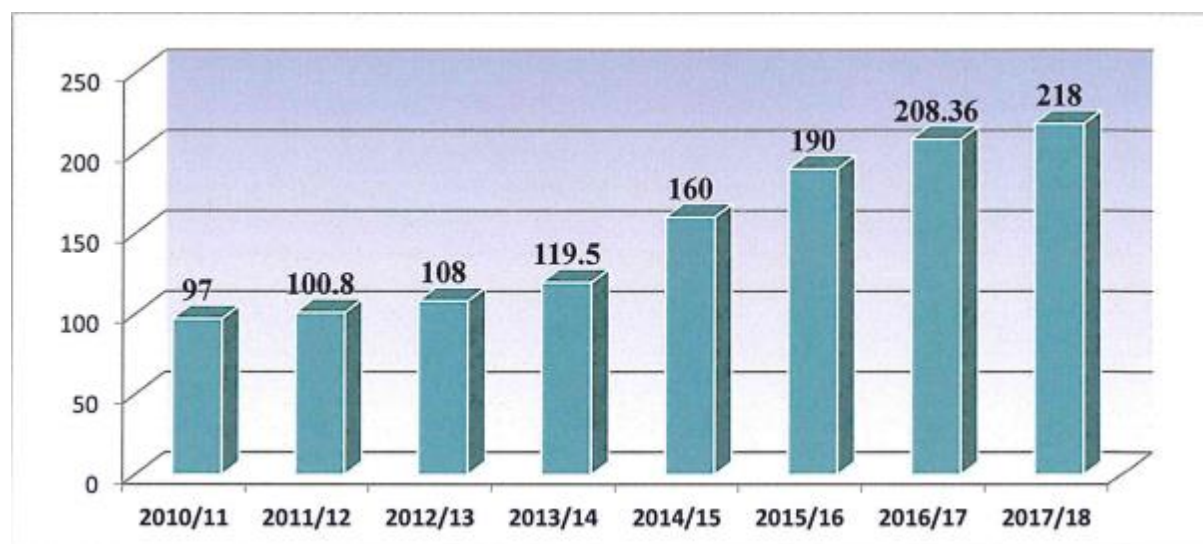


FIGURE 13: ENERGY GENERATION INSTALLED CAPACITY NEEDS (2010-2018)

The country has also made notable investment in road, air and trans-border transport in an effort to promote connectivity to other neighbouring countries, improve trade, increase competitiveness and attract private sector investment (The Republic of Rwanda: Ministry of Infrastructure. (2018).

4.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

The overarching development blueprint is the Rwanda's **Vision 2020** seeks to transform the country into a knowledge-based middle-income country. Faced with a population growth rate of 2.3% per annum (World Population Review, 2020), unsustainable resource use has been a challenge that has led to deforestation, depletion of biodiversity, poor waste management and pollution. To prevent further environmental degradation, the vision sets the target for the forest cover to reach 30% of national land area by year 2020. Further, extensive use of forest products is one of the challenges that have led to deforestation and soil erosion and as such, the country recognizes the need to diversification to other sources of energy other than woody biomass. Other key policy sections include; diversification to alternative renewable sources of energy such as exploitation of methane gas deposits in Lake Kivu, peat deposits and photovoltaic solar energy as a supplement for fossil fuels that are costly and exert pressure on biological resources; and research and innovation promotion by establishing centres of excellence that focus on biomedical engineering, biodiversity and natural resources management and life science; among others.

5.2.1 AGRICULTURE

As a biomass production sector, agriculture is equally the backbone of Rwanda's economy. Household biomass use at 91% (Ministry of infrastructure, 2018) accounts for the greatest biomass utilization sector in the country. The Ministry of Agriculture (MINAGRI) is mandated to implement agriculture related policies through sectoral policy setting, sectoral strategy planning; sectoral M&E; and sectoral capacity building. The Rwandan 2017 National Agriculture Policy (Ministry of Agriculture, 2017) therefore has key policy actions to: increase crop, livestock, fisheries and aquaculture productivity; promote high-value addition for Rwandan agriculture; foster active policy response to and fragmentation, by furthering producer cooperation and land leasing; encourage better post-harvest management, while also actively supporting the emergence of agri-food processing; and improve farmers' access to markets, particularly through better value chain integration; among others. Though

there is no explicit mention of Bioeconomy development in the document, the policy has emphasis on blue economy development through public private partnerships to increase productivity. In an effort to promote trade and encourage growth of the export for increased foreign exchange, value addition and agro processing has been highlighted as a key policy action. Still on the same note, the document recognizes the importance of crop diversification as a means to adapting to climate change, increasing soil fertility while protecting biological diversity and increased nutritional benefits. The role of biotechnology in adoption and use of superior genetic material in both crop and livestock production has been succinctly addressed. Of importance to note, is that use, and transfer of genetically modified organisms has been discouraged more so in the absence of biosafety and bioethics regulatory mechanisms. Other key policy actions in increasing agricultural productivity include strengthening agriculture research for development to promote and encourage generation and use of locally available technologies for continued and sustainable agro processing; encouraging better post-harvest management, while also actively supporting the emergence of agri-food processing through infrastructure development such cold storage facilities, and use of technologies to reduce post-harvest losses; improving availability and access to affordable, nutritious and safe food in rural areas; improve farmers' access to markets, particularly through better value chain integration; foster active policy response to land fragmentation, by furthering producer cooperation and land leasing; and pursue a deeper regional and international trade and knowledge integration with neighbouring economies

On promoting environmental sustainability in agricultural practices, the document seeks to encourage development of more efficient irrigation systems for the rural farming community to increase productivity and improve resilience to climate change effects. Additionally, eco system management, prevention of soil erosion and efficient use of agricultural inputs are key concerns in environmental management. In cognizance of the inadequacy of skilled labour the document seeks to promote skills development through vocational training, enhance information access by small holder producers and gender mainstreaming in the sector through policy.

The Strategic Plan for the Transformation of Agriculture (PSTA) (Ministry of Agriculture and Animal Resources, 2009) is a document that aims to drive growth of the agriculture sector in the country increasing productivity and competitiveness of the sector through efficient use of water resources, investment in infrastructure and sustainable use of inputs; sustainable agricultural production; and establishment of an effective institutional setting which is inclusive of the local government among others. Although there is no mention of Bioeconomy development in the document, the key strategic areas identified and mentioned in are critical to Bioeconomy development. Institutional implementation of sector policies and strategies is the mandate of the MINAGRI in collaboration with other agencies such as the Rwanda Agriculture Board (RAB), National Agricultural Export Development Board (NAEB); the National Agricultural Export Development Board; and the Rwanda Agriculture Board.

5.2.2 ENERGY

The Rwandan energy sector is highly dominated by biomass with the highest biomass consumption taking place at a household level (Fig 8). Other important source of energy is oil and gas products (11%) whereas hydro, coal and natural gas account for less than one percent (Hivos, 2020). The high cost of electricity in the country is inhibitory to industrial growth and private sector expansion and growth. In cognizance of these factors, the Rwanda Energy Policy 2015 (Ministry of infrastructure, 2018) highlights and maps out key strategic areas that are relevant to overall economic growth and development in the country. The key policy areas include building decentralized energy policy implementation capacity; promote value-for-money and increased market competition in energy development; private operation of government owned power plants; promoting private

sector participation; and “smart” subsidies aligned to social protection principles. Further, the document highlights the key strategic areas in the various energy sub sector in an effort to ensure availability and accessibility of energy to the masses. The policy proposes the need for robust legal, regulatory. Institutional and financial frameworks for sustainable development of the energy sector; the importance of diversification to cleaner energy sources and the significance of use of domestic resources for power generation among others have been well articulated.

Although there is no explicit mention of the Bioeconomy in the document, Bioeconomy related issues such as use of biofuels and biogas as energy sources has been well articulated. Biomass energy has been identified as a useful source of energy and as such the document puts emphasis on a shift from traditional biomass technologies to modern more efficient biomass technologies. Key strategic policy actions to promote sustainable use of biomass include social marketing/behavioural change models and partnerships with financial institutions to influence the switch to other sources of biomass other than wood and charcoal; update the technology standards for installation of biogas digesters; undertake subsidy reform initiatives for biogas and other clean energy technologies through the ministry of infrastructure and the ministry of finance to scaling up of existing programs; and develop new policy and regionally-integrated market for sustainable liquid bio-fuels. The policy will focus on harmonization of agricultural land use, increase biofuel mix in the country’s energy mix to reduce over dependence on imported petroleum and promote industrial use of biofuels including agro processing.

Inefficient Biomass utilization and use of other non-renewable sources of energy has dire impacts on natural resources, biodiversity loss and accelerating the effects of climate change. Achievement of a clean environment is a top priority for the Rwanda Vision 2020 (Republic of Rwanda, 2012) and in so doing; the policy puts emphasis on GHG emission reduction by use of alternative sources of energy such as biodiesel, ethanol and methane. One key component is the promotion of biofuels to integrate agricultural production and sustainable land use practices to prevent soil degradation and reduce greenhouse gas emissions. Although a viable source of energy, biofuel production could lead to competing use of agricultural land for food production and as such it is critical to have a balance between production of crops suitable for conversion to biofuels and production of food and cash crops. Research and development on renewable sources of energy has the capacity to drive agricultural growth, industrial production and development through agro processing to penetrate global markets, increase incomes for rural households and overall livelihood improvement. In cognizance of the importance of the energy sector, National Energy Policy and National Energy Strategy 2008-2012 strategizes use of biogas digesters and production of methane through gasification of solid waste as a source of household energy (Ministry of infrastructure, 2009). Building sustainable national capacity throughout the entire energy sector in both the private sector and across the government agencies is an important aspect championed for in the document. This coupled with investments in energy-related research and development has been proposed as a tool to promote sustainable biomass use for biofuel development that could arguably drive other sectors such as manufacturing, agriculture and conserve biodiversity while driving green economy.

The ministry of Ministry of Infrastructure (MINIFRA) has the overall mandate to oversee energy infrastructure in the country in collaboration with other key line ministries and agencies such as Ministry of Trade and Industry (MINICOM) which is key in implementation of energy sector policies. The Ministry of Natural Resources (MINIRENA) plays a significant role in ensuring sustainable use of natural resources and oversee compliance to the stipulated regulations as laid out by the environmental management authority. Other relevant key stakeholders include Rwanda Energy Group Ltd which has a mandate to oversee implementation of energy

sector policies, Rwanda Utilities Regulatory Authority, National Industrial Research Development Authority, Rwanda Environment Management Authority, the National Commission of Science and Technology and the Rwanda Standards Board.

5.2.3 ENVIRONMENT AND CLIMATE

The Ministry of Natural Resources in coordination with other key line ministries such as the Ministry of Infrastructure and the Rwanda Environment Management Authority have the mandate to oversee the implementation of The National Forestry Policy 2017 (Ministry of Natural Resources, 2017) towards economic growth and sustainable use of forest products by the masses. The document acknowledges the importance of forests in job creation, value addition and overall improved livelihoods. However, with increase in population, unsustainable use of forest biomass has dire implications on the environment through deforestation, greenhouse gas emission and eventual increased carbon footprint. The policy adopts seven statements involving the enhancement of the capacities of forest institution and actors for sustainable forest management, increase of private sector support and involvement in the forestry sector, enhancement of biodiversity and ecosystem services for efficient biomass supply, as well as the adoption of Agroforestry and Trees Outside Forest (TOFo) techniques to enhance forest resources and agriculture productivity. Among the key policy areas identified is the imbalance between biomass demand and supply of biomass from forest products and as such the potential of agro forestry to increase biomass availability. The Rwandan government seeks to regulate and promote the wood biomass energy production and use including development of green charcoal and wood pellets to replace traditional charcoal while promoting green energy technologies.

Being a signatory to the convention of biological diversity, in 2011, Rwanda enacted a National biodiversity policy (Republic of Rwanda, 2011) aimed at promoting biodiversity conservation. Amongst these is the Convention on Biological Diversity (CBD), with three main goals including the conservation of biodiversity, sustainable use of the components of biodiversity, and sharing the benefits arising from the commercial and other utilization of genetic resources in a fair and equitable way. Its biodiversity policy recognizes the role of the biodiversity and biomass in helping the country achieve its long-term developmental goals expressed in its strategic Vision 2020. The Rwanda biodiversity policy has a focus on ensuring biosecurity in handling, testing, and inspection, certification and approval procedures; acknowledgement of the importance of biotechnology applications to drive the agriculture, health, energy and manufacturing sectors in the country whilst raising public awareness on the associated risks in handling of Genetically Modified Organism (GMO's); and mainstreaming of biodiversity considerations into forestry, agriculture, trade and overall investment to enhance biodiversity conservation and efficient use of resources.

Efforts have been made towards development of a green economy in Rwanda. Development of the Draft National Environment and Climate Change policy 2018 (Ministry of environment, 2018) seeks to mitigate the effect of population growth on the environmental resources such as land and forests by encouraging diversification into other low carbon sources of energy; championing use of green technologies; and sustainable use of resources along different value chains in agriculture, manufacturing and transportation among others. Emphasis is put on diversification of energy sources and use of low carbon energy grid in industrial production; promote circular economy development by encouraging climate change and environmental considerations in biomass utilization; development of green technologies and procurement are initiatives introduced to improve sustainability as it has the potential to contribute to environmental improvement and diffusion of green technologies. This is in line with the country's development path of been a green economy while promoting use of eco-friendly products across all sectors of the economy. Achieving

the aforementioned policy actions requires an inclusive multi-disciplinary approach that is highly dependent on private sector participation. Private sector inclusivity is anchored on their participation in development of financial and insurance services and their engagement in carbon credit generating activities for global markets. The resulting effect is job creation, growth in the green economy and increased incomes for the masses.

5.2.4 INDUSTRY AND TRADE

The Rwandan government through vision 2020 seeks to increase share of industry contribution to the total GDP to about 26%. Attainment of such industrial transformation requires presence of industrial policies and an enabling legal and enabling environment to spur sustainable economic growth. The Rwanda Industrial policy 2011 acknowledges the importance of industry contribution towards Gross Domestic Product (GDP) for Rwanda to reach the Vision 2020 by contributing to about 12 % annual growth (Ministry of trade and industry, 2011). The policy seeks to address the issues of high energy costs which are an impediment to industrial development; the importance of innovative technologies in processing of high value products for a comparative advantage both domestically and internationally; and value addition along the different value chains to increase export and job creation to a growing population. Biomass for energy production to drive industrialization is an important aspect as highlighted in the document. There is need to move from over dependence on imported fossil fuels into cleaner locally available renewable sources of energy, while maintaining sustainable forests. In order for Rwanda to compete in an increasingly competitive global economy and open trading system, it must build and acquire appropriate science, technology, innovation entrepreneurial, engineering, and technical/vocational capacity to produce more value-added goods and services. Further, restructuring and expansion of the Institute of Scientific and Technological Research (IRST) to become the Industrial Research and Development Agency (IRDA) to facilitate the transfer of innovative technologies, to carry out industrial research and to stimulate national and international partnerships will greatly contribute to industrial economy development. The document highlights the role played by an enabling regulatory environment in promoting industrial growth and development. Some of the proposals outlined include promoting land registration as land has been indemnified as one of the biggest constraints to industrial growth and the strenuous process of paying taxes should be made less bureaucratic and reduced compliance costs. The linkages between raw material for industrial use and industrial development have been succinctly addressed. In an effort to promote sustainable availability of biomass from agriculture, forestry and minerals, the policy proposes formulation of policies that address the high cost of inputs and raw materials and infrastructure development to reduce the high transaction costs incurred in transportation, distribution and marketing of products.

The Rwanda Trade Policy 2010 (Ministry of trade and industry, 2010) is a policy document that gives direction to the development of the country's domestic and international trade. The policy vision is to promote *'growing sustainable and diversified quality products and services for trading locally, regionally and internationally, with the aim of creating jobs, increasing incomes and improving the living standards of Rwandans'*. The key strategic objectives are to increase productivity, competitiveness and diversified sustainable productive capacities for trading nationally, sub-regionally, regionally and internationally; increase investment, including foreign direct investment, into production of competitive goods and services for the export market; increase human resources skills in trade and development through training and retraining in private and public institutions; enhance participation of importers and exporters of goods and services in regional and international trade taking advantage of trade opportunities. Special attention would be paid to supporting women farmers and entrepreneurs as well as rural-based exporters; and strengthen science, technology and innovation policies,

strategies and institutions including intellectual property laws, in support of industrial development and creative knowledge-based industries. Relevant to Bioeconomy development in the document is the sustainable rural development by linking organic agriculture and decentralized renewable energy such as biogas and review potential for production and trade in bio-trade products and services. Such initiatives if undertaken are critical to Bioeconomy development in Rwanda.

5.2.5 RESEARCH AND INNOVATION

Science technology and innovation is a prerequisite for accelerated industrial growth and development. Most SSA countries have the advantage of using leapfrog and new emerging technologies to drive sustainable growth and development in different areas of the economy. To achieve knowledge-based Bioeconomy use of high technologies in different thematic areas of the economy requires investment in innovation and highly skilled labour. This includes application on biotechnology innovations in industrial feedstock to produce biofuels and drive bio processes (Lewandowski, 2018). Rwanda's Science, Technology and Innovation Policy (STIP), 2006 (Republic of Rwanda, 2006) recognizes the relevance of building science and technological capacities in education through innovative research and training. Succinctly addressed is the importance of public sector reforms and adjusts in creating an enabling environment for STI development. Some of the key commitments include human capacity building in all sectors of the economy, revision of the education curriculum to accommodate all aspects of science technology and innovation, encourage use of environmentally sound and sustainable technologies in manufacturing and investment in research and development infrastructure among others. In addition to emphasis on an enabling legal and regulatory framework, the policy seeks to address intellectual property related issues as an incentive to encourage research and development activities at the tertiary and industrial levels. The policy proposes establishment of intellectual property frameworks in institutions involved in science technology and innovation as protection of such rights is critical in biological diversity protection in the country.

Notably, the policy highlights the important sectors of the economy such as education, health, agriculture environment, energy, industry among others and the role played by STI in driving growth and development in the said areas. Given the importance of the agriculture sector in Rwanda, strategic policy actions are focused on use of STI to improve land yield and productivity which is crucial to optimising the use of Rwanda's limited land resource and promote use of technology on specific value chains with an aim of increasing the share of agriculture products for the export market. Further, the document highlights the importance and promotion of agricultural biotechnology in ensuring increased yields through sustainable utilization of an already over exploited land resource base: applications of STI in biodiversity conservation, water and soil conservation; issues related to use of alternative sources of energy to drive processing; and application of technology in disease diagnostics and drug manufacturing for healthy citizens.

The policy actions and objectives greatly contribute to the country's vision 2020, the continents development plan, the African Union 2063 Agenda and the global sustainable development goals.

The government of Rwanda is a signatory to the Convention of Biological Diversity and has signed and rectified the Cartagena Protocol on Biosafety. The National Biosafety Policy (NBF) of 2005 (Republic of Rwanda, 2005) seeks to ensure *'safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account human health'*.

TABLE 9: SUPPORTING INSTITUTIONS, LEGISLATION AND ACTS IN RWANDA

Thematic area	Institutional setting	Legislations and Acts
Agriculture	Ministry of Agriculture (MINAGRI) Rwanda Agriculture Board (RAB) National Agricultural Export Development Board (NAEB) Rwanda Vision 2020	Rwandan 2017 National Agriculture Policy Strategic Plan for the Transformation of Agriculture (PSTA)
Energy	Ministry of Infrastructure (MININFRA) Ministry of Natural Resources (MINIRENA) Rwanda Energy Group Ltd (REG Ltd) National Industrial Research Development Authority (NIRDA) Rwanda Utilities Regulatory Authority Rwanda Environment Management Authority (REMA) Rwanda Utilities Regulatory Authority National Industrial Research Development Authority Rwanda Environment Management Authority National Commission of Science and Technology Rwanda Standards Board.	Electricity Act (2011) Law on Mining and Quarry Exploitation (2008) Petroleum Law (2013). National Energy Policy and National Energy Strategy 2008-2012
Environment/Climate	Ministry of Natural Resources (MINIRENA) Rwanda Environment Management Authority (REMA)	The National Forestry Policy 2017 Convention of Biological Diversity Draft National Environment and Climate Change policy 2018
Industry and trade	Institute of Scientific and Technological Research (IRST) Industrial Research and Development Agency (IRDA)	The Rwanda Trade Policy 2010
Research and innovation	National Commission of Science and Technology (NCST)	Science, Technology and Innovation Policy (STIP), 2006 Rwanda Vision 2020 National Biosafety Policy (NBF) of 2005

5.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

Bioeconomy development just like any form of development cannot take place without sound legal and regulatory framework in different thematic areas of the economy. Robust legal and regulatory frameworks are fundamental in attracting private sector participation. Realignment of the current regulatory framework and establishment of new laws, standards and guidelines on biomass harnessing and exploitation is a prerequisite for Bioeconomy development.

In addition to this, the presence of funding and credit facilities will boost R&D and lead to the encouragement of development of intellectual property in the Bioeconomy sector. This coupled with monetary and fiscal macroeconomic interventions such as tax exemptions for bio-economic equipment will promote growth.

Biomass utilization is a cross setting issues that requires a sector wide approach to ensure sustainable use of resource both for current and future generations. Strong and consolidate institutional frameworks with a central coordinating unit is a key component in resource use planning in the manufacturing and agricultural production while conserving the diverse ecological diversity and at the same time mitigating climate change effects.

Scientific resources form a crucial factor as well in the growth of an innovative driven sector. To bolster this, Rwanda would benefit from the creation of research and innovation centres throughout the country and will be a backbone in ensuring efforts in the R&D of products is supported.

Economic development including Bioeconomy growth is reliant on the presence of a stable political environment. This is critical in attracting private sector investment, foreign direct investment and overall sectoral growth. In addition to this, partnerships will ensure that there is free movement of goods and information through opening up markets and support of information sharing.

5.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

Technology and innovation access will strengthen the foundation for research into Bioeconomy especially it is based on the local uses and hence readily adopted by the actors. Even as leapfrog technologies are better suited to avoid inventions of new technologies, where necessary, innovation funding options are needed especially in the private sector and small innovators who may not have the access. Property rights protection as an enabling legal framework will make innovators feel confident in going into bio-economic ventures.

Fiscal instruments such as the Feed in Tariffs (FiT- an instrument for promoting generation of electricity from renewable energy sources) are necessary to encourage private sector investment. Promote research and development activities in both government and public sector through private public partnerships

Availability of biological resources for industrial growth is a critical aspect to Bioeconomy development. Bioeconomy development is dependent on sustainable availability, access and utilization of domestic biomass. Policy and regulation can mitigate any misuse and also protect consumers through biosafety laws. Such can be launched in regulation of indigenous knowledge in traditional medicine as well as the recommendation or encouragement of consumers to use local products to streamline and create demand.

Investment human capital development has been emphasized as a prerequisite for sustainable development. This entails increasing the rate of enrolment in primary and post primary education while at the same time improving the quality of education offered. Having bio-economic thematic areas that will be as a result of

consultation to create industry relevant skills will go a long way as a result of linkages between government, academia and the private sector. In the existing mandatory skills taught in university such as entrepreneurship, Bioeconomy can be included as a means to creating awareness and interest in the field.

5.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS

In the short term, policies and strategies are needed in the bioenergy sector to create an enabling environment for businesses to operate. Agriculture would also benefit from value chain identification. From a biodiversity standpoint, it is prudent to identify projects and the raw materials along with the conservation policies that are in place to manage the sustainability of the use of the products in the Bioeconomy. In the same, collection of information should be done systematically to aid in the monitoring and evaluation of the processes involved. In health, there is a need to strengthen the infrastructure and build capacity to ensure that the country benefits from the Bioeconomy.

Investment in biological waste processing, forms part of the expectations in the medium term, in developing a Bioeconomy in Rwanda. Eco-tourism forms a part of the benefits to be witnessed from the biodiversity thriving while agro-processing would be part of the agricultural sector which is the major GDP contributor in Rwanda. In growth from the indigenous medicine, it is expected that there will be promotion of creation of biobanks, clinical trials for the development of medicine from the Bioeconomy. A thriving medical sector may lead an inclination to promote medical tourism.

A matured Bioeconomy would have generation of energy from waste; the agricultural sector would niche in organic value-based products and an existing market. To feed into the niche, crop variety will also have improved to ensure that there is sustainability and that there is no shortage of raw materials. In the same, there will be a valorised biodiversity and environment. In the health sector, biosecurity, presence of biobanks, biopharmaceuticals as well as improved patient diagnostics form the outlook in the long term.

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TANZANIA – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

6.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

6.1.1 INTRODUCTION

Economic development in the Tanzanian economy is highly dependent on agriculture which accounts for about 66% of employment, 30% of the total exports a source of raw materials for industrial use and contributes to 23% of the GDP (The United Republic of Tanzania, 2016). The tourism, mining and manufacturing sectors are also key contributors to economic growth, with mining and manufacturing attracting significant foreign direct investment (FDI) (UNIDO, 2014). Tanzania's has several national development strategies that have been earmarked as drivers of economic growth and development. The country's overarching development vision, Tanzania Development Vision (TDV) 2025 is implemented through the 2nd National Strategy for Growth and Reduction of Poverty (NSGRP-II) for Mainland and the 2nd Zanzibar Strategy for Growth and Reduction of Poverty (ZSGRP-II) both covering the period 2010/11–2014/15 (AFDB, 2016). The 1st Five Year Development Plan (FYDP-I) 2011/12 – 15/16, the FYDP II (2016–2020) that puts emphasis industrial economy growth and FYDP III (2021–2025) that seeks to promote export led growth (fig 14).

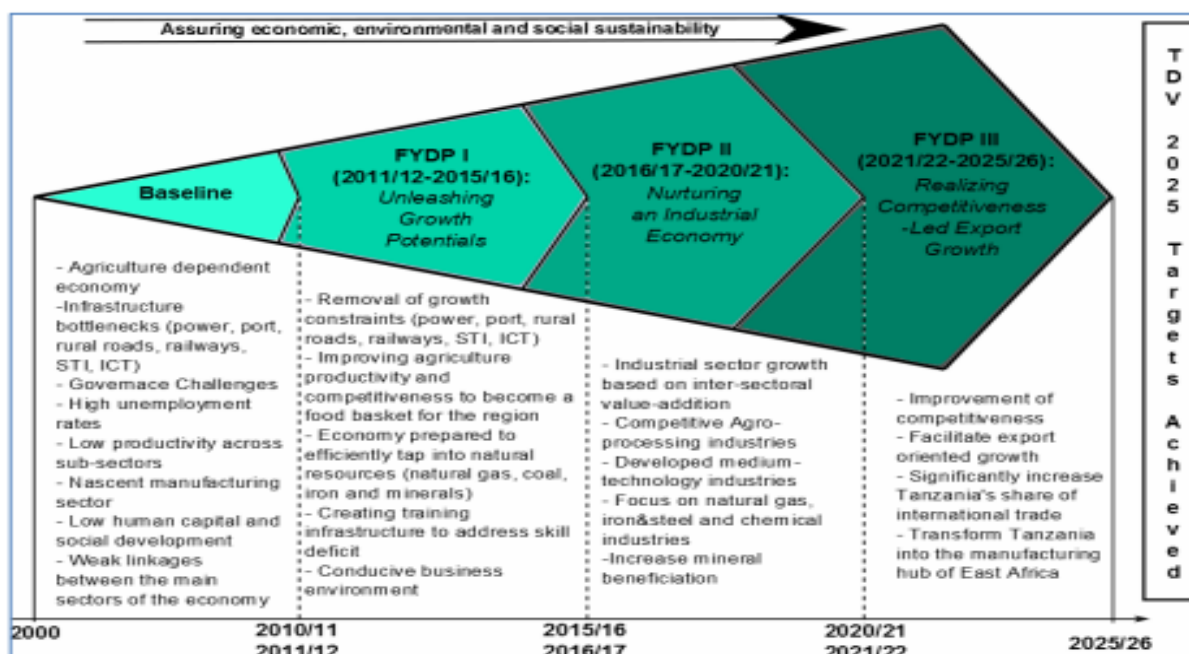


FIGURE 14: VISION OF ECONOMIC DEVELOPMENT THROUGH CONSECUTIVE FYDPs: 2011 – 2025

Source: POPC. URT ESRF, (2009)

The country has experienced a steady economic growth averaging 6-7% per annum with a high contribution from the service sector (39.3%) (World Bank, 2019) supported by Foreign Direct Investment. One of the biggest challenges facing Tanzania is the rapid population growth (2.7% per annum) with a 55 % working population and urbanization (UNDP, 2018). The high growth rate puts a constraint on the government's ability to provide basic infrastructure such as education, water and sanitation. Poor infrastructure has been cited as one of the biggest constraints to doing business in Tanzania by the World Economic Forum (WEF) global competitiveness rating.

6.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

6.1.2.1 MACROECONOMIC CONTEXT

Tanzania has in recent times experienced a stable macro-economic environment characterised by single digit inflation rates which have been as a result of prudent monetary policies, favourable food prices and declining fuel prices. The country's fiscal performance is however constrained due to high expenditure rates compared to domestic revenue collection. For instance, revenue collection increased to 12.4% in 2015 compared to 11.6% in 2011 (The United Republic of Tanzania, 2016). Although showing an upward trajectory, this is still below the set target (14.4%) in MKUKUTA I. International trade forms one of the country's largest source of foreign income and as such the stagnation in the country's trade performance has led to a growing balance of trade (The United Republic of Tanzania, 2016). Further, according to the World Bank (World Bank, 2019), there has been a decline in foreign direct investment. However, the country has experienced a stable single digit inflation rate. Projected economic growth and development is highly reliant on an enabling business environment to encourage private sector investment and increase the country's competitiveness.

5.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

The nation's overarching five-year development plan is anchored on '*nurturing industrialization for economic transformation and human development*'. In Acknowledging the role of science technology and innovation in nurturing industrialization, the National Five-Year Development Plan 2017- 2021, puts emphasis on the importance of STI in enabling economic development and growth. Currently, there is little application of innovative technologies in the country's manufacturing sector characterized by limited agro processing. However, the country through the Industrial Development Strategy seeks to move from a low technology manufacturing sector to higher technology diversified product economy. Further, there is cognizance on the significance innovative applications on agriculture led and biological resources as a driver of industrialization (Tralac. 2014). Establishment of the Tanzania Industrial Research and Development Organization (KIRDO) whose mandate is to oversee innovative use in the country's industries, sector is one such effort that seeks to encourage STI use for industrial competitiveness not only in the region but also at the global level.

5.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

Development of a knowledge-based Bioeconomy is dependent on the existing levels of training and efforts made towards meeting skilled labour market demands. Human capital development is an essential component of industrial development through technological application. The country has put a lot of emphasis on the importance of education and training in availing skilled labour which meets the market demands. The Tanzania overarching development blueprint Vision 2025 has an education vision in place which seeks to have '*a well-educated, knowledgeable and skilled Tanzanian able to competently and competitively cope with political, Social, cultural, economic and technological development challenges both at national and international levels*'. A number of institutional and regulatory frameworks have been put in place including the education and training policy of 1995, the technical and education training policy of 1996, the national higher education policy

of 1997 and the education sector development programme (1008-2017) among others (Msaki, 2010). There has been an increase in the country's expenditure on research and development activities (fig 15). The country's expenditure on research and development activities stands at 0.5% which is below the African Union recommended target of at least 1% of the GDP to be spent on R&D. Majority of the R&D funding is from the government (57.5%) with minimal contribution from the private sector (0.1%) (Hanlin and Khaemba, 2017).

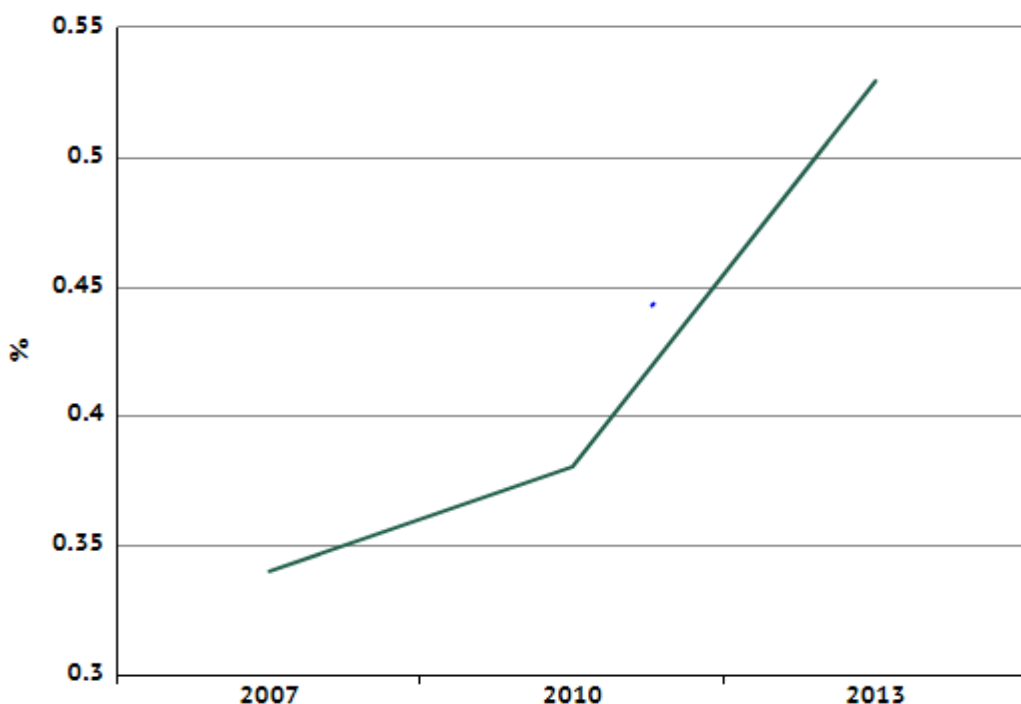


FIGURE 15: RESEARCH AND DEVELOPMENT EXPENDITURE TREND

Source : <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=TZ>

Further, there is recognition of the importance of private sector participation in research development which can be encouraged through incentives to reduce the high cost of technology sourcing and policies and regulatory frameworks that protect patent rights. According to the Tanzanian human development report of 2017 (UNDP, 2018), one of the bottlenecks of doing business in the country is the unavailability of skilled as highlighted in the Global Competitiveness Report for 2007/2008.

5.1.2.4 INFRASTRUCTURE

Implementation of the FYDP I led to significant investment in infrastructure assets in an effort to create trade linkages and increase the country's competitiveness. In recent times, efforts have been made to open up the country to her neighbouring states by putting in place four infrastructural development programs. The Central Development Corridor (CDC) seeks to connect Tanzania with the East African Community, COMESA and SADC economic blocks. Completion of the project will increase the countries cross border trade more specifically with landlocked countries that heavily rely on Tanzania's port services. Other infrastructure development projects include the Tanzam development corridor which connects the country's agricultural regions, the Mtwara development corridor which maintains a natural resource area mapped out as an industrial zone and the Tanga Development Corridor (TDC) is a potential avenue for promoting integrated economic growth in horticultural sector and hospitality growth. In terms on energy production, the country recognizes the

constraints of insufficient energy sources on industrialization and the overall business environment. In so doing, diversification to other renewable sources of energy has been used encourage to navigate the unpredictable and unsustainable use of fossil fuels including loss of biodiversity and climate variability. Efforts include formulation of the National Energy Policy (NEP), which acknowledges the importance of biomass as a source of household energy and if innovatively applied, could form a basis for industrial development³.

6.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

6.2.1 AGRICULTURE

The National Agriculture Policy (NAP) (2013) (The United Republic of Tanzania, 2013) of Tanzania is a prerogative of the ministry of agriculture food security and cooperatives. The policy focuses on developing an efficient, modern, commercial, competitive and profitable agricultural industry that contributes to the improvement of the livelihoods of Tanzanians and attainment of broad-based economic growth and poverty alleviation (The United Republic of Tanzania, 2013). Widely addressed in the policy is the competing use of land for food production and biofuel production. The country recognizes the relevance of biofuel production in meeting the growing energy needs. However, despite the potential benefits of biofuel, there are concerns that bio-fuel development could be pose a threat to national food security which has already been made worse climate change effects. Further, there is recognition of the pressing need for land in biofuel crop production such as jatropha, oil palm, castor bean for biodiesel and sugarcane for bioethanol and co-generation which could lead to biodiversity loss and environment degradation, if not undertaken in an environmentally sustainable manner. In cognizance of this, the government through the NAP succinctly outlines guidelines for production of biofuels in a manner that does not comprise food production. These guidelines include: production of bio-fuel crops where it competes directly with the national food security interests shall not be allowed; Production of bio-fuel crops shall be allowed only where there are minimum negative impacts on the environment; and Cereals and edible oil seeds shall only be used in the production of bio-fuel at times when there is surplus production. All this is seeking to create a complementary environment for Bioeconomy development whilst promoting agricultural production, environmental sustainability and conservation of biodiversity.

Recognition of the importance of intellectual property rights to encourage biological innovation is a key area addressed in the document. The introduction and operationalization of plant variety protection system in the country aims at creating conducive environment for seed production and trade through promotion of plant breeding activities, Intellectual Property Rights (IPR) and introduction of improved plant varieties for agricultural development. In promoting biotechnology application in agriculture, the country prioritizes development and application of agricultural biotechnologies that address national priorities while following National Biotechnology Policy and Bio-safety Framework; encourage development of genetically modified organism as a pathway to increasing productivity; protection in a sustainable way the productivity potential of crop germ-plasm and related biodiversity in the existing agro-ecosystem such that it is not endangered by the introduction of genetically engineered plants; and creating awareness on risks, benefits and potentials of biotechnology applications in driving sector growth. Biotechnology and Bio-Safety Biotechnology has been used for a long time in areas such as tissue culture applications, characterization of germ plasm using molecular marker techniques and in disease diagnosis.

³https://theredddesk.org/sites/default/files/national_energy_policy.pdf

The importance of sustainable use of biological resources for agricultural development has been succinctly addressed as a way to mitigate environmental problems such as desertification, land degradation and over exploitation of forests. Promotion of agro processing is a key priority for the GoT and as such, the country has identified the significance of energy including alternative sources of energy in driving agro industrialization. Value addition has been identified as one of the areas that if well utilized can create employment, increase rural household incomes and promote economic growth and development (Tisimia, 2014). Other key frameworks in the sector include the Agriculture Sector Development Strategy (The United Republic of Tanzania, 2015) which is one of the guiding frameworks for development of the agriculture sector in Tanzania. Some of the strategic intervention areas addressed by the ASDS II include the role of science technology and innovation in biological application and biological innovation in driving the sector to achieve the set target of 4% annual growth rate.

6.2.2 ENERGY

The Tanzanian National Energy Policy (NEP) (The United Republic of Tanzania, 2015) takes into account the energy consumption trends and the country's energy needs. In 2010, the energy consumption composed of residential (72.5 percent); industry (14.4 percent); transport (5.8 percent); agriculture (4.2 percent) and others (3.1 percent). Among other sources of energy, biomass is one of the most abundant sources of energy for rural households mostly derived from agricultural and forest-based products. To ensure sustainable utilization of use of biomass, the government promotes use of alternative sources of energy such as such as compressed natural gas, liquefied petroleum gas (LPG) and electricity. The policy seeks to address challenges associated with biomass use such as inadequate legal and institutional framework to support sustainable use of wood fuel, emissions associated with biomass use and inefficiencies that have led to deforestation. In acknowledging the importance of biofuel as a source of energy in the NEP, the GoT has made concerted efforts to promote sustainable development of biofuels by instituting guidelines for sustainable liquid biofuels development in Tanzania (Ministry of Energy and Minerals, 2010). The framework provides guidelines on the blending of biofuels with petroleum products as provided for in the Petroleum Act of 2008; guidelines on development of biofuels with minimum compromise on sustainability including biodiversity conservation, greenhouse gases emission and competing land uses between bio fuel crop production and food crop production; and investment guidelines for private sector development. However, a shortcoming of the policy is lack of a clear outline of the direction in which the energy sectors is taking in terms of comprehensive bio energy utilization. The document does not point out the identified priority areas for development of the energy sector and instead it widely addresses hydropower, gas, coal, biomass and biofuel source of energy.

Biomass constitutes one of the biggest sources of domestic energy directly and indirectly, a source of income and livelihood for the rural population (AFDB, 2015). However, there is widespread utilization of forest biomass in an unsustainable manner posing a risk to environmental degradation and contribution to climate change effects. In cognizance of the high biomass potential, the biomass energy strategy (BEST) in Tanzania among other issues seeks to address lack of a national policy framework for biomass energy; inadequate legal, regulatory framework and poor governance in commercial biomass energy production, utilization and trade and the low priority accorded to biomass by the government.

6.2.3 ENVIRONMENT AND CLIMATE

About 80% of the Tanzanian population relies on natural resources as a source of livelihood including biomass such as charcoal and firewood (USAID, 2014). Unsustainable use of biological resources has implications on

biodiversity, environmental degradation and adverse climate change effects. The national environment policy of 1997 identifies key areas such as deforestation, loss of wildlife and biodiversity, environmental pollution, land degradation, deterioration of aquatic systems and lack of accessible quality water for both rural and urban population as major environmental constraints that need to be addressed. Further, the policy recognizes the role and importance of agriculture as a driver for economic growth while at the same time; it acknowledges the negative impacts of agricultural activities such as over grazing and over tillage on biological resources' and the environment.

The policy provides a framework which forms the basis for environmental conservation. Although there is no mention of biomass in the document, the policy seeks to ensure sustainable and equitable use of resources for meeting the basic needs of the present and future generations without degrading the environment or risking health or safety; raise public awareness and understanding of the essential linkages between environment and development and to promote individual and community participation in environmental action; promote international cooperation on the environment agenda, and expand the country's participation and contribution to relevant bilateral, sub-regional, regional and global organizations and programs, including implementation of conventions; prevent and control degradation of land, water, vegetation and air which constitute life support systems; improve the condition and productivity of degraded areas including rural and urban settlements in order that all Tanzanians may live in safe, healthy productive and aesthetically pleasing surroundings; and conserve and enhance the natural and man-made heritage, including the biological diversity of the unique ecosystems of Tanzania.

The importance of science technology and innovation in exploitation and utilization of biological resources has been emphasized in the document. This includes the significance of sound technologies in reducing the amount of waste and emissions generated from utilization of bio resources. Further, conservatory measures have been pointed out as a means of ensuring the country's rich biological diversity is conserved. This includes policies and measures on biotechnology development in an economical and environmentally sustainable manner; use of environmental friendly agricultural practices and technologies to minimize negative environmental impacts; sustainable use of wood fuel and diversification to renewable sources of energy and reducing over reliance on fossil fuels; and guidelines on industrial emissions, waste disposal and use of clean technologies in industrial manufacturing.

Under the national environment policy, protection and conservation of policy areas has been identified as a policy action. This extensively covers deforestation, desertification, climate change and biological diversity protection. The policy objectives include; increase in forest cover through afforestation programs, conservations efforts towards natural forests with biological diversity and afforestation and reforestation efforts as a sustainable means of forest products consumption. The National Forest Policy (1998) complements the efforts of the environment policy by outlining strategic policies that promote environmental sustainability and conservationist efforts. The National Forest Policy seeks to 'enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of her natural resources for the benefit of present and future generations'. Although there is no mention of Bioeconomy development, there is recognition of the importance of forest based industrial development as a source of employment and foreign exchange and forest biodiversity conservation efforts in promoting a stable ecosystem. Other significant strategies and policy documents include the National REDD+ Strategy and Action Plan⁴ which extensively highlights the importance of forests as carbon sinks and the contribution of forest biomass to

⁴https://theredddesk.org/sites/default/files/2nd_draft_national_redd_strategy_1.pdf

greenhouse gas emission; the National Climate Change Strategy 2012 (Grantham research institute on climate change and the environment, 2020).

6.2.4 INDUSTRY AND TRADE

Tanzania's commitment to an industrial led economic growth can be seen in the development of the Agricultural Development Led Industrialization (ADLI) strategy, the Integrated Industrial Development Strategy 2025 (IIDS 2025) and the Sustainable Industrial Development Policy 1996-2020 (SIDP) all which seeks to transform the country's economy through industrialization. There is little attention and focus on Bioeconomy and bio-based industries development in the SIDP. The policy, however, puts a lot of emphasis on growth of agro allied industries such as food, leather and textile among others. Further, there is cognizance of the importance of use of sound technologies on the aforementioned industries to increase competitiveness. To encourage innovative industrial applications, focus has been put on the significance of sound intellectual property rights regulatory framework for effective protection of patent rights. Other key policy priority areas include use of alternative sources of energy; and encouraging linkages between research and development institutions and industrial needs among others. The national trade policy of 2003 goal is that of *'raising efficiency and widening linkages in domestic production and building a diversified competitive export sector as the means of stimulating higher rates of growth and development'* (The United Republic of Tanzania, 2003). Among other objectives, value addition has been highlighted as a pathway to increasing national incomes.

6.2.5 RESEARCH AND INNOVATION

The first science and technology policy of Tanzania was formulated in 1985 which was later reviewed to give rise to the National Science and Technology policy of 1996 that is the guiding development framework for STI related activities. Formulation of the policy was fundamental in incorporating technological innovations in the country's development blueprint. The policy has a focus on utilization of science technology and innovations such as high yielding seeds, better crop preservation and storage methods in the agriculture sector to increase food productivity and enhance food security; industrial development anchored on use of locally available raw materials, efficient technology transfer for industrial use, utilization of local technologies in food processing, biotechnology applications to accelerate the industrialization process, recycling of industrial wastes and strengthening linkages between research institutions and industry needs; the need to develop and disseminate sound technologies that can be efficiently applied to ensure sustainable use of wood fuel, the importance of renewable sources of energy and use of biomass (forest, agriculture and animal waste) for energy production. Fundamentally, use of technology in biological resource inventory management, introduction of new benefiting plant species through breeding and developing technologies to conserve biodiversity has been succinctly addressed. Given the cross-cutting nature of STI applications, there is need for a legal framework for efficient coordination and cooperation between the different actors.

Given the wide application of biotechnologies (health, food and agriculture), Tanzania acknowledges the role played by science technology and innovation in economic transformation from a rural based agriculture economy to a diversified semi industrial modern economy. The National Biotechnology Policy of 2010 is in cognizance of poor institutional coordination of biotechnology strategies between research institutions and industry which hinders dissemination and utilization of developed and available biotechnologies. Among other policy issues addressed in the document include inadequate funding towards biotechnology activities both by the government and private sector and the need to provide sustainable funding for biotechnology activities; absence of policies and regulatory framework for intellectual property rights access and patenting which is a

critical component of biotechnology development; and identifying strategic priority areas for biotechnology development including high yielding crop varieties, vaccine production, environmental bioremediation and biodiversity conservation through biotechnology. Though still at the infancy level, biotechnology development can be catalysed through investment in research and development activities; technological innovations and strengthening linkages between research and industry.

TABLE 10: SUPPORTING INSTITUTIONS, LEGISLATION AND ACTS IN TANZANIA

Thematic area	Institutional setting	Legislations and Acts
Agriculture	Ministry of Agriculture Food Security and Cooperatives National Environment Management Council Tanzania Bureau of Standards Centre for Agricultural Mechanization and Rural Technology Tanzania Official Seed Certification Institute Tanzania Food and Drug Authority Tropical Pesticides Research Institute Tanzania Fertilizer Regulatory Authority	Village Land Act, 1999 Land Amendment Act of 2004 The Land Use Planning Act, 2007 The National Land Policy of 1995 Land Regulation of 2001 The Forest Act 2002
Energy	Rural Energy Fund (REF) Ministry of Energy and Minerals Rural Energy Board (REB) Ministry of Natural Resource and Tourism National Environmental Management Commission Ministry of Agriculture Food Security and Cooperatives Energy and Water Utilities Regulatory Authority (EWURA) Rural Energy Agency (REA)	Energy and Water Utilities Regulatory Authority Act, 2001 Rural Energy Agency Act, 2005 Electricity Act, 2008 Petroleum Act, 2015 Oil and Gas Revenues Management Act, 2015 Extractive Industry (Transparency and Accountability) Act, 2015 Natural Gas Policy of Tanzania, 2013 Environmental Management Act, 2004
Environment/Energy	Ministry for Environment National Environmental Advisory Committee National Environment Management Council Regional Environmental Management Expert	Environmental Management Act, 2005 The Forest Act No 14 of 2002
Industry and trade	Ministry of Industry and Trade President's Office, Planning and Privatization Ministry of Foreign Affairs and International Co-operation Ministry of Agriculture and Food Security) Ministry of Cooperatives and Marketing Ministry of Water and Livestock Development Ministry of Energy and Minerals National Development Co-operation Small Industries Development Organization Tanzania Bureau of Standards Business Registration and Licensing Agency	Fair Trade Practices Act of 1994 Investment Act 1997 The Standards Act 2009 The export processing zones Act 2006

	Weights and Measures Agency Tanzania Industrial Research Development Organization Centre for Agricultural Mechanization and Rural Technology	
Research and innovation	Ministry of Science Education and Technology Tanzania Commission for Science and Technology	

6.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

According to the stakeholders present at the COSTECH discussion, political goodwill is among the anchoring factors that will aid the development of a Bioeconomy. In that regard, they indicated the necessity of consistency in the priorities for the country regardless of regime change to continually focus on science and technology especially in the aspect's Bioeconomy and biotechnology.

Macroeconomic factors and enabling conditions form an important part of creating a Bioeconomy. Notably, in Tanzania, the interest base rate from the reserve bank has been on a decline improving the ability of bank to facilitate development and borrowing that improves the GDP growth. From an interest rate of 15 percent in the year 2015 to 7 percent in 2019. Credit access has also been diversified to go beyond the conventional bank lending set up. Therefore, start-ups can access credit for R&D among other firms interested in the Bioeconomy field.

Central coordination and regulation also emerged as an area in need of improvement in Tanzania. The presence of a body or agency that will advise on feasibility, remove incoherencies, enforce regulations and be responsible for the monitoring aspects of the economy related to Bioeconomy. It can be established and empowered through an act of parliament and develop the Tanzanian economy into a thriving Bioeconomy in collaboration with other institutions that are involved in innovation and research. Existing institutions such as COSTECH can take the lead to create frameworks and pathways for formation of the needed elements. It will 1) share knowledge; 2) convene platforms for sharing and discussing issues regarding Bioeconomy; and 3) provide a database of information about the Bioeconomy.

Fiscal and monetary policies:

- Improving revenue yield out of expected recovery of both global and domestic economies through improving efficiency in tax administration.
- Pursuing prudent foreign exchange operations
- Pursuing and sustaining non- inflationary/ prudent fiscal and monetary policies such as restricting budget deficit and bank borrowing.

Creating an enabling business environment:

- Strengthening external market opportunities, especially regional, in order to create more export opportunities.
- Developing the infrastructure necessary such as better energy supply.
- Foster public-private partnerships to encourage R&D.

6.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

A legal framework is essential in enforcing standards, rules and regulations on use of biological resources and hence is a pre-requisite for sustainable development of a competitive knowledge led Bioeconomy sector.

According to COSTECH, Tanzania has a potential to transform its economy through mining, industry, energy and agriculture (COSTECH, 2016). However, science technology and innovation have to be at the core of this economic transformation. A fairly well-established national innovation system (NIS) is pertinent in driving production, utilization and distribution of biological resources for sustainable Bioeconomy development.

Building human capacity through education and training to avail experts in various areas of the Bioeconomy is an important aspect. Drawing from fairly established bio-economies such as the Dutch; attention to the education system by establishment of Bioeconomy related courses both at the undergraduate and postgraduate levels of education is significant in providing expertise in different thematic areas (ibid).

Government good will in public allocation and expenditure towards Bioeconomy related activities. Review indicates that there is low expenditure towards research and development activities; yet, development of a knowledge-based innovation led Bioeconomy is anchored on sustainable utilization of indigenous and emerging technologies in priority areas such as agriculture, health and manufacturing. The country should make efforts towards meeting and surpassing the minimum GERD expenditure of 1% as set by the AU. One of the challenges facing the South African Bioeconomy strategy is low allocation to research and development activities which led to a failure in commercialization of scientific research (Gonzalez, 2018).

Biological resource availability to form a basis for the various priority area such industry and energy is a key determining factor for economic development. The Tanzanian biological diversity gives the country a foundation for Bioeconomy development to take off. For instance, the Dutch Bioeconomy is anchored on agriculture and one of the biggest challenges facing growth is limited availability of domestic biomass (ibid).

R&D forms an integral part of the development of bio-economies. With laxity of exiting pharmaceutical firm in intensifying their allocation to research, the impact on Bioeconomy will be immense. The entire economy should be geared towards being part of an invention or innovation process that utilizes the biodiversity and raw materials that are available.

The government has made an effort in ensuring that infrastructure needed for businesses to thrive exist. Nonetheless, with anticipated growth in the businesses in the Bioeconomy, it is anticipated that some of the infrastructure will need to cater for influxes that will be presented. The biggest concern revolves around the energy that will be needed by the businesses.

6.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS

There is a need to take an inventory of existing intermediary and associated knowledge about the existing biodiversity and Bioeconomy. Coupled with awareness campaigns to the consumers, laws should be enacted that protect the existing biodiversity as part of the management or conservations efforts to ensure that the industry will be self-sustaining.

The biodiversity in the medium terms should be highly characterized and recorded. Laws regarding the Bioeconomy should be harmonized with the monitoring and enforcement mechanisms in place. Sustainable bioprocessing should be incentivized to encourage entrants through the created rules and regulations.

In the long term, strategy should be encouraging bioprospecting (value addition) as well as biodiversity conservation. Elaborate frameworks should exist of who takes ownership of the biodiversity and those managing the extraction of the same. In regard to the biomass, waste utilization is expected with various identified uses such as conversion to energy. From an industry perspective, Tanzania should be at the level of engaging in bioprocessing using advanced biotechnology. Some of the existing opportunities exist in using bioprocesses to reduce the effects of chemicals in the mining sector, such as inhaling cyanide.

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UGANDA – BIOECONOMY RELATED POLICIES AND INSTITUTIONS

7.1 COMPONENT ONE: BROAD OPERATING ENVIRONMENT

7.1.1 INTRODUCTION

Uganda's economic growth has recently slowed down from the high rates recorded in the immediate post-conflict period. The average annual real GDP growth rate declined to 5.7% over the 2011-16 period from 6.7% recorded during the 1987-2010 period. Real GDP growth is projected to remain between 5% and 6% over the next three years (World Bank, 2019). In spite of the economic slow-down, Uganda has significantly reduced its poverty levels from 56.4% in 1993 to 19.7% in 2014. Despite the presence of economic growth, the country is marred with a number of challenges such as income inequalities, low levels of industrialization, poor and inadequate infrastructure, and low agricultural productivity (World Bank, n.d).

The agriculture sector is the dominant sector contributing to about 25% of the Gross Domestic Product while creating employment for over 60% of the rural population. The overarching development blueprint Vision 2040 identifies opportunities in agricultural value addition through agro which will put the country on the global competitiveness map, boost foreign exchange earnings and create employment while reducing post-harvest losses and improving food security. Private sector competitiveness and involvement is still low and castigated by a weak enabling environment, lack of capital to encourage investment, entrepreneurship and innovation and poor and inadequate infrastructure development (USAID, 2018).

The Bioeconomy concept in the country is well supported in areas of biotechnology and use of biomass for energy. Concerted efforts have been made towards development of the bio energy sector through establishment and formulation of the Biomass Energy Strategy (BEST) which recognizes the importance of biomass in all sectors of the economy. The Biomass Energy Strategy seeks to address issues related to sustainable use of biomass using technologies that promote efficient resource use. Among others, the Renewable Energy Policy for Uganda (2007) proposes use of bio energy power generation and the transport sector for promotion of green economy development; the National Biotechnology and Biosafety Policy (2008) is a guiding framework on biotechnological innovations and safety issues in handling biological organisms.

7.1.2 ENABLERS FOR BIOECONOMY DEVELOPMENT

The development of Bioeconomy requires a deep connection between science technology and innovation, the socio-economic setting of the country, investment in research and education and infrastructural development in different sector of the economy.

7.1.2.1 MACROECONOMIC CONTEXT

The Ugandan economy has generally continued to be relatively stable in spite of recent inflationary and exchange rate depreciation pressures. Consumer inflation sharply decreased from a high of 24.6% in 2012 to

3.4% in 2015 and was projected to slightly increase to 6.8% in 2016, largely driven by depreciation of the Uganda Shilling against major currencies. The Shilling/US\$ exchange rate depreciation rate sharply declined from 10.1% in 2011-12 to 1.3% in 2012-13 and -2% in 2013-14 before rebounding to 11.4% in 2014-15.

Uganda's public debt has broadly remained within sustainable levels despite the country's continuing fiscal and balance of payments deficits and increased borrowing. The total public debt to GDP ratio increased from 22% in 2011-12 to 37.1% in 2016/17. However, following the 2014 rebasing of the country's real GDP statistics, the public debt to GDP ratio was reduced to 36.9% in 2015-16. Uganda's relatively strong economic growth and macroeconomic stability have been driven by fiscal policy slippages experienced during the last general elections, GoU has in the context of the IMF Policy Support Instrument (PSI) program, continued to pursue market-based economic reforms and prudent monetary, exchange rate, and financial sector policies. Such fiscal instruments are key in promoting private sector investment, attracting direct foreign investment and increasing revenue collection necessary for public infrastructure investment.

7.1.2.2 TECHNOLOGICAL READINESS AND INNOVATION

Investment in technology and innovation is a prerequisite for economic growth and development. The policy environment for STI promotion in Uganda can be traced to various legislations among them, the National Industrialization Policy 2008; the National Science, Technology and Innovation (STI) Policy 2009; the National Development Plan 2010; the Agricultural Sector Development Strategy and Plan (Ecuru and Kawooya, 2015). Additionally, in foresight, the government's Vision 2040 is invested in harnessing the full potential of technological innovation through partnerships with actors in the academia, industries and the private sector to stimulate use of technological innovations in agro processing, service delivery and eventual employment creation. Deliberate efforts have been made by the ministry of science and technology which include; establishment of the national innovation and industrialization fund as an incentive to support the commercialization of new technologies; inclusion of STEM related subjects in the education curriculum as an augmentation of capacity building.

7.1.2.3 RESEARCH, HIGHER EDUCATION AND TRAINING

The significant role played by education and educational institutions in steering development cannot be overlooked. Establishing and maintaining a vibrant national research infrastructure can be a complex and costly undertaking for any country. The Gross Expenditure on Research and Development (GERD) is one of the key indicators of how much money a country dedicates to research and development activity as a percentage of its GDP. Provision by the African Union dictated that African governments spend at least 1% of the GDP on research and development (AU, 2006). According to Uganda National Council for Science and Technology (UNCST) (2011), investment in Research and development stands at a mere 0.6% of the GDP which is below the recommended 1% by the African Union.

One challenge for research and training is inadequate funding experienced by Ugandan universities where in most cases, government funding falls short up to 50% of the prepared university budgets (OECD, 2013). Development of a knowledge-based Bioeconomy is reliant on the efficient transfer of innovations and technologies from research institutions into the business environment for applicability in industrializing. Disconnections and inadequate linkages between research and training and the industry is one of the challenges bio innovation applications in the country.

7.1.2.4 INFRASTRUCTURE

Given the high concentration of the country's labour force in agriculture, the transport sector is one of the critical drivers for agricultural transformation and economic growth. Although the Government has recently

increased its investment expenditure to develop the country's infrastructure and human capital base, more investments are still required to unlock the country's economic transformation potential. Despite the government's recent large public infrastructure investments, the quantity and quality of transport, water and sanitation, energy, and agriculture infrastructure remain inadequate to meet the country's economic transformation and development objectives. The high cost associated with energy is a hindrance to value addition of raw agricultural products, manufacturing and industrialization. The country recognizes the importance of renewable sources of energy as an incentive to establishment of industries, raising incomes and encouraging private sector development. Through the Vision 2040, Uganda seeks to increase investment in various forms of infrastructure

7.2 COMPONENT TWO: COMMITMENT TO BIOECONOMY PRINCIPLES

7.2.1 AGRICULTURE

One of the key policy documents guiding agricultural growth and transformation in Uganda is the National Development Plan (NDP) (Republic of Uganda, 2015) which identifies agriculture as one of the primary sectors likely to drive economy growth. In cognizance of the importance of the sector, the NDP is anchored on improving agricultural technology development; ensuring effective delivery of advisory services and through use of innovative technologies; controlling diseases, pests and vectors through biotechnology applications, and enhancing productivity of land through sustainable land use and management of soil and water resources.

The Agriculture Sector Strategic Plan (ASSP) (2015-2020) (MAAIF, 2020) targets sector investment in specified priority and strategic commodities (banana, beans, maize, rice, cassava, Irish potatoes, tea, coffee, dairy, and fish among others) across their entire value chains and focus on research, market access and value addition. The strategy is anchored on use of ecologically sound technologies and development of a policy and regulatory framework for biotechnology in agriculture. Specific to the aforementioned is the need to have a regulatory framework for utilisation of genetically modified organisms and capacity building for biotechnology and bio safety research activities. Further, the document prioritizes the importance of technological innovation in value addition and agro processing. Other key strategic areas relevant to Bioeconomy development include; investment in fertilizer production and marketing including use of bio fertilizers, biofuel production using cassava as a feedstock thus promoting bioenergy development especially in the industrial sector, creating awareness on the importance and nutritional benefits of bio fortified food products and the significance of sound technologies to curb environmental degradation while promoting biological diversity conservation.

The country's agricultural sector, a key biomass producer, the country has enacted the National Agriculture Policy (NAP) (2013) (Republic of Uganda, 2013), although there is no mention of biomass in this policy. The NAP (Tasia, 2015) recognizes the significance of the energy sector in driving mechanization, transportation, agro processing and storage for sectoral transformation. It therefore articulates the need for alternative source of energy such as biogas for efficient functioning of the sector. The policy strategizes to increase agricultural productivity and in so doing it acknowledges the importance of biomass valorisation to increase agro processing. In addition to that, the document proposes use of alternative sources of energy such as biogas to supplement the increasing cost of fossil fuels. It further highlights the cross-cutting aspect of the agriculture sector and the importance of other ministries including the ministry of agriculture in promoting sustainable use of environmental and biological resources. Succinctly addressed is the agro processing sub sector and more so in reference to the National Industrial Policy which has a focus on processing of food commodities, leather and leather products, textiles and garments, sugar, dairy products, and value-added products for niche export

markets. Availability of biomass to drive agro processing highly depends on the agricultural sector productivity. The institutional mandate of policy implementation falls under the ministry of agriculture animal industry and fisheries and related agencies. Both the national agriculture policy and the agriculture sector strategic plan acknowledge the importance of biotechnology as a catalyst for productivity in various agricultural value chains.

7.2.2 ENERGY

The Renewable Energy Policy for Uganda is anchored on the need to increase the use of modern renewable energy, from the current 4% to 61% of the total energy consumption by the year 2017 (Republic of Uganda, 2017). The policy objectives aim at promoting Bioeconomy growth in various sectors through production of biofuels; it encourages establishment of biofuel testing facilities in the country, provision of fiscal incentives to encourage blending of petroleum with biofuels; and legislation to enforce blending of at least 20% biofuels with petroleum. In so doing, the cost of manufacturing and production is projected to go down, reducing the operating costs, increasing incomes and employment creation in the long run. Further, the transportation cost is likely to decrease with a decrease in greenhouse gas emissions, a low carbon print and a driving force for green economy growth.

Secondly, the policy proposes the development of a biofuel programme which covers production of ethanol, biodiesels, methanol (gasification) and biogas. This is undertaken in recognition of the country's potential to produce substantial amounts of bio diesel which is likely to cut down on oil imports. Thirdly, use of waste as a source of energy such as biogas to drive different thematic areas manufacturing while at the same time it can be used as one way of promoting green economy growth. The projected industrial and domestic energy demand growth is expected to outstrip the current supply capacity if extra power generation, transmission, and distribution capacity is not installed. Presently, despite the increased energy supply capacity, electricity tariffs have remained high while power outages and load shedding have persisted resulting in increased costs of doing business and undermining of Uganda's economic and business competitiveness.

Uganda has made efforts towards Bioeconomy development and this has been highlighted in the Biomass Energy Strategy (UNDP, 2014) which widely outlines the importance of biomass in the energy sector. The strategy seeks to "To secure a stable biomass energy supply for long term social and economic development of Uganda including poverty reduction". Formulation of the strategy was meant to provide a road map for sustainable use of biomass in the country. The strategy highlights the importance of biofuel obtained from various sources of biomass such as liquid biomass, solid biomass and the different sources of biogas. Other key strategic areas such as production of energy crops such as grasses and forestry have been proposed as pathways for biomass utilization for energy production and electricity generation.

7.2.3 ENVIRONMENT AND CLIMATE

With about 24% of the total land being under forest cover, the country's forest endowment can be used to contribute to poverty eradication and income generation for the rural folks. Further, forestry is the largest source of energy contributing to 90% of energy needs more so from wood fuel. The Ugandan Forestry Policy of 2001 has a goal of ensuring "An integrated forest sector that achieves sustainable increases in the economic, social and environmental benefits from forests and trees by all the people of Uganda, especially the poor and vulnerable". The key strategic objectives of the document are promoting development of a modern, competitive, efficient and well-regulated wood and non-wood processing industry especially in the private sector. This is response to the recognition of the role played by the private sector in processing of wood products and value addition. The policy proposes establishment of a robust regulatory framework to curb

illegal forest product harvesting, while encouraging sustainable use of wood products for positive environmental and a social impact. Conservation of forest biodiversity has been succinctly addressed through institutionalizing strategies such as support of conservation initiatives in priority forests with high biodiversity value; increasing knowledge of forest biological diversity, its management and the potential for future use; and support the implementation of international biodiversity obligations and cross-border conservation initiatives, with any required subsidiary legislation and regulations. Although there is no explicit mention of Bioeconomy development in the forestry policy, the document touches on areas and objectives that are critical to Bioeconomy development.

The Uganda Green Growth Development Strategy of 2017/18 – 2030/31 (UNDP, 2017) can be defined as “an inclusive low emissions economic growth process that emphasizes effective and efficient use of the country’s natural, human, and physical capital while ensuring that natural assets continue to provide for present and future generations”. The document through its strategic objectives seeks to promote Bioeconomy development by encouraging sustainable agricultural production by upgrading the value chains of specific commodities. Emphasized in this objective is the importance of agro processing and effective use of innovative technologies in processing; sustainable forestry has been advocate through agro forestry and afforestation practices, sustainable wetland management and sustainable aquatic resource management; and encouraging green energy development through use of renewable sources of energy including biomass use for domestic and industrial purposes. In mitigating climate change impacts, the document points out the importance of biomass for energy production, use of climate smart agriculture techniques and the waste management in reducing carbon emissions.

In an effort to comply with the 10th meeting of the conference of Parties (CoP), the government of Uganda has formulated a National Biodiversity Strategy and Action plan (2015-2025) (Republic of Uganda, 2016). The document highlights the importance of biodiversity to national development through strategic areas such as forestry, agriculture, wildlife and tourism wetlands, aquatics resources and health. Further, there is recognition of various emerging issues and the threats they pose of sustainable biological organism for future use. These include; climate change characterized by melting of ice caps on mountains, increase in drought and wildlife fire among others that have led to loss of biodiversity; biotechnology and biosafety issues especially in the agricultural fields; and development and use of biofuels which has negative impacts on biodiversity, competing land use that could jeopardize food security, water availability and land ownership among others. The specific strategic objectives proposed in the plan include; strengthening of stakeholder co-ordination and frameworks for biodiversity management through of mainstreaming biodiversity issues in the national and sectoral planning frameworks; capacity building for efficient biodiversity management; encouraging environmentally sustainable practices to ensure positive impacts on biodiversity; and to promote use of biotechnology in a sustainable manner by updating information on biotechnology and biosafety; among others.

7.2.4 INDUSTRY AND TRADE

The National Trade Policy (2007) falls within the mandate of the Ministry of Trade Industry and Cooperatives with the sole mandate of ensuring private sector growth and increasing competitiveness of sectors directly and indirectly related to trade and industry. Although there is no mention of biomass in the trade policy objectives, the policy strategic areas seek to provide a solution to the developmental challenges facing the country such as increased population in the face of a constrained resource base, the effects of emissions on green economy development and the state of food security in light of climate change effects (SEATINI, 2014). Succinctly mentioned in the document is the need to have a national marketing and agro processing strategy (MAPS) as

an initiative to facilitate domestic trade activities, the need to implement strategies that promote value addition and production of high value crops and the importance of an enabling business environment by harmonizing local taxes and licensing policies. In promoting international trade, the policy seeks to harness technology in promoting establishment of necessary infrastructure such as cold storage facilities, refrigerated trucks and laboratories; and formulate policies that protect intellectual property rights as a way to conserve genetic resources in the country.

The National Industrial Policy (Republic of Uganda, 2008) seeks to 'build the industrial sector into a modern, competitive and dynamic sector fully integrated into the domestic, regional and global economies. The policy has a major focus on exploiting and developing natural domestic resource- based industries such as petroleum, cement, and fertilizer industries; and promoting competitive industries that use local raw materials; agro-processing; focusing on food processing, leather and leather products, textiles and garments, sugar, dairy products, and value addition in niche exports; knowledge-based industries such as: ICT, call centres, and pharmaceuticals that exploit knowledge in science, technology and innovation; and Engineering for capital goods, agricultural implements, construction materials, and fabrication operations. Relevant to Bioeconomy development is the identification of the vast biological resource base as a source of biomass for industrial use; and the emphasis on use of innovation and commercialization in product development, value addition and entrepreneurship. The policy explicitly highlights the importance of science technology and innovation and proposes strengthening of technology centres and research institutions to identify the industry's technological needs, promote establishment of technology-based incubators and improve protection of intellectual property among others.

The Ministry of Tourism, Trade and Industry as well as its affiliated institutions such as the Uganda Industrial Research Institute, Uganda National Bureau of Standards, Uganda Investment Authority, Management Training and Advisory Centre, and Uganda Export Promotion Board are key institutions in industrial policy implementation and overall sectoral development. The country is also a signatory to a number of trade and trade related agreements with the aim of developing regional and international trade. These include the East African Community Customs Union, the Common Market for Eastern and Southern Africa (COMESA), the African, Caribbean and Pacific- European Union (ACP/EU) Partnership Agreement (Cotonou Agreement), the World Trade Organization (WTO), and the African Union (AU). Such trade agreements open markets to a wide range of consumers of bio-based products both domestically and globally. As such, the national trade policy actions are keen on the efficient resource mobilization and utilization to produce high value-based products for the export market.

7.2.5 RESEARCH AND INNOVATION

The Ugandan Government recognizes the key role Science Technology and Innovation plays in fostering research and development and in building the human capital necessary for development of knowledge-based economy. Developed and emerging industrialized countries spend 2% to 3% of their GDP on research and development while the estimated figure for Uganda is averagely 0.2-0.3% of R&D. It is, therefore, essential to provide high priority to scientific and technological development needs in the overall socio-economic development strategy of the country. STI is envisaged to contribute effectively to diversification of the economy and sustainable use of biological resources.

The Science Technology and Innovation Policy (Republic of Uganda, 2009) is keen on the importance of legal and regulatory framework for R&D activities in traditional, conventional and emerging technologies, including

among others indigenous knowledge, biotechnology, Nano technology, information and communication technology, and microelectronics. In bio prospecting, the STI policy is in cognizance of the role of technological innovation in biological organisms' extraction. Technological innovations contribute to a good environment and a rich biological resource base, which are all critical for poverty eradication and economic growth.

The National Biotechnology Policy (2008) mirrors the guidelines laid out in National Environment Act, as well as the Cartagena Protocol on Biosafety that commits parties to put in place measures for ensuring the safe transfer, handling and use of GMOs. The policy has a goal to *'contribute to the national goals of poverty eradication, improved healthcare, food security, industrialization and the protection of the environment through the safe application of biotechnology'*. The key priority areas include human resource capacity development by promoting inclusion of biotechnology and biosafety components in the education curriculum, providing incentives to discourage brain drain and promote partnerships among research institutions, the private sector and universities; development of necessary infrastructure such as laboratory in major research organizations in the country to ensure access to safe and profitable biotechnology products; and use of biotechnology for industrial development in various sectors of the economy such pharmaceutical applications. The document has addressed bioethics and biosafety issues by recommending establishment of acceptable national ethical standards or code of ethics for undertaking biotechnological research and applications, establishing effective mechanisms for enforcing ethical conduct in biotechnology R&D and Integrating bioethics in all training programs on biotechnology so as to build a national culture of ethics in biotechnology applications. Further, the policy encourages sustainable exploitation of the country's bio-resources through regulated bioprospecting of these biological resources for use in agriculture, health and industry.

7.3 COMPONENT THREE: OPTIMISED OPERATING ENVIRONMENT

The development of Bioeconomy in Uganda is an initiative that requires a multi-sector and multi-stakeholder approach. This includes a sector wide approach of policy experts in the areas of energy, climate change, agriculture and industrialization, private sector participation and beneficial public private partnerships. Given the structure of the economy (agro based), utilization of biomass for different priority areas requires application of the right mix of long-term policies for efficient and effective delivery of bio-based products and services at the national, regional and global.

Of key importance is development of a functional mechanism that ensure seamless coordination between policies in different thematic areas such as agriculture, industry and trade, climate education and environment to create synergies in technological innovation and transfer between research institutions and the industry. There is need to review the framework at the national level to provide for a Renewable Energy Department with a Division dedicated to the development, conservation and utilization of the biomass energy resource which accounts for over 90% of the total energy consumed in the country.

For optimal functioning of the Bioeconomy, a regulatory framework should be in place to creative incentives for private sector involvement in science technology and innovation which is a key driver for industrial growth and development and establishment of knowledge-based Bioeconomy. The national government in collaboration with other lower levels of governance can have fiscal policies such tax holidays on bio innovations, low interest rates to create an enabling business environment for bio processing and use of biofuels. Such frameworks create incentives for private sector investment, increase in export of value-added products and job creation among others.

Establishment of standards and certification regimes as a response to bio safety issues in biotechnology applications in agriculture, health and bio processing activities can be used as a way to encourage bio innovations and its application for economic growth. This includes establishment of frameworks that enforce compliance with biosafety regulations in institutions undertaking biotechnology research and development.

A successful Bioeconomy is heavily reliant on the linkages between education, research and development activities and investment in research. The policy review indicates low research and little funding both by government, the private sector and donor community towards development of knowledge-based industries. For the Ugandan government to achieve its development objectives in different thematic areas of the economy, conscious efforts need to make towards increasing investment towards research activities to at least the bare minimum of 1% as set out by the African Union. Further, integration and inclusion of Bioeconomy related technical training in institutions of higher learning will greatly contribute to capacity building which is a necessary condition for development.

Investment in infrastructure and formulation of policies and regulatory frameworks that promote use of other sources of energy such as biofuels for transportation and processing is an approach that has been envisaged to reduce emissions and promoted green economy development. Among others, creating incentives for production of biofuel crops through input subsidies and tax reduction on biofuels are fiscal policies that if well implemented can create a favourable environment for bio-based products.

7.4 COMPONENT FOUR: SUSTAINABLE IMPLEMENTATION

Successful implementation and development of fiscal policies to drive Bioeconomy growth heavily relies on a number of things. A stable macro-economic environment is a necessary but not a sufficient condition for achieve Bioeconomy objectives. This entails concerted efforts in investment in Bioeconomy related sectors such as energy, agriculture health and environment; increase in private sector participation through provision of incentives that create a conducive environment for businesses to thrive; and increased investment in research, development and innovation. The current stable macro-economic environment and projected future growth, low risk of debt and ample foreign exchange reserves provide a strategic platform on which Bioeconomy development can take off.

The presence of a high demographic dividend where it is envisaged that 56% of the Ugandan population is below 18 years will be a contribution to the country's labour force (World Bank, n.d) and used as a resource for economic growth and transformation. The demographic dividend provides opportunities for innovation that can be used to drive industrialization, increase agricultural productivity, spur economic growth, create employment, foster technology transfers and generate revenues for investments in development of other strategic areas. Further, government investment in education and infrastructure such as innovation hubs and biotechnology laboratories will contribute to human capacity building which is a critical component for Bioeconomy development.

Uganda being a developing nation has an advantage in utilization of leapfrog technologies to spur economic growth in different priority areas. There is an opportunity to leapfrog in technology and attract labour intensive manufacturing industries which are being relocated from fast emerging economies as a result of rapid wage increases. Application of these technologies coupled with the abundance in natural resource endowment can be used as tool to develop agro processing industries leading to production of high-quality products for export markets, manufacturing and infrastructure development. ICT provides an opportunity to improve national

productivity by making government and business enterprises more efficient, effective and globally competitive. There is potential to improve availability of digital content and e-products, automation of government processes and inter-agency connectivity, innovation, bridging the gap between industry and the academia, and commercialization of research and development.

Natural Resource base which forms part of biomass necessary to drive bio processing, bio energy and overall Bioeconomy growth can be used to its advantage to spur economic growth. With sound policies and institutional frameworks, the rich natural resource endowment can be used to improve the rural community livelihoods through agro processing and value addition thus creating employment raising incomes for the rural folks.

7.5 COMPONENT FIVE: PROPOSED POLICY AND STRATEGIC RECOMMENDATIONS

Innovation forms a big agenda in the Bioeconomy, in the case of the Ugandan economy; more is needed in terms of the allocation made in the budget through the promotion of a framework and environment that will be supported by the ministry of science, technology and innovation. This strategy can be implemented through the GERD.

Once the country has started producing bio-based products, infrastructure and facilities to test for quality become a crucial part of the process. Infrastructure and capacity building can also come from partnerships between government and organizations as well. Such include clusters of small producers who have joined or are interested in joining the Bioeconomy sector. Growing ecological zones according to the consultations will be instrumental in crop production to sustain the growing consumption of the Bioeconomy.

That notwithstanding, Uganda is in need of an investment framework that will support the commercialization of bio-economic resources. In this framework, there will be certification that encourages sustainable use of resources on the demand side to ensure that the cycle of the economy is not undercut by inefficiencies in use of raw materials. The ease of getting the certification will play a huge role, such as through having a one stop shop for investment requirements including standardization. This can also be achieved through the decentralization of the Industrial Research Entities (URI).

In support of this the political environment needs to favour Bioeconomy activities through policies and goodwill such as going green campaign, energy tariffs to encourage use of LPG in place of firewood and charcoal. Thus, should be extended to the research and cooperation policies that are needed to make the industry thrive.

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ANNEX 1: GUIDING QUESTIONS AND SURVEY QUESTIONNAIRE FOR THE REVIEW AND ANALYSIS

Accessible on: <https://forms.gle/ngZiXQbnC32AeJyR9>

26/02/2020

Survey - Developing an innovation-led regional Bioeconomy Strategy for eastern-Africa (BiSEA): Policy and Institutions Review and Analysis

Survey - Developing an innovation-led regional Bioeconomy Strategy for eastern-Africa (BiSEA): Policy and Institutions Review and Analysis

This survey is prepared by the African Technology Policy Studies Network (ATPS) to assess the bioeconomy related policies and regulatory frameworks in the BiSEA project countries (Burundi, Ethiopia, Kenya, Rwanda, South Sudan, Tanzania and Uganda). The review is a situation analysis aiming to:

- Assess of bioeconomy related policies and regulatory frameworks. desk studies will be carried out on relevant grey literature including policy documents from the participating countries, regional policies, economic reports, relevant value chain reports and data among others with a view to understand the policy statuses, what works and what does not and why. This assessment also analyse the links with the strategy to the broader development framework in the region, including EAC Vision 2050, AU Agenda 2063 and the SDGs.
- Identify current governance structures, projects, initiatives etc. driving the current developments towards a modern bioeconomy in the region.
- Review the broader operating environment, taking into account factors such as the economy key assets and stakeholder landscape and to collect statistical, demographic information and projections.

The survey questionnaire is aimed to be filled by BiSEA stakeholders including policymakers, producers of biomass and biomaterials, researchers and analysts in the national commission and councils for science and technology, private sector actors, academic institutions and other STI intermediaries, potential social, business and venture capital investors, development bodies and agencies, among others.

The survey will take about 10 minutes of the respondent's time.

All the data and entries of the respondent will be anonymised in the analysis and project publications. Respondents will however be included in the distribution lists for final project outputs.

***Required**

1. Email address *

Respondent's Details

Bioeconomy Related Policies and Regulatory Frameworks in Eastern Africa

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2. Name Surname *

3. Phone Number *

4. Country *

Tick all that apply.

- ☐ Burundi
- ☐ Ethiopia
- ☐ Kenya
- ☐ Rwanda
- ☐ South Sudan
- ☐ Tanzania
- ☐ Uganda

5. Organisation *

6. Position in Organisation *

7. Years in Position *

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8. To which sector does your organisation belong? *

Mark only one oval.

- ☐ Agriculture
- ☐ Energy
- ☐ Chemicals
- ☐ Bio / pharmaceuticals
- ☐ Forestry
- ☐ Other: _____

Stakeholder Category

9. To which of these stakeholder groups does your organisation belong? *

Tick all that apply.

- ☐ Government / Policy Maker
- ☐ R&D Organisation
- ☐ Academic Institution
- ☐ Private Sector
- ☐ National science council / commission
- ☐ Continental / global agency / NGO
- ☐ Biomass / biomaterials producer

Other: ☐ _____

Review of
the Broad
Operating
Environment

Entails a description of the politico-economic status of the country alongside its competitiveness as measured by its macro-economic environment, infrastructure, institutions, technological readiness, innovation and higher education and training

10. 1.1. What is your understanding of the bioeconomy concept? *

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11. 1.2. In what ways do you/your organisation/employer work with a bio-based economy? *

12. 1.3. How would you rate below the different MACROECONOMIC components of the business environment of your country in relation to the bioeconomy, and the general economic health? *

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Purchasing power	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GDP per capita	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Literacy levels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Employment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13. 1.3.1 Please comment on the sufficiency of the macroeconomic environment in your country to build a bioeconomy, as you have have rated above in in 1.3. What informs your selection/rating? *

26/02/2020

Survey - Developing an innovation-led regional Bioeconomy Strategy for eastern-Africa (BiSEA): Policy and Institutions Review and Analysis

14. 1.4. How would you rate below the different INFRASTRUCTURAL components of the business environment of your country in relation to the bioeconomy, and their role in connecting supply chains and efficiently moving goods and services? *

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Modes of transport	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Electricity supplies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Telecommunications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. 1.4.1 Please comment on the sufficiency of the infrastructure in your country to build a bioeconomy, as you have have rated above in in 1.4. What informs your selection/rating? *

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16. 1.5. How would you rate below the different INSTITUTIONS components of the business environment of your country in relation to the bioeconomy, and their role in determining the frameworks in which economic exchange occurs? *

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Legal framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Administrative framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regulatory framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. 1.5.1 Please comment on the sufficiency of the institutions in your country to build a bioeconomy, as you have have rated above in in 1.5. What informs your selection/rating? *

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18. 1.6. How would you rate below the different TECHNOLOGICAL READINESS components of the business environment of your country in relation to the bioeconomy, and its role in enhancing business sophistication?

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Adoption of existing technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Capacity to leverage ICTs in daily activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. 1.6.1 Please comment on the sufficiency of the technological readiness in your country to build a bioeconomy, as you have have rated above in in 1.6. What informs your selection/rating? *

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20. 1.7. How would you rate below the different INNOVATION components of the business environment of your country in relation to the bioeconomy, and its role in productivity? *

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Investment in research and development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High quality scientific research and institutions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
University- industry linkages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

21. 1.7.1 Please comment on the sufficiency of the innovation environment in your country to build a bioeconomy, as you have have rated above in in 1.3. What informs your selection/rating? *

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22. 1.8. How would you rate below the different HIGHER EDUCATION AND TRAINING components of the business environment of your country in relation to the bioeconomy, and their role in building the overall skill level of the local labor force is one of the key drivers of local job growth and wage growth? *

Tick all that apply.

	Very Poor (Needs urgent attention)	Poor (Doesn't require urgent attention but needs attention in near future)	Satisfactory (No need to concern at present but will need attention in future)	Good (Doesn't require any attention in future)	Excellent (No need to concern at all)
Production of workforce	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Education	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

23. 1.7.1 Please comment on the sufficiency of the higher education and training in your country to build a bioeconomy, as you have rated above in 1.3. What informs your selection/rating? *

Commitment
to
Bioeconomy
Principles

Entails a review of the policies, institutions, regulations and strategies and a description of the commitments made in favour of the bioeconomy. This review is to be made in light of the bioeconomy thematic areas and their sub-components.

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24. 2.1. Do you have policies and institutions on AGRICULTURE that support the Bioeconomy in your country? *

Mark only one oval.

☐ Yes

☐ No

25. 2.1.1. Do these policies and institutions cover the following areas? *

Mark only one oval per row.

	Yes	No
Agriculture	<input type="radio"/>	<input type="radio"/>
Blue economy	<input type="radio"/>	<input type="radio"/>
Aquaculture	<input type="radio"/>	<input type="radio"/>

26. 2.1.1.1. If yes, list here the relevant policies *

27. 2.1.1.2. If yes, list here the relevant institutions *

28. 2.2. Do you have policies and institutions the ENVIRONMENT that support the Bioeconomy in your country? *

Mark only one oval.

☐ Yes

☐ No

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29. 2.2.1. Do these policies and institutions cover the following areas? *

Mark only one oval per row.

	Yes	No
Forestry	<input type="radio"/>	<input type="radio"/>
Biodiversity	<input type="radio"/>	<input type="radio"/>

30. 2.2.1.1. If yes, list here the relevant policies *

31. 2.2.1.2 If yes, list here the relevant institutions *

32. 2.3. Do you have policies and institutions on Industry and Trade that support the Bioeconomy in your country? *

Mark only one oval.

☐ Yes

☐ No

33. 2.3.1. Do these policies and institutions cover the following areas? *

Mark only one oval per row.

	Yes	No
Manufacture of bio-based products	<input type="radio"/>	<input type="radio"/>
Commercialisation of bio-based products	<input type="radio"/>	<input type="radio"/>

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34. 2.3.1.1. If yes, list here the relevant policies *

35. 2.3.1.2. If yes, list here the relevant institutions *

36. 2.4. Do you have policies and institutions on Research and Innovation that support the Bioeconomy in your country? *

Mark only one oval.

☐ Yes
☐ No

37. 2.4.1. Do these policies and institutions cover the following areas? *

Mark only one oval per row.

	Yes	No
Biotechnology	<input type="radio"/>	<input type="radio"/>
Nanotechnology	<input type="radio"/>	<input type="radio"/>
Artificial intelligence	<input type="radio"/>	<input type="radio"/>

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38. 2.4.1.1 If yes, list here the relevant policies *

39. 2.4.1.2 If yes, list here the relevant institutions *

Optimised
Operating
Environment

This is a normative description of what an optimised operating environment for the bioeconomy would look like relative to the specific macro-economic environment.

40. 3.1. What are the elements critical for bio economy development? would a conducive environment for the Bioeconomy look like in your country? *

41. 3.2. With respect to bioeconomy development, what would be your expectation on the "Agriculture, Blue economy and Aquaculture" sectors at a national level? *

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42. 3.3. With respect to bioeconomy development, what would be your expectation on the "Forestry and Biodiversity" sectors at a national level? *

43. 3.4. With respect to bioeconomy development, what would be your expectation on the "Bioenergy and Green economy" sectors at a national level? *

44. 3.5. With respect to bioeconomy development, what would be your expectation on the "Manufacture and Commercialisation of bio-based products" at a national level? *

45. 3.6. With respect to bioeconomy development, what would be your expectation on "High tech including biotechnology, nanotechnology", at a national level? *

46. 3.7. With respect to bioeconomy development, what would be your expectation on "Bioeconomy research and development" at a national level? *

47. 3.8. With respect to bioeconomy development, what would be your expectation on the "Education and human resource development" at a national level? *

48. 3.9. What indicators could be used to trace/measure this development? *

Sustainable
Implementation

Concerns on the assessment of the availability of capacities and systems for delivering an innovation-led bioeconomy. Assessment of public-private partnerships, SME involvement, academia-industry linkages, technology transfer units, farmer-industry associations etc., in the related processes.

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49. 4.1. Rate the importance of the following linkages in facilitating the delivery of an innovation-led bioeconomy in your country *

Tick all that apply.

	Very important	Important	Moderately important	Slightly important
Public-private partnerships	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SME involvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Academia-industry linkages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Farmer-industry associations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

50. 4.1.1 Please comment about the effectiveness of the institutions in your country responsible for providing the above linkages.

51. 4.2. What do you feel about your organisation's ability to operate competitively in the global and regional bioeconomy markets three years from now? *

Mark only one oval.

	1	2	3	4	5	
Very tough to compete	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Touch to compete

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52. 4.3. Are you optimistic about the future growth of your organisation and industry in your country? *

Mark only one oval.

- ☐ No
☐ Yes
☐ Maybe

53. 4.4. If yes, why are you Why you are/aren't optimistic about the future growth of bioeconomy business & industry in your state? (Please Answer in Points below) *

54. 4.5. Are there any barriers to a sustainable implementation of the bioeconomy? Please briefly describe them. *

Proposed Policy and
Strategic
Recommendations

Overall policy and strategic recommendations including identified gaps, proposed policy and strategy interventions in order of priority.

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55. 5. What policy changes would you recommend to promote bioeconomy development in your country?? *

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