[Development of a Framework and Roadmap
for a National Innovation System to foster low-carbon
and climate-resilient economic development in Zambia]

Evaluation of The National Innovation Environment for Climate Action

Science and Technology Policy Institute (STEPI)

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Ministry of Technology and Science

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Chapter 1.
Introduction

The effects of climate change have consistently increased, and climate-related disasters continue to occur. No country is free from the effects of climate change, so in 2021, a global goal of reducing greenhouse gas by 25~47% by 2030 was announced. There have been concurrent substantial discussions regarding innovation as a major solution for responding to climate change risks and driving economic growth.

Under this context, in 2023, the United Nations Climate Technology Centre & Network (UN CTCN) established a cooperative project with the Science and Technology Policy Institute (STEPI). The main theme of this project is to develop the Zambian National Innovation System (NIS) Framework and Roadmap to achieve a low-carbon economy and secure climate resilience. In Vision 2030, the Zambian government set the goal of both creating innovation to address climate challenges and advancing to a middle-income economy. For this, Zambia needs to facilitate the innovation ecosystem and develop the so-called national innovation system.

However, several impediments to achieving this objective include factors such as information asymmetry, coordination failures, a deficit in cooperation, inadequate incentives, underdeveloped institutions, and inflexible regulations. Thus, implementing a National Innovation System (NIS) may not be simple or effective in developing countries.

In order to address these issues, the STEPI team has made qualitative and quantitative diagnoses in the Zambian context and conducted SWOT analysis respectively and sequentially.

In qualitative diagnosis, we have reviewed main government policies, such as ‘The National Economic Development Plan’ and ‘The National STI Policies’ and legal institutions related to STI policies and activities. Then, we investigated national policies, government strategies and legal institutions regarding climate resilience. Finally, we have tried to figure out the governance and key stakeholders regarding national STI and climate resilience.

In quantitative diagnosis, we have used indicators, a Heatmap Dashboard and a Country Gap Profile to compare Zambia's status with other countries and figure out what should be done for capacity-building from now on. Based on qualitative and quantitative diagnosis, the SWOT analysis has been carried out, and the principal results and implications from the analysis will be utilised in developing a framework and roadmap for the National Innovation System of Zambia.

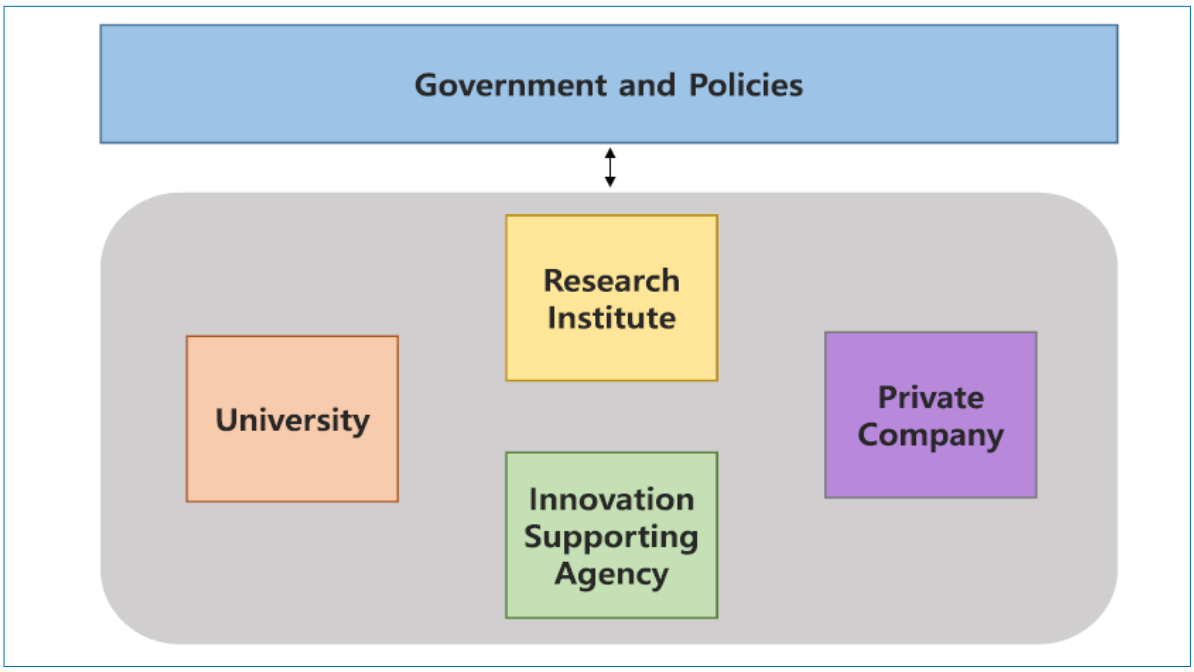
Chapter 2.

Qualitative Diagnosis

1. Diagnostic Framework

The framework for qualitative analysis on the Zambian National Innovation System (NIS) consists of two parts—government and policies, and key stakeholders—as shown in Figure 2-1 below. It is slightly modified from the NIS framework of Kuhlmann and Arnold (2001). Central to this framework is the fundamental role of government and public policies, shaping an innovation ecosystem where key stakeholders, including research institutes, universities, private companies, and innovation supporting agencies, collaboratively contribute to Zambia's technological and scientific advancement. This strategic collaboration aligns with the nation's overarching development goals, emphasising the interconnectedness of diverse entities working in concert within the NIS.

Figure 2-1. Qualitative Diagnosis Framework for NIS of Zambia



Source: Modified from S. Kuhlmann and E. Arnold (2001).

Zambia's NIS, shaped by a diverse array of stakeholders including governmental bodies, research institutions, universities, and various innovation-supporting agencies, relies on collaborative efforts. This multifaceted approach is instrumental in positioning Zambia for sustainable growth and development in the fields of science, technology, and innovation (STI). In order to analyse NIS with a special focus on low-carbon and climate resilient economic development in Zambia, this chapter examines national—policy and legal—institutions and key stakeholders from the both STI and climate resilient dimensions.

2. National STI and Climate Policy and Legal Institutions

This section addresses major national STI policies and legal institutions alongside with major national economic policies.

2.1. National Economic Development Plans

Vision 2030 is the national economic long-term plan of Zambia, aiming to be "a prosperous, middle-income nation by 2030." In regards to national STI policy directions, two sectoral visions are declared under Vision 2030 as follows: to be (1) "a nation in which science, technology and innovation are the driving forces in national development and which competes globally by 2030"; and (2) "an information and knowledge-based society by 2030." As shown in table 2-1 below, Vision 2030 clearly stresses the importance of STI fundamental elements for national economic development including the R&D infrastructure and research professionals, innovation from R&D to commercial products, and ICT connectivity among citizens.

Table 2-1. STI Sectoral Vision Declared in Vision 2030

Sector	Sector Vision	Targets/Goals
Science and Technology	A nation in which science, technology and innovations are the driving forces in national development and which competes globally by 2030.	1. Acquire and upgrade infrastructure required for training in science and technology and R & D academic institutions by 2030 2. Build and sustain human resource capacities and capabilities by 2030 3. Promote development of enterprise using outputs from science and technology and R & D activities by 2030 4. Strengthen linkages between productive sectors and research institutions in the economy by 2030 5. Establish and strengthen practical application of science and technology in all areas
Information Communication Technology (ICT)	An information and knowledge-based society by 2030.	1. Increase connectivity to fibre optic (telecommunication infrastructure rollout) and other high-capacity transmission technologies (networks) from 7 to 72 districts by 2010

Sector	Sector Vision	Targets/Goals
		2. Increase the access to phones per 100 people (tele-density) from 0.9 to 8 by 2015 and to 50 by 2030 3. Increase access to ICT services such as raising Internet users from 35,000 in 2005 to 100,000 by 2015 and to 1,000,000 by 2030

Source: excerpted from Ministry of Finance and National Planning (2006), *Vision 2030,* pp. 30-31.

In compliance with Vision 2030, the **8th National Development Plan (2022-2026)** elaborates more on the national emphasis on skilled human resources. "Improved education skills development" is highlighted as one of the expected outcomes of the Plan. In order to achieve the outcome of improved education and skills, four strategies are listed: (1) enhance access to quality, equitable, and inclusive education; (2) improve technical, vocational, and entrepreneurship skills; (3) increase access to higher education; (4) enhance science, technology, and innovation.

Table 2-2. Four Strategies for Human Education and Skilled Development in the 8th National Development Plan (2022-2026)

Strategy	Programmes
1. Enhance access to quality, equitable, and inclusive education	a) Early childhood education; b) Primary education; c) Inclusive education; d) Adult literacy; e) Secondary education; f) Curriculum review; g) Human resource development; h) Infrastructure development; i) ICT promotion; j) STEM; k) Menstrual hygiene promotion
2. Improve technical, vocational, and entrepreneurship skills	a) TEVET; b) Curriculum review; c) Research and development; d) Internship and apprenticeship; e) Digital skills development; f) Human resource development; g) Infrastructure development
3. Increased access to higher education	a) Infrastructure development; b) Human resource development; c) Curriculum development; d) Private sector participation promotion
4. Enhance science, technology, and innovation	a) STEM; b) Research and development; c) Curriculum development; d) Industry linkages promotion; e) Infrastructure development; f) Digital skills development; g) Partnership promotion

Source: excerpted from Ministry of Finance and National Planning, Republic of Zambia (2022), *Eighth National Development Plan,* p. 52.

2.2. The National STI Policies

Despite the implementation of various macro-economic and development strategies from 1964 to 1991, Zambia experienced a deterioration in the economic and industrial performance. The transformation of Zambia's economic policy framework in 1992 from a controlled Central State to a liberalized and free-market economy brought some beneficial results in some sectors of the economy and some negative results in other sectors.

One such industry that faced negative results was the manufacturing industry, mainly due to stiff competition from imported goods and services. A major contributing factor to the poor performance of the industry was the lack of application of science and technology, resulting in industries becoming uncompetitive with declining productivity under the global trade environment.

Against this background, the government realized that sustainable, socio-economic development can only be achieved through a strong, well-co-ordinated and monitored Science and Technology System. Hence, the government decided to formulate a National Science and Technology Policy.

Two major national STI policies have been designed and implemented so far in Zambia: the Science and Technology Policy of 1996 and the National Science, Technology, and Innovation Policy of 2020. While the 1996 version of the National ST Policy provided legal and institutional frameworks for the ST sector, the 2020 Policy forges closer links between R&D programmes and priority sectors of the economy.

Table 2-3. The National STI Policies of Zambia

Year	Policy Name	Policy's Main Features	Implementation Status	Ministry Responsible
1996	Science and Technology (ST) Policy of 1996	Designed to embed ST as part of the culture in key sectors to promote competitiveness, but had excluded the innovation element	No longer in use, but served as the major policy on ST between 1996 and 2020	Ministry of Science, Technology and Vocational Training (MSTVT)
2020	National Science, Technology, and Innovation (STI) Policy of 2020	Distinctively different from the 1996 ST policy in that the key 'innovation' element was incorporated	Implementation of the policy is a challenge, and coordination with agencies and line ministries requires reconsideration to improve the coherence of implementation.	Ministry of Technology and Science (MTS)

Year	Policy Name	Policy's Main Features	Implementation Status	Ministry Responsible
			Coordination and collaboration will need to further extend beyond government organisations to all STI stakeholders (e.g. firms and industries)	

Source: Author's elaboration

Science and Technology Policy of 1996

The Science and Technology Policy 1996 is the first-ever national STI policy providing legal and institutional frameworks of the ST sector. The government formulated the National Science and Technology Policy in 1996 with a broad objective of embedding ST as part of the culture of the key sectors to promote competitiveness in the production of a wider range of quality goods and services. The mission of this policy was to promote and implement ST as an instrument for developing an environmentally friendly indigenous technological capacity for sustainable socio-economic development in order to improve the quality of life in Zambia.

The strategies for achieving this broad policy objective include:

(i) recognizing gender concerns
(ii) changing institutional structures
(iii) ensuring that research is guided by national developmental goals
(iv) establishing a mechanism for increased innovation, transfer, diffusion, and commercialization of technology, especially for small and medium scale industries, with emphasis on indigenous technology
(v) putting in place efficient facilities to formulate and enforce standards and undertake quality control testing and assessment of industrial products
(vi) developing appropriate training which imparts practical skills and application of knowledge to develop prototypes, products, and processes in the changing environment of market technology
(vii) establishing a comprehensive data bank which is easily accessible at strategic locations by scientific, management and industrial users
(viii) providing incentives and targeted promotions for the furtherance ST's impact to economic development in the key sectors

The Science and Technology Policy of 1996 led to a complete re-organization of the legal and institutional frameworks of the ST sector in the country. The results of these reforms led to the repeal of the National Council for Scientific Research (NCSR) Act of 1970 and the creation of the National Science and Technology Council (NSTC), National Institute for Scientific and Industrial Research (NISIR), the National Technology Business Centre (NTBC), and the National Remote Sensing Centre (NRSC) through the Science and Technology Act No. 26 of 1997. Through this act, management boards were also created to oversee the administration of these institutions.

National Science, Technology, and Innovation Policy of 2020

While the essence of the 1996 National Science and Technology Policy objectives remained valid, the social, legal, political, environmental, and economic situation of the country had undergone significant changes. The Zambian ST environment had changed drastically as a result of scientific advancements during the period of the 1996 Policy. The policy, according to the situational analysis in the Sixth National Development Plan (SNDP, 2010), had not matched with the ST landscape and, therefore, had not been very effective. The consequences of not having an up-to-date policy have been detrimental to the advancement of ST in the country. For example, most of the technical colleges in the country rebranded with a focus on business-related programmes taking centre stage, and projects to improve the technical programmes were largely donor-driven. This had led to technical skills shortages in the local labour market. The 1996 Policy had not succeeded in putting in place measures for the identification and development of innovations.

Further, the ST Policy of 1996 did not contain concrete measures for promoting entrepreneurship and, in particular, lacked intellectual property (IP) provisions to incentivise entrepreneurs. The poor performance of the country in the area of technology production was captured by the statistics shown in Table 1 below.

Table 2-4. Comparison of Country Performances in the Area of Technology Production During the Implementation of the 1996 ST Policy

No.	Country	No. of Patents
1	South Africa	663
2	Angola	7
3	Zimbabwe	4
4	Zambia	0

Source: Author's elaboration

The **National Science, Technology and Innovation Policy of 2020** is therefore a revision of the National Science and Technology Policy of 1996. The new policy provides medium- and long-term measures for the development of the ST sector in the country. As a way of keeping pace with the demands of a knowledge-driven economy and ensuring the country's competitiveness, the policy addresses the enhancement of research, innovation, human resource development and retention, infrastructure, financing, and coordination of STI.

The National Science and Technology Policy of 1996 recognized that limited funding for R&D by both the government and the private sector had greatly contributed to the poor performance of ST's application in national development. Therefore, the revised Policy of 2020 has proposed the following as sources of funds for R&D:

a. Government allocation of 3% of GDP to scientific and technological activities
b. Public, private, and donors' contributions to the Science and Technology Fund, which was to be created
c. Research institutions to internally generate revenue through commercialization of technologies, contract research, and collaborative research
d. Creation of Technology Venture Capital by the private sector

In terms of the policy's link to sustainable development, this is well clarified in its vision, which states *"that science, technology and innovation should be the driving force for competitiveness, wealth creation, and sustainable national development by 2030."* Further, and based on the Sustainability Principle, the STI Policy shall be implemented in a manner that will preserve the well-being of both present and future generations.

The ST Policy 1996 was designed to embed ST as part of the culture in key sectors to promote competitiveness by establishing legal and institutional frameworks of the ST sector. The STI Policy 2020 provides medium- and long-term measures for the development of the ST sector in the country by forging closer links between R&D programmes and priority sectors of the economy. In the 2020

policy, seven objectives are announced: (1) strengthen the policy, legal, institutional, and operational framework of the STI system; (2) strengthen and build the human resource capacity in STI; (3) strengthen the commercialisation, transfer, and diffusion of technologies; (4) implement the Indigenous Knowledge System (IKS) into national development; (5) improve investment and funding to STI; (6) ensure quality assurance in STI; and (7) promote and popularize STI. The Ministry of Technology and Science announces measures for attaining (3) technology commercialisation, including promoting locally developed technological innovation and facilitating IP development and spinoff of universities and R&D institutions. While the policy was developed by the Ministry of Higher Education, now the Ministry of Technology and Science (MTS) is in charge of the policy.

Table 2-5. Emphasis of the National STI Policy of 2020 on STI Contribution to Major Sectors

Sectors of STI Application	Issues and Directions
Education	STEM, R&D, skills in tech & innovation
Agriculture	farming and fishing productivity
Health	indigenous knowledge systems
Manufacturing	resource-based and low tech, perception on R&D as cost
Mining	10% of GDP, export of raw base metals (e.g. copper), no value addition

Source: Author's elaboration

Challenges for Realizing Vision 2030 and the National STI Policy of 2020

Despite recognizing the critical role of STI in becoming a prosperous middle-income country by 2030, Vision 2030 and the subsequent 8th National Economic Development Plan (2022-2026), still lack action plans that delineate how to achieve the national economic goals and carry out the seven objectives identified in the National STI Policy of 2020.

Firstly, several issues arise from a dimension of the policy, legal, and institutional framework. Regarding STI governance, concerns stem from the fragmented resources and lack of collaboration among major ministries. The Ministry of Higher Education (MOHE) was responsible for National R&D program coordination and overseeing the various ministries responsible for R&D and policy implementation (agriculture, fisheries, livestock, mines and minerals, health, education, tourism, arts, lands, environment, natural resources, energy, water, sanitation, commerce, trade, and industry). This led to fragmented resources and absence of a mechanism to coordinate resource allocation. Furthermore, insufficient collaboration among key actors and no formal linkages between higher education, R&D institutions, and industry are bottlenecks for STI governance efficiency. Additionally, private sectors preferred relying on imported technologies, as many

companies are owned and run by foreign multinationals. An independent advisory STI think tank is absent as well.

Secondly, the lack of highly skilled talents is shown in several indices. There are only 50 researchers per million inhabitants in Zambia, whereas the average of a middle-income country is 1000. More concerningly, the number of STI professionals is declining due to increasing diaspora and fewer women in science as a result of misconceptions.

Thirdly, technology commercialisation is critical to STI-based economic development, however, commercialization of outputs from R&D with a tech index is 2.6, whereas the average of the middle-income economy is 4.6. While National Technology Business Centre (NTBC) is designated to be responsible for technology commercialisation, the country still suffers from insufficient funding and limited numbers of commercialisation players in the STI ecosystem.

Next, funding remains the main challenge. As mentioned above, fragmented R&D funding among ministries sets high barriers to the effective mobilisation of limited financial resources. Furthermore, there has been a tendency to aim external funding towards the priorities of foreign funders rather than the national priorities of the country.

Policy challenges addressed here are not new issues to face Zambia in recent years but, rather, have been discussed for the last several. That also requires more fundamental questions and further efforts to identify strengths, weaknesses, opportunities, and threats for Zambian policymakers to make STI policy work.

2.3. STI Legal Institutions

The National Council for Scientific Research (NCSR) had been mandated to carry out both advisory function and research activities in ST. It, however, failed in the advisory function because of weakness in its statutory linkages with other research institutions in the country. For this reason, it became imperative to enact new legislation to separate advice, formulation, co-ordination, and direction roles from physical laboratories

National Council for Scientific Research (NCSR) Act of 1967

The Zambian government established the National Council for Scientific Research (NCSR) in 1967 by an Act of Parliament (Act 236) to replace the Agriculture Research Council (ARC) of Central Africa, which was similarly preceded by other research institutions, namely the Agriculture Research Council of Rhodesia and Nyasaland (1959 - 62), Agriculture Research Council of Central Africa (1963- 66), and the Agricultural Research Council of Zambia (1967- 1970).

Apart from undertaking physical research, NCSR was mandated by an Act of Parliament (Chapter 236 of the Laws of Zambia) to advise the government on research policy and to coordinate, promote, and direct scientific research activities in the country.

A need arose to repeal the National Council for Scientific Research Act (Chapter 236 of the Laws of Zambia) and create a new act for the implementation of the establishment of the National Science and Technology Council (NSTC) and the provision of incentives for promotion of research and development in industry.

Science and Technology Act No. 26 of 1997

Since independence, NCSR, which was created through an Act of Parliament (Chapter 236 of the Laws of Zambia), had been carrying out both advisory functions and research activities in Zambia. However, one of the critiques of the NCSR was that it failed because of weakness in its statutory linkages with other research institutions in the county.

The results of the Science and Technology Policy of 1996 reforms led to the repeal of the NCSR Act of 1967 and the creation of the National Science and Technology Council (NSTC), National Institute for Scientific and Industrial Research (NISIR), the National Technology Business Centre (NTBC) and the National Remote Sensing Centre (NRSC) through the Science and Technology Act No. 26 of 1997. Through this Act, management boards were also created to oversee the administration of these institutions. Based on the current arrangements, STI Policy is implemented through the Science and Technology Act No. 26 of 1997.

Despite the apparent marked progress in the development of the legal and institutional framework, the sector has experienced challenges in the implementation of various pieces of legislation. For instance, the coordination of STI programmes continues to be fragmented. Although the NSTC was established as the coordinating organ for the sector under the Science and Technology Act No. 26 of 1997, the effectiveness of the coordination system has been hampered by, inter alia, inadequate legislation. The Sector Advisory Group (SAG) on ST, established in 2007 under the Fifth National Development Plan (5NDP) to address concerns on coordination, equally failed to overcome the segmentation and incoherence of ST programmes. It is therefore clear that in its current form, the Science and Technology Act No. 26 of 1997 is inadequate to achieve the objectives of the revised policy.

Apart from the Science and Technology Act No. 26 of 1997, the implementation of STI Policy is complemented by other existing sectoral legal frameworks (Table 3).

Table 2-6. Existing Sectoral Legal Frameworks to Complement the Implementation of the STI Policy of 2020

S/N	Legal Framework	Relevance to Sustainable Development	Implementation Process
1.	Environmental Management Act No. 12 of 2011	Provides for the management of environment and natural resources	Implemented by the Zambia Environment Management Agency (ZEMA)
2.	Forestry Act No. 4 of 2015	Provides for the conservation and protection of forests and trees	Implemented by the Forestry Department under the Ministry of Green Economy and Environment (MGEE)
3.	Zambia Wildlife Act No. 15 of 2015	Responsible for wildlife management and conservation	Implemented by the Department of National Parks and Wildlife (DNPW) under the Ministry of Tourism
4.	Agriculture Lands Act Cap 187	Provides for sustainable agricultural practices, development, investment, and management	Implemented by the Ministry of Agriculture
5.	The Mines and Minerals Development Act No. 11 of 2015	Provides for the sustainable use of minerals	Implemented by four technical departments under the Ministry of Mines and Minerals Development: Cadastre Department, Mines Safety Department, Mines Development Department, Geological Department.

S/N	Legal Framework	Relevance to Sustainable Development	Implementation Process
6.	Fisheries Act No. 22 of 2011	Provides for sustainable fisheries and aqua-cultural development and management	Implemented by the Fisheries Department
7.	Zambia Development Agency Act No. 11 of 2006	Provides for the trade, investment, and industrial development in Zambia	Implemented by the Zambia Development Agency under the Ministry of Commerce
8.	Water Resources Management Act No. 21 of 2011	Provides for the regulation and management of water resources	Implemented by the Water Resources Management (WARMA) under the Ministry of Water Development
9.	The Patents Act No. 40 of 2016	Provides for the protection and administration of patents as well as for the patentability of inventions	Implemented by the Patents and Companies Registration Authority (PACRA) under the Ministry of Commerce
10.	The protection of Traditional Knowledge, Genetic Resources and Expressions of Folklore Act No. 16 of 2016	Provides for a transparent legal framework for the protection of, access to, and use of traditional knowledge, genetic resources, and expressions of folklore, as well as equitable sharing of benefits and effective participation of holders	Implemented by PACRA under the Ministry of Commerce

Source: Author's elaboration

Zambia Academy of Sciences Act No. 18 of 2020

The Zambia Academy of Sciences Act No. 18 of 2020, among others, provides for the promotion of technological discovery and innovation, establishes the Zambia Academy of Sciences (ZaAS) and provides for its functions, provides for the investigation of matters of public interest relating to science and technology, provides for the promotion of research and its utilization in the development of science and technology, and provides for matters connected with, or incidental to, the foregoing.

The Act established the Zambia Academy of Sciences as an autonomous association of scientists whose main aim is to provide independent and objective advice on STI.

Other Legal and Regulatory Framework

Biosafety Act No. 10 of 2007

The Biosafety Act No. 10 of 2007 provides rules relative to the import, development, export, research, transit, contained use, release, or placing on the market of any genetically modified organism whether intended for release into the environment, for use as a pharmaceutical, for food, feed or processing, or as a product of a genetically modified organism. The rules intend to ensure that harm by GMOs is prevented to the environment, human or animal health, non-genetically modified crops, or biological diversity

The Biosafety Act No. 10 of 2007 established the National Biosafety Authority (NBA) as the implementing agency and prescribes its powers and functions. The functions of the NBA include processing notifications and applications of GMOs or products of GMOs into the country in accordance with the requirements of the Biosafety Act. The Authority also approves the import, export, development, transit, research, contained use, release, or placing on the market of any genetically modified organism or a product of a genetically modified organism.

The establishment of the NBA and Biosafety Advisory Committee (BAC) under the Biosafety Act of 2007 constituted the institutional framework for national decision-making and international cooperation on biosafety.

Patents Act No. 40 of 2016

The Patents Act No. 40 of 2016 provides, inter alia, procedures and requirements for patenting an invention, rights accruing from patentability and how to protect such rights, the use of patented information and technological knowledge, and promotes and encourages innovative and inventive activities and local generation of technologies. The act is supplemented by the patent regulations, which provide further details and prescribe forms in respect of various applications relating to patents.

Currently, the Patents and Company Registration Agency (PACRA) administrates and manages IP rights.

2.4. National Policies and Strategies Related to Climate Resilience

Zambia has developed several environment and related policies, strategies, projects, and programmes in response to climate change and other environment related impacts. These include the following: the National Policy on Environment (NPE); the National Climate Change Response Strategy (NCCRS); the National Forestry Policy of 2014; the National Energy Policy of 2008, the National Agriculture Policy of 2014; the Transport Policy of 2002; the National Strategy for Reducing Emissions from Deforestation and Forest Degradation (REDD+, 2015); the Second National Biodiversity Strategy and Action Plan (NBSAP2); the National Adaptation Plan of Action on Climate Change (NAPA); the Technology Needs Assessment (TNA); the Nationally Appropriate Mitigation Actions (NAMAs); the Third National Communication (TNC).

These policies and strategies have all been in line with the existing National Development Plans at the times of their respective enactments.

National Conservation Strategy (NCS), 1985

The National Conservation Strategy (NCS) was adopted by Government in 1985 and served as the first major environmental policy document in Zambia. NCS led to the establishment of environmental legislation and institutions in the country. NCS was developed to manage natural resources and the environment in the context of a centrally planned and controlled economy.

NCS's goal was to satisfy the basic needs of all the people of Zambia, both for present and future generations, through the wise management of natural resources. NCS's objectives were threefold:

- To ensure the sustainable use of Zambia's renewable natural resources
- To maintain Zambia's biological diversity
- To maintain essential ecological processes and life-support systems.

The Ministry of Environment and Natural Resources (MENR) was responsible for the implementation of NCS. NCS triggered, in 1990, the enactment of the Environmental Protection and Pollution Control Act (EPPCA – now the Environmental Management Act No. 11, 2011), which was a regulatory instrument that cut across sectors, and, in 1991, the creation of the Environmental Council of Zambia (ECZ – now the Zambia Environmental Management Agency) to regulate environmental matters and deal with related issues.

A decision was made by government to update NCS through the National Environmental Action Plan (NEAP) process in 1992 due to the following:

(i) the economy was undergoing a period of liberalization

(ii) the main NCS recommendations had been implemented

(iii) the technical information in the NCS needed updating

(iv) there was a requirement by the World Bank for NEAP as a prerequisite for International Development Assistance (IDA) loan funding

National Environmental Action Plan (NEAP) of 1994

The National Environmental Action Plan (NEAP) of 1994 was an update of the NCS and was prepared as a comprehensive plan to contain the ever-increasing environmental degradation in Zambia. The preparation of NEAP was as a result of government's desire to update NCS due to the following:

- The economy was undergoing a period of liberalization
- The main NCS recommendations had been implemented
- The technical information in the NCS needed updating
- There was a requirement by World Bank for NEAP as a prerequisite for International Development Association (IDA) loan funding.

The NEAP was founded on three fundamental principles:

- The right of citizens to a clean and healthy environment
- Local community and private sector participation in natural resources management
- Obligatory Environmental Impact Assessments (EIAs) of major development projects in all sectors.

The overall objective of NEAP was to integrate environmental concerns into the social and economic development planning process of the country. The main thrust of NEAP was to identify environmental problems and issues, analyse their causes, and recommend actions required to resolve those issues. In NEAP, this was done for the major sectors. Some recommendations, inevitably, cut across several sectors. From the recommended actions, an implementation strategy was drawn for each sector, and it proposed the action, priority ranking, time-frame for its implementation, and finally the agency responsible for the implementation of the recommendation. The proposed actions, therefore, formed the basis for a detailed action plan which supported the implementation of NEAP through the Environmental Investment Programme (EIP).

National Policy on Environment, 2007

The government developed the National Policy on Environment (NPE) to avoid conflicts of interest, harmonize sectoral strategies, and rationalize legislation that concerned the use and management of environment in order to attain an integrated approach to development through a national cross-cutting consensus.

The policy provides a framework for the management of Zambia's environment and natural resources to ensure that they are managed on a sustainable basis and retain their integrity in order to support the needs of the current and future generations without compromising either of the two. NPE underlines the government commitment in partnership with the people to effectively manage the environment for the benefit of present and future generations.

The main aim of the policy is to ensure sound environmental management within a framework of sustainable development in Zambia. The policy is supported by many other policies and strategies that have been developed for other sectors and now provides a holistic approach to establish a national strategy based upon cross-sectoral consensus for care of the environment.

The emphasis of the policy is that it is the duty of any institution, government or non-governmental organization, any community group or people's organization, or any individual that uses or carries out activities that affect the environment in any way, to exercise proper control to maintain the productivity and integrity of the environment.

NPE is guided on the principle that a fundamental set of premises must be established for the integration of decision making, legislation, financing mechanisms, regulation, and enforcement in relation to Zambia's environment and, in some specific circumstances, those that concern trans-border and regional matters. Underlying the entire policy is the government's commitment to reduce poverty and achieve sustainable development for the nation as a whole on the basis of "development without destruction."

National Climate Change Response Strategy (NCCRS) of 2011

The gaps noted in the National Policy on Environment (NPE) led to the formulation of the National Climate Change Response Strategy (NCCRS) of 2011, a policy aimed at addressing climate change. The strategy was developed to support and facilitate a coordinated response to climate change issues in the country. It aimed at enabling Zambia to position itself strategically to respond to the adverse impacts of climate change and contribute to the achievement of the overall objective of the United Nations Framework Convention on Climate Change (UNFCCC), which it ratified in 1993.

However, the NCCRS was never adopted by government, nor was it fully implemented, as stakeholders realized that a specific policy on climate change was required so that it could provide

the required long-term institutional framework. As a result, the formulation of the National Policy on Climate Change (NPCC) commenced around 2012 and was adopted in 2016.

National Policy on Climate Change, 2016

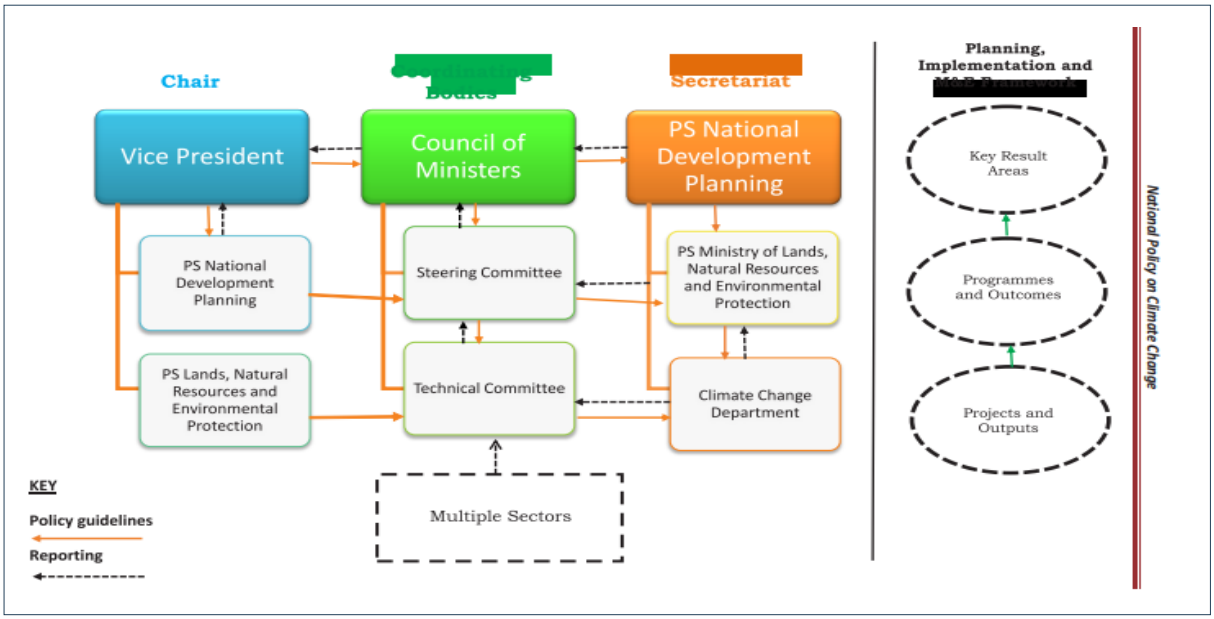
The National Policy on Climate Change (NPCC) was adopted by the Zambian cabinet in April 2016 with an overall objective of providing a coordinated approach to the challenges of climate change in the country. The policy's major provision regards institutional arrangements and assigns roles and functions to several ministries and other government agencies.

NPCC was intended to establish a coordinated national response to climate change. At the apex of NPCC institutional framework is the council of ministers, chaired by the vice president (Table 4). The council of ministers is the supreme decision-making body on climate change in the country and provides policy guidance and direction. The council of ministers is supported by a steering committee of permanent secretaries, which provides oversight to the implementation of climate change projects and programmes.

In order to ensure that climate change issues are integrated in the development planning process, the steering committee is chaired by the ministry responsible for development planning. The steering committee is supported by a broad-based technical committee on climate change with members drawn from line ministries, private sector, civil society, and financial institutions. This has just over thirty institutions represented and meets every quarter to review and make recommendations to the steering committee of permanent secretaries on various matters related to climate change.

To support these various committees whose members are part time, the government, through the NPCC, created a dedicated department on climate change. The department, which is under the Ministry of Green Economy and Environment, provides secretariat services to the technical committee and the steering committee on climate change. Among other things, the department is responsible for coordinating the implementation of climate change projects and programmes in the country.

Figure 2-2. Institutional Framework Created under the NPCC



Source: Ministry of National Development Planning (2016), p. 24.

Table 2-7. Major Environmental Policies in Zambia Including Responsible Ministries

Year adopted	Policy name and background	Timeframe	Status	Responsible Ministry
1985	National Conservation Strategy	1985-1994	No longer in use	Ministry of Environmental and Natural Resources (MENR)
1994	National Environmental Action Plan (NEAP)	1994-2007	No longer in use	MENR
2007	National Policy on Environment	2007-present	Current supreme policy on environment	Ministry of Green Economy and Environment (MGEE)
2011	National Climate Change Response Strategy (NCCS)	Not adopted by Government	Not implemented	Ministry of Lands, Natural Resources, and Environment
2016	National Policy on Climate Change (NPCC)	2016-present	Being implemented	MGEE

Source: Author's elaboration

2.5. Legal Institutions Related to Climate Resilience

With all the available policy landscape on climate change and sustainable development in Zambia, the remaining piece in the jigsaw puzzle has been the enactment of an overarching enabling legislation. Below are some of the legislations related to climate change and sustainable development.

Climate Change Bill

The government of the Republic of Zambia is currently in the process of formulating the Climate Change Bill which is expected to be enacted into law in 2023. Once enacted into law, the bill will provide a legal framework to address issues of climate change in the country.

The National Disaster Management Act No. 13 of 2010

The act came into force on the 13th of April, 2010 and establishes and provides for the maintenance and operation of a system for the anticipation, preparedness, prevention, coordination, mitigation, and management of disaster situations, as well as the organization of relief and recovery from disasters. Disaster situations include those caused or brought about by climate change.

Further, the act establishes the National Disaster Management and Mitigation Unit (DMMU) and provides for its powers and functions, provides for the declaration of disasters, establishes the National Disaster Relief Trust Fund, provides for the responsibilities and involvement of the members of the public in disaster management, and provides for matters connected with, or incidental to, the foregoing.

The act is implemented by the DMMU under the office of the vice president.

Forestry Act of 2015

The Forestry Act of 2015 provides for the establishment and designation of national forests, local forests, joint forest management areas, botanical reserves, private forests, and community forests.

The act allows the participation of local communities, local authorities, traditional institutions, non-governmental organizations, and other stakeholders in sustainable forest management. The act established the Forest Development Fund and allowed the implementation of various international conventions such as:

- United Nations Framework Convention on Climate Change
- Convention on International Trade in Endangered Species of Wild Flora and Fauna
- Convention on Wetlands of International Importance
- Convention on Biological Diversity
- Convention to Combat Desertification

The act is implemented by the Forestry Department under MGEE.

Forestry Carbon Stock Management Regulations, Statutory Instrument (SI) No. 66 of 2021

The Forestry Carbon Stock Management Regulations of 2021 encourages community forest groups to mobilize and participate in carbon trading through, among others, reduction in deforestation and forest degradation, forest conservation, and sustainable management of forest.

However, SI no. 66 is restricted to forest related carbon and does not address other forms of carbon and, as such, to incorporate the other forms of carbon which are equally important with enormous potential for usage, the government has developed interim guidelines for carbon markets and trading which will enable the country to facilitate approval, implementation, and regulation of carbon projects.

The regulations are implemented by the Forestry Department under the MGEE.

3. National STI & Climate Governance and Key Stakeholders

Figure 2-3. Actors in Zambia NIS

National Innovation System in Zambia

Government and Policies

Ministry	Key Policies
Ministry of Green Economy and Environment	• National Policy on Environment 2007 / National Climate Change Response Strategy 2011 / National Forestry Policy 2014 / Zambia National Strategy to Reduce Emissions from Deforestation and Forest Degradation 2015-2030 / National Policy on Climate Change 2016 / Interim Guidelines 2022 – Carbon Markets and Trading etc.
Ministry of Water Development and Sanitation	• Water supply and sanitation Policy 2020 / Water investment program 2022-2030
Ministry of Fisheries and Livestock	• National Policy on Wetlands 2018 / National Aquaculture Trade Development / Strategy and Action Plan 2020-2024 / National Livestock Development Policy 2020
Ministry of Agriculture	• Masterplan for Promotion of Irrigated Agriculture for Smallholders in the Peri-Urban Areas, Republic of Zambia 2011 / Second National Agriculture Policy 2016
Ministry of Energy	• National Energy Policy 2019
Ministry of Technology and Science	• National Science, Technology and Innovation Policy 2020 / National Science and Technology Policy 1996 / Biotechnology and Biosafety Policy 2003 / National Nuclear Policy 2020 / Revised National Intellectual Property Policy 2020
Ministry of Mines and Minerals Development	(Each sectorial policy)
Ministry of Health	
Ministry of Youth, Sport and Child Development	
Ministry of Commerce, Trade and Industry	
Ministry of Education	

Research

National Institute for Scientific and Industrial Research (NISIR)	Zambia Agriculture Research Institute (ZARI)	Zambia Academy of Sciences (ZaAS)
Center for Veterinary Research Institute (CVRI)	Golden Valley Agricultural Research Trust (GART)	

University

University of Lusaka	University of Zambia	Information and Communication University
Northern Technical College	Natural Resources Development College	
The Copperbelt University	ZCAS University	

Innovation Supporting Agency

Public

National Science and Technology Council (NSTC)
National Technology Business Centre (NTBC)
Zambia Development Agency (ZDA)
Zambia Information and Communications Technology Authority (ZICTA)
Zambia Chamber of Commerce and Industry (ZACCI)
Zambia Environmental Management Agency (ZEMA)
National Biosafety Authority (NBA)
Citizens Economic Empowerment Commission

Private

Zambia Chamber of Small and Medium Business Associations (ZCSMBA)
BongoHive
Women's Entrepreneurship Access Center (WEAC)
FinTech4U Accelerator
Agribusiness Incubation Trust
Impact Hub
Jacaranda Hub
Private Enterprise Programme
She Entrepreneur
Asikana Network
Kukula Seeds
Amano Capital
African Business Angel Network (ABAN)
Zanaco Innovation Lab

Source: Author's elaboration

Each actor of Zambia's NIS can be categorized as above. Following is a brief explanation of each institution.

3.1. Government and Policies

Ministries Contributing to NIS

In Zambia, the **Ministry of Technology and Science (MoTS**) oversees national innovation based on its National Science, Technology, and Innovation Policy of 2020, and the National Science and Technology Policy of 1996. Sectoral policies, such as the Biotechnology and Biosafety Policy 2003, the National Nuclear Policy of 2020, and the Revised National Intellectual Property Policy of 2020, are managed by MoTS.

Ministry of Green Economy and Environment (MoGEE) has published the Zambian National Strategy to Reduce Emissions from Deforestation and Forest Degradation for 2015-2030, National Policy on Climate Change of 2016, Interim Guidelines for 2022 – Carbon Markets and Trading recently. Former policies are the National Policy on Environment of 2007, the National Climate Change Response Strategy of 2011, and the National Forestry Policy of 2014. MoGEE, in collaboration with the Ministry of Agriculture, the United Nations Development Program (UNDP), the Food and Agricultural Organization (FAO), and the World Food Program (WFP), is strengthening climate resilience of agricultural livelihoods through the project "Strengthening Climate Resilience of Agricultural Livelihoods in Agro-ecological Regions I and II in Zambia" (SCRALA).

The **Ministry of Water Development and Sanitation**, with its Water Supply and Sanitation Policy of 2020 and Water Investment Program for 2022-2030, and the **Ministry of Energy**, with its National Energy Policy of 2019, are also part of the governmental sector of NIS. The **Ministry of Agriculture** and the **Ministry of Fisheries and Livestock** also play an important role based on the National Agriculture Policy of 2016 and National Livestock Development Policy of 2020.

Other ministries, such as the Ministry of Mines and Minerals Development, the Ministry of Health, the Ministry of Youth, Sport and Child Development, the Ministry of Commerce, Trade and Industry, and the Ministry of Education, also present policy for each sector.

3.2. Research Institutions

The **National Institute for Scientific and Industrial Research (NISIR)** is a government-funded research institution that undertakes research in agriculture, water resources, minerals and industrial raw materials, and nuclear science and technology. NISIR in collaboration with the Japanese International Cooperation Agency (JICA) piloted the replacement of charcoal with coal-based briquettes through a project modifying the charcoal cook stove (*mbaula*) to enhance its efficiency.

The **Zambian Agriculture Research Institute (ZARI)** researches crops, soil, and water, and provides quality services to farmers. Researchers at the Malaria Institute at Macha, in partnership with the Johns Hopkins Malaria Research Institute, work to prevent and control the mosquito-borne illness.[1]

The **Zambian Academy of Sciences (ZaAS)** was formed at the National Science and Technology Council offices in 2005. This non-profit organization aims to provide totally independent and objective opinion on science matters, and also to play a role in planning and coordinating Zambia's science education.[2]

The **Centre for Veterinary Research Institute (CVRI)** is responsible for providing solutions to the livestock business through innovative veterinary services which cover a wide range of technical disciplines including training, research, and epidemiology. [3] [4]

The **Golden Valley Agricultural Research Trust (GART)** was created in 1993 by the government of the Republic of Zambia in partnership with the Zambian National Farmers Union. It is a substantially self-sustaining and autonomous public private partnership initiative and is part and parcel of the National Agricultural Research and Extension System.[5] GART has been at the forefront of developing climate-smart conservation agriculture systems and agroforestry. Some of the climate-smart techniques are: soil improvement and value addition, tillage and planting techniques, and tillage and crop residue management. Smart agroforestry is focused on integrating trees with crops on the farm.[6]

The **International Institute of Tropical Agriculture (IITA)** has collaborated with local institutions to enhance climate-adapted agricultural practices, develop environmentally sustainable cultivation practices, and restore degraded farmlands.[7] The Aflasafe Technology Transfer and Commercialization (ATTC) project by IITA aims to widely adopt aflasafe, a biocontrol product that significantly reduces aflatoxin contamination in staple crops. This initiative involves transferring aflasafe technology to the private sector or governments for large-scale production and distribution. Targeting eleven African countries, including Zambia, the project's goal is to enhance crop safety and enable smallholder farmers to access both domestic and international markets that test for aflatoxin contamination.[8]

[1] https://www.commonwealthofnations.org/sectors-zambia/education/research_institutes/
[2] https://www.interacademies.org/organization/zambia-academy-sciences
[3] https://www.asti.cgiar.org/zambia/directory/central-veterinary-research-institute-cvri
[4] https://hub.unido.org/news/zambias-central-veterinary-research-institute-accredited
[5] https://www.developmentaid.org/organizations/view/17464/golden-valley-agricultural-research-trust-gart
[6] http://www.gart.co.zm/
[7] https://www.iita.org/iita-countries/zambia/
[8] https://www.iita.org/iita-project/aflasafe-technical-transfer-commercialization/

3.3. Universities

Prominent universities supporting NIS include the University of Lusaka, the University of Zambia, the Natural Resources Development College, the Copperbelt University, and ZCAS University.

The **University of Lusaka** is a private university located in Lusaka, Zambia. It was established in 2007 and offers undergraduate and postgraduate programs in various fields such as business, law, education, and health sciences.[9]

The **University of Zambia** is a public university located in Lusaka, Zambia and was established in 1965. It is the largest and oldest learning institution in the country. The university offers undergraduate and postgraduate programs in various fields such as agriculture, engineering, humanities, and social sciences.[10]

The **Natural Resources Development College (NRDC)** is a public training institution under the Ministry of Agriculture in Zambia. It was established in 1965 and offers diploma courses underwritten by the University of Zambia in various fields such as agriculture and other related disciplines.[11] [12]

Established in 1964 as an engineering skills training institute, **Northern Technical College (NORTEC)** has been a key provider of technical manpower for Zambia's copper mines. Over its five-decade history, NORTEC has consistently produced highly competent craftsmen, technicians, and technologists who have significantly contributed to the success of the mining industry.[13]

The **Copperbelt University** is a public university located in Kitwe, Zambia established in 1987.[14]

ZCAS University is a private university located in Lusaka, Zambia and was established in 2008. It offers undergraduate and postgraduate programs in various fields such as business, law, computing technology, and applied sciences.[15]

[9] https://www.unilus.ac.zm/
[10] https://www.unza.zm/
[11] https://www.agriculture.gov.zm/?page_id=1667
[12] https://www.nrdc.biz/aboutus.html
[13] https://www.eafinder.com/zm/study-at-northern-technical-college-nortec/
[14] https://www.cbu.ac.zm/
[15] https://zcasu.edu.zm/

3.4. Innovation Supporting Agencies

Public Agencies

The **National Science and Technology Council (NSTC)** is a statutory body established by the Science and Technology Act No. 26 of 1997. The main function or mandate of the council as prescribed in the act is to 'promote science and technology so as to improve the quality of life in Zambia.' NSTC offers grants such as the Strategic Research Funds and the Science, Technology, and Innovation Youth Fund.16

The **National Technology Business Centre (NTBC)** is a statutory body under the Ministry of Technology and Science operated since 2002. Through a multifaceted approach, NTBC adds value to manufacturing, medium-small and micro enterprises (MSME), innovators, and researchers by enhancing productivity and quality. NTBC actively realizes its mandate of technology transfer by facilitating the acquisition, development, and deployment of technology to entrepreneurs. This includes drafting technology licenses, conducting technology needs assessments, and providing intellectual property advice. Moreover, NTBC serves as a vital information hub, offering insights on new technologies, intellectual property, investment opportunities, and technology marketing.[17] Recently, NTBC has developed a technology to create biomass briquettes, mainly from crop residues, as an environmentally friendly alternative to coal briquettes. This initiative has been extended to women's cooperatives in rural Zambian areas like Kasempa. The widespread adoption of these briquettes could significantly reduce deforestation and greenhouse gas emissions.

The **Zambian Development Agency (ZDA)**, established in 2007 under the Ministry of Commerce, Trade, and Industry, is Zambia's primary economic development institution. Created through the amalgamation of five statutory bodies, its mandate includes promoting trade, investment, and enterprise development. The agency actively contributes to economic growth, increased capital inflows, and the development of the MSME sector. Operating strategically, the ZDA enhances Zambia's trading capacity, conducts economic studies, provides advice to the Minister of Commerce, and fosters dialogue between public and private entities. Committed to accessibility and growth, the ZDA is dedicated to establishing a comprehensive database of facilities, furthering industry development for the overall economic progress of Zambia.[18]

The **Zambian Information and Communications Technology Authority (ZICTA)** is a statutory body established under the Information and Communication Technologies Act No. 15 of 2009 to

[16] https://nstc.org.zm/
[17] https://ntbc.co.zm/
[18] http://www.zda.org.zm/

regulate the ICT sector, postal and courier services, and oversee cybersecurity in Zambia. ZICTA's mandate is derived from four key legislations, including the Information and Communication Technologies Act, the Postal Services Act, the Cyber Security and Cyber Crimes Act, and the Electronic Communications and Transactions Act. The authority's role is further shaped by the ICT Policy of 2006, the National Postal Policy of 2021, and the Cyber Security Policy of 2021. Emphasizing capacity building, competitiveness, and effective legal frameworks, ZICTA collaborates with public and private entities to promote ICT adoption for sustainable social and economic development.[19]

The **Zambian Chamber of Commerce and Industry (ZACCI)** is a local organization, based in Lusaka, dedicated to advancing the interests of businesses in Zambia. Its members include a diverse range of international and local companies engaged in various sectors such as law, real estate, tourism, manufacturing, import/export, finance, IT, and electronics. ZACCI plays a crucial role in safeguarding business interests, facilitating the exchange of business experiences, maintaining contact with governments and civil society, and organizing trade shows and events. It serves as a platform for collaboration and information-sharing among businesses, contributing to the overall development and promotion of the local business community in Zambia.[20]

The **Zambian Environmental Management Agency (ZEMA)** is an independent environmental regulator and coordinating agency, established by the Environmental Management Act (EMA) No. 12 of 2011. Mandated through an Act of Parliament, ZEMA is responsible for safeguarding the environment, controlling pollution, and ensuring the well-being of humans, animals, plants, and the overall ecosystem. Governed by a board, ZEMA operates with strategic direction, policy development, work plan and budget approval, and function monitoring related to the administration of the EMA. The agency plays a pivotal role in enforcing environmental protection measures and promoting the health and welfare of all living entities in Zambia.[21]

The **National Biosafety Authority (NBA)** in Zambia is a government agency tasked with regulating the use and development of genetically modified organisms (GMOs) to optimize benefits from modern biotechnology. The NBA conducts risk assessments on GMO applications, ensuring no harm to crops, human and animal health, biodiversity, and the environment. The Scientific Advisory Committee reviews proposals, considering scientific, economic, social, and cultural factors. Public comments on GMO permits are integral to risk assessment.[22] NBA's vision is to secure Zambia's benefits from safe modern biotechnology, and its mission is to ensure safety

[19] https://www.zicta.zm/
[20] https://www.chamber-commerce.net/dir/11665/Zambia-Association-of-Chambers-of-Commerce-and-Industry-in-Lusaka
[21] https://www.zema.org.zm/
[22] https://www.fao.org/fileadmin/user_upload/gmfp/resources/168_Zambia.pdf

in the development, use, and handling of gene modification technologies and products, with the goal of regulating and monitoring gene technologies in Zambia.[23]

The **Citizens Economic Empowerment Commission (CEEC)** operates as a statutory body within Zambia's Ministry of Small and Medium Enterprise Development. Established by the CEE Act of 2006, the commission's mandate is to foster broad-based and equitable economic empowerment for citizens facing marginalization or disadvantage due to factors such as race, sex, education, status, and disability. CEEC provides financing to targeted citizens, MSMEs, and cooperative enterprises nationwide to enhance their participation in economic activities, contributing positively to Zambia's economic development. Additionally, the commission manages the Constituency Development Fund (CDF), which supports development projects at the constituency level.[24]

Private Agencies

The **Zambian Chamber of Small and Medium Business Associations (ZCSMBA)** is a private sector organization established in 2000 to advocate for the interests of micro-, small-, and medium-sized enterprises (MSMEs) nationwide. Registered under the Societies Act, the chamber focuses on safeguarding and promoting trade, business, and services, influencing policy decisions, and facilitating information dissemination. Additionally, it fosters relationships among government entities, businesses, and society. Since 2004, the ZCSMBA has been a registered training provider, emphasizing its commitment to supporting the development and growth of MSMEs in Zambia.[25] [26]

BongoHive, founded in 2011, is Zambia's first technology and innovation hub and was initiated by a group of programmers to address gaps in the local tech industry. Focused on fostering coordination, skills exposure, and productivity, BongoHive offers a variety of services supporting entrepreneurs and startups, including entrepreneur support, consulting, coworking, and community engagement. The hub actively organizes events like the Digital Health Hackathon to encourage grassroots solutions for enhanced healthcare delivery and improved patient well-being, aligning with its commitment to promoting innovation and collaboration in the technology sector. [27]

The **FinTech4U Accelerator** is a three-month business accelerator program in Zambia, initiated through a partnership between the United Nations Capital Development Fund (UNCDF) and

[23] https://www.times.co.zm/?p=88798
[24] https://www.ceec.org.zm/about-us/
[25] https://www.commonwealthofnations.org/organisations/zambia_chamber_of_small_and_medium_business_association_zcsmba/
[26] https://www.developmentaid.org/organizations/view/238147/zambia-chamber-of-small-and-medium-business-associations-zcsmba
[27] https://bongohive.co.zm/

BongoHive. The program focuses on supporting ten Zambian fintechs that offer innovative digital financial products and services, especially targeting underserved populations. Participants receive technical assistance and support from BongoHive, UNCDF, and regulatory bodies.[28]

The **Jacaranda Hub** is a social enterprise based in Lusaka, Zambia, with a focus on fostering the development of young people in ICT and entrepreneurship through innovation hubs. The organization offers various services, including entrepreneur support, consulting, coworking facilities, and community engagement.[29]

The **Agribusiness Incubation Trust** is a public-private partnership with the goal of commercializing Zambia's agribusiness sector by promoting business and technological innovation in the field.[30]

The **Women's Entrepreneurship Access Centre (WEAC)**, supported by the U.S. Department of State, is a hub for women and youth entrepreneurs in Zambia. Formerly WECREATE, it provides a secure environment, essential resources, and tools for women's economic empowerment. WEAC facilitates the shift from informal to formal sectors, aiming for measurable economic and societal change. Through tailored programs and events, WEAC focuses on advancing gender equality in entrepreneurship.[31]

The **Impact Hub Lusaka (IHL)** is an organisation specializing in applied learning to guide individuals, organizations, and communities from intention to action. As part of the global Impact Hub Network, IHL is equipped with cutting-edge skills, tools, and processes in leadership and organization development. The organization focuses on creating both physical and mental spaces that foster collaboration among aspiring and emerging entrepreneurs, setting the stage for success. Additionally, IHL serves as a research hub exploring learning and thinking processes, aiding individuals and organizations in unlocking their capacity for creativity and innovation.[32]

ZANACO Innovation Lab, launched in 2019 by Zambia National Commercial Bank (ZANACO), is an initiative designed to serve as a platform for startup entrepreneurs, youth, and partners. The primary goal is to facilitate the transformation of ideas into solutions that create value for the government. The lab enhances the bank's role as an innovation platform and offers coaching in various areas, including product and service design, business and financial modelling, holistic business storytelling, and impact measurement and management.[33]

[28] https://www.uncdf.org/article/6136/ten-fintechs-join-the-sophomore-class-of-the-fintech4u-accelerator-programme-in-zambia
[29] https://jacarandahub.org/about/
[30] https://impactspace.com/financial-organization/agribusiness-incubation-trust
[31] https://weaczambia.org/
[32] https://lusaka.impacthub.net/
[33] https://digilogic.africa/digital-innovation-in-zambia/

The **Private Enterprise Programme-Zambia (PEPZ)**, a £13.9 million initiative funded by the Department for International Development (DFID), aims to enhance the capability of MSMEs for inclusive economic growth by creating jobs and diversifying the economy.[34] Focused on agriculture, manufacturing, tourism, and ICT, PEPZ seeks to build commercially sustainable and inclusive businesses with the potential for growth and job creation, particularly benefiting women and youth.[35]

She Entrepreneur, a non-profit organization co-founded by Inota Cheta, is dedicated to improving the livelihoods of females in Zambia. The organization achieves this through training in entrepreneurship, job readiness, and financial literacy, aiming to empower women economically. She Entrepreneur also provides a platform for female entrepreneurs to connect, share information, and receive coaching and mentorship.[36]

Asikana Network, located in Lusaka, Zambia, specializes in empowering girls and women in STEM, with a particular emphasis on technology. In 2019, Asikana Network launched the eZibo Digital Literacy program in Zambia in partnership with Facebook. The program is aimed at training youths across Zambia about internet safety. The organization has hosted several events such as Women Game Jam Zambia and SPARK for Kids, a fun 2-day project-based program during school holidays that introduces kids to STEM and computer programming.[37]

Kukula Seeds, established in 2013 by Kukula Capital, is a seed fund based in Zambia that specializes in impact investments. With a focus on businesses supplying the mining industry in the North Western province of Zambia, the fund has invested $15 million in nine impact-driven companies. Kukula Seeds aims to foster the growth of SMEs in Zambia, contributing to job creation, sustainable economic growth, and overall development.[38]

Amano Capital is an impact-driven advisory-brokerage firm in Zambia that bridges the gap between opportunity and capital in the SME market. Specializing in start-ups and medium-scale enterprises, the firm's mission is to present top-performing SME prospects in Zambia to the international investment market. Amano Capital offers a range of services, including venture capital, advisory, and brokerage, providing strategic and operational improvements to targeted SMEs. With an extensive international network, the firm efficiently facilitates the investment transition process.[39]

Established in 2015, the **African Business Angel Network (ABAN)** is a Pan-African organization comprising six pioneer angel networks. ABAN plays a crucial role in the emerging sector of African

[34] https://beamexchange.org/practice/programme-index/288/
[35] https://www.devex.com/organizations/private-enterprise-programme-zambia-pepz-107039
[36] https://www.inclusivebusiness.net/ib-voices/young-leader-who-pushing-female-entrepreneurship-zambia
[37] https://asikananetwork.org/
[38] https://kukulacapital.com/our-services/kukula-seed/
[39] https://www.amanocapital.com/about-us

early-stage ecosystems by facilitating valuable human and financial capital for startups. This support is extended through a network of angel investor groups, syndicates, and networks across the continent. The angel investment sector in Africa is growing rapidly, with an estimated annual investment exceeding $100 million in startups.[40]

The **Common Market for Conservation (COMACO)** is a social enterprise that supports wildlife conservation and small-scale farmers in Zambia, leading the World Bank-funded REDD+ project for reduced emissions from deforestation. Working alongside the Ministry of Green Economy and Environment and the Ministry of Finance and National Planning, COMACO has covered 1.6 million hectares, primarily in eastern and central Zambia, achieving 228,000 tons of CO2 emission reductions. Additionally, they have planted 283 million gliricidia sepium plants and distributed 100,000 fuel-efficient cook stoves, enhancing both agroforestry and energy efficiency efforts.[41]

4. Policy Implications

Chapter 2 analyses major STI and climate institutional aspects of Zambia's NIS. Based on the overall review of major policies and legal institutions related to STI and climate, critical challenges are identified into three groups: limitations of the national STI policy implementation, lack of resources and absence of control tower, and cultural aspects hindering innovation in the innovation ecosystem.

Among several national intuitions addressing the Zambian innovation environment for climate action, the National STI Policy of 2020 is the most recent and relevant. Aligned with the National Development Plan, Policy 2020 clarifies STI roles in national socio-economic development; however, there are limits to its implementation. Since Policy 2020 was developed by the Ministry of Higher Education in 2020, the domestic and international STI environments for a sustainable society have significantly changed. However, it is not clear how the government has responded to the changing environment by realizing the Policy 2020. As the main ministry responsible for the National STI Policy of 2020 implementation is now the Ministry of Technology and Science, some difficulties can be expected in the new governance system of Policy 2020. In addition, there has been no impetus, such as action plans or remarkable initiatives, to further implement Policy 2020. As there are several "will be" announcing phrases in Policy 2020 documents, an audit process or mechanism should be in place to check how the seven objectives in Policy 2020 have been

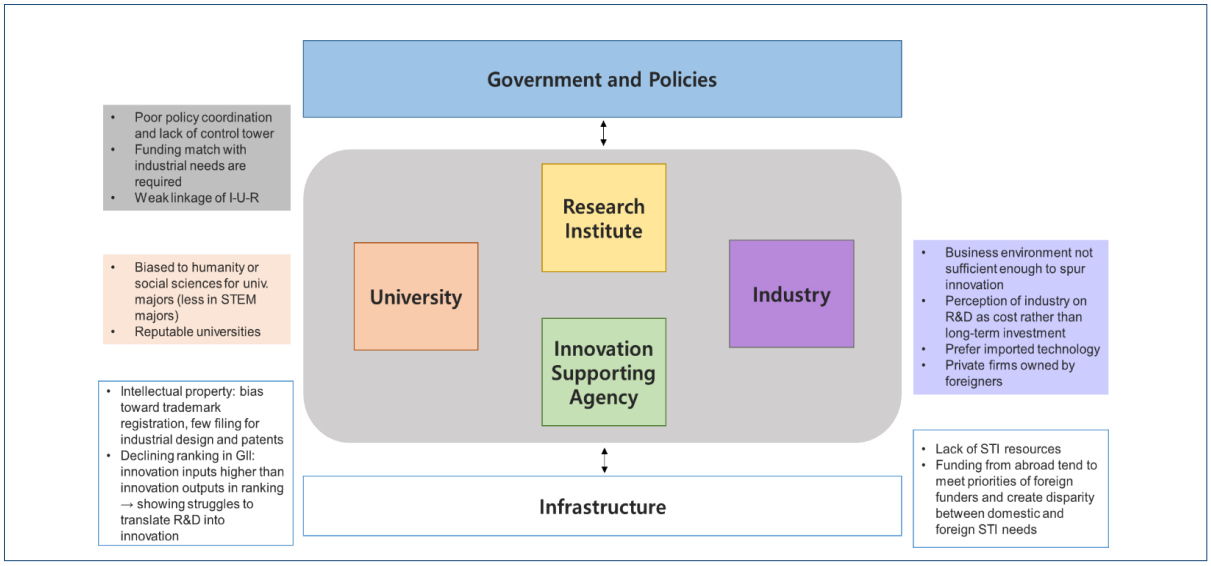
[40] https://abanangels.org/
[41] https://itswild.org/

addressed until now. Specific timelines and clear policy goals with specific numbers to achieve can be developed and pursued as well.

Another significant challenge is the lack of resources. Across most policy documents related to STI and climate resilience, the lack of STI resources is emphasized as one of the critical national challenges. Besides tangible resources such as funding, human resources, and research infrastructures, STEM skills and policy capability are also limited to meeting the minimum inputs required for national STI development and sustainable growth. Given the scarce resources available for STI investment, policy coordination is critical to effectively mobilizing resources and channelling them to the nation's top priorities. However, the absence of a control tower for policy coordination leaves the nation no opportunity to improve towards effective and efficient mobilization of the limited resources, which was also highlighted by Zambian experts during the CTCN workshop. The linkage between industry, university, and research institute remains weak, emphasizing the need for demand and funding alignment based on industrial needs, and it should be strengthened further by the control tower.

The last issue for facilitating innovation is a better understanding of the cultural aspects that hinder national innovation performance for sustainable development. Regarding university and education, a significant issue is the low enrolment of students in STEM fields, with a bias toward humanities or social sciences. Workshop participants attributed this trend to various factors, including cultural perceptions that historically encouraged girls to pursue social sciences. Additionally, the curriculum design was noted as lacking encouragement or favourability for girls to pursue STEM subjects. Nevertheless, reputable universities present an opportunity for Zambia's future NIS.

Figure 2-4. Diagnostic Results of NIS



Source: Author's elaboration

Concerning industry and business, the environment lacks adequacy to stimulate innovation, with a prevailing perception that R&D is seen more as a cost than a long-term investment. Additionally, a significant number of private firms are foreign-owned, and the industry tends to favour imported technology over domestically invented solutions.

The overall infrastructure plays a crucial role in NIS, but Zambia faces a shortage of STI resources. Foreign funding tends to prioritize the preferences of foreign funders, creating a disparity between domestic and foreign STI needs. Zambia's Global Innovation Index (GII) ranking is on the decline, indicating higher innovation inputs than outputs and highlighting the struggle to translate R&D into tangible innovation.

Chapter 3.

Quantitative Diagnosis

1. Diagnosis framework

To efficiently function, a national innovation system (NIS) is required to not only have the capacities and roles of key stakeholders within the system, such as the government, research institutions, industry, and education but also to have efficient governance between these actors. It also needs the support of policy instruments and infrastructure. In this context, before designing the framework and roadmap for Zambia's national innovation system, it is necessary to understand the current environment of innovation in Zambia. To achieve this, it is first essential to define the factors required for innovation and diagnose the current state of each factor. This diagnosis involves collecting recent data for each factor and using it to analyse Zambia's performance, providing both an absolute and relative comparison of Zambia's level with other countries. Then, such comparisons are carried out to indirectly assess Zambia's readiness for an innovation environment. As well as expressing the requirements for fostering innovation, appropriate indicators will assist policymakers in identifying the systemic issues within their STI (Science, Technology, and Innovation) systems.

The 'UNIDO-STPEI Toolkit[42]' is a set of diagnostics tools to appraise a country's current readiness to tackle the opportunities and challenges of innovation for industrial upgrading. The toolkit uses publicly accessible data from a wide range of countries, including developing countries that are especially relevant to STI policy. It has been designed to be representative and straightforward enough for policymakers to understand its linkages and relevance to the real world easily. For this reason, the modified version of the 'UNIDO-STPEI Toolkit' has been adopted for the quantitative diagnosis of Zambia's national innovation environment.

In this section, the modified toolkit is explained in detail with its main components, the main categories, and their respective indicators. Then it is explained how they can be interpreted.

[42] For detailed description on the original toolkit, see Park et al. (2022), Analyzing the Landscape of Industrial Innovation in Developing Countries, UNIDO. Available at: https://downloads.unido.org/ot/31/25/31251192/STEPI%20NSI_V3_FINAL.pdf

1.1. Main Components

In line with the UNIDO-STEPI toolkit, the modified toolkit is composed of three main components:

i. A diagnostic framework and an indicator system addressing questions requiring policymaking in the context of enhancing national innovation policy;

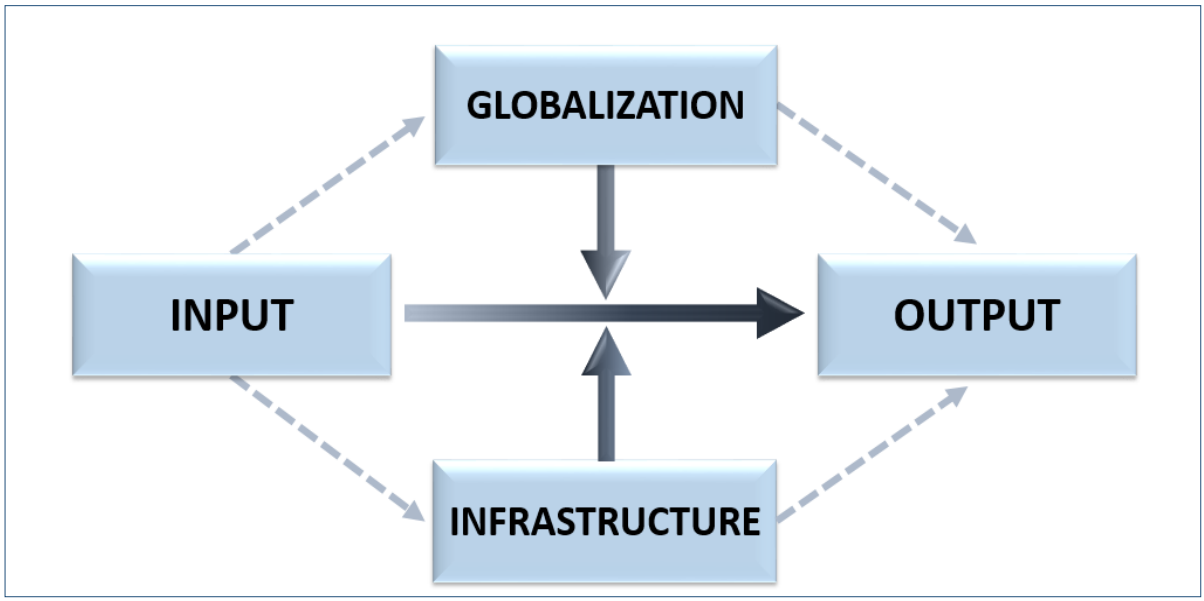
ii. A heatmap dashboard as a synthesis tool for policy gaps (both comparative and absolute) analysis and prioritization;

iii. A country gap profile as a methodology to assess where countries' national systems of innovation are relative to other close country comparators.

1.1.1. A Diagnostic Framework and Indicator System

The concept of national innovation systems (NIS) is commonly used in analysing a developing country's innovation system and adopts many different versions of sub-components, depending on the purposes of the projects. Here, we adapted the methodology used by UN ESCAP for the Ministry of Industry, Science, Technology, and Innovation (MISTI) (2021), which diagnosed Cambodia's NIS based on five key components: governance, education, research, collaboration and ecosystem. This lead us to the use of four key categories that can be measured as indicators of the readiness of a country's NIS, which are input, output, globalization, and infrastructure.

Figure 3-1. Diagnostic Framework



Source: Adapted from MISTI (2021), CAMBODIA'S SCIENCE, TECHNOLOGY & INNOVATION ROADMAP 2030, the project supported by UNESCAP

Then, we consider candidate indicators that can be measured and show the performance of each country while also having data that is widely available for many developing and developed countries so that we can implement a comparative analysis not only within the same income group but also among different income groups. The fourteen indicators[43] are categorised into four themes input, output, globalization, and infrastructure with three subcategories, academics, technology, and economics. The rationale and reasoning behind the selection of each indicator is provided below.

Table 3-1. Category and Indicators of Zambia diagnosis

Category	Subcategory	Indicators
INPUT	Economy	Gross fixed capital formation as % of GDP
	Technology	Expenditure on R&D, % of GDP
	Academics	Government expenditure on education, % of GDP
OUTPUT	Economy	Share of ICT imports in total imports
	Economy	ISO 9001 certificates per 10 million people
	Technology	Patents by resident per million people
	Academics	Progression to secondary school (%)
	Academics	Scientific and technical articles per million people
GLOBALIZATION	Economy	Share of firms exporting directly/indirectly (at least 10% of sales)
	Technology	Intellectual property payments per million GDP
	Academics	International co-authored scientific articles per 100,000 people
INFRASTRUCTURE	Economy	Installed capacity of electricity generation (kW) per million people
	Technology	Fixed broadband subscriptions per 100 people
	Technology	Patents by foreigners per million people

Source: Author's elaboration

(1) Input

'Gross fixed capital formation'

Gross fixed capital formation quantifies the infusion of investment such as land quality, procurements of plants, machinery, and equipment into a country's production activities, thus serving as an indicator that approximates the expansion of the nation's production capacity. These assessments are made with the country's economic scale, as gauged by its GDP.

Data source: Gross fixed capital formation from World Bank national accounts data, and OECD National Accounts data via World Bank Databank[44] and available for 159 countries between 1960 and 2021.

[43] There are diverse ways to construct this indicator system with other candidate indicators and therefore, there is flexibility in its modification according to the purpose of diagnosis as done from "the UNIDO-STEPI toolkit." For example, alternative indicator of "Share of ICT imports in total imports" can be "Share of medium/high-tech exports in total manufactured exports, measuring the level of industrial upgrading". Or, an alternative indicator of "Progression to secondary school" can be "Enrollment ratio in tertiary education". An alternative indicator of "Patents by resident per million people" can be "Number of trademarks per capita" likewise.

[44] https://data.worldbank.org/indicator/NE.GDI.FTOT.ZS

'Gross expenditure on R&D as a percentage of GDP'

To measure governance to create a governmental innovation environment, the indicator "Gross expenditure on R&D as a percentage of GDP" (%GERD for short) has been selected. This measure provides a more comprehensive reflection of the overall effort of institutional frameworks.

Data source: Gross expenditure on R&D as a share of GDP from the UNESCO UIS database via World Bank[45] and available for 78 developing countries between 2010-2020.

'Government expenditure on Education'

The government's ratio of investment in education to GDP is defined as an input, and the progression rate to secondary education is measured as an outcome. The availability of an adequate workforce is a vital prerequisite for the innovation of countries. As education plays a fundamental role in acquiring, comprehending, assimilating, and eventually generating new knowledge, we assume that investment in education contributes to national innovation.

Data source: Gross expenditure on education as a share of GDP is from the UNESCO UIS database via the World Bank[46] and is available between 2010-2022.

(2) Output

'Share of ICT import in total imports'

The 'Share of ICT import' indicator has been used as an indirect outcome measurement of R&D investment. This is grounded in the logic that increased investment in research and development leads to higher domestic production rates and reduced reliance on imported foreign technology or products. An increase in this ratio suggests that the country is transitioning toward digitalization as part of its industrial advancement.

Data source: The ratio of ICT imports in total imports is from UNCTAD's UNCTAD stat database via the World Bank[47] and is available for 170 countries between 2000 and 2020.

'ISO9001 certificates'

ISO 9001 certificates have been analysed in terms of research capacity to reflect not only productivity or production volume. It has been chosen because they also have the advantage of

[45] https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
[46] https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS
[47] https://data.worldbank.org/indicator/NV.MNF.TECH.ZS.UN

indicating the performance of research, which should be one of the policy goals for STI development in developing countries.

Data source: Number of valid ISO 9001 certificates is from the ISO Survey of Management System Standard Certifications 2020[48] *and is available for 195 countries.*

'Patents by resident'

Patents are a proxy for measuring the technological capability of a country. The number of patents filed by residents in Zambia shows the country's capability to innovate and create new knowledge and technology. This indicator is measured by the number of patents filed by residents.

Data source: The number of patents filed is from the World Intellectual Property Organization (WIPO) via the World Bank[49] *and available for 234 countries between 1960 and 2020.*

'Progression to secondary school'

Adequate allocation of human resources stands as a crucial prerequisite for the industrialization of a developing nation. This serves as an indicator for assessing the ability of the knowledge infrastructure to support innovative activities.

Data source: Enrolment ratio in tertiary education is from the UNESCO UIS database via the World Bank[50] *and is available for 118 countries between 2010 and 2022.*

'Scientific and technical articles'

The number of scientific and technical articles published by a country shows the country's capability in science as a proxy for measuring the capability of a country's basic science. This indicator is measured by the number of scientific and technical journal articles per 1,000,000 people in a country.

Data source: The number of scientific and technical articles per million people in the country is from the National Science Foundation, Science and Engineering Indicators via World Bank[51] *and available between 2010 and 2020.*

[48] https://www.iso.org/the-iso-survey.html
[49] https://data.worldbank.org/indicator/IP.PAT.NRES
[50] https://data.worldbank.org/indicator/SE.TER.ENRR?end=2020&start=2010
[51] https://data.worldbank.org/indicator/IP.JRN.ARTC.SC

(3) Globalization

'Share of firms exporting directly/indirectly'

The indicator 'Share of firms exporting directly/indirectly' measures the level of interaction between domestic and foreign companies at the production level. Such interactions between domestic firms and foreign counterparts through their exporting network, can occur in the form of the import of capital goods or components and informal knowledge transfer.

Data source: Share of firms exporting directly/indirectly is from the World Bank Enterprise Survey[52] and available for 231 countries between 2003 and 2019.

'Intellectual property payments'

Intellectual property payments are a nation's expenditures for accessing advanced foreign technologies. By acquiring foreign intellectual properties, developing countries can enhance their exposure to novel knowledge from overseas sources. This metric is an indirect measure for assessing the extent of technological engagement with foreign entities in the pursuit of external knowledge. The indicator is determined by intellectual property payments as a proportion of a country's GDP, with consideration for the economic scale of each respective nation.

Data source: Intellectual property payments data is from the International Monetary Fund, Balance of Payments Statistics Yearbook and data files via the World Bank[53] and available for 196 countries between 1960 and 2021.

'International co-authored scientific articles'

Maintaining a presence at the forefront of scientific advancement necessitates connectivity with the global scientific research sphere. This engagement is a representative measure for assessing the extent of interaction within the international scientific research community. This indicator is defined by the quantity of internationally co-authored scientific articles involving at least one domestic author per 100,000 people. This consideration accommodates the demographic size of the country.

Data source: International co-authored scientific articles per 100,000 people in country is from SciVal, Scopus and are available for 207 countries between 2011 and 2021[54].

[52] https://www.enterprisesurveys.org/en/data/exploretopics/trade
[53] https://data.worldbank.org/indicator/BM.GSR.ROYL.CD
[54] https://www.scival.com/

(4) Infrastructure

'Installed capacity of electricity generation (kW)'

The presence of accessible electrical energy stands as a vital component supporting industrialization and innovation within countries. It represents one of the indicators employed to measure the calibre of essential physical infrastructure, such as transportation, necessary for facilitating innovative endeavours. This indicator quantifies a nation's collective ability to furnish electricity. It is characterized by the per capita electricity generation capacity (in kilowatts).

Data source: Installed capacity of electricity generation (kW) per capita is from the UN Energy Statistics Database[55] *and is available for 225 countries between 1990 and 2020.*

'Fixed broadband subscriptions per 100 people'

In the present digital era, possessing access to fixed broadband serves as a crucial factor for both industrialization and innovative undertakings. It functions as an indicator reflecting the calibre of ICT infrastructure essential for fostering innovative activities. This metric is quantified by the count of fixed broadband subscriptions per 100 individuals within a country.

Data source: The number of fixed broadband subscriptions is from the International Telecommunication Union (ITU), World Telecommunication/ICT Indicators Database via World Bank[56] *and available for 206 countries between 1998 and 2021.*

'Patents by foreigners per million people'

When a country has a limited market size and the ability to adopt foreign technologies, there are few patent applications from non-residents. As the country's market grows and it becomes more capable of integrating foreign technologies, non-residents also become more interested in the market and seek technology transfer opportunities. This prompts the government to enforce stronger intellectual property rights (IPR) regulations. This process establishes a strong IPR framework, encouraging non-residents to apply for patents. This indicator reflects a country's institutional strength and regulatory effectiveness in IPR. It is measured by the number of patents filed by foreign nationalities per million people in Zambia.

Data source: Number of patents filed by foreign companies in country is from the World Intellectual Property Organization (WIPO) via the World Ban[57]*k and is available for 123 countries between 1980 and 2020.*

[55] http://data.un.org/Data.aspx?d=EDATA&f=cmID%3AEC
[56] https://data.worldbank.org/indicator/IT.NET.BBND.P2
[57] https://data.worldbank.org/indicator/IP.PAT.NRES

1.1.2. Diagnosis of Indicators Heatmap Dashboard and Country Gap Profile

Depending on the data availability, there are two types of diagnosis for each indicator. If the historical data for an indicator is available, both a column chart and a transition path are presented. A column chart shows the value of an indicator for Zambia and several African countries for comparison in addition to the average values of LI, LMI, UMI, and HI. A transition path is constructed based on the average values of LI, LMI, UMI, and HI with their improvement rate over the last 10 years (see 2. Diagnosis results). On the other hand, if the historical data for an indicator is not available, a scatter chart between the value of the indicator for countries and the GDP per capita of countries is presented instead of a transition path.

A heatmap dashboard is a table comprising all the results from the diagnosis that can provide a picture of intuitive comparisons with countries that are interested. It aims to provide three results:

i) *Traffic light (comparative signal), making intra-income group competitiveness stand out more*

ii) *Arrow sign, showing the rate (speed) of improvement during the recent period*

iii) *Grades, representing an absolute performance of each country compared to the average value of each income group*

Table 3-2. Heatmap dashboard explanation

Traffic light (comparative signal), making intra-income group competitiveness more standing out.	
Red light	a country is performing below 85% of the average value of its income group
Yellow light	a country is performing close (85~115%) to the average value of its income group
Green light	a country is performing above 115% of the average value of its income group
Sign showing the rate (speed) of improvement during the recent period	
Downward arrow (↓)	a country has improved below the average of its income group over a certain period
Upward arrow (↑)	a country has improved above the average of its income group over a certain period
Grades, representing an absolute performance of each country compared to the average value of each income group.	
Grade "D"	< the average performance of LI countries
Grade "C"	the average of LI countries ≤ and < the average performance of LMI countries
Grade "B"	the average of LMI countries ≤ and < the average performance of UMI countries
Grade "A"	the average of UMI countries ≤ and < the average performance of HI countries
Grade "S"	the average performance of HI countries ≤

* Note: LI: low income, LMI: lower middle income, UMI: upper middle income, HI: high income
Source: Author's elaboration

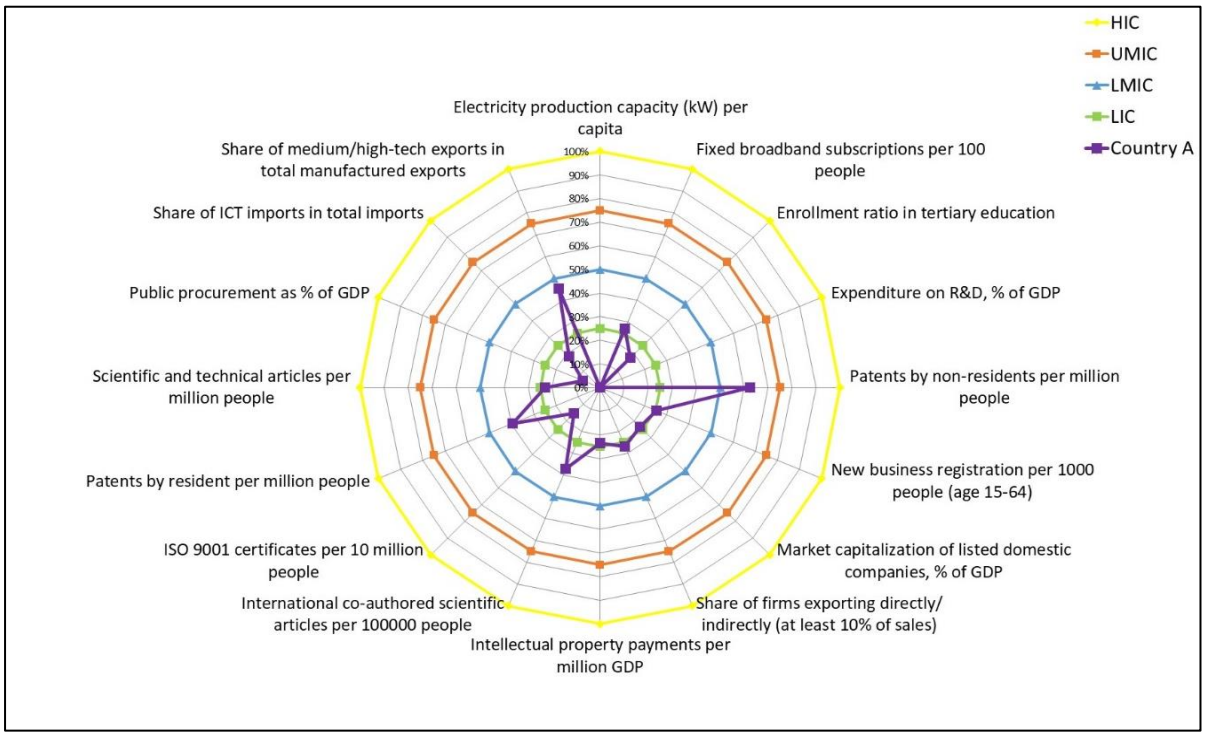
Figure 3-2. Heatmap dashboard (example)

									Africa				Asia				Latin America			North Africa & Middle East		East Europe	Central Asia
Tool title	Component	Category	SuB ↓ category	Indicator	HIC's average	UMIC's average	LMIC's average	LIC's average	Ethiopia	Kenya	South Africa	Uganda	Cambodia	Indonesia	PRC	Thailand	Costa Rica	Honduras	Peru	Jordan	Morocco	Romania	Uzbekistan
System failure framework	Reflexivity	Infrastructure	Physical	Electricity production capacity (kW) per million	2479.8 (-7%)	1187.0 (37%)	248.1 (26%)	46.6 (-23%)	D↑	C↓	B↓	D↑	C↑	C↑	A↑	B↓	B↓	B↑	B↓	B↓	C↑	B↓	B↓
			Digital	Fixed broadband subscriptions per 100 people	35.79 (37%)	26.13 (213%)	3.68 (273%)	0.47 (713%)	D↑	C↑	C↓	D-	C↑	B↑	A↑	B↑	B↓	B↓	B↓	B↓	B↓	A-	B↑
			Knowledge	Enrollment ratio in tertiary education	79 (9.9%)	58 (78.0%)	27 (45.0%)	9 (15.1%)	C↑	C↑	C↓	D↑	C↓	B↑	A↑	B↓	A-	C↑	A↑	B↓	B↑	B↓	C↑
		Institution	R&D investment	Expenditure on R&D, % of GDP	2.37 (25%)	1.23 (62%)	0.52 (3%)	n/a	C	C↑	B↓	C	C↑	C↑	A-	C↑	C↓	C↓	C↑	C↑	C↓	C↓	C↓
			IPR protection	Patents by non-residents per million people	560.88 (28%)	89.56 (29%)	18.77 (19%)	1.95 (30%)	D↑	D↑	A-	D↑	C↑	B↑	A↑	A↑	A-	B↓	B↑	B↓	B↑	C↑	C↓
			Business	New business registration per 1000 people (age 15-64)	4.60	6.30	0.44	n/a	n/a	1.55	12.50	n/a	0.54	n/a	8.58	1.29	3.61	n/a	3.80	0.43	2.24	6.23	2.71
			Finance	Market capitalization of listed domestic companies, % of GDP	1.34 (70%)	0.73 (80%)	0.69 (82%)	n/a	n/a	C↓	S↓	n/a	n/a	C↓	A↑	A↑	C↓	n/a	C↓	C↓	C↓	C	n/a
		Interaction (or Network)	Production	Share of firms exporting directly/ indirectly (at least 10% of sales)	24	15	13	11	D	A	D	B	B	D	A	D	C	C	A	S	S	A	D
			Technology	Intellectual property payments per million GDP	7000 (38.4%)	2850 (29.6%)	1540 (30.2%)	83 (-57.9%)	D↑	C↑	A-	D-	C↑	C↑	B↓	S↓	S↑	B↑	B↓	C↑	C↑	A↑	B↑
			Science	International co-authored scientific articles per 100000 people	113.9 (21.2%)	15.6 (134.4%)	5.8 (133.3%)	2.1 (53.0%)	C↑	B↓	A-	D-	C↑	C↑	B↑	C↓	A↑	D↑	B↑	A↑	B↑	A-	D-
		Capability	Production (capacity)	Gross fixed capital formation as % of GDP	22.29 (8.28%)	34.34 (11.4%)	25.31 (-7.9%)	25.27 (0.5%)															
			Production (quality)	ISO 9001 certificates per 10 million people	3402	1727	183	10	D	C	B	C	C	B	A	B	B	C	B	B	B	S	C
			Technology	Patents by resident per million people	715.22 (1%)	551.53 (308%)	12.73 (65%)	0.90 (-93%)	D-	C↑	C↓	D-	D-	C↑	S↑	C↓	C↓	D↑	C↑	C↓	C↓	B↓	C↓
			Science	Scientific and technical articles per million	1192.03 (8%)	323.43 (71%)	87.09 (129%)	8.16 (130%)	C↑	C↓	B↑	C↓	C↑	B↑	A-	B↑	B↑	D-	C↑	B↑	B↑	A-	C↓
	Demand articulation	Domestic market	Public sector	Public procurement as % of GDP	14.2	8.7	13.4	7.3	n/a			n/a	n/a							n/a	n/a		
			Private sector (domestic)	Share of ICT imports in total imports	14.1 (10.9%)	19.3 (19.0%)	13.3 (86.5%)	2.7 (-31.6%)	D-	C↓	C↓	C↓	D-	C↓	S↑	B↓	C↓	C↓	C↓	C↓	C↓	C↓	C↓
		Int'l market	Private sector (foreign)	Share of medium/high-tech exports in total manufactured exports	48 (-1.6%)	32 (6.8%)	25 (15.0%)	14 (-28.0%)	C↓	C↓	A-	C↑	D↑	B↓	S↓	S↓	S↓	C↓	D-	A-	S↑	S↑	B↓

Source: Author's elaboration

In comparison, a country gap profile can be constructed, focusing on a country that is the main target of the diagnosis. The radar chart has the average values of low income (LI), lower middle income (LMI), upper middle income (UMI), and high income (HI) country groups as values of 25%, 50%, 75%, and 100% respectively so that the performance of each indicator can be easily compared to one another.

Figure 3-3. Country gap profile (example)

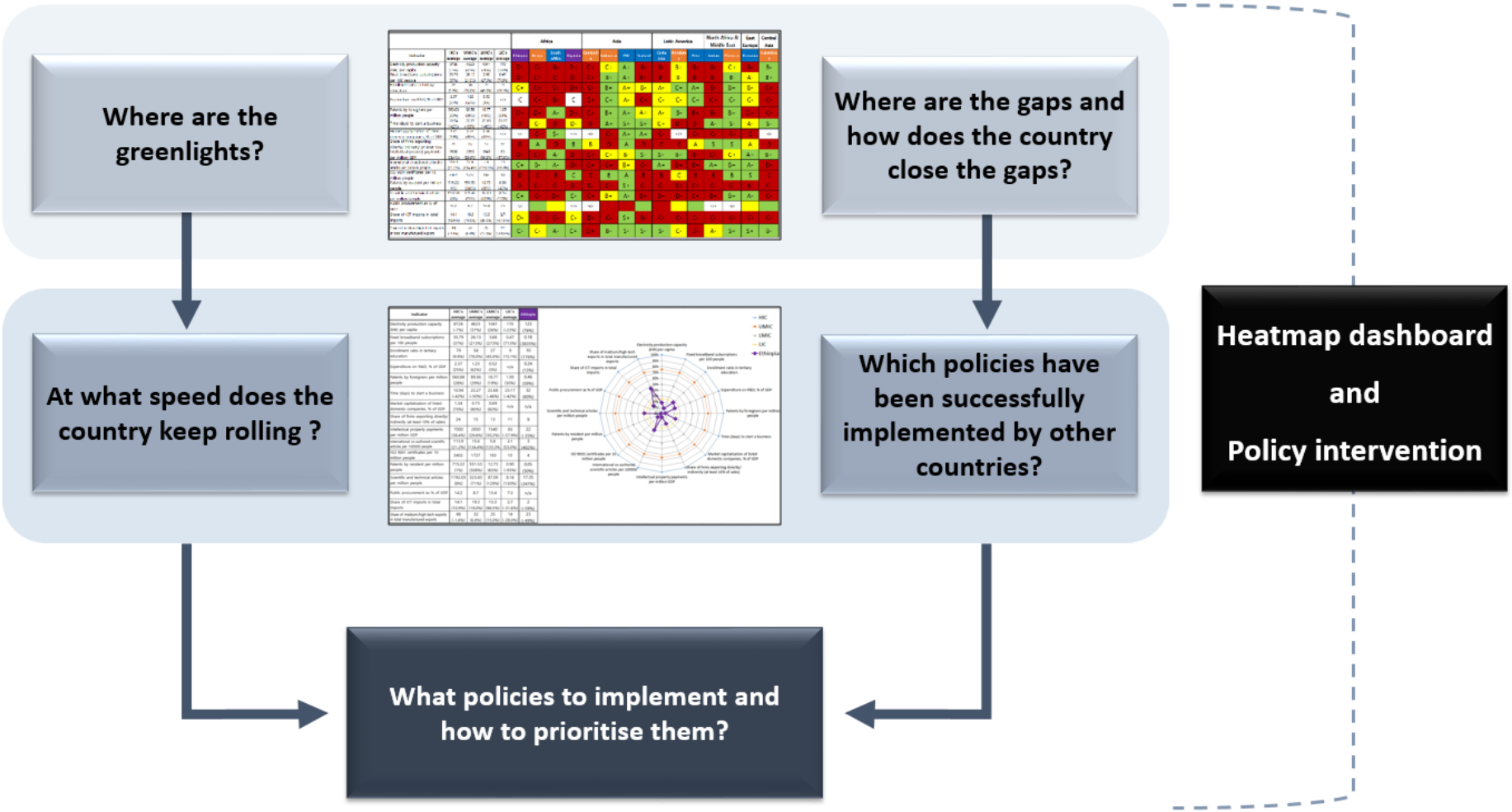


Source: Author's elaboration

1.2. Policy Intervention Procedure

Understanding the main elements of the toolkit, the diagnostic procedure begins by identifying a development or transition path, which is created based on the averages of the LI, LMI, UMI, and HI country groups. It is a trajectory that a country should consider as a benchmark. Then, an analysis country is compared to other countries in terms of each indicator so that we can measure how good the performance of the country is against its income group comparators and other countries. With the help of a heatmap dashboard and a country gap profile, we can identify where the greenlights are and where the gaps are in the analysed country. Then, we consider what pace the country should keep for the greenlights and also decide what policy areas the country should work on and how to prioritize within these areas.

Figure 3-4. Diagnostic procedure



Source: Author's elaboration

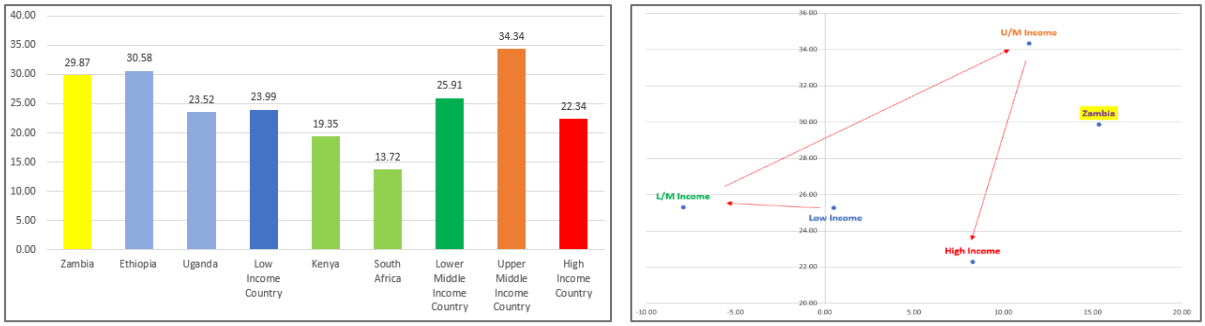
2. Diagnosis Results

This section provides the diagnosis results of Zambia in terms of all four categories of NIS, input, output, globalization, and infrastructure, covering all fourteen indicators listed in the indicator system. In comparison with Zambia, four sub-Saharan African countries, namely Ethiopia, Uganda, Kenya, and South Africa, are analysed as comparators in addition to the average values of four income groups, LI, LMI, UMI, and HI.

2.1. Input

(1) Gross fixed capital formation as % of GDP

Figure 3-5. Gross fixed capital formation as % of GDP and a transition path



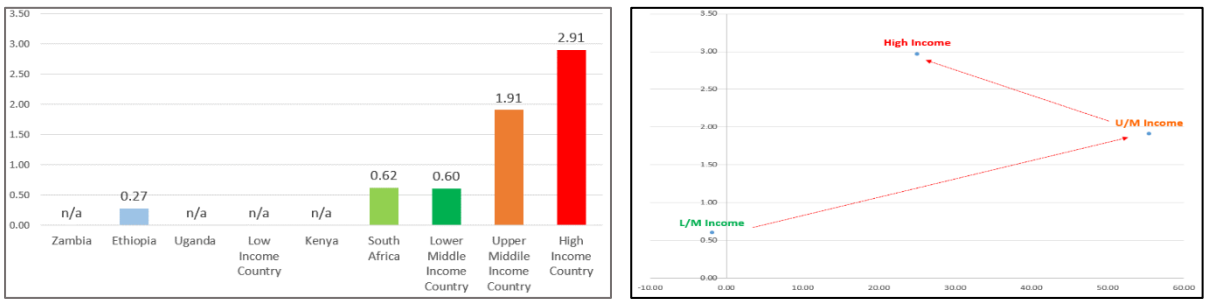
Source: Author's elaboration

- Zambia's gross fixed capital formation is relatively high compared to the average in the same income group and it is even higher than the LMI average. It can be argued that a positive environment has been formulated in the field of production capacity in Zambia.

As shown in Figure 3-5, the transition path shows a clockwise direction, starting to the left from LI to LMI, then, goes up and to the right to UMI, and drops downward from UMI to HI. There is a significant decrease between UMI and HI in terms of gross fixed capital formation.

(2) Gross expenditure on R&D as a share of GDP

Figure 3-6. Gross Expenditure on R&D (% of GDP) and a transition path

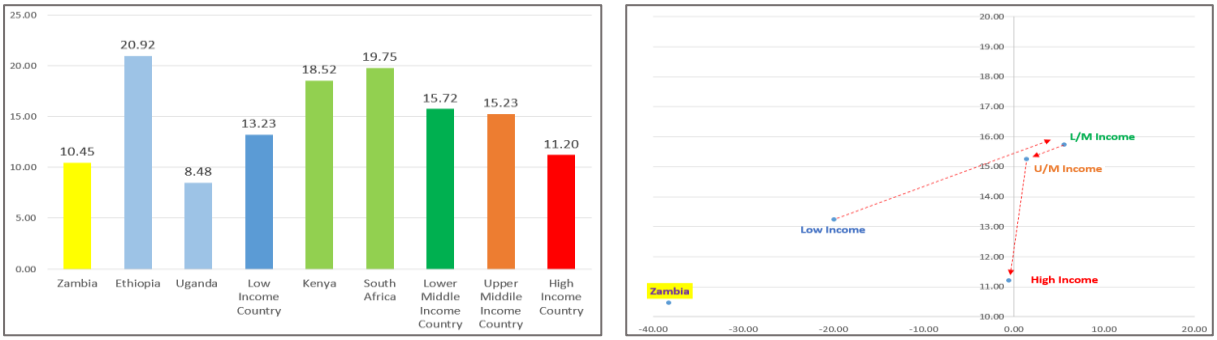


Source: Author's elaboration

- Analysis and diagnosis for Zambia are not feasible due to the absence of the data since 2008. It is a priority for the Zambian government to establish infrastructure to gather and produce exact data on the scale of investment itself.
- The transition path follows a counter-clockwise direction from LI, LMI, UMI to HI groups as shown in Figure 3-6.

(3) Government expenditure on education as a share of GDP

Figure 3-7. Government Expenditure on Education (% of GDP) and a transition path



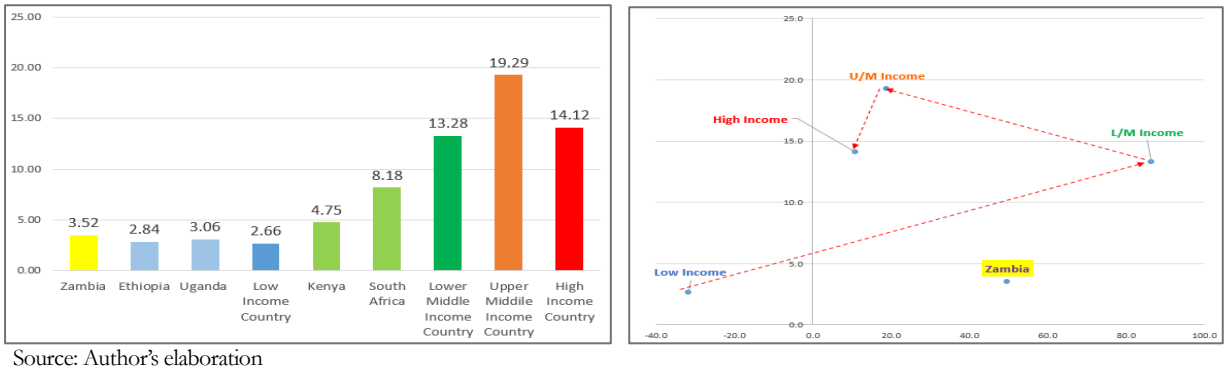
Source: Author's elaboration

- The Zambian government invests 10.45% (2022) of total GDP into education, which is very low even compared to the LI group average. In addition, the relative change of the indicator is also negative in Zambia.
- The average of this indicator moves upward from LI to LMI, then downward from LMI, UMI to HI, which sits at 11.2%.

2.2. Output

(1) Share of ICT goods imports in total imports

Figure 3-8. Share of ICT goods imports (% total goods imports) and a transition path

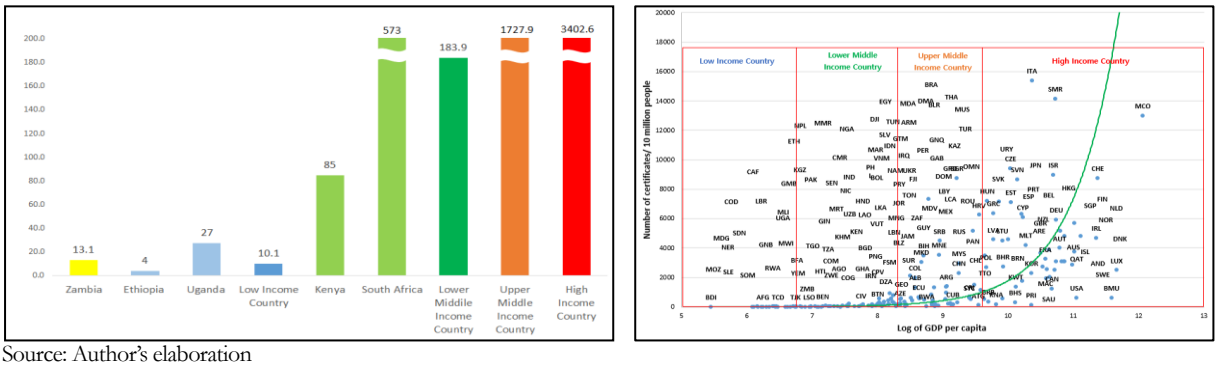


Source: Author's elaboration

- Figure 3-8 shows that the share of ICT imports in Zambia is 3.52, which is relatively high compared to its comparator countries, however, it remains at a lower level compared to the average of LMI countries.
- The transition path follows a counter-clockwise direction similar to that of gross expenditure on R&D.
- Zambia's growth rate is high, between LI and LMI, even though its share of ICT goods import is still at a low level.

(2) ISO 9001 certificates per 10 million people

Figure 3-9. ISO 9001 certificates per 10 million people and its relation with GDP per capita

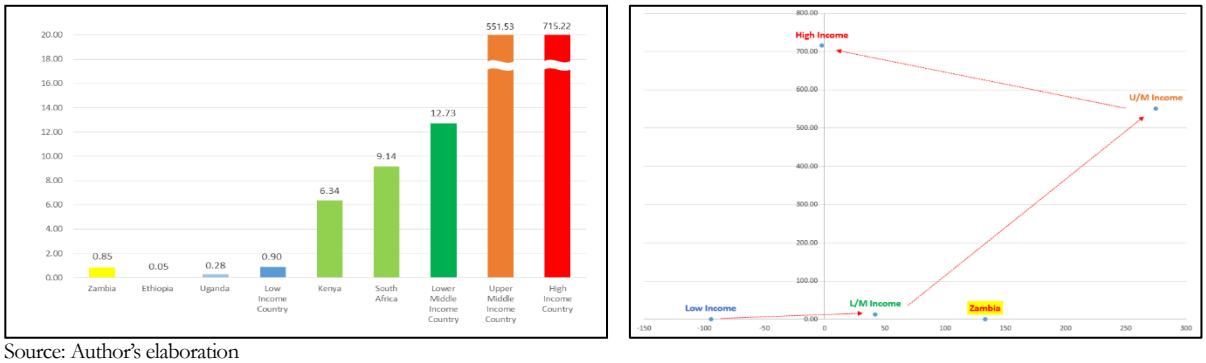


Source: Author's elaboration

- The average ISO 9001 value per 10 million people is 10.1 for the LI group, 183.9 for the LMI, 1727.9 for the UMI, and 3402.6 for the HIC. Zambia has 13.1, slightly higher than the average of LI but lower than the average of LMI.

(3) Patents by resident per million people

Figure 3-10. Patents by resident per million people and a transition path

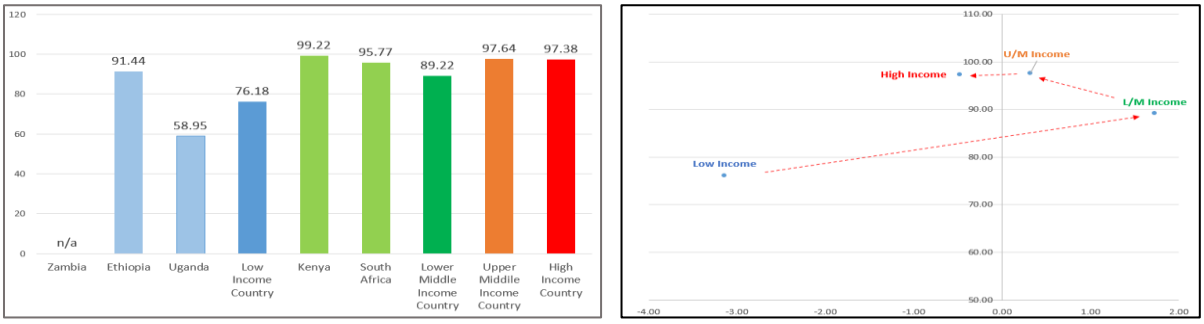


Source: Author's elaboration

- Both the value of the indicator and its relative change experience substantial increases as a country progresses from LMI to UMI.
- Zambia also has a very low value in this indicator.

(4) Progression to secondary school

Figure 3-11. Progression to secondary school (%) and a transition path

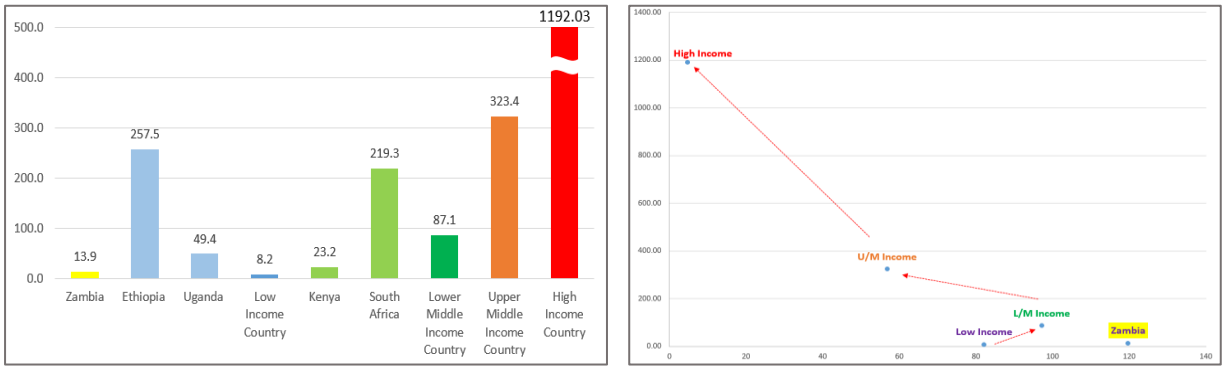


Source: Author's elaboration

- The analysis and diagnosis are not feasible due to the absence of data on progression to secondary school in Zambia (The latest data recorded 60.58% in 2010). It is a priority for the Zambian government to establish infrastructure to gather and produce exact data on this indicator.
- The transition path follows a counter-clockwise direction when plotting the indicator vs relative change as shown in Figure 3-11.
- The LMI group shows a rapid growth rate from the LI group in this indicator.

(5) Science and technical articles per million people

Figure 3-12. Scientific and technical articles per million people and a transition path



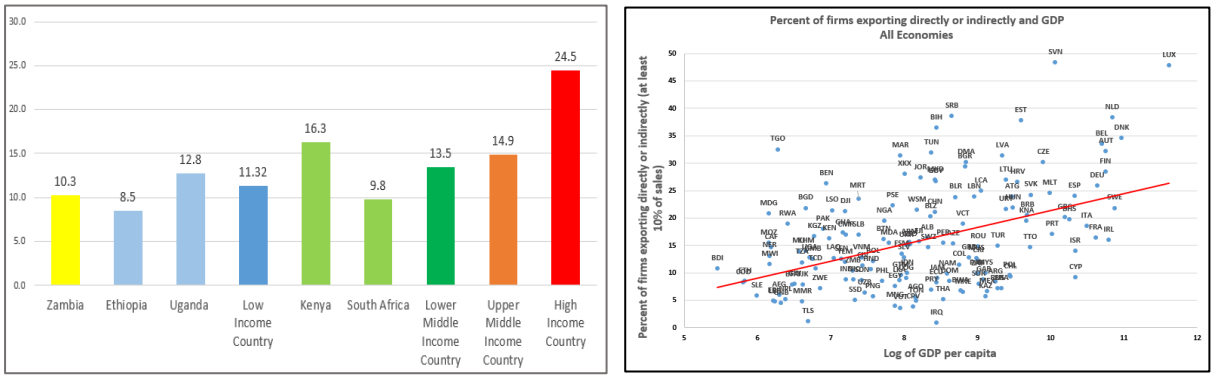
Source: Author's elaboration

- Although the value of the indicator, 13.9, is very low even in the LI group, the growth rate has been 119.7% over the last 10 years, far higher than the average of all income groups.
- Generally, the growth rate diminishes as the income level rises. Moreover, a substantial gap exists between the HI and UMI groups as advanced countries primarily lead the publication of science and technology articles.

2.3. Globalization

(1) Share of firms exporting directly/indirectly

Figure 3-13. Share of firms exporting directly/indirectly and its relation with GDP per capita

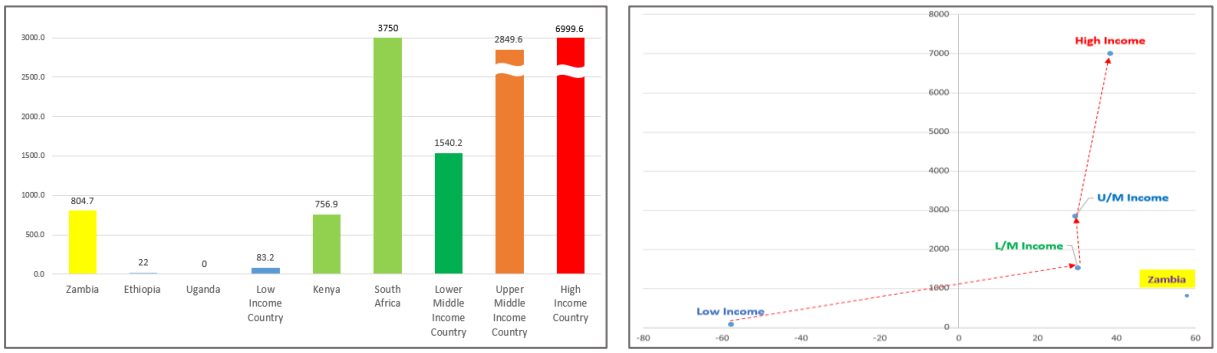


Source: Author's elaboration

- The average share of firms exporting directly/indirectly to Zambia is 10.3% while the average value of LI, LMI, UMI, and HI groups are 11.32%, 13.5%, 14.9%, and 24.5%.
- The gap between the UMI and HI groups is about 10%, and it can be seen that the gap increases as the income bracket rises.

(2) Intellectual property payments per million GDP

Figure 3-14. Intellectual property payments per million GDP and a transition path

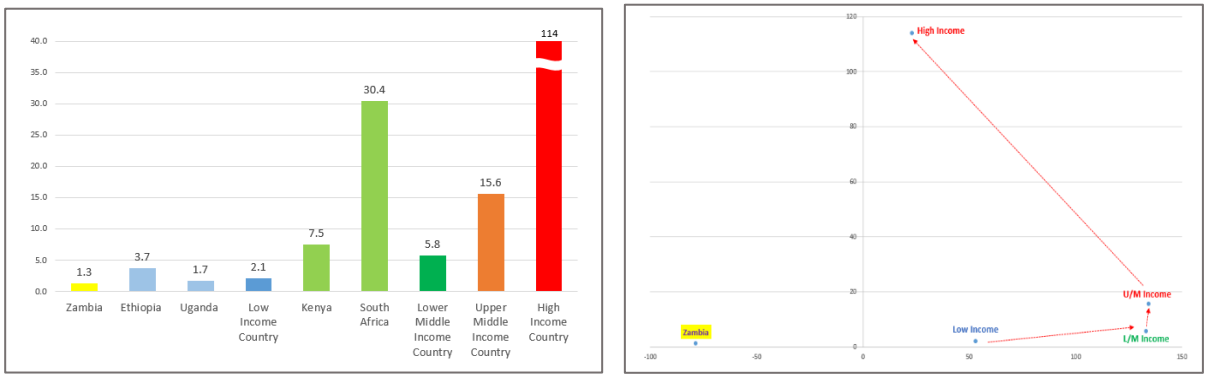


Source: Author's elaboration

- Zambia shows a ten times higher value in this indicator compared to the LI group but lower than the average of the LMI group.
- Zambia shows a significantly higher growth rate than all income groups over the last 10 years.

(3) International co-authored scientific articles per 100,000 people

Figure 3-15. International co-authored scientific articles per 100,000 people and a transition path



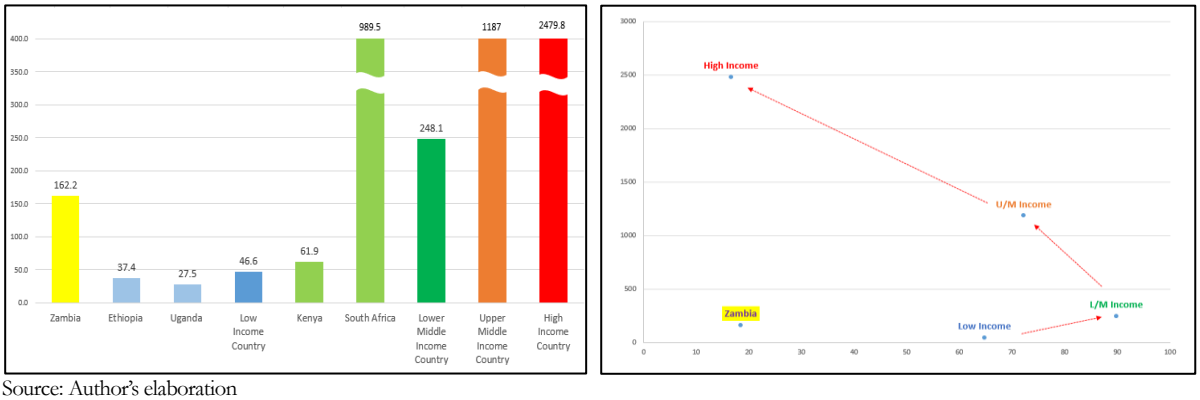
Source: Author's elaboration

- The number of international co-authored scientific articles per 100,000 people in Zambia was 1.3 as of 2021, lower than the average of 2.1 for the LI group. Compared to 6.26 in 2011, it has declined by -78.5% over the past 10 years.
- The transition path shows a counter-clockwise direction but significant growth is seen from UMI to HI groups.

2.4. Infrastructure

(1) Installed capacity of electricity generation (kW) per million people

Figure 3-16. Installed capacity of electricity generation (kW) per million people and a transition path

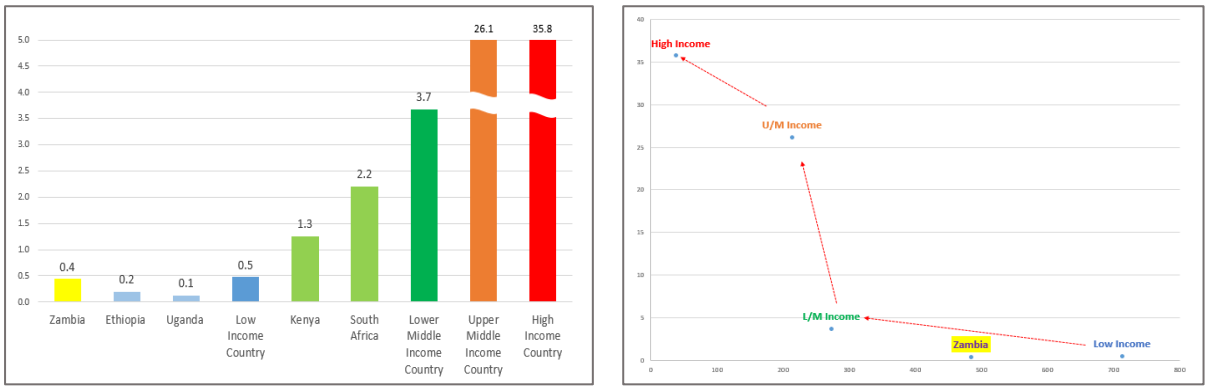


Source: Author's elaboration

- Zambia's current electricity production capacity (2019) is about 4 times higher than the average of the LI group but lower than the average of the LMI group. Its relative change shows that Zambia has not managed to increase its electricity readiness over the last 10 years.
- The transition path shows a counter-clockwise direction.

(2) Fixed broadband subscriptions per 100 people

Figure 3-17. Fixed broadband subscriptions per 100 people and a transition path

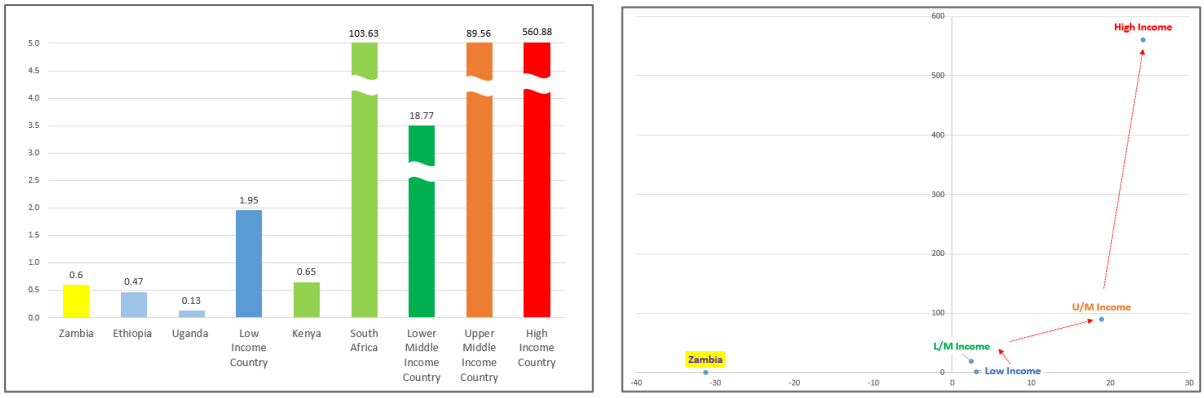


Source: Author's elaboration

- Zambia is on the way from LI to LMI in this indicator. The growth rate is relatively high, but there is still a lot to be achieved compared to those in countries in the higher income brackets.
- The transition path shows an inverse s-curve.

(3) Patents by foreigners per million people

Figure 3-18. Patents by foreigners per million people and a transition path



Source: Author's elaboration

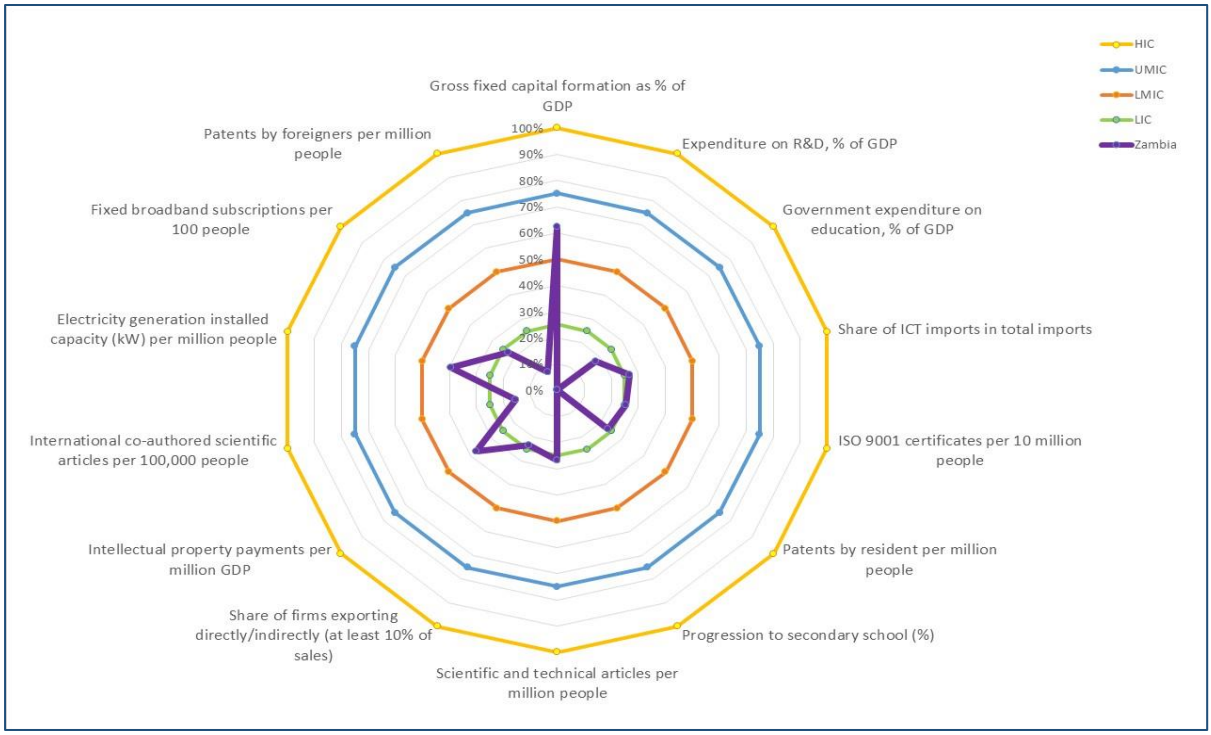
- Zambia has maintained its value lower than the average of the LI group. From 2010 to 2020, its growth rate shows a downward trend, recording -31.2%.
- The transition path shows an exponential curve, leaping from UMI to HI groups.

2.5. Radar Chart and Heatmap Dashboard

Radar Chart

Firstly, Figure 3-19 shows Zambia's recent performance divided into 14 indicators. The highest value among the fourteen indicators is 'Gross fixed capital formation'. There were also some indicators that showed outstanding growth compared to other countries, but just as important as the growth is the achievement.

Figure 3-19. Radar Chart



Source: Author's elaboration

Heatmap Dashboard

Table 3-3. Heatmap Dashboard provides comparisons with neighbouring countries and income groups. The results displayed by the indicators vary significantly based on the income group to which a country belongs. Given Zambia's challenges with economic instability in the past five years, the values in each indicator for recent years are particularly vulnerable.

It shows five indicators with C (bad if Zambia is LMI) and five indicators with D (bad even if Zambia is LI). Only one indicator with B, which is gross fixed capital formation as % of GDP. Intellectual Property Payments are also an indicator of good performance.

Table 3-3. Heatmap Dashboard

CATEGORY			INCOME GROUP				AFRICA					
Category	**Sub-category**	**Indicator**	**HIC's average**	**UMIC's average**	**LMIC's average**	**LIC's average**	**Zambia**	**Zambia**	**Ethiopia**	**Kenya**	**South Africa**	**Uganda**
Input	Economy	Gross fixed capital formation as % of GDP	22.29 (8.28%)	34.34 (11.4%)	25.31 (-7.9%)	25.27 (0.5%)	B ↑	B ↑	B ↓	D ↑	D ↓	D ↓
	Technology	Expenditure on R&D, % of GDP	2.53 (25%)	1.47 (55.4%)	0.57 (-1.9%)	n/a	n/a	n/a	C	C ↑	B ↓	C
	Academics	Government expenditure on education, % of GDP	12.02 (-6.73%)	14.98 (-1.48%)	15.21 (-5.31%)	14.62 (-19.86%)						
Output	Economy	Share of ICT imports in total imports	14.1 (10.9%)	19.3 (19.0%)	13.3 (86.5%)	2.7 (-31.6%)	C ↓	C ↑	D ↓	C ↓	C ↓	C ↓
	Economy	ISO 9001 certificates per 10 million people	3402	1727	183	10	C	C	D	C	B	C
	Technology	Patents by resident per million people	715.22 (1%)	551.53 (308%)	12.73 (65%)	0.90 (-93%)	D ↑	D ↑	D ↓	C ↑	C ↓	D ↓
	Academics	Progression to secondary school (%)	97.77 (-0.47%)	97.25 (0.46%)	88.23 (5.17%)	77.68 (-5.09%)	n/a	n/a	C ↓	S ↓	B ↑	D ↑
	Academics	Scientific and technical articles per million people	1192.03 (8%)	323.43 (71%)	87.09 (129%)	8.16 (130%)	C ↓	C ↓	C ↑	C ↓	B ↑	C ↓
Globalisation	Economy	Share of firms exporting directly/indirectly (at least 10% of sales)	24.0	15.0	13.0	11.0	D	D	D	A	D	B
	Technology	Intellectual property payments per million GDP	7000 (38.4%)	2850 (29.6%)	1540 (30.2%)	83 (-57.9%)	C ↑	C ↑	D ↑	C ↑	A ↓	D ↓
	Academics	International co-authored scientific articles per 100,000 people	113.9 (21.2%)	15.6 (134.4%)	5.8 (133.3 %)	2.1 (53.0%)	D ↓	D ↓	C ↑	B ↓	A ↓	D ↓
Infrastructure	Economy	Electricity generation installed capacity (kW) per million people	2479.8 (-7%)	1187.0 (37%)	248.1 (26%)	46.6 (-23%)	C ↓	C ↑	D ↑	C ↑	B ↓	D ↑
	Technology	Fixed broadband subscriptions per 100 people	35.79 (37%)	26.13 (213%)	3.68 (273%)	0.47 (713%)	D ↑	D ↓	D ↑	C ↑	C ↓	D ↓
	Technology	Patents by foreigners per million people	560.88 (28%)	89.56 (29%)	18.77 (19%)	1.95 (30%)	D ↓	D ↓	D ↑	D ↑	A ↓	D ↑

Source: Author's elaboration

3. Policy implications

Before proceeding to policy suggestions, it is worth reiterating that the results of the UNIDO-STEPI toolkit are provided as an example and should be used as an entry point for open discussion, not an endpoint. The toolkit should be utilized and reconstructed according to the specific context of each country and the purpose of the diagnosis. A development (or transition) path derived from the modified indicator system is a world benchmark based on previously accumulated global data. Therefore, as highlighted in the inception workshop with key stakeholders in Zambia, a new (sustainable and inclusive) industrialization path for Zambia should be carefully designed for the benefit of the Zambian people, in particular, reflecting digital and green transformations in the pursuit of climate resilience.

In addition, Zambia has faced an unstable economic condition. Following a rebound in the price of copper in 2021 and a sharp deterioration in exchange rates in 2022, Zambia is reclassified as a country in the low-income group by the World Bank Group, which ultimately leads to two contrasting outcomes, depending on the decision of whether Zambia belongs to the LI or the LMI group of countries. However, the issue here is not about whether Zambia's performance is good or bad, but about which policy areas the Zambian government finds the most challenging, which of the analysed indicators it prioritizes and which gaps it decides to fill through new policy initiatives.

In order to do so, we first propose that the government of Zambia create a governance mechanism to regularly collect relevant data with which it can measure the performance of Zambia in the policy area of each indicator under its own indicator system, which can be updated regularly through the course of its enhancing STI capabilities, by including or excluding indicators. In addition to the STI-related indicators proposed in the previous section, it is recommended that indicators be developed that will enable the government of Zambia to monitor and evaluate the status of its NIS in responding to climate change and thus manoeuvre towards sustainable development.

To this end, new candidate indicators that are highly relevant to a country's climate resilience are proposed at both country level and sector level, as shown in the table below. These additional indicators can construct a new category, considering the importance of showing a country's intention towards sustainable development. Adding climate resilience-related indicators should enable the government of Zambia to monitor whether its industrial development is sustainable or not. In the case of Zambia, the indicators listed at the country level are all available in publicly open data platforms. On the other hand, most of the indicators listed at the sectoral level are not publicly available. At this point, this is not a critical issue for Zambia as it does not currently have a strong manufacturing sector nor a fossil-fuel-based energy production system, which can result in high CO_2 emissions. However, there is no doubt that Zambia at some point needs to be equipped with the policy capacity to produce and provide the statistical data that can allow for monitoring and evaluating the level of sustainability in its course of industrial development.

Table 3-4. Indicators related to Climate Resilience

Level	Indicator
Country	• GDP per capita
	• Level of water stress (https://sdg6data.org/en/indicator/6.4.2) (%) a) Total freshwater withdrawal by all major sectors (m^3/year) b) Total renewable freshwater resources (m^3/year)
	• Share of sectoral value added in GDP (%) a) Share of industry value added in GDP (%) b) Share of agriculture, forestry, and fishing, value added in GDP (%) c) Share of service value added in GDP (%)
	• Energy mix a) Share of energy production from fossil-fuels b) Share of energy production from renewables
	• Country CO_2 emissions ($MtCO_2$)
	• Country CO_2 emissions per capita
	• Country CO_2 emission per unit of energy production (carbon intensity) ($kgCO_2$/KWh)
	• Primary energy consumption per unit of GDP (energy intensity) (kWh/GDP)
	• Growth of manufacturing value added vs. growth of industrial CO_2 emissions
Sector	• Industrial CO_2 emissions as a share of total CO_2 emissions
	• Share of coal CO_2 emissions by sub-sector in manufacturing (%) a) Coal CO_2 emissions from fuel combustion of manufacturing sub-sectors (Mt CO_2) b) CO_2 emissions from fuel combustion of manufacturing sub-sectors (Mt CO_2)
	• Manufacturing sub-sector CO_2 emissions as a share of total CO_2 emissions
	• Carbon intensity by manufacturing sub-sector ($kgCO_2$/toe) a) CO_2 emissions by manufacturing sub-sectors b) Total final energy consumption (TFC) of manufacturing sub-sector

Source: Author's elaboration

If the government of Zambia is interested in measuring the performance of green transformations in its economy, the indicators listed in the table below can also be used. They can be divided into two groups: input side and output side so that policymakers can evaluate the status in terms of an input-output perspective. Here, defining and setting the scope of green technologies, products, and services is an important practice. One option is that we utilize the classification of environmentally sound technologies based on International Patent Classification (IPC) codes provided by the WIPO Green[58] for green technology areas and the classification of climate-friendly products based on HS codes by UN ESCAP[59].

[58] https://www3.wipo.int/wipogreen/en/, accessed 8 Aug 2023
[59] https://www.unescap.org/sites/default/files/7-PART~1_0.PDF, accessed 8 Aug 2023

Table 3-5. Indicators to measure Green Transformation

Indicators to measure "Green Transformation": Input side
• Share of green innovation investment as % of GERD (gross expenditure on R&D) • Size of green innovation fund
Indicators to measure "Green Transformation": Output side

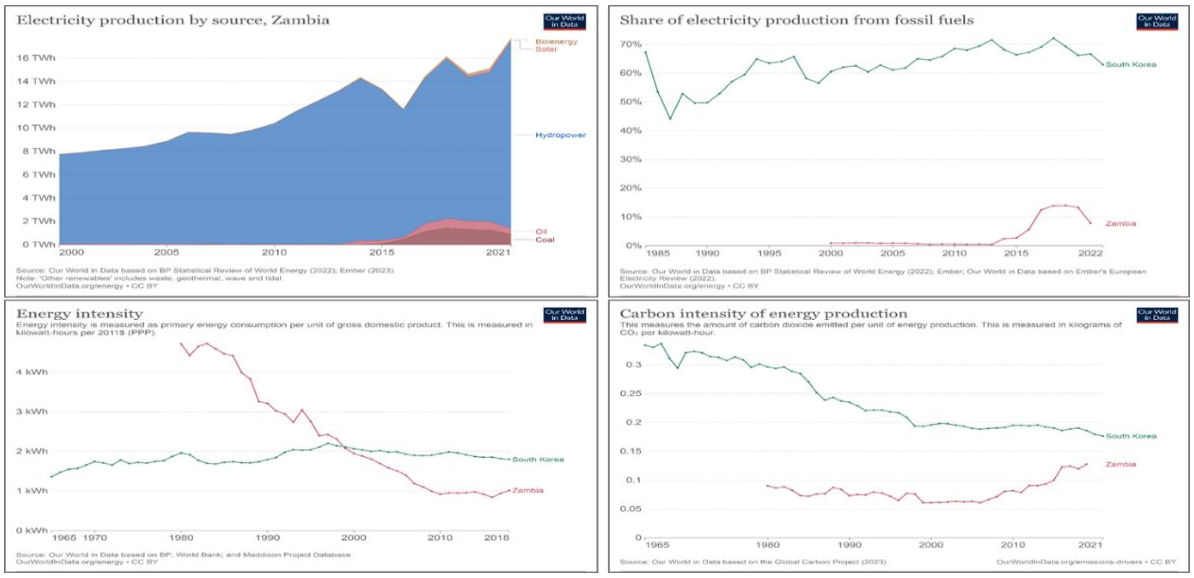
• Numbers of students/engineers in green technology areas
• Number of Journals & Patents in green technology areas
• New business registration (start-ups) in green industries
• Green transformation in Trade
  – Share of imports of green products in total imports
  – Share of exports of green products in total exports

Source: Author's elaboration

As shown in the Figure below, Zambia currently generates approximately 85% of its electricity from renewable sources, mainly hydropower. Yet, we observe the contribution of oil and coal at around 15% of electricity production. In terms of energy intensity, we have observed a dramatic decrease in Zambia since the mid-1980s. On the other hand, we have witnessed a gradual increase in the carbon intensity of energy production since the early 2010s.

In conclusion, we propose that the government of Zambia should establish a governance structure that can overall lead to evidence-based policy design, implementation, and evaluation, to collect and analyse appropriate data, monitor and evaluate the status quo, and reflect on and improve upon feedback.

Figure 3-20. Selected indicator performances of Zambia



Source: retrieved from Our World in Data, https://ourworldindata.org/energy/country/Zambia, accessed 11 July 2023.

To this end, an extension of the indicator system can be suggested. As shown in Table 3-6, there can be an additional category that can cover and measure the area and achievement of a country's sustainability, three indicators are provided as exemplary indicators. They aim to observe the sustainability of energy, technology (manufacturing), and institutional infrastructure. Thus, seventeen indicators are categorised into six themes governance, education, research, collaboration, ecosystem, and sustainability.

Table 3-6. Category and Indicators of Zambia diagnosis

Category	Subcategory	Indicators
INPUT	Economy	Gross fixed capital formation as % of GDP
	Technology	Expenditure on R&D, % of GDP
	Academics	Government expenditure on education, % of GDP
OUTPUT	Economy	Share of ICT imports in total imports
	Economy	ISO 9001 certificates per 10 million people
	Technology	Patents by resident per million people
	Academics	Progression to secondary school (%)
	Academics	Scientific and technical articles per million people
GLOBALIZATION	Economy	Share of firms exporting directly/indirectly (at least 10% of sales)
	Technology	Intellectual property payments per million GDP
	Academics	International co-authored scientific articles per 100,000 people
INFRASTRUCTURE	Economy	Installed capacity of electricity generation (kW) per million people
	Technology	Fixed broadband subscriptions per 100 people
	Technology	Patents by foreigners per million people
SUSTAINABILITY	[INPUT] **Technology**	Share of green innovation investment as % of GERD (gross expenditure on R&D)
	[OUTPUT] **Economy**	Growth of industrial CO_2 emissions over growth of manufacturing value added
	[OUTPUT] **Technology**	Carbon intensity as country CO_2 emission per unit of energy production ($kgCO_2$/KWh)
	[OUTPUT] **Academics**	Numbers of students/engineers in green technology areas

Source: Author's elaboration

Chapter 4.
SWOT Analysis

Based on the findings from the qualitative analysis in Chapter 2 and the quantitative analysis in Chapter 3, a SWOT analysis for the Zambian NIS was carried out by the STEPI research team. Through the discussion of NIS environments, which considered both internal factors (strengths and weaknesses) and external factors (opportunities and threats), a draft version of the SWOT analysis was produced and it was presented to key stakeholders of the Zambian NIS for an in-depth review during the inception workshop, which was held in Lusaka, Zambia, 19 and 20 July 2023. Reflecting on the comments and suggestions from the workshop, the final version of the SWOT analysis is presented in Table 4-1.

In terms of strengths, three factors are positive. At the national level, the Zambian government's intention to promote STI, in particular by the establishment of the Ministry of Technology and Science, is very encouraging. At the industrial level, the country's mining sector has promising potential for sustainable development if it takes advantage of low-carbon STI solutions. In particular, its energy mix is not dependent on fossil fuels, which means there are no concerns about stranded assets with path dependency. This means that Zambia can manoeuvre its own sustainable development path without resistance from vested interests, which is one of the main obstacles when promoting sustainable development in other countries.

However, we observed several important weaknesses in the Zambian NIS among others. Firstly, there is a lack of data availability and accordingly weak evidence-based policymaking. In particular, the working group confirmed our finding that there is a lack of STI visibility and influence in society, and therefore the tendency for a low preference for STEM in general. There is also a necessity for a huge improvement in terms of domestic access to clean energy, e.g. electricity and cooking.

In terms of opportunities that come from external environments, we find that international climate mechanisms and initiatives will facilitate technology transfer from developed to developing countries, and therefore, it is important that Zambia begins to prepare to accumulate sufficient capabilities to adopt and absorb advanced technologies from developed countries. In addition, increasing demand for natural resources produced in Zambia, e.g. batteries for electric vehicles, will contribute to the economic stability of Zambia in the coming years.

Lastly, accelerating climate change is currently disrupting the energy supply in Zambia. Severe climate disruption could push the Zambian people towards a more conventional, less sustainable development path. Severe competition from neighbouring countries, such as South Africa, can also hamper the country's efforts to achieve sustainable development in general.

Table 4-1. SWOT Analysis

Strengths
• Zambian government's commitments to the promotion of STI for its economic transformation (the establishment of MoTS) • Mining sector with high potential for value-added and low-carbonization through STI application • Reputable universities • Rising numbers of female students in higher education - 47% of students in tertiary education (undergraduate) are women • No path dependency on the fossil-fuel energy system, no stranded assets: renewable dominant energy mix with 85% hydro-power • Strong growth in fixed capital formation • Active adoption of foreign advanced technologies (comparatively high IPP) • Decreasing energy intensity
Weaknesses
• Lack of STI resources (funding, infrastructure, skilled STEM workforce, policy capability, etc.) • Limited effectiveness of policy coordination - weak inter-sectoral coordination and programme linkages (policy designer-implementer-regulator) • Lack of data availability and evidence-based policy making - weak investment in education and research - no official data available • Absence of strategies for resource mobilization (i.e., international collaboration) • Lack of confidence in local solutions • Weak linkage among education - R&D - industry • Lack of STI visibility and influence in society, low preference for STEM • Low domestic access to energy (electricity, clean cooking) • Large portion of bio-energy → Environmental impact and food security • Increasing carbon intensity of energy production
Opportunities
• Increasing interactions with neighbouring countries such as South Africa and Zimbabwe • International Support Funding: Prototype Carbon Fund (WB), Carbon Emission Reductions Programme (AfDB), Danish International Development Assistance Programme, Norwegian Development Fund, Energy and Environmental Partnership Programme (Finish Government)

etc. • Market expansion from regional integration and free trade agreements: Southern African Development Community (SADC), Southern African Universities Radiometric Network (SAURAN) • International climate mechanisms and initiatives to facilitate technology transfer to mitigate climate change (e.g. CTCN, Sustainable Development Mechanism (SDM), Joint Crediting Mechanism (JCM), Climate Club) • Increasing demand on natural resources produced in Zambia for EVs (e.g. Cobalt, Nickel) creating opportunities toward vertical integration from simple extraction to more value-added • Renewable energy technology being matured
Threats
• Continuous support from international development agencies and developing countries might occur 'Donor fatigue' • Severe competition with neighbouring countries such as South Africa • Accelerating climate change disrupts energy (hydropower) supply • Global (U.S.-China) technological rivalry and competition results in fragmentation, hampering international collaborations • Higher technical barriers to trade (TBT) under the New Climate Regime (e.g. RE100, CF100, EU Carbon Border Adjustment Mechanism CBAM)

Source: Author's elaboration

References

Disaster Management and Mitigation Unit (DMMU) (2015), *National Disaster Management Policy*, Lusaka.

Ministry of Agriculture and Co-operatives (2004), *National Agricultural Policy*, Lusaka: Government of the Republic of Zambia.

Ministry of Energy and Water Development (2019), *National Energy Policy*, Lusaka: Government of the Republic of Zambia.

Ministry of Finance and National Planning (2006), *Vision 2030: A Prosperous Middle-Income Nation by 2030*, Lusaka: Government of the Republic of Zambia.

Ministry of Health (2012), *National Health Policy*, Lusaka: Government of the Republic of Zambia.

Ministry of Industry, Science, Technology, and Innovation(2021), *CAMBODIA'S SCIENCE, TECHNOLOGY & INNOVATION ROADMAP 2030*, Cambodia, UNESCAP.

Ministry of Lands and Natural Resources (2020a), *Revised Nationally Determined Contribution (NDC)*, Lusaka: Government of the Republic of Zambia.

_____(2020b), *Third National Communication to the UNFCCC*, Lusaka: Government of the Republic of Zambia.

Ministry of National Development Planning (2016), *National Policy on Climate Change*, Lusaka: Government of the Republic of Zambia.

Ministry of Science, Technology, and Vocational Training (2003), *Biotechnology and Biosafety Policy*, Lusaka: Government of the Republic of Zambia.

Ministry of Tourism, Environment and Natural Resources (1999), *National Biodiversity Strategy and Action Plan*, Lusaka: Government of the Republic of Zambia.

_____(2002), *Zambia National Action Programme (NAP) for Combating Desertification and Mitigating Serious Effects of Drought*, Lusaka: Government of the Republic of Zambia.

_____(2006), *United Nations Convention on Biological Diversity: Third National Report*, Lusaka: Government of the Republic of Zambia.

_____(2007), *National Adaptation Programme of Action (NAPA) on Climate Change*, Lusaka: Government of the Republic of Zambia.

_____(2012), *Technology Needs Assessment for Climate Change Adaptation. Technology Action Plan Report (Water and Agriculture & Food Security Sectors)*, Lusaka: Government of the Republic of Zambia.

Kuhlmann, S., dan Arnold, E. (2001). *RCN in the Norwegian Research and Innovation System*. Background Report No. 12 in the Evaluation of the Research Council of Norway. Brighton: Technopolis.

Park. et al.(2022), *Analyzing the Landscape of Industrial Innovation in Developing Countries*, UNIDO. Available at: https://downloads.unido.org/ot/31/25/31251192/STEPI%20NSI_V3_FINAL.pdf

United Nations Conference on Trade and Development (UNCTAD) (2022), *Zambia Science, Technology, and Innovation Review*, Geneva: United Nations.

<Website>

African Business Angel Network, https://abanangels.org/

Agribusiness Incubation Trust - ImpactSpace, https://impactspace.com/

Amano Capital, https://www.amanocapital.com/

Asikana Network, https://asikananetwork.org/

Beam Exchange - Programme Index, https://beamexchange.org/

BongoHive, https://bongohive.co.zm/

Copperbelt University, https://www.cbu.ac.zm/

Citizens Economic Empowerment Commission Zambia, https://www.ceec.org.zm/

Commonwealth of Nations, https://www.commonwealthofnations.org/

DevelopmentAid, https://www.developmentaid.org/

Devex, https://www.devex.com/

Digilogic Africa, https://digilogic.africa/

EAfinder, https://www.eafinder.com/

Food and Agriculture Organization, https://www.fao.org/

Impact Hub Lusaka, https://lusaka.impacthub.net/

Inclusive Business, https://www.inclusivebusiness.net/

International Institute of Tropical Agriculture, https://www.iita.org/

International Organization for Standardization (ISO), https://www.iso.org

It's Wild, https://itswild.org/

Jacaranda Hub, https://jacarandahub.org/

Kukula Capital, https://kukulacapital.com/

Ministry of Agriculture of Zambia, https://www.agriculture.gov.zm/

Natural Resources Development College, https://www.nrdc.biz/

National Science and Technology Council Zambia, https://nstc.org.zm/

National Technology Business Centre, https://ntbc.co.zm/

Our World in Data, https://ourworldindata.org

SciVal, https://www.scival.com

Times of Zambia, https://www.times.co.zm/

UN Data, http://data.un.org/

UN Economic and Social Commission for Asia and the Pacific (UNESCAP), https://www.unescap.org

United Nations Capital Development Fund, https://www.uncdf.org/

University of Lusaka, https://www.unilus.ac.zm/

University of Zambia, https://www.unza.zm/

Women Entrepreneurs Access Centre Zambia, https://weaczambia.org/

World Bank Enterprise Survey, https://www.enterprisesurveys.org/

World Bank Open Data, https://data.worldbank.org/

World Intellectual Property Organization (WIPO), https://www3.wipo.int/

Chambers of Commerce Worldwide, https://www.chamber-commerce.net/

Zambia Centre for Accountancy Studies University, https://zcasu.edu.zm/

Zambia Development Agency, http://www.zda.org.zm/

Zambia Environmental Management Agency, https://www.zema.org.zm/

Zambia Information and Communications Technology Authority, https://www.zicta.zm/

Appendix

Appendix 1. Other Policies related to STI in Zambia

Besides the two major STI policies of 1996 and 2020, there are other research domain oriented policies that either have an element or elements of S&T as well as Innovation and these are highlighted below.

Biotechnology and Biosafety Policy 2003

At the time of writing, the Biotechnology and Biosafety Policy of 2003 was undergoing review (Personal Communication with the Registrar) and therefore, the Biotechnology and Biosafety Policy of 2003 was still in effect. The Policy generally guides the judicious use and regulation of modern Biotechnology for the sustainable development of the nation, with minimum risks to human and animal health as well as the environment including the country's biological diversity. The Policy objectives are to support the development of research and industrial capacity to safely apply biotechnology techniques for the enhancement of Zambia's socio-economic and environmental well-being.

The Precautionary Principle is one of the guiding principles of the Biotechnology and Biosafety Policy of 2003 in which approval for transfer, use and release of genetically modified organisms (GMOs) shall not be given where there is reason to believe that harm or damage may result. The release of GMOs is highly restricted and subjects products intended for direct use as food or feed to the same application procedures as notification for release into the environment.

The other guiding principles are: Advance Informed Agreement; recognition of undesirable effects of GMOs; Risk Assessment; Socio-economic Impact; Public Participation; Liability and Redress; recognition of possible conflict between conservation of biodiversity and trade; as well as recognition of rights of both developers and innovators over genetic resources and technologies.

National Nuclear Policy, 2020

Although Zambia has been applying nuclear science and technology in various sectors of the economy generally, issues of nuclear science are an emerging subject especially when it comes to the need to address energy security. However, in the last decade or so, various nuclear energy application institutions have been established and these include the National Cancer Diseases Hospital and the Nuclear Physics Laboratory at the University of Zambia. These were an addition to the Nuclear Analytical Laboratory at National Institute for Scientific and Industrial Research (NISIR) which was established in 1988. Furthermore, the growth in the mining sector has led to the exploitation and mining of radioactive minerals such as uranium.

Against this background, Government through the National Nuclear Policy of 2020 intends to have a diversified economy that is proficient in the application of nuclear science and technology for socio-economic development. The Policy will be the basis through which Government will enhance the utilization of nuclear science and technology. Further, the Policy represents the country's commitment to enhance the development of nuclear science and technology in research and development, health, agriculture, mining, industry and energy.

Revised National Intellectual Property Policy, 2020

The National Intellectual Property Policy of 2020 is a revision of the Intellectual Property (IP) Policy of 2010 and is guided and motivated by Vision 2030. The Vision 2030 is the national long-term planning instrument and reflects the collective understanding, aspirations and determination of the Zambian people to be a "prosperous middle-income country by 2030".

Among many others, the vision of the revised national IP Policy has provided that Zambia is a nation that will continuously and steadily make progress in establishing a scientific and progressive society that is innovative and forward looking and that is not only a technology consumer but also a contributor to the global and future scientific and technological advances of humanity.

Currently, the level of innovation and creativity as well as generation of IP Assets by universities, R&D institutions, Small and Medium Enterprises (SMEs) and industries is low in Zambia. The government will address this in the revised IP Policy through:

- Increased funding for R&D and Innovation
- Promotion of the use of IP information for Innovation and Creativity
- Promoting appropriate policies to encourage Innovation and Creativity
- Increasing the number of IP Applications by Zambians

The revised IP Policy recognized several national policies, which guided its formulation and these included those on Climate Change, Agriculture, biotechnology, Commerce, Trade and Industry, Education, Energy, Environment, Forestry, Health, Information, Communication and Technology (ICT), and Mining. The Policy aims at promoting technology transfer and commercialization of IP rights with a specific attention to licensing. To facilitate IP licensing, the Policy has provided general guidelines (Table 1).

Table 1. General Policy Guidelines of Revised IP Policy 2020

S/N	Guideline	Provisions
1	IP Audit and Valuation	It is important that all inventors, creators of works, universities and Research and Development institutions undertake an IP audit and valuation to determine the economic value of products, technologies and intellectual Property Rights (IPRs). This is critical to ensure successful commercial transitions, handling of litigations, assessment of damages
2	Confidentiality Agreements	In licensing of certain IP assets, the parties involved must sign confidentiality agreements to safe-guard all confidential and proprietary information shared during such partnerships.
3	Material Transfer Agreement (MTA)	All universities, R&D institutions, inventors, and creators of works, who wish to undertake Transfer of Materials must sign Material Transfer Agreement (MTA). An MTA is a written contract that defines, inter alia, the rights of the provider and the recipient with respect to IP (actual and potential), liability, confidentiality of provided information, publication of recipient research results, and other associated legal formalities that the provider and recipient may wish to cover in the transaction or are obliged to protect or undertake
4	Technology Licensing Agreement (TLA)	The Policy appreciates the importance of Technology Licensing Agreement in managing the relation between the owners of technology and the users. Technology Licensing Agreements defines the scope of licensing, which includes type of rights covered, region, duration, royalty payment, training, new IP etc.
5	Fees and Royalties	The Policy makes cognizance of the need for appropriate payment of fees and royalties to be paid under any IP licensing undertaking. In this regard, the contracting parties must agree on the level of fees and royalties to be paid taking into account various factors such as the amount of revenue the product is expected to generate once commercialized.

Source: Revised National IP Policy, 2020

Summary of other STI related policies

Table below summarizes the status of other policies that have an element of STI in one way or the other.

Table 2. Status of Implementation for other STI related policies

Name of policy	Year adopted	Status of implementation	Responsible Ministry
Biotechnology and Biosafety Policy	2003	Although it is being reviewed, it is the current policy on Biotechnology and Biosafety Policy in Zambia and is implemented through the National Biosafety Authority (NBA)	Ministry of Green Economy and Environment (MGEE)
National Nuclear Policy	2020	Existing policy which guides the application of nuclear science and technology in Zambia	Ministry of Technology (MoTS)
Revised National Intellectual Property Policy	2020	The policy guides the administration of intellectual properties (Ips) and is implemented through the Patents and Company Registration Authority (PACRA)	Ministry of Commerce, Trade and Industry

Source: Author's elaboration

Appendix 2. Other environmental and climate change related policies

National Forestry Policy, 2014

The National Forestry Policy aligns the forestry sector to current trends in forestry and to the necessity of meeting the national strategies as enshrined in the National Policy on Environment.

This National Forestry Policy is a review of the National Forestry Policy of 1998 which was based on the Zambia Forestry Action Plan (ZFAP) and stakeholder views. The major objective of ZFAP was to develop a national strategic framework for the forestry sector of Zambia. Under ZFAP, a number of thematic studies in the forestry sector were undertaken resulting in a number of successes but with a few gaps.

Even though the National Forestry Policy of 1998 provided initiatives for sustainable forest management, the current Policy has addressed new challenges and other emerging issues including strategies related to the contribution of the forestry sector to poverty reduction and Zambia's national economy based on projects that anchored in the national sustainable development criteria, and carbon forests and trade. Forests, woodlands and trees are some of the nation's most extensive natural heritage resources which require judicious management. They are renewable assets whose continued availability depends on our actions. In deriving benefits from these resources, it is incumbent upon us to ensure that biological diversity, soil and water conservation are not compromised.

Several of the 13 specific policy objectives are directly relevant to a National Policy on Environment, namely:

- to ensure the integrity, productivity and development potential of the forest reserves (especially through the involvement of stakeholders);
- to ensure adequate protection of forests, by empowering local communities and promoting the development and use of forest and non-wood forest products;
- to ensure sustainable management of forest ecosystems and biodiversity application through scientific and indigenous technical knowledge (through, inter alia, promoting the value of forests for catchment protection, biodiversity and ecosystem goods and services);
- to ensure sustainable management of forest resources for wood fuel production;
- to recognise and support the development of non-wood forest products;
- to regulate exploitation and ensure efficient use of forest resources and products, and
- to ensure gender equity in all aspects of forestry management, production and utilization of forest products, extension training and education.

The Policy is implemented by the Forestry Department under the Ministry of Green Economy and Environment.

National Disaster Management Policy, 2015

The National Disaster Management Policy of 2015 is a revision of the 2005 Policy. The revision arose due to various reasons. One such reason was the fact that at the time of developing the 2005 Policy, emphasis at the global, regional, sub-regional and national levels was more on disaster management and not disaster risk reduction. As such, the National Disaster Management Policy having been developed during the period prior to the paradigm shift was skewed towards disaster management, which is a re-active approach.

During the period the National Disaster Management Policy was being developed (1999 to 2004), issues of climate change were of course being discussed but not to the level of occupying a Centre stage at global, regional, sub-regional and national levels as the case is now. This being the case, the National Disaster Management Policy of 2005 was devoid of climate change-related issues.

The Policy Vision is to have a sustainable safety-net for the protection of the citizenry, its assets and the environment from disasters while its mission is to develop, coordinate and monitor disaster risk management programmes in order to minimize loss of life, damage to property and the environment.

The main objectives of this Policy is to promote sustainable development among vulnerable communities and improve their resilience, thus making them contribute more to the national development.

Under this Policy, the overall responsibility for national disaster management shall remain in the Office of the Vice-President while the implementation of disaster management activities and programmes in the country shall be done through the Disaster Management and Mitigation Unit (DMMU). DMMU shall exercise its responsibilities through the National Disaster Management Council, Disaster Management Technical Committee and appropriate broad-based committees at Provincial, District and Satellite levels.

Zambia's Climate Change Gender Action Plan (CCGAP), 2016

The Zambia's Climate Change Gender Action Plan (CCGAP) is an intersectional Plan aiming at advancing women empowerment and enabling gender equality while setting climate change response plans. The Plan focuses on the following priority areas:

- Sustainable agriculture and food security;

- Health;
- Forests, biodiversity and wildlife;
- Water security, Disaster risk reduction, preparedness and resilience;
- Infrastructure; Energy; and
- Tourism.

It also promotes policy reform and synergy; education and awareness-raising; academic research, sex-disaggregated data, and information dissemination—both for public awareness and to inform policy; and capacity building and training.

National Energy Policy, 2019

The National Energy Policy 2019 (NEP 2019) builds on previous policies of 1994 and 2008 and is anchored on the Seventh National Development Plan (7NDP) (now revised to (8NDP) and Vision 2030. While the essence of the previous policy objectives remains valid, the social, political, environmental and economic situation has undergone significant changes. This has prompted the review of the 2008 Energy Policy and the formulation of the NEP 2019 which incorporates current developments not only in the energy sector and the entire economy but also the regional and international environment. Zambia is aspiring to become a middle-income economy by 2030. This entails formulating and implementing robust enabling policy measures that meet the energy demand of the future.

The NEP 2019 therefore, is aimed at guiding the energy sector in the development of the electricity generation, transmission and distribution capacity. Further, it will enhance cost - effectiveness and efficiency in the supply of petroleum products. It will also facilitate the development and deployment of renewable and alternative energy. Furthermore, the Policy will promote security of energy supply through diversification of energy sources at cost reflective pricing which will promote new investment in the sector, consequently scaling up access to energy services in rural and urban areas.

The NEP 2019 also considers climate change mitigation and adaptation while advancing sustainable development of the sector. In addition, the Policy mainstreams gender and disability aspects aimed at increasing access to clean and efficient energy thereby reducing poverty among vulnerable groups especially women and children.

Environmental and climate change related strategy documents

National Adaptation Programme of Action (NAPA), 2007

Zambia has experienced a number of climatic hazards over several decades. The most serious have been drought, seasonal floods and flush floods, extreme temperatures and dry spells. Some of these, especially droughts and floods have increased in frequency, intensity and magnitude over the last decades and have adversely impacted on food and water security, water quality, energy and the sustainable livelihoods of rural communities.

Prior to 2004, climate change was merely treated as an environmental issue confined to the ministry responsible for environment not crosscutting all ministries. The National Adaptation Programme of Action (NAPA) developed from 2004 to 2007 brought to light the multi-sectorial nature of climate change effects and responses. The NAPA identified water, energy, agriculture, health and natural resources (forestry and wildlife) sectors as among the most vulnerable with rural areas being more vulnerable than urban areas. The major shortcoming which led to this NAPA not being implemented was the fact that it only focused on short-term adaptation actions for immediate implementation and not long-term actions.

Technology Needs Assessment (TNA), 2013

The role of technology in combatting climate change through mitigation and adaptation to its inevitable impacts has been acknowledged and highlighted by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). In the developing world, this has received particular attention through the technology needs assessment (TNA) process.

Zambia completed its TNA in 2013. The TNA highlighted several technologies. The Technology Action Plan proposes to establish a Pilot Project on Climate Change and Water Access. This project aims to install fifteen small dams, two hundred boreholes and tube wells and 10,000 wells. These measures are intended to safeguard Zambians who are affected by drought, seasonal floods and a lack of access to clean water, and they will provide a better access to water for both consumption and agriculture. Energy generation in Zambia relies almost entirely on hydro-power (nearly 90% of total capacity). Facing serious electricity supply deficits from recent droughts, the TNA has led to a framework proposal being issued by the Zambian government. This will promote small-scale, renewable and decentralized energy projects to fast-track the country's electrification efforts with a diversified mix. Apart from working as an adaptation measure, together the development of small-scale renewables and rural electrification have the potential to reduce the population's dependence on charcoal and firewood, thereby reducing emissions from land use, one of the major sources of carbon emissions in Zambia.

Based on the outcomes of the TNA, a large-scale project has been launched to support the Government of Zambia's renewable energy feed-in tariff (REFIT) policy. With funding from the Green Climate Find, it will provide technical assistance, support local financial institutions and build the capacity for rural electrification. The project has a lifespan of 23 years, and it is anticipated that emissions of 4,000,000 tCO2e will be avoided.

Tables 3 and 4 show priority identified priority technologies for adaptation and mitigation, respectively.

Table 3. Priority technologies for adaptation

S/N	Sector	Technologies
1	Agriculture and Food Security	○ Conservation farming ○ Mixed farming ○ Crop diversification and new varieties
2	Water	○ Rainwater collection from ground surfaces, small reservoirs and micro-catchments ○ Boreholes and tube wells to supply domestic water during droughts ○ Improving the resilience of protected wells to flooding

Source: Author's elaboration

Table 4. Priority technologies for mitigation

S/N	Sector	Technologies
1	Energy	○ Electricity generation-biomass combustion, geothermal, wind energy, bio methanation and photovoltaic utility ○ Biofuels: biodiesel from jatropha, and bioethanol from sugar cane, sweet sorghum and maize ○ Energy efficiency: energy management systems, industrial and commercial end-use efficiency, and household end-use efficiency ○ Improved cooking devices: improved charcoal stoves, improved firewood stoves and biogas for cooking ○ Improved charcoal production-brick kilns, traditional improved kilns and metal kilns ○ Off-grid systems: mini-hydro, biomass gasifiers, biogas digesters
2	Agriculture, land-use change and forestry	○ Conservation agriculture

Source: Author's elaboration

Technology Action Plans (TAPs), 2013

The Technology Action Plan (TAP) is one of the four (4) main deliverables from the Technology Needs Assessment for Zambia. The other three (3) are; TNA Report, Barrier Analysis and Enabling Framework Report, and Project Ideas.

The Technology Action Plans (TAPs) Report details the steps needed in each relevant sector and for each technology to diffuse the selected technologies. The TAPs report provides a short comprehensive description of the action plans for adaptation technologies identified under the Water and, Agriculture and Food Security sectors. It presents the action plans which are the results of the process, which has led to a selection of several options for groups of measures described in the barrier analyses and enabling framework report. The TAP report is purely based on the content from the Barrier Analysis report. TAPs also deal with crosscutting issues.

Nationally Appropriate Mitigation Action (NAMA), 2016

As a part of the agreed outcome to the Bali Action which were concluded at the 18th Conference of the Parties (COP18) in Doha, developing country Parties were to take Nationally Appropriate Mitigation Actions (NAMAs) in the context of sustainable development.

The NAMAs refer to any action that reduces emissions in developing countries and is prepared under the umbrella of a national governmental initiative. They can be policies directed at transformational change within an economic sector, or actions across sectors for a broader national focus. NAMAs are supported and enabled by technology, financing, and capacity-building and are aimed at achieving a reduction in emissions relative to 'business as usual' emissions in 2020.

Zambia prepared her NAMAs on small hydro, sustainable agriculture, and sustainable transport, integrated waste management, and sustainable charcoal production. The NAMAs were submitted to the UNFCCC NAMA registry in 2016

National Strategy for Reducing Emissions from Deforestation and Forest Degradation (REDD+, 2015-2030)

This document lays down the Zambia National Strategy to Reduce Emissions from Deforestation and Forest Degradation (REDD+). Zambia developed this strategic document under the REDD+ mechanism. Its vision is to realize a prosperous climate change resilient economy by 2030, anchored upon sustainable management and utilization of Zambia's natural resources towards improved livelihoods.

Its goal is to contribute to national reductions in greenhouse gas emissions by improving forest and

land management, and to ensure equitable sharing of both carbon and non-carbon benefits among stakeholders. The strategy is guided by seven core principles: effectiveness, efficiency, fairness, transparency, accountability, inclusiveness and sustainability.

Implementation of the national REDD+ strategy will focus on tackling different drivers of deforestation in both the forestry and other identified key sectors, in particular: agriculture, energy, mining and land use. The strategy will be implemented through a landscape approach at watershed level and through policy reforms at national level. It will take into account all land uses in a holistic way (including water and wildlife) and will work to lessen the competition for natural resources among different sectors.

This overseen under the Forestry Department under the Ministry of Green Economy and Environment (MGEE).

Zambia's Second National Biodiversity Strategy and Action Plan (NBSAP - 2), 2015-2025

Zambia's Second National Biodiversity Strategy and Action Plan (NBSAP -2) is a national cross-sectoral strategic document for the period 2015-2025. Its main goal is to achieve that, by 2025, biodiversity is valued, conserved, restored and wisely used, as well as maintaining ecosystem services, sustaining a healthy environment and delivering benefits essential for all Zambians and the Zambian economy. Specifically, the document is to address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society; to reduce the direct pressures on biodiversity and promote sustainable use; improving the status of biodiversity by safeguarding ecosystems, species and genetic diversity; and to enhance the benefits to all from biodiversity and ecosystem services.

In the area of climate change, the NBSAP-2 provides for mainstreaming climate change adaptation measures that will enhance resilience of priority ecosystems, as well as to regularize forest management plans to ensure connectivity, habitat resilience and ultimate refuges for wildlife in the face of climate change.

The ministry responsible for environment and natural resources, as focal point on the Convention on Biological Diversity and also responsible for environmental policy, is responsible for the overall coordination of NBSAP implementation in close collaboration with the National Steering Committee which was formed at the beginning of NBSAP1, the Zambia Environmental Management Agency (ZEMA), the ministry responsible for Wildlife and National Parks, the ministries responsible for fisheries and other key stakeholder organizations active in the environment sector in general and biodiversity conservation in particular, were all to play various roles.

Nationally Determined Contribution (NDC), 2020

Zambia's first NDC was submitted on 9th December, 2016, and consisted of both mitigation and adaptation components based on the country's national circumstances. This NDC was submitted with a conditional pledge of reducing Greenhouse Gas (GHG) emissions by 25% (20,000 Gg CO2 eq.) by 2030 against a base year of 2010 under the Business As Usual (BAU) scenario with limited international support or by 47% (38,000 Gg CO2 eq.) with substantial international support. The mitigation actions were focused on three programmes:

(1) Sustainable forest management;

(2) Sustainable agriculture, and;

(3) Renewable energy and energy efficiency.

Adaptation actions in this NDC were focused on strategic productive systems (agriculture, wildlife and water), strategic infrastructure and health systems and enhanced capacity building, research, technology transfer and finance for adaptation. The country required substantial resources to meet the means of implementation of these interventions.

In the revised NDC, Zambia enhanced its NDC by broadening the scope of sectors under mitigation by adding transport, liquid waste and coal (production, transportation and consumption) and by elaborating the adaptation component of the NDC by developing indicators that will enable the country track progress on building resilience in both the human and physical systems and on adaptation actions. By broadening the sectors, the country's NDC is slowly moving towards becoming an economy-wide NDC.

The NDC is overseen under the Ministry of Green Economy and Environment who house the focal point under United Nations Framework on Climate Change (UNFCCC).

Third National Communication, 2020

The Third National Communication (TNC) for Zambia builds on climate change activities reported in the Second National Communication (SNC) and provides information on the socio- economics of the country, gives an insight into the country's emission and mitigation status, and vulnerability to impacts of climate change, including other information relevant to meeting the objectives of the Convention.

The TNC presents the country's efforts in addressing climate change issues and the future capacity requirements in order to meet national and global climate change obligations as enshrined in the Convention and the Paris Agreement.

The mitigation assessment conducted for the TNC revealed that Zambia's total GHG emissions are

projected to grow by 42 percent from 120,785.2 Gg CO2 eq. in 2010 to 171,532.1Gg CO2 eq. in 2050. The total removals or sinks are projected to decrease by 25 percent from -137,322.9Gg CO2 eq. in 2010 to -103,684.3 Gg CO2 eq. in 2050. The net emissions however will increase from -16,538.2Gg CO2 eq to 67,843.0 Gg CO2 eq. in 2050.

Analysis of projected emissions showed that Zambia will transition from net sink to net source in 2018 under the business-as-usual scenario. This is attributed to increasing emissions from opening up new land for settlements and agriculture, wood removals for firewood, charcoal and commercial timber, fertilizers on agriculture land and increased usage of fossil fuels. Further, the emissions will be driven by population and economic growth, urbanization and changes in production and consumption patterns among others. If all the mitigation policy recommendations in the Seventh National Development Plan (7NDP) and other national strategies are implemented, total emissions mitigation potential are projected to decrease from 120,784.8 Gg CO2 eq. in 2010 to 42,468.6 Gg CO2 eq. in 2050.

Furthermore, the net sink will be retained during the same period. Mitigation options include promotion of renewable energy and energy efficiency; sustainable Forest Management, Conservation and CSA. A total of 4,328.1Gg CO2 eq is projected to be reduced in 2019, representing 11 percent progress against the 2030 Nationally Determined Contribution (NDC) target. The achievement is largely attributed to greater ambitions and projects that are under implementation in the renewable energy and energy efficiency sub-sector and mitigation actions in other sectors such as agriculture and forestry.

Tracking emission reductions under this scenario will enable Zambia to attain emissions reduction of 137,409.7 Gg CO2 eq. and achieve the NDC target by 2030.

The National Communication is undertaken under the auspices of the Ministry of Green Economy and Environment.

National Adaptation Plan (NAP) formulation process (2014-2023)

The country's climate has been marked by an increased mean annual temperature over decades, increased frequency and severity of droughts and floods, and reduction in mean annual rainfall of about 2.3% per decade since 1960. Rising average temperatures and changing rainfall patterns are projected to cost the country about 0.4% of annual economic growth.

The current NAP process builds on previous adaptation planning that, since 2004, has assisted the government in prioritising responses such as promoting better land management, diversifying crops and livestock to improve food security, and climate-proofing sanitation in urban areas.

The main goals of the 2021 – 2023 NAP development process will be to:

1. Strengthen institutional coordination and collaboration for adaptation planning in Zambia. The National Policy on Climate Change provides for comprehensive national-level coordinating arrangements for climate change. However, there are gaps in terms of cross-sectoral linkages and processes related to national adaptation planning. In addition, there is lack of clarity about how adaptation will be coordinated at subnational levels, such as provinces, districts, and wards;
2. Establish a system of integrating climate change adaptation in plans and budgets. Currently, climate change adaptation is not mainstreamed into national and subnational development plans and budgeting in Zambia. A key reason for this is the lack of guidelines and a clear process for including climate change adaptation in national and sub-national planning and budgeting;
3. Develop an overarching national plan that prioritises medium-to-long-term high-level adaptation actions for key economic sectors affected by climate change. The previous adaptation planning process for Zambia, the National Adaptation Programme of Action (NAPA), only focused on short-term adaptation actions for immediate implementation;
4. Strengthen the capacity for implementing the NAP. Support is needed to carry out technical assessments, analysis, and project appraisals, including preparation of projects to access climate finance from international climate funders; and
5. Develop a strategy for mobilizing financial and other resources for NAP implementation in Zambia. It is estimated that the country requires about US$ 50 billion to meet the 2030 climate change commitments made in the Paris Agreement of 2015. However, accessing this money is largely dependent on financial, technical, and capacity building support from the international community.

Carbon Market and Trading Interim Guidelines on Carbon Market and Trading, 2022

The government, through the Ministry of Green Economy and Environment (MGEE), has developed Interim Guidelines on Carbon Market and Trading, which will enable the country to manage the approval, implementation, and regulation of carbon projects.

The interim guidelines on carbon markets and trading outlines some administrative measures and procedures to guide government and stakeholders in the regulation and management of the carbon market in Zambia during the interim period ahead of a more detailed Climate Change Act expected to be enacted in 2023.

Credibility of carbon offsets is critical for the integrity of any carbon market, and ultimately the quality and value of the carbon offsets produced. The Guidelines seek to ensure that the trade and regulation of carbon markets in Zambia does not only meet international best practice but also benefits local communities that own the natural resources.

Unlike the Forests Carbon Stock Management Regulations S.I No. 66 of 2021 (the "Forest Carbon Regulations"), the Guidelines cover a broader range of eligible carbon projects that are specific to the regulation of forest carbon projects. The Guidelines list the following categories of eligible projects:

- promotion of renewable energy sources;
- switching from high carbon fuel to lower carbon intensive fuels; energy efficiency on the supply side;
- energy efficiency on the demand side;
- agricultural sector projects (other than land-use change);
- transport sector projects (electric mobility in road or rail networks);
- reducing methane emissions from landfills and other waste-handling activities;
- waste management and wastewater treatment; and
- reforestation, sustainable forest management, avoided deforestation, restoration and forest regeneration.

The Guidelines state that technology proposed for deployment for eligible projects must be proven, established, and commercially feasible technology, although not necessarily in Zambia. It should also be replicable and/or effectively transferrable to Zambia.

The Guidelines are implemented through the National Designated Authority (DNA) comprising various stakeholders and the secretariat is under the Ministry of Green Economy and Environment (MGEE).