Scoping Report

Nigeria's Transition to Green Economy: Linking Circular Economy and Natural Capital for Public Private Partnership (PPP) Investments

African Green Growth & Development Forum (AGDF) & Partners

November 2022

Rijksdienst voor Ondernemend Nederland

FEDERAL MINISTRY OF ENVIRONMENT

Table of Contents

List of Tables and Figures

List of Tables

List of Figures

Abbreviations and Acronyms

AfDB	African Development Bank
AFOLU	Agriculture, Forestry, and other Land Uses
AGDF	Africa Green Growth and Development Forum
ASLR	Accelerated Sea Level Rise
ATA	Agriculture Transformation Agenda
CBOs	Community Based Organisations
CC	Climate Change
CE	Circular Economy
CEBP	Circular Economy Business Plan
CEBs	Circular Economy Business Strategy
CEFs	Circular Economy Finance
CELP	Circular Economy Legislative Plan
CEPs	Circular Economy Projects
CETs	Circular Economy Technologies
CSOs	Civil Society Organisations
CSP	Climate Smart Potentiality
DCC	Department of Climate Change
DST	Decision Support Tools
Dutch RVO	Netherlands Enterprise Agency
E - WASH	Effective Water, Sanitation and Hygiene
EA	Ecosystem Accounting
EHORCON	Environmental Health Officers Registration Council
EMF	Ellen MacArthur Foundation
EU	European Union
E-Waste	Electronic Waste
FD	Fossil Depletion
FDF	Federal Department of Fisheries
FE	Freshwater Eutrophication
FGN	Federal Government of Nigeria
FMA	Federal Ministry of Aviation
FMARD	Federal Ministry of Agriculture and Rural Development
FMEv	Federal Ministry of Environment
FMOP	Federal Ministry of Power
FMOT	Federal Ministry of Transportation
FMST	Federal Ministry of Science & Technology
FMWR	Federal Ministry of Water Resources
FREL	National Forest Reference Emission Level
GDP	Gross Domestic Product
GG	Green Growth
GGI	Green Growth Index
GHG	Green House Gases
GIS	Geographic Information Systems
GIZ	German Development Agency
HT	Human Toxicity
ILO	International Labour Organisation
IPPU	Industrial Process and Product Use
LCA	Life Cycle Assessment
LTV	Long Term Vision for Nigeria
MDAs	Ministries Department & Agencies
ME	Marine Eutrophication
MRD	Metal Depletion
MRV	Monitoring, Reporting and Verification
MSW	Municipal Solid Waste
MTNDP	Medium-Term National Development Plan
NAMA	Nationally Appropriate Mitigation Actions
NATIP	National Agricultural Technology & Innovation Plan
NBS	National Bureau of Statistics

NBS	Nature Based Solutions
NBSAP	The National Biodiversity Strategy and Action Plan
NC	Natural Capital
NCA	Natural Capital Accounting
NCAA	Natural Capital Accounting and Assessment
NCCFL	National Climate Change Framework Law
NCCP	National Climate Change Policy
NCEIP	National Circular Economy Investment Plan
NCEP	Nigerian Circular Economy Program
NCEWG	Nigeria Circular Economy Working Group
NCM	Natural Capital Management
NCP	Natural Capital Protocol
NDC	National Determined Contribution
NEEDS	National Economic Empowerment and Development Strategy
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGERP	Nigeria's Economic Recovery Plan
NGOs	Non-Governmental Organisations
NIFFR	National Institute for Freshwater Fisheries Research
NIRSAL	Nigeria Incentive-Based Risk Management System for Agricultural Lending.
NIMASA	Nigerian Maritime Administration and Safety Agency NNCS National Natural Capital Strategy
NOSDRA	National Oil Spill Detection and Response Agency
NPA	Nigerian Ports Authority
NPCE	National Policy on Circular Economy
NSDS	National Strategy for the Development of Statistics
NSS	National Statistical Systems
OD	Ozone Depletion
OECD	Organisation for Economic Cooperation and Development
PES	Payment for Environmental Services
PMF	Particulate matter formation
POF	Photochemical oxidant formation
PPP	Public Private Partnerships PSUT Physical supply and use tables
RBDA	River Basin Development Authority
REDD+	Reducing Emissions from Deforestation and Forest Degradation
REEEAA	Renewable Energy and Energy Efficiency Associations Alliance
SDGs	Sustainable Development Goals
SEEA-EA	The System of Environmental-Economic Accounting for Ecosystem Accounting
SITRA	Finnish Innovation Fund
SNA	System of National Accounting
SWOT	Strength, Weaknesses, Opportunities and Threats
TA	Terrestrial Acidification
TACCC	Transparency, Accuracy, Consistency, Comparability and Completeness
TEEB	The Economics of Ecosystem and Biodiversity
UNCHS	United Nations Centre for Human Settlement
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
UPRC	Nigerian Upstream Petroleum Regulatory Commission
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WEF	World Economic Forum
UN	United Nations
LDN	Land Degradation Neutrality

Acknowledgements

This report was drafted by a team of consultants led by Professor Francis Bisong (AGDF). It was produced under the overall guidance and direction of Innocent Onah, Chief Natural Resources Officer of the African Natural Resources Management, and Investment Centre (ECNR) who led the establishment and pioneer coordination of the Nigeria circular Economy Working Group (NCEWG) when he was the Climate Change and Green Growth Consultant covering Nigeria (RDNG).

The African Development Bank (AfDB) team was led by Anthony Simpasa, Lead Economist, Nigeria Country Department (RDNG) and Davinah Milenge Uwella, Principal Program Coordinator who leads the Circular Economy Programme of the African Development Bank. The team is grateful for many useful inputs, comments, suggestions, and guidance received from the report's peer reviewers, including: Julius Tieguhong (AfDB), Diego Fernandez De Velasco (AfDB), Melissa Murara (AfDB), Aboje Andrews Enenche (AfDB), Arona Soumare (AfDB), Ekeoma Onuoha (AfDB), Gerald Esambe (AfDB), Chigoziri Egeruoh (AfDB), Rosemond OFFEI-AWUKU (AfDB), Andre-Marie TAPTUE (AfDB), Ncube MTHOKOZISI (AfDB), Adeolu OJO (AfDB), Arie Plieger (Dutch Embassy in Lagos), Tien Hoang (Dutch Enterprise Agency, RVO), Kabir Yusuf (Federal Ministry of Agriculture, Nigeria), and Charles Ikeah (Federal Ministry of Environment, Nigeria).

This report was funded by the African Development Bank and the Government of Netherlands.

The Nigeria Circular Economy Working Group (NCEWG) is gratefully acknowledged for providing the inspiration for the study and platform for its several criticisms and reviews. Special thanks to Professor Jimmy Adegoke, of the University of Missouri, Kansas City, who provided external reviews and independently critiqued the report.

Last but not the least, we deeply appreciate the numerous stakeholders of largely government MDAs, Civil Society Groups, the Private Sector Organizations and Development Partners who participated in the preliminary workshops to review the report from its inception to its validation. Several of who as individuals and corporate entities responded to the e-survey for the study.

Study Team

This Study was carried out by a research consortium – AGDF & Partners. The team lead of the study was Professor Francis Bisong and assisted by Professor Elizabeth Esekong Andrew-Essien. The key experts, inclusive of the team leader and assistant, are Dr Enoabasi Deborah Anwana, Ekaba Bisong, Odigha Odigha, and Funmi Eyeoyibo, who was the internal coordinator of the team. Other experts are Jackson Akor, Christopher Abetianbe, and Asuquo Okon. The Project Research Assistants are Taiwo Adediran, Dr. Chinasa Uttah, Ms Bridget Nkor, Chidera Bisong, Joy Atsa, Dr. Jacinta Foncha, Arch. Hannah Kanu, Nta-Akare Ginika, Temi Ajila and Joseph Okputu.

We would like to acknowledge the following contributors to the Report: Professor Chidi Magnus, James Chidi Okeuhie and Engineer Richard Okibe.

The participating firms in the consortium led by African Green Growth and Development Forum (AGDF) are the University of Calabar Climate Change Working Group, NGO Coalition for Environment (NGOCE), Silicon Blast Ltd (Canada), and Integrated Ecodev Systems Konsults (Nigeria).

Executive Summary

Context and Purpose

The present linear economic model of production (which encourages a “make, consume and discard” approach) exerts substantial pressure on natural capital (NC) and has adverse environmental and economic consequences. Global attention is, therefore, justifiably shifting towards enabling circular economy (CE) and natural capital accounting (NCA) as a viable means of achieving green growth (GG) and sustainable development. The 2021 Circularity Gap Report states that the global economy is only 8.6% circular (down from 9.1% in the 2018 report) and sets a target of becoming 17% circular by 2030 by targeting sectors with high potential for change. To this end, various countries have made rapid progress toward developing the vast store of untapped resource using circularity strategies within the public and private sectors. Despite the concerted efforts, substantial potential for investment in CE-related business opportunities remains untapped, especially in African countries such as Nigeria.

Nigeria is strategically positioned to embrace the responsibility of charting the course towards a circular economy, given the rich natural resource capital base and the vast opportunities for investment in green growth. Nigeria’s recent Nationally Determined Contribution (NDC), 2021-2025, accorded a significant role to Natural Capital as a prime climate adaptation strategy through the development of nature-based solutions (NBS). All Circular Economy features with their attendant Natural Capital and green production attributes are relevant to Nigeria’s medium and long-term development objectives. The combined sectors of energy, Agriculture, Forestry and Other Land use (AFOLU), and waste sectors were recognized in the Nigerian NDC as critical climate mitigation sectors with multiple social and economic opportunities, including job creation. Transitioning from a linear to a more circular economy would deliver benefits such as reducing pressure on the environment, improving the security of the supply of raw materials, increasing competitiveness, stimulating innovation, and boosting economic growth in addition to creating jobs. Further benefits include providing consumers with more durable and innovative products, reduction of expenses and general increase in the quality of life.

This scoping study was commissioned by the African Development Bank (AfDB) and supported by the Government of the Netherlands focuses on the transition from a linear economic model to a circular economy in Nigeria. The study examines various sectors of the Nigerian economy and identifies the opportunities and challenges associated with implementing circular economy principles with the aim of helping the Nigerian government set the agenda that will inform public-private sector investments.

For this study, the definition of CE concept was adopted from the World Economic Forum (2013) [1]:

> **“An industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.”**

The Scoping Process

The Scoping process sets out to evaluate the current landscape for transitioning from an unsustainable linear model to a circular model within different sectors of the Nigerian economy. The seven sectors identified in the Nigerian NDC and the ’Medium-Term National Development Plan (MTNDP 2021-2025)

were adopted for the sector selection. Four priority sectors are selected with their focal industries namely:

- Forestry Agriculture and Other Land Uses (AFOLU): Agro-allied products and forestry.
- Services Sector (inclusive of waste and water sub-components): packaging, electronics, and organic waste industries
- Energy: power, oil and gas, and transport/logistics.
- Industrial Processes and Product Use (IPPU): construction and textiles.

To explore critical issues within each sector, the following processes are explored:

1. Interconnectedness of Circular Economy and Natural Capital: The relationship between circular economy principles and the concept of natural capital is examined. The role of Natural Capital Accounting (NCA) in facilitating the implementation of a circular economy is explored.
2. Policy Context: The existing legislative, policy, and institutional frameworks within the priority sectors are analyzed to identify opportunities for adopting a circular economy. The policy context is assessed to understand the support available for circular economy practices.
3. Sectoral Issues: Key issues and problems specific to each sector are identified and examined in the context of transitioning to a circular economy.
4. Stakeholders and Business Clusters: Current stakeholders and business clusters involved in circular economy concepts are identified. Their activities and initiatives are studied to determine potential opportunities and business models that can be leveraged.
5. Activities and Projects: Activities and projects related to natural capital and circular economy within Nigeria's public and private sectors are reviewed to understand the prevailing initiatives in these areas.
6. Public-Private Partnerships (PPP): The existence of policy enablers for Public-Private Partnerships (PPP) is assessed, and opportunities for investments in circular economy practices are identified.
7. Waste and Energy Efficiency: Strategies to improve waste management and energy efficiency in all priority sectors are explored.

The scoping study employed various data collection methods, including a review of national policy and legislative documents related to each sector, examination of activities and projects related to natural capital and circular economy, and a review of existing academic and grey literature. The study also aimed to fill information gaps and propose pathways to address those gaps. Additionally, the study mapped the circular economy landscape among different stakeholders, business clusters, and economic models related to natural capital. Local examples of circular businesses across sectors and potential scaling-up opportunities were identified using the "10Rs" (refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover, and redesign) framework.

It is worth noting that the scoping report was prepared between September 2021 and June 2022, during which the exchange rate ranged from N420 to N600 to the dollar.

Sectorial Reviews and Problems

The sectorial reviews provided in the text highlight key issues and challenges within each sector. The reviews provide an understanding of the challenges and problems faced in each sector, highlighting the areas that need attention and intervention to facilitate the transition to a circular economy model.

Here is a summary of the sectorial reviews and the problems identified.

B. Forestry Agriculture and Other Land Uses (AFOLU):

In agriculture, the dynamic nature of agroecosystems provides a multi- dimensional production scale for harnessing forest, fish, animals, crops, and other agro-allied resources to meet the teeming population demands and supplies for food and fibre. However, the Agri-food system has witnessed a relatively slow pace of growth towards contributing to the country's overall economic development because of the over-dependence on oil. Problems identified are:

- Slow pace of growth and contribution to overall economic development due to over-dependence on oil.
- Inadequate farming inputs leading to poor returns on investments.
- Absence of viable markets for agricultural produce.
- Inefficient transportation systems.
- Weak/inadequate storage and processing facilities, resulting in significant post-harvest losses.
- Low investment by the public and private sectors to promote industrialization options for food and agriculture.
- Insecurity caused by farmers-herders clashes exacerbating challenges in the sector.

C. Services (Waste & Water):

Nigeria has pressing challenges regarding water access, water contamination, sanitation, hygiene, economic costs, health implications, waste management, legislation, and infrastructure. Nigeria produces approximately 63 million tonnes of municipal solid waste (MSW) annually, with only about 30-50% of this being formally collected [2] and organic waste making up the largest proportion of MSW. The waste sector in Nigeria was recently included in Nigeria's 2021-2025 revised NDC in recognition of its growing impact on the release of GHG emissions as well as its rich potential for creating opportunities for various stakeholders. Informal circular economy activities such as the collection, reuse, recycling and refurbishing of waste items have been taking place across the country. However, these have been primarily driven by a need to create a means of livelihood, not as a result of conscious, sustainable growth efforts. Waste management initiatives currently operational are mostly private sector driven or partnerships.

Nigeria imports over 500,000 tonnes of second-hand electronic goods annually, a quarter of which are defective and non-operational on entry into the country, adding to the already large quantity of e-waste being generated on a daily basis across the country [3]. As much as 99.6% of the e-waste produced in the country is informally recycled using unsustainable techniques to retrieve useful substances. The informal e-waste sector employs approximately 100,000 workers in Nigeria [4] and this workforce is continuously exposed to the hazardous materials from which electrical/electronic parts are made that are harmful to human health and the natural environment. Nevertheless, the huge amount of e-waste can be used as a resource bank to drive industrial growth.

About 70% of Nigerians have access to water. However, more than half of the water is contaminated, and on average, each person in Nigeria has access to only about 9 liters of water per day. This limited water availability can lead to difficulties in meeting basic needs such as drinking, cooking, and sanitation. Approximately 70 million people use unsanitary or shared latrines, while 32 million have

no access to latrines at all and resort to open defecation. Poor sanitation practices contribute to the spread of diseases and have significant economic costs (the country loses about 455 billion naira yearly, equating to about 1.3% of GDP, to poor sanitation [5]). Faeces contaminate drinking water sources and is the root cause of an annual average of 5,400 cases of cholera affecting Nigeria [6]. Approximately 121,800 Nigerians, including 87,100 children under 5, die each year from diarrhoea, nearly 905 of which is directly attributed to poor water, sanitation, and hygiene [7].

Some of the problems identified in this sector are:

- Large amount of waste generated, with a significant percentage remaining unrecovered and untreated.
- Insufficient waste collection and recycling infrastructure.
- Poor enforcement of legislation and lack of clarity of duties among establishments.
- Limited funding for waste management initiatives.
- Application of unsuitable techniques for waste management.
- Ignorance of the consequences of bad waste management practices.
- Poor maintenance culture and absence/inadequacy of waste-related records.
- Need for conscious and sustainable growth efforts in waste management.
- Obsolete and abandoned water infrastructure is prevalent across state waterboards and river basin authorities.
- Existing water-related legislation is outdated and needs to be reviewed, particularly in light of the challenges posed by climate change.
- Lack of a comprehensive and up-to-date database on Nigeria's natural capital (water resources, ecosystems, etc.).

D. Energy

Oil, gas, and biomass constitute the main sources of energy in Nigeria. However, there are significant efforts ongoing in the country to harness the high potential available from renewable energy sources such as solar and wind, etc.

The problems identified in this sector are:

- Energy utilization not efficiently harnessed, with inadequate data validation.
- Generation, distribution, utilization, and losses not well captured.
- Reluctance to allow sitting of gas-related infrastructure near populations due to health and safety concerns.
- Environmental and social risks associated with hydropower and considerations for land use in solar and wind power generation.

E. Industrial Processes and Product Use (IPPU)

Nigeria’s revised Nationally Determined Contribution (NDC) document indicates that the IPPU sector has the least GHG emission with an estimate of 18.391 MtCO2eq. This could, however, be partly due to data paucity and the low level of industrialization in Nigeria. This report focuses on the built environment and the textile industry. The industry is projected to grow at the rate of 2.8% in real terms between 2022-2025, with government plans to invest in the country’s infrastructure, such as

energy and transport infrastructure. According to the Nigerian National Bureau of Statistics, the "textile, apparel, and footwear" sector in Nigeria has averaged a growth of 17% since 2010. This is partly because of an increase in demand but also because of several initiatives that have put a spotlight on Nigeria in the global fashion industry.

- Insufficient data on GHG emissions and industrialization in Nigeria.
- Poor-quality built environments impacting implementation of lockdowns and sanitation.
- Informal and unplanned construction of buildings with insufficient access to critical infrastructures.
- Lack of access to finance, knowledge, and skill sets for sustainable building construction.
- Poor waste management due to poor design of the built environment and population increase.
- Energy-intensive and resource-depleting cement manufacturing process.

Several barriers exist to closing the loop and shifting from a linear to a more circular model within the textile and fashion industry. These include:

- Consumer behavior and education affecting sustainable practices.
- Inadequate disposal practices.
- Insufficient collection and sorting infrastructure and processes.
- Lack of appropriate recycling technologies.

Stakeholder Consultations

The scoping report has undergone consultations with key stakeholders from relevant government departments and agencies, as well as interviews with key informants and focus group discussions with businesses and business clusters in the focal sectors. Successful business models have been identified and recommended for scaling. From our analysis, a high potential for circularity exists within the services (wastewater), energy, AFOLU, and IPPU sectors but with a high concentration in Lagos, FCT, and Akwa Ibom because of the proximity to raw materials, access to natural resources, proximity to customers and availability of infrastructure, among other reasons. Most of the stakeholders know about natural capital and circular economy but a vast majority are not aware of Natural Capital Accounting nor of the existence of Economic and Environmental Accounting for Nigeria. However, there is currently a lack of a harmonized database of circular economy stakeholders in Nigeria, which needs to be addressed to transition to a CE in Nigeria.

Circular Economy, Natural Capital Objectives and, Recommendations

This report proposes a GG model that demonstrates the relationship between natural capital, circular economy, and green growth, aiming for a near-zero-waste system. Objectives for circularity and natural capital have been developed for each sector to guide policies and proposals in a consistent manner. These objectives reflect desired environmental, social, and economic outcomes from transitioning to a circular model in each sector.

The report provides recommendations for each sector on how to transition from the current linear model to a circular one. Waste management and environmental protection policies were identified as foundational entry points for the transition to a green/circular economy. Investment opportunities in each sector are summarized in Table A while Table B highlights GE objectives and recommendations for each sector.

Opportunities for circularity and improving efficiency were identified through waste and energy efficiency analyses in each sector. The report also presents a stock-taking and scenario assessment of priority sectors, highlighting strategies for promoting natural capital accounting and circular economy. Entry points for private sector participation and investment opportunities were identified.

One major challenge identified is the lack of verifiable data across the priority sectors, which hinders the implementation of a circular economy in Nigeria. Monitoring, Reporting, and Verification (MRV) are recognized as essential tools for planning and implementing natural capital accounting and transitioning to a circular and green economy. An MRV framework is proposed, including policy reviews, activities, institutional arrangements, and metrics for monitoring and measuring progress in implementing circular economy and natural capital accounting.

Known strategies in natural resource management such as the Natural capital protocol, National REDD+ Strategy, National Biodiversity Strategy and Action Plan, and Waste Management Strategy were appraised as baselines for developing a National Natural Capital Strategy (NNCS) in Nigeria and steps enumerated towards the development of the NNCS. Steps are outlined for the development of a Monitoring, Reporting, and Verification (MRV) Roadmap for Circular Economy and Natural Capital Accounting in the short, medium, and long terms.

The Next Stages

Political ambitions to reduce dependence on oil could become a driving force behind the transition to a GE in Nigeria. The country hopes to encourage and promote the development of green growth initiatives that relate to the CE. The recommendations in this report, together with relevant stakeholders' engagement, are an integral process that will lead to developing the Nigerian Circular Economy Roadmap (NCERM) across the priority sectors and business clusters. Finally, this report has proposed a checklist of criteria for prioritizing the CE/NC interventions. The final set of criteria for prioritizing circular economy interventions will be collectively determined in consultation with stakeholders across the different priority sectors during the implementation of the concept note for the development of the NCERM.

A Theory of Change (ToC) has been developed for the National Circular Economy Program (NCEP) to illustrate the country's strategy for transitioning Nigeria from a linear to a circular economy by 2050. The ToC illustrates the necessary steps and actions to drive the desired change.

Furthermore, an iterative framework has been created for the National Circular Economy Roadmap (NCERM). was developed to guide the timely development of the NCERM. The framework highlights deliverables in the form of initiatives and feasible projects while identifying the conditions that must exist for the desired change to occur.

Table A: **Summary of Investment Opportunities in Key Sectors**

Sector	Investment Opportunities
Cross-cutting across all sectors	• Strengthening citizens awareness and public orientation. • Support towards Policy reviews & strengthening Institutional framework/policy. • Creating a central reliable and credible database collection, storage, and analysis Centre. • Facilitating the transition of businesses in the informal sector to the formal sector. • Facilitating the setup of the recommended inter-agency framework. • Support for research, training, and capacity building nationwide.
AFOLU	• Create re-use opportunities (plant biomass into organic fertilizers), utilisation of by-products and food waste into organic feed for livestock, wastewater treatment plants for recycling of water inputs.

	• Low carbon emitting technologies use of solar hot water, air source heat pumps, ground source heat pumps, biomass heating, efficient gas boilers, wind turbines to generate energy. • High yielding input/ Improved varieties. • Promoting sustainability in Value chains and CSR engagements; afforestation/ecological restoration; harnessing biodiversity; agroforestry system/domestication of forest products; environmentally friendly wood utilisation technologies. • Establishment of fuel wood Lot. • Increasing products value through sustainable certifications; use of residues from wood processing industries, post-consumer recovered wood and processed wood-based fuel; use of Sawdust for making brittle; converting material into Industrial products. • Recycling and reuse of waste products; pro-forest livelihood; development of land use planning and management; support forest management plan; Bio-based materials/ biochemical processing. • Enhancing low-energy mineral exploitation technologies, creating green jobs • Exploring networking opportunities and linkages to local and international markets; investment in green mining. • Diversified commodities portfolio and substitution of energy sources, e.g., biofuels development instead of fossil fuels. • Development of Climate Smart Agricultural (CSA) Products.
Services (Waste & Water)	• Development of sector-specific guidelines for various waste streams. • Improved waste collection and treatment systems. • Storage and transportation systems for various wastes. • Processing/recycling plants. • Manufacture and trade of compost. • Establishment of waste to energy schemes. • Recycling waste from construction sites to produce building blocks and tiling materials. • Local production, sale, and maintenance of waste processing equipment such as incinerators, waste balers, conveyor belts, separators, shredders etc. • Design and maintenance of digital tools such as waste management databases and mobile applications will be relevant for planning and record keeping. • Establishment of wastewater recycling & treatment schemes. • Establishment & training of certified landfill construction businesses. • Support towards the revision of Nigeria's NDC for the inclusion of food waste in the Waste Sector. • Resuscitation of National Plastic Recycling Program. • Establishment of waste to energy businesses, e.g., powerplants that can convert plastic waste to electricity Intensifying and building capacity for e-waste recycling.
IPPU	
Construction	• Use of regenerative approaches to manage solid waste and wastewater. • Upcycling plastic waste for formal and informal built environment construction materials. • Establishment of national/regional remanufacturing, reprocessing and material recovery hubs. • Enhancing informal economy processes. • Developing waste micro-grids. • Supporting SMEs to align with the industrialization strategy. • Developing clear market push-and-pull policies that will accelerate the implementation of CE principles in construction industry. • Promoting the use of climate-friendly (and alternative local) construction materials. • Promoting the construction of green buildings.
Textile & Fashion	• Radically improve recycling and collection systems. • Supporting manufacturing in the country. • Make more effective use of resources and move to renewable inputs. • Providing more options for the way clothes are sold or rented. • Public education on garment care, end of garment life, and recycling. • Developing systems for product re-circulation. • Investing in advanced sorting. • Digital technologies can facilitate and unlock multiple elements. • Modelling industry and innovation hubs.

	• Providing grants and incubation. • Use of regenerative approaches to manage solid waste and wastewater.

Table B: Green Economy Objectives and Recommendations

Sector	Green Economy Objectives and Outcomes
AFOLU	• Development of new technologies to support the achievement of emissions targets. • Development and maintenance of green zones and conservation landscapes, particularly within urban areas. • Reducing losses and waste of foods, including changing diets. • Diversifying commodities portfolio and substitution of energy sources, e.g., biofuels development instead of fossil fuels. • Promotion of Sustainable Food and Agriculture (SFA). • Development of Climate Smart Agricultural (CSA) Products. • Investments in Research and Training for Development of CSA products. • Optimizing energy and water utilisation, improving crop yield and processing, decreasing waste using better preservation and logistics techniques, and using sustainable waste practices.
Services Sector (waste and water)	• Expansion of waste management businesses across the country. • Encouragement of more waste management entrepreneurs. • Incentivizing MSMEs to aid their transition from the informal sector to the formal sector. • Establishment of wastewater treatment schemes. • Development of specialized waste handling. • Establishment of research centres and upgrading existing institutions for research, data collation and publications on waste management. • Creation of sector-specific legislation for different waste streams such as e-waste, organic waste, textile, scrap metal etc. • Developing large-scale processes which involve recycled packaged plastics such as PET, flakes, and pellets for reuse by FCMG and construction industries. • Increase investments in water supply & sanitation infrastructure. • Development of appropriate local solutions for wastewater collection, treatment, and reuse. • Recovery of Energy, Nutrients and Water from reuse and recycling of wastewater. • Maximized value from toilet resources where sanitation system drives value chain e.g., agricultural products which use biological resources as their source.
Energy	• Development of low emissions, greener energy sources. • Facilitating the conversion and use of waste heat energy. • Introducing energy audits in critical sectors of the nation's economy. • Promoting education, information and public awareness campaigns on energy efficiency and conservation best practice.
IPPU	• Radically improving recycling and collection systems for waste clothes. • Implementing safer and better employment conditions. • Becoming more flexible in the way clothes are sold or rented, to break free from their increasingly disposable nature. • Strengthening consumers knowledge on sustainable value chains through consumer campaigns.

1. Introduction & Background

Highlights

This chapter discusses the methodologies employed for the various segments of this study.

The following four priority sectors were selected:

a) Agriculture, Forestry and Other Land Uses (AFOLU).

b) Services (which will cover waste and water sectors) - based on the categorization of specific sectors, including waste and water services, into one, by the International Labour Organisation (ILO) Employment Data (2021).
c) Energy.
d) Industrial Processes and Product Use (IPPU).

Some of the activities undertaken during the course of this study are:

- Review of national and international documents and existing academic and grey literature (materials and research produced by organizations outside of the traditional commercial or academic publishing and distribution channels, e.g., reports (annual, working papers, government documents, white papers, and evaluations).
- Review of conceptual frameworks and related theory.
- Identification of information gaps, and pathways are suggested to address those gaps (e.g., through stakeholder surveys).
- Review of policy/ strategic legislative documents, including activities and projects linking natural capital and circular economy within Nigeria's public and private sector settings.
- Review and mapping of circular economy with natural capital stakeholders, business/ economic and business models across green and blue economy.
- A country-wide representative stakeholders of various Natural Capital / Circular Economy affiliated organizations was done using an institutional mapping/snowballing approach across the six geopolitical zones and within selected sectors in the circular economy, the green economy, and the blue economy.
- Review of the value chain of Nigeria's economically most important and high Green House Gas (GHG) emitting sectors.
- Review the stock-taking, gaps, and scenario assessments to promote Natural Capital Accounting and Assessment (NCAA) and circular economy in Nigeria.
- Review of the waste and resource efficiency of Nigeria's economically most important sectors and the environmentally most polluting sectors.
- A Theory of Change (ToC) was developed for the National Circular Economy Program (NCEP) to illustrate the country's strategy to achieve the vision of transiting Nigeria from a linear to a circular economy by 2050.
- An iterative Framework was developed to serve as a guide to facilitate the timely development for the National Circular Economy Roadmap (The NCERM).
- The report in various forms (whole and excerpts) was presented and critiqued at various workshops, including at three internal reviews at AfDB, an internal AfDB validation exercise and a final nationwide validation exercise of both the Scoping Report and the Framework Roadmap on Thursday 29th September at the Rockview Hotel in Abuja.

The concept of Circular Economy (CE) builds around two streams of thought, which relate to materials flow through an economy and the economic conditions that facilitate such flows [8]. Although rooted in related concepts earlier postulated in academic literature spanning five decades, there has been a renewed interest in the idea of CE in recent years. Studies from China advocate its 'early' adoption as a national strategy [9] by global organisations, companies, and international policy shapers such as the World Economic Forum (WEF), Ellen MacArthur Foundation (EMF), the European Union (EU), and OECD (Organisation for Economic Cooperation and Development) countries.

The definition of the CE concept by myriads of its proponents encapsulates one or more of the following features in Box 1.1 below.

The economic production paradigm shifts from the extant linear economic model (make, consume and discard) to more circular options inspired by the growing pressure exerted on natural capital (NC), threatening to exceed planetary boundaries with negative environmental and economic backlashes.

1.1. Circular Economy and Climate Change Action

Global attention is justifiably shifting towards enabling circular economy and natural capital accounting as viable means of achieving green growth and sustainable development. A linear economy is material and energy-intensive, and it exerts pressure on the limited environmental resources. Moving towards a more circular economy could deliver benefits such as reducing pressure on the environment, improving the security of the supply of raw materials, increasing competitiveness, stimulating innovation, boosting economic growth, and creating jobs [10]. The use of circular economy measures such as materials/process reduction, reuse, repair, refurbishing, re-manufacturing, repurposing, recycling, and energy recovery improves overall efficiencies in the production of goods and our day-to-day activities in society. Incorporating these circular activities can lead to a massive reduction in the global demand for materials and products and decreased energy use due to improved energy efficiency, reduction of large amounts of fossil fuels usage and the utilisation of renewable energy resources. The consequence of this transition is a massive reduction in the release of anthropogenic GHG emissions into the atmosphere. It also leads to a reduced demand for environmental resources, which enhances the continuous regeneration of the earth's biosphere.

- **"Aims to realised waste minimization, environmental conservation, energy efficiency and economic development simultaneously, so it equals a package of the all-round, systematic strategies and tools approaching the goals mentioned above" [11].**
- **"An industrial economy that keeps materials flow circulating in perpetuity at a high-rate barring entry into the biosphere except they are biodegradable" [12].**
- **"A stock optimizing system with a structure of three loops: 'reuse and remarketing of goods, product-life extensions for goods, and a recycling loop for secondary resources" [13].**
- **"An industrial system focused on closing the material and energy flows loop and contributing to long-term sustainability. CE incorporates policies and strategies for more efficient energy, materials, and water consumption while emitting minimal waste into the environment." [14].**
- **"An industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims to eliminate waste through the superior design of materials, products, systems and business models." [15].**
- **"A multiple value-creating economies decoupled from the consumption of finite material resources, sustained within by maximizing the value of its existing structures, materials and products" (…).**
- **"An industrial system that is restorative by intention and design. The idea is to use and reuse products to maximize their value rather than discard products before the value is fully utilised" [15].**

financial leader in Africa. The models do not encourage green growth in line with global best practices.

The 2021 Circularity Gap Report states that the global economy is only 8.6% circular (down from 9.1% in

1.2 Nigeria and the Circular Economy

The 2021 Circularity Gap Report (an annual report which measures the state of circularity with the aim of inspiring action and realising a global circular economy) sets an ambitious target of becoming 17% circular by 2030 by targeting sectors with high potential for change. In Africa, the options available within the public and private sectors to embrace a circular economy as a sustainable economic growth model is gaining rapid attention through the Africa Circular Economy Alliance (ACEA). The existing linear economic models challenge Nigeria, a financial leader in Africa. The models do not encourage green growth in line with global best practices. Despite this hurdle, Nigeria is strategically positioned to embrace the responsibility of charting the course towards a circular economy, given the rich natural resource capital base and the vast opportunities for investment in green growth.

Circularity thinking has been explicitly recognized and enshrined in Nigeria's economic and environmental policy documents. For instance, Nigeria's Mid-Term National Development Plan (MTNDP 2021-2025) identifies the following CE and natural capital (NC) related strategies across vital economic sectors:

- "Strengthening agricultural value chain, increasing productivity and reducing post-harvest losses" (Agriculture, Food Security & Rural Development).
- "Lay groundwork for increased energy from renewable sources to generate up to 1000 MW of power from renewable energy sources" (Power & Alternative Energy).
- "Strengthen the current legal framework for an environmentally sustainable economy by ensuring policy coherence and implementation. This ensures the implementation of the climate change bill, which supports the development of decarbonization pathways in line with a new climate economy" (Environment & Disaster Management).
- "Boost community awareness on the importance of environmental sustainability through public education campaigns. There will also be increased focus on recycling through public campaigns in local languages" (Environment & Disaster Management).
- "Grow circular economy capacity through waste prevention, waste management and recycling systems; including policy, brief to encourage eco-design, reuse, repair, refurbishment, re-manufacturing, and extended producer responsibility schemes" (Environment & Disaster Management).
- "Boost production across sectors through adopting bio-economy models" (Environment & Disaster Management).
- "Introduce and adopt low-cost production technologies and innovative, affordable housing delivery systems" (Housing & Urban Development).

Nigeria's recent Nationally Determined Contribution (NDC), 2021-2025, accorded a significant role to Natural Capital as a prime climate adaptation strategy by developing nature-based solutions (NBS). It aims to protect biodiversity and sustainably manage and protect ecosystems while simultaneously pursuing numerous sustainable development goals as co-benefits. The energy, agriculture, forestry, and other land use (AFOLU) and waste sectors are recognized as critical climate mitigation sectors with multiple social and economic opportunities, including job creation identified as co-benefits. Nigeria also encouraged circularity to address its waste management issues, contributing to climate mitigation, environmental protection, and job creation opportunities.

Both the Nigerian Climate Change Policy and the 2050 Long-Term Vision for Nigeria (LTV-2050) were recently passed into Law and. The LTV -2050 has an ambitious vision to transform Nigeria into a country of low-carbon, climate-resilient, high-growth circular economy that reduces its current level of emissions

by 50%, moving towards having net-zero emissions across all sectors of its development in a gender-responsive manner.

To support the Federal Government of Nigeria's efforts at developing a Circular economy and natural capital accounting frameworks, the African Development Bank (AfDB) in collaboration with the Government of Netherlands, engaged African Green Growth and Development Forum (AGDF) and Partners to carry out a green economy study, "Nigeria's Transition to Green Economy: Linking Circular Economy and Natural Capital for Public Private Partnership (PPP) Investments". The study's deliverables have three components as shown in Box 1.2.

- **Component 1: Preparation of a Scoping Study on Circular Economy, Natural Capital Accounting & Green Growth.**
- **Component 2: Design an MRV Framework for measuring, reporting, & verifying circular economy & natural capital within the Nigerian context to build back a better, greener, & resilient economy post- COVID-19.**
- **Component 3: Design of a NCEP (Nigeria Circular Economy Program) Roadmap Framework (2023 – 2050).**

This study covers Components 1 & 2 (scoping report and MRV) of the project's deliverables.

1.3 Overall Goal of Study

The overarching goal of this study is to propose a green economy plan for Nigeria that could guide the transition from a linear and unsustainable economic model to a circular economy model. This circular economy model will incorporate an inclusive and integrated set of initiatives to impact Nigeria's environmental, social, and infrastructural landscape. Also critical to the project's goals is to develop a textual analysis of relevant literature, documents, and databases in consultation with critical stakeholders, to highlight the current and future challenges, opportunities, and the potential impacts of natural capital and circular economy and climate-resilient activities to determine appropriate public-private sector investment options to circularize the economy. This project will inform the design of a Nigerian Circular Economy Program (NCEP) and a detailed concept note for developing a Nigerian Circular Economy Roadmap (NCERM). NCEP will also contain a range of activities that will lead to a proposed National Natural Capital Strategy (NNCS) to enable Nigeria's gradual transition from a linear to a circular economy model of development. Finally, it will further align with Nigeria's long-term growth to sustainable development goals (SDGs) and the Paris Agreement and implement its most potent document, the Nationally Determined Contribution (NDC).

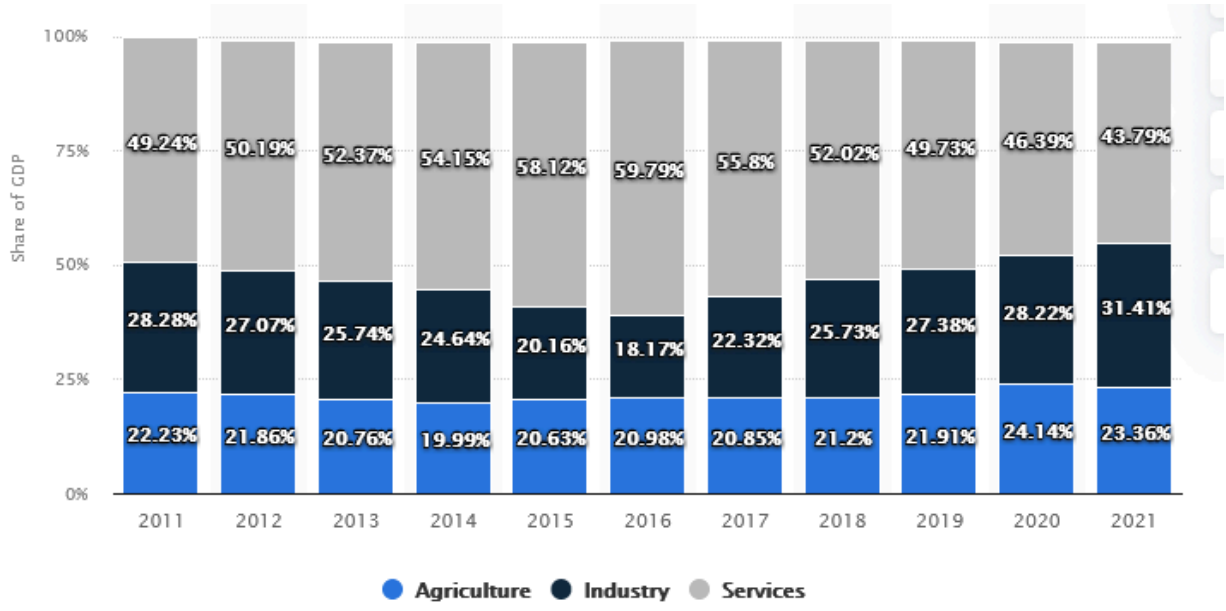
From Nigeria's policy perspective, all CE features with their attendant NC and green production attributes are relevant to Nigeria's medium and long-term development objectives. Therefore, the study aims also to set the agenda to inform public-private sector investments and donor support that will aid this transition.

1.4 Analysis of Nigeria's Economic Terrain, Development Partners Support & Trade Relations for CE Interventions

The Nigerian economy is highly dependent on crude oil, accounting for 77.24% of her exports (estimated to be ₦4.9 trillion in 2022). Non-oil export currently stands at ₦1.44 Billion (22.76%). In 2021, agriculture

contributed around 23.36 percent to Nigeria's GDP, 31.41 percent came from industry, and 43.79 percent from the services sector.

Figure 1.1: Contribution of different sectors to the Nigerian Economy over time.



Source: https://www.statista.com/statistics/382311/nigeria-gdp-distribution-across-economic-sectors/

Nigeria's trade deficit of ₦1.87 trillion consists of materials and natural resources exported to her trade partners (Netherlands, Spain, China, India & South Africa), accounting for 95% of her export. Total foreign trade stands at ₦12 trillion, with an export component of ₦5.1 trillion (42%) and an import component of ₦6.95 trillion [16].

Interestingly, these same trade partners that import natural resources have identified circular opportunity investments in their respective countries. They seek to close waste gaps from their production process while using the natural resources imported from developing nations such as Nigeria. Many wealthy countries send their recyclable waste overseas because it is cheap, helps meet recycling targets and reduce domestic landfill. For developing countries taking in the waste products, it is a valuable source of income but usually at the expense of fresh, natural resources exploited and exported back to the wealthy nations. Therefore, there is a critical need for Nigeria to analyse circular economy investment opportunities in the entire natural resources value chain and the primary services and industries sectors of her economy. This presents a chance to close waste loops, circularize Nigeria's economy, and close her deficit trade balance in the long run.

The Circular Economy in EU-Africa: Nigeria Country Report (2021) highlighted the significant economic impacts of incorporating circularity in Nigeria's economy. These include the creation of new business and employment opportunities, increased local production because of linking of secondary materials to new manufacturing activities, reduced imports due to substitution with local production and the recovery of otherwise lost economic value from waste. The environmental impact will include resource efficiency, recycling of wastes and diversion from landfills.

1.5 Green Economy, Circular Economy, Natural Capital & Related Concepts

The Circular Economy (CE)

The circular economy is a strategy that propels a society towards zero-level waste generation. The CE design implements and incorporates with the production systems, elongating the lifecycle of materials and phasing out the concept of 'waste,' which, in turn, leads to a reduction in GHG emissions and their impact on climate change. Rethinking the modes of material production and consumption of goods and services in ways that are socially, economically, and ecologically sustainable necessitates a shift from a linear to a circular economy.

It is instructive to note that the ecosystem services from natural capital underpin productivity and the global circular economy. Circular economy processes aim to achieve zero waste in the lifecycle of materials, thereby minimizing GHG emissions to the lowest level possible.

For this study, we will be adopting the World Economic Forum [1] definition of the CE concept.

Circular Economy. An industrial system that is restorative or regenerative by intention and design ([1]. It replaces the 'end-of-life' concept with restoration, shifts towards renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the superior design of materials, products, systems, and, within this, business models.

CE is an economic system to design waste out from a product's lifecycle by continuously utilizing materials as long as possible, after which they are eventually used to replenish the environment. The system pushes for manufacturing with materials that can be recovered, reused, and repaired instead of discarded after a single use. It is the norm in a linear economy that is currently in use by many societies in the world.

Natural Capital (NC)

Nature as a fundamental economic factor offers a wide range of renewable and non-renewable resources to support ecosystem services and economic growth. Natural capital is part of the 'global commons' and is often treated as a free 'good.' The natural capital comprises the earth's natural assets (soil, air, water, flora, and fauna) and the ecosystem services, making life possible. Ecosystem services from natural capital support productivity and the global circular economy. They provide services worth trillions of US dollars per year in equivalent terms [17] and constitute food, fibre, water, health, energy, climate security, and other essential services for everyone. "Natural capital refers to assets that occur in nature and can be used for economic production or consumption. Naturally occurring assets provide us benefits through raw materials and energy used or could be used in economic activity one day. They are subject to depletion through human use. Natural assets fall into four categories: mineral and energy resources, soil resources, water resources, and biological resources" [18]
Until recently, none of these services and stock of natural capital that provided them were valued adequately in terms comparable to manufactured and financial capital. Despite being fundamental to human well-being, the use of natural assets remain undetected and unaccounted for within economic systems. It is imperative for governments, decision-makers, and the private sector to understand and account for the use of natural capital and recognize its value in maintaining economic growth and sustaining human well-being today and into the future. For value recognition to work, governments need to develop a clear, credible, and long-term policy framework regulating and incentivizing the private

sector, including the financial sector, to operate responsibly regarding the sustainable use of natural capital and thereby work towards internalising environmental costs through the following processes [19]:

. Requiring companies to disclose the nature of their dependence and impact on NC through transparent qualitative and quantitative reporting.
. Use of enforceable fiscal measures to discourage businesses eroding natural capital while at the same time offering incentives to companies that integrate value and amount for NC in their business models.
. Endorsement and implementation of international agreements, including but not limited to Convention on Biodiversity.
. To build an understanding of the impacts and dependencies of NC relevant to organisations' operations, risk profiles, customer portfolios, supply chains and business opportunities.
. To support the development of methodologies that can integrate NC considerations into the decision-making process of all financial products and services, including in loans, investments, and insurance policies, recognizing that given the diversity of the financial sector, embedding natural capital considerations will differ across asset classes and types of financial institutions.
. To work towards building a global consensus for the integration of NC into private sector accounting and decision making, supporting, when appropriate, the related work of The Economics of Ecosystems and Biodiversity (TEEB) for Business Coalition and other stakeholders and
. To collaborate when appropriate with the International Integrated Reporting Committee and other stakeholders to build a global consensus around the development of Integrated Reporting, which includes NC as part of the wider definition of resources and relationships key to an organisation's success.

Governments carry the public responsibility to create the boundary conditions for the circular economy to achieve its full potential, for it is not a given that circularity automatically generates positive societal spill overs. By setting legislative agendas, developing strategic programs and public services, and making smart decisions regarding internal agency operations, the government can drive the demand for circular products and influence the way businesses operate. The public sector is a major contributor to the CE transition not only as a policymaker but also as a significant purchaser, consumer, and user of goods and services.

The analysis of Natural Capital (NC) has further revealed inter-related concepts such as green economy, bioeconomy, and blue economy.

Green economy

A green economy seeks to improve human well-being and social equity results while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low carbon, resource-efficient, and socially inclusive [20]. The green economy sets out to rectify the failure of classical economics on matters that impact climate change and biodiversity loss by assigning a monetary value to nature and integrating ecosystem services into the market system. Quantifying (accounting), appropriating and offsetting are the critical methods of this route out of the climate and biodiversity crisis [21].

Bioeconomy

The environmental necessity to replace fossil-based, non-renewable resources with natural alternatives supports the bioeconomy. This concept within the national policy domain and academia correlates with economic growth, job creation and increased value addition. It is also a pathway to move from a linear economic model to a circular one. By and large, the awareness of the bio-economy concept has dramatically raised in recent times in the governance domain as a strategy to solve the unsustainable use of resources that results in environmental degradation [22]. Furthermore, the bioeconomy represents a restructuring of the relationships between socio-economic systems and the environment, centred around bioresources and bioprocesses sourced from nature.

Blue economy

Blue economy, a major component of natural capital, focuses primarily on ocean resources for economic growth, improved livelihoods and jobs, and the overall ocean ecosystem health. It encompasses sectors such as fisheries and aquaculture, maritime transport, tourism, and emerging sectors such as biopharmaceuticals and marine renewable energy [23].

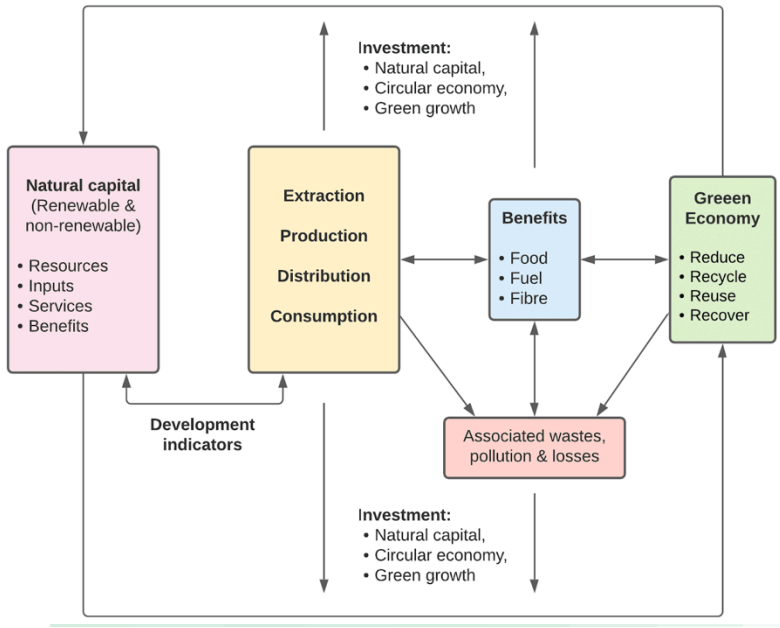
1.6 Conceptual Framework

Natural resource flow: natural capital, circular economy, and green growth

Material flow regulation within natural and artificial systems has rapidly gained global attention. The resource flow theory provides a comprehensive guide for the natural system's flows and stocks. Resources or material flow emphasises the integration of natural capital and human-derived capital as critical indicators to stabilizing ecosystem service delivery. The material flow theory highlights the integration of ecological, economic, and social parameters to predict the direction of a supply chain and the indicators that can aid the decision-making processes within defined systems [24]. Material flow is categorised into the material flow, material flow cycle, and flow management. Material flow includes the various techniques of resource use, from extraction to consumption. The material flow cycle illustrates the supply chain trends within systems stemming from the extraction of renewable and non-renewable resources to constitute integral parts of a supply system to undergo transformative processes to consumption. Material flow management enables system throughput processes to be coordinated efficiently and reduce wastages. The theory of material flow encapsulates the systemic relationships between natural capital, economy, and green growth. It shows that the circular nature of system accounting is dependent on the resources-production-material- flow-consumption-recycled resources loop [25].

The green growth model in Figure 1.2 illustrates the relationship between natural capital (NC, circular economy (CE) and green growth (GG) as a closed system targeted at achieving a near-zero-waste system. Natural capital comprising renewable and non-renewable resources provides inputs that foster ecosystem services and benefits such as the provisioning of flora and fauna, maintenance, and regulation of bio- geochemical regulation, and others. Advancing human ingenuity, foresight, technology, and innovative progression guided by vibrant economic policies have acted as catalysts that have encouraged large-scale extraction, production, distribution, and consumption of natural capital. Typically, the use of natural capital indicates linear production patterns with unsustainable consequences that jeopardize the continuity of material stock, flow, and supply. Such ecological challenges show the linear production pattern as pollution, global warming, climate change and other associated effects. The model (Figure 1.2 encapsulates the nature of circularity within systems and the links to a circular economy for green growth in the most resource-efficient manner and shows that there are investment opportunities at

every section of the design from the source capital input to the final consumption within a net zero-waste limit (i.e., ensuring that limited waste is sent to landfills).



The circular economy provides solutions to the most significant challenges humans face – overconsumption of natural resources, climate change and biodiversity loss in addition to pollution and the attendant health implications, and the reduction in the aesthetic quality of life. In addition to promoting low-carbon energy, GE can leverage ecological processes occurring in natural and semi-natural systems to benefit human beings without jeopardizing the sustainability of these ecosystems. Circular transition challenges humankind to rethink the way products are produced, consumed, and designed in a manner that is within ecologically sound boundaries. By mimicking the closed-loop systems in nature, the industry can be used as a force for good, one that brings economic, ecological as well as environmental value and eliminates the concept of waste to become regenerative in its own right.

In the equation below (Box 1.4), we propose a model of the relationships between Green Economy, Natural Capital and Circular Economy with stated assumptions proceeding from Box 1.3.

$$GE_{M} = \frac{(Q_{NC} + Q_{CEP}) * Ext_{CI}}{2} \quad (2.1)$$

Green Economy (GE): Economy that is driven by sustainability; optimizing the use of materials; the use of renewable resources as economic drivers.
Natural Capital Assets (NCA): Natural capital (NC) is needed to achieve GE; NC's are tangible environmental assets like water, land, air and mineral resources.
Circular Economy (CE): CE is an intangible measure of actions to ensure sustainability in the use of NCA's. Examples of CE activities are recycling, re-manufacturing, and refurbishing to optimise the use of NCA in the production lifecycle.

and the consumption pattern for the "priority" NCA of the country. Where the NC extent (E), condition (C) and consumption pattern (CP) are assigned scores between $[0, 1]$ where 0 equals totally depleted, and 1 refers to excess and in abundance. qnc can be expressed as:

$$qnc = \frac{(E + C) * CP}{2}$$

Hence, the total quality of natural capital Q_{NC} is expressed as:

$$Q_{NC} = \sum_{i}^{N} \frac{qnc_i}{N}$$

- The quality of circular economy practices, Q_{CEP} is influenced by sustainable resource acquisition (sra), green manufacturing workflows (gmw), optimization of resource consumption (orc) and green disposal mechanisms (gdm). These practices capture the breadth of behaviours to facilitate transitions to circularity. The CE practices are assigned scores between $[0, 1]$ where 0 equals fully linear and destructive, and 1 refers full circularity. Hence, Q_{CEP} can be expressed as:

$$Q_{CEP} = \frac{sra + gmw + orc + gdm}{4}$$

- External circularity indicators Ext_{CI}, refer to other socio-economic and environmental factors that impact the transition pathway to greening the economy. These factors are summarized into CE legislative framework (lf), regulatory effectiveness of bodies tasked with implementing CE policies (re), general literacy (gl), poverty index (pi), quality of life, i.e. availability of power, clean water (qol) and measure of technological advances (ta). These circularity indicators are assigned scores between $[0, 1]$ where 0 equals not existent, and 1 indicates strong presence. Hence, Q_{CEP} can be expressed as:

$$Q_{CEP} = \frac{(lf + re + ta) - pi}{3}$$

By normalizing the green economy metric GE_M to stay between $[0, 1]$, the scores can be consistent, agnostic and easily adapted for different macro/ micro-communities. ∎

1.7 Lessons/ Benchmarks from the CE Roadmap of other Countries

Finland was the first country to prepare a national roadmap to a circular economy in 2016. The roadmap created a platform to launch and advance circular economy initiatives throughout the country, which was a unique combination of strategy, purpose, and an action plan. Since then, several other countries have made inroads in developing a roadmap, including Netherlands, Switzerland, Chile, France and Italy. Some of the lessons learned from Finland's experience are:

- The specific country must create a similar roadmap based on its perspective.
- Synergy by all stakeholders is vital for progress.
- The roadmap must balance action with flexibility.
- A situational picture needs to be formed in order to deepen the understanding of the current state of the circular economy in the specific country in a participatory way that involves relevant stakeholders.

- To stay relevant, the roadmap must be agile (with the inbuilt flexibility and ability to respond quickly to changes) to stay relevant.
- Measures of success, the monitoring of progress made, and the development of roadmap phases are important.
- There must be investment vehicles in the execution to enable investors gain positive returns on their money. They can be low risk, such as CDs or bonds, or high risk such as options and futures.

The Netherlands has also launched a circular economy roadmap in which the country aims to achieve complete circularity by 2050. Several European countries such as France, Poland, Portugal, Finland, Germany, Spain, Luxembourg, and Slovenia [26] have also drawn up their national roadmaps. See Appendix 1 for circular economy benchmarks made in the select countries. We observe that the Dutch economy, which is among the world's most circular economies, aims to achieve 100% circularity by the year 2050. With the world's second-largest population of 1.38 billion people, India has put together a 'Clean India Mission' initiative to raise public awareness of proper waste management to encourage sustainable waste management practices as a circular economy initiative. Rwanda has positioned itself as a regional model for Circular Economy activities by integrating measures such as prohibiting single-use plastic bags. In 2020, Rwanda launched 'Environsere,' an e-waste collection and dismantling plant to combat e-waste generation.

1.8 Scope: Sector Selection and Focal industries

The Nigeria NDC – 2021 Update' document highlights seven sectors (Power, Oil and Gas, Transport, AFOLU, IPPU, Waste, and Water), some of which are stated in the Medium-Term National Development Plan (MTNDP)-2021-2025', and the '2021 National Policy on Climate Change. This implies that these sectors are essential to the country's development. Therefore, these seven sectors serve as a basis for the sector selection analysis. We outlined a variety of economic, environmental, and social criteria to analyse the contribution of these sectors to Nigeria's development:

- Gross Domestic Product- GDP (Economic).
- Investment potential (Economic).
- GHG Emissions (Environmental).
- Pollution (Environmental).
- Employment (Social).
- Job creation potential (Social).
- African Circular Economy Alliance (ACEA) criteria for Africa, namely food systems, packaging, the built environment, electronics, and fashion and textiles.

Using the above criteria, we assessed the seven sectors based on verifiable data from national and international agencies. Each sector's corresponding impact and contribution were scored based on their strengths and ranked accordingly. A summary of this analysis has been tabulated in Appendix 1 of this report. We see that AFOLU, in terms of ranking using the above, is first followed by the Energy sector, IPPU and then the Services sector. The process involved a review of national strategic documents, identification of critical sectors in the documents, analysing each sector's impact based on various national criteria, ranking the sectors accordingly, and eventually choosing the four priority sectors along with their focal industries. Based on this and the results obtained, four priority sectors were selected, namely:

- Agriculture, Forestry and Other Land Uses (AFOLU).

- Services (which will cover waste and water sectors) - based on the categorization of specific sectors, including waste and water services, into one by the International Labour Organisation (ILO) Employment Data (2021).
- Energy.
- Industrial Processes and Product Use (IPPU).

Industries were then identified as focal areas to represent the sector activities from each sector based on their contribution to the economy. Figure 1.3 shows these four priority sectors and the assigned focal industries to stand as case studies representative of the respective sector's activities. Figure 1.3 shows these four priority sectors and the assigned focal industries to serve as case studies representative of the respective sector's activities.

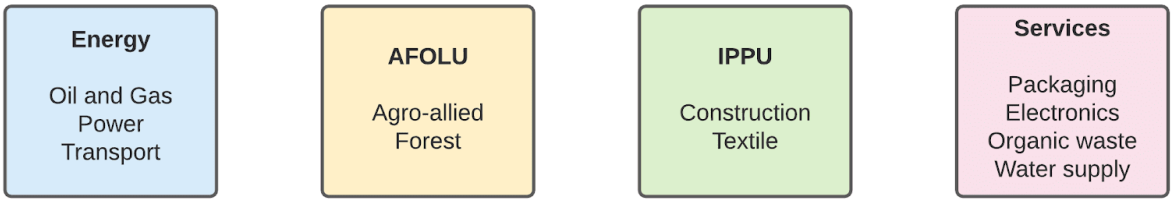


Figure 1.3: Scoping map showing four priority sectors and related focal industries.

The nation's primary revenue earner, the energy sector, was aligned to three industries: power, oil & gas, and transport. Due to its socio-economic significance, two sectors were assigned to AFOLU: agro-allied products and forestry [16]. IPPU synergized with the construction and textiles industries based on their high economic impact [27]. The services sector (with waste and water sub-components) was situated with the packaging, electronics, organic waste industries, wastewater, and toilet resources due to their high recycling opportunities [27].

2. Methodological Overview

Highlights

The methodological overview provided in the study describes the approach taken for different segments of the project, which aims to guide Nigeria's transition from a linear and unsustainable economic model to a greener and circular economic model. Here is a summary of the methodologies employed for each segment:

Preparation of a Scoping Study on Circular Economy and Natural Capital:

- Review of national and international documents and existing literature.
- Review of conceptual frameworks and related theory.
- Identify information gaps and suggest pathways to address them.
- Review of policy/legislative documents and projects related to natural capital and circular economy in Nigeria.
- Review and mapping of circular economy stakeholders, business models, and value chains.
- Review of Nigeria's economically important and high GHG emitting sectors.
- Review of gaps in stock-taking and scenario assessments for promoting natural capital and circular economy.
- Review of waste and resource efficiency in important and polluting sectors.

Agriculture & Food System Value Chain Analysis (AFOLU):

- Adoption of a value chain approach to evaluate the components of the agriculture sector.
- Engagement of relevant stakeholders along the agricultural input-to-supply chain.
- Use of mixed-method research processes such as interviews, questionnaires, and market mapping.

Services Sector (Waste & Water):

- Analysis of waste and water management governance and scenarios.
- Identification of catalysts and inhibitors in the sector.
- SWOT analysis to highlight gaps, prospects, and proposals for circular economy activities.
- Baseline survey of the waste sector and assessment of waste management institutions and initiatives.
- Review of strategic documents related to the water sector.

Energy Sector:

- Waste Efficiency Analysis through waste audits and reviews of strategic documents.
- Identification of key regulators and stakeholders.
- Assessment of material and waste efficiencies and identification of opportunities for minimizing material losses and waste.

Industrial Process and Product Use (IPPU):

- Focus on the Built Environment and Textile Industry.

- Mapping of value chains and identification of circularity challenges and investment opportunities.
- Life Cycle Assessment (LCA) methodology for the cement industry to assess environmental impacts.
- Use of Life Cycle Inventory (LCI) methodology and ISO 14040:2006 standard.
- Life Cycle Impact Assessment (LCIA) to evaluate potential environmental impacts.

CE Stakeholder Identification, Engagement & Business Cluster Analysis:

- Institutional mapping to identify stakeholders.
- Mendelow matrix to determine stakeholders' level of influence and interest.
- Desk analysis of circular economy business ecosystem and circular economy businesses.
- Stakeholder interviews, focus group discussions, and workshops for data collection and validation.

Energy and Waste Efficiency Analysis:

- Analysis of GDP growth scenarios and energy demand projections.
- Waste audit and efficiency analysis for different sectors.
- Identification of stakeholders, production activities, waste types, and disposal techniques.
- Assigning roles and responsibilities to stakeholders.

Natural Capital Accounting and Assessment:

- Application of the SEEA Ecosystem Accounting framework for ecosystem accounts.
- Integration of ecosystem accounts into a unified system.
- Use of the SEEA central framework for measuring the environment-economy relationship.

Overall, these methodologies encompass literature reviews, data analysis, stakeholder engagement, waste audits, value chain analysis, and various assessment techniques to guide Nigeria's transition to a circular and greener economic model.

2.1 Preparation of a Scoping Study on Circular Economy and Natural Capital

Several processes, factors, actors, and strategies interplay to achieve a circular economy that embraces natural resources accounting for green growth. The following points summarize some of the activities undertaken during the course of this study:

- Review of national and international documents and existing academic and grey literature to define key terms.
- Review of conceptual frameworks and related theory.
- Identify information gaps, and suggest pathways to address those gaps (e.g., through stakeholder surveys).
- Review of policy/ strategic legislative documents, including activities and projects linking natural capital and circular economy within Nigeria’s public and private sector settings.
- Review and map circular economy with natural capital stakeholders, business/ economic and business models across green and blue economy.

- Review the value chain of Nigeria's economically most important and high GHG emitting sectors.
- Review the stock-taking gaps, and scenario assessments to promote NCAA and circular economy in Nigeria.
- Review the waste and resource efficiency of Nigeria's economically most important sectors and the environmentally most polluting sectors.

2.2 Agriculture & Food System Value Chain Analysis (AFOLU)

Nigeria recognizes agriculture as an economic engine that contributes to the economy's growth. This makes agriculture a critical priority sector for harnessing natural capital for resource circularity geared towards green growth. This priority sector is adopting the value chain approach as a veritable framework to provide a holistic evaluation of the components within the sector to portray the investment gaps in the upstream and downstream agricultural industries.

The value chain approach is considered adequate for this sector because it examines the complete range/stages of agricultural processes, including the major and minor actors along the agricultural chain from field input to final consumption. A high point of the value chain approach is that it also identifies critical areas wherein gaps or weaknesses exist to enable rational investment decisions and actions that will add more value to each stage, thereby charting a course for natural accounting and the green economy.

The agricultural value supply chain will engage relevant primary and secondary actors and stakeholders along the upstream and downstream agricultural input-to-supply chain. These include agrarian manufacturing and processing outfits, namely input companies focusing on small, medium, to large scale seedling & fertilizer companies, farmers, processors, distributors, and storage firms (where applicable) and agricultural credit institutions.

The value analysis comprises the use of mixed-method or both qualitative and/or quantitative research processes such as observation, Semi-structured interviews, focus group meetings, structured questionnaires, and market mapping to guide the investment opportunities for green growth.

A desk-based review of strategic documents provided information on essential institutions controlling water and related resources, including policies and regulations. The researcher further mined policies to assess their compliance with climate resilience and circular economy goals. Additionally, a value chain analysis of fisheries was done based on information gleaned from desk-based searches. A form of ground-truthing to confirm the information obtained from desk-based reviews was done by paying two separate field visits to two wholesale fishing communities in Oron, Akwa Ibom State and Akpabuyo, Cross River State, respectively.

2.3 Services Sector (Waste & Water)

2.3.1 General Methodology

An analysis of the current status of the Nigerian natural capital and circular economy landscape related to waste and water will be carried out by undertaking a review of the current scenarios in their management governance. This process will consider the catalysts and inhibitors across the country, identify gaps, and make proposals to drive the desired modifications and growth in Nigeria's natural

capital and circular economy sectors. Furthermore, a SWOT analysis will be carried out to highlight existing gaps, prospects for and viable proposals concerning the use of CE activities.

To carry this out, a baseline survey of the waste sector was first carried out from a review of existing Nigerian waste sector legislation and strategic documents to highlight data currently in the sector. The objectives, targets, context and intervention approaches of each waste sector policy and program and the presence or absence of relevant policy alignment and policy enabling instruments and indicators were identified closely with natural capital and circular economy features.

An assessment of the waste management institutional framework and key existing initiatives were made using institutional websites, social media platforms, online publications, phone calls and electronic correspondences with contact persons in these organisations. A tabulated list of relevant institutions and projects was developed to highlight their natural capital and circular economy features and the private sector opportunities of each critical project and program.

A SWOT Analysis was used to analyse the extent of compliance with the legislation, strategic documents, institutions, and initiatives to enhance natural capital assets and the utilisation of circular economy measures. A colour code in Appendix 9 was used to depict the increasing levels of green growth compliance. The feasibility of the use of NCAA Tool in Nigeria's Waste Sector was then examined to highlight its potential benefits, challenges and the data required for its implementation.

Strategic documents related to the water sector will be reviewed to provide information on key institutions involved in water and related resources governance, including policies and regulations. These will be assessed to determine the level of their compliance to climate resilience and circular economy goals.
From the results obtained and the analysis made, the study will make recommendations to highlight ways the services sector can be sustainable using circular economy strategies.

2.4 Energy Sector

2.4.1 General Methodology

The Waste Efficiency Analysis was undertaken by carrying out a desk-based waste audit of the highlighted focus industries through reviews of certain strategic documents. This helped to identify prospects and challenges in enhancing production efficiencies.

The key regulators and stakeholders of the various focus industries were first identified. A waste audit was conducted using industry-specific publications, websites, and literature to highlight the sector's key production activities and processes. This process showed the significant types of waste and current waste disposal techniques. However, all efforts to get the volumes of waste generated and recycled in the various priority sectors yielded no results due to the unavailability and inaccessibility of such data. These volumes are not in the analysis.

The researcher reviewed Strategic documents and legislation to obtain relevant information on material and waste efficiencies, combined with the results from the waste assessments to identify opportunities and gaps for minimizing material losses and waste across various production stages within the industries.

2.5 Industrial Process and Product Use (IPPU)

The focus of our study under the Industrial Process and Product Use (IPPU) will be on two selected industries, namely: The Built Environment and the Textile Industry. Their value chain shall be mapped and examined to understand better and approach a detailed circularization framework. We shall track the processes to identify circularity challenges and explore investment opportunities.

Life Cycle Assessment (LCA)

LCA will be carried out for the cement industry to assess product environmental impacts throughout its entire life from the cradle to the grave (e.g., from the extraction of raw material, preparation of materials, manufacturing, distribution, use, end-of-life treatment, recycling, and disposal). This is to track and identify all the production stages requiring improvement, control, and mitigation of environmental impacts.

Most cement production LCAs adopt the cradle-to-grave approach. However, this study will consider ways of adopting the cradle to cradle (zero waste) approach consistent with CE & Natural Capital accounting methodologies.

Life Cycle Inventory (LCI)

For consistency and comparability with global best practices, the study adopted the LCA methodology to assess the environmental impacts of cement production in line with ISO 14040: 2006 standard for the various sectors selected.

The ISO 14040: 2006 standard broadly involves four major stages of LCA, namely:

- Goal and scope definition
- Life cycle inventory (LCI)
- Life cycle impact assessment (LCIA) and
- Interpretation and communication of main results.

LCI involves the quantification and compilation of all inputs and outputs data of the system. It indicates material, fuel and energy use and waste generated to produce a functional unit of product with a system boundary. The primary data is usually collected from key personnel of the organisation through multiple interviews while secondary data is sourced from Ecoinvent database, one of the most reliable databases for LCAs [28]. This study used secondary data sources for the LCI.

Life Cycle Impact Assessment (LCIA)

The LCIA stage is the phase of identification and evaluation of quantifiable and important potential environmental impacts emanating from the LCI. Among some existing approaches, the ReCiPe (H) assessment mid-point approach comprising 18 mid-point impact categories could be adopted. They include ozone depletion (OD), photochemical oxidant formation (POF), terrestrial acidification (TA), climate change (CC), particulate matter formation (PMF), freshwater and marine eutrophication (FE) & ME respectively), human toxicity (HT), metal & fossil depletion (MRD and FD respectively), terrestrial,

freshwater, and marine ecotoxicity (TET, FET and MET respectively) [29]. Table 2.1 shows some of these mid-point categories.

Table 2.1: Classification into global, regional, and local effects.

Global	Regional	Local
Climate change representing the main global effect	Acidification and eutrophication representing the main regional effects	Resource depletion and gaseous emission representing the main local effects

Interpretation and communication of main results.

At this stage, the result is evaluated and cross-checked for consistency and completeness with the set goals and scope of the project. This stage will identify and examine issues emanating from the LCIA. The life cycle interpretation is a cyclic process within the arrangement and other steps of the LCA, which involves a description of all interested stakeholders and their roles and responsibilities.

2.6 CE Stakeholder Identification, Engagement & Business Cluster Analysis

An institutional mapping/snowballing approach will identify country representatives of various Natural Capital / Circular Economy affiliated organisations and stakeholders. The representatives drawn from the six geopolitical zones and selected sectors in the circular economy, the green economy and the blue economy will make up the pool of these stakeholders. Their level of influence and interest in driving a transition to a circular economy in Nigeria will be determined using the Mendelow matrix.

Desk analysis is employed to show the current state of play of the circular economy business ecosystem and circular economy businesses in various sectors with high potential for circularity in Nigeria (Waste, Energy, AFOLU, Water & IPPU). However, to present the current state of play for circular economy business clusters in Nigeria, data will be collected across various business clusters with linkages to natural capital/ circular economy space across identified sectors with potential for circularity. SITRA's definition of circular business models identifies five strategies for businesses to adopt circular practices, namely: circular supply chain, sharing platforms, product as a service, product life extension, and resource recovery and extension. These strategies are used as the criteria for determining circular economy business models.

2.6.1 Review Analysis and Processes

The SWOT analysis framework is adopted to identify internal factors and analyse external factors impacting circularity measures. Processes will involve mapping stakeholders in relevant business clusters and clearly defining the roles, procedures, and responsibilities of the involved stakeholders to implement the circular economy.

2.6.2 Key Informant Interviews

The study will involve consulting and interviewing selected government officials of relevant Ministries, Department and Agencies (MDAs) in the four focus sectors. Consultations will also include private sector

players such as Non-Governmental Organizations (NGOs), Community based Organizations (CSOs), research institutions, businesses and business clusters, and journalists.

Government (Ministries, Department and Agencies).

The study will involve relevant MDAs in the critical sectors, associated state agencies and development partners. The interviews will identify key policies and legislation, key indicators, and existing circular and natural capital frameworks, including data collection tools and plans, reporting plans, information dissemination plans, and major challenges and opportunities. Key government institutions we will be engaging are Directorate for Climate Change of the Federal Ministry of Environment (DCC/FMEnv), Federal Ministry of Power (FMOP), Federal Ministry of Agriculture and Rural Development (FMARD), Federal Ministry of Transportation (FMOT), National Environmental Standards and Regulations Enforcement Agency (NESREA), Energy Commission of Nigeria (ECN), Standard Organization of Nigeria (SON), National Water Resources Institute (NWRI), Nigerian Maritime Administration and Safety Agency (NIMASA), Nigerian Ports Authority (NPA), Nigeria Climate Innovation Centre (NCIC), Federal Ministry of Housing, Federal Ministry of Works, National Assembly and Nigeria Governors Forum.

Private sector players (NGOs, the media, and research institutions).

The interviews will assess the extent of circular economy and natural capital compliance among private sector players in the industry in line with existing laws (if any) to address challenges and uncover circular business opportunities. We shall engage the Renewable Energy and Energy Efficiency Associations Alliance (REEEAA), consisting of seven associations/ industry players actively supported by Nigerian Energy Support Programme (NESP), European Union (EU), the German Agency for International Cooperation (GIZ) and German Government, selected national media (print and electronics). We will also interview other established private sector industry players, media (electronic and print) and research institutes.

Civil Society Organisations (CSOs).

The interview shall identify required information on the circular economy and natural capital status regarding access to information, challenges, opportunities, and available capacity development (technology and human). We shall engage CSOs such as Pan African Climate Justice Alliance (PACJA), Coalition of Civil Society Network in Nigeria and the Nigeria Conservation Foundation.

2.6.3 Focus Group Discussions

Focus Group Discussions with ten to twenty key stakeholders will triangulate information gathered via desk studies and key informant interviews. Expert opinions are presented and used for data validation during these discussions.

2.6.4 Stakeholder Workshops

AfDB, Dutch partners, FME and Research team, will organise stakeholder validation workshops/ webinars to validate the deliverables of the project. The information generated at the validation workshops/ webinars will revolve around the completeness of data, its accuracy and robustness, attention to detail, reliability and most importantly, the validity of the information captured. The validation workshop will

employ the UNFCCC's Transparency, Accuracy, Consistency, Comparability and Completeness (TACCC) standard. We will synthesize and integrate comments and inputs from the workshop into the deliverables.

2.7 Energy and Waste Efficiency Analysis

For the energy efficiency analysis, the researcher analysed various GDP growth scenarios in the National Energy Policy based on short, mid, and long terms for projections of energy demand and renewable energy supply.

The study conducted a waste audit involving a waste efficiency analysis of the highlighted sectors. The exercise identified vital stakeholders, production activities and significant types of waste produced. Adding to this, the researcher obtained current waste disposal techniques. Meanwhile, efforts to collect data on the volumes of waste generated proved abortive. The data was either unavailable or inaccessible. Moreover, relevant strategic documents and legislation revealed opportunities for circularity. Recommendations were then made from this analysis for the various sectors while the investigator assigned roles and responsibilities to relevant stakeholders.

The study set up a design for Municipal Solid Waste Management in Low-Income Countries using a modified UNDP/UNCHS model so that other researchers can use verifiable data in subsequent waste efficiency analysis for the various sectors in Nigeria.

2.8 Natural Capital Accounting and Assessment

2.8.1. The SEEA Ecosystem Accounting

The System of Environmental-Economic Accounting for Ecosystem Accounting (SEEA EA) provides a consistent set of accounting concepts, approaches, and principles to create different ecosystem accounts, integrating them into a unified system. The SEEA central framework is the standard for measuring the environment and its relationship with the economy. The five ecosystem accounts of the SEAA main framework are ecosystem extent, ecosystem condition, physical economic ecosystem services flow, economic ecosystem services flow, and monetary ecosystem asset accounts. These accounts record information on the stock of ecosystem assets (i.e., distinct biophysical areas such as forests, agriculture, urban areas, and rivers) and the flows from these assets in the form of ecosystem services.

The unified view of these five ecosystems accounts, documents, and provides perspectives on the inter-relationship among ecosystems, people, and economic units. They give a perspective on the impact of ecosystems in supporting human domestic and economic activity and the various externalities (such as clean air and clean water) that make for the overall assessment of national wealth.

2.8.2. SEEA Compilation Approaches

The difficulty in acquiring and processing high-quality spatially explicit ecosystem asset data makes it particularly difficult to record detailed information on ecosystem extents and conditions and carry out comprehensive measurements of ecosystem services. To this end, the "minimum spatial" approach may be implemented. This is a traditional, aggregate, national accounting perspective, generally undertaken

at a national (or large, sub-national region) level and aims to provide broad context to support discussions and decisions pertaining to the use of environmental assets and ecosystem by giving a broad overview of essential ecosystem assets and services [30].
In practice, however, ecosystem accounts may utilise mid-way methods that depend on policy focus, source data, and resources available for compilation.

Hence, we observe a flexible and modular implementation strategy for ecosystem accounting where countries may differ in their specific policy issues and their level of statistical development given their environmental, political, and economic context.

2.9 Scenario Analysis

The transition from a linear economy to a circular economy involves systematic changes which comprise many interconnected actors, sectors, and geographies. It is essential to carry out a prospective analysis of these changes required to transition to a more circular economy. This may be achieved via scenario-based approaches. This section has identified and combined a list of issues facing the four key priority sectors in Nigeria (AFOLU, Energy, IPPU and Services) due to the current linear economy model. We have also highlighted some of these impacts on ecosystems, biodiversity, and climate. Based on the linear economy issues identified within each key priority sector, we identified business opportunities for CE/ NCA business and strategies to promote Natural Capital Accounting and Assessments within the sectors. Next, we listed the policies that addressed the identified problems and the critical solution measures to fix the issues within the key sectors. We also carried out a policy review, which detailed how to adapt and implement these policies in the critical priority sector. Lastly, we compiled a list of ecosystem accounts required based on the thematic time series, i.e., the time frame in which we should ideally collect these accounts.

Each scenario assumes insights into opportunities and policies and is evaluated based on indicators that have some relationship with targets to be reached.

Circular scenarios describe those scenarios that analyse the consequence of specific circular policies or opportunities that are implemented and go beyond expected baseline developments. The baseline scenario represents the events or conditions most likely to occur without assessing the policy or action.

A conventional difference-to-baseline approach is ideal when the circular economy scenario compares against a baseline in which no explicit assumptions are made about the circular economy activity (a business-as-usual scenario) to compare outcomes. It will involve the following elements:

1. System boundary definition. It encompasses significant anthropogenic GHG and known-GHG emissions.
2. Baseline scenario. This is the scenario for a NAMA activity that reasonably represents the anthropogenic emissions by the source of GHG that would occur in the absence of the proposed NAMA intervention.
3. Project activity scenario. This is a NAMA intervention. In this instance, a circular economy model of collecting and separating waste for onward recycling and conversion to compost and the related anthropogenic emissions by a source of GHG occur due to the project activity.

Emissions reduction calculation.

We determine the GHG emissions reduction achieved by the project activity by calculating the difference between the baseline and project emissions. Monitoring defines the parameters to be monitored while reporting and verification describes the reporting requirements and verification procedures.

2.10 Measurement, Reporting and Verification for Natural Capital Assessment and Accounting, and Scenario Analysis

Measurement, Reporting and Verification (MRV) was first used within the Bali Action Plan and refers to processes where factual information is provided, examined, and assessed to see whether parties meet their obligations [31].

For natural capital accounting and circular economy, MRV is a system that consists of data, procedures, protocols, and tools to monitor human activities and their impact on the environment. MRV provides information on resource use's social, economic, and environmental effects and tracks progress towards mitigation and adaptation actions, policies and the finance used to support these actions. MRV also includes information about emission sources and trends, helps with identifying the most practical and efficient use of resources, provides the necessary data to guide strategic planning, design and implement programs and projects, and allocate as well as re-allocates resources in more effective ways [32].
In the transition to a circular economy, MRV is an integral management tool for planning and implementation with an evidence-based approach for identifying and documenting successful programs, processes, and policies. It aims to systematically track performance and outputs while measuring the effectiveness of the implementation plan.

NCAA requires high-quality, spatially explicit datasets that record the value of environmental service flows. MRV provides the methods and data that consider the supply of goods and services, emissions, waste, stocks, and others. MRV is an iterative (repetitive) and evolving process, with the task of preparing an account, helping to identify data needs, and updating data to facilitate performance revisions.

Achieving a paradigm shift from a linear to a circular economy requires an effective accounting and management of the natural capital. A credible and transparent MRV framework will provide Nigeria with an accurate and credible information framework that can serve as a basis for understanding the impact of holistic circular actions and activities and identifying areas needing more targeted effort. Figure 2.1 illustrates the MRV process.

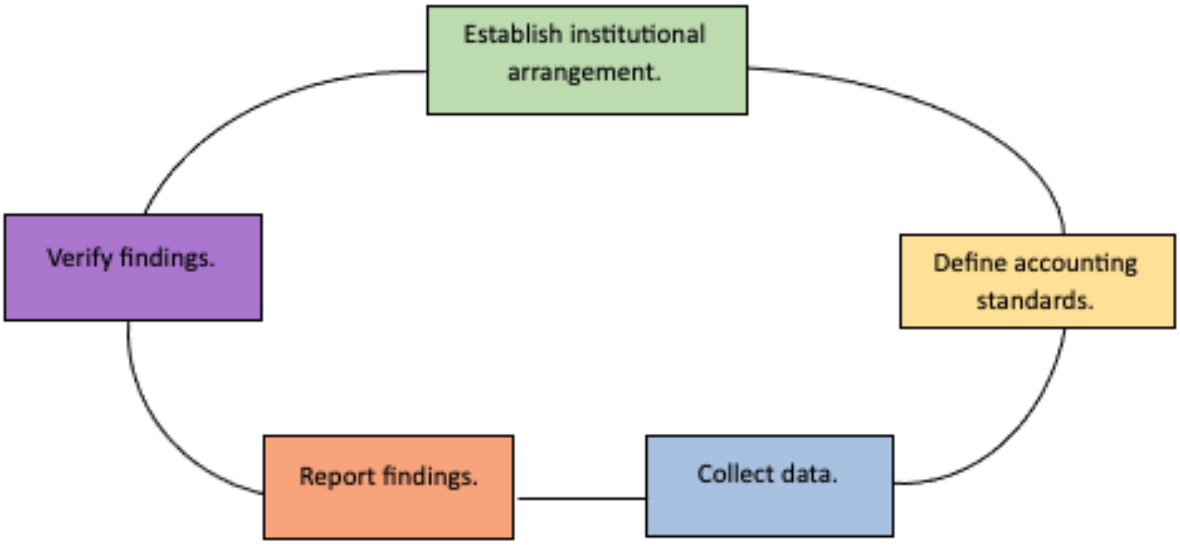


Figure 2.1 MRV process

MRV should provide the measurement required to produce data for each selected sector. The MRV system in Nigeria is relatively new. This study seeks to close this gap and provide a solution to the non-availability of data on Natural Capital and Circular Economy, including Green Economy, especially the Green Growth Index (GGI), which measures a country's performance in achieving sustainability targets, including Sustainable Development Goals (SDGs), Paris Climate Agreement, and Aichi Biodiversity Targets. The MRV analysis should include the following:

- Inputs: Resources that go into implementing a policy or action, such as financing.
- Activities: Activities involved in implementing the policy or action (undertaken by the authority or entity that implements the policy or action), such as permitting, licensing, procurement, or compliance and enforcement.
- GHG Effect: Changes in greenhouse gas emissions by sources or removals by sinks that result from the intermediate effects of the policy or action.
- Non-GHG Effect: Changes in relevant environmental, social, or economic conditions other than GHG emissions or climate change mitigation and adaptation that result from the policy or action.

2.11 Theory of Change and National Circular Economy Program (NCEP) Framework

A Theory of Change (ToC) was developed for the National Circular Economy Program (NCEP) to illustrate the country's strategy to achieve the vision of transiting Nigeria from a linear to a circular economy by 2050. This included a process flow of various components of the roadmap showing their interrelationships, dependencies, assumptions and expected outcomes and outputs. The overall objectives are that this program will enhance the nation's natural capital assets through a reduction in

the pressure on the environment, will stimulate innovation, and boost economic growth while enhancing livelihoods and wellbeing.

Furthermore, a Framework was developed for the National Circular Economy Roadmap (The NCERM). It is an iterative structure that will serve as a guide to facilitate the timely development of the NCERM. Some of the components covered within the framework include the objectives, barriers to the goals, activities to be carried out, stakeholders identified and current capabilities/competencies to deliver these goals. The framework also highlights the deliverables in the form of initiatives and feasible projects while identifying key assumptions, which are the necessary conditions that must exist for the desired change to occur. The ToC and Roadmap Framework are available as part of the deliverables of Component 3 of this study and have not been included in the Scoping Report.

2.12 Validation of Report and Roadmap Framework

The design of this study ensured that, at various stages of the study, a robust system was in place for seeking input, feedback and improving the final report in terms of content and structure.
The Scoping Report and Roadmap framework were at different stages of the study subjected to scrutiny and a robust feedback/input mechanism that involved various hierarchies and departments within the African Development Bank, groups of experts in Nigeria with an interest and expertise in the topic, and other development agencies working in Nigeria on similar or closely related research.
The progress report on the Scoping exercise was presented at the 9th meeting of the Nigerian Circular Economy Working Group (NCEWG) quarter two meeting which took place on the 19th of May 2022. The NCEWG is convened by the AfDB and made up of industry leaders and environment specialists in various sectors of the Nigerian economy. The report in various forms (whole and excerpts) was also presented and critiqued at various other workshops including those listed below:

1. Kick off presentation to Funding & Development Partners - Tuesday, September 14, 2021.
2. Kick off workshop with Africa Food Waste Working Group – UNEP - Tuesday Oct 19th, 2021.
3. AGDF CE in-house workshop on Friday the 7th of January 2022
4. Presentation to All Stakeholders Workshop (NCEWG, MDAs, Development Partners, etc.) Thursday, February 24, 2022.
5. Presentation at a consultation meeting with FCDO by AGDF, Monday, March 14, 2022.
6. Presentation to the NCEWG, Thursday, March 17, 2022.
7. Presentation at CE training Workshop for MDAs organized by FMEnv. in Collaboration with UNEP. Title of presentation, Date Abuja, April 11 -12, 2022 Lagos, April 13-14, 2022.
8. Presentation at UNEP Regional Working Group on Food Waste: by AGDF date: May 17th, 2022.
9. Presentation at UNEP Switch Africa Green Regional Validation Meeting on Advancing Circular Economy and Green Financing in Africa, 24 August 2022, in Accra, Ghana.
10. Presentation at African Ministerial Conference on Environment (AMCEN) Side Event, organized by UNEP on 15 September 2022, Dakar, Senegal.
11. Presentation at UNEP CE Training Workshop for the Private Sector, organized by the FMEnv. in Collaboration with UNEP, 14-15, November, Abuja, 16-17, November, Lagos.

There were at least three internal reviews of the drafts of the Scoping report by AfDB, the comments and inputs of which were used to further refine and revise the Scoping Report before a final internal validation exercise was carried out by the Bank.

The AfDB internal validation was followed by a nationwide validation exercise of both the Scoping Report and the Framework Roadmap on Thursday 29th September at the Rockview Hotel in Abuja. The event, which was a hybrid one, had 160 people in attendance (52 physical attendees and 108 virtual attendees). These 100 attendees represented individuals drawn from 11 Federal MDAs, 6 State MDAs, 2 Research Institutions, 3 Media organisations, 4 Development Agencies, 9 NGO/NPO, and at least 36 Private sector stakeholders. (See full list of attendees attached as Appendix 35 (a), 35 (b), & 36). Both documents were sent to all registered participants well ahead of the Validation Workshop to give ample time for a thorough review and feedback. The collated inputs and feedback were incorporated into the final Report and Roadmap before final submission to AfDB.

3. Baseline Scenario & Analysis: Agriculture, Forestry & Other Land Uses

Highlights

- Agriculture, forestry, and other land uses (AFOLU) is an important sector when it comes to climate action, enabling the provision of food fuel and fibre (3Fs), raw materials for the processing industry, and employment for more than 60% of the working population.
- The sector stimulates economic growth through international trade, fosters economic advancement and enhances the national income at local and national levels.
- AFOLU sector is well-positioned to be relevant to all of the critical sectors responsible for broad-based economic growth and development.
- AFOLU sectors rely on natural resources and therefore the rate at which these resources are exploited undermines the future of these sectors and the benefits generated for economic and social gains.
- Low investment triggered by a lack of political will by decision-makers, markets, technology and weak capacity of smallholders and traditional farmers limits the circular approach to resource utilization.
- In Nigeria's AFOLU is the second largest contributor to total GHG emissions, contributing approximately 25% of national total GHG emissions in 2018.
- The major challenge for the country is destructive land use practices such as a high rate of deforestation to the extent that only less than 10% of forest cover remains.
- However, there are ample opportunities for a circular economy in the AFOLU sector through the contribution of sustainable agriculture, bioenergy and greenhouse gas reduction through conservation, increased vegetation, and soil carbon capture.
- With over 70% of the population relying on fuelwood as a source of energy, Nigeria is the world's third largest producer of bioenergy in the form of fuelwood, agricultural residues, animal, and forestry waste and garbage may be used to generate energy for individuals who rely on wood for fuel.
- Appropriate policies in support of NCA and CE frameworks and strategies to address Nigeria's linear economy and enable the transition to CE are imperative.
- Further efforts are required to align Nigeria's AFOLU along sustainability pathways through the introduction of NCA and CE initiatives.

Current status

- In Nigeria, agriculture remains the largest contributor to the nation's GDP contributing 24.6% in Quarter two of 2020. It remains the highest non-oil export earner and highest employer of labour.
- Also, the forest is a major source of livelihood, raw materials for industries, income, and foreign exchange earnings.
- The Covid-19 outbreak has had an impact on the forestry industry. This is due to Africa's growing reliance on forest resources in climate-sensitive industries such as rain-fed agriculture and forestry.
- Unsustainable practices in the AFOLU sector have resulted in a variety of issues such as resource depletion, increased waste, deforestation, and land degradation.
- Estimate from Nigeria's National Forest Reference Emission Level shows the country is losing forest cover at 63,359 hectares annually, while equally losing roughly 351,000 hectares of its landmass

each year to desert encroachment, which is thought to be moving south at a rate of about 0.6 km per year.

- Despite its importance for local economies and livelihoods, forest-based mitigation for sustainable forest products is still not given due attention in natural resource management policy.
- Existing economic models based on linear production, consumption, and disposal cannot sustain the current anticipated resource use, necessitating the adoption of sustainable models such as the circular economy. Circular economic models provide a safety net for renewing natural capital for livelihood and income stability.

Challenges

- The country tilts towards a mono-economy through over-dependence on an oil-based economy.
- Policy and decision-making on resource management are not enough to enable just a transition from linear to CE.
- The agriculture sub-sector has seen reverse growth for more than a decade and is unable to make a meaningful contribution to the economy.
- increasing food import at the expense of local production that provides jobs and higher living standards.
- The forest sector is also influenced by the rising demand for forest resources, which leads to unsustainable practices such as unregulated agricultural development, which causes fast deforestation and forest degradation, badly impacting the forest and forest resources.
- The unsustainable policy and linear economy culminate in persistent food shortages, resource losses and increased waste.
- The devastating effect of climate change weakens the production system and significantly impact the economy.

Way Forward/Recommendations

- Supporting a gender-responsive, sustainable bioeconomy that strives towards net-zero emissions.
- Capacity Building, effective institutional framework, and innovative technology at all levels as a requirement to deploy agricultural and forest resources to drive Circular Economy.
- Strengthen public-private partnerships in the AFOLU sector to enhance growth and reduce dependence on oil as the mainstay of the economy.
- Through circular bio-economy business models, small and medium-sized enterprises (SMEs) can develop, create, deliver, and capture value of resources and wastes.

3.1 Sectoral Context of Baseline Scenario and Situational Analysis: AFOLU

Agriculture remains a viable means of providing food fuel and fibre (3Fs), reducing poverty and unemployment, and providing raw materials for industries and building strong economies through international trade in the short to long term. The agricultural sector is positioned to be relevant to all the essential sectors that are responsible for generating broad-based economic growth and development. In Africa, the diverse and rich agro-ecological zones make the agricultural and food system the largest and most significantly viable economic sector.

The four major agricultural food-system ensembles comprising crop production, livestock, fisheries, and forestry have tended to lean towards a linear-line flow of production processes from farm to markets. In Nigeria, crop production accounts for approximately 87.6%, with livestock, fisheries, and forestry accounting for approximately 8.1%, 3.2% and 1.1% respectively [33].

The population advantage of Nigeria provides ample investment opportunities in green entrepreneurship within the various upstream and downstream agroecosystems sectors.

Nigeria's agricultural sector contributed approximately 42% of GDP and employed about 60% of the working population in 2010. However, the sector growth has slowed, and it now contributes just 24.14% to the country's GDP [16]. Table 3.1 shows the contribution of the various sectors of the economy to the GDP at various points in time.

Table 3.1: Sectoral Output Contribution to GDP, Five Year Average [%] Change [34]

Year	Agriculture	Industry	Services	Wholesale & Retail	Building & Construction
1981 – 1985	15.50	5.40	5.90	10.36	-9.37
1986 – 1990	26.46	24.53	13.93	33.24	24.23
1991 – 1995	50.72	43.85	33.38	51.51	26.16
1996 – 2000	14.29	21.97	27.15	14.28	17.55
2001 – 2005	36.45	20.49	27.44	29.65	27.93
2006 – 2010	16.76	20.72	21.66	20.65	30.61
2011 – 2015	8.54	5.73	14.90	14.93	17.29
2016	9.61	-4.65	8.90	14.68	3.87
2017	11.29	42.81	5.00	4.34	18.72
2018	2.88	3.70	2.29	5.14	6.97

The driving factors accounting for the steady decline include increased emphasis on crude oil-based products and the importation of foreign goods and services, including food materials and products. In addition, the reduced focus on agriculture has also resulted in the alteration of the employment options in favour of manufacturing and processing to the detriment of investments in agriculture. The continued economic benefits from crude oil industry have overshadowed the prospects for diversification in agriculture. In addition, economic-based dependence on the importation of agricultural produce readily available in Nigeria has resulted in reduced investment in agriculturally relevant businesses.

In the forestry sector, there are numerous benefits that support the economy, livelihood, and health of the large population of people across the globe. Forests perform vital roles in maintaining the continuity of ecological processes such as natural cycles generation and recycling, provision of medicinal plants, sources of raw materials for industrial growth processes, stabilisation of weather, climate change mitigation and also contributing to food security by providing 3Fs. Furthermore, forests also play pivotal roles in traditional agroforestry systems. In local communities, many forest products are used for

subsistence and in support of small-scale household-based enterprises that provide income and employment for rural people, especially women [35], [36], [37].

Despite the importance of forest for local economies, livelihoods, forest-based mitigation for sustainable, forest products remains largely inadequate in the policy and decision-making processes of natural resource management. The Covid-19 pandemic has exerted its impact on the forestry sector. As a result of the lockdown, non-forest income-generating activities in forest dependent communities were halted, forcing increased on forest resources.

The forest sector is adversely affected by the increasing demands for forest resources that culminate in unsustainable practices such as unregulated expansion in agriculture that trigger rapid rates of deforestation and forest degradation to negatively affect the forest and forest resources. Deforestation is a major global contributor to climate change through the emission of CO2 emissions. Climate change is projected to likely aggravate the problem leading to reduced resource availability and conflicts in shared resources. Asare and Kwakye (2013) [38] indicate that illegal logging is driven by the demand for wood products, income, and livelihood. Natural capital's ability to provide ecosystem services and associated functions that support social and economic systems has been threatened and severely impacted by the outcomes of human demands to further aggravate the challenges of climate change with threats to the economy and sustainable development.

Statistics in Nigeria's nationally determined contributions indicate that AFOLU is the second largest contributor to total GHG emissions, contributing approximately 25% of national total GHG emissions in 2018 [39]. Nigeria's Third National Communication (2020) [40], shows that the total GHG emissions from AFOLU stand at 366,734 Gg CO_2 −eq, representing about 60% of the total net GHG emissions for the country. The major challenge for the country is destructive land use practices such as a high rate of deforestation to the extent that only less than 10% of forest cover remains. Nigeria's FREL estimates for 2016 indicate a forest cover loss per year of 63,359 hectares per annum. It is estimated that the country, on the whole, is currently losing about 351,000 hectares of its landmass to desert conditions annually, and such conditions are estimated to be advancing southwards at the rate of about 0.6 km per year [41]. The increase in deforestation contributes to land degradation and enhances desert encroachment in the northern flank of the country. Between 50% and 75% of the 11 frontline states of Nigeria, namely Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe, and Zamfara States [42] are under severe climate change threat.
The prevailing environmental challenges that characterize land use in Nigeria have contributed to natural capital deterioration, decline and destruction. The agricultural production processes in Nigeria are mostly linear and the resultant challenges of such linear models cut across environmental, socio-economic, financial and food insecurity impacts. The linear nature of agriculture also affects the sustained viability of agri-food systems. The accounting determinants/variables that may challenge agricultural yields include the use of toxic inputs and fossilized energy processes, poor storage options, massive post-harvest losses, the absence of improved seedlings, and a dearth of efficient and modern farming facilities or methods, just to mention a few. Africa's population hold on climate- sensitive sectors such as rain-fed agriculture and Forestry, the emergence of climate change with potential fluctuation in rainfall imposes significant impacts on the four dimensions of food security: food availability, food accessibility, food utilisation and food systems stability [43]. Climate change will likely alter the functioning and resilience of ecosystems, including forests, mangroves, and rangelands, among others, which support the livelihoods and economy of local communities.

Existing economic models based on linear processes of production, consumption, and disposal cannot sustain the present projected resource use, making it imperative for sustainable models such as the circular economy to be adopted. Circular economic models provide safety-net platforms for regenerating natural capital for livelihood and income security.

The key to delivering a forest-based circular bioeconomy is integral to sustainable development [44]. The circular bioeconomy is an economy powered by nature and its sustainable resources, which offers a unique opportunity to use renewable natural capital to holistically transform and manage our land, food, health, and industrial systems as well as our cities. If managed sustainably for people and the planet, it has the potential to decarbonize our economy and restore biodiversity while providing jobs and achieving inclusive growth. Bioeconomy encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value-added products such as food, feed, bio-based products, and bioenergy. This will create opportunities for new income streams, job creation, linkages to new sectors, make small and medium-scale businesses more economical and sustainable in the long term reduce risk, reduce waste, electricity generation through renewable energy from biomass and decarbonize the economy.

Nigeria has put in place a plan to become low carbon and decarbonized economy through the long- term vision that will achieve a low-carbon, climate-resilient, high-growth circular economy that reduces its current level of emission by 50%, moving towards having net-zero emissions across all sectors of its development in a gender-responsive manner by 2050 [45]. The vision will promote a sustainable bioeconomy, blue, green and food economies, especially at this time that Nigeria is also engaged in developing medium-term (2021-2025) and long-term (Agenda 2050) national development plans.

3.2 Policy Context, Review, Challenges and Opportunities in AFOLU Sector

Different agriculture and associated policies have been put forward to address the challenges within the agricultural sector in Nigeria. These policies have highlighted frameworks and strategies to address the low-impact level of agriculture in Nigeria. However, the persisting challenges of policy instability, consistent food shortages and losses are prevailing indicators that encourage increased importation of food at the expense of local production that offers employment and enhanced living standards. The development of formal regulatory mechanisms to guide agricultural production gained grounds from 1962-1968 with the initiation of commercialization and agricultural extension programs that encouraged the use of modern equipment, plantations, and research institutions. This policy promoted the establishment of agric-pyramids based on mono-cropping's such as groundnuts, grains, and cocoa. Thereafter, the crude oil-based growth and development processes intensified the political focus along mono-economic lines and the neglect of the agricultural sector for small and medium scales investors and actors. Examples of policy initiatives over the years include extension programs such as the National Accelerated Food Production (1972), Operation feed the Nation (1976), Green Revolution (1980) and other Agricultural Development Projects (ADPs). Other programs include River-Basin Development Authorities (1976), Directorate of Food, Road, and Rural Infrastructure (DFRRI), Better Life for rural women (BLF, 1987), Agricultural Policy for Nigeria (1988-2000) and National Economic Empowerment and Development Strategy (NEEDS, 1999) amongst others.

The Nigeria Vision 20:2020 was launched in 2009 to develop viable strategic objectives to radically transform agricultural productivity through deliberate agricultural delivery systems and the use of improved varieties and inputs required by farmers, amongst others, by 2015. A key feature of the

agricultural policies in Nigeria was characterised by a linear focus on effective intensification and mechanized farming options to transform Nigeria into a front-line agribusiness and agro-allied industrial Nation. The major challenge of the agricultural sector included the weak legislative frameworks of the policies for effective implementation strategies resulting in a low rate of agricultural productivity growth. The low rate was based on neglect by the government and the weak capacity of smallholder and traditional farmers who rely on basic low-yielding production techniques, limited opportunities to access modern inputs and credits, poor infrastructure, land and environmental degradation, climate change and seasonal variabilities and the non-circular nature of the production processes.

Other challenges included poor returns on investments; the absence of viable markets for agricultural produces, inefficient transportation systems such as ultra-modern rail systems; weak or inadequate and ineffective storage and processing facilities, given the perishable nature of most agricultural produce, thereby resulting in enormous post-harvest losses and the low-level investment by public-private sector to promote industrialization options for food and agriculture. The implication of the prevailing challenges in the agricultural sector has resulted in reduced agricultural yields that induce food insecurity, as evidenced by the prevailing farmer-herder conflicts in communities of Nigeria. These challenges are evidently the result of the inability of the various policies to generate the maximum value through the regeneration of resources and materials throughout a product life cycle for a net zero-waste result and enhanced investments in the various production streams. In particular, the natural capital upon which agriculture is based, land, requires a stabilized balance flow or preservation that will enable the sustainability of resources. The maximization of agricultural yields can best be mainstreamed by circulating the components within the agricultural production chain through recycling with the sustainable use of waste for added value.

The introduction of the Agricultural Transformation Agenda (ATA) (2011-2016) provided a basis for critical stakeholders in the agricultural sector to re-position and revitalize the Nigerian economy for reduced exports in a system that emphasised. In addition, the African development bank (AFDB) approved support for the special agro-industrial processing zones (SAPZ) to boost agricultural productivity and enhance production, processing, and marketing within the SAPZ catchment areas of Nigeria. The first phase focused mainly on Cross River, Imo, Kaduna, Kano, Kwara, Ogun, and Oyo states, seeks to drive an inclusive, sustainable agro-industrial development in Nigeria that generates employment and revenue for the populace of Nigeria. Investment opportunities abound in all the spheres of the agricultural value chain to provide multiplier loops for emerging and established Agric-entrepreneurs for wealth generation, job creation, food supply and eco-innovative measures. Nigeria's commitment to promoting natural capital along sustainable development lines gained ground with the promotion of such policies like the National Policy on the Environment, Economic Recovery & Growth Plan (2017-2020); National Policy on Climate Change; Agriculture Transformation Agenda, Nigeria Economic Sustainability plan (2020), Global Forest Resources Report (2020), The Agriculture Promotion Policy (2016 – 2020), National Gender Policy Strategic Framework (Implementation Plan) 2008 – 2013; Nigeria's Vision 20:2020 sought to improve agricultural productivity by enhancing yield per hectare, reducing post-harvest losses, and increasing processing and integration with an industrial value chain to feed the nation's growing population. Nigeria's Medium-Term National Development Plan (MTNDP) - 2021-2025 and the Revised Draft National Policy on Gender in Agriculture (2016), and Nigeria's Nationally Determined Contribution (2021).

Further efforts to align Nigeria's Agricultural policies along sustainability pathways lead to the introduction of the National Agricultural Technology & Innovation Plan (NATIP) 2021-2024. NATIP provides a robust analysis of the policy trends in agriculture between 1960-2019. The policies collectively

capture a wide base of strategies for enhancing agricultural productivity, human livelihood development and sustainable growth and development. Key policies and plans of direct relevance to desertification control in Nigeria include:

- National Policy on the Environment,
- National Drought and Desertification Policy,
- National Drought Preparedness Plan and
- National Action Plan to Combat Desertification (NAP). Other policies and plans of action that are relevant to desertification control and drought mitigation include:
  - Nigeria National Environmental Action Plan (NEAP) and States Environmental Action Plans (SEAPs),
  - Nigeria Climate Change Policy and Response Strategy,
  - National Adaptation Strategy and Plan of Action for Climate Change,
  - National Forestry Action Plan,
  - National Conservation Strategy,
  - National Biodiversity Strategy and Action Plan (NBSAP),
  - National Resources Conservation Action Plan,
  - National Policy on Agricultural Policy (NPA),
  - National Water Resources Master Plan (NWRMA).

The Federal Ministry of Agriculture developed the Nigeria Strategic Investment Framework (NSIF) for Sustainable Land Management (SLM) 2010-2020, with Cross River State as the center of excellence. It aligns towards achieving long-term economic growth, guaranteeing food security and conservation of the nation's resource capital. The key components of the framework include Integrated Nutrient Management (INM); Strengthening policy and Institutional environment for SLM; Strengthening Commercial and Advisory Services For SLM And Alternative Livelihood Options; Supporting SLM research, and dissemination of best techniques: to promote the creation of additional knowledge to support SLM interventions; Improving and strengthening SLM knowledge management, monitoring and evaluation and information dissemination: this is aimed at ensuring that knowledge generated is managed and communicated in a user-friendly manner to SLM stakeholders.
Legislative frameworks to guide the sustainable transition of agriculture have been formulated at diverse decision-making levels. Within the banking sector, investment in natural capital and circular economy is regarded as the foundation for contributing to the Sustainable Development Goals (SGDs). To this end, the Nigerian Sustainable Banking Principles (2012) report jointly signed by the Bankers' Sub-Committee on Economic Development and Sustainability, in conjunction with sector regulators and financial services providers, has committed to promoting investments in businesses within the three priority sectors, namely the Agriculture Sector, Power Sector and Oil and Gas Sector. In addition, the Economic Growth and Recovery Plan (EGRP) and the National Technology and Innovation Plan (NATIP) have detailed the needed direction to help Nigeria build capacity in food production along the sustainable economic growth and development principles. NATIP, a 4-year strategy, aims to achieve knowledge and technology drive in agriculture for sustainable national food security and nutrition, diversification, jobs creation and resilience.

Reducing GHG emissions from AFOLU offers a great opportunity for Nigeria to contribute to climate change mitigation at global, national, and local levels whilst supporting millions of smallholder farmers to adapt to climate change impact. The vision will also deploy low- carbon agricultural adaptation technologies and practices, water management in irrigated rice farms, low methane fodders for livestock, low-input farming; development of soil carbon storage methodologies and management; and replacement of fossil fuel with clean energy sources. The Government will pursue Research and

Development on these low-carbon farming practices and expand education and support for farmers for wider application. The Government will also scale up certification and labelling of low–carbon agricultural produce, meats or dairy products that are produced using farming practices that minimise inputs, such as chemical fertilizers and pesticides. In the urban areas, significant effort will be targeted at

- optimizing the use of city long spaces by diversifying uses, for example, agripolis urban farming systems, while promoting urban forms that are resilient to the effects of climate change, and
- stopping degradation of agricultural, natural and forest areas and limiting the drying of wetlands [45].

The implementation of the NDC will also enhance the transition to a circular economy and offer Nigeria several opportunities to advance the attainment of sustainable development goals in the country by mobilising finance for climate change from diverse sources and creating an enabling environment for private sector investment in climate mitigation and adaptation, presenting a common force to strengthen national adaptation efforts, transition into a low-emission resilient development pathway and help mainstream climate action into sectoral policies and investments, among others.

This approach supports national efforts on the attainment of SDGs, and all that Nigeria now needs is a further development of the political framework and existing institutions to strategically plan and implement the necessary climate change and adaptation measures within a well-formulated long-term vision of development [39].
The policy challenges and opportunities for policy reforms in the AFOLU sector are briefly highlighted:

1. Challenges within AFOLU Sector
    - Agricultural policies and programs have since post-colonial years undergone several changes based on inconsistency in various organisational networks and mandates.
    - Unregulated development processes and land uses.
    - Despite the plethora of policies, Nigeria is yet to achieve food security.
    - Paucity of data and statistics on current available natural capital stocks; for instance, within the protected area networks, data on plants and animals have not been updated in the past four decades.
    - Obsolete technologies still in use, especially amongst small-land holder farmers.
2. Opportunities within AFOLU Sector
    - Development of new innovative technologies in congruence with emission targets.
    - Development and maintenance of green zones and conservation landscapes, particularly within urban areas.
    - Availability of options to strengthen and build a stronger intersectoral relationship as agriculture intersects with different sectors within the economy.
    - Reducing losses and waste of foods, including changing diets.
    - Diversified commodities portfolio and substitution of energy sources, e.g., biofuels development instead of fossil fuels.
    - Changes in natural wood consumption to combat current levels of logging.
    - Promotion of Sustainable Food and Agriculture (SFA) to achieve zero hunger and the SDGs through the integration of the five key principles of SFA, i.e., Increase productivity, protect, and enhance natural resources, improve livelihoods, and foster inclusive economic growth, enhance the resilience of people, communities, and ecosystem, and Adapt governance to new challenges.
    - Development of Climate Smart Agricultural (CSA) Products.
    - Investments in Research and Training for development of CSA products.

3.3 Circular Agricultural Business Systems in Nigeria: Investment Gaps

Agriculture is an economic mainstay that presents multiple socio-economic benefits for Nigeria and its inhabitants. Despite the mounting challenges that the sector has grappled with over the years, the agricultural sector provides enormous investment opportunities in natural resource capital and circular economy development for investment through Public & Private sector partnerships. This includes accelerating the growth and development of the sector through eco-preneurship options to increase employment opportunities and reduce poverty in Nigeria. This involves the production of crops and livestock, predicated on the continuous interplay of natural resources and cycles to consistently support sustainable agricultural production, and also provides viable opportunities for investment in the agricultural sector. The typical agri-food system is categorised into three major comments: Upstream, Mid-Stream, and Low-Stream. Within each of these streams are several natural capital developments and circular economy opportunities. The Circular Economy investment gaps and opportunities in the agro-business sector are highlighted in Table 3.2.

Table 3.2: Circular economy flow components in the agri-food business sector.

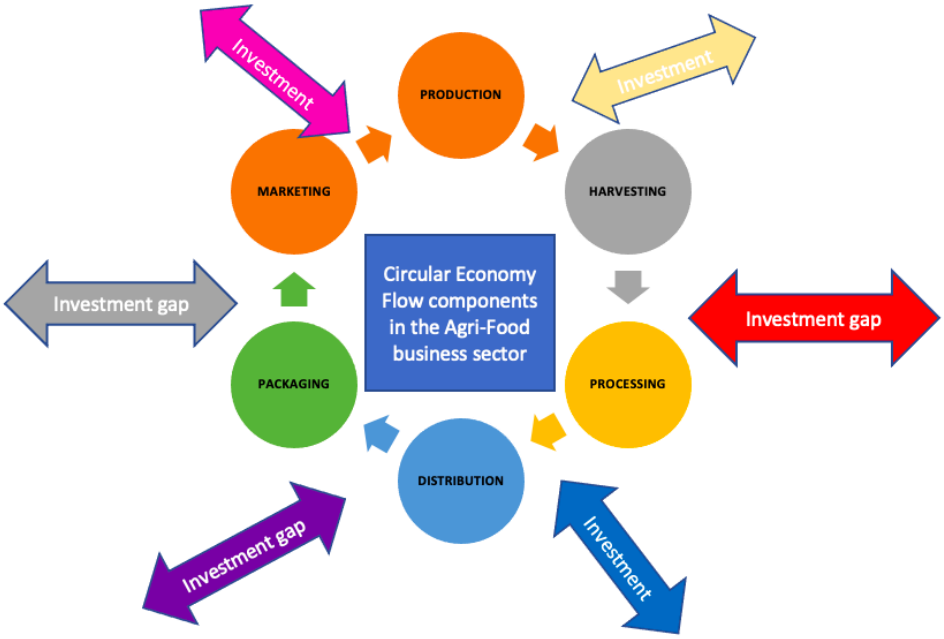
S/n	Agri-food system	Investment gaps	Investment opportunities
1	Production	• Manure management and materials recovery. • Fish feed production facilities and Hatcheries. • Wastewater recycling facilities and treatment plants.	• Manure processing facilities- possible investors include political support from state governments, grants from World Bank, Bank of Agriculture, Agro – Allied Banks. • Lower cost Fish feed processing facilities for large-scale aquaculture entrepreneurs. • Modular wastewater recycling plants that target quality water reuse for fish farmers. • Techniques for Nutrient and Energy recovery from fish farm wastewater. • Techniques for reuse of stormwater and rainwater for fish farms. • Wood Ash up – cycling from forests, timber markets, carpenter's workshops. • Possible investors include private collaborations, SMEs.
2	Harvesting	Regenerative produce machinery: inputs, processing storage distribution; farmer training/ technology.	• Waste collection sources – crop residues from farms and forests, organic wastes from markets, supermarkets, homes, event centres, schools, recreational sites, restaurants, and hotels. • Possible investors include private sector partnerships, SMEs, micro finance bank. • Eco-friendly fish drying kilns such as provision of Solar PV for fish processors. • Provision of climate-controlled logistics and energy efficient technologies.
3	Processing	• Primary processing (mild processing). • Secondary processing. • Tertiary processing (ultra-processed food).	NIRSAL, state and local governments, private collaborations, SMEs.
4	Distribution & retailing.	This includes transportation, supply, marketing, trading, and selling.	Private collaborations, SMEs.

3.4 Food Systems: NCAA and CE Value Chain Analysis in Nigeria

There are typically seven major Agric-business component links in Nigeria, namely:

1. Natural capital.
2. Production: within large, medium, and small scales or scopes, cooperatives, and associations.
3. Harvesting & Distribution: where post-harvest gains and losses may be incurred and distribution of products by farmers requiring storage and logistics.
4. Processing: along a three-tier level namely primary, secondary, and tertiary, and at small, medium and large-scales.
5. Production Distribution: requiring logistics.
6. Packaging: provides the required packaging solutions to compliment the marketing of products for sale within retail stores.
7. Retail & Outlets.

The circular economy model provides opportunities for agric-based investments that can be harnessed at various levels to stimulate growth and development and enhance Nigeria's natural capital base. The



circular economy flow chain (Figure 3.1) highlights the sectoral investment gaps/opportunities within the agricultural chain using color-coded arrows. The nature of circularity requires the critical development of viable, sustainable alternative processes to reduce the carbon footprint in the agriculture and food systems sector. This method is preferable to the business-as-usual model approach that is linear based from production to marketing. Circularity embraces the net-zero-waste approach where off-cuts such as post-harvest losses and food waste are regenerated for re-use within the system. Table 3.3 x-rays the agricultural Stream Sectors & Players in Food Production, Forest, and Non-Forest Products, highlighting the stakeholders and actors' investment segments, gaps and opportunities of the agricultural sector.

Table 3.3: Agri-Food System Investment Gaps and Opportunities

Sector Category	Stakeholders	Production	Benefits	Challenges	Opportunities	Value Chain Actors	Financial/Support Services Required
Upstream	Food production, forest, and non-forest products. 1. Land Ownership and Fishing Rights 2. Fertilizer Suppliers 3. Irrigation System Suppliers 4. Machinery and Equipment Suppliers 5. Plant Protection Product Suppliers 6. Seeds Suppliers 7. Fingerlings 8. Fish Feed Suppliers 9. Transport (in bulk by truck, train, ship, or aircraft) and Storage Providers 10. Energy 11. Wood Product Suppliers Wood Manufacturing which includes machinery and equipment suppliers	Natural capital Input Supply 1. Natural capital land or water 2. Seeds, Fish Feeds, and fingerlings. 3. Equipment. 4. Materials Production: Human or machine labour.	Reduction of waste generated in food systems.	Poor practices; traditional and inefficient technologies .	Create re-use opportunities (plant biomass into organic fertilizers), utilisation of by-products and food waste into organic feed for livestock, wastewater treatment plants for recycling of water inputs.	Financial: Banks/ Agric-Banks, Micro–Finance Institutions; Non-formal Credit schemes e.g., Esusu groups. Non-Financial: Input Suppliers/Companies Farmers, Fisherfolks, Fishmongers, Communities.	Investment & Training. Capacity building for better farming practices crop protection, animal health and nutrition, crop insurance and food, management.

Midstream (Primary & Secondary)	Recycling, recovery and re-use of agricultural products, forest, and non-forest products. 1. Traders 2. Distributors 3. Processors 4. Packagers Wholesalers/Retailers	Production & Processing. Manufacturing or processing outfits/Firms/ Storage facilities. Distribution & Logistics agents & partners.	Food processing. High efficiency energy consuming facilities & machines.	Post-Harvest wastages.	Low carbon emitting technologies use of solar hot water, air source heat pumps, ground source heat pumps, biomass heating, efficient gas boilers, wind turbines to generate energy.	Financial: Banks. Non-Financial - Subsistence farmers, Commercial Farmers.	Training to high tech Agro companies: farmers, large-scale fisheries and traders, handling, processing.
Downstream	Recycling, recovery and re-use of agricultural products, forest, and non-forest products. 1. Biomass Production A. Machinery and Equipment suppliers. B. Transport (in bulk by truck, train, ship, or aircraft) and Storage Providers. 2. Biogas or Biofuel Production A. Machinery and Equipment suppliers. Transport (in bulk by truck, train, ship, or aircraft) and Storage Providers	Transport & Distributors: Local and Foreign markets. Marketing.	Service provision. Low – carbon alternatives. Effective & efficient transport system.		High yielding input/ Improved varieties Provision and finance provision.	Financial: Banks. Multinational corporations, Agric cooperatives. Non-Financial provision.	
FORESTRY SECTOR							

Upstream	1. Forestry Department/Commission 2. Forest Ownership 3. Loggers 4. Machinery and Equipment Suppliers 5. Transport (trucks/trailers) and Storage Providers 6. Energy 7. Wood Manufacturing which includes machinery and equipment suppliers 8. Fuelwood extractors 9. NTFPS' gatherers Extraction ion of non-woody products (e.g., bushmeat, snails)	Natural capital Input Supply: 1. Timber 2. Non-Timber Forest Product (NTFPs) e.g., leaves, seeds, resins, spices, fodder, Non-Woody Forest Product (NWFP).	Sustainable harvesting Provision of ecosystem service.	Unsustainable harvesting; Deforestation and forest degradation; Biodiversity loss.	Promoting sustainability in value chains and CSR engagements; afforestation/ecological restoration; harnessing biodiversity; Agroforestry system/domestication of forest products; environmentally friendly wood utilisation technologies, establishment of fuel wood lot.	Multiple financing options: green bonds, FIP, PES/carbon finance; CSR commitments.	Private sector investment in forestry sector; Capacity building for sustainable harvesting; Afforestation and agroforestry.
Midstream	1. Forestry Department/Commission 2. Timber processors 3. Wood dealers 4. Machinery and Equipment Suppliers 5. Transport (trucks/trailers) and Storage Providers	Processing of timber products, sales of NTFPs, NWFP.	Increase in number of jobs; Forest goods and services support the economy livelihoods.	Post-harvest wastages; high energy use from Fulwood.	Increasing products value through sustainable certifications; Use of residues from wood processing industries, post-consumer recovered wood and processed wood-based fuel; use of sawdust for making brittle; Converting material	Multiple financing options: green bonds, FIP, PES/carbon finance; CSR commitments.	Private sector investment in forestry sector; Capacity/training on new technology for the sustainable processing, recycling, and reuse of materials.

	6. Energy supplier 7. Fuelwood dealers (wholesale) 8. Charcoal producers 9. NTFPS' dealers (wholesale) 10. Dealers of NWFP (wholesale				into industrial products.		
Downstream	1. Wood dealers 2. Transport (trucks/trailers) and Storage Providers 3. Fuelwood supplier (retail) 4. Charcoal supplier 5. NTFPS' supplier Suppliers of NWFP (retail)	Distribution and marketing of products; export to foreign market.	Increase value of marketed wood fuel; Roundwood.	Increase demand for wood and non-wood product.	Recycling and reuse of waste products; pro-forest livelihood; development of land use planning and management; support forest management plan; Bio-based materials/ biochemical processing.	Multiple financing options: green bonds, FIP, PES/carbon finance; CSR commitments.	Private sector investment in forestry sector. Training for conversion of materials and increased value chain of product. Sustainable funding for implementation; building capacity in knowledge management, MRV and database management.
	OTHER LAND USES (E.G. MINING)						
Upstream	1. Ministry of Mining 2. Ministry of Environment 3. Land Ownership 4. Machinery and Equipment Suppliers 5. Transport (trucks/trailers	Extraction of Solid minerals.	Low cost and low energy.	Deforestation, land degradation land use and land tenure conflicts.	Remediation of old mines, reclamation of tailings and bye products from mine sites.	Multi-national corporation; Bank of Industry; Nigerian Association of Chambers of Commerce, Industry, Mines, and Agriculture (NACCIMA).	Building capacity of the local and business community to actively explore and exploit the mineral resource.

	) and Storage Providers 6. Energy providers Labour						
Midstream	1. Wholesale 2. Processors Transporters	Processing and conversion of solid minerals to other goods.	Production of goods and jobs within the solid mineral value chain.	Increase in waste products, Post-production wastage of resources; high energy inputs; environmental pollution.	Enhancing low-energy mineral exploitation technologies, creating green jobs.	Multi-national corporation; Bank of Industry; Nigerian Association of Chambers of Commerce, Industry, Mines, and Agriculture (NACCIMA).	Building capacity of the local and business community to actively explore and exploit the mineral resource.
Downstream	1. Distributors Transport	Transportation, distribution, and marketing of products; export to foreign market.	Service provision. Low–carbon alternatives. Effective & Efficient transport system.	Post-production wastage; high cost of investment in mining processes.	Exploring networking opportunities and linkages to local and international markets; investment in green mining.	Multi-national corporation; Bank of Industry; Nigerian Association of Chambers of Commerce, Industry, Mines, and Agriculture (NACCIMA).	Building capacity of the local and business community to actively explore and exploit the mineral resource.

3.5 Scenario Analysis: Agriculture, Forestry and Other Land Use (AFOLU)

3.5.1 Synopsis of Gaps and Barriers

AFOLU sector relies on natural resources and has the potential to compensate for emissions through carbon sequestration and storage, which can deliver economic, environmental, and social benefits. However, there are barriers that hinder the provision of such sustainable benefits. The poor diversification of the economy and reliance on crude oil with 70% of revenue and 90% of foreign exchange earnings from the oil sector in 2019. The decline in oil prices arising from the COVID-19 pandemic threatened the country's economy. This underlines the intense need for greater diversification [16]. In Nigeria, agriculture remains the largest contributor to the nation's GDP contributing 24.6% in Quarter two of 2020. It remains the highest non-oil export earner and highest employer of labour. Circularizing the AFOLU sector will provide more jobs and diversify the economy.

Various agriculture and associated policies have been put forward (see Chapter 3 - Policy Context & Review), some of which can address the CE and NCAA challenges within the AFOLU sector. However, some of the major barriers to the realisation of CE and NCAA opportunities in the AFOLU sector include the weak legislative frameworks of these policies to enable implementation strategies.

Nigeria's approach to strengthening its agricultural sector has, until now, lacked the innovation and foresight needed to generate an ecologically and economically sustainable agricultural economy. Thus far, government policies have focused entirely on intensification of production through traditional high-external input and resource-intensive agricultural techniques (Centre for the Study of the Economies of Africa [46]. This has resulted in vast deforestation, biodiversity loss, water scarcity, soil depletion, and high levels of greenhouse gas emissions [47].

Nigeria is the world's third largest producer of bioenergy in the form of fuel wood, agricultural residues, animal, and forestry waste [46] with over 70% of the population depending on fuelwood as a source of energy. The waste can be harnessed to provide energy for people depending on fuelwood. The reliance on non-renewable energy still persists. Also, the firewood and charcoal sector involves some 41 million workers and provides an estimated 530,000 full-time equivalent direct jobs. Some additional 200,000 workers, most often also full-time employment, provide transport services for retail and wholesale trade. Any measures that look to limit the use of firewood will need to manage this transition carefully [39]. The increase in the number of people involved in the fuelwood business posed a threat to forests leading to biodiversity loss, climate change, and pollution and arousing the need for land, natural resources, and waste management.

Appendix 2 shows the scenario analysis within the Agriculture, Forestry and Other Land Use (AFOLU) sector. We have identified some key linear economy issues, such as poor land management practices plaguing this key priority sector along with its effects on the environment. The table also lists possible opportunities for CE/ NCA businesses that could be realised in this sector. Further, we highlighted some strategies needed in promoting NCAA with these sectors and Policy responses and reviews to these issues. Accounts required for NCAA were also listed. Appendix 2 identifies three issues: poor land management, food loss/ waste in the agricultural food value chain, and livestock waste. We analysed the effects of these issues and catalogued the opportunities for CE and NCA businesses. Further, Appendix 2 highlights strategies to promote NCAA, proposed policy responses (for solving CE and NCA challenges) and policy reviews (to indicate how to adapt the proposed policies. See Appendix 2 for more details.

Famers-herders crisis is another major issue relating to AFOLU sector. This difference in the perception by herders and farmers of the social value and use of land has also defined their social relation of competition and conflict. Changing patterns of land reforms have increased the competitive demands for land between the owners of land (farmers) and the "landless" (herders). The principal driver of conflicts between farmers and herders is economic in nature, with land-related issues at the centre, especially issues of accessibility and use of land and water resources. Conflicts from land encroachments have created economic hardships in various communities and pressure between farmers and herders [48]. Land and water resources are under increasing stress due to climate change, leading to fierce competition and violent conflict over their use. While climate change was not a precursor to the migration of herders to the southern part of Nigeria, it has increased their migration to the southern forest zone, from areas with increased frequency of drought and lower availability of natural resources into new havens with better resources for their livestock. Unfortunately, the increasing stress placed on shared natural resources—namely fresh water and land as a result of climate change—has further strained the relationships between the farmers and herders.

3.6 Forests and the Nigerian Economy

Forests and woodlands cover about 7.7% (9.6 million hectares) of the total land area of Nigeria. Of the forest cover, primary forests make up 2.9%, modified forests make up 93.9%, while plantations make up 3.1%. The mix of forest ecosystems in the country ranges from mangrove forests around the coast in the south, through a belt of the Guinean Rainforest zone, extensive zone of Guinea Savanna woodland, the Sudan Savanna grassland, and a dry Sahel scrubland in the north, to plantation forests that are scattered across the country.

In addition, forests, trees, and landscapes have long played a critical role in the economic development of many countries, particularly rural economies. The availability of their biological resources as renewable sources of energy, building materials, food, and other ecosystem services. Forests provide raw materials for their products and services. This includes producers of pulp, paper, cardboard, packaging, and biofuel. Similarly, sawmills producing all sorts of boards, planks, roof trusses and other prefabricated construction elements are also included.

The macro-economic and demographic trends have several impacts on the forest sector:

- Firstly, the commercial forest sector is small (0.25% of GDP), about 100 times smaller than the agricultural sector.
- Secondly, it is likely that forests face increasing cumulative anthropogenic pressure as a resource for agricultural land, timber, and fuelwood. On the other hand, unplanned urban expansion can also endanger wetlands' ecosystems, in the case of Nigeria's mangroves and freshwater swamps. Urban expansion around Lagos, Nigeria, caused losses of wetlands in four local government areas of 38-100% between 1986 and 2006 [49].
- Pressure on forest resources results in a reduction in forest cover. However, well-planned development help to reverse forest ecosystem service losses. In Nigeria, significant investments in infrastructure, labour reform policies, national poverty reduction policies, expenditure and revenue-sharing frameworks seek to drive equitable and inclusive growth in cities.

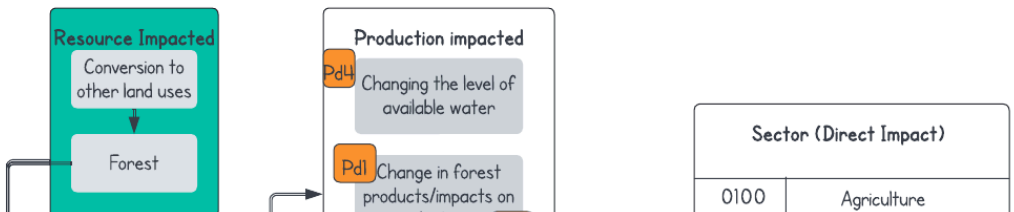


Figure 3.3 presents the scenario to demonstrate a pure carbon mechanism applied in the Eastern Littoral basin (Cross River State), where the CRS returns 25% of the area deforested since 2000 (i.e., 285,000 ha) to forest area through a long-term rehabilitation program.

Macro Biophysical Indicators		
Net ecosystem service value gained	*Million Naira/a*	16,540
Sustainability frontier		70%

Macro-economic impacts		Direct Effect		Total Effect	
Indicator	**Unit**	**Change**		**Change**	
GDP	*Million Naira/a*	-2,901	-0.01%	6,653	0.01%
Compensation of employees	*Million Naira/a*	-1,507	-0.01%	1,602	0.01%
Balance of payments	*Million Naira/a*	399	0.00%	-2,539	-0.03%
Fiscal effect	*Million Naira/a*	1,665	0.19%	7,169	0.84%

In the light of global pandemics and climate change, forestry has been brought into the limelight to increase the economic, social, and environmental resilience of production systems that meet the needs of society. For instance, according to literature, the projected demand for industrial wood in Africa is estimated to grow from about 75 million m^3/per year today to 250 million m^3 per year by 2030 [51]. However, the rate of deforestation and low technology are the major setback for the industry.

3.6.1 Adding value to wood products creates jobs and wealth for youths

Nigeria's forest area has dwindled over the years due to deforestation, expansion of agricultural lands and other agents of forest conversion. Today the country is known to have moderate forest cover at between 11% and 20%, which cannot meet the wood needs of its burgeoning population, more so in the light of weak downstream processing capacities [52]. For instance, it is estimated that Nigeria suffered huge trade deficits of US$ 5.37 billion over a period of ten years (2011 to 2020) or US$ 537 million per year associated with the importation of a few processed wood products: three secondary processed wood products and seven tertiary wood products, valued at US$1.25 billion and US$ 4.12 billion respectively [53]. Wooden furniture and doors, as well as writing/printing papers, remain the dominant products imported by Nigeria.

These statistics, the magnitude of which could be more than double for all wood products imported, are indicative of grievous loss of economic opportunities (jobs, foreign exchange) for Nigeria. Moreover, the huge trade deficits suggest the existence of local demand that could be turned into opportunities for targeted investments in the wood industry. For instance, it is estimated that US$ 44-271 could be earned locally as the potential value added if one cubic metre of sawn- wood is processed into finished products such as furniture. This could create 4-12 times more jobs. The analysis of World Bank data shows that over the period of 20 years (1998 to 2017), the forestry sector only contributes on average about 2% to the GDPs of Nigeria. This could be far more with the industrialization of the sector and better accounting for other forest products and services.

The circular economy is based on the principles of designing out waste, keeping products and materials in use, regenerating natural systems, and empowering consumers. Forestry and the timber industry fit well into these principles. Forests contribute to the substitution of fossil-based materials such as plastics in downstream industries. Forests play a significant role in mitigating CO2 emissions through carbon sequestration. Initiatives that increase forest cover and/or reduce deforestation are wealth examining for low carbon development in Nigeria. There is a need to examine clean technology opportunities that convert wood-based biomass into electricity, heat, biofuels, bio-chemicals, and building materials, as well as technologies such as the use of drones to rapidly afforest and reforest landscapes.

3.6.2 Land Degradation, and Specific Targets to Avoid, Minimise and Reverse Land Degradation

The phenomenon of land degradation can be dated back to the more recent introduction of agricultural expansion programs that favour cash crops production, mainly cotton and peanuts in the Sahelian countries, coffee, cocoa, and pineapple in coastal countries, as well as timber exploitation for varied uses. These trends are generally characterised by uncontrolled production processes and endemic poverty that emanate from a strong dependence of the rural population on natural resources.

In compromising food production, desertification aggravates famine and starvation in areas already affected by poverty. Following the desertification process, the land becomes more fragile, resulting in a significant reduction of its resistance to natural climate variability. In order to achieve Land Degradation Neutrality, Nigeria is leveraging on NERGP, Nigeria's Agriculture Promotion Policy 2016-2020, Nigeria Ecologic fund, and Great Green Wall involving all concerned stakeholders. The policy and legal frameworks related to LDN, including the UNCCD National Action Program (NAP), were analysed, and LDN transformative projects and program opportunities were identified to include:

- Improve land productivity and soil organic carbon stocks (SOC) in 463,300 hectares of cropland and grasslands by 2030 as compared to 2015.
- Rehabilitate 1,722,660 ha of cropland showing declining land productivity and 10,565,040 ha of cropland showing early signs of declining land productivity by 2030.
- Halt the conversion of forests and wetlands to other land cover classes by 2020.
- Increase forest cover by 20% by 2030 as compared to 2015.
- Reduce the rate of soil sealing (conversion to artificial land cover) by 40% by 2030 as compared to 2015.

Desertification and land degradation have a strong negative impact on the food security and livelihoods of the local communities in Africa's drylands, home to the world's poorest populations. In 2007, African Heads of State and Governments endorsed the Great Green Wall for the Sahara and the Sahel Initiative with the objective of tackling the detrimental social, economic, and environmental impacts of land degradation and desertification in the region. The initiative aims to support the efforts of local communities in the sustainable management and use of forests, rangelands, and other natural resources in drylands. It also seeks to contribute to climate change mitigation and adaptation, as well as improve the food security and livelihoods of the people in the Sahel and the Sahara.

Such a biological corridor along the southern border of the Sahara is seen as a means of halting the progression of the Sahara Desert southward, protecting water sources, which have been drying up for decades, and restoring habitats for biodiversity (for energy resources and foodstuffs). Since the launch of GGW, the concept has gradually shifted from a thematic project focusing on the creation of a wall of trees for protection of the land against encroaching sand and erosion to a more holistic and integrated vision of sustainable land management (SLM).

- Prevent further loss of biodiversity and restore already degraded areas and protect ecologically sensitive sites.
- Harness and sustain natural resource use.
- Reduce the impact of climate change on socio-economic development processes.
- Make Nigeria a visible actor in global climate change response.
- Halt land degradation, combat desertification and mitigate impacts of droughts.
- Secure a clean environment through appropriate waste management.
- Reduce the occurrence and impact of environmental hazards and disasters.
- Raise the level of awareness on the state of the Nigerian environment and
- Improve the overall governance of the environment.

3.6.3 Mitigation Action

Agriculture, Forestry and Other Land Uses (AFOLU) is the second largest contributor to total GHG emissions, contributing approximately 25% of national total GHG emissions in 2018. As well as being the second largest source of GHG emissions in Nigeria, the AFOLU sector is also hugely important for climate adaptation. For example, more information on the important role of nature-based solutions in adaptation, afforestation, and reforestation; sustainable forest management and reducing deforestation; cropland and tree crop management; grazing land and rangeland management; restoration of organic soils; fisheries management; and wetland and peatland rehabilitation and management. Table 3.4 shows some proposed GHG mitigation measures in the AFOLU sector of the country.

Table 3.4: Some GHG mitigation measures for AFOLU sector.

S/N	Sector	Measures
1	Agriculture	• Climate smart agriculture – a range of measures taken forward as an integrated approach to managing landscapes (e.g., cropland, livestock, forests, and fisheries). • 50 % of cultivated land adopts intermittent aeration of rice paddy fields. • A 50 % reduction in fraction of crop residues burnt by 2030.
2	Forestry and other Land Uses	• Improved natural forest management (128,528 ha of natural forests in the southern belt and southwest quadrant of the country). • Forest restoration (115,584 ha of degraded forest area across the states in the southern belt, southwest quadrant and in states located in the savanna ecological zone of the country). • Increased forest protection (46,219 ha of forest throughout the country). • Reduced fuelwood harvest (Reduce the area of forestland used for fuelwood harvesting by 19,346 ha). • Protection and restoration of mangrove forest ecosystems (13,012 ha of mangrove ecosystems across all the coastal states in the Niger Delta).

3.7 Green jobs and a Just Transition

3.7.1 Green Jobs

A key co-benefit from climate action will be the creation of green jobs. The impact of Nigeria's climate policies on employment, GDP and emissions is evidently challenged by the increasing job losses

orchestrated by the prevailing economic backwardness. Hence, it is projected that over the period 2020 up to 2035, on average, around 12 million net additional jobs will be added across the economy as compared to a baseline scenario. The significant increase in employment needs to be interpreted in light of the significant capital investments (USD 80 billion), which generate massive job opportunities in construction and installation in the short to medium term. In addition to the first short to medium-term effect, secondly, it is imperative to consider the long-term structural change effects. Comparing the 11 policies studied in the report, there are significant differences in terms of size, but all have an overall positive employment and economic growth effect, which lasts beyond 2035. Appendix 3 shows the various green jobs for youth and women in various ecozones in Nigeria as used in Cross River State green economy.

A policy that would incentivize climate-smart agricultural production systems has the potential to add some 3 million net jobs across the economy. The report also considered the cost-effectiveness of green jobs potential from different mitigation measures. For example, comparing the Biofuel with the Cement policy reveals that both policies add a total of around 800,000 jobs to the economy. Agriculture, Forestry and Fishery sector results in the highest job-creation multiplier platform. Economy-wide, between 230 and 290 job opportunities are created per one million US dollars invested while reducing GHG emissions by up to 30 tons (such as through tree planting). The job multiplier in renewable energy is also comparatively high, with approximately over one hundred and fifty (150) jobs.

3.7.2 Potential Green Jobs

The potential green jobs used in CRS presented in Appendix 4 identified different jobs across economic sectors and ecological zones. Agriculture sectors offer green jobs in processing and marketing organic manure, fodder production, and vegetable gardening. Other potential jobs in agriculture that also include some aspects of forestry include commercial fuel woodlots, domestication, and marketing of NTFPs, apiculture, snailry, and rearing of bush meat, among others. The forestry sector has the potential for jobs such as domestication and marketing of NTFPs, honey production, commercial production of woodlots as an alternative to fuel wood and building material etc.

Presently, there are some ongoing projects funded by GEF which are relevant to LDN. They include Sustainable Fuelwood Management in Nigeria at 20.9 million. USD, Food-IAP: Integrated Landscape Management to Enhance Food Security and Ecosystem Resilience in Nigeria at 64.3 million. USD and LCB-NREE: Nigeria Child Project: Comprehensive and Integrated Management of Natural Resources in Borno State at 35.8 million. USD. Also, the Imeko/Aworo restoration project to restore 108,000 hectares of degraded land is in design.

The following are suggested Forest-based circular bioeconomy business models in Finnish SMEs by D'Amatoa, Veijonahoa, and Toppinen (2020) [54] namely:

- Maximizing material and energy efficiency was realised by the selected companies through the offer of environmentally and/or socially more sustainable products and services created through technological improvements (reducing inputs and outputs). This contributed to reducing costs (e.g., less raw material needed, lower transport costs) and reducing the environmental impact.
- Creating value from waste was operationalised by recycling raw materials and waste in production, possibly by turning them into higher-value products or services. For instance, we use sawdust here as a raw material, which is a by-product of the spruce sawmill. We make a product from it with quite high added value.

- Substituting with renewables and natural processes was realised by using forest-based renewable resources for production. These new raw materials can be compatible with existing production technologies or require innovations. In addition, these new products can have better or more unique qualities than existing alternatives: 'We can create different patterns and looks for the material with wood chip fractions. And what is maybe special compared to other composite products is that the resin we are using is as clear as glass. So, in a way, the look of the material comes from the wood chips inside the composite'.
- Adopting a stewardship role were found in the use of certified materials and the communication of lifecycle impacts to influence customers' buying behaviour. Value was captured by the higher price resulting from branding and reducing environmental impacts during production.
- Encouraging sufficiency concerned products designed to be more durable: concerned products designed to be more durable: '[. . .] that is why we have tried to position our product in this (shopping) bag field as an environmentally-friendly, multi-use bag, which can be used multiple times – the bag facilitates this because it lasts so well' (CEO, Company G); 'It is light and durable, so the idea is that it will last for a long time and there will be no need to get rid of it (Export manager, Company H).
- Developing scale-up solutions was operationalised by the companies by designing products or ideas that could be sold on or exported, for instance, through licensing or developing new value chains with partners.

Expanding the frontiers of forest-based circular bioeconomy measures is critical in Nigeria despite the vast resources in the ecological system and given the other resources in socio-economic systems such as waste and bio-resources. Harnessing these resources through investment in the various resources would be a source of (much needed) green jobs in the various sectors.

Table 3.5 indicates the number of green jobs and the estimated amount of investment required with indicators to measure the success in each sector in Nigeria.

Table 3.5: Potential Jobs by Sector

S/N	Sectors	Sub Sector	Jobs	Period	Other Benefits	Estimated Investment Required/yr.	Indicators
1	Energy	Solar Power	250,000		Powering 5 million Households	$3 billion	No. of people using solar power; increase in energy supply.
		Biofuel	800,000	2020-2035	Availability of Bioenergy	$3.6 billion	No. of households that switch to bio-fuel.
		Other Renewable Energy (hydropower)	540,000	2020-2035	Affordable energy	$2 billion	Quantity of renewable energy supply and quantity demanded.
		Clean Cooking Solution	24,000	2020-2035	Reduction in carbon footprint per household	$3600 million	No. of households using clean cook stoves.

2	Agriculture	CSA	3 million	2020-2035	30 tons GHG reduction; increase in carbon stocks.	$3675.5 million	Emission reduction from agricultural activities Carbon stocks per ha/yr of forest; Annual emission reduction per ha of forest.
	Forestry	Reforestation	828,000 – 1,044,000	2020-2035			
3	Water	Water use efficiency	612,000	2020-2035	Water security	$8 billion	Quantity of portable water supply.
4	IPPU	Cement	270,000-288,000	2020-2035	Increase in number of employments; emission reduction.	$7594 million	Reduction in emissions per tons of cement production.
	Iron	Steel	72,000	2020-2035	Emission reduction.	$3,797 million	Reduction in emissions per tons of steel production.
5	Service	Expansion of BRT	306,000	2020-2035	Emission reduction.	$3.6 billion	Reduction in Emission.

Source: Adapted from Nigeria's NDC, Nigeria Green Jobs Assessment Report

3.7.3 AFOLU Sector Recommendations

There is significant justification for scaling up low-carbon investment in Nigeria. In line with the global Sustainable Development Goals (2030), governments are opting for the triple bottom line policies, measures and programs that foster low-carbon- high growth economy pathways to build a climate-resilient society. This is particularly vital in the AFOLU sector, where the human pressures created by the unending demand and supply of resources, environmental benefits, and challenges have promoted the need for circularity along eco-investment lines with opportunities for job creation and livelihood.

AFOLU, as a pivotal sector, has viable incentives that could provide the needed catalyst to mainstream circular economy, green economy, blue economy, and natural capital business development opportunities for sustainable production. The challenging situation of varied concerns that plague AFOLU is captured as follows:

- Weakness of enabling Agriculture and other Land-use development policies/regulations – Product certification through quality controls, price stabilisation and land use taxation regulation for building natural capital through agriculture or nature-based solutions have impacted the sustainability of the AFOLU. This is in addition to financial support for agri-business and sustainable land-use development, innovation, procurement policy, research & development, and standards.
- Existence of Database and information for investment decisions on Circular Economy/Natural Capital activities – The absence or unavailability of agricultural input data on production, processing, and associated biophysical assets, agro statistics, etc., pose huge constraints to investors. There is also insufficient collated information on Circular Economy opportunities due to the weak nexus between policy and research.
- Access to Technology – The presence or absence of this could affect the scaling up of Circular Economy businesses among Medium and Small -scale platforms.
- Access to Financial Services – E.g., Credit and insurance for Circular Economy businesses would be critical for innovative agric-produce waste re-generation, mix-rotation crops along hyper-flexible environments that do no constraint the development of private forestry and private sector interventions in ecosystem restoration projects.
- Infrastructure – Availability of the necessary infrastructure to provide the investment incentives and opportunities for Circular Economy enterprises to thrive across the various industrial sectors.

Agriculture, Forestry and Land uses have significant socio-economic and environmental impacts on Nigeria's economy; therefore, the transition to a circular economy should be tailored towards circularity along the following recommendations:

- Review of the extant policies, laws, and regulations to make AFOLU compliant with Natural Carbon Accounting and Circular Economy.
- Build capacity at institutional and individual levels as a requirement to deploy agricultural resources to drive Circular Economy.
- Engage stakeholders, private sectors, civil society, and communities in a collaborative approach in the use of efficient practices.
- Upscale of green job opportunities through sensitization, awareness using locally available innovation (Table 3.5).
- Strengthen institutional affiliations for private partnerships.

Support sustainably smart innovative creations within AFOLU.

4. Baseline Scenario & Analysis: Services Sector (Waste & Water)

Highlights

- Nigeria generates up to 63 million tonnes of domestic waste every year and only about 30-50% of it is collected.
- Waste collection uses unsustainable techniques that have serious health and environmental consequences.
- As much as 70% of waste generated in the country is recklessly disposed of, thereby polluting the surroundings where they are generated, leading to large heaps of refuse, untidy environments.
- However, there is a significant economic opportunity to turn enormous volumes of waste into profit in an investor-friendly waste industry.
- Nigeria is a signatory to many conventions and treaties and has also domesticated the treaties as a foundation for NCAA and CE in the waste sector.
- The National Policy on Solid Waste Management (2018) and the National Policy on Plastic Waste Management (2020) are the latest national trash management regulations.
- In recognition of its rising influence on the release of GHG emissions and its great potential for providing opportunities for numerous stakeholders, the waste sector in Nigeria was recently included in Nigeria's 2021–2025 revised NDC.
- There are institutional frameworks for waste regulation and management across the different tiers and levels of government with the Federal Ministry of Environment as the lead through NESREA.
- Government and private sector work in silos in waste management which affect harnessing NCA and CE in the waste sector.
- There are existing large-scale procedures involving recovered packaged plastics such as PET, flakes, and pellets for reuse in construction industries that create opportunity for NCA and CE in the waste sector.
- In the aspect of wastewater, there are no processes and legal framework for managing/reusing wastewater.
- The country loses about 455 billion naira yearly, equating to about 1.3% of GDP to poor sanitation.
- Nigeria has significant water resources, estimated at 333 billion m^3 of surface water and 88 billion m3 of Groundwater.
- If these resources are harnessed, promoted, and assisted by the public-private partnerships it will help Nigeria to transition to a more circular economy that improves its natural capital.

Current status

- Assessment of waste management legislation revealed that Nigeria's waste sector legislation contains several natural capital and circular economy-oriented traits.
- Most existing policies and regulations have been shown to be NCA/CE compliant as they have incorporated modern circular and sustainable measures in them.
- Waste collection does not keep pace with waste generation resulting in indiscriminate disposal and environmental pollution.
- There are various activities and initiatives to address some waste management challenges as well as institutional and legal frameworks that are NCAA and CE compliant.
- There is huge energy production potential in the country: if 1 tonne of MSW will produce approximately 500-600kWh of electricity. Therefore, 13-17 million tonnes have the potential to produce a minimum 6500GWh (6.5 x 109kWh) and maximum values reaching 10,200GWh (10.2 x 109kWh).
- Nigeria buys more than 500,000 tonnes of used electronic equipment each year. The amount of e-waste being produced every day across the nation increases since a quarter of this amount is faulty and non-operational upon entrance.
- Also, as much as 99.6% of e-waste produced is informally recycled using unsustainable techniques to retrieve useful substances.
- It is important to understand that toilet resources are mostly made up of water; faeces include up to 75% water, whilst urine comprises 95%.
- It appears that Nigeria lacks a defined legislative and regulatory framework for wastewater management/reuse.
- However, there are relevant institutional authorities for waste management, which in virtually all situations is limited to solid waste management.

Challenges

- Inadequate waste transformation/conversion results in a significant amount of indiscriminate waste disposal.
- The major challenges in the waste sector include inadequate private-sector drive and investment, a lack of good leadership, and a reluctant attitude among stakeholders.
- There is also a lack of waste data for effective planning and clear processes of providing support to aid local capacity in developing feasible waste projects.
- Poor enforcement of legislation, duplication, and lack of clarity of duties among establishments, limited funding, application of inappropriate techniques, mass ignorance of the consequences of inadequate waste management practices, poor maintenance, absence, and visibility of waste-related records are problems of management.
- lack of funding hinders the implementation of efficient waste management strategies across the country, degrading Nigeria’s natural capital.
- The Federal Government-initiated schemes currently have various challenges as many recycling plants are not operating at their installed capacities or operational.

Way Forward/Recommendations

- Private sector umbrella organizations should work with the appropriate government entities to provide industry-specific rules for different waste streams.

- It is vital in implementing natural capital and circular economy plans due to its role in environmental legislation enforcement.
- Public-private partnerships should be strengthened to foster effective waste management and waste conversion to other utilities and electricity generation.

Waste

4.1.1 Situational Analysis: Baseline Scenario

The average Nigerian produces 0.58kg of solid waste per day [55], and this figure is expected to increase as the sub-Saharan region is the fastest-growing region in the world, with waste expected to rise by threefold by the year 2050. These waste materials consist of municipal solid waste (MSW), industrial waste and wastewater, domestic wastewater, and other unclassified waste. MSW in Nigeria primarily consists of organic waste, plastics, paper, wood, textiles, e-waste, and other inert materials which are most times disposed of indiscriminately, and this unwholesome practice is usually a result of the low socio-economic status of the Nigerian citizens, weak regulatory systems, and lack of environmental knowledge among the general populace [56].

Waste management remains one of the significant challenges facing the Nigerian environment. Only about 30-50% of the municipal solid waste produced annually is formally collected [57], implying that a large percentage of wastes generated is unrecovered, untreated, and destroyed without any form of regeneration for utilisation for various other purposes.

The 2014 Waste Atlas Report states that six of the largest dumpsites in Africa are in Nigeria (Bioenergy):

- Olusosun dumpsite in Lagos, which is the largest in Nigeria with an area of 43 hectares and is 18 meters deep, receiving 2.1 million tonnes of waste every year.
- Solous 2 dumpsite in Lagos, which has an area of 8 hectares and receives 820,000 tonnes of waste every year.
- Epe dumpsite in Lagos, which covers 80 hectares of land and receives 12,000 tonnes of MSW every year.
- Awotan dumpsite in Ibadan, which covers 14 hectares of land and receives 36,000 tonnes of MSW every year.
- Lapite dumpsite in Ibadan, which covers 20 hectares of land and receives 9,000 tonnes of MSW every year.
- Eneka dumpsite in Port-Harcourt, which covers 5 hectares of land and receives 45,600 tonnes of MSW every year.

The governance regime for waste management consists of various legislations and implementing institutions. At the international level, Nigeria is a party to several international accords which promote sustainable waste management practices and has incorporated some of the details of these agreements into its waste legislation and governance processes.

Currently, the National Environmental Standards and Regulations Enforcement Agency (NESREA), an arm of the Federal Ministry of Environment (FME), regulates the Nigerian Waste Sector with a plethora of legislation aimed at waste management. The Agency seeks to work with various stakeholders in government ministries and agencies and the private sector and civil society, who have interests in the sanitary conditions of different localities in ensuring compliance by relevant individuals and corporations. Though the Local Governments are stipulated by law to carry out waste management activities, State Government agencies are currently taking up this responsibility in many States.
Waste management challenges are multifaceted and include poor enforcement of legislation, duplication, and lack of clarity of duties among establishments, limited funding, application of unsuitable techniques, ignorance of the consequences of inadequate waste management practices among the masses, poor maintenance, absence, and visibility of waste-related records, to mention a few.

Insufficient motivation and investments from the private sector, deficiency of solid leadership, and the unwilling attitude of stakeholders [58]) have all contributed to the creation of insightful heaps of refuse dumps, open burning, waste litter in water bodies and other unwanted scenarios.

These unsustainable practices have adverse health and environmental consequences and highlight a huge economic opportunity to translate the enormous volume of waste to wealth in an investor-friendly waste sector. The introduction of circular economy-oriented measures will provide the needed investment opportunities to improve the waste management system in the country and enhance its natural capital base.

This section highlights information mostly related to Municipal Solid Waste (MSW) as there is limited data on other forms of waste, such as industrial waste and wastewater for Nigeria. However, recommendations have been made accordingly on the collection, analysis, and usage of such data in this section, as well as circularity measures for wastewater in the Water Services section.

4.1.2 Nigeria's Waste Management Governance

The Nigerian Waste Sector governance has its origins in the 1987 Koko toxic waste dump saga. The event instigated the creation of legislation such as the Harmful Waste Degree 42 in 1988 and the creation of the Federal Environmental Protection Agency (FEPA) in the same year. This institution then metamorphosed into the present-day Federal Ministry of Environment (FME), which was formed in 1999 to oversee the Nigerian natural environment amid national strategies for development. In 2007, the National Environmental Standards and Regulations Enforcement Agency (NESREA) was created as an arm of the FME to serve as the regulatory agency to enforce and aid the development of relevant environmental legislation, including waste management guidelines. This agency is currently undertaking this mandate across the country.

4.1.3 Nigeria Waste Related International Treaties and Agreements

Over the years, Nigeria has ratified several international environmental treaties and conventions related to sustainable waste management practices. Some of these international collaborations and treaties which can drive Nigeria into natural capital accounting and a circular economy-oriented landscape on waste are outlined below:

1. London Convention (1972/2006)
2. The United Nations Environment Program (UNEP) (1972)
3. Montreal Protocol (1987)
4. The Basel Convention (1989)
5. United Nations Conference on Environment and Development (UNCED) -The Earth Summit (1992)
6. The Stockholm Convention (2001)

A list of other International Treaties and Conventions associated to waste management which Nigeria is a party to is given in Appendix 6. Appendix 6 lists some of Nigeria's International Waste Management-related Treaties from 1968 to 2018. These treaties affirm that the natural resources with which a country is endowed are irreplaceable and part of that country's heritage. These treaties also buttress the need to preserve these natural resources, as depletion of those resources is detrimental to that country and the continent and humankind.

4.1.4 Current And Potential Waste Management Mitigation Measures and institutions

The most recent national policies on waste management are the National Policy on Solid Waste Management (2018) and the National Policy on Plastic Waste Management (2020), National Environmental (Healthcare Waste Control) Regulations, 2021, while there is draft legislation on hazardous wastes and battery wastes

NESREA Nigeria's national environmental enforcement agency works with various stakeholders to develop a more sustainable environment by enforcing extant laws, including those related to waste management. Others have been developed as environmental protection and waste management laws and enforced by some State Governments through their ministries, agencies, and parastatals like their State Ministries of Environment.

A list of some state legislation on waste management are outlined in Appendix 7. Appendix 7 highlights some select waste management initiatives operational in Nigeria, including 'Briquette Plants' where an alternative for firewood is manufactured at 4 locations across the nation, reducing the rate of deforestation and promoting energy recovery. Furthermore, the 'National Hospital Intervention Scheme' plays a role in preventing hazardous medical waste in the natural environment by incinerating medical waste of up to 100kg/hr at 23 sites. These initiatives play their part in achieving effective waste management.

Waste Management Policies

The key waste management policies in Nigeria with their objectives have been outlined below:

1. National Policy on Environmental Sanitation (2005): his national policy was formulated to achieve set national objectives such as a sanitary and healthy environment.
2. National Policy on Chemical Management (2010): This policy's objective is to prevent the release of harmful chemical waste into the environment through proper management throughout their lifecycles.
3. National Healthcare Waste Policy (2013): This policy ensures Health Care Waste (HCW) from health organisations is properly treated before disposal using global health standards.
4. National Policy on Environment (2016): This national policy was developed to provide guidance on the use of environmental resources in various sectors of the Nigerian economy.
5. National Policy on Solid Waste Management (2018): The policy is to develop a circular economy-oriented solid waste management system which also aims to drive private sector involvement.
6. National Policy on Plastic Waste Management (2020): This was developed to sustainably manage the use of plastic materials and their resultant waste.

Waste Management Regulations

NESREA's (2021a) [59] website highlights thirty-three (33) environmental regulations, twenty-eight (28) of which have been identified as waste-related regulations. These twenty-eight guidelines have both natural capital and circular economy attributes that aim to optimise the sustainable use of environmental resources in Nigeria (see Table 4.1).

Table 4.1: List of Waste-related Environmental Regulations linked to specific industries in Nigeria.

S/n	Industries	Regulations
1	Packaging	National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector) Regulations, S. I. No. 17, 2011.
2	Electronics	National Environmental (Electrical/Electronic Sector) Regulations, S.I. No 23, 2011
		The Harmful Wastes Special Criminal Provision Act No42 of 1988 (1998).
		National Environmental (Hazardous Chemicals and Pesticides) Regulations, S. I. No 65, 2014".
3	Food systems	National Environmental (Food, Beverages, and Tobacco Sector) Regulations, S. I. No. 33, 2009.
4	Built Environment	National Environmental (Chemicals, Pharmaceuticals, Soap, and Detergent Manufacturing Industries) Regulations, S.I. No.36, 2009.
		National Environmental (Base Metals, Iron and Steel Manufacturing/Recycling Industries) Regulations, S. I. No. 14, 2011.
		National Environmental (Construction Sector) Regulations, S. I. No. 19, 2011.
		National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, S. I. No. 21, 2011.
		National Environmental (Pulp and Paper, Wood, and Wood Products) Regulations, S. I. No 34, 2013.
		National Environmental (Motor Vehicle and Miscellaneous Assembly) Regulations, S. I. No 35, 2013.
		National Environmental (Mining and Processing of Coal, Ores, and Industrial Minerals) Regulations, S.I. No 31, 2009".
5	Fashion and Textiles	National Environmental (Textile, Wearing Apparel, Leather, and Footwear Industry) Regulations, S. I. No. 34, 2009.
6	Oil and gas	National Environmental (Energy Sector) Regulations, S.I. No 63, 2014.
		The National Oil Spill Detection and Response Agency Act 2006 (NOSDRA Act)".
7	Water Supply services	National Environmental (Dams and Reservoirs) Regulations S.I. No 66. 2014.

Waste Management Institutional Framework

1. The Executive Arm of Government:
   a. The major government environmental parastatal saddled with the responsibility of waste management is the Federal Ministry of Environment, which develops environmental legislation, including national waste management laws. It aids the State and Local Government's application of national environmental legislation and strategies. Beside NESREA, an agency of the FME that, monitors waste management activities and executes national waste management policies in conjunction with other stakeholders in the public and private sectors. There are other constituents of the Federal Arm of Government involved in waste management including the Environmental Health Officers Registration Council (EHORCON), Nigerian Maritime Administration and Safety Agency (NIMASA), National Oil Spill Detection and Response Agency (NOSDRA), and Nigerian Upstream Petroleum Regulatory Commission (UPRC).
   b) State Governments: These include State-owned organisations in the 36 states of Nigeria, such as the State Ministries of Environment, State Environmental Protection Boards and Agencies, and State Waste Management Authorities.
   c) Local Governments: These government arms are located in the 774 Local Government Areas (LGA), and their parastatals may include Departments of Environment, Health, Works etc.

2. The Legislative Arm of Government: This consists of the National Assembly (Nigerian Senate and the House of Representatives), which formulate national legislation, including environmental and waste management laws. A list of single committees in the 9th National Assembly (2019-2023) which can enhance Nigeria's natural capital sector and drive the nation towards a circular economy with regard to the waste sector is given in Appendix 8. Appendix 8 lists the Federal Legislative Committees in Nigeria related to waste management.

3. The Judiciary Arm of Government: The Judiciary interprets legislation to aid proper understanding and related activities for the benefit of all stakeholders involved, in addition to penalizing transgressors of such legislation.

4. Private Sector These are entrepreneurial stakeholders in the waste sector who invest resources in one or more components of the value chain to obtain financial rewards. They can be categorised under the formal sector (registered practitioners) and informal sector (unlicensed, unregistered practitioners) and can also form public-private partnerships (PPPs) to increase efficiency while providing waste management services. Examples include members of formal private sector umbrella bodies such as Extended Producer Responsibility Organisation (EPRON), Food and Beverage Recycling Alliance (FBRA), Alliance for Responsible Battery (ARBR), Manufacturers Association of Nigeria (MAN), and the Waste Management Society of Nigeria.

5. International Organisations and Agencies These foreign institutions partner with various arms of government to execute social, environmental, and economic strategies, including waste management projects which are beneficial to the country as a whole. Their activities include supporting the development of relevant legislation, strengthening institutional capacities, and providing aid for different interventions. Examples of these institutions include AfDB, UNDP, World Bank, EU, Islamic Development Bank (IsDB), and Kingdom of the Netherlands, whom all facilitated the creation of the Nigeria Circular Economy Working Group (NCEWG). Other examples are the United Nations Environmental Program (UNEP), World Bank, and the United States Environmental

Protection Agency (USEPA), which have supported the Integrated Waste Management Initiatives in Lagos.

6. CBOs/NGOs/Civil Societies/Welfare Organisations These are bodies and organisations which aid the most susceptible/vulnerable in society to meet their various needs and are interested in developing waste facilities and manpower which will economically empower the populace and improve their health and wellbeing. The Clinton Climate Initiative (CCI) is one such example that has also supported the Lagos Integrated Waste Management Initiatives.

4.1.5 Waste Related NCAA & CE Activities and Initiatives

An assessment of key documents was made to highlight waste-related natural capital accounting and circular economy features. Various indices such as the roles and relationships in the governance regimes, adaptation and mitigation measures in the sector, financing, and investment profiles, MRV implementation and other metrics were also assessed to highlight key drivers related to natural capital and circular economy activities.

Some of the strategic documents reviewed include the following:

- Nigeria's Nationally Determined Contribution (NDC)
- Sector Action Plans for Nigeria's NDC
- First Biennial Update Report (BUR1) – March 2018
- Third National Communication of the Federal Republic of Nigeria
- Waste/Circular Economy (CE) Analysis for the Enhancement of Nigeria's Nationally Determined Contribution (NDC) 2021-2025
- Nigeria's Medium-Term National Development Plan (MTNDP)
- Nigeria's Agenda 2050
- Nigeria Economic Sustainability Plan 2021
- 2012 Climate Change Policy Response and Strategy

Various stakeholders in the public and private sectors have invested resources for varying purposes to enhance the natural capital in the environment and incorporate circular economy solutions to drive sustainability and eliminate waste. The initiatives vary from tangible projects to intangible services.

Informal circular economy activities such as the collection, reuse, recycling and refurbishing of waste items have been taking place across the country, but these have been largely driven by a need to create a means of livelihood and not as a result of conscious, sustainable growth (NL Enterprise Agency, 2021). In addition to the activities carried out at the national and state levels, the Federal Government initiated some projects located in various states to address some waste management challenges. These include the National Plastic Recycling Program (2009-2012), National Hospital Intervention Scheme for medical waste (2009-2020), Integrated Waste Scheme with Scrap Metal Recovery and Recycling Initiatives (2006-2007), and the Extended Producer Responsibility (EPR) program which was launched 2013.

The Ministry of Mines and Steel Development has also carried out various measures to support Nigeria's circularity drive with three of its key programs: the Environmental Protection and Rehabilitation Program (EPRP), which rehabilitates and reclaims mining sites in an environmentally acceptable manner; Climate Smart Mining sensitization which promotes sustainable practices in the mining sector; and Material Recovery Mechanisms which are recycling plants that process waste for onward use in other industries and commercial centres.

In Lagos State, many initiatives have been undertaken by the government and the private sector to incorporate circular economy measures in the waste management activities of the State. Successful PPPs such as Integrated Solid Waste Management Facilities, the Blue Box Program, and Recycling Banks have been created, along with many private sector waste management initiatives, which have enabled the State to become a model for other states in terms of waste management. This has resulted in a recycling rate of 13.5% within Lagos [60]), a national high, which has given the rest of the country an insight into the available opportunities in the waste sector. This can have a ripple economic effect on society as a whole if well implemented.

The waste sector in Nigeria was recently included in Nigeria's 2021-2025 revised NDC in recognition of its growing impact on the release of GHG emissions and its rich potential for creating opportunities for various stakeholders. Adopting a CE strategy in the various waste-generating sectors of the economy can solve multifaceted issues associated with environmental, social, and economic challenges.

Appendix 7 highlights some selected key waste initiatives and projects in Nigeria (obtained from the Waste/Circular Economy (CE) Analysis for the Enhancement of Nigeria's Nationally Determined Contribution (NDC) 2021-2025).

4.1.6 SWOT Analysis of the Waste Sector

SWOT analysis was carried out on different components of the waste sector to assess how they support Natural Capital and Circular Economy ambitions in Nigeria. These components included policies, regulations, institutions, and initiatives.

Appendix 9 analyses the current policies, regulations, institutions, projects/initiatives, & strategic documents in the NCA & CE Assessment and has identified their strengths, weaknesses, opportunities, and threats. There are exciting opportunities presented, and the actualization of the various opportunities, such as 'Capacity building trainers and educators who will train various levels of waste management stakeholders,' can lead to a more robust, effective, and efficient NCA & CE.

Summary of SWOT Analysis: From the SWOT Analysis carried out, most existing policies and regulations have been shown to be NCA/CE compliant as they have incorporated modern circular and sustainable measures in them. The institutions have been found to be partially compliant with the existence of relevant agencies and programs, but they do not adequately cover the whole country, and stakeholders require more resources and capacity for the effective implementation of key projects and regulatory functions. Strategic documents are partially compliant as they lack waste data for effective planning and clear processes of how support will be provided to aid local capacity in developing feasible waste projects. But waste projects and initiatives have been shown not to be NCA/CE compliant due to the lack of formal initiatives and common unsustainable practices nationwide.

4.1.7 Level of Compliance with Natural Capital/Nature-Based Solutions (Policy Alignment & Enablers)

Policy Alignment

Policies.

An assessment of the waste management legislation showed that Nigeria's waste sector legislation has a lot of natural capital accounting and circular economy-oriented attributes due to their recent

enactments. This has enabled policymakers to incorporate modern sustainable methods such as circular economy activities involving the R-frameworks. This is evident in the policy objectives of the six waste management policies examined and linked to the Natural Capital Accounting and Circular Economy (NCA and CE) attributes in Nigeria. As a result of these incorporations, the key waste management policies in Nigeria are seen to be compliant with natural capital/nature-based solutions in development thinking and circularity measures.

Appendix 10 highlights waste management policies, natural capital accounting, and circular economy features, as well as embedded private sector opportunities which can be harnessed. In **Appendix 10**, the objectives of these policies were analysed and strategies for implementation suggested with opportunities identified for the Private Sector, such as 'Capacity building of private sector in managing hazardous chemicals in private and workplaces,' stemming from the National Policy on Chemical Management (2010).

Regulatory Alignment:

The waste-related regulations are also compliant with natural capital/nature-based solutions in development thinking and circularity. This is due to the incorporation of natural capital and circular economy features in most of the environmental regulations that span across various sectors in Nigeria, as highlighted on the NESREA website.
It was noted that among the regulations:

- There was a high concentration of regulations in the Built Environment sector with six (6) regulations, implying a focus on the varied waste generated due to industrial expansion linked to national economic growth.
- The Packaging industry and Food and Textile industries had only one (1) regulation each.
- more guidelines will be required to manage all kinds of packaged waste such as PET bottles, Styrofoam etc.
- Organic waste is a waste stream produced in huge volumes in Nigeria. Additional regulations are required to tackle the organic waste generated in huge volumes all over the country.
- The electronics industry has three (3) regulations, while the Food Systems and Oil and Gas industries have two (2) regulations each.

The analysis shows that the number of regulations can be increased to properly cater to activities in certain sector-specific industries that produce different waste streams. Specifically, food waste and fashion industry regulations need to be enhanced.

Alignment of Nigeria's Waste Related International Treaties and Agreements

All international treaties assessed were found to be compliant with natural capital and circular economy characteristics based on their objectives, which include regulation of sea pollution, prohibition of hazardous waste imports, and tackling POPs.

The period between the ratification and domestication of these treaties can be shortened due to the urgency of the execution of climate change mitigation actions. An example was Nigeria's ratification of the Stockholm Convention on POPs in 2001 but domesticated in 2004.

The Bamako Convention, which is essential in stemming the inflow of hazardous waste into the country, is yet to be ratified by Nigeria, and no recent official reason has been provided. However, the NCEP and its associated documents will consist of Circular Economy commitments from various stakeholders, including government representatives, who will stimulate conversations about relevant international

accords that will drive the transition. Ratification and implementation of international agreements such as the Bamako Convention would be vital in achieving the NCEP objectives.

Alignment of Institutional Framework in Waste Sector

The assessment showed that the waste management institutions are partially compliant with natural capital/nature-based solutions in development thinking.

Natural Capital Accounting and Assessment:

With regards to natural capital, the existence of current institutions and businesses has provided a platform for programs to be initiated though challenges have been identified such as delays in passing relevant bills, lack or inadequate institutional capacities, ineffective monitoring and compliance, lack of financial and technical support to the informal sector.

Circular Economy:

The institutions assessed are partially compliant with circular economy characteristics. This is due to the presence of environmental regulatory and management agencies across Nigeria. Still, their absence in some LGAs leaves an enforcement gap, especially regarding the EPR program. Some of the government-owned institutions also lack the capacity and resources to undertake enforcement as well as to effectively manage the EPR nationwide.

The FME has been active over the years, developing a host of waste-related legislation and enforcing them through its regulatory arm, NESREA. However, NESREA is present in only 22 states out of the 36 states of the country. This shows that there are 14 states yet to have a NESREA office indicating an enforcement gap.

Private Sector:

Private sector participation has been encouraged to complement waste management authorities and encourage the participation of the sector in profitable ventures related to waste gathering, movement and processing, and the development of waste structures.

Assessment of Waste Management Initiatives

Most waste initiatives in Nigeria are not compliant with nature-based solutions thinking. Though there is a large informal waste management sector across the country and a variety of waste is processed, most of the waste management personnel across the country are carrying out unsustainable waste management practices.

From the analysis, Lagos State (which makes up only 7% of the total population in Nigeria with approximately 17 million people) has a lot of waste initiatives which have incorporated circular economy measures. [61]). However, these waste schemes in Lagos consist of activities that process mixed waste materials showing the viability of investments in various waste streams. The ownership structure of the projects was also found to consist of a mix of government and private sector-led initiatives. The success of the PPPs in Lagos State is an indicator of the possibility of such schemes running successfully in other parts of the country. This assessment also shows the growing confidence that the private sector has in the current investment climate of the country.

It is also pertinent to note that operational waste management initiatives are currently all private sectors driven or partnerships. The Federal Government-initiated schemes currently have various challenges as many recycling plants are not operating at their installed capacities or are not operational at all. This

shows that even though the government can establish a circular economy scheme, its sustainability would be enhanced if members of the private sector were actively involved and partnered in such schemes.

Strategic Documentation Review

From the assessment carried out, the strategic documents were found to be partially compliant with natural capital/circular economy solutions thinking as they contain proposals for implementing a circular economy with finance mechanisms such as the 'Green Bonds' and the 'feed-in-tariffs.' They also highlighted plans to stimulate the growth of SMEs, which can drive NC/CE growth from the grassroots level, but the documents are also lacking in the following desirable aspects:

- absence of waste data required for national waste management planning.
- discrepancies in available data among government agencies.
- lack of support in developing bankable projects which would attract global funding, thereby growing the private sector and transiting the informal sector to the formal sector.

4.1.8 Waste Potential for Electricity Production

Energy can be produced from waste materials using a variety of measures in Waste to Energy (WtE) plants. The Energy Saving Trust (2019) [62] outlines these methods as "combustion, gasification, pyrolysis, anaerobic digestion and landfill gas recovery." Incineration (combustion) is usually the preferred method due to its improved efficiencies, reduced costs, decreased amounts of GHGs released, large electricity output and high reduction potential of waste heaps [63].

In recent times, WtE facilities have been sustainably designed by upgrading old incinerator mechanisms to facilitate the separation of toxic and recyclable materials from waste fuel before combustion, produce electrical energy and incorporate safety and improved features to cater to the well-being of the plant users and neighbouring community. A majority of WtE plants utilise a steam boiler mechanism with MSW as their fuel source. It is also estimated that a ton of MSW can deliver an electrical output of 500-600 kWh [64].

However, it is vital to obtain the calorific value of waste fuels, such as the Lower Heating Value (LHV) or Net Calorific Value (NCV), to verify the viability of a WtE project. The LHV or NCV highlights the energy potential of various waste materials whilst also taking into consideration their degree of wetness and is dependent on the composition of the fuel, which is usually made up of Municipal Solid Waste. If the exact details of a given quantity of characterised MSW are known in addition to its moisture content at a given time, an estimate of the calorific value of the waste fuel can be made, which can be used to calculate the resulting electricity output [65].

Further research and feasibility analysis can be carried out to obtain the NCV of the waste components so that more accurate estimates of the quantities of electricity produced from MSW can be made.

Projection of Nigeria's MSW Generation

The Waste/Circular Economy (CE) Analysis for the Enhancement of Nigeria's 2021-2025 NDC - Report has projected the generation of MSW in Nigeria for the period 2022 –2030 with details highlighted in Table 4.2. This table includes the estimated percentages of waste disposed at Solid Waste Disposal Sites (SWDS) as well as the composition of the MSW.

Table 4.2: Projected Municipal Solid Waste (MSW) - Activity Data for Nigeria (2022-2030) [39]

Year	Populations (millions)	Waste per capita (kg/cap/yr)	Total MSW (Gg)	% waste sent to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, others inert	Total
2022	217401423	141.7	30811.32281	42%	8%	43%	10%	4%	4%	0%	31%	100%
2023	223241624	142.8	31875.39996	43%	8%	43%	10%	4%	4%	0%	31%	100%
2024	229225172	143.8	32972.46385	42%	8%	43%	10%	4%	4%	0%	31%	100%
2025	235356155	144.9	34103.56232	42%	8%	43%	10%	4%	4%	0%	31%	100%
2026	241641337	146	35270.151	43%	8%	43%	10%	4%	4%	0%	31%	100%
2027	248088277	147	36473.83102	42%	8%	43%	10%	4%	4%	0%	31%	100%
2028	254705440	148.1	37716.3696	42%	8%	43%	10%	4%	4%	0%	31%	100%
2029	261502320	149.1	38999.72336	43%	8%	43%	10%	4%	4%	0%	31%	100%
2030	268489584	150.3	40326.06509	42%	8%	43%	10%	4%	4%	0%	31%	100%

Potential of Nigeria's MSW Generation

The waste projected to be disposed of at SWDS between 2022 and 2030 represents 42-43% of total MSW in the country, and this is an equivalent of 12,941-16,937 Gg (or approximately 13-17 million tonnes). This amount of waste can be used to generate electricity. An estimate of electricity production without the net calorific values of the MSW is as follows:

1 tonne of MSW will produce approximately 500-600kWh of electricity. Therefore, 13-17 million tonnes have the potential to produce a minimum 6500GWh (6.5 x 109kWh) and maximum values reaching 10,200GWh (10.2 x 109kWh).
Though the NCV of the constituents of the MSW is required to obtain more exact values, these electricity estimates are quite promising, showing that MSW can contribute greatly to the Nigerian power sector, which has a yearly demand of 144kWh per capita [66].

Recommendations

The following recommendations are made with the aim of attracting investors in the private and public sectors to partake in the following sustainable areas:

1. Sector-specific legislation should be created for waste streams such as e-waste, organic waste, textile, scrap metal etc., by NESREA in collaboration with the relevant trade bodies and umbrella organisations.

2. Decrees should be formulated by National Legislators to facilitate the creation of more enforcement agencies to assist NESREA in a bid to carry out waste management enforcement over the whole nation.
3. Legislation should be developed by NESREA, FME, Federal Ministry of Finance, Trade and Investment and other relevant key stakeholders to aid the start-ups of innovative waste management businesses as well as green growth industries and encourage. This should include the transition of businesses in the informal sector to the formal sector. This legislation should also stimulate the continuous growth of this entrepreneurship and may include tax incentives and low capital costs.
4. Discussions to facilitate the speedy passage of relevant legislation should be stimulated by legislators to reduce the turnaround time for the development and implementation of waste-related legislation.
5. There should be clarity on the roles of various stakeholders in the implementation of waste management activities.
6. Sector-specific guidelines for various waste streams should be developed by the private sector umbrella organisations in collaboration with relevant government agencies. This can include entry point requirements for businesses such as capacity expectations, skills requirements, techniques, standards etc.
7. International agreements made by the country should be based on future mandatory assistance from external partners to the country's waste management sector to aid Nigeria's achievement of agreed objectives.
8. A document highlighting the list and brief details of all waste management policies and regulations should be developed to assist stakeholders in having an overview of the sector legislation.
9. Further research and analysis on Waste to Energy schemes should be undertaken to acquire more information on their viability and potential to meet energy requirements in certain parts of the country where waste generation is high. This analysis would entail obtaining MSW Activity Data at SWDS, characterization of the waste materials, calculation of their Net Calorific Values (NCV), which considers their moisture content over a period, estimations of potential electricity outputs, and measures how these WtE plants can be established.

4.1.9 Waste Sector Value Chain Overview

Nigeria generates up to 63 million tonnes of domestic waste every year, and only about 30-50% of it is collected [41]. The Waste/Circular Analysis Report for the Enhancement of Nigeria's NDC (2021) states that the composition of Municipal Solid Waste (MSW) consists of approximately food waste (8%), garden waste (43%), paper (10%), wood waste (4%), textiles (4%), plastics and other inert materials (31%). This massive quantity of waste is a valuable resource that, when tapped, can contribute to economic growth within a locality.

FRN [57] states that as much as 70% of waste generated in the country is recklessly disposed of, thereby polluting the surroundings where they are generated, leading to large heaps of refuse, untidy environments, clogged up water bodies and blocked drainage channels, and this has a detrimental effect on humans and animals within those vicinities.

Though the Local Government Areas have been stipulated to be responsible for waste management, the State Governments are currently carrying out these activities due to the capacity and funding required. Bioenergy Consult [67] states that a key issue in the sector is the lack of funding. It hinders the

implementation of efficient waste management strategies across the country, resulting in a degradation of Nigeria's natural capital.

In order to address this challenge and unlock the massive potential in the waste sector, a country-wide approach involving natural capital accounting and circular economy measures can be used. Recommendations on how natural capital can be utilised should entail sustainable plans for land use, urban expansion, water, and energy resources etc., as well as circular applications such as waste reduction, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recovery can be used to harness the various opportunities which exist along the value chain of various waste streams in different sectors. The identification, assessment, and development of relevant proposals along these prospects will enhance the growth of the national economy towards more sustainable objectives, which the private sector will drive. This private sector consists of both formal and informal sector businesses that have also been involved in waste management in different parts of the country due to the economic potential of the high volumes of waste generated. They have employed workers of different skill sets and have catered for the different levels of society, ranging from large organisations to small informal waste collectors who scavenge waste scraps for subsequent sales and recycling.

In 2011, NESREA initiated the Extended Producer Responsibility (EPR) program in a bid to promote sustainable waste management using circular economy practices with an initial focus on plastics (packaging) and electronics (e-waste and lead acid batteries) while an upcoming used tyre program will soon be launched. This initiative has encouraged the birth of umbrella bodies known as Producer Responsibility Organisations (PROs) which became responsible for waste management of their products across their cycles using 'buy-back' plans.
However, despite an initial take-off with these two sectors, NESREA has been limited in its enforcement. The country has also taken steps to drive circularity by being among the first to join the ACEA, forming its own NCEWG, and developing a national roadmap towards a circular economy.

In this study, we have selected three industry focus areas for analysis: Packaging, Electronics and Organic Waste. However, other waste classes highlighted in the National Policy of Solid Waste Management (2018) are rich in economic potential and can be harnessed for natural capital enhancement and incorporation of circular economy measures.
These include:

1. Industrial waste
2. Special bulk waste
3. Medical waste
4. Used tyres
5. End-of-life vehicles
6. Unserviceable fridges and freezers
7. Used batteries
8. Construction/asbestos waste

A list of some key projects and initiatives, which include some of these waste industry focal areas highlighted above, have been tabulated in **Appendix 7** of this report.

4.1.10 Life Cycle Inventory Analysis & Impact Assessments

Packaging

Nigerians are heavily dependent on plastics and packaged products with plastic beverage bottles, water sachets popularly called 'pure water' and carrier bags found in most small and large retail shops in the country. Plastic and packaging producers are in densely populated cities and centres across Nigeria, such as Lagos, Ibadan, Onitsha, Port-Harcourt, and Kano, and they manufacture plastic products for their own use or for sale to other industries which are dependent on their products, such as food, beverages, and household goods companies.

After use and disposal, these plastic wastes litter the surroundings, block drainages, and use up space at landfill sites. Figure 4.2 shows packaging waste quantities in Nigeria with components such as Returnable Glass Bottles (RGB), Non- Returnable Glass Bottles (NRGB), Polyethylene terephthalate (PET) and other materials from 2013 to 2018.

Figure 4.1: A Plastic PET bottle dump site (Netherlands Enterprise Agency) [68]

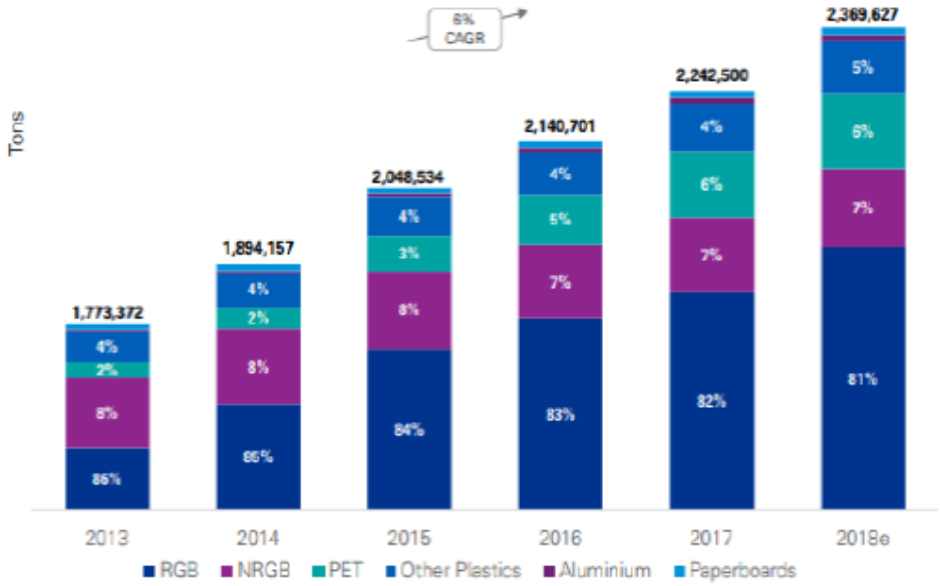


Figure 4.2: Quantity of Packaging Waste Generated in Nigeria based on Material Types [69]

For Nigeria to transit to a more circular economy that enhances its natural capital, large-scale processes which involve recycled packaged plastics such as PET, flakes, and pellets for reuse by FCMG and construction industries should be encouraged and facilitated by the private and public sector [68]. Potential reuse and recycling schemes can save plastic companies materials costs and earn revenue to waste recycling firms.

Case Studies

The Food and Beverage Recycling Alliance (FBRA), which is a Producer Responsibility Organisation of the EPR program initiated in 2014, consists of companies and industries which strive to acquire and recycle plastic and packaging waste disposed of by consumers. With its headquarters based in Lagos, they currently consist of sixteen major organisations and have expanded its activities to attain national coverage. In 2020, FBRA collected and processed up to 5,000 tonnes of packaging waste.

Another initiative is the *Project ReflexNG* initiated by Dow (NYSE: DOW) in 2020 to collect and recycle plastic waste in Lagos with a target of up to 600 metric tonnes of plastic waste (about 300 million water sachets). It collaborates with Omnik, RecyclePoints and Lagos Business School, which will purchase waste from collectors with cash, mobile phone credits, and provisions.

Alkem Nigeria Ltd, in partnership with Coca-cola, established a Polyethylene Terephthalate (PET) bottles–to–fiber recycling plant in Lagos, the first of its kind in the country, in 2005. The project members now include Nigeria Breweries Plc, Nestle Nigeria Plc, Nigeria Bottling Company, and Seven-Up Bottling Company Plc, and it employs about 1,800 workers with up to 26 collection centres in 10 cities. Approximately one billion bottles have been recycled since the project began [70].

Engee Manufacturing Ltd, a company that manufactures PET resin, obtained a loan of $39million in 2020 for the construction of a resin plant located in Ogun State. 20% of the raw material for production will be plastic waste from its surroundings, and it hopes to recycle 30,000 tons of used plastic bottles annually. The company started operations in 2014 and currently has about 500 staff.

Obed Green Technology is finalising ongoing plans to establish a post-consumer polyethylene terephthalate (PET) bottle recycling facility in Akure, Ondo State, Nigeria. The recycling plant will have a processing capacity of about 2,500 kg (2.5 metric tonnes) per hour to produce recycled PET flakes (rPET), thereby reducing approximately 10,000 metric tonnes of PET waste annually from landfills and waterways. It intends to cater to the two states of Ondo State and Ekiti, which have an estimated combined population of over 8 million persons. The recycling facility is projected to employ about 110 people and much more as it will create a value chain linked to the collection, processing, resale, and reuse of PET waste.

The Nigeria Climate Innovation Center (NCIC) collaborated with Coca-cola in April 2022 to launch a plastic recycling project - Cycle Plast Project at Abuja, with the aim of ridding the environment of plastic waste, enhancing sustainable practices, and opening other plastic value chain opportunities, including job creation. It will aid the PET collection rates in the 6 geopolitical zones of the country, with centers at Abuja for the North Central zone, Kano for the Northwest, Adamawa for the Northeast, Kwara for the Southwest, Abia for the Southeast, and Edo for the South-South [71].

The Empowering Collectors Initiative (ECI) is also a plastic waste sustainability program designed to build capacity among disposers, collectors, and aggregators to facilitate the retrieval of plastic waste. The initiative, which was launched in May 2022, involves a synergy between the Growing Businesses Foundation and the Coca-Cola Foundation, and it seeks to collect at least 25,000MT of PET over the next 2 years while providing economic opportunities for up to 3,000 women and youths.

Lifecycle Assessment: Plastics Packaging

Extraction:
This involves obtaining natural capital resources such as crude oil, coal, natural gas, and cellulose. Those who carry out these processes are specialists who collect the relevant minerals and make them available for onward processing.

Processing of raw materials & Fabrication of plastic products:
At this stage, mineral resources are processed (e.g., in an oil refinery) through polymerization and polycondensation to obtain monomers and polymers, which are further treated to produce two types of plastics and their subsequent products: thermosets which do not melt once they are moulded into desired shapes, and thermoplastics which melt whenever heat is applied and solidify when cooled. These stages release production waste which can be processed if properly collected. Skilled and unskilled workers are also required at this stage for these processes to produce plastic products.
The finished products are then passed on to the distributors and retailers in the market.

Use/Reuse:
This involves the use of plastic products by consumers until the end of the product life. Due to the durable nature of plastic materials, the products can be reused for similar or various purposes other than those that the original manufacturer intended.

Waste:
At the end of the product life, the consumers or end-users dispose of the plastic waste, which can then be recycled or converted to recover energy. This will involve proper waste handling and include the activities of waste collectors, sorters and buyers and does not require much skill but a lot of physical effort to retrieve and classify the waste material into different components.

Recycle:
This activity in which waste is processed after collection into a material that would be of further use in the value chain. The collected waste is treated through various means to obtain feedstock for the plastic raw materials (resins and monomers) or as inputs for plastics/other related products.

Energy recovery:
This is another proposed activity in which plastic waste which cannot be recycled is used up in waste-to-energy schemes to provide power to other value chain activities, thereby creating a circularized value chain.

Appendix 11 shows a Lifecycle Impact Assessment of the Plastic Packaging Waste Value Chain based on the impact of key plastic packaging lifecycle processes on the climate, ecosystem, energy use, water use, human health, and social issues across the phases of production. Appendix 11 also highlights the Lifecycle impact of the plastic packaging waste value chain on the climate, ecosystem, energy use, water

use, human resources & climate. It presents two scenarios; the first scenario is without NC/CE measures and the second scenario with NC/CE measures, and why the implementation of the R-Framework is an absolute necessity for a positive Lifecycle Impact in the Plastic Packaging Waste Value Chain.

Electronics

Nigeria imports above 500,000 tonnes of second-hand electronic goods annually. A quarter of this amount is defective and non-operational on entry into the country, adding to the already large quantity of e-waste being generated daily across the country. Also, as much as 99.6% of e-waste produced is informally recycled using unsustainable techniques to retrieve useful substances [68]. Figure 4.3 shows some national e-waste data obtained for the period between 2014 and 2019.

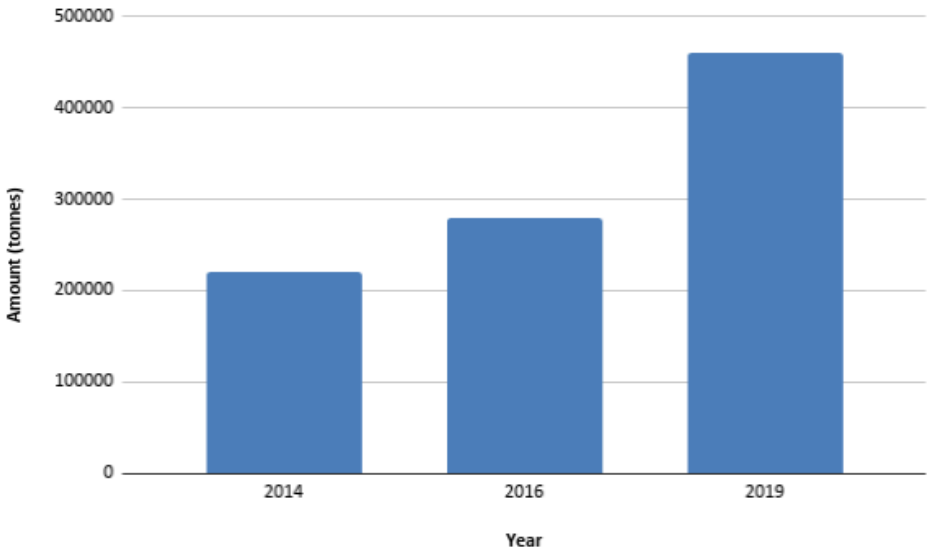


Figure 4.3: Amount of e-waste generated in Nigeria in certain years [72]

Lifecycle Assessment: Electronics

Extraction:

Raw materials required to manufacture various electronic components are collected from natural capital resources. These include copper, palladium, gold, iron, oil, platinum, and other important materials used for electronics manufacture. It involves both skilled and non-skilled producers who manually or mechanically mine certain minerals and substances for subsequent use in the production of electrical and electronic parts.

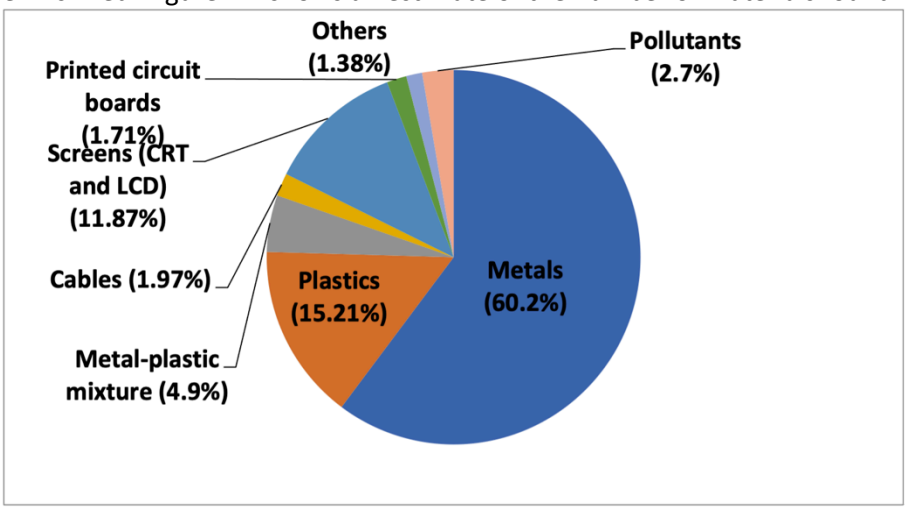
Manufacture:

The materials and components, which consist of plastics, metal-plastic mixtures, cables, CRT and LCD screens, semi-conductors, printed circuit boards, integrated circuits, pollutant materials and other substances, are then used to manufacture electrical and electronic products. It is important to note that electronic parts continuously change over time due to modern technological advances, making e-waste quite complex to manage. The characterization of e-waste is usually based on the wealth of citizens, the presence of a used goods market, recycling facilities, waste management initiatives and ensuring that industry guidelines are followed [73].

Use/Reuse:

At this stage, the electronics will be utilised by consumers who dispose of them. If recycled or refurbished, these products are reused and then recycled continuously until they are perceived to have reached the end of their shelf-life.

Waste:
E-waste is generated after electronic products are disposed of by consumers. The waste is then collected and sorted by collectors, who then sell it to e-waste processors. The workforce at this stage is mostly unskilled and semi-skilled. Figure 4.4 shows an estimate of the number of materials found in e-waste.



Recycle:
The e-waste processors obtain e-waste from the collectors and then disassemble the electronic parts to process them accordingly based on the relevance of various electronic components for further use. The recycled parts are then used as raw materials for other products, make new electronic components, or can be used as spare parts for other electronics. The collected waste is treated through various means to obtain feedstock for the plastic raw materials (resins and monomers) or as inputs for plastics/other related products. Recyclers and producers here are usually equipped with technical skills in electronic products.

Energy recovery:
This is the conversion of unwanted unrecyclable e-waste, which is used to generate energy for use in the production process or other activities.

Landfill, open burning and dumping of waste:
These are disposal techniques which take place where there are no sustainable measures and enforcement in place. E-waste is harmful to the environment due to the release of hazardous chemicals and toxic substances which endanger human health and surrounding ecosystems.

Food Systems

Waste from food and farm produce is known as organic waste, and this makes up the most significant proportion of Municipal Solid Waste (MSW) in Nigeria [74], and this trend may be set to continue as the country's population increases over the years. Post-harvest waste generated from the agriculture sector if further increased by the absence of food storage and processing facilities necessary for preserving and transporting agricultural products over long periods and long distances across the country.

It, therefore, becomes imperative to prevent these food losses and cater to the under-fed population in Nigeria, which stands at 24.5 million citizens [2] In order to improve the circularity of existing food networks, unique strategies are required to be implemented in such a manner that they also enhance the natural capital of the country. These measures include optimizing the utilisation of energy and water, improving crop yield and processing, decreasing waste using better preservation and logistics techniques and using sustainable waste practices [1].

USEPA (2020) [75] proposes a food recovery hierarchy which maximizes food waste by utilizing it for multiple activities where necessary and reducing waste to a minimum.

Case Studies

The Earthcare Solid Waste Composting Project is a modern compost facility located in Ikorodu, Lagos, which aims to reduce Lagos landfills by 10-20%. It has the capacity to process 1,500 metric tonnes of mainly organic waste daily to produce 200,000 metric tons of fertilizer and employs approximately 90 workers. In 2009, the Federal Government purchased 2,500 metric tons of compost from the company for distribution in the 36 states of the country as part of its Agricultural Development Programs [76].

West Africa ENRG is the largest private landfill diversion company in West Africa. It is a waste management organisation that uses a patent-protected technology to convert non-recyclable solid waste into electrical power. Its Materials Recovery Facility (MRF), located in Igando, Lagos, has the capacity to receive 130 waste trucks daily and process 300,000 metric tons of municipal waste. It also employs about 600 people, 72% of whom are women and 95% from the immediate locality [77].

Lifecycle Assessment: Organic Waste

Agricultural Produce: This stage entails the growing of crops and rearing of livestock to produce food for consumption or processing. Farmers are the main stakeholders here, using farmlands and other natural capital resources to grow their agricultural produce.

Food Processing: This is the conversion of agricultural produce to other forms of food or products, and this usually entails a series of processes using energy resources. Workers in this phase consist of the unskilled, semi-skilled and skilled.

Consumption: This stage involves the purchase and use of food products by the consumer. Any remains which are no longer needed are then discarded.

Waste: In this stage, the collector receives the waste and sends it to a variety of destinations depending on the output required. It can be converted to compost and fertilizer using an aerobic biological processor, or energy using an engineered landfill to recover biogas for subsequent use, or as leachate, which is the water content in the waste mixed with organic constituents which can be treated to become permeate, which is safe for release into water bodies such as rivers which in turn can be used for agricultural production.

Appendix 12 shows a Lifecycle Impact Assessment of the Organic Waste Value Chain based on the impact of key organic waste lifecycle processes on the climate, ecosystem, energy use, water use, human health, and social issues across production phases. **Appendix 12** highlights the Life cycle impact of the organic waste value chain on the climate, ecosystem, energy use, water use, human resources & climate. We are presented with two scenarios for organic waste disposal, one without NC/CE measures and the other with NC/CE measures. It highlights the impact of both scenarios and the SDGs associated with NC/CE solutions.

From the LCA, the organic waste value chain engages in activities which have an impact on the ecosystem based on the use of land resources for farming activities, fertilizer and chemical applications, and landfill sites. The impacts on climate include the release of GHGs from livestock, fertilizer, and fossil fuels used for power and transport. A large amount of energy and water resources are also used at various stages of the production process. Human health is also impacted by exposure to hazardous chemicals during farming, as well as land and air pollution. Therefore, the NC/CE measures which have been recommended to address these impacts have been highlighted in the table.

4.1.11 Value Chain Opportunities and Funding Programs

A review of strategic documents was made to identify any value chain drivers in waste management, and the highlights from those documents were combined with the results of the findings of the LCA and impact assessment carried out to identify the following opportunities nationwide:

1. There is a need for improved collection of waste from generation points and sites for onward sales.
2. Entrepreneurs can engage in the purchase of collected specific waste materials from waste generators and collectors for resale to waste processors and manufacturers.
3. Logistics services are required for the transportation of waste materials from the point of generation to treatment and processing centres, energy recovery plants, markets, and potential customers and engineered landfill sites.
4. Storage facilities for waste materials are needed in close proximity to where they will be processed.
5. Opportunities exist for the sustainable processing of plastic waste so as to produce recycled materials such as recycled pellets and granules for sale top plastic producers.
6. Recycling plants can be opened to train manpower and undertake sustainable processing of e-waste so as to retrieve precious metals and resell valuable components, thereby reducing waste.
7. There are opportunities for the manufacture and trade of compost from organic waste for soil use.
8. Entrepreneurs can engage in the manufacture of animal feed for organic waste.
9. There are gaps in the establishment of waste-to-energy schemes such as biogas power plants to utilise organic waste to provide and trade in electrical power and domestic gas.
10. There are opportunities for recycling waste from construction sites to produce building blocks and tiling materials.
11. The local production, sale, and maintenance of waste processing equipment such as incinerators, waste balers, conveyor belts, separators, shredders etc. can be carried out within the shores of Nigeria.
12. The design and maintenance of digital tools such as waste management databases and mobile applications will be relevant for planning and record keeping.
13. The development and maintenance of certified landfill sites at relevant locations by individuals, communities and organisations can be carried out as a business enterprise.
14. Debt and equity financing of investors and venture capitalists willing to invest in viable and sustainable waste management schemes are required for the establishment of successful waste initiatives.

15. Funding opportunities from various donor agencies and financial institutions for entrepreneurs interested in sustainable businesses using natural capital and circular economy-oriented techniques would facilitate green growth.
16. Grant applications specialists who can develop sustainable waste management proposals and provide advisory services will be relevant to obtain funding from donor organisations.

A list of funding initiatives that have been set up to provide support for sustainable projects, including waste management projects, are:

- Green Climate Fund
- The Emerging Africa Infrastructure Fund (EAIF)
- Adaptation Fund (AF)
- The Climate Finance Accelerator (CFA)
- The Clean Technology Fund (CTF)
- The Global Climate Change Alliance (GCCA)
- The Global Energy Efficiency and Renewable Energy Fund (GEEREF)
- The Global Climate Partnership Fund (GCPF)
- The International Climate Fund (ICF)
- The International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
- Ariya Capital Sub-Saharan Africa Cleantech Fund (ARIYA)
- The Emerging Africa Infrastructure Fund (EAIF)
- Energy Access Ventures Fund (EAVF)

Individuals and organisations who are interested in obtaining assistance such as grants, loans, and technical support from these initiatives must understand and satisfy the specific criteria and requirements for each initiative and agree to their terms and conditions.

4.1.12 Green Jobs Opportunities in Waste Sector for Youths

The implementation of circular economy measures and natural capital-oriented projects will provide opportunities for youths in areas such as waste collection and processing, waste business start-ups, capacity building, research and development, and database management. This is due to the skills and capabilities possessed by teenagers and young adults, which are a good fit for the roles in these respective areas. These youth-affiliated capabilities include skills in Information Technology, social networking, mobile applications, innovation, physical fitness (for waste collection activities and logistics) etc. Youths can also be easily trained in waste entrepreneurship and as service providers in improving waste efficiencies. In addition to these, marketing skills can be developed to increase patronage of processed waste and sensitise other sectors on the availability of processed waste which can be used as possible raw materials alternatives in production processes. These trainings can be carried out during skills acquisition programs, business seminars, capacity-building events, and practical apprenticeships with fees for such schemes subsidised or made free to interested youths.

The informal e-waste sector employs approximately 100,000 workers in Nigeria [4]. This workforce is continuously exposed to the hazardous materials from which electrical/electronic parts are made that are harmful to human health and the natural environment. Nevertheless, the huge amount of e-waste can be used as a resource bank to drive industrial growth, but this would be dependent on the systems in place and the deliberate measures which should take place to ensure a transition to a circular economy for the e-waste stream.

ACEA proposed sustainable measures such as financing recycling schemes, expanding the Extended Producer Responsibility (EPR) program, improving product development, reusing used components, and lengthening product lifespans as key activities that can be carried out effectively to tackle e-waste in the African continent [1].

Case Studies

The *Otigba 'Computer Village'* in Lagos is the largest West African electrical devices market which contains more than 3,000 e-businesses and trades in recycled e-waste with an estimated annual revenue of
$2billion [78]

Hinckley Recycling, which is Nigeria's first registered e-waste recycler, has a facility in Lagos which recovers, repairs, and refurbishes Waste Electrical and Electronic Equipment (WEEE) for reuse. With branches across Africa, the company has been operating in Nigeria for 20 years in the ICT market and has an authorized HP Service Centre. In 2012, it recycled more than 2000 WEEE products.

E-terra Technologies, an indigenous e-waste recycling firm with many private and corporate client base, undertake e-waste management and data destruction with a workforce of skilled and semi-skilled workers. The company has a Material Recovery Facility (MRF) which can process 200 cathode-ray tubes daily.

The Union Autoparts Manufacturing Company Ltd owned by the Ibeto Group, has lead-acid batteries recycling plant with the capacity to annually produce 300,000 units of lead-acid batteries, 120,000 units of sealed maintenance-free batteries, 5,500 tonnes of lead, 500 tonnes of accessories and 1,500 tonnes of friction parts. The company was incorporated in 1987, and since 1991, it has been exporting pure, and antimonial lead to Europe, Africa, and Asia [79].

Conclusion

From the assessment carried out for the Nigerian Waste Sector Value Chain, using plastic packaging, e-waste, and organic waste streams as case studies, opportunities have been identified for investments using natural capital and circular economy-oriented measures along with sustainable funding schemes which aim to provide support to waste management schemes across the waste sector value chain. Some of these recommendations highlight opportunities in waste management collection and processing, logistics, waste-to-energy projects, compost manufacture, database development, training of certified technicians, regulatory frameworks, and also landfill construction and reclamation.

Recommendations

The following recommendations are made with the aim of attracting investors in the private and public sectors to partake in the following sustainable areas:

Entrepreneurs/Businesses

1. New and existing waste management businesses should be encouraged with start-up capital, grants, and guidance/mentorship over a period of time to aid the expansion of formal waste management businesses across the country, which would utilise up-to-date, sustainable measures in their waste management processes and treatment. These businesses may undertake any activity along the waste sector value chain, including collection, sorting, transportation, processing, packaging, and resale of waste in various locations nationwide.

2. Renewable energy investors are required who would invest in the provision of stable power supply across the value chains depending on the demand required and localized renewable energy resources available. This is capital intensive and would require a skilled workforce, but its establishment can be facilitated by finance institutions and private sector umbrella bodies.
3. Individuals should be encouraged to pursue careers as Natural Capital/Circular Economy consultants to aid businesses and organisations effectively and efficiently managing their waste and also assist in developing and implementing relevant State and National strategies.
4. Waste management stakeholders should be encouraged to use modern telecommunication tools such as websites, social media, mobile applications etc., in running their operations. These tools also have the added advantages of giving the business exposure and a global outlook relevant for applying for funding and grants. This can be done by undertaking awareness campaigns highlighting the benefits of harnessing the internet and social media.
5. Waste management entrepreneurs should be encouraged to harness national natural capital/circular economy-related programs such as the National Biofuel Program and Climate Smart Agricultural schemes. This can be facilitated by proper sensitization by the relevant government MDAs on the benefits of these programs to the general public.
6. The use of membranes from recycled ceramic wastes, settlement tanks and non-chemical treatment methods which are inexpensive and sustainable can be explored for the recycling of wastewater and the establishment of wastewater treatment schemes by PPPs. Existing water facilities can also be retrofitted for this purpose.
7. Certified landfill construction businesses should be encouraged to start-up in various parts of the country so as to develop approved landfill sites for waste disposal. This can be facilitated by advertisements, provision of financial support and training of the key personnel required. This is necessary for densely populated areas where unregulated landfills have become an issue (e.g. LAWMA (2019) stated that the government had concluded plans to decommission the Olusosun and Solous landfill sites) or at new settlements which intend to be proactive in their waste management approach.
8. Waste management specialists are required to manage unique waste such as medical waste from hospitals, laboratories, and pharmaceutical firms; agrochemical waste from farm estates; as well as chemical, toxic and hazardous waste from factories. An example is the use of experts in the National Hospital Intervention Scheme, a program which has installed biomedical incinerators at 23 sites across the country, with 10 currently operational.

Funding

1. Funding schemes should be provided for start-ups and businesses involved in natural capital and circular economy initiatives, such as the Sustainable Energy Fund for Africa managed by AfDB and the $70million fund provided by Agence Francaise de Developement (AFD) for renewable energy and efficient energy projects.
2. Financial partnerships involving financing institutions, funding partners and venture capitalists should be facilitated to provide capital for the establishment of waste management affiliated businesses, research, and training nationwide across various phases of waste streams. This may include PPPs, consortiums and technical partnerships between indigenous entrepreneurs and relevant national/international organisations. Examples include LAWMA-PPP partnerships: the Blue Box program, recycling banks, methane capture plant at Abule etc.
3. Incentives should be given to informal MSME's to aid their transition from the informal sector to the formal sector, such as tax breaks, free training on sustainable practices, subsidised registration fees, awareness creation on available grants and funding opportunities. This will promote increased sustainability in the sector.

Research & Data

1. Establishment of research centers and upgrading existing institutions for the purpose of research, data collation and publications of waste management. An example is the establishment of technology clusters by the Federal Ministry of Science, Technology, and Innovation.
2. The collection, storage, and analysis of data on other forms of waste, such as industrial waste, wastewater, medical waste etc., should be carried out by the relevant government MDAs with assistance from the private sector so that Nigeria can have an up-to-date database on various waste types. This will help the effective planning on how to address the various waste management issues across the country
3. Collaborations between the private sector with institutions of higher learning and individuals undertaking academic projects should be encouraged. The funding required is dependent on the scale of the research; however, the dividends are guaranteed due to the subsequent sale of the information and intellectual rights to members of the industry and governments.
4. Public institutions should continuously synergize with their counterparts in other developed countries to regulate, enforce, share knowledge, and build technical capacities.
5. Research should be carried out to seek alternatives to hazardous substances used in electronics production, cement, building materials etc. This requires high capital and a skilled workforce to develop materials that can replace these components without compromising functionality.

Capacity Building

1. Entrepreneurship training should be organised nationwide for potential waste entrepreneurs who can be taught how to develop their ideas into reality, how to develop bankable proposals, how to access grants, low-interest loans and technical support from national and international institutions and funding partners
2. Training and capacity building should be organised for various relevant public sector stakeholders across the waste sector to improve their skills with up-to-date technologies and applications.

Governance & Legislation

1. Sector-specific legislation should be created for waste streams such as e-waste, organic waste, textile, scrap metal etc., by NESREA in collaboration with the relevant trade bodies and umbrella organisations. An example is the National Waste Battery Management Policy which aims to promote the environmentally sound management (ESM) of waste batteries.
2. Decrees should be formulated by National Legislators to facilitate the creation of more enforcement agencies to assist NESREA in a bid to carry out waste management enforcement over the whole nation.
3. Legislation should be developed by NESREA, Department of Pollution Control -FME, Federal Ministry of Finance, Trade and Investment, and other relevant key stakeholders to aid the start-ups of innovative waste management businesses as well as green growth industries. This should include the transition of businesses in the informal sector to the formal sector. This legislation should also stimulate the continuous growth of this entrepreneurship and may include tax incentives and low capital costs.
4. Discussions to facilitate the speedy passage of relevant legislation should be stimulated by legislators to reduce the turnaround time for the development and implementation of waste-related legislation.
5. There should be clarity on the roles of various stakeholders in the implementation of waste management activities.

6. International agreements made by the country should be based on future mandatory assistance from external partners to the country's waste management sector to aid Nigeria's achievement of agreed objectives.
7. A document highlighting the list and brief details of all waste management policies and regulations should be developed to assist stakeholders in having an overview of the sector legislation.
8. The capacity of regulatory institutions should be increased. This should include establishing a Food Systems/Waste Unit in NESREA, which should be well funded with adequate technical capacities in all states across the country to aid the enforcement of food waste-related legislation enforcement. This will include all government-relevant institutions and private sector umbrella bodies, and this can be done over the next three years.
9. Child labour legislation should be enforced by the relevant government and community agencies like the Federal and State Ministries of Women Affairs and Social Development, Ministry of Education, Ministry of Labour and others after awareness and implementation of child labour alternatives have been provided to potential offenders.
10. The inclusion of food waste in the Waste Sector of Nigeria's revised 2026-2030 NDC should be carried out next Nationally Determined Contributions with a clear strategy on how to reduce it and corresponding emissions and increase efficiency from the farm-to-fork process. The Federal Ministry of Environment can carry this out by the next NDC revision, which is due to take place in 2024.
11. The Extended Producer Responsibility (EPR) program should be extended to the agricultural sector so that larger agricultural organisations are accountable for the waste activities which take place across the value chain. This will include NESREA in collaboration with the private sector and can be executed over the next three years.
12. Waste stream- specific policies should be developed outlining guidelines and measures for the sustainable management of specific waste streams such as e-waste, food waste, construction, textile, and fabric waste.
13. The enforcement of the ban on single-use plastic bags should be carried out similarly to what Rwanda did. This should be done by NESREA, Department of Pollution Control in FME, and State enforcement agencies so that innovative biodegradable alternatives can be produced locally.

4.1.13 Sector Specific Waste Value Chain Recommendations

Packaging: Plastic Waste

1. Recycling businesses: new plastic waste management businesses and expansion of existing ones should be facilitated to undertake the collection, sorting and packing of relevant waste material during plastic production and disposal after use so that it can subsequently be utilised as a raw material or feedstock for another process. An example can be the establishment of a mini-aggregation hub for packaging waste equipped with a baler and weighbridge operated by about 4 staff over a land mass of 0.6 hectares. The cost to set up this hub is approximately N10,000,000. However, this can be scaled upwards or downwards.
2. New Recycled Products: Recycled plastic waste can be repurposed into new innovative products such as plastic brooms, brushes, textiles etc.
3. Resuscitation of National Plastic Recycling Program: The purchase or lease of National Plastic Recycling Program facilities installed at 26 locations across Nigeria should be facilitated [43]. Semi-skilled workers will be needed for this, and funding will be required to refurbish some of these facilities and equipment depending on the level of deterioration, but agreements can be reached with the FME and State Governments on managing the plants.

4. Innovation and Technology: Entrepreneurs can develop alternative eco-friendly products and technological processes to replace plastics, such as biodegradable bags, boxes, and food packs made from plant-based substances. An example is Paper bags products by Ebees, based in Lagos, which creates sustainable packaging for food services, agro-processing, groceries, and fashion. This organisation offers a variety of products with different dimensions and price ranges and with active social media channels on LinkedIn and Facebook, including a company website.
5. Plastic Waste to Energy: Power plants that convert plastic waste to electricity can be established at viable sites using applications such as pyrolysis.

Electronics: E-waste

1. E-waste Recycling: Establishment of e-waste battery recycling businesses that can include collection points. Common electronics like mobile phones and batteries can be focused on so that recycling plants can be opened at urban and commercial centers across the country, collecting, sorting, and recycling e-waste from consumers or at collection points in a sustainable manner. The metallic and plastic components and precious metals can be removed by semi-skilled workers and can then, in turn, sell them to other users. It also requires medium to high capital. Existing small and medium-scale businesses that are into electronic sales and repairs can be encouraged to add this section to their business. Businesses that engage in circularizing used heating, ventilation and air conditioning equipment can also be established to work autonomously or in partnerships with larger electronic manufacturers and distributors.
2. Entrepreneurship Training and Capacity Building: Opening of a free e-waste recycling training program and school which teaches entrepreneurs to recycle e-waste using eco-friendly techniques. Skills acquired will include electronic repairs, refurbishing, repurposing, recycling, and recovery. On completion of the training, start-up grants can be given to participants who would be encouraged to utilise sustainable practices in their e-waste businesses to make it a low-cost venture with a high ROI. The government and NGOs can establish many institutions like this in close proximity to e-waste commercial centers like the Otigba Computer Village and Alaba International Market in Lagos and other parts of the country.
3. Electronics Verification and Validation: Individuals who can verify original authentic electronic products in open markets can become verification consultants and liaisons to assist customers in avoiding fake products which are yet to be purchased. This SME business is very low cost but requires the knowledge of being able to differentiate quality products from others to be able to build a long-term reputation.
4. The Federal Ministry of Environment and related MDAs should instigate and support the creation of international regulatory waste management collaborations which will govern and enforce international trade standards and movements. This synergy will consist of all producers, exporters, and importers of second-hand electronics goods into the country.
5. The Federal Ministry of Environment and related MDAs should push for the country's ratification and prompt implementation of treaties such as the Bamako Convention to serve as a deterrent to illegal e-waste operators within and outside the country (i.e., exporters and importers).

Food Systems: Organic Waste

1. Compost Plants: Compost-making plants can be built from organic waste to provide alternatives to chemical fertilizers. They require low-skilled labour and low to medium-scale funding to establish. Also, compost produced can be well packaged and sold for personal and commercial use.
2. Waste Collection and Processing Businesses: Establishment of organic waste management businesses which would collect, pack, and transport this waste from abattoirs, domestic, commercial, and industrial facilities to be used as feedstock for compost or waste-to-energy plant.

Unskilled labour is required, and it is a low-capital business to run, which makes a profit by receiving payments from consumers and feedstock buyers who purchase organic waste.

3. Waste-to-Energy Businesses: Waste-to-energy schemes and compost-making plants should be established at engineered landfill sites in every State capital of the country as this is usually the most populated urban centre in the State to use the associated waste generated. The private sector can drive this in collaboration with the State Ministries and Environment, Agriculture and Power agencies to establish PPPs.
4. Agricultural Processing: Proposals for modern agricultural processing and equipment for various food items to prevent food spoilage and elongate their life span should be developed and implemented to attract investors. Incentives such as zero-interest loans, tax waivers, rent-free land, etc., should be included. This can be carried out by the Federal and State Ministries of Agriculture, Finance, and Technology and civil society groups, which can be done within two years.
5. A food systems data management system should be developed, which should be easily accessible to all stakeholders for the measurement and recording of food data across the value chain for national and regional planning. The Federal and State Ministries of Agriculture and Information, National Bureau of Statistics, in collaboration with the private sector and international agencies who have the technical expertise to obtain such data such as the AfDB, UNEP, WRAP, P4G, GO4SDGs etc., and this can be done in the next three years.

4.2 Water Services

Introduction

Water is a finite resource crucial for socioeconomic development as it is vital in all spheres of human development, including domestic, industrial, agricultural, and recreational purposes. Agriculture, for instance, accounts for about three-quarters of global freshwater withdrawals, while energy production and mass tourism consume respectively 15% and 9% of water resources [80]. Issues of water resources, fall under two major categories: demand-side and supply-side. While the demand-side deals with water abstraction and competing demands by individuals, households, and industries, the supply-side, on the other hand, focuses on the spatial and temporal distribution of the resource, its management and protection. A key challenge to water and sanitation security is the reconciliation of water and sanitation demand and supply both for the medium and long term. As a natural resource, it exists in different forms, saltwater, underground water, and surface water. However, of all the forms of water resources available, accessible freshwater is most important for humans. The lack of access to fresh water can be detrimental to human health and lives, as drinking contaminated water and sanitation are linked to the transmission of several diseases, such as cholera, diarrhoea, and typhoid. Contaminated water not only affects human health, but it also cascades to productivity at work, absence from school and productivity of water resources by way of lower fisheries output [5]. Hence, water is critical for development, and its efficient management guarantees a sustainable future. Additionally, it is a central element in addressing so many of the development ambitions contained in many SDGs beyond the specific water-related targets of SDG 6 [81].

The Sustainable Development Goal 6 sets ambitious goals for all parties to be achieved by 2030 for water management and conservation. Target 6.1 calls for universal and equitable access to safe and affordable water, whereas target 6.2. advocates elimination of open defecation, and target 6.3 addresses the reduction of untreated wastewater. Unfortunately, historical progress reports indicate the need for more efforts from national governments to achieve the SDG set goals. For instance, as of 2020, 2 billion persons globally, lack safely managed drinking water services. Most of these numbers are recorded in

the least developed and low-income countries. Noteworthy is the fact that eight out of ten persons who lack basic services globally live in rural areas [82]. In Nigeria, about 70% of the population are reported to have access [83]. However, more than half of the water is contaminated and only about an average of 9 litres of water is available to each person daily [7]. Available statistics as regards sanitation and hygiene indicate that 70 million Nigerians use unsanitary or shared latrines, while 32 million have no latrines at all and defecate in the open. In economic terms, the country loses about 455 billion naira yearly, equating to about 1.3% of GDP to poor sanitation World Bank, 2012]. All of these are pointers to the inefficiency of the country's current levels of water resource management and government priorities. With an exploding population, rapid urbanisation and climate change realities, stresses and pressures on water resources are most likely to increase in the near future. Hence, a calculated paradigm shift is needed from the linear model of water management to circular economy thinking that offers water reuse opportunities and conservation.

Circular economy is built on three core principles based on design: elimination of waste and pollution, circulation of products and materials, and regeneration of the natural system/capital. All of these can be achieved through re-engineering product design for longer use/shelf-life, reuse, and recycling. In line with the new wisdom, the nation's waters can be reused, recycled, and conserved. However, to achieve these ideals and for a smooth upward transition from current linear practice, this section attempts an assessment of the current state of water service sector, its political landscape, challenges, and opportunities that exist for circularization. Case studies of successful application of circular economy elsewhere are presented for drawing parallels between countries that will ultimately lead to better policy direction, long-term development planning and public-private partnerships/donor interventions. Recommendations include the need for the establishment of multi-scale wastewater treatment centres and for a coordinating agency whose sole mandate revolves around the provision of water services and ensuring sanitation for all categories of usage and levels of citizenship. Such an agency will also be involved in investment sourcing, finance, and partnerships, and provision of water utilities and maintenance. Additionally, decentralization of water services and sanitation from the central government to municipalities will lead to efficiency in services and management of water resources. As water reuse can be monitored locally, and health risk reduction can be achieved faster within specific areas of reuse. In addition, building a successful and innovative PPP will improve the sustainability of wastewater management, minimise environmental impacts and, in the long run, will have multiple benefits for the community.

4.2.1 Water Supply and Access

Nigeria has significant water resources, estimated at 333 billion m3 of surface water and 88 billion m3 of Groundwater [39]. These water resources are distributed unevenly across geographical regions and are subject to seasonal variability [84]. The north, with annual precipitation of 100-250mm, experiences more scarcity than the south [85]. Despite the vast water resources, only about 69-73% of the Nigerian population have access to basic water supply [3] & [7]. As detailed in the recently submitted NDC, 82 percent of people in urban areas have basic supply, whereas, in rural areas, only about 54% have access. With increasing population, water shortage is worst in the north based on the increasing demand for irrigation, water supply and energy generation [86]. Yet, both regions are vulnerable to current climate change, and resultant losses affect the resource base. For example, the devastating effects of the flash floods in 2012 that caused destruction in physical assets amounted to N1.48 trillion (US$9.5 billion), equivalent to 2% rebased GDP [39]. Communities within water-scarce areas depend on surface water, unimproved sources of water or trek long distances in search of water. This has far-reaching effects on the health of the citizens, particularly on women and girls who traditionally are saddled with the

responsibility of fetching water for domestic household use. Also, the transition from rural to urban centres, as witnessed in-country, creates an unprecedented demand for reliable, safe, and sustainable urban water supply and sanitation services [87] & [88]. The Global Environment Outlook reports show Nigeria as one of the 25 African countries that will be subject to water scarcity/stress by 2025 [89]. The forecast predicts a water stress level of about 1,000-1,7003 m /person/year. Thus, the sustainability of water resources cannot be taken for granted. Efforts must be made by the government across scales to improve water supplies for positive water outcomes.

A significant program in the current discussion for water services improvement is the National Water Supply and Sanitation program. Under the program, four sub-sectors were proposed for water supply and sanitation:

1. urban areas,
2. small towns,
3. rural areas,
4. water resources management and sanitation.

The strategy for urban water is to improve service delivery through optimal public-private partnerships (PPP) investment, management, and delivery of water services. Whereas that of small towns is to decentralize ownership and management of water supply systems to attract and involve optimal community involvement and support from the private sector, including operating under contract and regularizing the services of independent providers. For the rural areas, the government's goals are to increase the water supply to attain 60 percent rural coverage by 2027, with a three-pronged approach of water rehabilitation, expansion, and construction of low-cost rural water schemes. However, these schemes and goals are still in their nascent stages; hence widespread adoption and implementation are lacking in most of the nations over 700 local government areas.

Importantly, according to [90], the National Water and Sanitation Policy defines water as an economic good, leading to the classification of the commodity under economic services at the federal level. But this is not so in the States and the Local Governments, where water resources and sanitation are classified as social commodities. This discrepancy, the report argues, can constrain private investment and the zeal behind the provision of water resources. Additionally, in its use for sustaining life and the environment, water should be treated not only as an economic good but also as a social good. This distinction is important in the pricing of services for water supply and sanitation and in the formulation of policies on water allocation for sustaining life and the environment [91].

4.2.2 Sanitation and Hygiene

The importance of clean and accessible water is intertwined with sanitation and hygiene as enshrined in the SDG 6 and equally seen in the emergence and handling of the SARS-CoV-2 pandemic. Target 6.2 explicitly addresses issues of sanitation and hygiene; by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. The cost of poor sanitation in the nation, as stated in the introductory section, is astronomical but not insurmountable. For instance, open defecation can be overcome through investments of less than a 6.5million to build latrines, which is by far less than the current annual loss of 455 billion Naira. Faeces contaminate drinking water sources and are the root cause of an annual average of 5,400 cases of cholera affecting Nigeria [6]. In fact, approximately 121,800 Nigerians, including 87,100 children under 5, die each year from diarrhea, nearly 905 of which are directly attributed to poor water, sanitation, and hygiene [7]. In the circular economy, nothing is wasted;

rather, waste is considered a resource. For instance, within the context of Water, Sanitation and Hygiene (WASH), water reuse (wastewater) and sludge reuse drive processes and product design. According to [92], natural resources must be preserved, and what is considered waste must become an opportunity for recovering resources and materials. Circular economy comprises two cycles:

1. Technical, which is concerned with the management of the stocks of finite resources and
2. Biological, managing the flows of renewable resources [93].

But industries so far have largely paid attention to the technical cycle (e.g., metals & plastics), leaving the biological cycle/biocycle) largely untapped. The Biocycle is an emergent business space and presents a large sphere of opportunities for small and medium-scale entrepreneurs focused on optimizing nature-based solutions to solving waste issues.

4.2.3 Toilet Resources

Biological materials represent most of the “waste” stream in low-income markets [94]. Hence, developing a broad and holistic biological resource system, including toilet resources, is not only valuable but enables innovation in the use of biological substitutes for a wide range of products. [93]. In the reuse of toilet resources, old mindsets and thinking must be discarded to embrace the new wisdom of considering toilet waste as resource material. Importantly and noteworthy is the fact that toilet resources are principally composed of water; faecal matter contains up to 75% water, whereas urine is 95% water [95]. Several examples exist of companies which are currently extracting toilet water, filtering it and producing either potable or processed grey water for use in agriculture, aquaculture, or water-intensive industrial operations. This is one area that should form part of the nation’s focus under the urban area within the national water and sanitation program. In addition, [93], in their report on toilet resources opportunities, produced six key points summarised below, which could be leveraged by academics, industry giants and business start-ups.

They include:

- **Toilet resources are a major part of the biocycle that are mostly unexploited**; yet they are almost always handled separately from other resources. This is mainly for historical reasons because sanitation has been addressed primarily as a health issue. An approach to the circularity of toilet resources is being blended with food and farm “waste,” plus compostable items, such as packaging. This could enable manufacturers to favour biological materials for many applications.
- **The Circular Economy could transform sanitation from a costly service to a self-sustaining and value-adding system of resources**; involves converting toilet waste from a cost into a valuable economic resource; by so doing, the newly generated valuable resource can be used to maintain and sustain sanitary facilities.
- **There are 3 Circular Economy opportunity cycles for sanitation that include**; Maximise value from toilet resources (sanitation system drives value chain, e.g., agricultural products which use biological resources as their source), Integrated approach to resources, favouring the biocycle (e.g., integrating toilet resources, farm and food resources, and other compostable items. This is both a productive biocycle, and a route to reducing other "waste" challenges such as plastics), and Self-sustaining facilities and operations (e.g., developing models that change traditional ownership of plant and equipment, with the supplier providing an ongoing support service rather than making a one-time sale. The models are circular because the supplier is incentivized to support long product life and finally to take responsibility for the product at end-of-life).
- **There are renewable resources available for corporate supply chains today**; recognizes five major sources of value that can be derived from the sanitation system if it adopts the circular model. Three are available today (energy, agricultural products, and water), and two as potentially

significant business opportunity spaces for the not-too-distant future (Innovative products/raw materials and Information/health data).

- **There are innovative applications for industry in the future**; from animal feed to plastics and even cosmetics and pharmaceuticals, there are already some surprising applications that could make use of material derived from toilet resources.
- **There are significant leapfrog opportunities for low-income economies**; low-income market "waste" is mostly biological, whereas developed markets have a much larger proportion of non-biological materials such as metals and plastics. This creates a unique opportunity to leapfrog into the Circular Economy.

4.2.4 Wastewater

Common sources of wastewater production emanate from domestic, industrial, and commercial areas. These sources are considered potential production sites for water recovery [96]. Wastewater is of two forms: blackwater and greywater [97]. Whereas blackwater originates from toilets, made up of urine, excreta, and faecal sludge, greywater, on the other hand, is wastewater from bathtubs, showers, hand washing basins, laundry machines, and kitchen sinks in households, offices, schools, and commercial buildings. Arguably, large quantities of wastewater come from industrial effluent discharges, stormwater, agricultural, horticultural and aquacultural activities [98]. Water reuse is an opportunity as it provides new approaches to meet the increasing urban demand and represents one of the most important alternatives to conventional freshwater sources to address water scarcity [99], especially in low-income countries, as well as in arid or semiarid regions [100]. Essentially treated wastewater can be reused for multiple purposes such as industrial sectors, agricultural purposes, irrigation, groundwater replenishing and by effluent quality improvement, it can also use for domestic use, fire protection, car wash, and toilet flushing [101].

Globally, 80% of wastewater flows untreated back into the environment, and 1.8 million people are exposed to contaminated water for their drinking water source [102]. In Nigeria, over 95% of wastewater reused for various purposes in Nigeria is untreated [97] & [103]. Consequently, wastewater is still a major problem in Nigeria and could lead to groundwater pollution and environmental pollution [104].

Apparently, Nigeria has no clear legal and regulatory framework for managing/reusing wastewater. However, relevant institutional authorities exist for waste management which, in almost all cases, narrows down to solid waste management [97]. As in the case of toilet resources, circularizing wastewater in Nigeria will have a resultant beneficial effect on water resource recovery and a better efficient waste management system. Ultimately, recycling or water reuse will extend the lifetime use of water resources. Consequently, wastewater treatment plants should be established across major regions of the country. Lessons abound globally and within the continent that offer parallels for experience sharing and inclusion of wastewater within the country's circular economy agenda. Examples include:

- **Singapore's NEWater Project:** Singapore is a highly developed economy, yet lacks the water resources it needs, as it lacks natural aquifers and lakes. In recognition of the demand and needs of consumers, Singapore's Public Utilities Board (PUB) launched an aggressive water reuse and recycled wastewater project. The ensuing product is nicknamed "NEWater" (www.climateadaptationplatform.com). NEWater has reclaimed municipal water that augments and diversifies water resources for all users. Singapore implemented water reuse in 2003, at a time when Windhoek, Namibia, and Orange County, California, had already been producing reused water for several decades [105]. The water reuse supplies 40% of the nation's water needs, and it is

projected to expand to 55% by 2060, mainly by streamlining the water infrastructure to collect 100% of wastewater [96].

- **Buiksloterham, Amsterdam:** Buiksloterham is an upcoming district in Amsterdam that is a good example of recycling wastewater based on circular economy principles. The district previously was an industrial hub but is currently being transformed to house about 6,500 residents. The circular design of the city centres around the use of wastewater from the toilets. Wastewater from toilets is collected via a vacuum sewer system before treatment with Up-flow Anaerobic Sludge Blanket (UASB) reactors. Byproducts obtained include biogas, nitrogen, and phosphorus. All these recovered products are useful and can be reused within the system; for instance, both nitrogen and phosphorous are important elements of inorganic fertilizer manufacturing, while biogas is a good alternative to fossil fuels [106].

- **Turku region, Finland:** The Turku region in Finland is the 3rd largest city in the country and another acclaimed leading example of circular water management. This they attribute to a strong research and innovation community as well as cooperation with other Baltic cities. While municipalities in the Turku region have collaborated to implement joint circular solutions in areas ranging from water extraction to resource recovery, regional actors, on the other hand, have developed innovative managed aquifer recharge techniques to protect groundwater. These recognized innovations have led to the availability of high-quality drinking water in the region, and the nutrient load in the Archipelago Sea has been significantly reduced. However, challenges remain in ensuring the region is ready to face increasing stormwater levels and other climate change-related risks [107].

- **Republic of Benin:** In Benin, sanitation is relatively young and became prominent in 2003. The central government saw the need to decentralize sanitation to the municipality level. Results from this strategy saw the development of sanitation and sewerage facilities in the big towns. In rural areas, the use of toilets and the practice of basic hygiene at home and schools were encouraged. Municipalities are the owners of water and sanitation utilities and those responsible for planning, financing, building, and operating drinking water supply and sanitation infrastructures in rural and urban areas. Finally, local and collective non-profit organisations (NGOs) elaborate and coordinate projects and ensure their management as a support operator for municipal project management, often in partnership with decentralized and non-governmental cooperation actors [108]

- **Dakar, Senegal:** Senegal has made concerted efforts toward adopting holistic circular economy approaches in water and sanitation management. The process has included policy and regulation reviews for more efficient water and waste use and reuse. Presently, Dakar's sanitation and stormwater utility Office National de l'Assainissement du Senegal (ONAs), in partnership with the private sector, is pivoting the lead for efficient circular economy asset opportunities in wastewater and sanitation.

- **Ghana:** The CapVal project [109] is a project of the International Water Management Institute on several resource recovery and reuse solutions that have significant potential to incentivize more investments in sanitation planning and management in Ghana and beyond. One of the lessons for the current discussion on circular economy is the use of water from effluents for urban and peri-urban aquaculture. Household effluent from a community of about 1,800 people in the southern city of Kumasi is directed into a wastewater treatment plant comprising, among others, five stabilisation ponds. Fish are raised in the last (maturation) ponds where water quality is sufficiently high. In 2020, a greenhouse was installed at the plant. Wastewater generated from the

hatchery and grow-out tanks is channelled to the greenhouse to grow vegetables in aquaponics. These vegetables are also sold, helping to diversify the plant's revenue streams.

Another solution is the use of compost made from faecal sludge in the agriculture sub-sector. In Somanya in the Yilo-Krobo Municipal Assembly, the project has supported the construction of a composting facility. Operated by Jekora Ventures Limited, the facility can produce 200 tonnes of nutrient-rich fertilizer annually by transforming up to 5,000 cubic meters of municipal fecal sludge and at least 300 tonnes of organic waste. The fertilizer is produced by drying faecal sludge on beds of sand. The dried sludge is then mixed with organic waste, mainly food waste collected from local markets, and 'co-composted' for three months. This involves regular heaping, moistening, and turning of the material as it decomposes. Heat generated in the process kills any pathogens, resulting in a product that meets the safety standards set by the World Health Organisation for reuse of human excreta. After it is certified by the government, the fertilizer will be sold to local farmers as an affordable alternative to imported variants. Through capturing the value of waste, the IWRM project in Ghana aims to show that waste-treatment facilities can be sustainably operated in the long run.

- **Durban, South Africa:** Durban is the third biggest city in South Africa and a major commercial hub with an increasing human population. During the 1990s, Durban was facing a sewage capacity constraint. The existing infrastructure could not cope with the growing population and the economic development of the city. Through a public-private partnership (PPP), the municipality successfully implemented a wastewater recycling project for industrial purposes, underscoring the usefulness and merit of recycling wastewater rather than its disposal [110]. Instead of increasing the capacity of the existing marine outfall pipeline in the city's Southern Wastewater Treatment Works (SWTW) to discharge primary treated wastewater to the ocean, Durban explored the possibility to further treat it and reuse it for industrial purposes. Mondi, a paper industry, and SAPREF, an oil refinery, expressed interest in receiving the treated wastewater. The goal of the project was to treat around 48 million litres per day (approximately 10 percent of the city's wastewater) and achieve an acceptable quality for industrial reuse: 85 percent of the treated water would go to Mondi and the rest to SAPREF. In order to be able to supply recycled water to the two industrial users, the municipal water utility (Ethekwini Water Services [EWS]) needed to upgrade the existing activated sludge process, build a new tertiary wastewater treatment plant, refurbish the high-level storage tank, and install a reclaimed water reticulation system. The city was able to convert a challenging situation into an opportunity, leveraging the local conditions and innovative thinking that resulted in a win-win solution for all stakeholders [110].

4.2.5 Policies and Legislation

The transition to a circular economy is new wisdom, especially in a resource-dependent country such as Nigeria; however, the journey can be demanding based on political systems and structures that could impede the transition. The policy framework in Nigeria is replete with water-related policies and regulations. Some important sector policies include:

- National Water Supply and Sanitation Policy, 2000
- Rural water supply and Sanitation Policy, 2000
- National Water Resources Management Policy, 2003
- National Water Policy, 2004
- National Environmental Sanitation Policy, 2005
- National Water Resources Act (draft), 2007

- National Water Resources Masterplan, 2013
- Water Resources Act 1993 and Water Resources (Amendment) Act 2016
- River Basin Development Authority (RBDA) Act,1990
- National Water Resources Institute Act, 1985
- National Water Resources bill, 2020

The National Water Supply and Sanitation Policy (NWSSP) of 2000 were formulated to address issues relating to WASH. Its emphases are the provision of potable water and adequate sanitation to all Nigerians in an affordable and sustainable manner through participatory investment by the three tiers of government (i.e., federal, state, and local governments), the private sector and the beneficiaries [111]. An interesting point of this policy is the involvement of the private sector's investments. However, to date, water supply services are largely government driven.

Whereas the National Water Policy (NWP) 2004 recognizes the need to balance water uses, water allocation and water protection carefully through a regulatory system of river basin-based management and a participatory approach. The recognition of the participatory approach in this policy is important for water efficiency and sustainability. Still, water management in the nation is operated only from the top, as in the earlier case mentioned.

The current National Environmental Sanitation Policy (NESP) 2005 was developed by the Federal Ministry of Environment. The Policy is broad spectrum and covers: Solid waste; Medical waste management; Excreta and sewage management; Food sanitation; Sanitary inspection of premises; Market and abattoir management; Adequate potable water supply; School sanitation; Pest and vector control; Management of Urban drainage; Control of reared and stray animals; Disposal of the dead (humans and animals); Weed and vegetation control and Hygiene education and promotion. The objective of the 2004 Sanitation Policy is for all Nigerians to have access to adequate, affordable, and sustainable sanitation through the active participation of Federal, State and Local Governments, NGOs, development partners, the private sector, communities, households, and individuals.

National Water Resources Institute Act (NWRIA): This Act established the National Water Resources Institute for the promotion and development of training programs and courses in water resources and to advise the Government on water resources training needs and priorities and other matters ancillary thereto. [1985 No.3.]. Inter alia functions of the NWRIA include,

1. Advise the Minister on national water resources training needs and priorities,
2. Perform engineering research functions related to such major water resources projects as may be required for flood control, river regulation, reclamation, drainage, irrigation, domestic and industrial water supply, sewage, and sewage treatment,
3. Perform such ancillary services on planning of water resources management and river basin development and produce necessary codes of practice in water, resources engineering related to and suitable for Nigerian conditions and

4. Promote the establishment of a uniform national data collection system relating to surface and subsurface water resources.

Water Resources Act (WRA): An Act to promote the optimum planning, development and use of Nigeria's water resources and other matters connected therewith. [1993 No. 101.]. This Act vest right and control of the nation's waters to the Federal Government, as stated in section 1, "The right to the use and control of all surface and groundwater and of any watercourse affecting more than one State as

described in the Schedule to this Act, together with the bed and banks thereof, is by virtue of this Act and without further assurance vested in the Government of the Federation for the purpose of, inter alia, promoting the optimum planning, development and use of Nigeria's water resources. However, notwithstanding the provision of section 1, section 2 pronounces that any person who has a statutory or customary right of occupancy to any land may take and use water from the underground water source or if abutting on the bank of any watercourse, from that watercourse, without charge for domestic purposes, for watering livestock and for personal irrigation schemes. Penalties: Any person who contravenes or fails to comply with any provisions of this Act, or any regulation made thereunder commits an offence and is liable upon conviction to a fine not exceeding N2,000 or to a term of imprisonment not exceeding six months or to both such fine and imprisonment, and, in the case of a continuing offence to an additional fine not exceeding N 100 for every day or part of a day that the offence continues.
The Water Resources (Amendment) Act 2016: This Act amends the Water Resources Act Cap. W2, LFN 2004. Enacted by the National Assembly, it amends the following section: Section 18 (1) of the "Principal Act" by substituting the following expression "N2,000" in line 3 (for) the expression, N500, 000 and "100" in line 5 (for) the expression, N2, 000 and the words "six months" (for) the words, "one year".

The River Basin Development Authority (RBDA), 1990 established 12 RBDAs and empowered them to develop and manage surface and groundwater resources within their jurisdiction to promote agricultural development and provide domestic water supply. Section 4(1) (a)-(d) of the RBDA Act vest the authorities with the legal powers to undertake comprehensive development of both surface and underground water, to construct and maintain dams' irrigation and drainage system, to supply water to all users, and to construct and maintain infrastructural services including roads and bridges across project sites.

The legal framework is all-encompassing, as in all cases of existing policies reviewed. There are details of the area coverage of the natural capital, institutions formation, organogram, mandate and, importantly, the function of the Act in the protection of water resources. However, some of these Acts are antiquated and obsolete, calls for an upward review, particularly within the purview of current climate change. An understated case in all of the available water-related policies and Acts is the prescribed penalties for defaulters and polluters. For instance, in the National Inland Waterways Authority Act, penalties for offences under the Act is inadequate and misleading, as quoted in the following statement, "A person who is guilty of an offence under subsection (I) of this section is liable on conviction to a fine not exceeding N50,000 or to imprisonment for a period of six months or to both such fine and imprisonment and, in the case of a continuing offence, to an additional fine or NI 00 for every day or part of a day that the offence continues. Where an offence under this Act has been committed by a body corporate or firm, or association of individuals, it shall be liable upon conviction to a fine of N200,000 and, in the case of a continuing offence, to an additional fine of NI ,000 for every day or part of a day that the offence continues".
The punishment and stipulated fine in this Act are insufficient to deter activities that are inimical to the resource base. It is perhaps cheaper for a person or corporate bodies to pay the stated fine than to maintain global best practices within the sphere of the nation's inland water.

Inappropriate pricing of water resource use, penalties, and lack of incentivization within the sector are perhaps responsible for the current rot in the system. Equally missing is the lack of a framework for water reuse and recycling; this creates a vast opportunity for investments and circularization.

4.2.6 Institutional Structure and Governance

All the three-tiers of government (i.e., federal, state, and local) are involved in national water governance, however, to varied degrees. **The Federal Ministry of Environment** acts as the apex ministry regarding environmental resources within the nation. It has a mandate for a suite of issues, including many that had previously been under other ministries, such as the Federal Ministry of Health and Federal Ministry of Water Resources. Some of these responsibilities include the provision of potable water, excreta, and sewage management. *However, collaboration between ministries is recognized in some of the policy documents. For instance, in the NWSSP, the Federal Ministry of Water Resources (FMWR) is to collaborate with the Federal Ministry of Environment on water sanitation activities, including sewage, stormwater control and quality control of water supply sources.*

Specific institutions involved in managing the water sector are mainly.

A. **On the Federal level**, the principal Federal ministries and agencies include.
   - Federal Ministry of Water Resources (FMWR),
   - The 12 River Basin Development Authorities (RBDAs),
   - Federal Ministry of Transport,
   - Federal Ministry of Aviation (FMA) and
   - Hydro power generation companies.

Most water resources development activities undertaken by the Federal Government besides power production are carried out through the twelve RBDAs under the direct surveillance and coordination of the Federal Ministry of Water Resources.

B. **On the State level**,
   - The 36 state governments have created their own agencies that oversee water resources development,
   - The State Ministries of Works and Housing and of Agriculture,
   - State water boards, and
   - Rural Electrification boards

C. **On the local government level**,
   - The 774 local governments are mandated to provide rural water supplies and sanitation facilities within their areas of jurisdiction

D. Other Relevant water-focused initiates and groups include:
   - Water Initiatives Nigeria (Non-profit organisation),
   - Water Aid Global (Started working in Nigeria in 1995, working closely with government and other partners to expand WASH),
   - UNICEF (working closely with government on WASH),
   - Globalwaters.org (Initiative of the USA government for a sustainable water plan through its agency-USAID),
   - Effective Water, Sanitation and Hygiene (E-WASH) initiative (Work with state water boards to deliver better urban services to Nigerians),
   - Bread of life development foundation manages news on water and sanitation across Nigeria through the weblog eWASH (available on www.assemblyonline.info)
   - Society for water and sanitation (NGO coalition for WASH in Nigeria)

E. Furthermore, are,

- World Bank,
- African Development Bank,
- Japan International Cooperation Agency, JICA,
- European Union and
- the French Development Bank.

Whereas water resources have a ministry saddled with the mandate of its management, sanitation on the other hand, does not have a dedicated ministry. This is a gap that should be addressed, given the importance of sanitation in the scope of WASH and in transiting to a circular economy. Below is the policy direction that will aid the nation's transition from the current linear practice to a more sustainable circular economy in the water and sanitation sector.

'POLICY DIRECTION'

There is an urgent need for reforms within the sector if the nation must meet the SDG goals on water and sanitation. Reforms will include the development of a peculiar agency with the sole mandate of ensuring Sanitation issues are well articulated and addressed. Such agency may be given the role of coordinator for water and sanitation matters, investments, provision of water utilities and maintenance. Circularity demands that water is recycled and reused; in line with this, we propose the emergence of Wastewater Treatment plants in the six geopolitical zones starting with one in each major urban city of the said geopolitical zones. Decentralization of water services and sanitation from the central government to municipalities will improve efficiency, as reflected in the neighbouring Republic of Benin. Decentralization will mean water reuse can be monitored locally, and health risk reduction can be faster achieved within specific areas of reuse. In addition to all of these is a successful and innovative PPP such as mirrored in Durban. Such alliances will improve the sustainability of wastewater management, minimise environmental impacts and, in the long run, will have multiple benefits for the community.

4.2.7 Swot Analysis of Legislation and Governance Landscape

The available water-related legislation/policies and Governance Structure were put through an initial assessment and mined using the SWOT tool for their compliance to natural capital-based solutions and incentives that contain elements of circular economy as shown in **Appendix 31. Appendix 31** gives a SWOT analysis of Governance Landscape Assets. Though there are some notable strengths, we observe that they are overshadowed by threats & weaknesses, such as 'Investment gap, Inadequate and non-existent infrastructure, the gap for improved services is about 64.1% (USAID),' in the area of Infrastructure. We have identified several opportunities that PPPs and Donor Agencies can exploit.

However, notable challenges that are barriers to circularity include the following:

- Weak legal structure for circular economy, for instance, is the lack of a legal framework for wastewater management.
- Low budgetary allocation, annual budget and finance not clearly stated in any of the policies/Act; For instance, federal budget allocation to water supply in 1991 was 0.03% of the annual federal budget, by 2002, it increased to 3.3% [112], yet the seemingly increase is barely adequate in meeting the water service demands of the nation's population. Insufficient finance will frustrate progress towards meeting the SDG for WASH.
- Lack of investment in recycling and recovery of nutrients and energy from wastewater and stormwater.

- Low community involvement and participation, the decision-making process is still driven by a top-bottom approach with a multiplicity of water-related agencies and institutions at the federal and state level of governance; to achieve WASH goals all stakeholders must be involved in water governance; community influencers are critical change agents in changing traditional practices such as open defecation within waterbodies.
- Low adoption of modern treatment technologies, translating to widespread obsolescence and abandoned infrastructures across state-owned waterboards and river basin authorities; inadequate/obsolete and non-existent infrastructures translate to high-level Investment gap; Gap for improved services is about 64.1%.
- Weak database of extant natural capital; in addition, current levels of water use, and services are not properly accounted for in Systems of National Accounting, leading to underutilised and unutilised assets.

4.2.8 Opportunities and Challenges offered to boost Public, Private Sectors & Donors/Bank Partnerships:

Opportunities abound within the water supply chain for public-private partnerships, and they include the following,

- **Develop Capacity of Water Managers**; In-career professional development for MDAs, including local government and community-level operators, upgrading training programs congruent with current circular economy paradigm, capacity building of water managers creates Opportunities for detailed assessment of Nigeria's water sector's vulnerability to climate change on a region-to-region basis is needed for planning and future projections. For instance, there are no reliable data on the comprehensive assessment of the extent of the 2012 extreme weather disaster on water resources. Data paucity leads to inadequate preparedness in crisis and disaster management.
- **Strengthen Institutional framework/policy**; through building the capacity of legislators for policy reforms, involving peer-to-peer exchanges that lead to the formulation of relevant legal and regulatory frameworks such as those needed for wastewater reuse and recycling.
- **Increase Investments in water and sanitation**; the prevailing water systems in the nation are inefficient, inappropriate, and ill-planned, and need upgrading, same with the practice of trucking water from catchment to households and other customers and back to catchment that leads to water loss, misuse, and pollution. Thus, to maximize the value of water across the country and transform the urban water sector, Investments are needed for the re-engineering of existing systems. Investments such as the use of renewable energy (solar systems) to generate water will aid the optimization of energy or resource extraction from the water system.
- **Development of appropriate eco-solutions for wastewater collection, treatment, and reuse**, for instance, the reuse of wastewater from household kitchen drains, bathroom pipes and sewer pits for agricultural and industrial processes. Water reuse is an opportunity as it provides new approaches to meet the increasing urban demand and represents one of the most important alternatives to conventional freshwater sources to address water scarcity [99]. Notably, most wastewater in developing countries is untreated. If this is to be halved by 2030 to meet SDG 6 targets, substantial amounts of additional energy will be needed if traditional methods of treatment are applied [35]. However, the energy contained in wastewater is about ten times greater than the energy needed to treat it and recovering this amount of energy may address the challenge of water management across Sub-Saharan Africa; other resource recovery options include inorganic and organic matter, which can keep resources in perpetual use.

- **Development of Stormwater runoffs treatment plants and recycling**, especially within municipal areas and coastal cities,
- **Development of Techniques for Resource Recovery from Toilet and Septic Tanks**; recovered resources from toilets can form the bulk of agricultural fertilizers or can be integrated into farm and food resources, and other compostable items to form durable construction products. This is both a productive biocycle, and a route to reducing other waste challenges such as plastics.
- **Creation of Circular Economy business models** that could be used as pilot programs across regions with a plan for a nationwide adoption based on successful outcomes, for instance, designs that address Rainwater harvesting systems with the ultimate function of recharging aquifers. Also treated rainwater can form an additional and expanded water supply to water-scarce regions or during droughts occasioned by ongoing climate change.
- **Improve National Water Governance**; Water and sanitation are cross-cutting issues across several sectors, hence. It's important that partnerships are forged with intersecting partners and agencies in charge of other sectors such as energy, agriculture, and waste for water use efficiency through building capacity in new thinking and appropriate technological transfer; in addition, such partnerships will form the basis for the analysis of national level cross-sectoral and within-sector explicit and implicit water commitments. However, these partnerships demand an efficient coordination.
- **Adopt integrated water resources management (IWRM) approach** for the sustainable development of the country's river basins, through involvement of all critical stakeholders such as local government, municipal councils, informal sectors, also is the inclusion of community influencers who are critical in attitudinal changes across communities.
- **Create Platforms for International Cooperation** by Integrating basin-level mechanisms, both at national & regional (transboundary) levels to evaluate the robustness and flexibility of water commitments, within and between catchments.
- **Introduce measures that are necessary for monitoring, reporting, and verifying programs, such as the NCEP proposed MRV** to monitor and manage water demands and supply.
- **Strengthen Citizen awareness and information management** through timely information dissemination and sharing, also is the mobilisation of cross-sectoral relevant actors (MDAs, civil society, private sector) to support NDC implementation of water sectoral plan.

4.2.9 Job Creation and Opportunities for SMEs Business Start-ups

Circular economy is an emerging market with opportunities for young entrepreneurs whose mindset is on providing eco-solutions to resource use, efficiency, and sustainability. For instance, within the water-use and recycling domain, youths could be trained in relevant technologies to create and manage wastewater treatment plants that could service small to medium size communities in their region. The case has also been made for the conversion of toilet resources to valuable resources, applicable for a start-up within the agricultural industry. *Upcycling biological resources to agricultural products could help provide complimentary products to chemical fertilizers to address the degradation of nutrients in the soil over time while reducing the transport impact of industrially produced fertilizers* [93]. Youths and women could be trained along these lines. Other opportunities for youths include:

- Develop training and business start-ups for youths and women in wastewater recycling and reuse, e.g., recovering of energy, nutrients, and water from wastewater plants.
- Develop modular/community-level business start-ups that focus on biological resources such as those from toilet facilities with the objective of maximizing value from toilet resources where sanitation system drives value chain, e.g., agricultural products which use biological resources as their source.

- Develop a critical mass of youths who can be engaged in Community-based monitoring systems & service provisions at the state and rural levels.
- Mobilise and train youths and women groups to establish nurseries, plant trees upstream as a measure against soil erosion to improve water quality as part of green jobs within the water sector.

4.2.10 Recommendation

Fresh water is a finite resource that is largely undervalued and it's the imbalance in the distribution of water that propels global dialogues and consideration for its sustainability and conservation. Current infrastructural designs and operations do not consider options for Reuse or Recycling. Invariably, the impacts of discharges into receiving water bodies and environments are not considered. Adopting a circular economy approach will help manage and minimise waste from sources such as domestic, agricultural and industry. In particular, the recovery of wastewater from toilets and kitchens will revolutionize water management and conservation. Nigeria can borrow a leaf from globally tested solutions from countries such as the Netherlands, Singapore, and Finland. A range of cost-effective solutions and strategy is needed to address the technical, institutional, and social hurdles. The strategy may take time; however, in the long run, a coordinated design will ultimately lead to new local, Business opportunities and models.

Public-private partnership is largely lacking in most of the available national programs, policies, and initiatives. Invariably, there is little decentralization of policies and investments. Local government involvement generally appears low, and from available literature, national policies appear to tilt more toward water supply with minimal consideration for sanitation. Likewise, institutional responsibility for water supply and infrastructural provision is clear; however, that of sanitation appears grey. Also, several agencies appear to have similar water-related mandates, which in the long run, is counterproductive. Despite these challenges, well-intended policies such as the National water policy, if properly implemented, may put the nation on the pathway to meeting its water supply and demands. Other specific recommendations include:

- Key sectors such as manufacturing industries, chemical and textile factories, food processing plants, eateries etc. should have wastewater treatment and reuse plants in each factory depending on the type of effluent generated according to stipulated legislative requirements

Re-engineering of water treatment facilities at strategic stormwater and wastewater collection points based on drainage networks within urban and rural areas of the country is needed for water efficiency [113].

5. Baseline Scenario & Analysis: Energy Sector

Highlights

Current status

- Nigeria has both renewable and non-renewable sources. Whereas the non-renewable is more pervasive, renewable sources are still rudimentary in the country.
- The energy system is interlinked with other sectors as it is one of the fundamental drivers of economic development. Thus, the demand for energy is cross-cutting.
- The activities in the energy sector also affect the natural capital because unsustainable practices are employed in the exploration, mining, and processing.
- In response to the Paris agreement and other UNFCCC COP obligations, Nigeria has set targets in reducing its reliance on non-renewable energy sources and cutting down emissions as stated in the recently submitted NDC document.
- Additionally, to chart a low carbon pathway, the government enacted a National Energy Policy with the objective of providing clean, affordable, adequate, and reliable energy with the active participation of the private sector.
- The 2022 Nigeria Energy Transition Plan is also one of the most important developmental plans within the energy sector for a net zero energy economy. It details the cost of transiting to a net zero economy and highlights what sectors of the economy should be the focus for the change to occur and presents a more realistic target year for meeting net zero emissions within the energy sector and several others.

Challenges

- The country is currently heavy reliant on fossil fuels which emit greenhouse gases, contributing to climate change.
- The Transport sector is the major emitter of CO_2, having about 15.64% of CO_2 emissions of the country.
- Other sectors that contribute to the nation's emission levels include power, the built environment, Industry, oil, and gas activities.

Way Forward/Recommendations

- Transit to a better energy efficient resource, such as natural gas, solar energy; through investments and establishment of Renewable Energy plants across Nigeria.
- Many job creation opportunities for youths exist within the energy sector, such as installation and maintenance of renewable energy systems. Establishment of waste to energy products, trade in energy-efficient merchandise.

Oil, gas, and biomass are Nigeria's main sources of energy, although various efforts to harness the high renewable energy potential (from sources such as solar and wind) are underway. However, the energy sector analysis in this report focuses on electric power, transport, oil and gas. While chapter 4 deals on the use of plant biomass as an energy source.

Energy provides services worth trillions of US dollars per year and is fundamental to many activities we carry out daily, including transport, cooking, heating, cooling, manufacturing, lighting, and entertainment. Its supply and use are essential parameters with which to measure the level of development of any nation or community. The energy system is interlinked with other sectors as it is one of the fundamental drivers of economic development. The main environmental impacts of energy production and use come in the form of toxic gases, oil spills, and particulate matter, and acid rain associated with fossil fuel exploitation. Activities in the energy sector affect the NC if they use unsustainable practices in the exploration, mining, processing, use, and disposal of energy resources. This can have adverse effects on human health and the environment, including GHG emissions. Therefore, the energy sector will need to play a significant role in driving Nigeria towards a new NC and CE-based paradigm.

5.1 Social and Environmental Risks in Nigeria's Energy Sector

The nature and type of environmental and social (E&S) risks associated with power generation projects depends heavily on the nature, scale, and location of the activity or facility. The information below highlights the primary E&S considerations related to private sector investment in different types of energy production in Nigeria. This is a critical input to the CE and NCA framework. For instance, current production and mining activities of crude oil jeopardises the livelihoods of oil-producing communities within the Niger Delta, a case in time is the Ogoni-land environmental pollution in Rivers State. In the same vein there are environmental and social risks in the use of natural gas. Although more desirable than oil, the risk of pipeline vandalization confers on its operation's equal hazards to oil.

Oil

Oil-fired power generation units emit comparable levels of pollutants to coal-fired units. However, most technologies that use oil can also use natural gas, except diesel-fired generators. Therefore, natural gas and oil-fired capacity are roughly interchangeable. High oil prices, environmental degradation, climate change concerns, and demands from stakeholders for a cleaner fuel have encouraged a switch from oil to natural gas. Operators of oil-fired power plants may attract additional reputational risk for their investors. Furthermore, the production of oil to supply these power stations leaves, oil-producing communities sometimes prone to pollution and destruction of their natural environments, as well as to inter- and intra-communal conflicts.

Natural Gas:

Natural gas has become an increasingly popular fuel in Nigeria and elsewhere because of its thermal efficiency, relative cost efficiency in transport and environmental performance.

Natural gas-fired plants emit lower particulate gases (SOx and NOx emissions are about 60% of those from coal-fired plants) and have lower CO_2 emissions per unit of electricity produced. Although natural gas is viewed as a cleaner fuel than other fossil fuels like coal, it can still generate E&S concerns. For example, local communities in Nigeria have a growing reluctance to site gas-related infrastructure close to populations for health and safety reasons. Transportation of gas in pipelines or as LNG also poses safety (risk

of explosion and pipeline vandalism) and security (e.g., attacks on LNG tankers or re-gasification plants) challenges.

Coal:

Coal is abundant in Nigeria but burning it has substantial adverse environmental impacts. The reputational risks potentially associated with coal, combined with its material ecological impacts, make it an unattractive fuel for power generation. There are several different types of coal plant technologies in development that include cleaner coal technology. Each technology carries a distinct environmental profile and different receptivity from local communities and public health and environmental stakeholders Therefore, Nigeria should pay attention to coal technology when lending or investing in coal-fired power generation. The following is a list of coal power generation types [114] in decreasing order of efficiency and increasing level of potential E&S risk:

1. Integrated Gasification Combined Cycle with Carbon Capture Storage
2. Integrated Gasification Combined Cycle
3. Supercritical & Ultra SC Pulverised Coal
4. Circulating Fluidised Bed Combustion
5. Sub-critical Pulverised Coal

Hydropower:

As increasing scrutiny is brought to the greenhouse gas emissions profile of power generation technologies, hydropower projects appear comparatively attractive. Hydropower, especially large-scale plants, is not, however, without significant E&S risks. Consideration should be given to risks such as the inundation of critical natural habitats and protected areas; people and economic displacement (e.g., loss of assets such as land, crops, and fisheries, including those upstream or downstream of the reservoir,); how water flow or quality will be affected (especially with projects that involve international waterways) and where dams will significantly affect the water supply and quality of downstream ecosystems or communities.

Biofuels:

The rapid rise in biofuels investment (mainly ethanol) as a “sustainable” fuel source [115] is a defining feature of the sustainable energy debate. Scaling up biofuels production has the potential to have several significant E&S impacts These include the conversion of natural habitats and a range of social implications in forest-rich countries of Africa, Asia and Latin America resulting from large-scale biofuels production. In addition, certain biofuels are subject to criticism in some cases where biofuel crops compete with the production of food crops.

Solar & Wind:

Solar and wind technologies as rising sources of power generation (e.g., large-scale concentrated solar power operations, onshore and offshore wind farms) are relatively low risk in terms of E&S impacts. However, consideration should be given to the significant land use required for large-scale wind and solar power generation activities. This can have measurable effects if sensitivities around land ownership, habitat destruction and fragmentation. Other potential E&S impacts include natural resource use, impacts caused by associated facilities, such as existing national power transmission stations, as well as potential social impacts of land use and economic displacement or resettlement.

5.2 Analysis of the policy, legal, and regulatory framework in the energy sector

This section analyses the policy, legal, and regulatory framework in the energy sector at the national level. It highlights and reviews the relevant clauses in the principal policy, legal, and regulatory documents to assess the state of the CE and NCA within the sector. It identifies stated activities and projects in line with the ideals of CE and gaps where it exists and may be addressed to achieve circularizing the energy sector. Nigeria has several policies, laws, and regulations that guide how institutions in the energy sector are organised and governed. Table 5.1 lists some important policies, laws, and regulations necessary within the scope of CE and NCA.

Table 5.1: List of policies, laws, and regulations related to Nigeria's energy sector

	Document	Implementing Institution (s)
1	National Energy Policy	Energy Commission
2	National Climate Change Policy	National (FME)
3	Nigerian Climate Change Act 2021	National
4	Electric Power Sector Reform Act 2005	Power
5	Energy Commission of Nigeria Act 1979	Energy Commission
6	Petroleum Act	Petroleum Resources
7	Nigeria National Petroleum Corporation Act 2004	Petroleum Resources
8	National Gas Policy	Petroleum Resources
9	Guidelines for Flare Gas Measurement Data	Petroleum Resources
10	National Renewable Energy and Energy Efficiency Policy	Rural Electrification Agency (REA)
11	Nigeria Biofuel Policy and Incentives	National
12	Petroleum Industry Act 2021	National
13	National Environmental Standards and Regulations Enforcement Act 2007	National
14	Nigeria's Sustainable Banking Principles and Guidelines	CBN
15	Nigeria Energy Transition Plan 2022	National

5.2.1 National Energy Policy

The National Energy Policy (NEP) of Nigeria, developed by the Energy Commission of Nigeria (ECN), provides a workable framework for sustainable energy development in the country with the overall objective of providing a clean, affordable, adequate, and reliable energy supply with the active participation of the private sector. The NEP policy provides guidelines for protecting the environment and the exploiting Nigeria's fossil fuels while emphasising low carbon pathways and thus encouraging the exploration of renewable and alternative energy sources (primarily solar, wind and biomass). The NEP's goal is to ensure that sustainable and affordable renewable energy sources meet half of Nigeria's total energy demand, thereby contributing to the country's efforts to keep GHGs at the barest minimum.

Enabling conditions

The NEP contains several measures that may support the establishment of a CE and NCAA in Nigeria

(**Appendix 16).** These include aspects of the legal and institutional frameworks and measures related to capacity building, data collection, and research and development.

Implementation strategies and actions

As reflected in **Appendix 17**, some implementation strategies and actions in the NEP are relevant to the establishment of the legal and institutional frameworks for the CE and NCAA in Nigeria. **Appendix 17** highlights two strategies: "mainstreaming energy policy into national development" (putting NDC implementation and transparency-related activities front and centre in the planning and development of energy policies) and "roles and responsibilities of institutions" (promoting collaboration among interest groups and stakeholders).

5.2.2 National Climate Change Policy (NCCP) 2021

The review of the NCCP revealed that its overarching climate goal and related objectives, enabling conditions, and implementation strategies and actions of the envisaged mitigation policy measures might lay the foundation for the establishment of the legal and institutional frameworks for the CE and NCA in Nigeria. The NCCP's overall goal is to promote low-carbon, climate-resilient, gender-responsive and sustainable socio-economic development. Its objectives are, to some extent, favourable to the establishment of CE and NCA. Actions listed in the NCCP include:

- Implementing adaptation and mitigation measures that promote low carbon development.
- Strengthening capacities and synergies at the local, sub-national and national levels and the individual and institutional levels to implement climate change response.
- Promoting scientific research, technology, and innovations to address the challenges presented by climate change.
- Developing an effective climate change communication and information management system that facilitates access by all stakeholders to climate information.
- Strengthening national institutions and mechanisms (policy, legislative and economic) to establish a suitable and functional system for climate change governance.

Enabling conditions

Appendix 18 outlines the NCCP enabling policy measures that may support the move to CE and NCAA. **It** highlights various relevant Legal Institutional Capacity enabling condition components and their relevance for CE and NCA. These include legal and institutional frameworks, capacity development, private sector, and R&D

Implementation strategies and actions

Some of the NCCP's implementation strategies and actions are relevant to the establishment of the legal and institutional frameworks for the CE and NCAA in Nigeria (**Appendix 19). Appendix 19** highlights those that are key to a robust and sustainable CE and NCAA, outlining the policy measures related to institutional development and capacity building and their relevance (expected outcome if the policy measures are successfully applied).

5.2.3 Nigerian Climate Change Act (NCCA) (2021)

The goal of the Climate Change Act of November 2021 is to provide a framework for achieving low GHG emissions, inclusive green growth, and sustainable economic development. It is a

binding legal instrument that seeks to mainstream climate change actions into national plans and programmes, the establishment of a system for Carbon Budgeting (approved quantity of GHG emissions that is acceptable over a specified time), and the establishment of the National Council on Climate Change (NCCC). Implementation of the Act will lead to the refinement and the formalisation of the existing climate change-related governance in Nigeria by establishing a legal and institutional framework for climate change management and creating various entities with binding legal mandates. The climate change management-related legal and institutional arrangements envisaged by the Act will support the establishment of the CE and NCAA system in Nigeria. Relevant goals of the NCCFL include:

- Ensuring that Nigeria formulates programmes for achieving its long-term goals on climate change mitigation and adaptation.
- Facilitating the coordination of climate change actions needed to achieve long-term climate objectives.
- Mainstreaming climate change actions in line with national development priorities
- Ensuring that climate change policies and actions are integrated with other related policies for promoting socio-economic development and environmental integrity.
- Setting a target for achieving net-zero GHG emissions in the period 2050-, in line with Nigeria's international climate change obligations
- Implementing mitigation measures that promote low-carbon economy and sustainable livelihoods.
- Ensuring that private and public entities comply with stated climate change strategies and targets and the National Action Plan.

The Act requires MDAs and public and private entities operating in Nigeria that are concerned with the development and implementation of mechanisms to foster a low-carbon, environmentally sustainable, and climate-resilient society.

The NCC would benefit CE and NCAA-related input to support decision-making on and the mainstreaming of climate action in national development policy. The NCC is a high-level council chaired by the President of Nigeria and comprised of representatives of various institutions:

- President of the Federal Republic (Chair)
- Vice-President of the Federal Republic (Vice-Chair)
- Ministers responsible for: (i) Environment, (ii) Petroleum Resources, (iii) Budget and national planning, (iv) Justice, (v) Mines and steel development, (vi) Finance, (vii) Agriculture and rural development, (viii) Power, (ix) Women's affairs, (x) Transportation, and (xi) Water resources,
- Governor of the Central Bank of Nigeria (CBN)
- National Security Adviser
- Chairman of the Nigerian Governors' Forum
- President of the Association of Local Government of Nigeria
- A representative of the private sector, (xvii).

Appendix 28 highlights the relevance of these documents for CE and NCAA. It lists the various institutions responsible for promoting CE and NCAA, their functions and Powers, and the role each may

play in implementing a robust and sustainable CE & NCAA system in Nigeria.

5.2.4 Nigeria Energy Transition Plan 2022

This document outlines a pathway for Nigeria to achieve carbon neutrality via a just transition, highlighting core areas of energy consumption (such as transport, industry, cooking, oil and gas, and power) that can reduce their emissions. The Plan seeks to achieve the country's 2021 NDC targets of a 20-45% reduction in emissions compared to business-as-usual and compares the NDC-guided scenario to a net-zero energy transition scenario:

- The **NDC-guided scenario** estimates an increase in solar PV capacity of 2GW per year until 2050. It assumes that more than 50% of the country's population will use Liquefied Petroleum Gas (LPG) by then and that about 80% of vehicles will be using compressed natural gas (CNG). Net job creation of 270,000 is expected between 2020 and 2030.
- **The Net-zero 2050 scenario** estimates an annual increase in solar PV capacity of 7GW per year until 2050 and more than 90% of the installed 2GW of electricity generating capacity in 2050 being fuelled from renewable energy sources. It also assumes that about 80% of vehicles will be running on electricity by then and that more than 80% of the population will use clean cooking fuels and technologies. Net job creation of 340,000 is expected between 2020 and 2030.

Achieving the "Net-zero 2050" scenario will require additional funding of aboutUS$410 billion over the next 30 years (compared to business-as-usual). Most of this will be used to build electricity generation (US$270 billion) and transmission and distribution (US$135 billion) infrastructure.

The Plan also considers a more realistic scenario— "Net-zero 2060". – This encompasses decarbonisation strategies with slower progress in replacing firewood with electric and biogas for cooking fuel, slower adoption of electric vehicles, and National Environmental Standards and Regulations Enforcement Agency (NESREA)

The NESREA, which was established in 2007, has been mentioned in the previous sections of this report. According to the Act: "The Agency, shall, subject to the provisions of this Act, have responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines." **Appendix 21** highlights NESREA's roles as part of legal and institutional capacity for developing CE and NCA in Nigeria and suggests strategies and avenues for realising the CE & NCAA vision.

5.3 Natural Capital and Circular Economy Investment Opportunities in the Energy Sector

The transition from a linear economy to a more circular one that would enhance the nation's NC also involves a transition from fossil fuels to renewable energy sources and improvements in energy

efficiency. Nigeria is teeming with opportunities to generate renewable energy and enhance energy efficiency to satisfy energy demands across the country.

The following investment opportunities offer socio-economic and environmental benefits:

1. **Installing renewable energy-based power plants and technologies**, due to insufficient generation and grid constraints, as majority of households, businesses and industries in the nation generate their own electricity with diesel/petrol generators. this, is needed to augment national power grid, especially to unserved customers across the nation.
2. **Establishing businesses that** manufacture, sell, and install renewable fuels, facilities, associated equipment, and energy-efficient devices that can help consumers reduce their energy consumption.
3. **Implementing "Waste –to-wealth" schemes** to encourage sustainable waste management practices, circularise waste in various locations, and produce energy for lighting, cooking, and electricity generation. These could be implemented by the private sector alone or partnerships with government agencies.
4. **R&D** in areas like developing patented indigenous energy solutions, creating databases, and fabricating: This could be sponsored by the private sector.
5. **Capacity building and consultancy services**: The private sector can establish capacity-building organisations that will provide consultancy services, training, and certifications on the latest renewable energy technologies, energy efficient appliances, and best practices in the natural capital and circular economy landscape in the country. Training can also be provided to communities on using energy efficient equipment and eco-friendly practices such as clean stoves.

Jobs for Youths

The incorporation of various circular economy processes in the energy sector will lead to job opportunities for youths in the oil and gas, power, and transportation sectors. Activities such as the installation and maintenance of renewable energy systems, the use of energy efficient procedures, the establishment of WTE projects, energy trading, and research are all areas youths can be actively involved in and make vital contributions to. Skills required for these activities include sales and marketing of renewable energy products and services, social networking, data management, community liaison, and innovation on initiatives such as car-sharing and bicycle projects. Harnessing these opportunities will require technical expertise related to renewable energy systems and entrepreneurship skills across the energy value chain. Capacity-building workshops, skills acquisition programmes, and on-site training—either free or subsidised—can support the required skills development.

The following actions can help harness the available opportunities to transition to a NC/CE based power sector:

NC and CE:

1. **Governance and legislation**: The creation and effective implementation of legislation to promote sustainable practices in the energy sector (such as the National Transport Policy that the Ministry of Transportation is developing).

2. **Capacity building**: The development of businesses and training centres that provide certified training courses to help workers in high-carbon industries take up new employment opportunities related to gas, renewable energy, and other cleaner energy resources can support a just transition.
3. **Local production of renewable energy and energy efficient equipment**: The establishment of facilities to produce solar equipment and devices, electric vehicles, biofuel systems for transport, and vapour recovery units for offshore fields) locally. This can be enhanced by developing partnerships with foreign organisations to build their plants in Nigeria, thereby creating jobs and encouraging the use of these products and services. Examples partnerships with Tesla, BMW, Hyundai, and Toyota to set up local electric car assembly plants in Nigeria.
4. **Development of new renewable energy plants**: New off-grid and grid-connected installations are required (in addition to the Mambila Hydropower Project) to meet the electricity demand of residential, commercial, and industrial consumers in various parts of the country. For example, solar installations in Northern and Southern Nigeria where sunlight is abundant, onshore wind installations in hilly regions across the country, offshore wind systems along the coastal areas, and small-scale hydro installations along rivers in various states. Waste–to-energy schemes can also be developed at feasible sites to use waste to generate energy for lighting, cooking, and electricity generation. West African ENRG has proposed this kind of project for development in Lagos State.
5. **Replacement of materials with sustainable alternatives**: Supply chains of sustainable alternatives can be created with assistance from foreign technical organisations and indigenous research institutions. This would also create new types of jobs in the sector. Examples of such innovations include using calcine clay to replace 50% of clinker used in cement production and using bioenergy as an alternative energy source in cement manufacturing. Clean cooking solutions should also be facilitated through financial incentives the adoption of electric stoves in urban areas and efficient firewood and biogas stoves in rural areas The creation of green and blue ammonia value chains that produce renewable and carbon-free ammonia should also be explored, as highlighted by recent efforts by the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) in conjunction with the United States Department of Commerce to develop projects on methane abatement (discussed at the CERAWeek Energy Conference in Houston, Texas in March 2022).
6. **Repurpose and reuse of equipment**: Oil rigs and existing wells can be repurposed with minor adjustments and reused for carbon capture and storage, avoiding the need for new carbon capture equipment, and decommissioning old oilfields and increasing the lifespan of the assets. Businesses can be created to research these solutions and their activities can include acquiring data from oil fields and developing solutions for specific oil and gas facilities.
7. **Refurbishment of electricity infrastructure**: Businesses can be created to refurbish existing distribution infrastructure to reduce losses between electricity transmission and end-users.

This would encompass improvements to substations and associated electrical equipment and increase network efficiency.

5.4 Scenario Analysis: Energy

5.4.1 National Energy Transition Plan: Net-zero Scenarios

As part of its quest to achieve a net zero-energy target for the country, the National Energy Transition Plan proposes decarbonisation measures that complement NC and CE objectives. Several key stakeholders in government have initiated programmes to support the achievement of this vision. These include the Office of the Vice-President, Federal Ministry of Petroleum Resources, FME, Federal Ministry of Power, REA, ECN. Other collaborators include the Federal Ministry of Transportation, Nigerian Atomic Energy Commission, and the Federal Ministry of Industry, Trade, and Investment.

Oil and Gas

Fugitive emissions, which occur from leaks or other unintended or irregular releases of gases, are a substantial source of GHG emissions but have decreased since 1990 [116]. Around 19Mt CO_2-e was emitted from oil and gas activities such as gas fugitives, oil fugitives, oil venting and flaring. as well as fuel use across the industry. This represented 6.9% of Nigeria's total CO_2 emissions. The 2050 Net-zero emission scenario envisages reducing oil and gas demand in Nigeria to help keep the average global temperature below 1.5^{O}C.

Transport

The transport sector released an estimated 43Mt CO_2-e, with key emitters being passenger cars, trucks, two- and three-wheels vehicles, and the maritime and aviation sectors. This represents 15.64% of total CO_2 emissions in the country. Projects with NC/CE features include the National Gas Expansion Programme (NGEP) managed by the Federal Ministry of Petroleum Resources and Office of the Vice-President and the Clean Energy Transport Scheme (CETS) managed by the FME. The 2050 Net-zero emission proposes transitioning to low-emissions transport such as biofuel blends in existing vehicles as an interim step before electric public transport and electric 2 and 3-wheeled vehicles are more widely adopted. Scaling up electric transport will rely on access to reliable, affordable electricity and depend on individual choices.

Power

An estimated 77.5TWh of electricity is generated in Nigeria and more than 59% of this comes from off-grid sources such as diesel and gas generators, and gas turbines in oil and gas facilities. Diesel generators account for 80% of the country's electricity generation capacity (Nigeria Energy Transition Plan [117]. Initiatives with NC/CE features include the Presidential Power Initiative and Mambila Hydropower Project, both of which are managed by the Federal Ministry of Power; the development of a renewable energy market by FME; the Nigeria 2050 Calculator managed by the ECN; and the SEforAll Country Action Agenda executed by non-government stakeholders. The 2050 Net-zero scenario has proposed increased electricity generation with 197GW from grid-connected solar systems and 24GW from off-grid solar systems by 2050, with natural gas as a backup option and diesel generators fully replaced by then.

Industry

The production and use of cement, ammonia, ethylene, iron and steel, low and high temperature generating equipment, and generators resulted in emissions of 27Mt CO_2-e (NETP, 2022)9.82% of total

CO_2 released in the country.

Initiatives with NC/CE features include the NGEP managed by the Federal Ministry of Petroleum Resources and Office of the Vice-President, and the Nigerian Gas Flare Commercialisation Program (NGFCP) managed by the Federal Ministry of Petroleum Resources.

Measures envisaged in the 2050 Net Zero Emission to reduce industrial emissions include substituting 50% of clinker with calcine clay and using bioenergy and carbon capture and storage (BECCS), both in cement production; replacing heating equipment with low-carbon alternatives such as solar boilers, electric boilers, heat pumps, and hydrogen furnaces; and using green or blue hydrogen in ammonia production. Employment opportunities in hydrogen production, the biomass value chain, and the installation and maintenance of boilers and furnaces.

Buildings

Commercial and residential buildings in urban and rural areas consume 72% of the country's electricity and emitted about 29Mt CO_2-e. These emissions—from generators, kerosene, and charcoal-based cooking—represented 11.27% of total CO_2 emissions in the country.

Initiatives with NC/CE features are the Infrastructure Clean Energy Scheme, and Urban Residential Housing Scheme, all three managed by the FME; the NGEP managed by the Office of the Vice-President; Solar Power Naija, the Nigeria Electrification Project (NEP), and the Energizing Education Programme, all three managed by the REA; and the SEforAllCountry Action Agenda and Universal Green Energy Access Programme, both initiated by non-government stakeholders.

The 2050 Net-zero Scenario envisages a transition from traditional cookstoves to cleaner solutions such as electric stoves in the urban areas, and efficient firewood and biogas stoves in the rural areas. It also envisages replacing fossil fuel generators used for back-up with renewable energy systems. Employment opportunities exist in cleaner cookstove value chains; the expansion of LPG networks; and the production, installation, and maintenance of grid-connected and off-grid solar facilities.

Synopsis of Gaps and Barriers

Nigeria's energy sector faces various structural, legal, regulatory, and financial barriers to becoming sustainable. A major policy-related barrier to realising CE and NCAA opportunities in the sector is a lack of effective implementation of core reforms. In addition, even though developing and deploying cleaner energy is sometimes part of the investment strategy, a lack of know-how and finance hinder the achievement of this at a sufficient scale.

An appropriate incentive structure based on industry restructuring, privatisation, and a sound regulatory framework, combined with financial support for renewable energy, should be put in place to improve the likelihood of a successful transition from a linear economy to a CE.

Appendix 23 shows the results of the scenario analysis for the energy sector. Within the three focal industries (oil and gas, power/electricity, and transport), the analysis identified several linear economy-related problems. The table in Appendix 23 lists these problems and their impacts on the climate, health, and the environment and ecosystem. It then identifies opportunities for CE/NCA businesses and possible policy responses to address each problem. Accounts required for NCAA were also listed. Finally, it notes the accounts required (the series for thematic extent and condition accounts).

6. Baseline Scenario & Analysis: Industrial Process and Product Use (IPPU)

Highlights

- Nigeria's population growth is projected at over 214 million people in 2030, increasing the demand for buildings and building materials such as cement, iron, and steel which are unrenewable resources, and their continued use is unsustainable.
- For instance, the cement manufacturing process is energy-intensive and uses a lot of water; requiring between 60 to 130 kg of fuel oil and 90 – 130KWh of electricity, largely dependent on limestone ranges and technology types deployed.
- The manufacture and use of these materials contribute CO_2 emissions to the atmosphere, which are likely to increase as the cement and concrete market grows. Also, buildings in the current built environment are hardly refurbished, recycled or retrofitted and produce substantial emissions during operation and demolishment.
- Another impact on global natural resources is the fashion and textile industry. On the average, annual carbon footprint of total new and existing household clothing is estimated to be 1.5 tonnes of CO_2. Includes water use of more than 200,000 litres per year and 70 kg of waste per year.
- GHG emissions are emitted from industrial processes during the chemical or physical transformation of materials.
- Hence, de-carbonization of the vital industrial sectors (such as the cement, textile, and packaging) critical to the economy of the country, will put the nation on the pathway of circularization of its industrial processes.

Current status

- Urbanization leads to increasing demand for more buildings.
- In the same vein, population implosion translates to use of more textiles. In Lagos State alone, it is reported that 12% of its waste comes from textile, made up of disposed clothes and other textile items, and waste from tailoring shops.

Challenges

- Rapid urbanization translates to more pressure on resources. With lack of access to finance, knowledge and skill sets acting as drivers of unsustainable resource use that leads to deficit in recycling and reuse practices.
- Cost of building materials is high and reliance on high energy consuming materials such as cement for built environment.
- Most building materials and technologies are imports from abroad, high exchange rates automatically push prices upward.
- Cities generate large amount of waste, due to lack of required skills and knowledge on sustainable cities.

Way Forward/Recommendations

- Recycling and Reuse principles should be adopted to reduce pressure on natural capital.

- Retro-engineering of buildings in line with circular economy principles to increase energy efficiency for buildings and minimise waste generation. In addition, is the propagation of green buildings for energy efficiency and sustainability.
- Alternate substitutes for building materials such as processed wood chippings are advocated to eliminate GHG emissions and promote sustainable use of natural capital.

6.1 IPPU Sector Classification and Structure

Nigeria's NDC document indicates that the IPPU sector was responsible for a small share of the country's GHG emissions, estimated at 18.391 $MtCO_2$-eq. This could be partly due to a lack of data and the low level of industrialisation in Nigeria. The five focus areas (i.e., food systems, the built environment, fashion and textile, electronics, and packaging) identified by the ACEA as having high potential for circularisation reflects Nigeria's economically most viable and critical economic industries. However, this report focuses on the built environment (construction) and textile industries, recognising their growing importance to Nigeria in the context of rapid urbanisation and high demand for clothing. To better understand the potential for circularisation, it maps and analyses these industries' value chains, tracking the processes to identify challenges to applying the CE model and opportunities for investment.

6.2 Nigeria's Construction industry

Nigeria's construction industry struggled in 2020, experiencing a 7.7% decline in output in real terms due to the COVID-19 pandemic and associated lockdown measures. According to the NBS, the industry contracted by 31.8% in the second quarter of 2020, although it recovered in the third quarter. This recovery continued through 2021 in line with the slowdown in COVID-19 cases and the global economic recovery. The industry is projected to grow by 2.8% in real terms between 2022-2025, supported by Government plans to invest in the country's energy, transport, and other infrastructure.

Nigeria's rising population and rapid urbanisation will increase the pressure on resources. The country's population is projected to exceed 214 million people in 2030, increasing the demand for buildings and building materials such as cement, iron, and steel. As the manufacture and use of these materials emit CO_2, these trends are expected to contribute to rising emissions. Additionally, the current nature of buildings in the built environment are made of unrecycled products that tend to produce substantial emissions during fabrication and when buildings must be demolished to make room for new ones. If sustainable construction practices are not embedded in the industry, the increasing demand and limited recycling are likely to increase pollution and GHG emissions over the next decade.

Nigeria's informal built environment is characterised by unplanned and unregulated construction of buildings with insufficient access to critical infrastructure such as water, power, and sanitation networks. SMEs largely control Nigeria's informal built environment economy, accounting for more than half of the enterprises operating in the construction sector. In contrast, the formal built environment is regulated, planned, and capital-intensive. It has access to most infrastructure networks and the regulations it operates under promote the health and safety of the buildings' occupants.

Challenges to developing a sustainable built environment in Nigeria.

The cost of building materials is one of the main challenges to constructing a sustainable built environment in Nigeria. The country's construction industry still relies heavily on cement. The cement

manufacturing process is NC-intensive, consuming substantial amounts of energy and water. As some of the materials and technologies used in the construction industry are imported, sustainable building construction will remain expensive. A lack of access to finance and limited knowledge and skills are also major challenges to sustainable building construction. These challenges, among others, lead to poorly constructed buildings, especially in informal settlements. The poor design of buildings and the population increase in Nigerian cities hinder proper waste management, polluting the environment and creating health risks. Large cities such as Lagos produce vast volumes of waste daily and could run out of landfill sites in less than a decade.

6.2.1 Circular Economy in the Construction industry

Applying CE principles to increase the recycling and reuse of construction materials will reduce the pressure for virgin materials such as ore for steel and iron and limestone for cement production, reducing energy consumption and CO_2 emissions. Additionally, the construction of regenerative and restorative buildings increases energy efficiency and minimises waste generation. While similar to the concept of green building, CE is holistic as it incorporates all built elements in the urban ecosystem.

Opportunities

Nigeria's built environment can be made more sustainable and create economic opportunities by applying these four CE principles or actions:

a) Making design the basis of a sustainable built environment.
b) Using climate-friendly and locally available, alternative construction materials.
c) Promoting the construction of green buildings to increase their sustainability.
d) Using regenerative approaches to managing solid waste and wastewater.

a) Making design the basis of a sustainable built environment

The design of a building is influenced by the materials used in construction, and for refurbishment where needed. To achieve sustainability, building designs must evolve towards a "planet-centric design" to create an organic process for sustainability. Four major aspects of building design that should be considered as part of efforts to apply CE principles are:

- Large-scale service infrastructure (superstructures of buildings)
- Intermediate building components (such as major machinery and auxiliary equipment requiring significant maintenance or complete refurbishment every 10 years)
- Contact elements (requiring maintenance or replacement on a twice a year basis—for example, light bulbs)
- Consumables and waste generated in daily operations.

Taken these aspects could support the transition to a net-zero carbon future in which the planning, construction, and retrofitting of the built environment is dramatically changed.

b) Using climate-friendly (and locally available, alternative) construction materials

Replacing concrete (which contributes 8% of global GHG emissions), with alternative materials such as processed wood chippings (mass timber); recycled aggregates; and recycled plastic bricks, flooring, and roofing materials will cut emissions from building materials.

Using mass timber to construct buildings is more sustainable than concrete because wood is recyclable throughout its life cycle. Wood absorbs carbon from the atmosphere and, depending on how it is disposed of at the end of its life, can be carbon-neutral, with most of the carbon released being recaptured, sequestered, or used as an energy source. Using mass timber for 90% of new urban buildings could avoid nearly 8 billion metric tonnes of CO_2 emissions by 2050, equivalent to a 4% annual reduction in global emissions from manufacturing and construction. It generates less waste during construction because the materials are typically prefabricated before being sent to the building site. In addition, construction using wood is cheaper than using conventional construction materials as it involves half the labour cost.

There are two types of high-tech mass timber construction materials: cross-laminated timber (CLT) and low-tech materials (wood-based panels such as veneer sheets and dry-process fibreboards). High-tech mass timber is already being used, particularly in Western countries, Asia, and Australia, but to a limited extent in Nigeria. To harness this opportunity, Nigeria would first need to strengthen the low-tech mass timber industry before gradually moving towards high-tech mass timber construction materials.

Upcycling plastic waste for use as inputs to the formal and informal built environment, in the form of plastic bricks, roofing tiles, and floor tiles, is an emerging innovation that can be explored in Nigeria to provide affordable building materials while removing plastic waste from the environment. According to Conceptos Plasticos, a manufacturer of bricks made from secondary plastics, plastic bricks are 40% cheaper than conventional bricks, and about 27 metric tonnes of plastic could make enough bricks for one house.

Another opportunity to expand the use of more sustainable building materials is building on the current practice of many SMEs of using second-hand building materials by repurposing and refurbishing fixtures and fittings. This could reduce the use of natural resources to make construction materials while offering households an affordable alternative [49].

Table 6.1 lists alternatives to imported materials.

Table 6.1 Imported Building Materials for Building Construction in Nigeria and the alternative Local Building Materials

	Building Components	Available imported materials	Alternative local materials
1	SUBSTRUCTURE Foundations	● Cement – Sandcrete ● Mild steel and high tensile steel ● Steel sections ● Flat steel sheets	● Stones and rocks ● Stone-crete block units
2	SUPER STRUCTURE Floors	● Ceramic Tiles ● Steel reinforcements and structural steel ● Concrete	● Timber ● Bamboo floors and foist ● Stones and rocks

3	Structural Frames and Walls	● Cement sandcrete blocks ● Lime ● Steel beams and columns ● Hardboard ● Fibre glass ● Bricks ● Fibre glass ● Plywood ● Steel reinforcements ● Particle boards	● Plywood ● Partial boards ● Unstabilised earth ● Fired/unfired clay bricks ● Hardwood ● Bamboo walls and trusses ● Stones and rocks ● Stabilised laterite earth bricks
4	Roofs	● Steel reinforcements ● Aluminium sheets ● Cement concrete roofs ● Fibre glass ● Galvanised zinc sheets ● Steel nails structural ● Steel section	● Aluminium sheets ● Bamboo roof tiles ● Timber ● Zinc sheets ● Asbestos sheets ● Steel nails
5	Ceiling	● Steel flat sheets ● Plaster of Paris ● Fibre boards ● Timber ● Plastic sheets ● Aluminium extrusion sections	● Plywood ● Hardwood ● Fibre matrix ceiling boards ● Asbestos sheets
6	Doors and Windows	● Aluminium extrusion sections ● Steel sections ● Glass ● Fibre boards ● Particle boards ● Ironmongery ● Steel nails ● Plywood ● Hardwood	● Steel nails ● Plywood ● Hardwood ● Wooden shutters and louvres
7	Electrical Fittings	● Lifts and other electrical appliances ● Copper wire ● PVC pipes ● Electrical lamps ● Copper pipes ● Aluminium wire	● Moulded wooden lamp holders ● Aluminium wire ● Timber poles ● Copper wire ● Electrical lamps
8	Plumbing	● Water heaters ● PVC pipes and fittings ● Hand washing basins ● Toilets ● Ceramic fittings ● Steel baths ● Steel pipes and fittings	● Paint ● Hardwood panelling ● Marble ● Terrazzo ● Earth plastering ● Sawdust/cement floors and wall tiles ● Bricks tiles for floors

9	Finishing	● Paint ● Marble ● Wallpaper ● Terrazo ● Fibre board ● Plaster ● Brick tiles ● Mosaic tiles mineral ● Plastic sheets ● Ceramic tiles	● Paint ● Ceramic tiles ● Hardwood panelling ● Marble ● Terazzo ● Stucco plastering ● Core and bamboo partitions and wall panelling ● Sawdust/cement wall and floor tiles ● Earth plastering

c) Promoting the construction of green buildings to increase their sustainability

This is another way to create new loops in construction because such buildings are designed to consider circularity. The formal construction of green buildings must incorporate regenerative and restorative designs that generate and conserve energy, use green roofs and skins, and harvest rainwater. The buildings will have a lower environmental impact by using less energy and maintaining bio-nutrients in the ecosystem. Moreover, using CE models for efficient building fixtures and fittings—such as "product-as-a-service" (a business model that allows for wide variation on the type of value offered) leakage monitoring, and clean energy technologies—will reduce resource consumption, lowering the cost of operating buildings, particularly commercial and institutional ones [75].

d) Using regenerative approaches to manage household rubbish and wastewater

Wastewater and MSW are alternative sources of energy: through anaerobic digestion, biological waste can be converted into energy. For example, at the Northern Works wastewater treatment plant in South Africa, sewage is turned into biogas. The facility produces methane gas that powers about 15% of the plant's electricity needs. Engineers hope to add more facilities to increase that share to 50%.

To realise the above opportunities, Nigeria needs clear policies to regulate or provide incentives for the industry to shift towards circularity and mobilise SMEs to industrialise [49]. Ways in which this can be done include:

a) **Developing clear market "push" and "pull" policies to accelerate the implementation of CE principles in construction.**

For example, realising the potential for mass timber in construction will require mandatory regulation for sustainable forestry conservation. Partnering with organisations such as the Forest Stewardship Council International will help facilitate the use of tools to certify that no deforestation was involved in wood used for construction and that biodiversity and local communities who rely on the forest in question were protected. Nigeria could also adopt green building policies to guide and regulate the construction sector, such as those created by South Africa's Department of Public Works and Rwanda's Green Building Code. Market "pull" policies such as financial incentives like tax breaks for green buildings, green mortgages, revolving funds that can be repaid with cash flow from energy savings, and energy efficiency certificates that can enable building owners to trade their emissions allowances, could be instrumental in accelerating the adoption of sustainable and CE built environment projects [49].

b) Supporting SMEs to align with the industrialisation strategy.

Linking informal SMEs with industrialised, formal enterprises will allow skills transfer and enable SMEs to access larger markets. Consolidating SMEs in informal clusters will create value chains within the informal built environment that could increase economies of scale and the productivity of existing CE activities. Another option is to formalise current construction activities by allowing a large player to invest in informal built environments [75].

Further opportunities and best practices for the construction industry

- Adopting modular, adaptive, and resilient design principles can help deliver high quality housing and infrastructure at a low economic and environmental cost.
- Establishing regional remanufacturing, reprocessing, and material recovery hubs that import used products and repair them ready for resale to consumer markets will make participation in CE value chains possible.
- Developing robust regulations to avoid exporting countries exploiting such hubs by using them to dump waste.
- Recycling, selectively demolishing and prefabricating buildings.
- Upcycling and recycling building materials.
- Creating simpler, locally sourced buildings.
- Enhancing informal (that includes artisans, micro and meso) economy processes.
- Developing waste micro-grids. That produces electricity from waste.

Existing global and national regulations that support the use of CE principles in the construction industry

Major existing regulations governing Nigeria's built environment sector include:

- **National Environmental (Construction Sector) Regulations**, 2011, S.I. No. 19, Gazette No. 46. Vol. 98 of 17th May 2011. The purpose of these regulations is to prevent and minimise pollution from construction, decommissioning, and demolition activities to the Nigerian environment.
- **National Energy Efficiency Building Code**, 2017 which was developed to improve power supply to and the energy efficiency of buildings.
- The **National Energy Efficiency Building Code** was designed to eliminate or reduce to the barest minimum the incidences of building collapses in Nigeria while promoting safe and high-quality housing for all Nigerians. Section 6 of the Code could be amended to provide a legal framework to circularise the built environment in Nigeria.

To revise the existing regulations to support the circularisation of the construction sector, Nigeria could leverage several international green building and construction codes. Relevant international codes include IFC Edge, the Building Research Establishment Environmental Assessment Method, Leadership in Energy and Environmental Design, and the Energy Conservation Building Code.

6.3 Nigeria's Cement Industry

Nigeria's exploding population continues to drive cement consumption by spurring demand for infrastructure and housing. However, the oligopolistic nature of the country's cement industry tends to disenfranchise consumers over market price control. Two firms (Dangote Cement and Lafarge WAPCO

Cement Plc) control over 80% of the market.

The cement manufacturing process is both energy- and water-intensive. It requires between 60 to 130 kg of fuel oil and 90-130kWh of electricity, depending on the limestone type, the specific process, and the technology used, as well as the age of the plant. To meet their energy demands, Nigerian cement manufacturers largely depend on the use of gas or low pour fuel oil (LPFO). Due to the unreliability of Nigeria's power grid, most manufacturers have invested heavily in infrastructure to generate their own electricity.

Table 6.2 summarises the main challenges to and opportunities for circularising Nigeria's cement industry.

Table 6.2: Challenges to and Opportunities for Circularisation in Nigeria's cement industry

Inputs/processes	Challenges	Opportunities
Electricity input	About 80% of Nigeria's electricity generation is fossil fuel based	Use low-carbon, renewable energy sources to generate electricity
Particulate matter emissions	Negative ecological and Public Health implications	Use low-carbon, renewable energy sources to generate electricity
Gaseous emissions	Environmental and human health pollution	Use an environmentally friendly alternative fuel
Fuel (diesel) input	Source of GHG emissions	Use an environmentally friendly alternative like biodiesel
Coal input	High percentage of CO_2 emissions	Use an environmentally friendly alternative fuel
Natural gas input	Source of GHG emissions	Use an environmentally friendly alternative fuel
Raw material input	Unsustainable practices deplete natural capital stocks	Manage NC effectively to ensure sustainable use
Intermediate products	Source of GHG emissions	Reduce GHG emissions in the production process and deliver eco-friendly products
Final product	Source of GHG emissions	Reduce GHG emissions in the production process and deliver eco-friendly products

6.4 Nigeria's Fashion and Textile Industry

Planet 3R [118] summarises the impact of the textile industry on the global NC. It is estimated that

washing and drying one kilogramme of clothing over its entire life cycle, using typical methods, generates 11 kilogrammes of GHG emissions [111]. Furthermore, on average, the annual carbon footprint of total new and existing household clothing is estimated to be 1.5 tonnes of CO_2-e. The global footprint of clothing per household also includes the use of more than 200,000 litres of water per year and 70 kg of waste per year [105].

According to Nigeria's NBS, Nigeria's "textile, apparel, and footwear" sector has averaged annual growth of 17% since 2010. This is partly because of an increase in demand, but also due to several initiatives that have put a spotlight on Nigeria in the global fashion industry. Shifting from a linear to a circular model within the country's textile and fashion industry will require overcoming several barriers. Such barriers include consumer behaviour and poor disposal practices; a lack of mainstreamed processes and know-how to collect and sort textiles by type; and a lack of commercially viable recycling technologies for low-grade textiles. These barriers are discussed further in Table 6.3.

Table 6.3: Barriers to Closing Loop

Consumer behaviour	Disposal practices and collection and sorting infrastructure and process	Recycling technologies
● Limited consumer demand for recycled textile products, which tend to be perceived as lower quality	● Collectors focus on "re-wearable" textiles, while neglecting streams of waste that require costlier recovery solutions	● Lack of commercially viable recycling ● technologies for low-grade textiles
● Inadequate awareness by consumers that textiles should be recycled and of how they can be disposed of most responsibly.	● Lack of mainstreamed processes and know-how to collect and sort textiles by type	● Lack of mainstreamed processes and know-how to separate types from the mixed blends and composite structures
	● Limited availability of infrastructure, such as recycling receptacles at the local and regional levels	● Costly recovery process.
	● Lack of traceability in the global waste chain.	● Low-quality materials and blends dominate the recycling end-market.
	● Policy frameworks such as regulations that govern numbers of collectors, recyclers, and waste managers in an area.	● Costly logistics and limited availability of textile recycling plants at the local and regional levels.

Circularity in the textile industry

Nigeria is the most populated country in Africa, with around 200 million people. By 2050 its population will overtake that of the United States of America, bringing a substantial challenge in terms of the quantity of textile waste. For example, it is reported that 12% of waste in Lagos State comes from textiles, consisting of clothes and other textile items that consumers have disposed of, as well as waste from tailoring shops. Almost all textiles in Nigeria are imported, with most of Nigeria's textile factories having closed in the 1990s. Any revival of the sector should be consistent with circularity principles as textile factories use a lot of water and energy and therefore impact heavily on NC.

The following six major requirements proposed by Rouch ([82]) provide a collective approach to delivering long-term benefits from a new textile CE:

1. Phase out substances of concern and microfibre release.
2. Implement safer and better employment conditions.
3. Break free from the increasingly disposable nature of clothes by more flexibly meeting demand (for example, by providing more options in the way clothes are sold).
4. Radically improve durability, reuse, and recycling by transforming clothing design.
5. Radically improve recycling and collection systems.
6. Make more effective use of resources and move to renewable inputs.

6.5 Scenario Analysis: Industrial Processes and Product Use (IPPU)

6.5.1 Synopsis of Gaps and Barriers

Based on the analysis of the construction and textiles industries, there are several barriers to implementing CE and NCAA practices in Nigeria's IPPU sector. These include inadequate infrastructure—For example, to develop a successful and efficient recycling and recovery system, there is a need for better infrastructure to support the industriess' transition from a linear economy to a CE. Likewise, there is a lack of supportive CE and green economy policies and knowledge of how to practically achieve sustainability in the IPPU sector, particularly in the construction industry.

6.5.2 Scenario Analysis

Appendix 24 details the scenario analysis carried out for the IPPU sector, which. focused on two key industries (construction and fashion/textiles). Within these two industries, the analysis identified some key linear economy issues plaguing this key priority sector along with their effects. However, it also identified several opportunities for CE/NCA businesses. Further, Appendix 24 highlights various strategies to promote NCAA in these industries and appropriate policy responses to the challenges identified. Accounts required for NCAA were also listed. For example, the reuse of local excavated earth to make new eco-friendly building materials is an opportunity to develop new CE-aligned businesses that will also address the challenge of waste management in the construction industry. Similarly, investments in initiatives that enable the transformation of waste into new resources to be used within the industry could help slow down resource depletion.
See **Appendix 24** for more details.

7. Stakeholder & Business Cluster Analysis

Highlights

Stakeholders and business cluster identify the major players a within the Circular Economy and Natural Capital ecosystem business. The delineated sectors with high priority for circularity are AFOLU, Services (Waste and Water), Energy and Industrial Processes and Product Use (IPPU). These sectors have high prospects for generating employment in a circular economy. The 2020 Circular Economy in Africa Nigeria Country report shows that an additional 1.9 million jobs will be created by 2030 with AFOLU being the highest generator of these forecasted jobs.

Current status

A summarized natural capital & circular economy business cluster analysis across the six geo-political zone is presented below:

South-West: (Lagos, Ogun, Oyo and Ondo)	16 waste and recycling companies exists in Lagos, the presence of the largest electronic retail market in Lagos (computer village).; The highest number of transport industry terminals exists in Lagos (Land, Air and Water). A large automobile spare-parts retail market exists in Lagos (Ladipo). Animal husbandry feed mills exists in Ibadan, Oyo axis. Fast Moving Consumer Goods (FMCGs) producing consumers exist in Lagos, Ogun, and Oyo corridors. High forestry activities by businesses in the Ondo corridor. Construction companies and telecommunication companies are headquartered in this region.
South-East (Anambra, Abia, Enugu and Ebonyi)	A huge market for automobile manufacturing, repairs and maintenance exists in Anambra. Battery Recycling activities by business are also present here. Agriculture activity in rice production exists in Ebonyi. A large concentration of textiles, plastic and rubber manufacturing companies exists in Abia State.
South-South (Rivers, Cross River, Akwa-Ibom, Edo, and Delta)	Oil and Gas activities by businesses are high in Rivers, Delta and Akwa-Ibom. Fishery and water-related enterprises exist in Rivers, Cross River, and Akwa-Ibom. Agro and Forestry-related businesses are high in Cross River and Edo States."
North-West: (Kaduna, Kano, and Sokoto, Zamfara)	Agricultural production activities are High in this region (plant and Sokoto, Zamfara) and animal inclusive). Leather works (Hides & Skin) activities by businesses is also high in Sokoto. Plastic and textile business activities are high in Kaduna and Kano. Vehicle tubes and tyre recycling activities are high in Kano and Kaduna; pockets of mining activities exist in Zamfara.
The activities of North-East (Adamawa, Taraba, and Borno)	Leatherworks (Hides and Skin) by businesses are high in Adamawa and Borno.; Agricultural production activities by businesses are high in this region (plants and animals inclusive). Forest and Energy generation activities by businesses exist in Taraba State. Fishing activities by enterprises exist in this region.
North-Central: (Niger, Nasarawa, Plateau, Kogi and Benue)	Electricity energy generation by businesses exists in Niger. Agricultural production activities by businesses are also high in this region (plants and animal inclusive); Forestry and Mining activities by businesses exists in this region.

Challenges

1. Low level of awareness on potential of circular economy
2. Policy gaps
3. Knowledge gaps

4. Low technical expertise

Recommendations

- Nationwide awareness creation to fast track attitudinal and cultural re-orientation toward circular economy.
- Increased collaboration among public and private sectors to create tangible solutions to enable transition to circular economy.
- Put policy and legislation in place to enable a smooth transition to circular economy.
- Develop more circular business models for private sector participation.
- Develop finance plan (Example: climate finance windows and other green climate finance windows).
- Design and implement Monitoring, Reporting and Verification (MRV) system that will drive circular economy.

7.1 Introduction

Currently, there is a lack of a harmonized database of country representative circular economy stakeholders in Nigeria. Relevant institutions (businesses, government institutions, research institutions and civil societies) were being identified through desk research and referrals (snowballing) across the six geopolitical zones of Nigeria to develop a robust database of stakeholders. The analysis was done in such a manner that showed stakeholders' level of influence across the various sectors identified with high potential for circularity and thus were selected for this study (Waste, Energy, AFOLU, Water and Industrial Processes & product Use - IPPU). Mendelow matrix for stakeholder analysis was deployed for this analysis using a 2-stage approach.

A desk analysis was utilised to show the status of the current circular economy business ecosystem and the existence of circular economy businesses in various sectors with high potential for circularity in Nigeria within the priority sectors of waste, energy, AFOLU, water & IPPU priority. However, to present the current state of play for circular economy business clusters in Nigeria, data was collected across various clusters with linkages to natural capital/ circular economy space across identified sectors with potential for circularity. SITRA's definition of circular business models, which identifies five strategies for businesses to adopt circular practices, was used, namely:

1. Circular Supply Chains: Products are designed to have a long-life cycle, and product components are replaceable and made from recycled, renewable bio-based materials.
2. Sharing Platforms: A Sharing Platform is a circular business model that promotes user collaboration to increase product usage and value. This model creates value by exploiting underutilised assets ranging from services, products, space and even waste.
3. Product-as-as-Service: A business that retains ownership of an asset and leases it out for use by clients offers a product-as-a-service. The critical environmental advantage of this model is that it optimises the use of assets. There is also more oversight and accountability for products and materials. The business advantage is that it can deepen client relationships and foster customer loyalty as the service provider is well-positioned to upgrade equipment and user experiences.
4. Product Life Extension: Repair, maintenance, upgrading, resale, and remanufacturing are the core components of "product life extension" business models.

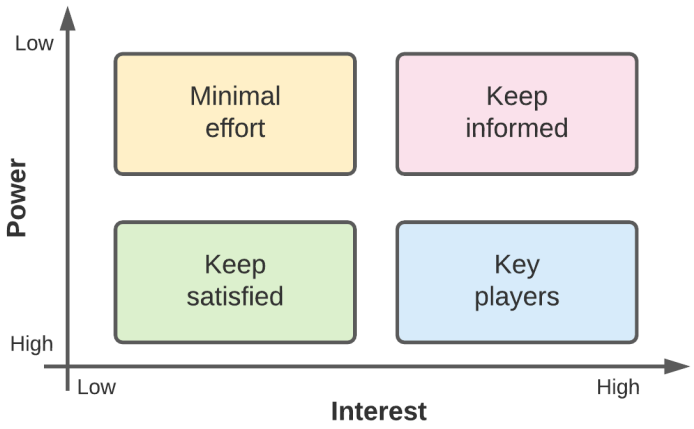
5. Resource Recovery and Recycling: Resource recovery models recycle waste into secondary raw materials, which divert waste from disposal and reduce levels of extraction and processing of natural resources.

All collected data were subjected to the various dimensions of business cluster analysis such as geographical scope, density, breadth, depth, activity base, growth potential, innovation capacity, development stage and employment size. This was then mapped for localization quotient and concentration index to show various cluster maps of circular economy businesses in Nigeria. A SWOT analysis of various clusters was conducted, which shows the need for business cluster development policies. This is to stimulate investment in these circular economy business clusters.

7.1.1 Stakeholder Mapping and Analysis

In **stage one** of determining their influence and interest, a desktop ranking of all stakeholders' interest and impact on a scale of 1-5 was carried out. This was done based on the research team's knowledge of these stakeholders from previous project engagements, such as the circular economy analysis of Nigeria's waste sector and the Lagos Circular Business Platform development.

Stage two of determining stakeholders' influence and interest was through a survey questionnaire to these identified stakeholders. This led to a more accurate stakeholder categorization in the four quadrants, as shown in figure 7.1. The rankings of some stakeholders may change after the collection of survey data.

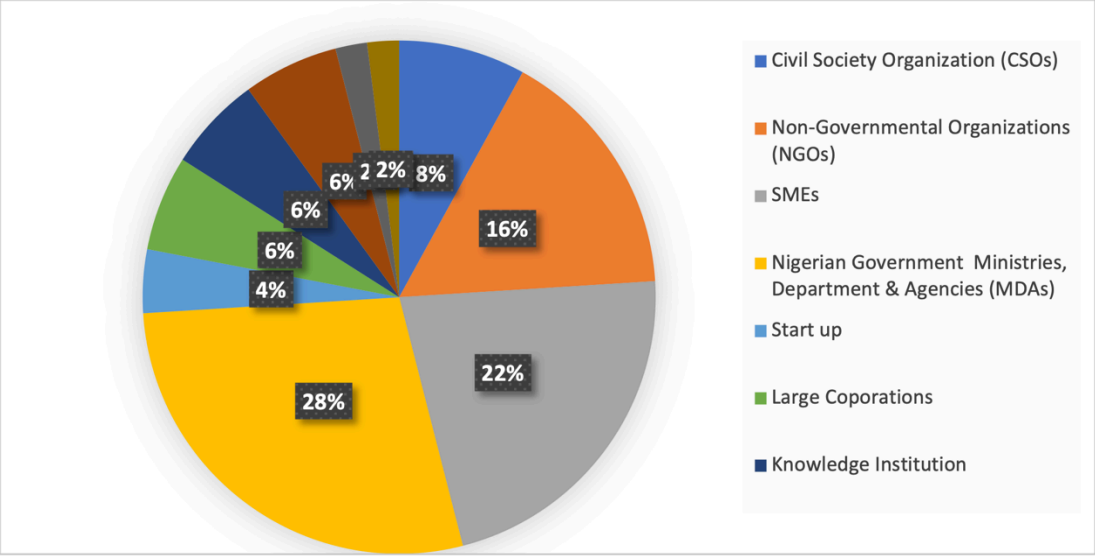


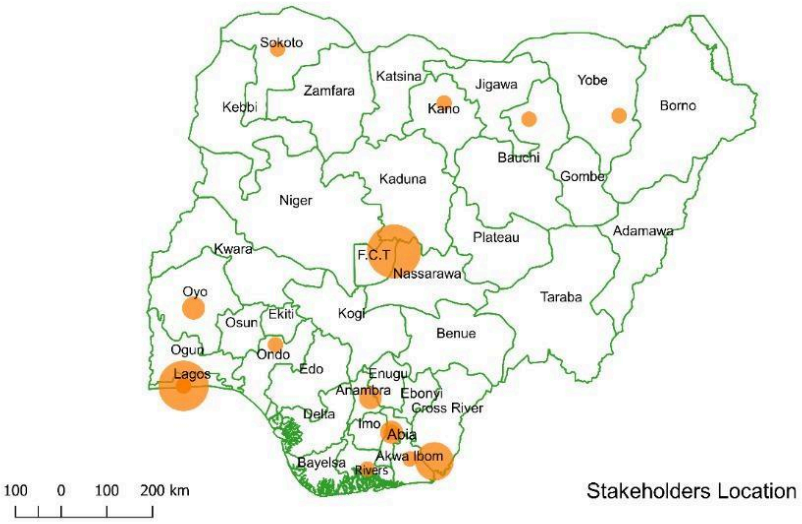
The Mendelow matrix analysis shows the intersection of interest and power in Circular Economy and Natural Capital landscape in Nigeria by various stakeholders.

Stakeholders who are categorised as key players with high interest and high power are critical; these include Large Business corporations (Coca-Cola, Dangote, Lafarge), various SMEs working in priority sectors, Knowledge institutions (University of Ibadan, University of Calabar, Alex Ekwueme University, Pan African University), Foreign Government Institution (Embassy of The Netherlands, The British Council), Federal and State Government Ministries, Department and Agencies (Ministry of Environment,

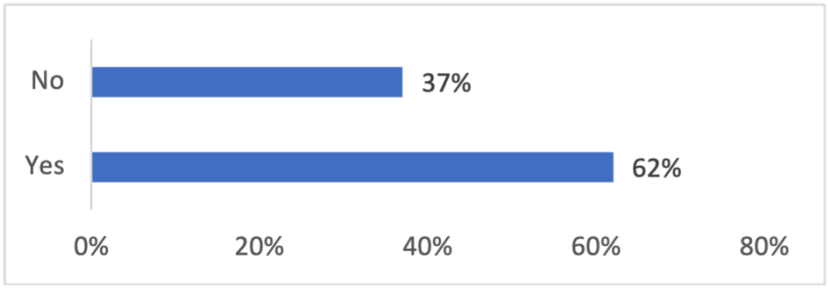
Ministry of Finance, Budget and National Planning, Ministry of Science and Technology, Ministry of Agriculture & Rural Development, Nigerian Bureau of Statistics, Ministry of Transportation), Development partners and banks (European Union, African Development Bank, United Nations Environment Program).

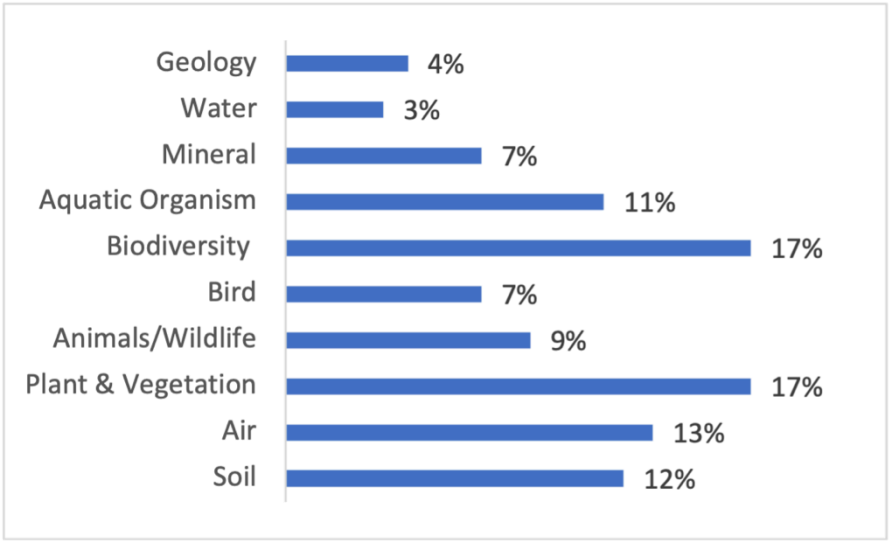
Figure 7.2 presents percentage distribution of stakeholders across various institutions and Figure 7.3 shows the location of these stakeholders in Nigeria.

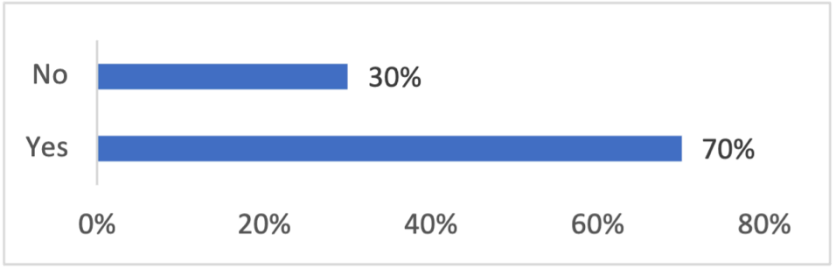


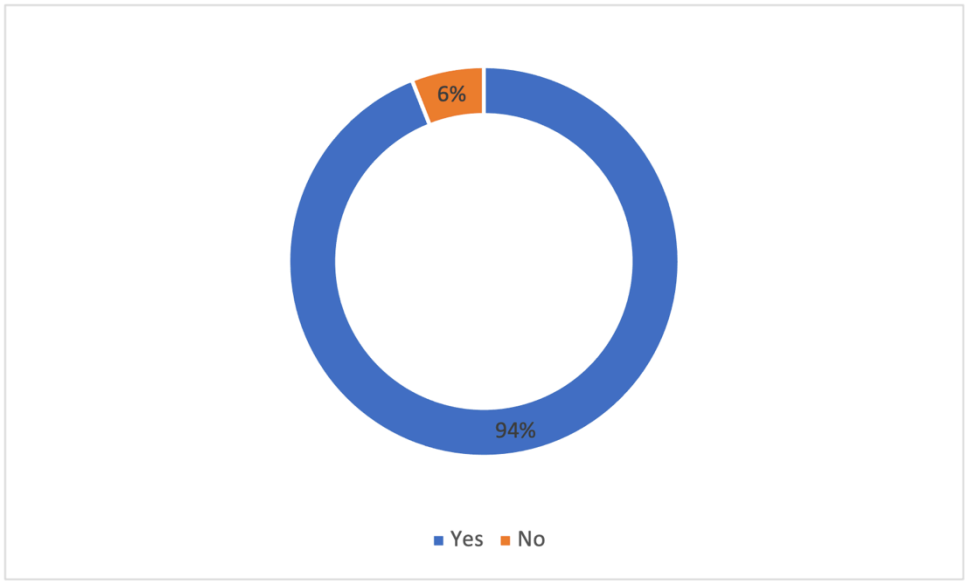


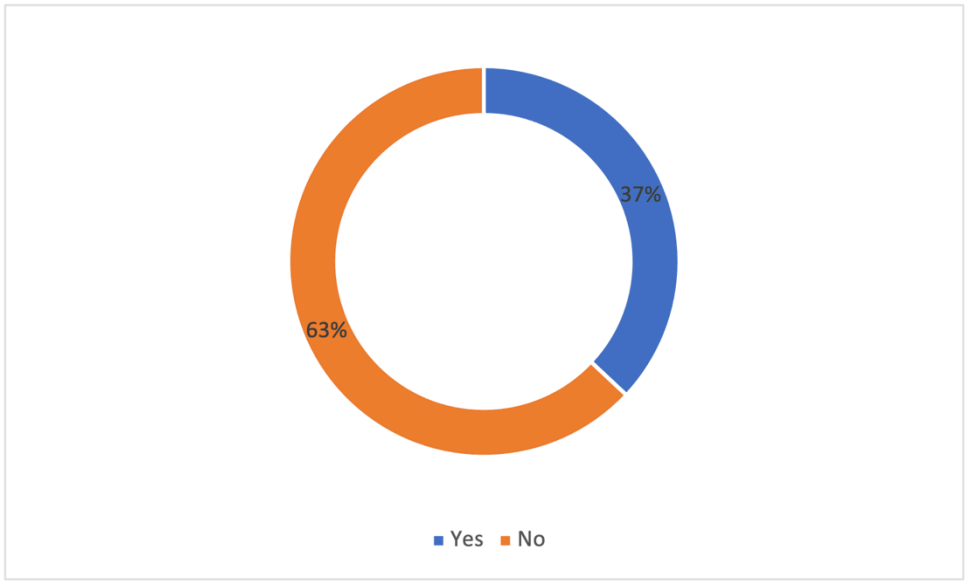
Circular Economy and Natural Capital related insights drawn from the survey questionnaire distributed to stakeholders across various institutions and business is presented in Figures 7.4 to 7.9 and Tables 7.1 to 7.5.








6%
94%
Yes
No


37%
63%
Yes
No

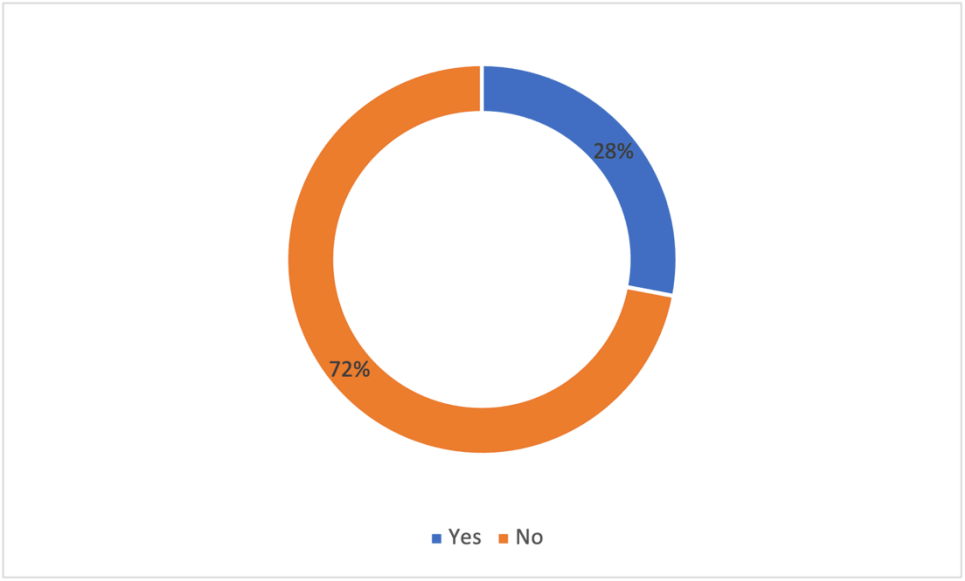


Table 7.1: Nature-based solutions relevant to stakeholders

Nature-based solutions relevant to stakeholders	Regeneration. Composting. Restoration of degraded land through afforestation/reforestation. Use of Biodegradable materials. Afforestation. Urban Ecosystem Restoration. Site Support Groups, Model Urban Conservation Centre. Natural home and lifestyle products and fashion accessories. For example, making buttons for fashion from coconut and bamboo thereby replacing plastic buttons. Preservation of peat lands and swamps of Niger Delta and planting of economic trees. Agricultural waste to produce eco-friendly charcoal. practicing Environmental Benefit Analysis (NEBA) Protection of the sensitive nature estuaries, wetlands, and prohibition of open burning of bush, and expired or confiscated products. Natural attenuation (bio-control) of oil spill impacted environment. Smart Agriculture and Climate change Resilience Wildlife preservation & Re-vegetation Permaculture. Tree planting and replanting. National Park services, forest reserves and wildlife protection. Reduce. To efficiently reduce plastic pollution, there is an evident need of reducing our usage of plastic. Reuse. Plastic may cause pollution when poorly managed, but it has lots of advantages too, such as being resistant. Monitoring to prevent exploitation of natural resources. Also monitoring to prevent bush burning and subsequent loss of habitat.

Table 7.2: Natural Capital Projects or Conservation measures, Programs and Plans

	Tropical high and mangrove forest conservation. Tree Planting, Ocean and Marine Clean Up. Afforestation and reforestation projects. Energy transition plans.

Natural Capital Projects or Conservation Project(s)	Waste minimisation and recycling Adequate soil test and soli analysis Natural Capital of City Trees. Lekki Conservation Centre, Abuja Conservation Centre, Finima Nature Park. Livelihoods and biodiversity conservation. Marine Plastic Recovery. Use of Tissue Immersion Bioreaction to multiply plantlets for recovery of desertified or degraded land in 11 front line states of Northern Nigeria. Protection of the endangered species of flora and fauna from illegal trade, wetlands, and marine ecosystem protection. Wildlife and aquatic life protection. Adoption of Environmental Sensitivity index (ESI) and Net Environmental Benefit Analysis (NEBA) in oil spill management and response. Monitoring effluent discharges from petroleum facilities. Ensure facilities conduct emergency preparedness drills and personnel are well trained. Smart Agriculture and Climate change Resilience and Nature Based Solution. Environmental Impact Assessments. Protection of endangered wild fauna and flora, protection of Ecosystem integrity including habitat, etc. Biodiversity conservation and forest conservation Tree planting and protection of our forest reserves**.**

.

Table 7.3: Circular Economy Research Opportunities

Circular Economy Research Needs	Value addition to timber and Non-Timber Forest Resources (NTFPs). Using plastics as raw materials for road construction. Local adaptation of technology to Nigeria. Amount of PET generated across the 36 states in Nigeria and monthly volumes. Waste to Energy (cow dung, rice husks etc), Climate smart agriculture (integrated farming). Alternatives to packaging and applications for waste packaging material. Standardization of Color Codes for Recyclable Waste Segregation and Biodegradable Waste in Nigeria. The effectiveness of Waste Segregation and Evacuation of Recyclable Waste from Source to Recycling Centers. The effect of limited Recycling Centers on Recyclable Waste generation and Segregation. Ineffective implementation of Solid Waste Laws. E-waste quantification, its direct impact on the Nigerian environment Sustainable timber harvesting. Inventory of total amount of batteries for renewable energy and automotive sector and the collection, transportation, storage, and recycling of used batteries in Nigeria. Integration of multiple waste management and disposal solution in an Eco-Park to drive the circular economy. Economic feasibility for the conversion of post-consumer plastics into fibre-reinforced building Materials using extrusion technology. Prototyping on some selected green products via the use of shredded post-consumer plastic as raw materials instead of plastic pellets in 3D- printing technology. Degumming, Scutching and Hacking technology suitable for the various natural fibers Effective implementation of the National Waste - to - Wealth program using Appropriate Technologies being coordinated by Federal Ministry of Science, Technology, and Innovation. Capacity for turning agricultural and industrial wastes to useful resources. The Agency have research need on information and awareness raising on air pollution control, banning on use of single-use plastics, electrical and electronic equipment and end of life vehicle scrapping and procurement.

	Need to utilise agricultural wastes in manufacturing absorbents for oil spill cleanup. There is need for circular economy research in the area of plastic management and municipal solid waste management. Research in Jute and the value chain for wider Cross cutting application. Meeting the need of including the scavengers on the health side and partnerships support to their welfare. Biodegradable material as alternatives to plastic materials and metal recycling processes. Recycling or upcycling of residue waste (POP). The need for plastic recycling and converting waste to energy. Profitability recycle PET bottles in several value chains Renewable energy (production of briquettes). Research on reducing carbon footprints causing depletion of the ozone layer.

Table 7.4: Stakeholder Opinion on public- private partnerships to drive investment in Circular Economy

Stakeholder Opinion on public- private partnerships to drive investment in Circular Economy	Waste-to-Energy can be perfectly executed under PPP. Private Sector is best placed to implement large infrastructure projects, government should facilitate by offering land and guaranteeing waste supply through a concession contract. Government can get a profit share in return. Capacity development & Mass Advocacy: There is a huge level of poverty and unemployment in Nigeria. A properly structured capacity development program will enable young Nigerians discover the opportunities that exist within the sector. The principles of CE should be broken down and for the government to support the work that is being carried out by the private sector. The Extended Producer Responsibility (EPR)program is an initiative by NESREA under the Battery Control Regulations. It was designed to facilitate cradle to cradle management of waste by ensuring all waste producers take responsibility in its management. The EPR program is an effort to transit Nigeria from a linear economy to a circular one. Building an Abia state Waste city where both private and public partners can work and build sustainable waste management practices from collection to transportation to treatment. Establishment of recycling plants for used pet bottles, textiles, glasses, rubber. Establishment of a robust sewage treatment plant and conversion of waste for energy production.

Table 7.5: Stakeholders recommendation to drive circularity in Nigeria's private & public sectors.

Stakeholders' recommendation to drive circularity in the private & public sector in Nigeria	Distribution of knowledge Nationwide Awareness to fast track attitudinal and cultural re-orientation of the citizenry. Advocacy campaign to promote CE Adequate power supply availability and finance availability. The introduction of roles and positions for sustainability managers; this person would be responsible for ensuring practices within the organisation are sustainable and in line with world ESG standards. Collaborations & Partnerships: A lot is going on within the CE sector, but the public and private sector need to work together to create tangible solutions.. Other recommendation include: i. ii. Put policy and legislation in place.. iii. Develop finance plan (Example: climate finance windows and other green climate finance windows). iv. Put in place an MRV system that will drive the CE. SMEs in waste management should be support with mechanized production tools and skills that will ease manual labour.

	Organisations need to meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole lifecycle basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst significantly reducing negative impacts on the environment. There is need to fully implement Extended Producer Responsibility and also inclusion of a system of Waste Segregation using the colour-coded bin for proper Waste Management Adequate data collection. The inclusion of the Extended Producer Responsibility (EPR) into policies of the Nigerian economy as well as the development of approaches and frameworks for its implementation to increase circularity will aid the private & public sector of Nigeria transit into circular economy. The use of durable, renewable, or reused materials. The most efficient way of promoting the circular economy in the private and public sector is to extend the lifecycle of products by using durable materials and make long-life products that can be repaired and that are reused at the end of their life cycle. Implement a number of Waste to Energy projects to see there is value in waste. Implement strict emission and project implementation standards. There are several recommendations that have been documented by the Steering committee of the African Circular Economy Network (Nigeria Chapter). Easy access to investments in the sector. The Nigerian government should provide more support to small businesses in the sector. Awareness and sensitization Advocacy, training, right policy development and enforcement. Inventory, Identification, mapping, and stakeholder's engagement. Synergy and corporation among players in the waste value chain, Training of regulators on circularity. Continuous advocacy, enlightenment and public awareness Smart Agriculture and Climate research. Private sector investment in circular economy projects. Policies to promote circular economy activities at various sectors and also invest in it. Informal sector should be approved to work as a stakeholder. Full-scale policy implementation and self-awareness even on the side of policy makers. Policy framework shouldn't just be term papers. Rather, solutions and programs should be PPP driven and downscaled to accommodate start-up companies or enterprises. In order to drive a circular economy, funds should be provided as well as enabling environment for the private sector to thrive. The Government should stop the third party (Asians) involved in illegal shipment of the valuable fractions from e-waste out of the country. Structure, standardisation, and sustainability of the circular economy Landfill should be well planned in state with fence.

7.2 Issues and Challenges of Circular Economy and Natural Capital among Public and Private Sector Stakeholders

A survey of stakeholders drawn from the study's priority sectors covering both private industries within the sectors and public agencies was carried out with the aim of identifying the key Circular Economy challenges and gaps. The identified challenges include but are not limited to a low level of awareness and technical know-how for achieving circularity, gaps in policy and regulatory framework, knowledge gaps and technical expertise.

Low level of awareness in technical know-how for achieving circularity.

Across private sector stakeholders in Nigeria's priority sectors for circularity, there is awareness of the term circular economy, but it often associated with recycling in the waste sector. There is a limited awareness of the components of a circular economy relevant to achieving circularity. In other words, knowledge of technical know-how is limited. For example, the knowledge of the accounting system to be adopted by the private sector and even the public sector to enhance circularity is low. 63% of sampled stakeholders on circular economy are not aware of Natural Capital Accounting (NCA). More so, 72% of these stakeholders are also not aware of the existence of Economic and Environmental Accounting for Nigeria. There is, therefore, a critical need to develop the capacity of relevant stakeholders, especially in the private sector, to understand how to embed circularity in their operations.

Policy Gaps

Nigeria has made tremendous efforts in enacting the climate change policy, which has elements that will encourage circularity. Given the pivotal role of circular economy in the global economy, relevant stakeholders in Nigeria indicated the need to develop policies and regulatory frameworks that stipulate a clear guide for Nigeria to transition from a linear economy and move toward a circular economy. In order to tap into the potential benefits of circular economy, tailored and specific circular economy policies and frameworks are critical. 17.3% of stakeholders in the Private sector identified policy support as a critical component to scaling their businesses that have a circular economy and natural capital underpinnings.

7.2.1 Knowledge Gap

There exist gaps in knowledge to enhance circularity, for which research that can provide the necessary knowledge insights for circularity in Nigeria will be required. Relevant research leads to knowledge creation that can bring the needed awareness of the potential of a circular economy. These research, when conducted, act as a catalyst for action. Among stakeholders from the public and private outfits in the priority sectors, various knowledge gaps were identified, which include but are not limited to economic feasibility for the conversion of post-consumer plastics into fibre-reinforced building Materials using extrusion technology, smart agriculture and climate change research, Inventory of total amount of batteries for renewable energy and automotive sector and the collection, transportation, storage and recycling of used batteries in Nigeria. It is, therefore, critical to consider filling up these knowledge gaps through research across various institutions that are saddled with product research and development in Nigeria. These include universities and research units in industries as well as in government Ministries, Departments and Agencies (MDAs). Engaging with stakeholders from universities and research units in industries/government MDAs reveals that a major driver for creating knowledge through research is the availability of funding. The private sector and the government agencies charged with providing research funds are encouraged to seek collaboration that will roll out a call for research grants within the circular economy and natural capital priority sectors.

7.2.2 Low Technical Expertise

The transition to a circular economy requires a workforce with the right skills and technical expertise. The relevant skill sets to power a circular economy are also embedded in green job skills. This includes not only skills in the low carbon and environmental goods and services sector but also those needed to help all businesses use natural resources efficiently and sustainably and to be resilient to climate change.

The International Labour Organisation [4] highlighted that the core skills identified as necessary for green jobs include environmental awareness and willingness to learn about sustainable development. Relevant stakeholders identified a gap in these skills to power a circular economy. There is a critical need for institutions of learning in Nigeria to incorporate training components that will empower Nigeria's future workforce to acquire the needed technical expertise to power a transition to circular economy.

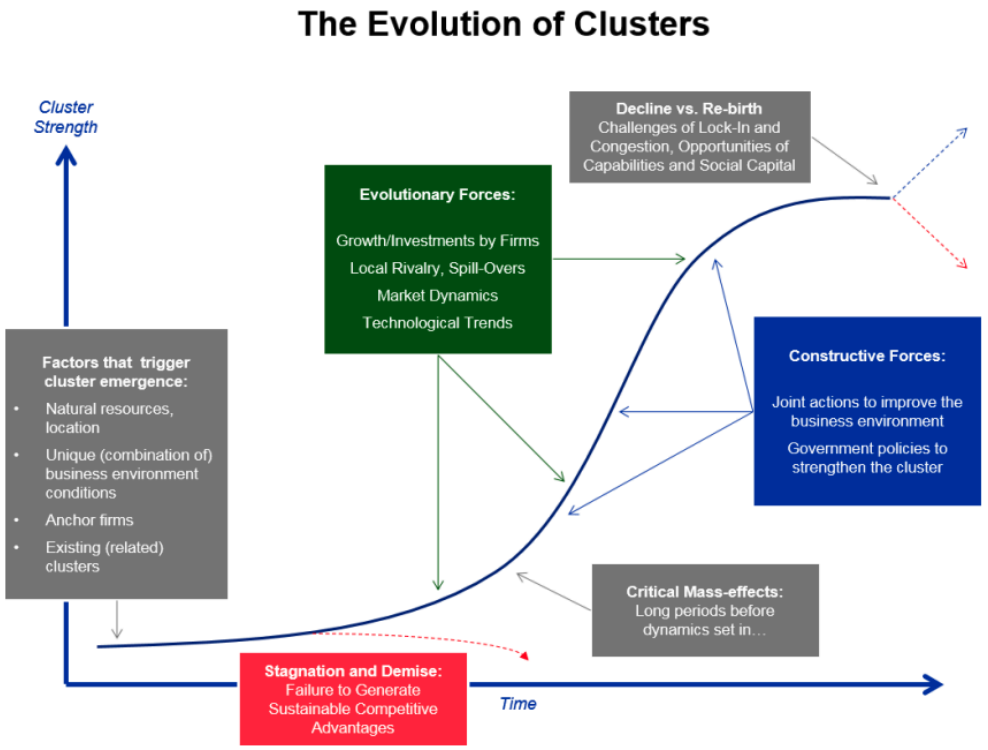
7.3 Analysis and mapping of NC and CE business clusters.

Business clusters are local concentrations of horizontally or vertically linked enterprises that specialize in related lines of business together with supporting organisations [120]. Business clusters have been recognized as vehicles of innovation among enterprises. Though there is an element of competition among businesses in clusters, they also cooperate with each other since they are geographically interconnected enterprises [121] Studies have also shown that business clusters emerge naturally triggered by the benefits of shared location, investment decisions, government decisions, and competition [122, 123].

Mapping clusters describes the process of systematically measuring the presence, size, and performance of clusters across locations [124] The benefits of business cluster analysis and mapping include but are not limited to: the potential to identify local and regional competitive advantage, upgrade firm's competitiveness and innovation level, data insights for regional and local development policy design and implementation, local development and building the strength of SMEs and the attraction of foreign direct investments (FDI).

7.3.1 Evolution of Business Clusters

The evolution of business clusters in any geographic location provides a business cluster evolution curve where the strength of any business cluster lies on four drivers: natural resources location, unique business environment conditions, anchor firms and existing related clusters [124]. The benefits derived is that over time, the combination of these strengths enable the business cluster to grow and develop as against becoming stagnated to the point of folding-up. See Figure 7.10.



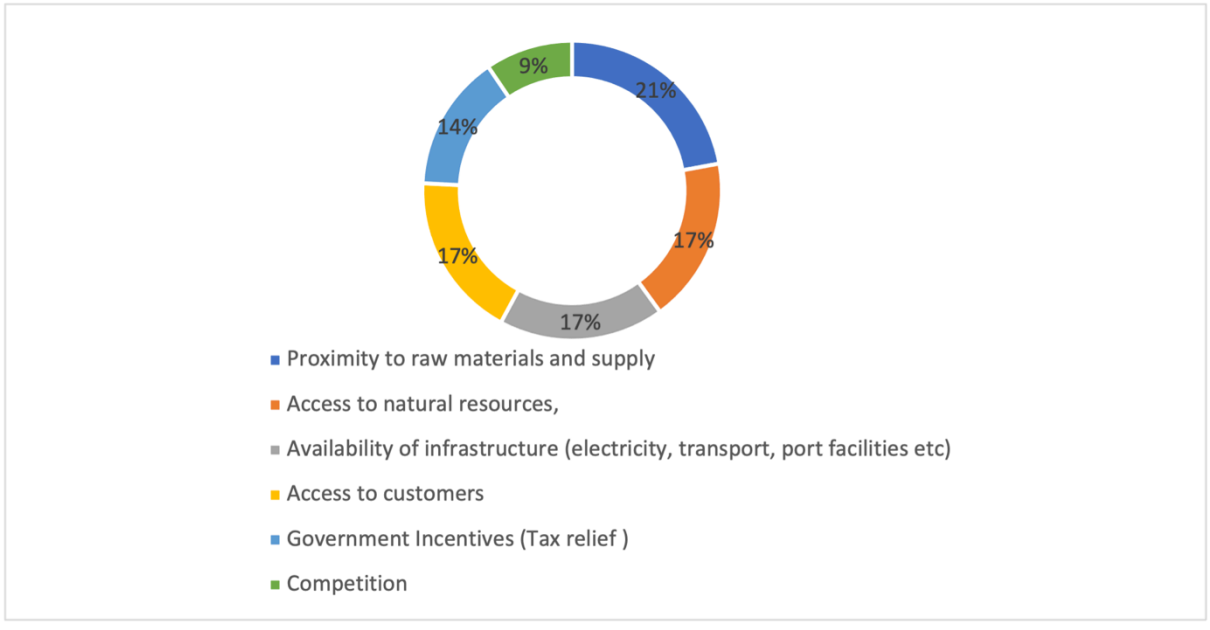
A regional business cluster is illustrated in Table 7.6 highlighting the various concentration of industries in the 6 geopolitical zones of Nigeria.

Table 7.6 Regional Profile of Leading Industry Concentration in Nigeria

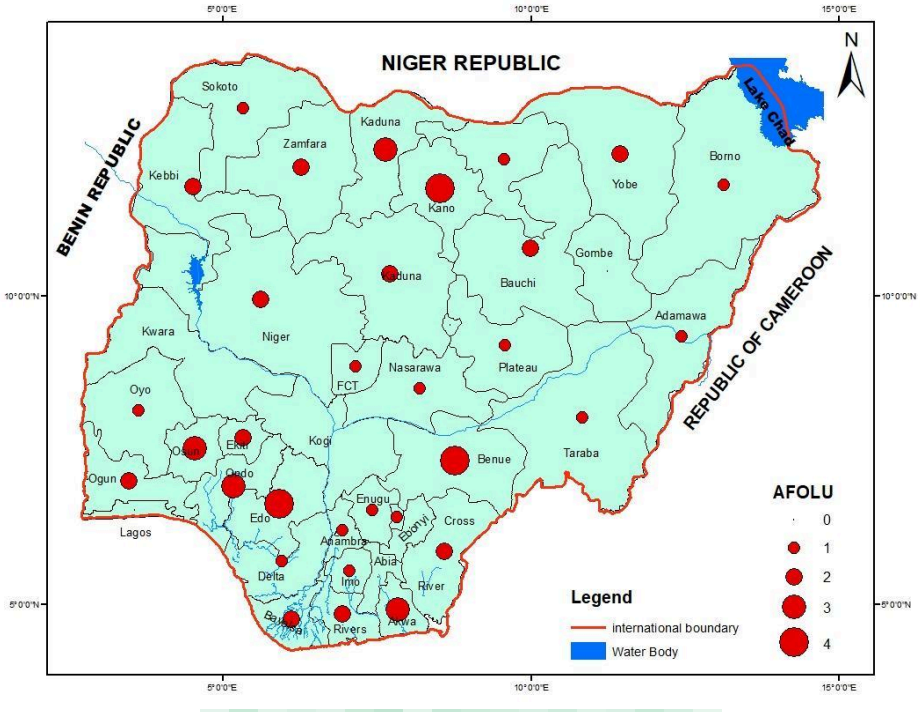
Region	Industry Concentration
South-West: (Lagos, Ogun, Oyo, and Ondo)	16 waste and recycling companies exists in Lagos, The presence of the largest electronic retail market in Lagos (computer village).; The highest number of transport industry terminals exists in Lagos (Land, Air and Water). A large automobile spare-parts retail market exists in Lagos (Ladipo). Animal husbandry feed mills exists in Ibadan, Oyo axis. Fast Moving Consumer Goods (FMCGs) producing consumers exist in Lagos, Ogun and Oyo corridors. High forestry activities by businesses in Ondo corridor. Construction companies and telecommunication companies are headquartered in this region.
South-East (Anambra, Abia, Enugu and Ebonyi)	A huge market for automobile manufacturing, repairs and maintenance exists in Anambra. Battery Recycling activities by business are also present here. Agriculture activity in rice production exists in Ebonyi. A large concentration of textiles, plastic and rubber manufacturing companies exists in Abia State.
South-South (Rivers, Cross River, Akwa-Ibom, Edo, and Delta)	Oil and Gas activities by businesses are high in Rivers, Delta

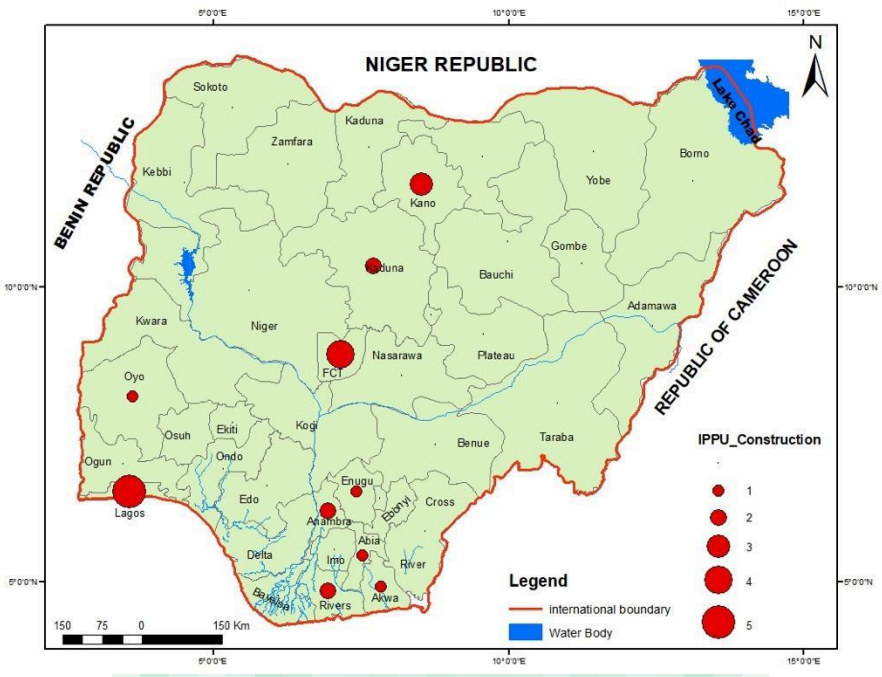
	and Akwa-Ibom. Fishery and water-related enterprises exist in Rivers, Cross River, and Akwa-Ibom. Agro and Forestry-related businesses is high in Cross River and Edo States."
North-West: (Kaduna, & Kano, and Sokoto, Zamfara)	Agricultural production activities are High in this region (plant and Sokoto, Zamfara) and animal inclusive). Leather works (Hides & Skin) activities by businesses is also high in Sokoto. Plastic and textile business activities are high in Kaduna and Kano. Vehicle tubes and tyre recycling activities are high in Kano and Kaduna; pockets of mining activities exist in Zamfara.
The activities of North-East (Adamawa, Taraba, and Borno)	Leatherworks (Hides and Skin) by businesses are high in Adamawa and Borno.; Agricultural production activities by businesses are high in this region (plants and animal inclusive). Forest and Energy generation activities by businesses exist in Taraba State. Fishing activities by enterprises exist in this region.
North-Central: (Niger, Nasarawa, Plateau, Kogi and Benue)	Electricity energy generation by businesses exists in Niger. Agricultural production activities by businesses are also high in this region (plants and animal inclusive); Forestry and Mining activities by businesses exists in this region.

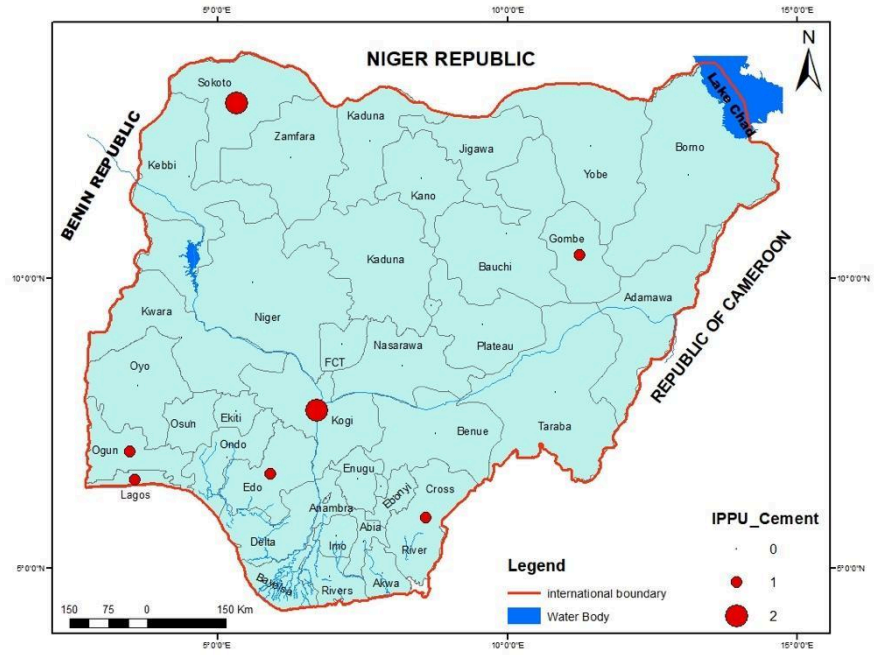
In Nigeria, across the four priority sectors with potential for circularity, various business clusters were identified, and factors leading to the existence of such clusters are presented in figure 8.8. Most of the clusters were organically formed as a result of access to raw materials and natural resources. Other clusters emerged because of available infrastructure, such as the Free Economics Zones with relevant facilities. Some clusters emerged due to access to customers. Figure 7.11 presents the percentage distribution of drivers to business clusters.

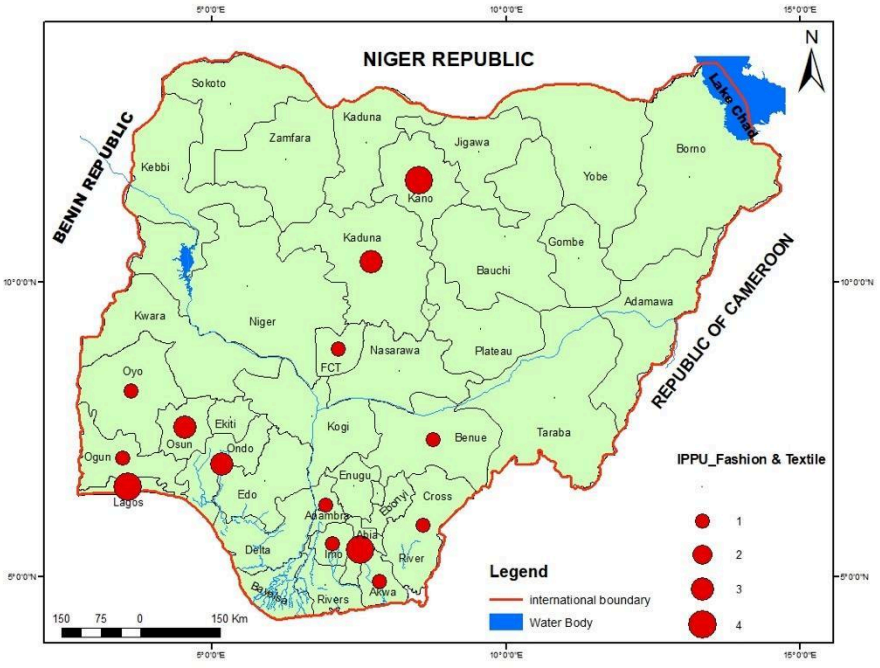


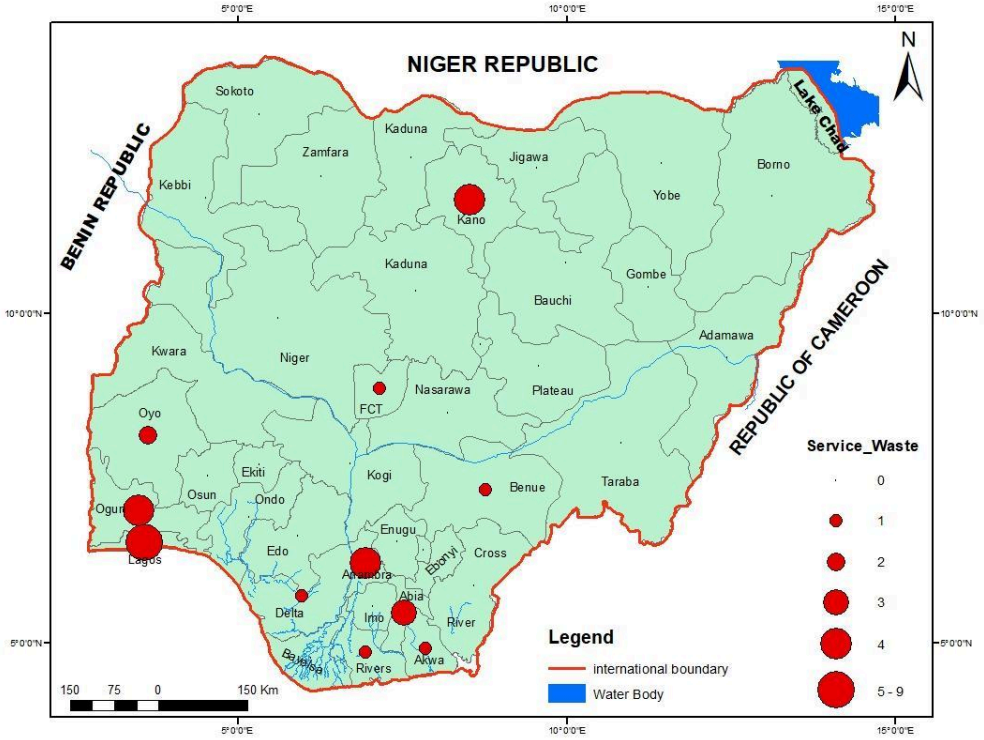
Figures 7.12 to 7.18 show the various concentration dimensions of business clusters in various priority sectors.

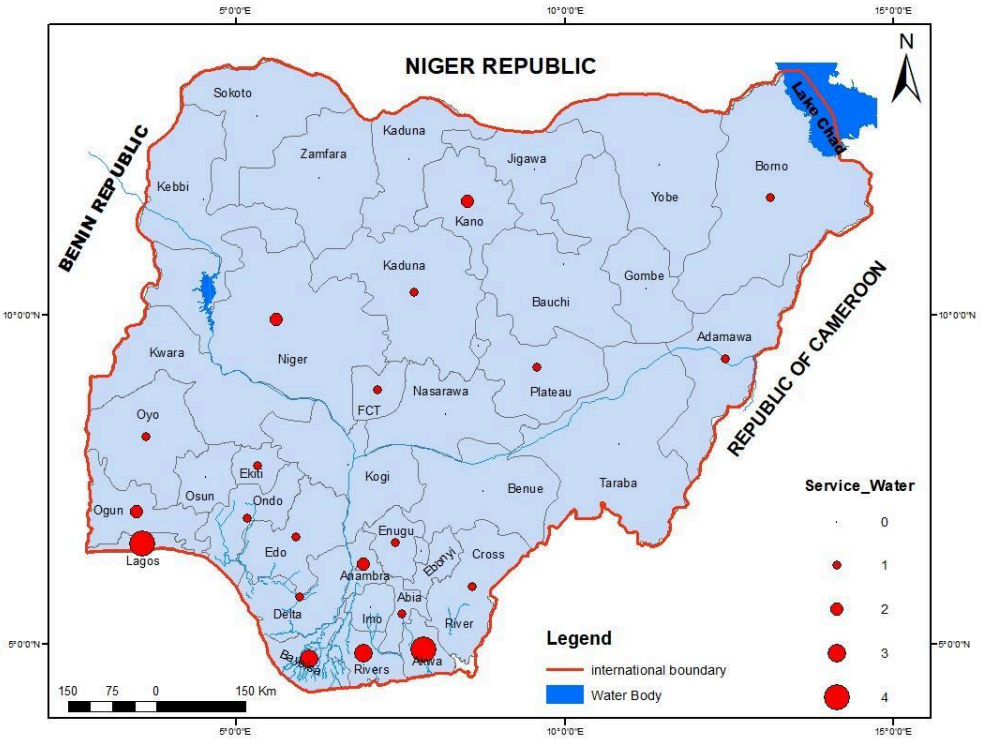


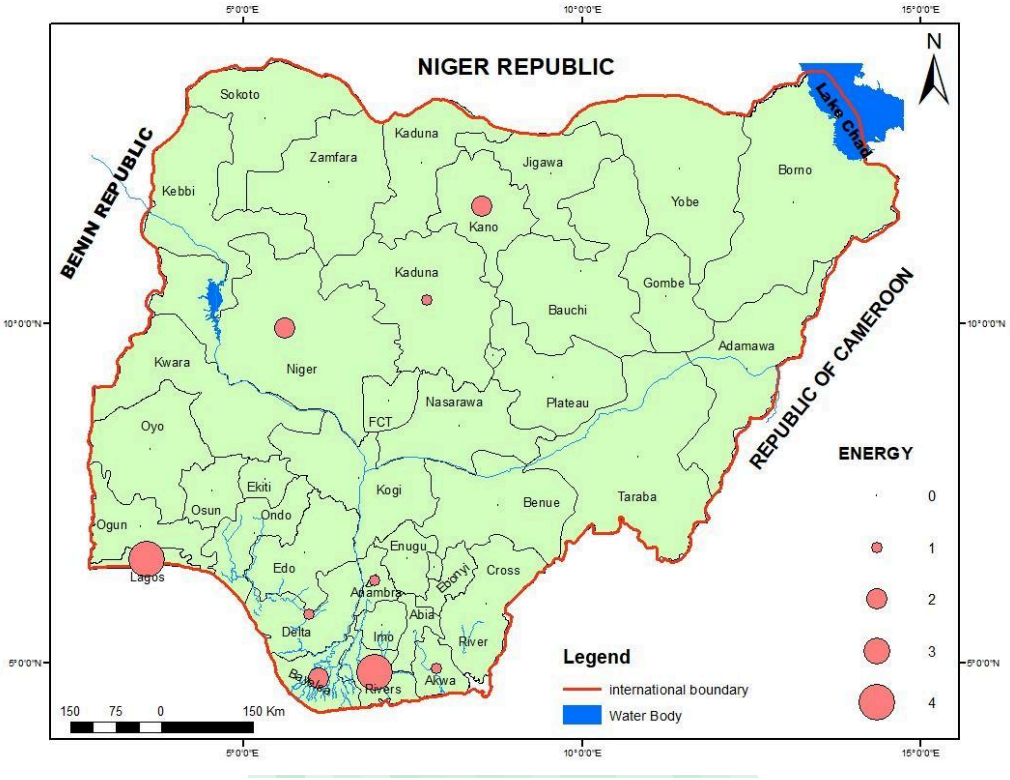



NIGER REPUBLIC
N
BENIN REPUBLIC
REPUBLIC OF CAMEROON
Lake Chad
Sokoto
Kaduna
Zamfara
Kebbi
Jigawa
Borno
Yobe
Kano
Gombe
Bauchi
Adamawa
Kwara
Niger
Nasarawa
Plateau
FCT
Oyo
Kogi
Osun
Ekiti
Benue
Taraba
Ogun
Ondo
Enugu
Lagos
Edo
Ebonyi
Cross
Anambra
Abia
Delta
Imo
River
Bayelsa
Rivers
Akwa
150 75 0 150 Km
IPPU_Cement
0
1
2
Legend
international boundary
Water Body


NIGER REPUBLIC
N
BENIN REPUBLIC
REPUBLIC OF CAMEROON
Lake Chad
Sokoto
Kaduna
Zamfara
Kebbi
Jigawa
Borno
Yobe
Kano
Gombe
Bauchi
Adamawa
Kwara
Niger
Nasarawa
Plateau
FCT
Oyo
Kogi
Osun
Ekiti
Benue
Taraba
Ogun
Ondo
Enugu
Lagos
Edo
Ebonyi
Cross
Anambra
Abia
Delta
Imo
River
Bayelsa
Rivers
Akwa
150 75 0 150 Km
IPPU_Fashion & Textile
1
2
3
4
Legend
international boundary
Water Body


NIGER REPUBLIC
N
BENIN REPUBLIC
REPUBLIC OF CAMEROON
Lake Chad
Sokoto
Kebbi
Zamfara
Kaduna
Jigawa
Kano
Yobe
Borno
Gombe
Bauchi
Adamawa
Kwara
Niger
Nasarawa
Plateau
FCT
Oyo
Ekiti
Osun
Ondo
Ogun
Lagos
Kogi
Benue
Taraba
Edo
Enugu
Ebonyi
Cross
Anambra
Abia
Delta
Imo
River
Rivers
Akwa
Service_Waste
0
1
2
3
4
5 - 9
Legend
international boundary
Water Body
150 75 0 150 Km
5°0'0"E
10°0'0"E
15°0'0"E
10°0'0"N
5°0'0"N


NIGER REPUBLIC
N
BENIN REPUBLIC
REPUBLIC OF CAMEROON
Lake Chad
Sokoto
Kebbi
Zamfara
Kaduna
Jigawa
Kano
Yobe
Borno
Gombe
Bauchi
Adamawa
Kwara
Niger
Nasarawa
Plateau
FCT
Oyo
Ekiti
Osun
Ondo
Ogun
Lagos
Kogi
Benue
Taraba
Edo
Enugu
Ebonyi
Cross
Anambra
Abia
Delta
Imo
River
Rivers
Akwa
Service_Water
0
1
2
3
4
Legend
international boundary
Water Body
150 75 0 150 Km
5°0'0"E
10°0'0"E
15°0'0"E
10°0'0"N
5°0'0"N



A summarised SWOT analysis table of business clusters across the priority sectors in each of the region is presented in Table 7.7.

Table 7.7: Swot Analysis of Business Clusters across the four priority sectors in Nigeria

Region	Strength	Weakness	Opportunity	Threat
South-west	National economic hub with skilled talents.	Low industry-research Centre collaboration in circular economy and natural capital research.	Emerging research hubs in universities and other government institution for circular economy and natural capital research, with potential for industry-research centre collaboration.	Rising population causing a excessive stretch in the use of public facilities. Especially in Lagos and its environs business clusters.
South-east	A vibrant entrepreneurship culture for innovation in circular economy and natural capital businesses.	The rise in insecurity and separatist activities, coupled with migration of talents and businesses to south-west Nigeria.	The completion of the second Niger bridge.	The rise in informal businesses without due regulation.
South-south	Dominant industrial presence of the oil and gas industry.	Environmental pollution due to a high dependence on oil and gas production.	The presence of oil and gas business giants that can incubate technology business in alternative energy (hydrogen).	Insecurity challenges: Kidnapping of business leaders and high net worth individuals.

North-east	Arable land for Agriculture and other land uses.	Poor investment climate due to the rise in insecurity.	The presence of solar, wind and hydrogen energy options.	Poor education and absence of talents.
North-west	Arable land for Agriculture and other land uses.	Poor investment climate due to the rise in insecurity.	The presence of solar, wind and hydrogen energy solutions. Potential for industry-research centre collaboration.	Rising Migration of talents.
North-central	Agricultural linkage to southern part of Nigeria.	Poor investment climate due to the rise in insecurity.	The presence of solar, wind and hydrogen energy solutions.	Intensive competition from Abuja.

7.3.2 Circular Business Bright Spots in Nigeria (Local /Informal Examples of Circularity)

The 10Rs framework in assessing the CE opportunities was deployed in identifying local examples of circular businesses across various sectors and CE Innovation with potential for scaling up. This cuts across:

- Individuals in the informal sectors
- Local Governments and Communities
- Private entrepreneurs – MSMEs
- Corporations & Big Corporation (Dangote, Larfage, Nigerian Breweries, etc.).
- Research Laboratories and Academic Departments of Universities /Tertiary Institutions.

Table 7.8: Circular Economy & Natural Capital Bright Spots in Nigeria

S/N	Name	Business Focus	Location	Geopolitical Zone Coverage	Website
1	The Coca-Cola Foundation Cycleplast	Plastic Waste Collection	National	National	https://www.coca-colacompany.com/shared-future/coca-cola-foundation
2	Lagos Circular Business Platform	Circular Education Awareness, Research, and Investment opportunities linkages to businesses.	Lagos	National	https://circularlagos.com/
3	The Future is Green & Energy: Electric Vehicle	Energy: Electric Vehicle	Maiduguri, Borno	North-East	https://punchng.com/i-dropped-out-from-unimaid-to-pursue-dream-of-building-electric-vehicles-borno-man-gajibo/
4	Salubata	Waste & Sustainable Fashion	Lagos	South-West	https://salubataofficial.com/collections/all
5	Planet 3R.	Textile & Plastic Waste	Ibadan, Oyo State	South-West	https://www.planet3r.com/
6	Free Town Waste Management Recycle Company	Production of reusable, eco-friendly rubber moulded products.	Ibadan, Oyo State	South-West	https://www.freetownwaste.com/

7	Informal shoe manufactures	Waste	National	National	https://www.nairaland.com/2270445/innovative-footwears-recycled-tires

7.3.3 CE Business Model

Some CE business models are highlighted in Table 7.9 based on Public-Private Partnership (PPP) and Public-Public Partnership (PuP). The PuP is an ownership agreement between the federal government and state government, state government and international development agencies.

The National Plastic Recycling Program was initiated by the Federal Government's Ecological Fund at various sites across the country, and the facilities were handed over to the respective State Governments to create a public-public partnership (PuP). However, almost all facilities are non-operational, with issues ranging from lack of basic amenities and equipment failures to waste feedstock and bureaucracy. The National Hospital Intervention Scheme is another national initiative which has installed incinerators in various Federal Hospitals with the objective of sustainably disposing of medical waste. Ten of these incinerators have been handed over to the Federal Ministry of Health for utilisation, while others are being planned. The Integrated Waste Management Initiatives is a project by the Lagos State Government which has attracted partnerships with UNEP, CCI, USEPA, and World Bank/IBRD with a bid to establish long-term waste management plants which process different waste streams at strategic sites in the state. The State Government in 2019 collaborated with its Local Governments to launch the Blue Box, which aided waste sorting at the source for faster processing and utilised the services of registered franchise collectors who gathered and processed this sorted waste at designated centers. The Lagos State Ministry of Environment also has partnered with Visionscape Sanitation Solutions to provide solid waste management facilities in the State to create a Public Private Partnership (PPP) known as the 'Cleaner Lagos Initiative.' In Akwa Ibom State, the State Government has partnered with P&A Environmental Solutions Partners, GEN Engineering, Boskel Nig Ltd, and AfDB to develop a 25-year Build-Own-Operate (BOO) /PPP integrated waste recycling joint venture across the state, which will process several waste streams in three primary centres of Uyo, Ikot Ekpene and Eket over a period of 25 years. Organic waste, plastics, metals, glass, paper, and medical waste will be part of the feedstock at these centres, which will also create up to 1,800 jobs state-wide.

In addition to these, the Federal Ministry of Science, Technology, and Innovation are working with the Cross River State Government to establish the first pilot project of the Ministry's Waste-to-wealth

program (2021-2025) at Idundu Industrial Layout, where a dumpsite is located in Calabar; this would generate biogas for energy use. This program has been designed to cover the 6 geopolitical zones of the country.

Table 7.9: Some Key Circular Economy Partnerships in Nigeria

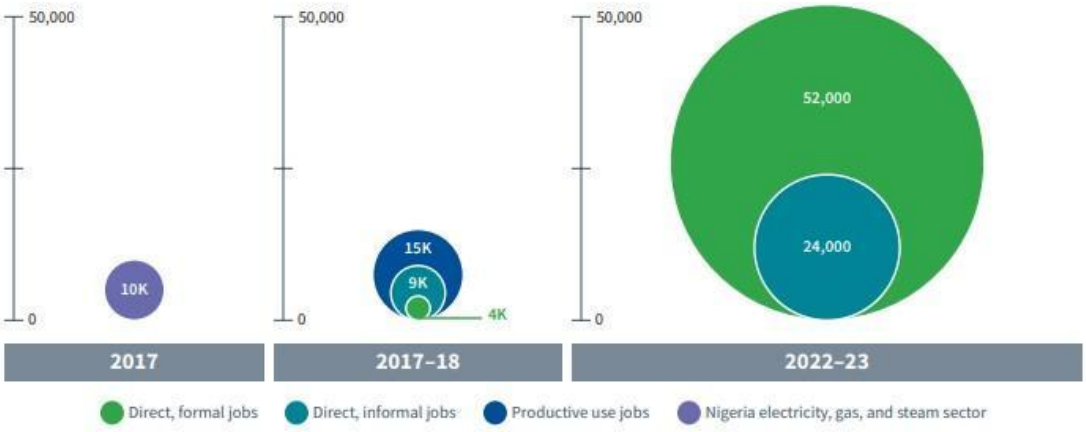
S/N	Name	Location	Owners	Partnership Structure	Duration	Description
1	National Plastic Recycling Program	Nationwide	Federal Government/ State Governments	PuP	2008 - date	26 plastic recycling facilities installed across the country to process plastic waste with processing capacities of up to 1000kg/cycle each.
2	National Hospital Intervention Scheme	Nationwide	Federal Ministry of Environment/ Federal Ministry of Health	PuP	2009 - date	Retrieval and re-circulation of waste from certain sectors (e.g., packaged plastic, e-waste, lead batteries) for further use nationwide.
3	Integrated Waste Management Initiatives	Lagos State	Lagos State Government, UNEP, CCI, USEPA, World Bank/IBRD, local investors and financial institutions	PuP/PPP	2009 - date	It consists of a Waste Containerization Strategy, Intermediate Waste Disposal Facilities (Transfer loading stationsTLS), a Medical Waste Treatment Plant in Oshodi, a Nylon Buyback program, a Waste-to-Wealth Compost Plant in Ikorodu, a Landfill Waste to Energy (WTE) Olusosun which has a Landfill Gas Capturing Facility, Biogas Plant for WTE using market waste.
4	LAWMA Blue Box Recycling Initiative	Lagos State	Lagos State Government & Local Governments	PuP	2019 - date	Scheme designed to separate waste at source using colour-coded bags for waste disposal in Lagos e.g., blue box for recyclable waste like plastic, water sachets, while black bags for non-recyclable waste. Franchised recyclers collect waste on designated days and deliver them to designated Community Recycling Centres (CRCs) for sorting or sale. (LSGOW, 2022).
5	Cleaner Lagos Initiative	Lagos State	Lagos State Ministry of Environment; Visionscape Sanitation Solutions	PPP	2017 - date	Erection, rebuilding and improvement of solid waste management structures, landfills, transfer sites etc. (Olukanni and Nwafor, 2019).
6	State-wide Recycling & Management Project	Akwa Ibom State	Akwa Ibom State Government, P&A Environmental Solutions Partners, GEN Engineering, Boskel Nig Ltd, AfDB	PPP	To commence 2022; 25-year BOO/ PPP joint venture	Development of recycling facilities at Uyo, Ikot Ekpene and Eket to process 1,600-2,000 tons of collected solid waste daily with an estimated indirect workforce of up to1,300-1,800 personnel to include: i) compost production facilities to produce up to 1,008 tons of compost daily at full capacity. ii) recycled plastics conversion infrastructure to recycle plastics to fuels, wheelie bins and for the market.

						iii) Recycled metals, glass, and paper for market. iv) Recycling and disposal of medical and non-disposable wastes (P&A Environmental Solutions, 2022).
7	Anaerobic Digestion/ Landfill Plant	Cross River State	Federal Min of Science, Tech & Innovation (FMSTI)/ Cross River State Government	PuP	To be confirmed	Establishment of a pilot scheme of an anaerobic digestion plant to be installed at designated waste landfill sites to generate biogas as part of the Ministry's Waste-to-wealth program (2021-2025). This would be the first pilot project among the 6 geopolitical zones ((FMSTI, 2022).
8	Solar Power Naija	Nationwide	Rural Electrification Agency (REA)	PPP	To be confirmed	To support the economic recovery in response to the COVID-19 pandemic, the Federal Government of Nigeria (FGN) launched an initiative as part of the Economic Sustainability Plan (ESP) to achieve the roll out of 5 million new solar-based connections in communities that are not grid connected. The Solar Connection Intervention Facility will complement the Federal government's effort of providing affordable electricity to underserved rural communities in Nigeria. and the Incentivization of the creation of 250,000 new jobs in the energy sector.

7.3.4 Business Cluster Job Creation Potentials

Job creation potential exists from both primary and secondary sources data sources exist across the various business clusters in the study priority sectors for Nigeria, job creation potential exists from both primary and secondary sources data sources.

Energy: In the Energy sector. A job survey for the decentralized renewable energy (DRE) sector in Nigeria by PowerforAll with support from the Rockefeller Foundation & Schneider Electric Foundation shows that the DRE sector accounted for 13,000 direct formal and informal jobs in 2017-18, already 30% more than Nigeria's electricity, gas and steam sectors combined, and that number is expected to increase to 76,000 in 2022-23. This does not include "productive use" jobs — new retail businesses or agriculture processing — created within the communities gaining access to electricity, which could be up to 5 times greater.



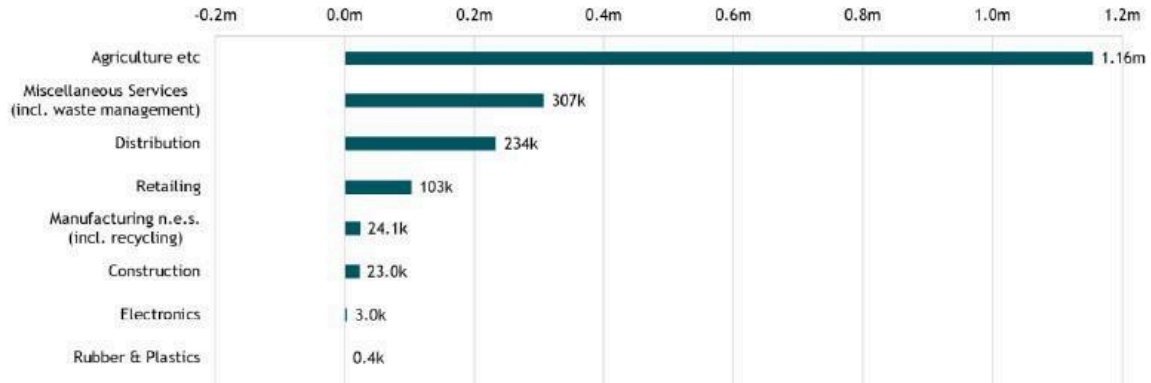
Nigeria's Solar Power Naija project, implemented by the Rural Electrification Agency under the Federal Ministry of Power and Steel, seeks to create 5 million new solar-based connections in communities that are not grid-connected. This has the potential to incentivize the creation of 250,000 jobs in the energy sector.

AFOLU: Small and Medium Scale Enterprises (SMEs) in AFOLU priority sectors are clustered across Nigeria, it is estimated that there are currently about 37 million self-employed SMEs clustered under AFOLU. These SMEs owners are estimated to create about 1,160,000 jobs. Given the numerous challenges for MSMEs to grow out of informality, which include access to finance, technology, technical and business skills, lack of infrastructure and frequent impacts from climate change.

Services: Waste and water under the services priority sector has also been established as a huge pipeline for the creation of jobs. Interview data from the leading entrepreneur in the waste value chain shows that aggregated waste recycling can create 500,000 jobs in Nigeria. The Netherlands Enterprise Agency recently estimated that e-waste within Lagos and Ogun states is capable of generating 100,000 jobs.

IPPU: The IPPU sector with a focus on construction will also generate significant employment. According to a modest estimate in the 2020 Circular Economy in Africa Nigeria Country Report, 23,000 jobs can be created.

In summary, job creation potential in Nigeria's circular economy across the priority sectors is enormous. The 2020 Circular Economy in Africa Nigeria Country report shows that an additional 1.9 million jobs will be created by 2030. The study further highlights that AFOLU will be the highest generator of these forecasted jobs. The bar chart (Figure 7.23) summarizes these job creation potentials.



8. Energy and Waste Efficiency Analysis

Highlights

Energy and waste efficiency are critical to attaining a circular economy in Nigeria. This makes providing insights into the energy and waste efficiency a precursor for gauging Nigeria's status for vital interventions. Energy efficiency analysis across different sectors of the economy reveal a high energy demand that is disproportionate to the supply of energy for socio-economic development. The energy demand projection analysis carried out by the Energy Commission of Nigeria (ECN) for by 2030 reveals high prospects for increased energy demand and utilization. However, the energy sector is grossly challenged by the prevailing cultural, socio-economic, and political dynamics that manifest to weaken existing institutional and legislative frameworks that create inefficient energy use-levels. Other associated challenges include the high cost-intensive status of energy infrastructure in the country, prevailing poverty, and the absence of political support for energy efficiency.

Current status

Waste from plastic in Nigeria is challenged by its poor disposal methods with attendant environmental implications. The existing vast opportunities for Natural Capital and Circular Economy in the Packaging industry provided viable platforms for sustainable investments in the development of biodegradable alternatives for waste efficiency.

Energy efficiency is pivotal towards the transition to green energy. Several policies have been put forward to support the development of Nigeria's circular economy roadmap. An energy demand projection analysis has been carried out using an energy demand model. It is expected to transform the country's current energy status to a sustainable energy driven industrialized nation by 2030. All viable economic sectors have been identified and strategies for enhancing sustainable energy efficiency in these sectors have also been highlighted. In addition, the Federal Government through partnership with some ministries and parastatals have identified several green programs that would enhance green energy efficiency, some of which include, The Abuja Centenary City, The Nigerian Clean Energy Access Program, Energy Efficient Housing Scheme and The Abuja Green City.

Recommendations

The following are recommended for achieving energy efficiency in the country:

1. Regulatory institutions such as Nigerian Customs, SON, MAN, ECN, NESREA, etc. should be strengthened with technical and financial capacities to enforce the prohibition of the importation, manufacture, and use of sub-standard equipment
2. The transition of informal private sector businesses to the formal sector should be facilitated with the relevant incentives.
3. Tax waivers should be provided for importers of energy efficient equipment in the short term as well as for local manufacturers who should also be supported with technical and financial aid in the short and long term.

8.2 Introduction

The sustainable and efficient use of materials is a key condition for the successful implementation of a national Natural Capital - Circular Economy development strategy. In addition to this, energy use and waste generation are also important factors to consider when enhancing production efficiency, and an analysis of both can be carried out to reduce losses as part of a circular economy transition. Therefore, an analysis of the energy and waste efficiencies in certain sectors of the Nigerian economy was done, and the details have been stated in this chapter.

It should be noted that this energy/waste efficiency analysis cuts across different sectors of the economy, and the analysis is different from the information in the Energy and Services Chapters of this report which are reviews of the Energy and Services (Waste) sectors of the economy.

8.3 Energy Efficiency Analysis

Energy efficiency refers to reducing the amount of energy required to achieve the same services or task. Energy efficiency is pivotal to accelerating transitions to clean energy towards realizing global climate and sustainability goals as it makes available more energy for use. This is what informed successive policies on energy and energy efficiency.
Some of these policies include:

1. Renewable Energy Master Plan 2005
2. Revised National Energy Policy (NEP) 2013
3. National Energy master Plan (NEMP) 2014
4. National Renewable Energy and Energy Efficiency Policy (NREEEP) 2015
5. Nigerian Energy Support program (NESP) 2015
6. National Energy Efficiency Action Plans (NEEAP) 2016

The policies mentioned above shall be reviewed to ascertain relevant sections to support the development of Nigeria's circular economy roadmap. Insufficient supply of energy limits socio-economic & inclusive growth and has an adverse effect on the standard of living of urban and rural dwellers.

8.3.2 Energy demand and supply projections of Nigeria

Energy demand is largely driven by developing and industrializing nations' economic and demographic characteristics. The Energy Commission of Nigeria (ECN), based on the government's vision for industrializing Nigeria by 2030, carried out a full energy demand projection analysis. The analysis estimated the required energy levels for transforming Nigeria into an industrialized nation by 2030 using the Model for Analysis of Energy Demand (MAED).

The following growth scenarios were considered illustrating projections in energy demand and renewable energy supply which would reduce the use of fossil fuels, thereby enhancing the nation's natural capital:

1. Reference Growth Scenario
    a. GDP grows by an average of 7% per annum
    b. Manufacturing sector as the main driver of growth
    c. Manufacturing accounts for 15% of GDP by 2020 from 4% in 2011
    d. Consistent with the SDG objective of poverty reduction

2. High Growth Scenario:
    a. GDP grows by an average of 10% per annum
    b. Manufacturing contributes 22% to GDP by 2030 from 4% in 2011
    c. Nigeria is transiting from an agrarian economy to an industrializing nation
3. Optimistic Growth Scenario:
    a. GDP grows by an average of 13% per annum
    b. Manufacturing contributes 22% of GDP by 2030 from 4% in 2021
    c. Nigeria is transiting from an agrarian economy to an industrializing nation

8.3.3 Strategy and Policy Frameworks for Improving Energy Efficiency In Nigeria

The revised National Energy Policy (NEP) 2022 recognizes that energy use in all economic sectors has remained inefficient. It considers sectoral areas for effective, conservative, and efficient energy use: residential sector, industry, transportation, services/commercial sector, agriculture, and energy-efficient building designs. It further proposes different strategies for enhancing energy efficient sub-sector as highlighted below:

Short-Term

a. Strengthening existing institutional and legal framework for the promotion of energy efficiency and conservation.
b. Strengthening national, regional, and international collaboration on energy efficiency and conservation.
c. Adopting appropriate policy instrument-building standards/codes, mandatory labelling, mandatory energy audits, energy use disclosure, soft loans, tax credits, investment subsidies, etc.
d. Conducting comprehensive energy end-use analysis in various sectors of the economy.
e. Introducing energy audits in key sectors of the nation's economy.
f. Promoting education, information and public awareness campaigns on energy efficiency and conservation best practice.
g. Promoting the establishment of Energy Services Companies (ESCOs).
h. Launching a national Demand-Side Management (DSM) initiative.
i. Providing economic, fiscal, and financial incentives to promote energy efficiency in all sectors of the economy.
j. Promoting research, development and adaptation of internationally available energy-efficient technologies and measures.
k. Introducing energy efficiency awards in all sectors of the economy.
l. Increasing the share of green electricity by 1% every year on Year- to- year (YTD) basis.
m. Setting and enforcing targets about energy efficiency and conservation.
n. Establishing necessary guidelines and regulations on energy efficiency, conservation, consumption, technology, fuel mix, information gathering, etc.

Medium-Term

a. Reviewing, improving and continuation of short-term strategies.
b. Ensuring reduction of electricity generation, transmission, and distribution losses from the current level of 15-40% to less than 10% within five years.
c. Establishing an appropriate energy efficiency regulatory and legislative framework.
d. Establishing guidelines for energy efficiency best practices in all sectors of the nation's economy.

e. Designing and implementing Minimum Energy Performance Standards (MEPS) for equipment and appliances.
f. Designing and implementing appropriate mandatory labelling for all energy consuming appliances.
g. Ensuring the certification and accreditation of energy auditors and energy efficiency practitioners.
h. Integrating energy efficiency and conservation studies into curricula of educational institutions in Nigeria.

Long-Term

a. Reviewing, improving and continuation of medium-term strategies.
b. Replacing all incandescent light bulbs in every home, industry, institution and establishment in Nigeria with LEDs and other energy-saving lamps by the year 2025.
c. Achieving by 2025, the establishment of a broad range of equipment energy efficiency standards and labelling by 2025.
d. Reducing by 2025 energy-related greenhouse gas emissions by 15% of trial by 2030
e. Furthermore, the Federal Executive Council of Nigeria in May 2015 also approved the National Renewable Energy and Energy Efficiency Policy. Key objectives of the policy include:
   - To ensure the prudent exploitation of the nation's energy resources.
   - To enhance energy security and self-reliance.
   - To reduce the production cost of energy-dependent goods and services.
   - To reduce adverse impacts of energy utilisation on the environment.
   - To eliminate avoidable investments in energy supply infrastructure.

8.3.4 National Energy Efficiency Initiatives

Following the approval of the National Renewable Energy and Energy Efficiency Policy (NREEEP) in 2015 and through the present efforts from other partners and relevant Ministries, Department and Agencies (MDAs), the National Energy Efficiency Action Plans (NEEAP) identified some programs planned by the Government to enhance energy efficiency in the country which include the following:

Energy Efficient Housing Scheme: the objective of this scheme is to promote energy efficient housing. This is to deliver energy effective and efficient housing, resulting in low energy consumption and ultimately lowering carbon emission.

The Abuja Green City: The Abuja Green City is a concept of the Renewable Energy program of the Federal Ministry of Environment, together with Green Carbon Afrique Creation Environmental Services and Integra Integrated Renewable Energy Services. The low-carbon development uses a combination of local electricity generation, improved insulation, and energy-efficient devices for the apartments.

Abuja Centenary City: Being planned by an investor from the Gulf and designed by Julius Berger International, this city will feature an array of sustainable measures, renewable energy sources, energy-efficient mechanisms.

The Nigerian Clean Energy Access Program (NCEAP): in line with the quest to reduce the global impact of climate change and as part of the solution to the epileptic power supply in Nigeria, NCEAP plans to distribute 150 million bulbs over the next five years under the Clean Development Mechanism (CDM).

This is part of the Federal Ministry of Environment's initiative to ensure the private sector drives energy efficiency.

8.3.5 Energy Efficiency – Private Sector Opportunities

1. Construction and erection of energy efficient buildings and infrastructure with increased flexibility that would incorporate modern green technology
2. Fabrication, importation, sales and maintenance of energy efficient equipment and gadgets.
3. Training of experts who will undertake the various roles in the energy efficiency value chain.
4. Consultants are required in various energy efficiency fields such as energy audits, advisory services, proposals development, capacity building workshops for government MDAs, private sector, and general public etc.
5. Financial institutions and venture capitalists can package various investment instruments for energy efficiency-focused businesses to ensure funding is available and accessible.
6. PPPs can be established as a result of a collaboration between the private sector and regulatory institutions to verify and validate locally manufactured and imported energy equipment and gadgets.

8.3.6 Recommendations

1. Regulatory institutions such as Nigerian Customs, SON, MAN, ECN, NESREA, etc. should be strengthened with technical and financial capacities to enforce the prohibition of the importation, manufacture, and use of sub-standard equipment
2. The transition of informal private sector businesses to the formal sector should be facilitated with the relevant incentives.
3. Tax waivers should be provided for importers of energy efficient equipment in the short term as well as for local manufacturers who should also be supported with technical and financial aid in the short and long term.

The table 8.1 illustrates the estimates for the energy that could be derived from waste from 2020-2030. The estimates were calculated using the relations:

A. Waste generation

$$G_{T\,i} = G_{Ri} * 10^{-3} * Pi * 365$$

where,

- $G_{T\,i}$ is the total waste generation in year i (ton/annum)
- G_{Ri} the per capita rate of waste generation in year i (kg/person/day)
- P_i is the population of the country in year i.

B. Energy generated from waste

$$E = 0.051[F + 3.6(CP)] + 0.352(PLR)$$

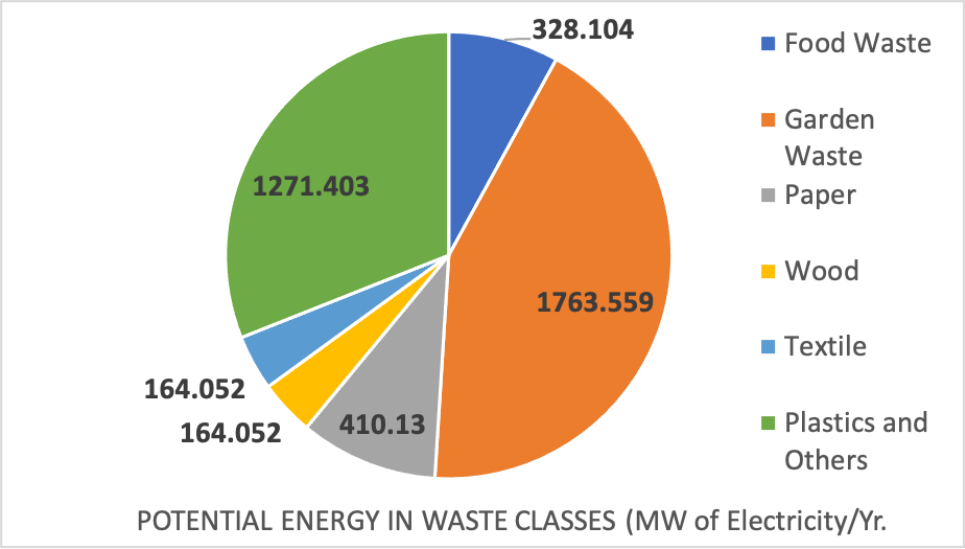
where,

- *E* is the energy content of the waste in MJ/kg
- *F* is the fraction of Food/garbage in the waste (%)
- *CP* is the fraction of Cardboard and Paper in the waste (%)
- *PLR* is the fraction of Plastics in the waste (%)

It was estimated that in 2020, 23.96 million tons of waste would be generated which would lead to the generation of 4101.3MW of electricity. This is expected to increase annually as the population increases.

Table 8.1: Estimates of Energy Value of Waste [113]

Year	Projected Population	Range of Quantity of Waste (Million ton/yr)		Range of Electricity Generated (MW of electricity per yr)	
		Min	Max	Min	Max
2020	197	38.69	40.09	2939	3046
2021	202	39.875	41.455	3029	3150
2022	206.7	41.079	42.845	3120.3	3255.7
2023	211.4	42.283	44.235	3211.6	3361.4
2024	216.1	43.487	45.625	3302.9	3467.1
2025	220.8	44.691	47.015	3394.2	3572.8
2026	225.5	45.895	48.405	3485.5	3678.5
2027	230.2	47.099	49.795	3576.8	3784.2
2028	234.9	48.303	51.185	3668.1	3889.9
2029	239.6	49.507	52.575	3759.4	3995.6
2030	244.3	50.711	53.965	3850.7	4101.3
2031	249	51.915	55.355	3942	4207
2032	253.7	53.119	56.745	4033.3	4312.7
2033	258.4	54.323	58.135	4124.6	4418.4
2034	263.1	55.527	59.525	4215.9	4524.1
2035	267.8	56.731	60.915	4307.2	4629.8



8.4 Waste Efficiency Analysis

This section analyses the waste efficiency of the selected sectors: Energy, AFOLU, Industries, Services (with sub-sectors of Water and Waste) sectors. It goes further to make recommendations on how to harness these opportunities. A framework was developed based on a modified version of the UNDP/UNCHS Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries. It could be used in various sectors to undertake subsequent and periodic improvements in their waste and material efficiencies using available relevant information collected. The plastic packaging, e-waste, organic waste, and the built environment industries were used as case studies representative of these sectors and therefore analysed.

Based on the development strides in Nigeria and the accompanying industrial activities since the 1950s, large amounts of losses and waste have been generated in the Nigerian economy due to the absence of certain relevant technical and administrative procedures required to optimise production in various sectors.

To address this challenge, circular economy measures and natural capital-oriented processes can be incorporated to enhance productivity, increase efficiency, and decrease losses throughout the lifecycle of products in the Nigerian economy. To address this challenge, circular economy measures and natural capital-oriented processes can be incorporated to enhance productivity, increase efficiency, and decrease losses throughout the lifecycle of products in the Nigerian economy. Figure 8.1 above shows the potential energy in waste classes measured in megawatts of electricity per year. These are huge opportunities that Nigeria could tap into to supplement her current energy deficits.

8.5 Background of Nigeria's Waste Efficiency

Manufacturing activities in Nigeria commenced around the mid-1950s with international organisations that previously carried out small and large merchandise transactions, establishing production firms focused on products for consumption by the general population. The motivation behind this industrialization was to utilise the abundant human and natural capital to create wealth for the Government, home-grown entrepreneurs, and multinational companies. The agricultural sector was the country's key sector, and its impact on the national economy reduced after the political independence in 1960 with the discovery of crude oil.

Energy plants in Ughelli and Kainji were then established to provide power supply with an oil refinery, and commercial enterprises followed soon after. Over the years, National Development Plans have been developed to utilise materials within the country to stimulate industrial growth with policy frameworks and initiatives developed to achieve the goal [43]. However, poor maintenance, which is a synergy of methodological and clerical activities to optimise the workability of a product or system, has hurt Nigeria's ability to achieve its developmental objectives leading to productivity failures, and these include material losses [129].

In 2018, Nigeria generated 2,370,000 million tonnes of packaged plastic waste, [69] produced approximately 450,000 tonnes of e-waste in 2019, [72] and generated up to 40% food waste from its total agricultural production [2]. These are huge amounts of waste that have a detrimental effect on the health of Nigerian citizens and pollute the various components of the natural environment. Inefficiencies resulting from material losses during production may be caused by discarded materials, valuable fragmented by- products, ruined items, and sub-standard materials in the production process. These losses may be because of low-quality raw materials used, unskilled workforce, lack of proper maintenance regimes, incorrect application of machinery, defective designs, absentee overseers, nonchalant scrutiny, and inhospitable working environment [130].

The consequence of utilizing resources throughout the lifecycle of a product and the production of the resultant wastes is a major strain on the environment. Therefore, strategies must be put in place to enhance resource efficiency, reduce waste generation, and convert waste into a valuable resource [131]. The introduction and implementation of circular economy processes will increase overall efficiencies through processes that aim to reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover materials across the lifecycle of the key products in the industries of different sectors in addition to redesigning products, retraining personnel, and standardizing produced goods. This will consequently lead to increased profitability, expansion in business outlets and reduced pressure on natural capital resources.

8.6 Waste Efficiency Analysis of Representative Focus Industries

The analysis of the waste efficiency in representative focus industries (Packaging, Electronics, Food Systems and Built Environment) is presented in Appendix 25. The table highlights the major stakeholders of each value chain, their waste production processes, losses during production, types of waste and waste disposal techniques. These industries have been selected because they are recognized for producing significant waste.

8.6.2 Packaging: Plastic Waste

The use of plastics as a packaging material (due to their unique mechanical properties) is common practice in Nigeria. Various sectors utilise it as the preferred choice for containers and vessels for various substances. Table 8.2 shows the proportion of the different packaging materials used in Nigeria; plastics take a whooping 60% of the total. Therefore, a case study for plastic materials is being used to represent the packaging industry.

Table 8.2: Distribution of Packaging Materials used in Nigeria in 2016 [132]

Characteristic	Proportion of Packaging Material
Glass	5%
Metal	10%
Paper	25%
Plastic	60%

When extracting raw materials from their natural state for plastic production, water losses are experienced due to a large amount of water required and wasted. Polluted wastewater from extraction

facilities is released into the environment poisoning the environment and the water table after fracking processes (during oil extraction) have taken place.

There is a likelihood of oil spills that can damage the environment, leading to acid rain, land contamination, and biodiversity losses due to water, land, and air pollution. The release of GHGs into the atmosphere during petroleum processing also contributes to global warming and climate change. There are also high risks of incidents of loss of lives and Lost Time Incidents (LTIs) in addition to adverse health effects during the mining and extraction of these raw materials.

There are also material losses that occur during the production of plastics and packaging products. They involve processes such as compression moulding, extrusion, thermoforming, casting, etc., in which materials are discarded.

When plastics and packaging are used and discarded, the losses generated include the material losses of recyclable plastics that are not properly collected, sorted, and recycled; unrecyclable plastics discarded without energy recovery, loss of land for use as landfill sites, loss of habitats in the land and aquatic environments due to indiscriminate disposal of plastic wastes, and loss of good quality air due to the open burning of plastic wastes.

Packaging Opportunities & Recommendations

Table 8.3 below details the opportunities and recommendations for Natural Capital and Circular Economy in the Packaging industry.

Table 8.3 Packaging: Opportunities & Recommendations

Natural Capital	Circular Economy
Investments can be made in the development of biodegradable alternatives to plastics such as eco-friendly bags, glassware, beeswax bags, glass jars, cotton bags etc. PaperBags by Ebees is one of such products based in Lagos.	Investments can be made in the development of biodegradable alternatives to plastics such as eco- friendly bags, glassware, beeswax bags, glass jars, cotton bags etc. PaperBags by Ebees is one of such products based in Lagos.
	Renewable energy installation companies should be established to provide sustainable energy solutions to packaging firms to ensure electricity stability.
Waste-to-energy schemes can be established close to waste generation sites, converting plastic waste to energy to reduce landfill sites	Waste-to-energy schemes can be established close to waste generation sites, converting plastic waste to energy using techniques such as pyrolysis. A Nigerian firm undertaking this is Pyro-Oil Nigeria Limited, located in Kano.
Entrepreneurs should be encouraged to engage in the sales, maintenance, and repair of modern packaging equipment, which are more efficient and consume fewer resources (water, materials, energy) at various locations in the country.	Resource efficiency consultancy businesses can be developed which would plan and advise businesses and organisations on efficiency: reduction, repurpose, reuse of resources across the lifecycle of packaged products.
	Training institutes and schools should be established to train the necessary manpower required in sustainable packaging processes and standard HSE practices to reduce human, material, and energy losses.
	Reuse, repurpose and recycle plastic waste for use as existing products or as new materials such as brooms, brushes, furniture fittings, and for in other sectors such as construction etc.

	Profitable small, medium, and large-scale waste management businesses can be set up to circularize waste materials from production companies and consumers.

8.6.3 Electronics: E-Waste

There are internal and external origins of electrical and electronic waste generated from used products in Nigeria [18]. However, it is also important to highlight the waste materials and activities in the earlier stages of electronic lifecycles to increase efficiency throughout the production process.

Raw materials extraction losses include water losses and water pollution after the mining of minerals and loss of land areas and clean air that have been contaminated because of released effluents ad particle emissions from the associated activities. There are also biodiversity losses as habitats of various living organisms are disrupted during mining as undesirable particulate matter, toxic materials, and chemicals released into the land, air, and aquatic environments are harmful to humans and wildlife.
The production of electronics gives rise to material losses in the form of unused materials of cables, wires, insulators, casings, silicon wafers, chips, memory boards etc. Some of these materials have been highlighted in Table 8.4.

When electronics are used and improperly disposed of, precious metals and useful material losses are encountered. In addition to this, there is a loss of land resources due to landfill sites and health hazards based on the release of POPs and other toxic materials during disposal and improper processing of e-waste.

Table 8.4: Electronic components and their Materials [133]

Electrical/Electronic component	Component Materials
Computers	Lead, mercury, cadmium and beryllium
Batteries	Cadmium, cobalt, lead, lithium, mercury, nickel silver, and zinc
Mobile phones	Lithium, copper, tin, cobalt, indium, antimony, silver, gold, and palladium
Photocopiers	Mercury, selenium
Circuit Boards	Silver, lead, copper, cadmium, brominated flame proofing agent, PCBs (polychlorinated biphenyls) and arsenic
Light Emitting Diodes (LEDs)	Arsenic
Cathode ray tubes	Cadmium, lead
Liquid Crystal Displays	Mercury

E-waste Opportunities & Recommendations

Table 8.5 below details the opportunities and recommendations for Natural Capital and Circular Economy in the E-waste industry.

Table 8.5: E-waste: Opportunities & Recommendations

Natural Capital	Circular Economy

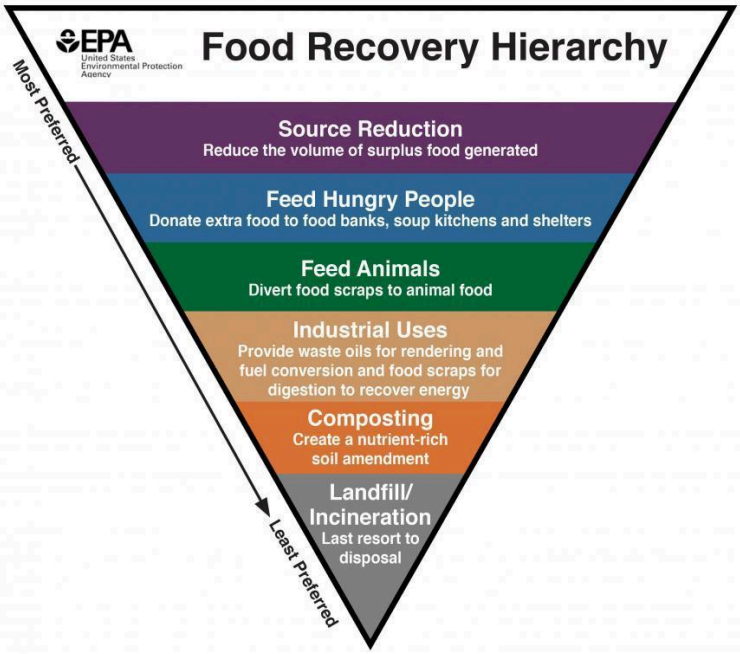
PPPs can be formed as collaborations between the private sector businesses, relevant regulatory authorities, and foreign manufacturers to regulate the electronics market and ensure standards are maintained using non-hazardous electronic materials only.	PPPs can be formed as collaborations between the private sector businesses, relevant regulatory authorities, and foreign manufacturers to regulate the electronics market and ensure standards are maintained using non-hazardous electronic materials only.
Individuals and organisations can develop skills in proposal writing and partner with e-waste businesses to apply for grants at an agreed fee given the high level of interest in the sector and the impact of POPs on humans and the environment.	Individuals and organisations can develop skills in proposal writing and partner with e-waste businesses to apply for grants at an agreed fee given the high level of interest in the sector and the impact of POPs on humans and the environment.
Training institutes with a specialist on the extraction of minerals can be established to train and build the capacity of certified miners and raw minerals extractors who will undertake sustainable extraction processes.	Individuals can be trained to become Resource Consultants who would advise organisations of efficient measures to optimise resources during electronics' extraction and production stages.
Investments can be made in the sales, repairs and maintenance of equipment used to extract necessary minerals and raw materials.	Small, medium and large-scale waste management businesses can be created to collect and sort defective materials such as silicon microchips during production and e-waste disposed of after use.
	E-waste processing businesses can be established to acquire e-waste for reuse, repurpose and recycling and subsequent sale of processed products and parts.
	There are opportunities for E-waste Training Consultants to carry out technical training and certification of e-waste recyclers on efficient and safe practices.

8.6.4 Food Systems: Organic Waste

Inefficient agricultural activities result in huge crop losses and waste, discarding useful animal dung and waste, and water losses that are not recycled and reused for further farming activities.

More losses are generated when agricultural products are processed as a lot of water and energy is required to process various food items and products; food losses occur due to the absence of effective storage techniques. Food wastes are by-products of agricultural processing. A Food Recovery Hierarchy (Figure 8.2) has been proposed for tackling this challenge and utilizing excess food waste appropriately to ensure it is optimised.

In addition to food waste, agro-waste such as animal waste (dung, carcasses) and crop waste (stalks, pruning, chaff, husks, fronds) can also be collected and utilised instead of discarded.



Organic waste: Food Systems Opportunities & Recommendations

Table 8.6 below details the opportunities and recommendations for Natural Capital and Circular Economy in the Organic Waste industry.

Table 8.6: Organic Waste: Opportunities & Recommendations

Natural Capital	Circular Economy
Certified businesses which create engineered landfills at designated sites in various communities can be established. These can work with local planning authorities to categorise sites for different uses.	Waste-to-energy schemes can be developed to provide energy for surroundings settlements. These can be located at markets & commercial centres where organic waste is frequently generated and supplied to communities that would pay for the energy service.
	Compost facilities and animal feed businesses can be established at large farms and markets where agricultural waste from crops, livestock and food items can be processed into manure and fertilizer and sold to the general public.
	Resource Consultants who can advise agricultural firms and individuals on the utilisation and reuse of resources such as water, energy, and other materials across the lifecycle of agricultural products.
	Agricultural processing businesses can be established to convert agricultural raw materials into processed foods and products. This industry may also utilise renewable energy resources to provide the power supply.
	Renewable energy providers would be a feasible business that would supply electrical

	power, heating, and cooling to various segments, from farm processes to recycling activities.
	The development of biorefining fruit waste schemes which will retrieve useful fruit waste parts like succinic acid which can be obtained from orange peels, lycopene which can be collected from tomato peels etc. These extracted substances can be harnessed for other uses or sold to generate income.
	NGOs can be created with various niches to tackle issues such as child labour, food waste awareness, eating habits/healthy eating, etc. These NGOs can apply for funds from donor agencies for education sponsorship, incentives to parents/guardians, food waste awareness etc.
	Agricultural storage businesses are viable and should be promoted for storing agricultural food items for a fee, thereby preserving them for subsequent sale and transportation. These facilities may utilise renewable energy resources to provide electricity for drying and freezing food items.

8.6.5 Built Environment: Construction Waste

As Nigeria's economy grows, it is hoped that its industrial landscape will expand to cater to the corresponding demand for materials in various sectors. An effective waste management system is therefore essential to cope with the associated industrial waste generated.

Using the Built Environment industry as a case study, the results showed that there are water losses during the extraction of raw materials because of excessive usage and also pollution from water released as effluents. Parcels of land, water bodies, and surrounding air are also contaminated due to the release of particulate matter, which contributes to the loss of biodiversity. Unhealthy practices also lead to Loss Time Incidents (LTIs) and health issues among workers who undertake the raw material extraction process.

Material losses are also experienced during product manufacturing, whereby defective substances are not recycled but discarded as waste.

In addition to these, losses that will occur after the products are used include material losses due to the disposal of relevant used and unused materials at sites, loss of land used for waste disposal sites, and loss of habitat of fauna and flora in the local environment.

Industries: Built Environment Opportunities & Recommendations

Table 8.7 below details the opportunities and recommendations for Natural Capital and Circular Economy in the Built Environment industry.

Table 8.7: Built Environment: Opportunities & Recommendations

Natural Capital	Circular Economy
Businesses should be encouraged to develop innovative products using indigenous substances as alternatives to conventional materials used for building and construction. Examples include clay as a material for modern bricks, kitchenware, furniture etc.	Businesses should be encouraged to develop innovative products using indigenous substances as alternatives to conventional materials used for building and construction. Examples include clay as a material for modern bricks, kitchenware, furniture etc.
Water recycling businesses will be viable where wastewater from mineral extraction processes can be reused on-site or distributed to surrounding settlements for other purposes.	Water recycling businesses will be viable where wastewater from mineral extraction processes can be reused on-site or distributed to surrounding settlements for other purposes.
The sale, maintenance, and repairs of modern tooling and equipment for use during mineral extraction and manufacturing would be profitable as materials efficiency would be increased, and costs would be reduced.	Sustainable waste management businesses can be established to collect, reuse, repurpose and recycle waste for use as existing products or as new materials used in other sectors. These waste materials would be acquired from material effluents during construction and product manufacturing.
Businesses involved in landfill development and landfill recovery can be created to develop landfill sites at designated locations and reclaim landfill sites where land resources are required for other future developments.	Entrepreneurs can undertake the training and certification of technicians, artisans and builders in efficient methods and practices to reduce material losses, which would then be preferred to other personnel in the industry.
	EPPPs can be established with businesses partnering with regulatory authorities to enforce sustainable waste management practices and reduce biodiversity losses. The aim would be to reach all geographical locations where regulatory authorities do not have any presence there and the business would charge a fee for these services.
	Waste-to-energy schemes can be established using construction and demolition waste as feedstock. This can then provide energy services for targeted communities.

9. Stock-Taking, National Capital Accounting (NCA) & Planning

Highlights

Current status

The Chapter discusses the link between natural capital and the circular economy, particularly in the context of Nigeria's natural ecosystems. The study highlights the country's diverse ecological zones and rich natural capital assets, ranging from rainforests to mangrove forests and grasslands. However, data shows that Nigeria's natural capital stock has been steadily declining. For example, the forest area has decreased significantly, with an increase in the average annual deforestation rate. The decline of mangrove forests is attributed to factors such as overexploitation, urbanization, and crude oil exploitation.

The Nigerian government is taking steps to mainstream Natural Capital Accounting (NCA) into national development policy and planning, with a focus on promoting the circular economy (CE) and green growth initiatives. Several key policies and regulations have been introduced to support this integration. Some of them are:

1. Economic Recovery and Growth Plan (2017)
2. Draft National Policy on Plastic Waste Management (2020)
3. E-waste initiative
4. Extended Producer Responsibility (EPR) policy
5. National Biodiversity Strategy and Action Plan (2016-2020)
6. Natural Capital Protocol (NCP)

Despite the relative novelty of CE models and NCA in Nigeria, the government aims to build capacity for implementing the System of Environmental and Economic Accounting for Ecosystem Accounts (SEEA EA) and demonstrate its benefits to policymakers.

Challenges/Limitations

There is no collective national framework for Natural Capital Accounting and Assessment (NCAA) in Nigeria CE models and concepts are relatively novel in Nigeria with limited formal uptake. Policies developed around waste management and environmental protection serve as a starting point.

Recommendations

To develop a National Natural Capital Strategy (NNCS) in Nigeria, it is important to identify gaps in stakeholder engagement, establish institutional mechanisms, build a national natural capital database, and assess low-carbon development options. The strategy should prioritize reducing resource wastage, transitioning to a circular economy, and incorporating natural capital and ecosystem services accounts into sector policies and plans. Additionally, changing consumer behavior is crucial for a successful circular economy, and efforts should be made to raise awareness, provide certifications, and incentivize the adoption of green products.

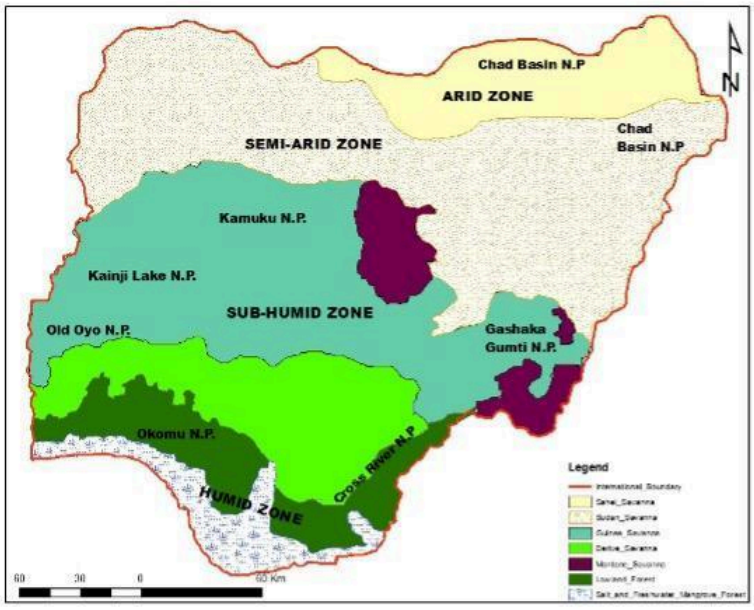
9.1 Natural Capital Accounting and Circular Economy

An understanding of the link between natural capital and circular economy is essential to assessing natural ecosystems' contributions to the economy and also helps to gauge the reliance of the economy on natural systems and track changes in natural systems that may have implications for industries. Natural capital accounting promotes the management of natural resources and ecosystems to ensure their economic benefits are sustained into the future. Policy decisions on poverty reduction, investment, economic growth, and environmental management are increasingly sensitive to natural resource values, scarcities, and deterioration [134].

A standard framework for natural capital accounting, such as the System of Environmental and Economic Accounting (SEEA) developed by the United Nations and partner organisations, describes several categories of natural capital accounts. One of these, ecosystem accounts, tracks the extent and condition of ecosystem assets and the flows of ecosystem services they provide to people and the economy. On the other hand, "Circular Economy" approaches follow a tradition that is well established in the field of sustainability, emphasising performance metrics and accountability. Substantial efforts are underway to make Circular Economy practises more quantifiable, and there are many analytical tools available to support organisations in identifying opportunities to reduce or close waste flows, set targets, and monitor progress. Measurement is essential in helping to build Circular Economy models and assess their impact. The Measuring, Reporting and Verification (MRV) system thus provides the tools that track progress towards achieving NCA and CE-related goals.

9.1.1 Natural Capital Assets and Asset Condition in Nigeria

Nigeria has seven (7) major ecological zones, which illustrate the existing natural capital assets. From the Lowland Rainforest to the Mangrove Forest and Coastal Vegetations, the Derived Savanna to the Sahel Savanna, the Sudan Savanna to the Freshwater Swamp Forest and the Guinea Savanna, Nigeria is blessed with an abundance of natural capital assets. However, data shows that the national natural capital stock has been steadily declining. Figure 9.1 shows the 7 ecological zones in Nigeria.



The tables (9.1 and 9.2) highlight the indicators of declining stocks of natural capital (forest and biodiversity) culled from the World Bank's (2007 and 2017) [135] [136]. Little Green Data Book on the state of forest and biodiversity in Nigeria. Comparatively speaking, in 2007, the total percentage of forest area to land was 12.2%, which shrunk significantly to 7.7% in 2017. This represents a 36.9% decrease in the forest area between 2007 and 2017 to the total percentage of land area. Table 9.1 also shows an increase in the average annual deforestation rate from 2.4% in 2007 to 4.1% in 2017. This reflects a 70.8% increase in the average annual rate of deforestation within Ten (10) years.

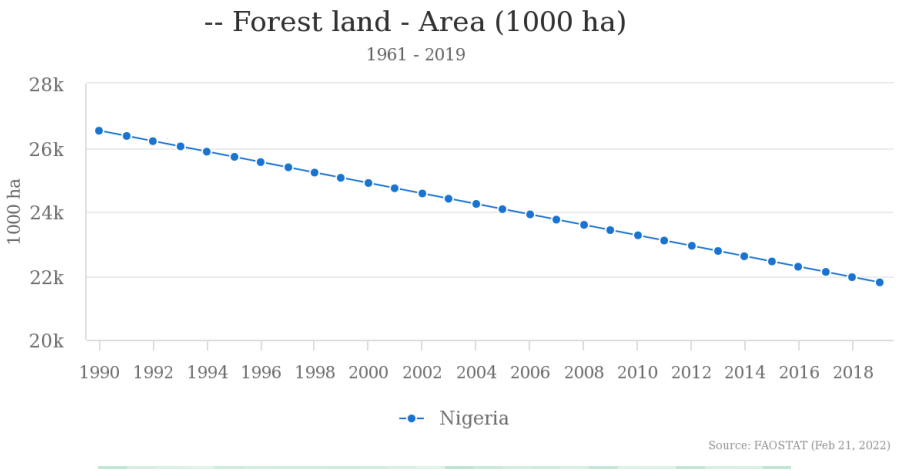
Table 9.1: Change in Forest to Land Area [135] [136]

Forests	2007	2017
Forest area (% land area)	12.2	7.7
Deforestation (avg. annual %)	2.4	4.1

Table 9.2: Change in Biodiversity Status [136] [137]

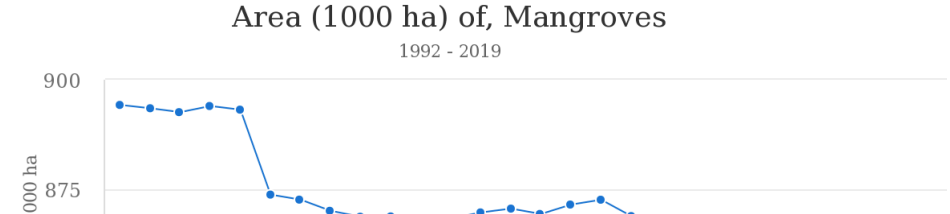
Biodiversity	2010	2017	% Increase
Threatened species mammals	27	29	7.4%
Threatened species birds	12	21	75%
Threatened species fish	21	71	238%
Threatened species higher plants	171	197	15%

Figure 9.2 portrays the rapid decline in forest lands from 1961 to 2019, further supporting the fact that the natural capital stock of forests in Nigeria is in great danger.

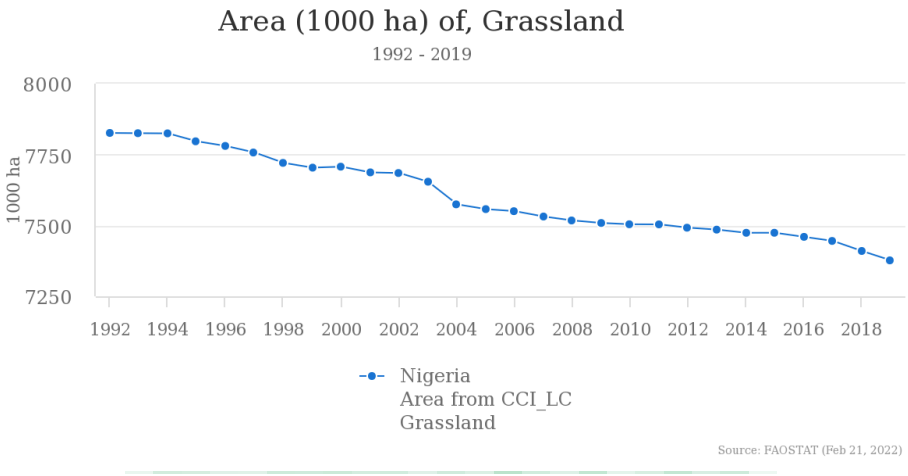


The status of Nigeria's fresh and saltwater mangrove ecosystems is also on the decline. Figure 10.3 shows the trend in the decline of the area covered by mangrove forests in Nigeria from 1992 to 2019 (from about 890,000ha to 860,000ha). The rapid decline in its biomass comes from over exploitation, urbanisation and, most especially, crude oil exploitation by the oil and gas industry across the nation's coastal ecosystem.

Mangrove Forests are very important because not only are they the earth's natural filter of saltwater and toxic material, but they also stabilize the shores by creating a buffering system against the energy of waves, thereby reducing the effects of erosion. Mangroves also provide breeding grounds and shelter for biodiversity. Figure 9.3 shows the decline of mangroves in Nigeria from 1992 to 2019.



In the northern fringes of Nigeria, the process of desertification is ongoing [135] & [137]. The direct causes of desertification stem mostly from drastic reduction and destruction of the perennial plant cover, especially trees, and simplifying the vegetation structure. Figure 9.4 shows the decline of grasslands in Nigeria from 1992 to 2019.



Management Regime of Different Forest types

From the NDC, Nigeria proposes to reduce emissions by 20% with national resources and 45% with external financial assistance. **In the forest sector, 20% of the annual emissions is approximately 32,397,230 tCO2e/year, which is 6.5 million tCO2e each year up to 2030, through emission reductions and enhanced removals.** Based on this, the forest sector seeks to deliver GHG emission reductions and enhanced removals equivalent to approximately 65 MtCO2e by 2030 through the implementation of REDD+ strategies and programs and other initiatives. Table 9.3 provides the target area for protection and restoration.

Table 9.3: Carbon Emission Reduction, Removal and Area Targets till 2030

Mitigation Action	Carbon Emission Reduction Target Including Enhanced Removals in Brackets (Mt CO2e)2	Area Target
Improved natural forest management	25 (7.5)	108,305 ha of natural forests in the southern belt and southwest quadrant of the country.
Forest restoration	23 (6.9)	99,640 ha of degraded forest area across the states in the southern belt, southwest quadrant and in states located in the savanna ecological zone of the country.
Increased forest protection	10 (3)	43,322 ha of forest throughout the country.
Reduced fuelwood harvest	4 (1.2)	Reduce the area of forestland used for fuelwood harvesting by 17,329 ha.
Protection and restoration of mangrove forest ecosystems	3(0.9)	12,997 ha of mangrove ecosystems across all the coastal states in the Niger Delta.
TOTAL	**65**	

9.1.2 Case Study of Value of Natural Capital Assets in Nigeria

As stated above, there is no collective national framework for Natural Capital Accounting and Assessment (NCAA) in Nigeria; however, some projects that relate to NCAA have been carried out on micro-levels. These range from the valuation of water assets to forest carbon, nature tourism and non-renewable items such as plastics. The indicative monetary value of selected natural capital assets is highlighted in tables 9.4, 9.5. The features of natural capital accounting are excluded from the data presented in Tables 9.4 and 9.5; as such, they do not present the typical natural capital accounting table. The information provided in this section and the section dealing with MRV for NCAA could be utilised to gauge the role and valuation of natural assets in development planning decisions and can further be leveraged to build a natural capital accounting framework for Nigeria.

Monetary Value of Water Assets: Case Study of 5 LGAs in Benue State.
Table 9.4 shows an example of water asset value from five local government areas in Benue State. It reveals that the average consumption of water per person per day is 9 litres. This translates to 45 litres per household per day. At 80 kobo per litre of water, an estimated Two (2) Billion Naira could be generated annually. States, Local governments, and the private sector could be made to harness significant revenue from water resources where appropriate policy frameworks are put in place.

Monetary Value of Forest Carbon
Another example of NCA is seen in table 9.5, where the monetary value for carbon was calculated using the ability/value of landscape and trees to promote green growth and conservation. The methodology for the calculation of Forest applied here is the Biome Average System. The farmer or Forester does not need high or advanced technology to estimate the potential revenue from his investment in plantations. This simple MRV method uses the principle of population as the key component for determining the unit measurement obtained from one tree. Measurement can be made using the volume of one tree by measuring the (DBH) Di and a metre at breast height and merchantable height to obtain the volume. The volume is now converted to biomass and then to carbon. An estimation of market carbon price may then

be evaluated on this basis. Table 9.5 highlights the value of forest carbon per acre of land using the land space and trees approach.

Table 9.4: Estimating value of water from 5 Local Government Area in Benue State. Source of Data: UNEP and Water Board Makurdi

Location	Population	No. of HH (P/5)	GWR (kobo)	Av per/pe a day	1 HH per day (Litre)	1 HH per month (Litre)	All HH Per day (Litre)	All HH per month (Litres)	All HH per month In Kobo	All HH per month In Naira	Total HH per Year in Naira
Otukpo	199,009	39,802	80	9	45	1350	1,791,090	53,732,700	4,298,616,000	42,986,160	515,833,920
Ado	184,389	36,879	80	9	45	1350	1659501	49785030	3,982,802,400	39,828,024	477,936,288
Agatu	115,597	23,119	80	9	45	1350	1040373	31211190	2,496,895,200	24,968,952	299,627,424
Apa	96,780	19,356	80	9	45	1350	871020	26130600	2,090,448,000	20,904,480	250,853,760
Buruku	206,215	41,243	80	9	45	1350	1855935	55678050	4,454,244,000	44,542,440	534,509,280

Key:

- AL = Average litre received per day (One unit according to UNICEF data as at 11 Nov., 2020 estimated that each Nigeria receive average of 9 litres per day.)
- HH = Household (1 household in Nigeria is defined by Population Commission as 5 persons)
- P = Population
- GWR = Government Water Rate

Calculation breakdown:

- 1 HH per day = (AL x HH) litres per day
- All HH per day (AL x HH) x P/5
- All HH per month in Kobo = (AL x HH x 30) x P/5) x GWR
- 1 HH per month= (AL x HH x 30) litres per month
- All HH per month (AL x HH x 30) x P/5
- All HH per month in Naira = ((AL x HH x 30) x P/5) x GWR)/100
- All HH per Year in Naira = ((AL x HH x 365) x P/5) x GWR)/100

Table 9.5: Calculating monetary value for carbon using land space and trees. Source of Data: Global Default Values

Method 1 (Use of Land space)	Method 2 (Use of Trees)
1 Tonne of a tree emits 3.67 tonnes of Carbon-dioxide. Average tonnes per Clear-cut harvest is 87 tonnes per acre.	1 Tonne of a tree emits 3.67 tonnes of Carbon-dioxide. Average tonnes per Clear-cut harvest is 87 tonnes per acre.
It is assumed that averagely, 87 standing trees can be found in 1 Acre.	It is assumed that averagely, 87 standing trees can be found in 1 Acre.
1 standing tree can emit 3.67 tonnes of Carbon-dioxide (Global default value).	1 standing tree can emit 3.67 tonnes of Carbon-dioxide (Global default value).
87 trees per acre = (87 x 3.67) = 319.29 tonnes of CO2-eper acre. For a land of 5 Acres the estimate of Carbon-dioxide will be; 319.29 x 5 = 1,596.45 tonnes of CO2-e in 5 acres of land.	87 trees per acre = (87 x 3.67) = 319.29 tonnes of CO2-eper acre. For a land of 5 Acres the estimate of Carbon-dioxide will be; 319.29 x 5 = 1,596.45 tonnes of CO2-e in 5 acres of land.
The international price for carbon is $3 per tonne and $1 is ₦411 at the moment of compiling this paper. Therefore $3 = 3 x 411 =N1233. For 1 acre the value in Naira is 319.29 tonnes of CO2e x ₦1233 = ₦393,684.57.	The international price for carbon is $3 per tonne and $1 is ₦411 at the moment of compiling this paper. Therefore $3 = 3 x 411 =N1233. For 1 acre the value in Naira is 319.29 tonnes of CO2e x ₦1233 = ₦393,684.57.
For 5 acres the value is; ₦393,684.57 x 5 = ₦1,968,422.85	To get the number of trees for 1 acre;

Estimation from 1 million acres = 393,684.57 x 1,000,000	(1,000,000 x 435) / 5 = 87,000,000 Trees
= ₦393,684,570,000	87,000,000 x 3.67 tons Co2e = 319,290,000 tons Co2e 319,290,000 tons Co2e x (411 x 3) exchange rate = 393,684,570,000 = **₦393,684,570,000**

The information presented in table 9.5 shows that a state government or private sector entities could invest in conservation if they can identify a market that will be able to harvest ₦393 billion from one million acres of land or approximately ₦2 million from 5 acres as shown in the table. Individual farmers can be encouraged to go into conservation as businesses by the government.

Monetary Value of Solid Minerals

Table 9.6 highlights both in-situ value and cumulative production value of solid mineral production in Nigeria as of 2018. Limestone granite and laterite account for 86% of cumulative total production value of solid mineral assets. Some of these minerals are being mined illegally and not accounted for in national production estimates.

Table 9.6: Summary of solid mineral production and their respective monetary value in Nigeria [139]

Minerals	Production	Value (in-situ)	Cumulative	Contribution	Cumulative contribution to production
TON (million)	**₦ (Trillion)**	**TON**	**%**	**%**	
Limestone	25.6	15,362,748,822.00	25,604,581.37	54.85	54.85
Granite	11.1	15,198,014,070.00	36,751,755.70	23.88	78.73
Laterite	3.5	2,090,138,250.00	40,235,319.45	7.46	86.19
Coal	1.9	4,774,532,125.00	42,145,132.30	4.09	90.28
Clay	1,752,047.07	700,818,828.00	43,897,179.37	3.75	94.03
Sand	1,486,133.61	1,188,906,888.00	45,383,312.98	3.18	97.21
Shale	1,026,279.23	513,139,615.00	46,409,592.21	2.2	99.41
Lead-Zinc	60,944.04	4,923,160,200.00	46,470,536.25	0.13	99.54
Manganese	58,666.32	586,663,200.00	46,529,202.57	0.12	99.66
Gypsum	39,051.61	195,258,050.00	46,568,254.18	0.08	99.74
Feldspar	26,409.39	79,228,170.00	46,594,663.57	0.06	99.8
Dolomite	23,664.40	23,664,400.00	46,618,327.97	0.05	99.85
Marble Concentrate	21,649.76	64,949,280.00	46,639,977.73	0.05	99.9
Silica Sand	12,059.18	9,647,344.00	46,652,036.91	0.03	99.93
Kaolin	10,428.80	26,072,000.00	46,662,465.71	0.02	99.95
Tin ore	4,656.63	1,176,172,500.00	46,667,122.34	0.01	99.96
Iron Ore	3,197.95	20,786,675.00	46,670,320.29	0.01	99.97
Calcite	3,167.67	1,900,602.00	46,673,487.96	0.01	99.98
Quartz	2,900.00	2,900,000.00	46,676,387.96	0.01	99.99
Talc	1,426.66	4,279,980.00	46,677,814.62	0.01	100
Columbite ore	1,299.80	519,920,000.00	46,679,114.42		
Mica	1,080.00	1,620,000.00	46,680,194.42		
Bentonite	120	600,000.00	46,680,314.42		
Zircon Sand	120	720,000.00	46,680,434.42		
Barite	82.5	660,000.00	46,680,516.92		
Kunzite	50	2,500,000.00	46,680,566.92		
Wolframite	50	50,000,000.00	46,680,616.92		
Copper ore	30	1,200,000.00	46,680,646.92		

Tantalite Crude	6.11	30,550,000.00	46,680,653.03		
Topaz	4.97	24,832,800.00	46,680,658.00		
Crystals Quartz	0.08	75,000.00	46,680,658.08		
Tourmaline	0.05	44,087,581.00	46,680,658.13		
Amethyst	0.02	104,960.00	46,680,658.15		
Gold concentrate	0.01	245,214,000.00	46, 680,658.16		
Aquamarine	2,067,400.00	46,680,658.16			
Bruit	0.08	70,000.00	46,680,658.16		
Garnet	10,000.00	46,680,658.16			
Sapphire	4,803,000.00	46,680,658.16			
	46,680,658.24	47,872,015,740.00			

The above case studies highlight the need to account for the value of ecosystem resources in social, economic, and ecological policy decisions.

9.1.3 Mainstreaming of (National Capital Accounting) NCA into national development Policy and Planning

CE models and concepts are relatively novel in Nigeria with limited formal uptake. Policies developed around waste management and environmental protection serve as a starting point [140]. Political ambition to reduce oil dependence could become a driving force behind a CE transition. Nigeria hopes to encourage and promote the development of green growth initiatives that relate to the circular economy.

Key policy and regulations include:

- Economic Recovery and Growth Plan (2017). Macro-economic stability and economic diversification away from dependence on oil. Mainstreaming CE principles into this plan could provide a clear vision for economic diversification in Nigeria.
- The draft National Policy on Plastic Waste Management (2020) lays the foundations for plastics and a CE. This policy is yet to be published.
- Steps recently taken to tackle large E-waste problem, including a CE initiative for electronic products in Nigeria, to increase the circularity of the E-waste sector.
- The country is implementing an Extended Producer Responsibility (EPR) policy based on international guidance. This can encourage the industry to shift to closed-cycle manufacturing and efficient take-back schemes for remanufacturing and recycling.
- The National Biodiversity Strategy and Action Plan (2016-2020). The goal of the NBSAP is to conserve and enhance the sustainable use of the Nation's biodiversity and to integrate biodiversity into National Policy and decision- making.
- The Natural Capital Protocol (NCP) is a decision-making framework that enables organisations to identify, measure and value their direct and indirect impacts and dependencies on natural capital. The NCP emerged in the private sector and was initially developed with an orientation toward users looking at the firm or project level. It consists of a series of questions or steps to be integrated into existing business operations. It is, therefore, best understood as a process for incorporating natural concerns into decision-making rather than as a set of accounting principles.

As the practice of natural capital accounting has grown in both the private and public sectors worldwide, there has been growing convergence and increasing opportunities for and interest in collaboration

between the NCP and SEEA communities. For example, the SEEA offers a framework that can provide useful data for businesses and serve as a model as the private sector seeks to move toward greater standardization of methodology. Conversely, the NCP can be an effective tool for a country's efforts to implement and expand its environmental-economic accounting programs.

Incorporating natural capital into national accounts can support inclusive development and better economic management. For example, land and water accounts can help countries interested in hydropower to assess the value of competing land uses and find the optimal solution. Ecosystem accounts can help biodiversity-rich countries manage the trade-offs between ecotourism, agriculture, subsistence livelihoods, and ecosystem services like flood protection. In this way, ecosystem accounting is a tool for maximizing economic growth while identifying who benefits and who bears the cost of ecosystem changes, helping governments gauge whether their growth is inclusive.
The challenge now is to build capacity for Nigeria to implement the SEEA and to demonstrate its benefits to policymakers to mainstream natural capital accounting in development planning decisions.

9.2 Current Experience of National Capital Accounting (NCA) in Development Planning in Nigeria

The System of Environmental and Economic Accounting for Ecosystem Accounts (SEEA EA) is an international statistical framework to guide the development of countries' National Capital Accounting Assessment (NCAA). This is an emerging methodology to take countries beyond the conventional System of National Accounting (SNA) to integrate the value of natural capital in the development policies and programs of countries. Nigeria is yet to domesticate this framework into her development planning decisions. The integration of Climate Smart principles in Nigeria's development planning decision can be built upon a robust application of NCA principles in national development planning. For instance, in the National Budget Office, Decision Support Tools (DST) are utilised to assess the Climate Smart Potentiality (CSP) of development projects from MDAs, if they are approved. The DST addresses climate risks and integrates mitigation and adaptation measures to implement Nigeria's capital investment program. The tool is designed to help government entrench the prioritisation and selection of climate-smart infrastructure projects in the medium term that meet available global funding arrangements. The tool has been proposed for full pilot implementation in the next budget cycle.

9.2.1 Links between National Capital Accounting (NCA) and Sustainable Development Goals (SDGs)

Natural capital accounting is suitable as an information system that provides data required to determine a broad range of indicators for several SDG targets. And it is also useful for the development and estimation of a broad range of SDG indicators related to the management of natural resources and those connected to other SDG clusters [141]).

SEEA methodology is therefore useful in establishing the links of how NCAs could support the achievement of SDGs. For instance, Bann, 2016 [142] shows that for SDG 6 (clean water and sanitation), many of the indicators can be directly measured using the SEEA Water methodology. More specifically, target 6.3. ('Improved water quality by reducing pollution'), can be assessed against an SEEA-Aligned Global Indicator related to the percentage of wastewater that undergoes treatment and draws information from the water accounts, namely the physical supply and use tables (PSUT) and the water emission accounts. Similarly, a fisheries account could provide information for the conservation and

sustainable use of the oceans and marine resources (SDG 14) by assessing the value of stocks over time, alternative management practices and employment opportunities. Forest accounts can also provide information for a number of the SDGs – in particular SDG target 15.2, which says that, by 2030, a country should promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase reforestation. Another target is SDG 15.9, which calls for ecosystem and biodiversity values to be integrated into national and local planning, development processes, poverty reduction strategies and accounts, for which ecosystem and biodiversity accounts provide essential information. **Appendix 26** provides the link between NCAA and SDGs and how these links provide positive potential outcomes for the various NC or economic domains.

In Nigeria, the Office of the Senior Special Assistant to The President on the SDGs is charged with intra-governmental coordination of the SDGs implementation, planning, multi-stakeholder partnerships, resource mobilization, and ensuring seamless and robust strategic communications and advocacy around the SDGs Agenda. Adopting the SEEA framework will enhance the achievement of the SDGs. See **Appendix 26** for more information.

9.3 Towards Developing a National Natural Capital Strategy (NNCS) in Nigeria

In order to provide momentum for the implementation and institutionalization of NCAA in Nigeria while also mainstreaming Natural Capital Accounting into Nigeria's National Development Plans, a strategy for advancing Natural Capital Accounting is imperative. An effective strategy will help decide where efforts and resources should best be targeted. These decisions are crucial in ensuring a profitable and sustainable future, providing direction and action plans, prioritizing, and aligning activities with the United Nations System of Environmental Economic Accounting (UN SEEA) and the System of National Accounts (SNA), and providing a framework for ongoing decision making to foster commitment. An integrated and holistic approach is needed to advance NCA in the country. An institutional mechanism and database will be required to build national natural capital account. The development of the Strategy will be made possible through the appraisal of other strategies in natural resource management such as the Natural capital protocol, National REDD+ Strategy, National Biodiversity Strategy and Action Plan, Waste management Strategy etc. The Natural Capital Protocol responds to natural capital being excluded from decisions by offering an internationally standardized framework for the identification, measurement, and valuation of impacts and dependencies on natural capital to inform organisational decisions.

The Natural Capital Protocol is a decision-making framework that enables organisations to identify drivers and/or dependencies through exploration and extraction of raw materials, measure changes in the state of natural capital arising from processing, the production of goods, distribution, consumption, disposal, or recycling and value impacts and/or dependencies of their direct and indirect impacts and dependencies on natural capital. Impacts on natural capital may be negative due to land degradation, pollution, or waste. It can be positive, which includes ecological recovery due to business investment in site rehabilitation which can result in the restoration of natural capital and improve the provision of services. The Protocol aims to support better decisions by including how we interact with nature, or more specifically natural capital, in decision making. Until now, natural capital has, for the most part, been excluded from decisions and, when included, has been largely inconsistent, open to interpretation, or limited by moral arguments [143].

The National Biodiversity Strategy and Action Plan (NBSAP) is intended to define the current status of biodiversity, the threats leading to its degradation and the strategies and priority actions to ensure its conservation and sustainable use within the framework of the socio-economic development of the country. The goal of the NBSAP is to conserve and enhance the sustainable use of the Nation's biodiversity and to integrate biodiversity into National Policy and decision-making. The NBSAP is a national instrument for identifying, documenting, and addressing the threats to biodiversity in order to prevent its loss. Its objectives are: to address the underlying causes of biodiversity loss by mainstreaming biodiversity across governments, societies and economic sectors; to reduce the direct pressures on biodiversity and promote sustainable use; to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity; to enhance the benefits to all from biodiversity and ecosystem services; and to enhance implementation through participatory planning, knowledge management and capacity building [144].

National REDD+ Strategy identifies drivers of deforestation and forest degradation, identifies existing and proposed policies and measures, and develops options for addressing the drivers of deforestation and forest degradation while integrating various systems to establish baselines, monitor and report performance, and enable validation of claims of emissions reduction attributed to the REDD+ programs or activities within the country.

The National Strategy for the Development of Statistics (NSDS II) 2017-2021. The Nigeria NSDS is aimed at transforming the entire statistical system in Nigeria, bringing together all agencies involved in data production across the three tiers of government.
Based on the strategies highlighted above, the NNCS will be informed by:

- Identifying risks and opportunities for business in natural capital and exploring ways of minimizing risk.
- Identifying the objective of the assessment and conducting a materiality process and natural asset assessment to select the most relevant impacts and dependencies from the perspective of both business institutions and stakeholders.
- Using relevant approaches to measure and value the costs and benefits resulting from material impacts and dependencies on natural capital.
- Interpreting, validating, and verifying the assessment process and results and integrating them into existing development planning and business processes to inform decision-making.

Furthermore, developing a sustainable consumption and production system is the most cost-efficient and effective way to achieve economic development, reduce impacts on the environment and advance human well-being. Providing the required services with reduced energy inputs can be achieved by reduced consumption and energy-efficient processes. Establishing and defining institutional arrangements and strengthening institutional frameworks to advance NCA are prerequisites. This will increase the use of natural capital accounts-based indicators and information for high-level sectoral policies and planning to build NNCS for Nigeria.

Therefore, the roadmap for implementing NNCS will follow the following steps:

- Identification of gaps in existing stakeholders' platform for NCA and CE, filling of gaps in the missing stakeholders expanding institutional arrangements needed to advance natural capital accounting in Nigeria -
- Facilitating the generation of specific Natural Capital Accounts (NCA) based on the priority sectors identified in NCEP, review of date and for the generation of the account

- Data collection of reference geographical datasets and updating and collection of basic data for the creation of a database of ecosystem accounting units
- Assessment of different low carbon development options on the economy, investment options for nature-based solutions to deliver ecosystem services for climate mitigation and adaptations
- Identification of potential applications Natural capital to business. Building on potential business risks and opportunities will help the decision to inform and how businesses may benefit from better information on natural capital.
- Comparison and selection from a range of alternative options while considering their relative natural capital impacts and/or dependencies.
- Ascertain which stakeholders are affected by changes in natural capital due to business activity and the level of impact.
- Determine the total value of natural capital linked to business activities. This may be useful for valuing landholdings or managing property, or other environmental assets owned by the business
- Facilitate the incorporation and mainstreaming of natural capital and ecosystem services accounts into different sector policy and plans
- Develop a strategy for reducing the wasteful and destructive flow of resources from depletion to pollution and a green business opportunity.
- Transition to a solution-based business model of circularizing business, certification and compliance and introducing alternative, environmentally friendly technologies, and innovations.
- Implementing whole-system design incorporating all relevant sectors, institutions and stakeholders and economic plans and strategies.
- Communicate natural capital impacts and/or dependencies, attracting investors and customers may require information on the achievements of the business in reducing natural capital impacts or dependencies.

9.4 Circular economy Strategies/Models: From a linear to a circular economy

Circular economy business strategies and models occur in many ways, depending on where they occur in the value chain. This diversity is what makes a circular economy dynamic and genuinely circular. This section describes some circular business strategies and models:

Re-use of products and raw materials: This involves re-using products or creating new products using waste as the new raw material. There is no longer the line: produce, consume and then throw away. In its place, a circular model that involves produce, consume, and convert waste to new products through upscaling is maintained. This saves raw materials and the environment and reduces CO2 emissions. It stimulates innovation, new business activity and employment. For example, plastic waste can be converted into new products when old tires are used in the production of foot wears.

Industrial symbiosis: This is where a by-product or residual product of one enterprise is used as a resource by another enterprise. An industrial symbiosis combines the logic from nature's ecosystems with the rationales of the economic system, for example, sawdust from a sawmill used for making briquette which is a source of fuel.

Circular Product Design: In a circular economy, manufacturers design products to be reusable. It also involves creating durable goods from recycled and reused parts that can be input for downstream circular business models. For example, electrical devices are designed in such a way that they are easier to repair. Products and raw materials are also reused as much as possible, for example, by recycling

plastics into pellets for making new plastic products. Also, products are used more intensively, so production is reduced, and the use of raw materials is reduced.

Extending the useful lifetime of materials, parts, and products across several customer goods: This involves the collection of redundant materials such as electronics, cars, IT equipment, and furniture from large organisations for remarketing. They can also serve as spare parts for repairs of other goods.

Sorting & pre-processing: Finding alternative value in the parts of products. It involves removing some parts of equipment. For example, removing parts of electronics, repainting them and used as furniture parts.

Changing Consumer Behaviour: An effective circular economy model for industrial production or the conservation of natural capital must prioritise changing consumers' behaviour for effectiveness. Intensive utilisation of products, repairing them and/or reusing products for other purposes is part of consumers' contribution to the circular economy. This can be achieved through awareness, certification, and incentives for patronizing green products.

10 Monitoring Reporting and Verification (MRV) for Natural Capital Accounting and Assessment (NCAA), Circular Economy (CE) & Green Growth (GG) in Nigeria

Highlights

Current Status

1. The Federal Ministry of Environment is the apex and coordinating agency for environmental and climate change issues. The Ministry coordinates other agencies' stakeholders and supports projects within the sector. The institutional arrangement is to enhance the participation of related institutions and ease data collection, archiving, monitoring, and reporting.
2. Informal interaction and data collection exist between the Department of Climate Change (DCC) of the Federal Ministry of Environment and some stakeholders (data providers)
3. There are many enabling policies for natural capital management in Nigeria. Some legislative, regulatory, and policy frameworks focus on forest, land, water resources management, pollution control, waste management, and energy.
4. Currently, there exists the Nigeria Circular Economy Working Group (NCEWG), which serves as a coordination platform in the country where stakeholders voluntarily met to share ideas and experiences and coordinate activities to take advantage of ample economic opportunities inherent in Circular Economy policies and bankable projects both at the national and sub-national level.
5. The NCEWG is currently coordinated by the AfDB and the Federal Ministry of Environment (FMEnV). Members are experts from the government, private sector, academia, and non-state actor. The main objective of NCEWG is to support inclusive green growth of the Nigerian economy through approaches that increase circularity.

Challenges/Limitations

1. During consultative meetings, interaction with the stakeholders revealed the absence of an established functional national MRV framework for the sector.
2. Nigeria still lacks the appropriate institutional arrangements for MRV in the different priority sectors. Institutional arrangements for data collection, archiving, monitoring, and reporting are weak.
3. The informal interaction nature of data collection does not give room for the growth and development of a robust functional national MRV system.
4. There exist fragments of institutional arrangement in relation to different activities and priority sectors.

Recommendations

1. The regulatory framework for MRV must be simplified for easy implementation by actors: The current structure places the National Assembly at the apex for Polices and Laws on MRV. The local administration can be saddled with the responsibility of collection for recycling and proceeds returned by some percentage to the state government.
2. The establishment of a local Environmental Standard, Regulatory and Enforcement Agency (LESRA) will help to regulate the activities at community level.
3. Private sector consultants must be engaged to provide the services for Quality Assurance (QA) in order to provide checks in revenues generated from Natural capital. This is lacking in the present arrangement of policies for Natural Capital Assessments.

4. Government should develop the MRV Policy framework (Regulatory or legal), which will also cover institutional MRV and allow the Private sector to support the framework and provide quality assurance. These could be policies on collaborative Natural Capital Management (NCM). External actors provide links to policies and processes that may affect the deliverables and efficiency of government targets.
5. In a Nigerian context, stakeholders may include local government environmental officers in the various local government areas to manage impact assessment, verify natural capital, and manage lands. For many of the projects on Natural Capital, Green Growth and Circular Economy, Universities, private organizations, community-based organizations, and Institutions should be required to provide significant technical MRV support.
6. Besides the international conventions, various laws, acts, regulations, and policies in different Ministries, Department & Agency (MDAs) at national and state levels can be reviewed and synergized to inform MRV for NCAA, CE, and GG.

INTRODUCTION

Lord Kelvin is famously quoted as saying: "To measure is to know. If you cannot measure it, you cannot improve it. When you can measure what you are speaking about and express it in numbers, you know something about it." This is the principle of MRV. It deals with the population of numbers and verification of the number and reporting the result for possible assessment in a research study. These measurement technics require a baseline for assessment of the present situation and determining the rate for which improvement can be applied.

MRV is the process of data collection, report generation, and verification that provides countries with the information they require to monitor their activities in different sectors for the purposes of national planning, implementation, coordination, and international reporting. It includes activities that collect, analyse, verify, and report information on the implementation status and results of actions in a timely manner. The process should align with national circumstances; be simple, robust, and accurate in reporting; and building upon existing institutions and institutional arrangements; and reflect the available technical and financial resources [145].

This definition considers any kind of data collection, management, review, and reporting related to mitigation and adaptation actions, policies and the finance used to support these actions requirements to be part of the MRV [2]. The development of an MRV system can catalyse coordination between different institutions and sectors within a country and facilitate information sharing on mitigation efforts, thereby enabling targeted policy making and assessing its effectiveness. The three core elements of mitigation, adaptation, and finance– can be elements of one integrated, national MRV system [146].

MRV involves direct measurement using devices or estimation using simple methods or complex models. It also includes calculations that follow strict guidelines and protocols. Reporting involves the production of documents to inform all interested parties guided by relevant methodologies, assumptions, and data. Verification comprises specific procedures or expert reviews used to authenticate/validate the quality of the data. This could be internal or external verification.

MRV can be applied in various fields/sectors, including climate change, agriculture, forestry, industrial processes, energy, water, policies etc. The application of MRV in climate change captures activities that

track progress and steer towards climate change-related targets, bringing together all aspects pertaining to transparency under the climate regime (COP 13, 2007 in FME, 2020). The MRV is the mechanism through which progress towards achieving climate change-related targets and commitments is tracked at the national and subnational levels [73].

MRV is a key tool to support planning and implementation of NCAA and the transition to a CE and achieving GG. It is an evidence-based approach for identifying and documenting the contribution of successful programmes, approaches, and policies to achieving goals and objectives by systematically tracking implementation and outputs and measuring implementation effectiveness.

Moreover, Green Growth Index for measuring a country's performance in achieving sustainability targets is being presented on annual basis through joint efforts of many organisations.
including World Bank, FAO, United Nations Industrial Development Organization (UNIDO), United Nations Conference on Trade and Development (UNCTAD), AfDB among others [148]. However, in the context of MRV, a Green Economy (GE) is a low carbon, resource efficient and socially inclusive [13]. Green economy requires green investments, public expenditure, policy reforms and changes in regulatory mechanism, tax system, and voluntary approaches including certification and standards, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services [13]. On the other hand, it creates employment, income, improve skills and other public benefits, the overall effect is improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource-efficient, and socially inclusive" [149]. MRV in this context uses green growth indicators to measure growth in employment and income, economic activities, infrastructures, and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services.

NC is the stock of natural ecosystems on earth including air, land, soil, biodiversity, and geological resources, and underpins the economy and society by producing value for people and businesses [143]. NCA is the process of calculating the total stocks and flows of natural resources and services in a given ecosystem or region. Accounting for such goods may occur in physical or monetary terms. On the other hand, natural capital assessments reveal the underlying networks of ecological infrastructure (naturally functioning ecosystems that deliver valuable) such as rivers, soils, forests etc. that affect the long-term risk-return profile of investments [62]. This process can subsequently inform government, corporate, and consumer decision-making as each relates to using or consuming natural resources and land with sustainable behaviour.

A Circular Economy reduces resource dependency and resource use, thereby reining in production costs, narrowing market exposure, and limiting costs stemming from resource extraction and generation. It also leads to the introduction of economically viable methods to reduce pollution and separate harmful from reusable waste material. MRV evaluates the degree of progress in circularity and policy transparently and reliably.
On the other hand, Green Growth results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities. It is a low carbon, resource-efficient, and socially inclusive" [59]. MRV in this context uses green growth indicators to measure growth in employment and income, economic activities, infrastructures, and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services.

The relationship Between Natural Capital, Green Growth and Circular Economy is that green growth is strictly connected with the idea of a green economy, oriented at increasing overall social welfare and social justice, at the same time, considerably reducing environmental risks and ecological deficiencies [59]. The whole essence of a green economy is to decarbonize our environment.

10.1 Why MRV Frameworks?

The link between NCAA, CE and GG is an important process of assessing natural ecosystems' contributions to the economy to understand its reliance upon natural systems better, track changes in natural systems that may have implications for industries and manage natural resources and ecosystems to ensure their economic benefits are sustained into the future. A standard framework for NCA, such as SEEA (developed by the United Nations and partner organisations) describes several categories of NC accounts.

One of these, ecosystem accounts, tracks the extent and condition of ecosystem assets and the flows of ecosystem services they provide to people and the economy. On the other hand, CE approaches follow a tradition that is well established in the field of sustainability, emphasising performance metrics and accountability. Policy decisions on poverty reduction, investment, economic growth, and environmental management are increasingly sensitive to natural resource values, scarcities, and deterioration [96]. MRV is the tool needed to analyse their linkages.

MRV for NCAA, CE and GG will help to deliver the following:

- The method that is required to provide data on NC in terms of stocks and flows of renewable and non-renewable natural resources that combine to yield a flow of benefits or "services" to people.
- Ecosystem accounting method, valuing ecosystem assets and services
- Approaches to measuring the CE and green growth.
- The indicators and metrics, which measures the degree of circularity of an economy.
- Provide the national material flow inputs, outputs, and stock.
- Provide a roadmap for the implementation of NCAA, CE, and GG in the short-, medium-, and long-terms.

10.2 Elements, Procedures and Planning for MRV

The MRV system is where institutional, regulatory, technical, and sectoral bodies at multiple levels and in different sectors interact to track emissions, waste, and pollution. This is achieved through proper monitoring of the effectiveness of mitigation actions and the support received both at the domestic and international level.

To implement a MRV system for NCAA, CE, and GG in Nigeria, the following procedures are necessary to identify sectors, specific activities, roles, and locations (Table 10.1). These will help improve the accuracy of information used in the MRV system.

Table 10.1: Key procedures for MRV

Element	Definition
What:	Sectors, activities and types of data (coverage)
Capacity:	Capacity that exists in institutions and organisations
Who:	Roles and responsibilities
How:	Methodologies used, data sources, underlying assumptions
Non-Compliance:	Enforcement rules

Quality:	QA/QC procedures, schedule (how to calculate and measure emissions waste, pollution)
When:	Timelines for MRV
Where:	Reporting platform and data disclosure
What happens	What happens... in case of non-compliance (enforcement rules)

Planning is a necessary component of MRV for identification and prioritization and improving coherence to improve the overall management of the MRV system. Table 10.2 summarises the activities involved in the planning process.

Table 10.2: Planning Process for MRV

S/n	Key activities	Definition
1	Workplan	Define work plan and schedule.
2	Roles	Define roles and responsibilities of governmental agencies, private sector and other stakeholders.
3	Data Collection	Focus on key categories of data in different sectors; Collect data at a level of detail appropriate to the method used; Review data collection activities and methodological needs on a regular basis.
4	Coordination	Establish coordination mechanisms; Coordination meetings with different entities involved in the system.
5	Verification	Establish verification mechanisms
6	Improvement	Define a system for tracking continual improvements
7	Capacity	Define capacity and capacity building needs
8	Fund	Plan funding allocation
9	Activities	Estimation of GHG emissions, waste and pollution
10	Monitoring	Monitoring of Mitigation actions
11	Support	Monitoring of Support received
12	QA/QC	QA/QC to ensure compliance to guidelines
13	Database	Archiving system

The planning process is followed by preparatory stage that involves various activities (Table 10.3)

Table 10.3: Activities for Planning and Report it in the form of an Emissions

Key Activities	Definition
Consultation	Consultation workshop with all stakeholders
Scope	Present scope of the national MRV system
Roles	Present suggested roles/responsibilities
Timeline	Present timelines and milestones
Feedback	Receive comments
Consensus	Reach agreement on the MRV system
Coordination	Hold Coordination meetings with different entities involved in the system

Box 10.1 shows the key requirements for implementing MRV.

- High-level political and policy support
- Coordination and cooperation
- Financial resources acquisition and distribution
- Technical expertise
- Data and method

Box 10.1: Capacities required to implement MRV.

Key Outcomes of an MRV System

Implementing MRV for CE should deliver the outcomes in Box 10.2.

- Quality data to help evaluate and report on policy and action for NCAA and CE.
- Quality data for international reporting.
- Promote transparency of GHG and NON-GHG reporting.
- Clear picture of national priorities, strengths and weaknesses clarifies future capacity building needs and financial support.
- Help reporting entities to assess their climate risks and opportunities.

Box 10.2: Key Outcomes of MRV System

Key Principles of MRV

MRV principles can be applied to any activity in NCAA, CE, and GG and at any level or sector. The implementation of MRV in CE should adhere to the key principles in Table 10.4.

Table 10.4: Key Principles of MRV

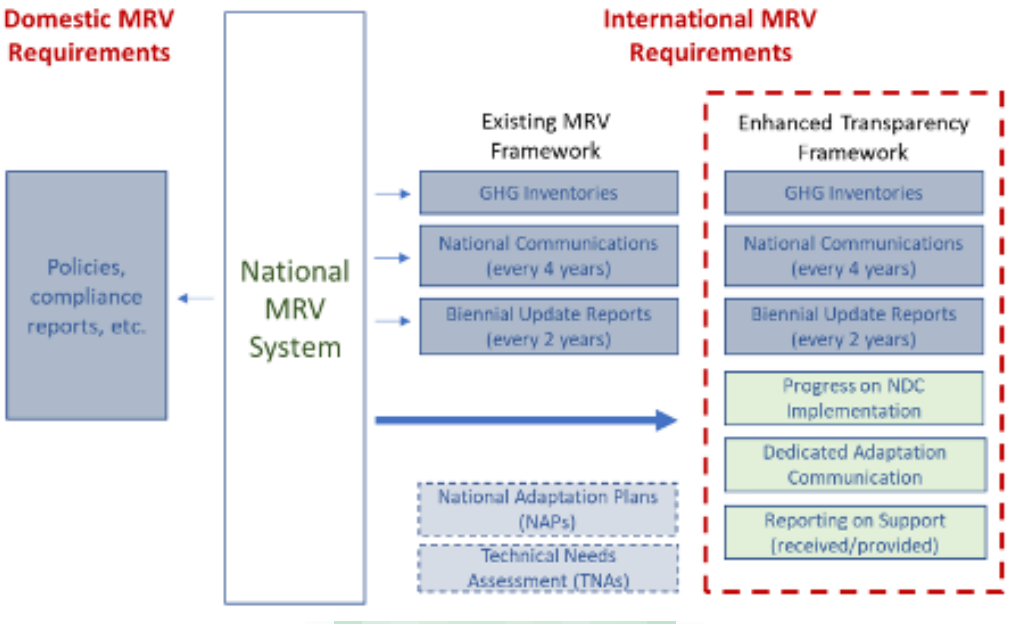
S/N	Key Principles	Definition
1	Transparency	Transparency assumptions and methodologies used as a basis for reporting should be clearly explained.
2	Completeness	Completeness inventory covers all relevant sources of data and sectors and issues such as emission, waste and pollution.
3	Consistency	Consistency application of same methodologies and data sets for all sectors and subsequent reporting years.
4	Comparability	Use methods comparable to other sectors and data.
5	Accuracy	Exactness of data in the various sector.

10.3 MRV for Nationally Appropriate Mitigation Actions (NAMA)

MRV was developed as an effective tool to secure the transparency and consistency of information on national mitigation actions. Establishing an MRV system is an essential and basic element of GHG reduction efforts, enabling countries to meet international reporting. requirements such as National Communications, Biennial Update Reports, and National GHG Inventories. It also enables countries to demonstrate progress under measures such as low emission development strategies, intended NDCs, and Nationally Appropriate Mitigation Actions (NAMAs). The MRV processes inform countries' broader climate change and sustainable economic development objectives. MRV frameworks are designed to

help drive countries' NAMAs. They have similar components to NAMAs: international MRV /NAMA, domestic MRV/NAMA, support needed by the country, and support received by the country.

Figure 10.11 shows the existing requirements for MRV at the domestic and international levels.



It is important to note that the NAMA and MRV are symbiotic. In the implementation of CE and achieving GG, the two mitigation actions are critical to measuring key performance indicators for CE and GG that have potential GHG emissions. MRV for NAMA is focused on climate change, and this set the foundation for MRV for NCAA, CE, and GG. Moreover, MRV provides a clear view towards reducing GHG emissions or strengthening adaptation action. Specifically, it relates to tracking the specific measures that have been identified within Nigeria's NDC for each sector. This will also set the tone for the MRV in non-GHG.

Three types of NAMA-related MRVs exist:

- **MRV of GHG emissions**, conducted at the national, organisational, and/or facility levels to understand an entity's emissions profile and report it in the form of an emissions inventory. This involves finding out: how much is being emitted? In which sectors? Which gases? How have emissions evolved over time?
- **MRV of mitigation actions** (e.g., policies and projects) to assess their GHG and non-GNG (wider sustainable development) effects as well and to monitor their implementation. This type of MRV focuses on estimating the change in GHG emissions or other non-GHG variables. For instance, is the mitigation policy effective? Are we on track to meet the NDC?
- **MRV of support** (e.g., climate finance, technology transfer, and capacity building) to track pledges and receipts of climate support, monitor the results achieved, and assess the impact. CE monitoring at a macro scale currently includes methods using Material Flow Analysis (MFA).

10.4 MRV Framework for Green Economy, Natural Capital Accounting and Circular Economy in Nigeria

A robust MRV system will be critical to Nigeria's transition to a low-carbon economy and circular economy, to attain green growth. However, the country's existing MRV system is relatively new and has limited scope, which only focuses on measuring, reporting, and verifying GHG emissions. Nigeria has no MRV framework for NCAA, CE, or GE.

This scoping report and other roadmap will be designed to close these gaps, while proposing solutions to the current lack of data on GE, NC, and CE topics. However, the Green Growth Index (GGI) provides country wide data for measuring a country's performance in achieving sustainability targets including SDGs, Paris Climate Agreement, and Aichi Biodiversity Targets for four green growth dimensions which include efficient and sustainable resource use, natural capital protection, green economic opportunities, and social inclusion [150]. All identified gaps will be validated. Developing the NCAA requires high-quality, geographically disaggregated datasets that record the value of environmental service flows. MRV provides the methods and data that take into account the supply of goods and services, emission, waste, stocks etc. This will be an iterative and evolving process, with the task of preparing an account, helping to identify data needs, and updated data facilitating revisions of an account. Statistics and information will be drawn from natural capital accounts, showing how nature supports people and the economy.

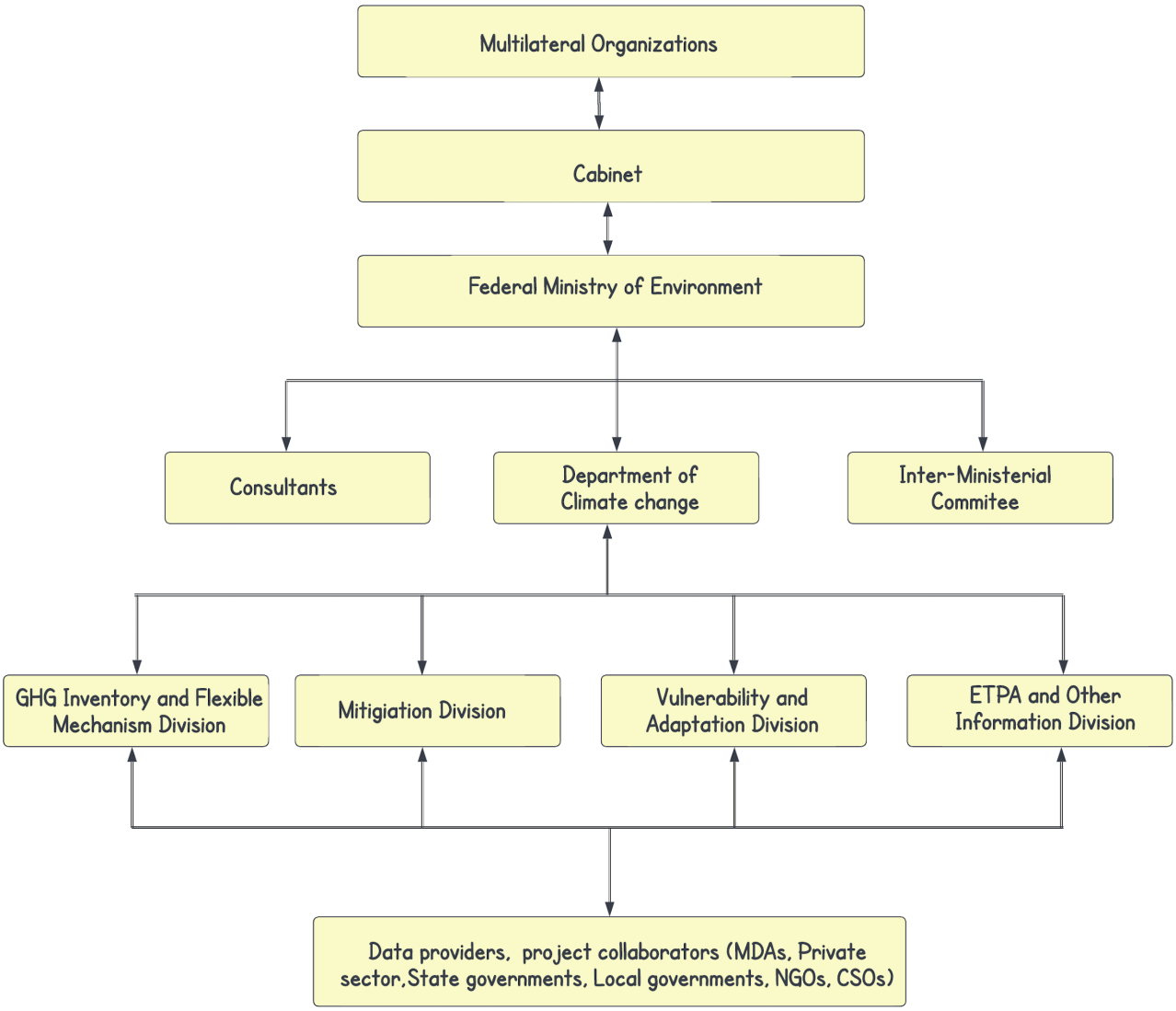
A transparent MRV framework will provide Nigeria with an accurate and credible information framework that can serve as a basis for understanding the impact of mitigation actions and for identifying areas needing targeted efforts. Developing an MRV framework for Nigeria will be consistent with the spirit of true federalism, as it will empower the local and state governments to harness NC to generate revenue and take ownership of the resulting revenues while contributing to the centre. Such a MRV system can enable the measurement of economic indicators such as poverty eradication, job creation, service delivery done to x-ray the labor market and provide opportunities for green jobs as well as a gradual transition to a GE. This will further help the country protect livelihood, build alternative livelihoods, improve water accessibility, energy, food security and promote the sustainable use of NC.

MRV provides the required coordination of the processes, regulation, and accountability framework for measuring progress towards GE and CE, while accounting for the natural assets including materials and ecosystem services. This enables monetary valuation using market and non-market-based methods, such as market price, production function, and avoided damage/replacement cost. The concept of MRV for NCA, CE, GE and attaining GG represents the vision of a new economy based on renewable and regenerative approaches, processes that do not damage ecosystems, reduce GHG emission and the delivery of material and immaterial benefits that fulfil the economic and social requirements of all people now and in the future [78].

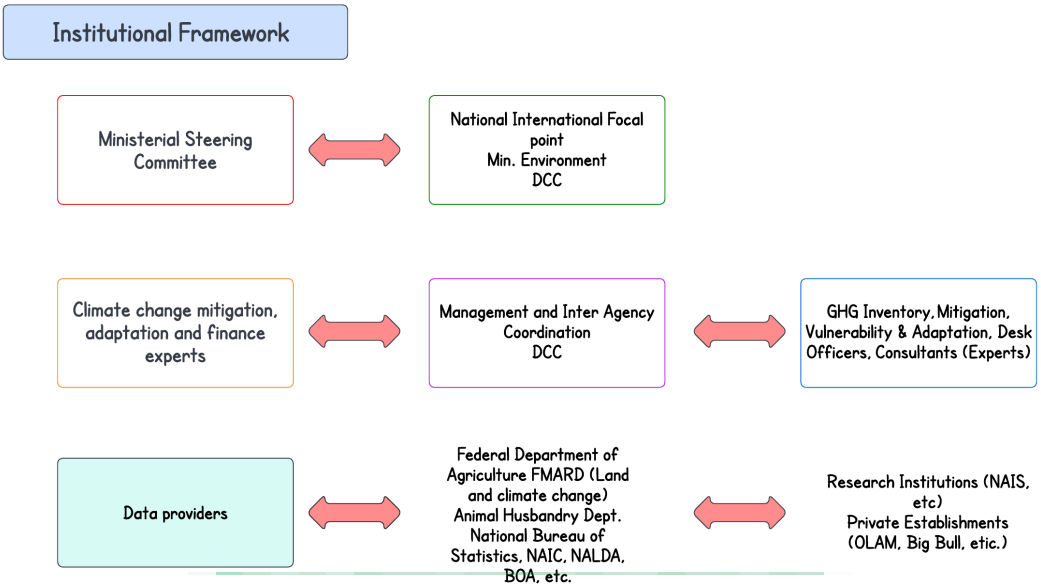
10.5 Existing Institutional Framework for MRV

FME coordinates environmental and climate change policy and planning on behalf of the Government of Nigeria. It liaises with representatives of other government agencies stakeholders to design, support and implement projects with an environmental focus across priority sectors (AFOLU, Energy, IPPU, and Services) The institutional arrangement in the FME is to enhance participation of related institutions and ease data collection, archiving, monitoring, and reporting. During consultative meetings carried out in

the preparation of this report, stakeholders noted the absence of an established, functional national MRV framework in the priority sectors. FME's Department of Climate Change (DCC) is the implementing agency for Climate change related policies and programmes in the country. It currently interacts informally with some stakeholders (data providers) to collect data. However, the informal nature of this interaction does not support the growth and development of a robust national MRV system. Nigeria still lacks the appropriate institutional arrangements for MRV in the different priority sectors. Institutional arrangements for data collection, archiving, monitoring, and reporting are weak [151]. However, the existing institutional arrangements for some activities and sectors (figures 10.2 to 10.4 can be used as foundations for the design of an institutional framework for MRV in NCAA and CE.




Inter-Ministerial Commitee
Federal Ministry of Environment
International Consultants
GHG Inventory Divisions
Energy Working Group
IPPU Working Group
AFOLU Working Group
Waste Working Group
Data providers, project collaborators (MDAs, Private sector,State governments, Local governments, NGOs, CSOs)

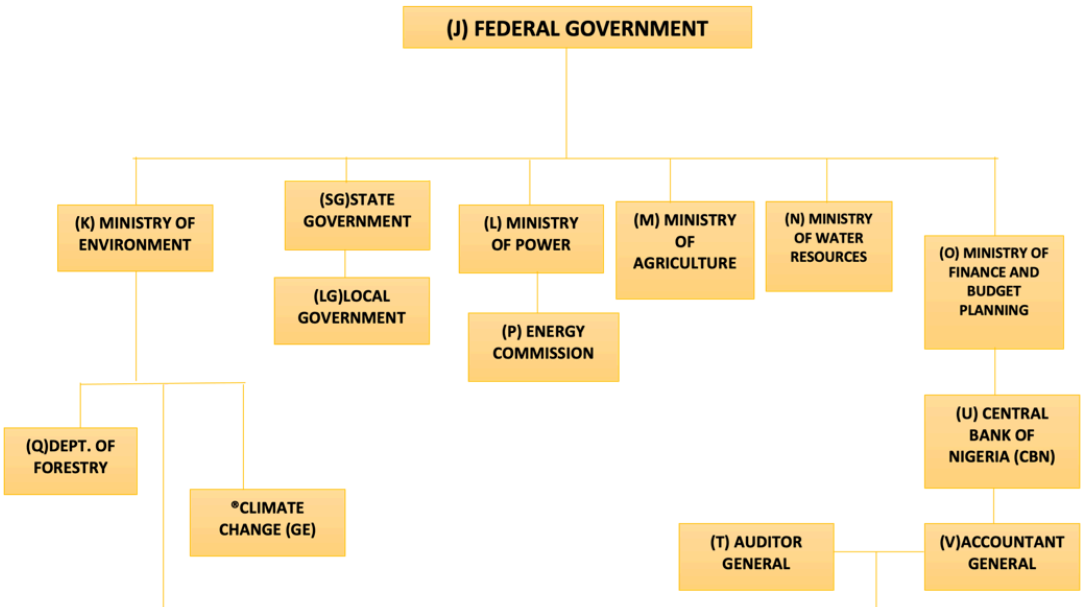

Institutional Framework
Ministerial Steering Committee
National International Focal point
Min. Environment
DCC
Climate change mitigation, adaptation and finance experts
Management and Inter Agency Coordination
DCC
GHG Inventory, Mitigation, Vulnerability & Adaptation, Desk Officers, Consultants (Experts)
Data providers
Federal Department of Agriculture FMARD (Land and climate change)
Animal Husbandry Dept.
National Bureau of Statistics, NAIC, NALDA, BOA, etc.
Research Institutions (NAIS, etc)
Private Establishments (OLAM, Big Bull, etic.)

In addition to the existing institution frameworks for developing MRV, the NCEWG is a coordination platform through which stakeholders voluntarily meet to share ideas and experiences and coordinate activities to take advantage of CE-related opportunities for bankable projects at the national and sub-national levels. It is coordinated by the AfDB and the FME. Members are experts from the Government, private sector, academia, and a non-state actor. The NCEWG's main objective is to support inclusive green growth of the Nigerian economy through approaches that increase circularity [60]. Thus, the implementation of MRV for NCAA and CE will be based on the existing government structure, with FME as the anchor. FME will coordinate other relevant institutions and stakeholders at the national, state, and local levels, including MDAs, academia, CSOs, the private sector, and financial institutions. These also include counterparts (such as committees and CBOs) at the state and local levels.

10.6 Proposed Institutional Framework for MRV in NCAA, CE, and GE

The Government should develop the policy, regulatory, and legal frameworks for MRV. These will also cover institutional arrangements and allow the private sector to design and support MRV framework and Quality Assurance. This could include policies on collaborative Natural Capital Management (NCM). In the Nigerian context, stakeholders may include local government environmental officers that will manage impact assessment, verify NC, and manage land. For many of the projects on NCA, CE, and GG, universities, private organisations, CBOs, and other institutions should be required to provide significant technical MRV support. For example, by developing methodologies for land use modelling and carbon assessment, acquiring software for Geographic Information Systems (GIS), and providing high-resolution satellite images.

Figure 10.5 shows the proposed institutional arrangements for NCAA-, CE, GG-related MRV in Nigeria. These reflect the federal structure that provides administrative governance at the national level. Building the capacity of the various institutions on MRV will enhance the propagation of NCAA and approaches for the extraction of various economic benefits. Each agency will determine the type of MRV in conjunction with FME. Local government agencies will be responsible for the natural assets found in their areas. This will encourage them to take responsibility for collecting revenue and disbursing part of it to the state and federal governments while retaining the rest to tackle environmental challenges at the local level.



Roles and responsibilities

FME leads on and coordinates all environmental matters, including climate change, pollution due to waste, environmental impact assessments, biodiversity conservation, ecosystem services, and watershed management. It is also responsible for international relations and liaising with external financiers. FME's Department of Pollution Control is responsible for implementing waste and CE-related policies. After its staff are appropriately trained, this Department will be able to implement relevant policies and MRV framework. The mission of FME is to ensure environmental protection and natural resources conservation for sustainable development.

The **Ministry of Power** is developing and implements policies and measures related to electricity generation, distribution, and transmission. Meanwhile, the **Energy Commission** is responsible for energy system planning and policy implementation and promoting the diversification of energy resources.

The **Ministry of Agriculture** is mandated to organise and manage the agricultural sector and stimulate employment along the agricultural value chain. The MRV Framework will guide decarbonizing the sector for green growth.

The **Ministry of Water Resources** develops and implements policies, projects, and programmes to enable access to safe and sufficient water to meet Nigeria's social, cultural, environmental, and economic development needs. Water is a natural asset and can be quantified, measured, and verified in a reporting format.

The **Federal Ministry of Finance, Budget, and National Planning** collects, manages, and disburses government revenue, formulates policies on taxation and tariffs, develops the annual budget and annual accounts for MDAs, manages federal debt, and regulates the capital market. It liaises with international and domestic funding windows natural capital, CE and GG initiatives, projects, and programs.

CBN ensures monetary and price stability, issues legal tender currency, and maintains external reserves to safeguard the economy. It also acts as government's bankers and regulates commercial banking activities. The **Office of the Accountant General of the Federation** works with the Ministry of Finance, Budget, and National Planning to manage receipts and payments of the Republic of Nigeria and to ensure that a proper system of account exists in every department of the nation's treasury. The **Office of the Auditor General of the Federation** is empowered to audits all the federal government's income and expenditure, among other tasks mandated by the government.

Private Sector and Other Stakeholder Involvement MRV

The private sector can play an essential role in accelerating Nigeria's transition toward a regenerative and circular economy. Private sector players have started to embrace this transition and the new business opportunities it offers by developing innovative business models, improving coordination along value chains, enhancing their processes and products, and generally re-evaluating what works [97]. CE-related activities in Nigeria range from small-scale projects involving relatively few stakeholders to large institutional arrangements.

At any level, stakeholders can be trained to use an MRV framework to measure and account for revenue resources potentials embedded in natural capital, including activities meant to identify leakages. The private sector, academia, CSOs, and others can be trained to drive the MRV framework as checks or Quality Assurance (QA). While the involvement of a larger number of stakeholders might complicate the institutional setup and increase transaction costs, such NC (CE, GE, NCA) projects are likely to receive more visibility and opportunities to attract investors and reap multiple economic benefits. Besides the stakeholders who are directly involved in NC projects, various external factors such as public authorities can contribute to the MRV framework.

The Resource and Environmental Policy Research Centre, Environment for Development (REPRC-EfD Nigeria), is actively working to develop NCA and incorporate NCA into its policies, plans, and programmes. The Centre held a 2-day training workshop in August 2021 called "Towards Natural Capital Accounting for Nigeria". It was designed to train technical staff from relevant MDAs, academic institutions, and the private sector on how to develop NC accounts (with a focus on energy, ecosystem services, land use, forests, and GHG emissions). It also presented to the stakeholders some draft accounts developed for Nigeria.

Support for Domestic MRV

Resource and Environmental Policy Research Centre of the University of Nigeria has volunteered to provide scientific and expert support to the country's NC project. In 2017 and 2018, the European Union trained relevant MDAs on MRV in the energy, AFOLU, waste, IPPU, and transport sectors. The training focused on emissions and decarbonisation. The World Bank sponsored MRV training for the Department of Forestry and other forestry subsidiaries in 2019. While these are good starting points, achieving the 2030 and 2050 emissions targets will require further efforts to build MRV-related capacity across various institutions.

Support for International MRV

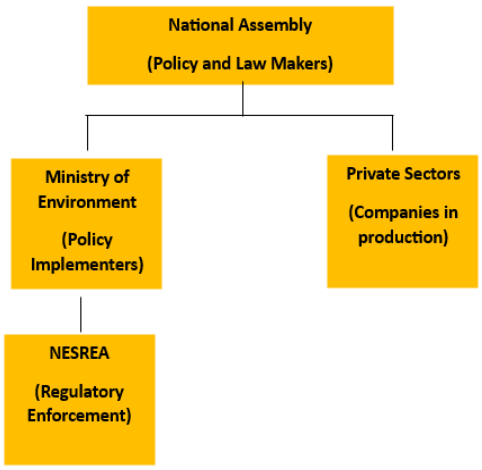
Implementing MRV for NC in Nigeria will rely heavily on attracting external funding and financial support. The global MRV system is designed to help developing countries access funds or facilities to tackle climate change and other environmental problems. Recognising that each country has unique circumstances, the system supports the development of domestic MRV systems. Funds are channelled to Nigeria through bilateral relationships between the Government and development partners such as UNEP, UNDP, the World Bank, AfDB, and FAO.

10.7 Existing Policy, Legal, and Regulatory Framework for MRV and NAMA

Nigeria boasts many policies, laws, and regulations to enable the implementation of NCAA, CE, and GG. These focus on forests, land, water resources management, pollution control, waste management, and energy, among others. Nigeria is also a signatory to several relevant international conventions. To

accelerate Nigeria's transition to a CE the various laws, acts, regulations, and policies in different MDAs at both the national and state levels should be reviewed and synergised to inform MRV for NCAA and CE. Recommendations for policy reform and development are made based on the existing policies' analysis and aligning them with the relevant sectors.

The regulatory framework for MRV/NAMA must be simplified to facilitate implementation. Figure 10.6 shows the current structure, with the National Assembly at the apex, for polices and laws related to MRV and NAMA. Within the Federal Ministry of Environment exists NESREA which acts as the policy and law enforcement arm, they ensure that private sector and other related entities comply with the laws, policies, and regulations.



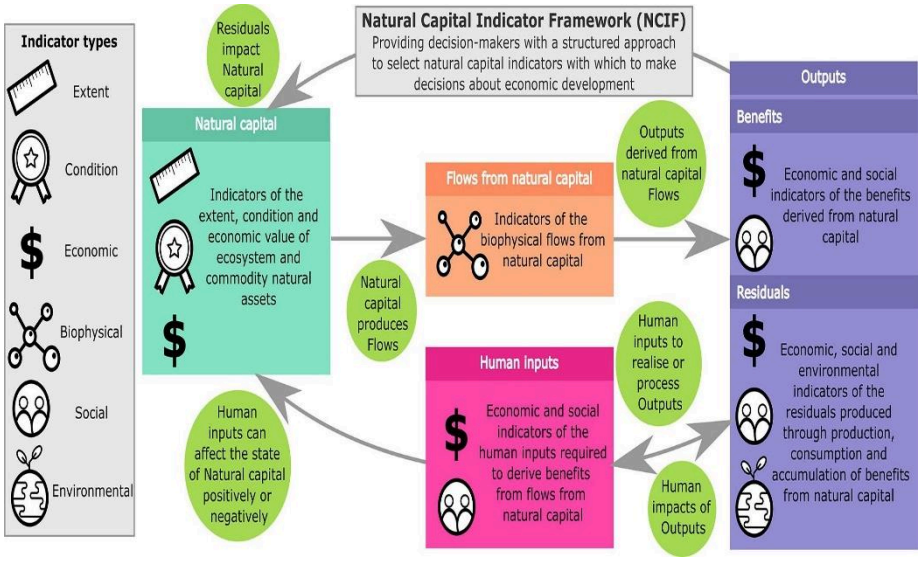
10.8 Proposed Policy, Legal, and Regulatory Framework for MRV in Natural Capital Accounting, Circular Economy, and Green Growth

Nigeria does not currently have any specific, finalised legal instruments for MRV in relation to NCAA, CE, and GG. However, there are some policies, laws, and regulations that, directly or indirectly, provide for the needed MRV. These provide a useful foundation for further progress. **Appendix 20** highlights the various institutions responsible for promoting NCAA, CE and GG, their functions, and powers, and to the roles they can play in supporting Nigeria's transition to a robust and sustainable green growth. For example, local governments can be made responsible for collecting waste for recycling, with parts of the proceeds given to the respective state government. The Local Environmental Standards, Regulatory, and Enforcement Agency (LESRA), if established, will regulate at this activity. Private sector consultants must be engaged to provide quality assurance (QA) services, including verifying revenues generated from NC. This QA function is lacking in the present policy framework for NC Assessments.

10.9 NCAA, CE & GG Indicators Framework

UNEP's Natural Capital Indicator Framework (NCIF) proposes various indicators to measure the impact of government policies and initiatives on a country's transition towards a GE. (Figure10.7). These six indicator types (extent, condition, economic, biophysical, environmental, and social) are categorised as follows:

- Indicators used to evaluate the present state of the environment, the risks and positive trends, and progress towards environmental goals.
- Indicators used to track the impacts of government initiatives and the effectiveness of economic policies.
- Indicators used to measure the impact of the GE on human well-being and social equity.



10.10 Data Framework for Natural Capital Assets in Nigeria

While Nigeria has abundant natural resources, it has not yet developed a way to incorporate NC and ecosystem services into its SNA. A data framework can help answer questions like:

- What is the contribution of ecosystems and their services to the economy, social well-being, jobs, and livelihoods?
- How is the condition, health, and integrity of ecosystems and biodiversity changing over time, and where are the main areas of degradation and enhancement?
- How can natural resources and ecosystems be best managed to ensure continued services and benefits such as energy, food supply, water supply, flood control, carbon storage, and recreational opportunities?
- What are the trade-offs between different land uses (for example, agriculture, mining, housing development, habitat conservation, and recreation) to achieve long-term sustainability and equity?

Ecosystem accounting is a coherent framework that integrates measures of ecosystems and the flows of services from them with measures of economic and other human activity. Ecosystem accounting complements and builds on the accounting for environmental assets described in the SEEA Central Framework. The accounting approach used in ecosystem accounting, as described in the SEEA

Experimental Ecosystem Accounting (SEEA EEA), recognises that individual resources as part of a broader system and within a given spatial area. It does this by integrating biophysical and economic data using standard accounting principles and accounts to produce detailed measurements of the linkages between ecosystems and economic and other human activity.

As an ecosystem's contribution to human well-being depends on its location (for example, its proximity to human settlements), ecosystem accounts are inherently spatial. Ecosystem accounting can produce information on the extent of ecosystems, their condition based on selected indicators, and the flow of ecosystem services. The spatial nature of ecosystem accounting means that maps are a common way to present the information. The links between an ecosystem and the economy can be presented in both physical and monetary terms, often by combining both kinds of data r, noting that monetary valuation is not a necessary feature of all accounts.

SEEA EEA is an integrated statistical framework for organising biophysical data, measuring ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. It comprises a set of accounts that collectively present a coherent and comprehensive view of ecosystems:

- **Ecosystem extent account**: This serves as a common starting point for ecosystem accounting. It organises information on the extent (area) of different types of ecosystems (for example, forests, wetlands, agricultural areas, and marine areas) within a country.
- **Ecosystem condition account**: This measures the overall quality of an ecosystem asset and captures, in a set of key indicators, the state of the ecosystem in relation to both its naturalness and its potential to supply ecosystem services.
- **Ecosystem services account**: This measures the supply of ecosystem services and their corresponding users and beneficiaries, classified by broad national accounting categories or other groupings of economic units.
- **Monetary asset account**: This records the monetary value of opening and closing stocks of all ecosystem assets within an ecosystem accounting area and additions and reductions to those stocks.
- **Thematic accounts**: These consist of standalone accounts for land, water, carbon, and biodiversity. They are important, in their own right, for policy and analysis but are also directly relevant to the compilation of ecosystem accounts.

Some existing databases provide secondary data for NCAA and measuring circularity.
These include:

a) Databases managed by national statistical agencies (e.g., Nigeria's NBS) [90] and national regulatory authorities responsible for the permitting of industrial and other processes subject to pollution emission legislation (such as, in Nigeria, DCC, NESREA, NNPC, and NERC).
b) FAOSTAT database) [26].
c) US Geological Survey databases.
d) Surveys and Census information from population commissions, agricultural departments etc.

Table 10.5 summarises the data available from different sources for NCA and CE in Nigeria.

Table 10.5: Summary of Data availability from different sources

Category Sub-Principal Data	Sub-category	Data Type	Data Source	Principal Data Provider

Circular Economy	Non-biodegradable	Plastics, Battery	Federal Ministry of Environment	Department of Pollution control and NBS
Green Economy	Forestry	Biodiversity loss	Federal Ministry of Environment	Department of Forestry, National Park and NBS
Ecosystem	Eco Tourism	Ecosystem Services	Federal Ministry of Environment and culture and Tourism	NBS
Agriculture	Productivity		Federal Ministry of Agriculture	FAO
Climate Change	Activity data and emission factor	Emissions accounting	Federal Ministry of Environment	UNFCCC

10.11 Existing Methodology for MRV in Natural Capital and Circular Economy

The Government of Nigeria compiled estimates of the country's GHGs for the first, second, and third National Communications and First Biennial Update Report. These were compiled using the IPCC 2006 Guidelines for National GHG Inventories [153] and the IPCC Good Practice Guidance and Uncertainty Management [67]. In the crop sector, the reports used the tier-one method for all analysis, reflecting the availability of relevant activity data. They used default emissions factors and sourced over 95% of the data from FAOSTAT. The IPCC 2006 software template was used for the inventory calculations. Based on the Third National Communication inventory report, activities in the AFOLU sector are among the highest contributors to emissions of greenhouse gases in Nigeria. This makes AFOLU a key category in both the NAMA and MRV.

10.11.1 Proposed methods and standards for Natural Capital Accounting and Measuring circularity in Nigeria.

The available methods for NCA include:

- **UN–SEEA methods and standards**: SEEA is the internationally agreed methodology for NCA. It is a central framework that contains the standard concepts, definitions, classifications, accounting rules, and tables for producing internationally comparable statistics on the environment and its relationship with the economy [154].

- **Methods used by World Bank-led WAVES partnership and the work programme by the United Nations Statistics Division (UNSD). These** promote sustainable development by mainstreaming the value of natural capital in development planning and national accounting systems. WAVES and UNSD use the SEEA to produce NCAs in countries as an important tool to inform economic decision-making on natural resources.

- **Methods used in major knowledge products to inform the development of natural capital accounts**, including the TEEB studies, Millennium Ecosystem Assessment, Inclusive Wealth Report, and World Bank studies on comprehensive wealth. **Adjusting or establishing add-ons to existing GDP-based measures.**

There are specific methods for measuring different variables in different sectors. These are summarised below:

General Measure of circularity of the inflow of a product.

This corresponds to the percentage of renewable content (or non-virgin material) by weight.

The formula is as follows:

$$\text{Material Inflow Circularity (\%)} = \frac{\text{(Volume of renewable material)}}{\text{(Total volume of material)}\ x100\%}$$

GHG emissions:
The formula for estimating the quantity of GHG emissions can be expressed as:

$E = ADxEF$

Where: E = GHG emissions, AD = Activity Data, and EF = Emissions factor

Waste

Waste can be estimated by analysing waste types and quantities of waste generated in a particular area and sector. This information can be collected using the following methods:

- **Weighbridge**—weighing the vehicles at the point of entry to the waste disposal facility and again on the way out. The difference in the mass of the vehicle between entry and exit represents the mass of the waste.
- **Vehicle capacity and estimates of waste densities** for the different waste streams—The waste mass estimation system uses a formula that requires waste volume, waste density, and waste loading to determine the mass entering a waste disposal facility.

Energy
The Third National Communication used the Leap Model (LEAP10 equations) to analyse scenarios for energy production and use in different sectors [127]. Other possible ways to analyse such scenarios include:

- **Nigeria's Energy Balance**, which being delivered in partnership with the International Renewable Energy Agency (IRENA).
- **The Nigeria Energy Calculator 2050** [155], which is being implemented by ECN. The United Kingdom Department for International Development (DFID) funded the development of this tool [127].

The energy circularity element is simply integrating the element of renewable energy as it measures the percentage of renewable energy consumed by operation.

$$\text{Renewable Energy Circularity index} = \frac{\text{(Annual renewable energy consumption)}}{\text{(Total annual energy consumption)}\ x100\%}$$

Water
Indicators derived from the water accounts cover many critical aspects of water management:

- Water resource availability
- Water use for human activities, pressure on water resources, and opportunities to use water more efficiently.
- Opportunities to increase effective water supply through reuse and managing return flows and system losses.
- Water cost and pricing policy: the user-pays and polluter-pays principles

Water inflow circularity index: This is the percentage of inflow of water that is circulated. It is calculated as:

$$\text{Water Inflow Circularity Index (\%)} = \frac{\text{Volume of the withdrawal water that is recirculated}}{\text{Total volume of withdrawal water}} x100\%$$

Water outflow circularity index: This is the percentage of outflow of water that is circulated. It is calculated as:

$$\text{Water Outflow Circularity Index (\%)} = \frac{\text{Volume of the outflow water that is recirculated}}{\text{Total volume of outflow water}} x100\%$$

Water Circularity Index (average of the circularity inflow and the circularity outflow.) This is calculated as follows:

$$\text{Water Circularity Index} = \frac{\text{Inflow Water Circularity Index + Outflow Water Circularity Index}}{2}$$

Biodiversity

The Local Ecological Foot printing Tool (LEFT) tool is used in "assessing the ecological value of landscapes beyond protected areas" to alert land use planners to areas of high ecological value. "The method uses existing globally available web-based databases and models to provide an ecological score based on five key ecological features (biodiversity, fragmentation, threat, connectivity, and resilience) for every 300 m pixel within any given region in the world" [92].

The UN Biodiversity Lab 2.0 enables access to state-of-the-art maps and data on human impacts on natural systems„ climate change, and human development to generate insights to support nature and sustainable development. It is an innovative tool to monitor trends, better understand the causes of global biodiversity loss, and provide data that can help assess the socio- economic implications of different pathways and transform decision making and reporting on biodiversity conservation and the sustainable use of biological resources.

Metrics and Indicators for 4 Key Priority Sectors

Land Use Charge analysis can be used to map changes in land uses (such as changes to forests). The AFOLU Calculator, an IPCC-based accounting method, allows the estimation of the CO_2 benefits and potential climate impacts of eight different types of land-based project activities: forest protection, forest management, afforestation/reforestation, agroforestry, cropland management, grazing land management, forest degradation by fuelwood, and support/development of policies. Table 10.6 and 10.7 show the indicators for measuring some issues across the four priority sectors. Table 10.8 indicates the methods and dataset for ecosystem mapping.

Table 10.6 Metrics and Indicators for 4 Key Priority Sectors

S/N	Sector	Sub-Sector	Metrics	Indicators	Measurement
		Agriculture	Carbon footprint	Production per unit area; proportion of organic agriculture to total agricultural land area; total	Flow Account and Asset Account, MCI; LCA

				consumption; volume of waste, Rate of emission; volume of waste recycled and reused; Number of exchanges for each material within the agri-food value chain; proportion of bio-fertiliser produced relative to the amount of raw material used; difference in input and output; amount of Energy used to make products or services.	
1	AFOLU	Forestry	Resource Productivity	Area of Forest per year; Average proportion of key biodiversity areas covered by protected areas; End-of-life recycling input rates, the use rate of recycled materials; Total material footprint; rate of emission.	Flow Account and Asset Account, S-LCA
		Mining	Resource Productivity	End-of-life recycling input rates, the use rate of recycled materials; Total material footprint; the difference in input and output; the amount of Energy used to make products or services.	LCA; S-LCA
2	Energy	Energy	Renewable energy consumption	Total energy production; Annual energy consumption; Renewable consumption; Population with access to electricity and clean fuels/technology (Percent); rate of emission/pollution; the proportion of green employment and investment; the amount of energy flow as inputs; energy flow that leaves the system (output).	LCA; MFA
3	IPPU	Construction	Resource Productivity	End-of-life recycling input rates; the use rate of recycled materials; Total material footprint; Material Inflow Circularity; proportion of green employment and investment.	LCA; S-LCA
		Fashion & Textile	Resource Productivity	Total material footprint: End-of-life recycling input rates, use rate of recycled materials; Material Inflow Circularity; rate of green employment and investment.	LCA; Socio-economic Life Cycle Assessment (S-LCA)
4	Service	Waste	Waste discharge, Material recovery/recyclable	Rate of waste discharge, the Recycling rate of all waste, Trade-in secondary raw material; rate of green employment and investment.	LCA, MFA, life cycle inventory (LCI)
		Water	Consumption, Waste discharge	Volume in stocks; Volume of the outflow water; Volume of the outflow water that is recirculated; Total volume of outflow water generated; water circularity index; Water use efficiency, number of populations with access to clean water.	Flow Account and Asset Account
	Ecological system	Ecosystem and Biodiversity	Ecosystem Services	Average proportion of Key Biodiversity Areas covered by protected areas (Percent).	Flow Account and Asset Account

Social inclusion	Gender	Ratio female to male involved in each sector

Table 10.7: Key Measurement Indicators for Selected Issues

Issues	Indicators
Climate change	• Carbon emission (ton/year) • Renewable energy (share of power supply) (%) • Energy consumption per capita (Btu/person)
Ecosystem Management	• Forest land (ha) • Water stress (%) • Land and marine conservation
Resource efficiency	• Energy productivity (Btu/USD) • Material productivity (ton/USD) • Water productivity (m^3 / USD) • CO_2 productivity (ton/USD)
Chemicals and waste management	• Waste collection (%) • Waste recycling and reuse (%) • Waste generation (ton/year)

Table 10.8: Mapping Ecosystem Account

Analytical	Action and Data Required	Data Requirement
Mapping Ecosystem	Identifying typology of the ecosystem, mapping their spatial scale, mapping land use land cover.	Land use land cover.
Mapping pressures on Ecosystems	Assessment of direct and indirect (habitat change, climate change, pollution, invasive species), trends of the pressure over space and time.	Data from land use land cover, socio-economic activities.
Assessing conditions of ecosystems	Define conditions of the ecosystem, Mapping changes over time.	Data on habitats, species, environmental quality, biodiversity status.
Mapping ecosystem services	Define ecosystem services and ecosystem capacity.	Data on conditions of the ecosystem, functions, and capacity of ecosystem services.

10.11.2 Agriculture, Forestry and Fisheries Accounting and the SEEA Central Framework

The Agriculture, Forestry, and Fisheries Accounts are one of the many types of accounts covered by the SEEA Central Framework. These accounts use the same accounting concepts as the SEEA and can be considered an application of the SEEA but with a specific focus on agricultural, forestry, and fisheries activities. They are mainly compiled at the level of the individual product. Two main types of accounts capture relevant agriculture, forestry, and fisheries information.

To date, CE solutions for the agricultural sector mostly target the beneficiation of organic wastes from consumers and the recycling of food packaging. CE solutions for unmanaged surplus or inevitable losses in the chain still need attention. Therefore, there is a need to explore the possibility of stimulating the CE approach to address food losses in Nigerian food value chains. Food waste provides bio-economy opportunities such as animal feed production, (liquid) fertilisers, and new biomaterials from agricultural by-products [12]. The agri-food sector needs to be central to Nigeria's CE pathway, given that the sector

is a major source of income and jobs in the country. CE principles could act as a driver to promote food security and increase productivity in the agriculture and food production sectors [128].

Link to Ecosystem Accounting

Agriculture, Forestry, and Fisheries Accounts are key to supporting the development of ecosystem accounts, particularly in terms of measuring the supply of ecosystem services. Links between agriculture, forestry, and fishery accounting and ecosystem accounting includes payment schemes for ecosystem services (for example, forestry and watersheds), biodiversity offsetting, designation of protected areas, environmental impact assessment and cost-benefit analysis, and green' infrastructure development.

10.11.3 NCA – Biodiversity & Forest Accounting

NCA in biodiversity accounting can be carried out using international instruments and agreements. These include:

- **Convention on Biological Diversity**: This applies biodiversity strategies, actions plan, and/or work towards the Aichi Targets as a framework for NCA – Ramsar Convention on Wetlands – Use monitoring of Listed Wetlands as a basis for NCA – UNFCCC – Use efforts to develop national GHG inventories as a basis for NCA.
- **UN-REDD**: Use national REDD+ strategies and associated financial support as a framework for and driver for NCA.

SEEA Experimental Ecosystem Accounting (SEEA-EEA) supports biodiversity accounting. It accounts for ecosystem services (flows) and assets (stocks) in physical terms, along with detailed carbon, water, and biodiversity accounts, to provide a general indication of the state of an ecosystem and the services it provides to socio-economic systems.

Data gaps for NCAA & Circularity Assessment in Nigeria

Though there are policies with relative link a less fossil dependence. However, very clear circular economy linking policies are largely missing. Moreso, there is still a lack of concrete policies to stimulate a shift to a green and more circular economy and promote investments in other sectors. Data gaps include specific data on various sectors integral to the transition to the CE. Data gaps for NCAA include:

- **Flow accounts**: These record physical flows of agriculture, forestry, and fishery products between the environment and the economy. Parallel monetary accounts then record the monetary flows associated with agriculture, forestry, and fishery transactions for products.
- **Asset accounts**: These measure the quantity of agriculture, forestry, and fishery resources and changes in these resources over an accounting period. They can be compiled in physical terms, which provide important information on the stock of environmental assets. Parallel monetary accounts then record the monetary flows associated with transactions for the agriculture, fishery, or forest products.

While some institutions hold data that may support MRV for NCAA, CE and GG, there is a lack of data-sharing agreements between stakeholders in the different sectors. None of the key emission sectors or MDAs are under a legal obligation to collect and process GHG data and share it with the DCC. Many of the existing datasets are poorly harmonised and are held by individual officers, rather than institutions. This hinders the sustainability of the data management processes.
Other critical challenges to effective MRV in Nigeria include:

- The absence of clear roles and responsibilities of relevant MDAs to collect, archive, and process data for developing a robust and sustainable MRV system in the four-priority sector.
- The absence of a clear definitions of institutional arrangements; data collection, transfer, and sharing methodologies; or reporting structures
- Incomplete or non-existent data on certain activities and a lack of experimental data for developing Nigeria-specific emission and stock change factors.
- Insufficient documentation and the absence of a system for archiving data from previous GHG inventories.
- There is a lack of significant solid waste infrastructure and inadequate data management on waste generated in the different cities based on their classes. Moreover, there are many uncontrolled open dumps. Composting.

10.11.4 Strategies to apply and promote NCAA and CE in Nigeria

Key strategies to apply and promote NCAA and CE in Nigeria [16] are:

- Involve international players to develop closed-loop systems for the relevant industries in the priority sectors. Nigeria could become a leader in the production and management of innovative, sustainable plastics.
- Involve the local packaging industry to support a transition to circular models. A local production label, "Made-In-Nigeria" could accelerate progress towards a new era of high-quality. Nigerian manufacturing. CE principles are key to ensuring that such an industrial revival does not increase pressure on the environment.
- Establish local value chains and an innovative local chemical industry based on secondary materials. Multinational chemical players are driving innovative development in the industry with local CE hubs.

10.12 Ecosystem Account of Natural Capital in Nigeria: Land Cover

The extent of forests and its existing stocks are analysed by Nigeria's distinct ecological zones.

Mangrove ecological zone

The research team analysed land use in the Mangrove Ecological Zone and the changes that took place between 2006 and 2016The zone had 15.4% mangrove in 2006, which fell to 12.3% in 2016 (Table 10.9) **Appendix 37 and Appendix 38**, respectively, present maps from 2006 and 2016 showing land use in the Mangrove ecological zone.

Table 10.9: Mangrove Ecological Zone Land Cover, 2006 vs 2016

Land cover	2006 area in hectares	2016 areas hectares	% land cover 2006	% land cover 2016
Undisturbed forest	292,264.83	156,888.18	6.9	3.7
Mangrove	649,737	518,063.85	15.4	12.3
Forested freshwater	1,288,084.77	846,048.06	30.6	20.1
Forest plantation	72,060.93	119,118.51	1.7	2.8
Disturbed forest	197,203.5	311,055.75	4.7	7.4
Tree crop plantation	326,884.59	619,223.4	7.8	14.7

Arable land	232,196.58	576,227.61	5.5	13.7
Settlements	222,843.96	242,786.7	5.3	5.8
Bare surfaces	555,038.19	135,239.67	13.2	3.2
Water Body	429,647.22	423,355.14	10.2	10.1

Lowland Rainforest ecological zone

Arable land accounts for the largest share of land cover in the lowland rainforest ecological zone (increasing rapidly from 17.8% in 2006 to 35% in 2016). Bare surface accounted for 20% of land cover in 2006, but only 6.6 percent by 2016 (Table 10.10). Appendix **39** presents a map of land cover in the Lowland Rain Forest ecological zone in 2016 and Appendix **40** presents the equivalent map from 2016.

Table 10.10: Lowland Rainforest Ecological Zone Land Cover, 2006 vs 2016

Land cover	2006 Area in Hectares	2016 Areas in Hectares	% land cover 2006	% land cover 2016
Undisturbed forest	680,628.24	618,433.47	6.8	6.2
Forested freshwater	782,610.48	775,138.41	7.8	7.8
Forest plantation	449,172.27	376,007.94	4.5	3.8
Disturbed forest	1,070,309.34	1,095,552.54	10.7	11
Tree crop plantation	1,127,234.97	1,055,112.21	11.3	10.6
Grassland	25,428.96	298,120.86	0.3	3
Arable land	1,773,899.91	3,517,485.66	17.8	35.2
Settlements	1,237,327.74	666,921.6	12.4	6.7
Bare surfaces	2,003,674.32	654,197.22	20.1	6.6
Water body	414,65.88	40,714.83	0.4	0.4

Derived Savannah ecological zone

In the derived savannah ecological zone, the major land cover class is arable land, which covered 31.8% of the zone in 2006 and increased rapidly to 45.6% in 2016 (Table 10.11). This indicates that farming is the dominant land cover class in the derived savannah zone, closely followed by savanna land, which accounted for 26.5% in 2006 and 20.3% in 2016. Forest cover decreased from 0.4% to 0.3% over the same period. Appendix **41** and Appendix **42** present land cover maps for the Derived Savannah ecological zone from 2006 and 2016, respectively.

Table 10.11: Derived Savannah Ecological Zone Land Cover, 2006 vs 2016

Land cover	2006 Area in Hectares	2016 Areas in Hectares	% land cover 2006	% Land cover 2016

Undisturbed forest	181,835.19	129,033.36	0.4	0.3
Forested freshwater	293,115.42	327,640.14	0.7	0.8
Forest plantation	1,629,425.79	113,085	3.9	0.3
Disturbed forest	884,182.41	685,316.61	2.1	1.6
Tree crop plantation	598,100.4	162,657.36	1.4	0.4
Savannah	11,212,827.84	8,565,775.29	26.5	20.3
Grassland	2,743,701.12	2,613,204.63	6.5	6.2
Arable land	13,422,872.25	19,272,630.87	31.8	45.6
Settlements	6,618,026.7	4,985,191.44	15.7	11.8
Bare surfaces	4,308,484.59	4,994,927.28	10.2	11.8
Water body	307,921.41	331,865.1	0.7	0.8
Total	42,256,275.3	42,256,275.3	100	100

Sudan and Sahel Savannah ecological zones

The major land cover classes in the Sudan and Sahel Savannah ecological zones are grassland and arable land (Table 10.12). They covered 30.8% and 44.8% of land, respectively, in 2006, and 24.6% and 43.7%, respectively, in 2016. Undisturbed forest cover increased from around 10,400 hectares in 2006 to just over 37,100 in 2016This was possibly due to the GGW project. Appendix **43** and Appendix **44** present land cover maps for the Sudan and Sahel Savannah ecological zones from 2006 and 2016, respectively.

Table 10.12: Sudan and Sahel Savannah Ecological Zones Land Cover, 2006 vs 2016

Land cover	2006 Area in Hectares	2016 Areas in Hectares	%Land cover 2006	%Land cover 2016
Undisturbed forest	10,428.57	37,170.27	0	0.1
Forested freshwater	21,539.97	725,819.58	0.1	2
Forest plantation	151,796.79	8,788.86	0.4	0
Disturbed forest	38,269.98	42,464.97	0.1	0.1
Tree crop plantation	202,151.34	8,219.16	0.6	0
Savannah	2,510,489.43	3,886,140.06	7	10.8
Grassland	11,124,877.95	8,872,589.97	30.8	24.6
Arable land	16,166,596.23	15,770,387.16	44.8	43.7
Settlements	2,514,628.26	2,382,348.33	7	6.6
Bare surfaces	3,092,231.16	3,912,356.16	8.6	10.8
Water body	201,944.16	386,259.12	0.6	1.1
Total	36,067,157.19	36,067,157.19	100	100

Total land cover for Nigeria

In 2006, arable land covered 34.1% of Nigeria's total land area. This share had increased significantly by 2016, covering 42% of the country. The shares of savannah and grassland,

respectively, fell from 15% and 15% in 2006 to 14.2% and 12.7% in 2016 (Tables 10.13 to 10.16). This indicates an aggressive conversion of grassland and savannah to other land cover, including arable land. Settlements reduced from 11.2 to 8.9%, likely due to the nature of Nigeria's settlements pattern [34]. The pattern of settlements in the south of the country differs significantly from that in the north. Most settlements in northern Nigeria have ornamental trees planted around residential buildings, especially in rural residential areas where trees protect the building and residents from harsh weather conditions during the dry season. Such deciduous trees grew to form a closed canopy in 2016, giving a semblance of increased forest cover and reduced settlements cover.

Table 10.13: Nigeria's Land Cover, 1995 to 2016

Land cover	1995 Area in hectares	2006 Area in hectares	2016 Area in hectares
Undisturbed forest	2,126,268.72	1,121,827.05	1,019,307.42
Mangrove	1,081,571.93	760,847.13	982,238.49
Forested freshwater	3,126,971.87	2,394,684.36	2,686,473.54
Forest plantation	269,294.07	2,310,004.35	617,959.8
Disturbed forest	10,258,307.08	2,204,034.93	2,146,483.53
Tree Crop plantation	214,482.18	2,265,453.54	1,848,847.86
Savannah	11,049,488.69	14,552,113.95	13,232,643.66
Grassland	522,417.29	13,969,741.86	11,855,946.24
Arable land	59,674,675.28	31,710,018.15	39,281,531.67
Settlements	522,417.29	10,642,392.9	8,325,510.48
Bare surfaces	2,683,627.13	10,017,383.85	9,748,393.29
Water body	1,527,378.24	1,108,397.7	1,311,563.79
Total	93,056,899.77	93,056,899.77	93,056,899.77

Table 10.14: Change in Nigeria's Land Cover, 2006 to 2016

Land cover	2006 area in hectares	2016 area in hectares	Change in area, hectares
Undisturbed forest	1,121,827.05	1,019,307.42	-102,519.6
Mangrove	760,847.13	982,238.49	221,391.4
Forested freshwater	2,394,684.36	2,686,473.54	291,789.2
Forest plantation	2,310,004.35	617,959.8	-1,692,044.6
Disturbed forest	2,204,034.93	2,146,483.53	-57,551.4
Tree crop plantation	2,265,453.54	1,848,847.86	-416,605.7
Savannah	14,552,113.95	13,232,643.66	-1,319,470.3

Grassland	13,969,741.86	11,855,946.24	-2,113,795.6
Arable land	31,710,018.15	39,281,531.67	7,571,513.5
Settlements	10,642,392.9	8,325,510.48	-2,316,882.4
Bare surfaces	10,017,383.85	9,748,393.29	-268,990.6
Water body	1,108,397.7	1,311,563.79	203,166.1
Total	93,056,899.77	93,056,899.77	

Table 10.15: Nigeria's Land Cover, 2006 and 2016

Land cover	2006 area in hectares	2016 area in hectares	% land cover, 2006	% land Cover, 2016
Undisturbed forest	1,121,827.05	1,019,307.42	1.2	1.1
Mangrove	760,847.13	982,238.49	0.8	1.1
Forested freshwater	2,394,684.36	2,686,473.54	2.6	2.9
Forest plantation	2,310,004.35	617,959.8	2.5	0.7
Disturbed forest	2,204,034.93	2,146,483.53	2.4	2.3
Tree crop plantation	2,265,453.54	1,848,847.86	2.4	2
Savannah	14,552,113.95	13,232,643.66	15.6	14.2
Grassland	13,969,741.86	11,855,946.24	15	12.7
Arable land	31,710,018.15	39,281,531.67	34.1	42.2
Settlements	10,642,392.9	8,325,510.48	11.4	8.9
Bare surfaces	10,017,383.85	9,748,393.29	10.8	10.5
Water body	1,108,397.7	1,311,563.79	1.2	1.4
Total	93,056,899.77	93,056,899.77	100	100

Table 10.16: Proportional Land Cover Change between 1995 and 2016

Land cover	1995 area in hectares	2006 area in hectares	2016 areas in hectares	Pr 1995	Pr 2006	Proportion 2016

Undisturbed forest	2,126,268.72	1,121,827	1,019,307	0.23	0.12	0.11
Mangrove	1,081,571.93	760,847.1	982,238.5	0.12	0.08	0.11
Forested freshwater	3,126,971.87	2,394,684	2,686,474	0.34	0.26	0.29
Forest plantation	269,294.07	2,310,004	617,959.8	0.03	0.25	0.07
Disturbed forest	10,258,307.08	2,204,035	21,464,84	1.1	0.24	0.23
Tree crop plantation	214,482.18	2,265,454	1,848,848	0.02	0.24	0.2
Savannah	11,049,488.69	14,552,114	13,232,644	1.19	1.56	1.42
Grassland	522,417.29	13,969,742	11,855,946	0.06	1.5	1.27
Arable land	59,674,675.28	31,710,018	39,281,532	6.41	3.41	4.22
Settlements	522417.29	10642393	8325510	0.06	1.14	0.89
Bare surfaces	2683627.13	10017384	9748393	0.29	1.08	1.05
Water body	1527378.24	1108398	1311564	0.16	0.12	0.14
Total	93056899.77	93056900	93056900	10	10	10

Proportional Land cover change between 1995 and 2016

The change occurring within the investigation period showed changes among the disturbed forest and arable lands (see Table 10.16).

Recent data on the change in forest stocks

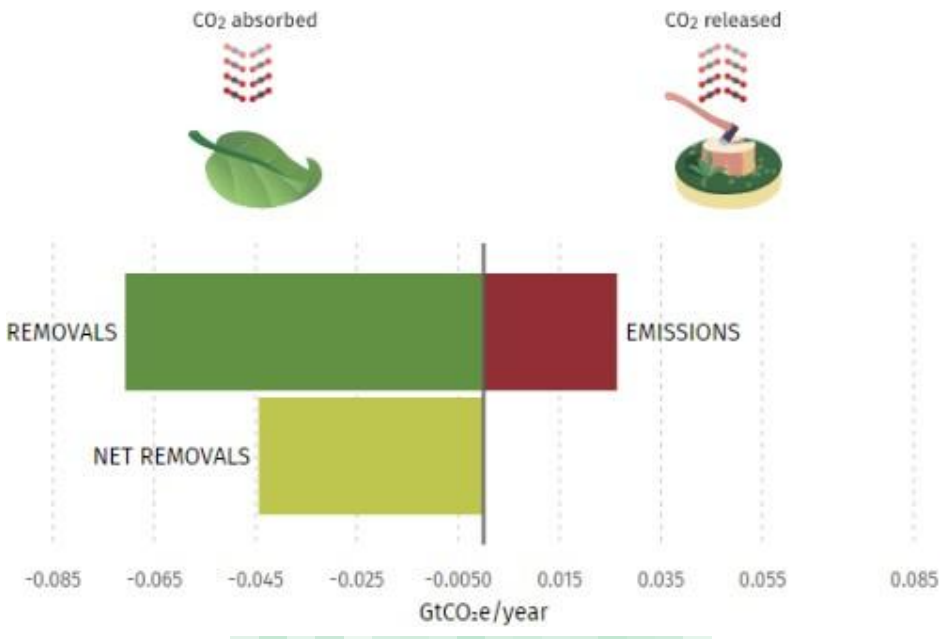
As of 2000, 11% of Nigeria (10.9 million hectares (Mha)) was covered by natural forest. Meanwhile, plantations occupied 28.6 thousand hectares (kha) and non-forest occupied 80.8Mha. In 2010, Nigeria had 10.0Mha of natural forest, extending over 12% of its land area. In 2020, it lost 97.8kha of natural forest, equivalent to 59.5Mt of CO_2 of emissions**. Appendix 48** shows the distribution of Primary Forest Cover in Nigeria in 2000 and 2020, as observed by Global Forest Watch. **Appendix 49** shows the Terrestrial & Marine Protected Areas, as well as other effective area-based conservation measures, as observed by the Global Forest Watch.

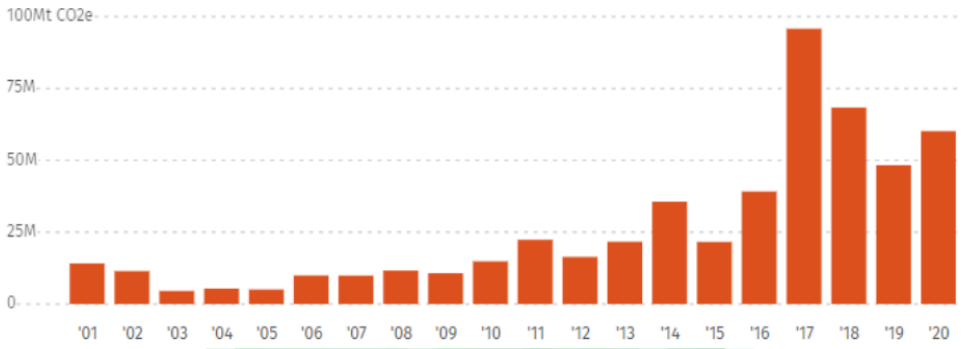
The loss in tree cover shows the extent of change in stocks of the forest ecosystem. The loss is intense in the southwestern part of the country **(Appendix 50).** Appendix 50 shows the tree cover loss between 2000 and 2020.

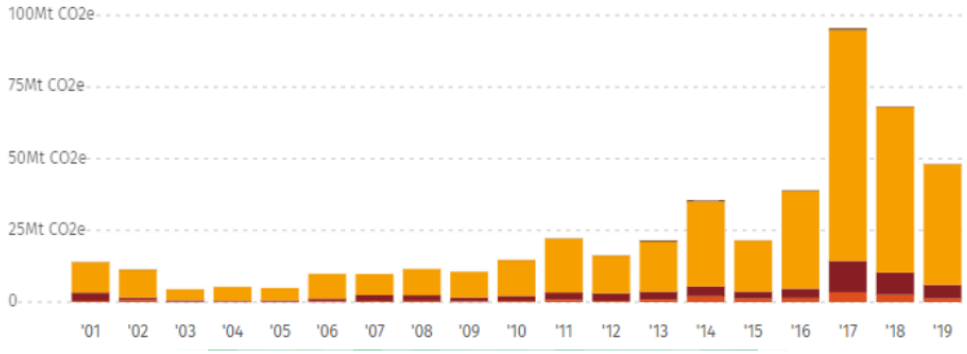
Forest-related GHG fluxes, emissions, and its dominant driver in Nigeria

Between 2001 and 2020, forests in Nigeria emitted 26.3MtCO_2-e per year and removed 70.7MtCO_2e per year. This represents a net carbon flux of −44.4*MtCO_2e/year* (Figure 10.7). Between 2001 and 2020, an average of 26.3Mt per year was released into the atmosphere as a result of tree cover loss in Nigeria. In total, 527MtCO_2e was emitted in this period (Figure 10.8). Between 2001 and 2019, average emissions of 71.4MtCO_2e/year occurred in areas where the dominant drivers of loss resulted in deforestation (Figure 10.9).

The population pressure shows high population density in the north-central and Southern parts of the country. This determines the dependencies on NC as shown in **Appendix 51.** It shows the Population distribution by ecological zones as observed by the Global Forest Watch.


CO_2 absorbed
CO_2 released
REMOVALS
EMISSIONS
NET REMOVALS
-0.085
-0.065
-0.045
-0.025
-0.0050
0.015
0.035
0.055
0.085
$GtCO_2e$/year


100Mt CO2e
75M
50M
25M
0
'01
'02
'03
'04
'05
'06
'07
'08
'09
'10
'11
'12
'13
'14
'15
'16
'17
'18
'19
'20



10.13 NCAA in Water, Plastic & Forest

This section provides an example of NCAA in the water sector. The accounts show the monetary value of water assets based on a case study of five LGAs in Benue State. MRV can be used in the accounting of measurement of water as an asset of Natural Capital as seen in table 9.3). The population of 199,009 in one LGA will spend ₦515,833,920. It shows the amount that can be generated from harnessing water resources.

NCAA in the plastic waste component of the CE focuses on the revenue a scavenger in the informal sector can earn from collecting plastic bottles. Table 10.16 converts plastic waste to monetary assets. If a scavenger collects 1 tonne of plastic bottles, he or she will be paid ₦25,000. If, in 2 months, he/she can collect 250,000 bottles (the capacity of a garbage truck), which together weigh 5 tonnes, he/she is expected to earn ₦125,000. Therefore, a hardworking scavenger can earn ₦750,000 in 1 year (based on global default value estimates).

The methodology for calculating value of forest applied here is the Biome Average System, for which the farmer or forester does not need high tech to estimate the potential revenue to be drawn from his or her investment in plantations. This approach uses population as the key component for the unit measurement obtained from one tree. An alternative approach is to estimate the volume of a tree is measuring the tree's Diameter at breast height (DBH) and its merchantable height. The volume is converted to biomass and then to carbon. The value is based on the amount of carbon and the market price of carbon (see Table 9.4)

Large areas of forest can be measured only using spatial technology such as remote sensing GIS and applying verification on the ground called ground trotting. This involves segmenting the forest land into plots, either temporarily or permanently, with measurement technologies used to estimate the carbon sink in the respective measurement area.

The measurement above showed in practical terms that a state government could invest in conservation as long as it identifies a market that will be able to harvest 393 billion Naira from 404,685.6 hectares of land and approximately 2million Naira from 2 hectares as shown above. Individual farmers can be encouraged to go into conservation as businesses by the government. The local administration can be saddled with the responsibility to provide Quality Control (QC) to such ventures in their areas.

Table 10.16: Converting Plastic waste to asset

Company	No. of Truck	Truck load Capacity (Tonnes)	Qty of Bottles per tonne	Qty of Bottles in truck(s)	Price of 1 tonne of Bottles (in Naira)	Total Amount made in Naira
Private Company A	1	5	50000	250000	25000	125000
Private Company B	4	20	50000	1000000	25000	500000
Private Company C	2	10	50000	500000	25000	250000
Private Company D	10	50	50000	2500000	25000	1250000
Private Company E	13	65	50000	3250000	25000	1625000
Private Company F	8	40	50000	2000000	25000	1000000

Assumptions:

- 1,000kg of plastic waste (1 tonne) is 50,000 bottles
- The price of 1kg of plastic waste is ₦25 (Cycled [157]). Therefore, the price of 1 tonne of plastic (1,000kg, or 50,000 bottles) is ₦25,000
- Total weight capacity of a garbage truck is 5 tonnes.

Calculations:

- Truck capacity (tonnes) = No. of trucks x 5 tonnes per truck
- Bottles in truck(s) = Truck capacity x bottles per tonne
- Total amount made in ₦ = Price of 1 tonne of bottles x truck capacity

10.14 Ecosystem Measurement (Using MRV)

Ecosystem services are part of NC assets. Ecosystem services are very much in the ecotourism sector. It is a revenue earner if driven by objective policies and regulations in the national space. Stakeholders in the area are hoteliers, wildlife parks etc.

The traditional ecosystem measurements are physical. The measurement of ecosystem services units is an issue Central to environmental policies. This includes Government performance Assessment. While it is so, application of MRV component is possible as the measurement using MRV system entails Ex- Ante measurement and Ex-post measurements. Practical measurement of ecosystem services cannot be standardized because the ecosystem is dynamic. Unit of measurement can also be determined in-country by stakeholders and government to enable standardized measurements.

A hotel built inside wildlife park can boost ecotourism. This system is in Zambia. Green GDP conservation priorities benefit transfer in cost-benefit analysis and trade in ecosystem services and should all rely on the same unit. This is the argument among environmental experts. The experts want standardised Units for Ecosystem services akin to the default values obtained in GHG measurements. Ecosystem assessment relies on ecosystem services as a framework concept for its measurements globally. Numerous governments at across the globe are trying to measure the ecosystem and its services through their various programs. These programmes are fitted with payment for ecosystem services (PES) in some countries.

10.15 Gaps

The analysis carried out for this report identified that MRV capacity is lacking in most sectors and types of NC. There is no specific regulation on capital assets. The MRV framework and policy proposed in this report use a bottom-up approach to empower local governments as the focal points for generating revenue from NC and contributing to the centre through the various state governments. Training of institutions at the local level will enhance the process of data gathering in the NC space.

Specific indicators to measure conditions of NC are scant in many sectors. Some indicators could be used and to ensure that the extent of NC and such indicators used are consistent as far as possible across ecosystem types and sectors. Such indicators should monitor spatial and temporal losses and gains in NC, identify priority areas for investment and inform management decisions in each sector, and link economic activity to specific types of NC, their hotspots and pressure.

There are statistical gaps in spatial and temporal dimension. Data generation, processing and archiving in Nigeria have been a challenging one. For instance, the data collected on distribution of natural capital and their extent are outdated and require collection of new data on the current conditions. There is no effective database management system for archiving of MRV data. This has made data processing particularly in comparison with historical data difficult. There are uncertainties around both the historical and current data from many sources, including the AFOLU, IPPU, energy, and waste sectors. Moreover, the lack of reliable data generally makes it impossible to estimate the flows of NC and to make projections based on certain conditions and the deviation from business-as-usual scenario if certain conditions changes.

Besides data, setting up a robust MRV system in Nigeria faces several other challenges. A lack of political will and corresponding lack of financial support hinder efforts to collect data sufficiently frequently. For example, some data, such as those related to GHG emissions, waste, and forestry, need to be collected annually. However, such data may only be collected once in a decade. Political will and support, including budgetary allocation, are vital to ensuring the continuous and sustainable operation of an integrated and comprehensive MRV system for NCAA, CE and GG.

Poor coordination and limited consultations between relevant institutions and other stakeholders, particularly in relation to methodologies for data collection and analysis, is another major gap. Various data were collected and analysed on a sectoral basis without uniformity. Though the FME's DCC is responsible for GHG and climate change reporting, MRV systems are mostly developed individually, on a case-by-case basis and in specific sectors. There is no or limited legal framework for reporting structure, data transfer and data sharing among institutions and stakeholders that can be leveraged for NCAA and CE.

The roles and responsibilities of relevant MDAs in collecting data are often unclear, and capacity is lacking. More so, limited data collection capacity exists, while in others such as local governments, capacity is non-existent and there is highly limited access to the appropriate tools and technologies required to collect the relevant data and information.

10.16 Recommendations For Policymakers

Policy Development: The federal government should capitalise on the advantages of Nigeria's NC by enacting policies, legislation, and standards, including a procedure for implementing MRV, into governance structures. NC can be measured by an MRV framework. The Government must take the MRV framework seriously as it provides the basis for unit measurement of NC in monetary terms for smallholder farmers, local governments, or the private sector.

The Government of Nigeria should lead the demand for NCA to generate better data on physical stocks and flows. It should develop a Natural Capital Development Plan (2023-2026). This will help map all the country's natural assets and balance the use of them against population growth.

Capacity Development: The federal government should support both state and local governments in building their understanding of MRV that should be in cooperated for governance since in this paper it is established that MRV can be applied to governance (example: 1 cup of carbon is measured, 1 cup of carbon is reported and 1 cup of carbon can be verified through quality assurance). This is the concept of MRV. In governance for MRV, the application is an example; if a person is asked to provide 164 beds in a hospital, the unit price of the bed is ₦40,000, and you are to provide 164 beds, the total amount in monetary terms will be 164 x 40,000 = ₦6,560,000. This data can be reported, verified as measured. This is MRV in governance.

All local governments should know how to measure NC, derive revenues from it, and use such revenues by sharing some percentage with the state government and then the federal government, while spending the rest on capital projects that support the environment. Standard reporting templates specify what the GHG inventory or MRV should include and which format it should be in:

- Name, location, contact information, reporting period.
- Emissions information (total, by source/gas/activity, uncertainty)
- Input data on fuel use, waste, production, and so on
- Data collection (metering data, invoices, production protocols)
- Sampling of materials/fuels
- Laboratory analyses of fuels/materials
- Maintenance and calibration of meters
- Methodologies and equations for calculations
- QA/QC procedures.

Specific recommendations to implement MRV for NCAA, CE and GG in Nigeria include:

- **Aligning indicators to the SDGs and NDCs.** More work is needed to identify the areas in which reference condition indicators could be used and to ensure that the indicators used are, as far as possible, consistent across ecosystem types.
- **Enacting legal instruments** such as memoranda of understanding or legal agreements to ensure the incorporation of MRV activities and data sharing protocols into the normal routines of relevant institutions. The exchange of information between the various stakeholders (including MDAs, the private sector, and academia) within the MRV system should have a legal basis.
- **Integrating policies on NCA, CE, and green growth into the different institutions and sectoral policies** to further engage and reinforce the involvement of stakeholders. This seeks to adapt and update the indicator framework for the analysis of NCAA, CE, and green growth. For example, new policies will identify areas for emission and waste reduction in the sector

processes, which could require additional indicators or indicators may be adapted to best fit newly identified datasets.

- **Clarifying the MRV-related roles and responsibilities of different stakeholders and strengthening coordination between them**: For example, there are numerous data sources for GHG, BUR, NDC FREL reporting process with varying degrees of result on the same issue. Coordination will enhance uniformity in data analysis and reporting. An integral component of an MRV system is agreeing on the provision of data from the network of institutions and data providers. Data management, analysis and reporting are also key tasks. Compilation and the flows of data to the MRV system from data providers and stakeholders need to be improved.
- **Establishing common guidelines, standards, formats, and templates to facilitate consistency in reporting MRV results for NCAA and CE**. This will include developing a framework to guide data collection, analysis, archiving, management, and reporting. It is also important to define the frequency of data collection and reporting.
- Organization – clear mandates, roles and responsibilities that bring people and data together to fulfil objectives to support decision-makers.
- **Disaggregating key Performance Indicators (by sector** to measure the performance of the actions and progress in each sector of the CE, including GHG-related impacts (e.g., emissions reductions), non-GHG impacts (contribution to the SDGs, adaptation to climate change, and gender-related objectives), and progress towards the NDC goals (e.g., means of implementation and support received).
- **Establishing an effective regulatory framework to enable the design and implementation of quality assurance /quality control procedures**. A clear quality assurance /quality control guidelines will help overcome bureaucratic bottlenecks to the regular flow of data from specific data collection services to useful analysis and reports.

10.17 Towards developing a Roadmap for MRV

The MRV system in NCAA, CE and GG provides a way to measure natural assets, enabling countries to set thresholds while balancing population expansion with the consumption of natural capital (for example, in the form of deforestation, water usage, waste disposal, and land-use.

The MRV process will entail:

1. Creating a consolidated database of NC assets as part of the National Accounts managed by NBS.
2. Compiling a consistent, comparable, and regularly produced national NCA based on the UN-SEEA framework, to include insights that will help identify and manage risks to achieving the NDCs, SDGs, and other policy targets at the national, sub-national, and local government levels, as well as in the private sector.
3. Developing metrics to ensure that mitigation actions are being implemented, such as establishing renewable energy portfolio standards or building waste treatment facilities.
4. Updating any existing maps of environmental assets and/or biodiversity ecosystems in Nigeria
5. Collecting geo-referenced datasets and creating a database of NCAs
6. Producing core accounts that measure total ecosystem capability and assess degradation or enhancement.
7. Undertaking functional analysis of ecosystem capital and services in monetary units; measuring unpaid degradation costs; and valuing ecosystem services.

The above actions are vital to mainstreaming the NCA into the national planning and budgeting system as they will enable Nigeria to better understand how the environment underpins wealth and economic activity and to monitor environmental degradation and its costs.

The roadmap will be implemented in the short-, medium-, and long-terms, as follows:

1. **Short-term** (the first 3 years)—This will involve establishing the institutional framework and carrying out spatial analysis of existing natural assets (their status, conditions, flows, and monetary value).
2. **Medium-term** (first 4 to6 years of implementation)—This will involve building capacity of government and private sector and infrastructure to support Nigeria's transition to CE and SEEA.
3. **Long-term** (7 to 10 years)—This will involve implementing NCAA, CE, and GG goals, MRV of emissions, pollution, and waste in different sectors, including monitoring the transition to CE and NCA.

11 Checklist: Nigeria Circular Economy Roadmap

A

ppendices 27 and 28 highlight the checklist utilised for the stakeholders' engagement process required for developing the Nigerian Circular Economy Roadmap (NCERM) across the priority sectors and clusters. The table information (**Appendix 27, 28**) provides the ingredients for prioritizing the CE/NC interventions along a set of criteria to be collectively determined by stakeholders. A programmatic approach will develop the Nigerian Circular Economic Roadmap (NCERM).

Guide to Checklist Development

This section gives a summary of the checklist utilised for the stakeholders' engagement across the priority sectors and clusters. See Appendix 27 and 28 for more details.

A. **AFOLU SECTOR:**

1. Checklists for CE Business Opportunities

- Issues/Challenges
- Circular Economy Business/Investment Opportunities
- Policy Options/Reforms (NPCE)
- Legislative Options/Reforms
- Investment Plan (NCEIP)

  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

2. Natural Capital intervention programs

- Issues/Challenges
- Natural Capital Business/Investment Opportunities
- Policy Options/Reforms
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

B. SERVICE SECTOR (WASTE AND WATER)

1. Checklists for CE Business Opportunities

- Issues/Challenges
- Natural Capital Business/Investment Opportunities
- Policy Options/Reforms (NPCE)
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

2. Natural Capital intervention programs

- Issues/Challenges
- Natural Capital Business/Investment Opportunities
- Policy Options/Reforms
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)

- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

C. ENERGY SECTOR:

1. Checklists for CE Business Opportunities

- Issues/Challenges
- Circular Economy Business/Investment Opportunities
- Policy Options/Reforms (NPCE)
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

2. Natural Capital intervention programs

- Issues/Challenges
- Natural Capital Business/Investment Opportunities
- Policy Options/Reforms
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

D. IPPU SECTOR

1. Checklists for CE Business Opportunities

- Issues/Challenges
- Circular Economy Business/Investment Opportunities
- Policy Options/Reforms (NPCE)
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)

- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

2. Natural Capital intervention programs

- Issues/Challenges
- Natural Capital Business/Investment Opportunities
- Policy Options/Reforms
- Legislative Options/Reforms
- Investment Plan (NCEIP)
  - Business Strategy (CEBS)
  - Finance & Projects (CEF, CEPs)
- Technology applications (CETs)
- Infrastructure (CEI)
- Planning Process & Mainstreaming
- MRV, NCA & National Natural Capital Strategy (NNCS)
- Corporate responsibility of firms and companies in green accounting (companies to disclose the nature of their dependence and impact on NC) – Policy & legislative intervention.

Appendices

1. Boxes

The Netherlands

- The Dutch economy which is presently among the most circular economies in the world at 24.5% has determined to be completely circular in the year 2050 and as such developed unique strategies to fulfill this objective [59].
- In the Netherlands, waste disposal requires strict precautions, because the landscape is relatively flat and the water-table just under ground-level [39].
- Dwindling land areas and growing knowledge in sustainability has been the key drivers to making radical changes and the Dutch government has developed more guidelines on waste management and recycling than many countries and their enforcement is a key reason for its circularity.

Finland

- Finland was the first country to prepare a national road map to a circular economy in 2016 which contains Finland's plans to reform its economic model to ensure successful sustainability.
- The aim of the project was to make Finland a global leader in circular economy by 2025 and promote the objectives set in the EU Commission's Circular Economy Package [85].

India

- India is one of the most rapidly developing countries, [95] with current population size of about 1.38 billion [111] and waste generation rate is continuously increasing due to its population size and industrialization. It is reported that the Government of India recently added policies on waste management to include partnership with private sector and this has helped to raise the competency level in the sector and boosted revenue [109].
- The Government of India with support of local authorities have acknowledged the importance of public involvement in waste management and have tried to encourage sustainable waste management practices and utilize circular economy measures [109].
- Its most recent initiative is called 'Swachchh Bharat Abhiyan', meaning 'Clean India Mission' were public awareness is created about the importance of proper waste management.

Rwanda

- The country of Rwanda located in central Africa is set to be a regional model for Circular Economy activities due to its legislation, strategies and initiatives which have been centred around sustainability. These have included measures such as prohibiting single-use plastic bags as it was one of the first nations to do so, stimulating the growth of the largest Green Fund in the continent, driving relevant policy changes, co-founding the ACEA, and has a history for providing an enabling environment for inventive trials before they are implemented in other African [46].
- Rwanda also recently launched an official e-waste collection site and dismantling plant in 2020 in the outskirts of Kigali which is a PPP called 'Environserve' to tackle e-waste generation [158].

Appendix 1: Other Country's Benchmarks on CE.

2. Tables

Appendix 1: Sector Selection Analysis for Nigeria: Key Economics, Environmental and Social Criteria

	SECTORS	Economic Criteria		Environmental Criteria		Social Criteria		ACEA Criteria	Ranking
		% of GDP Contribution 2020	Highest Investment Potential 2012	% GHG Emissions 2021	Most Polluting Sectors	% of Employment (2017)	Highest Job Creation Potential	Highest Impact of CE Potential Economic Significance, Positive Social & Economic Outcomes, and Current Regulatory Frameworks	Average Position of Sector
1	Energy	9.4% = 3rd	1st	60.2% = 1st	1st	3.3% = 3rd	3rd	3rd	2nd
2	AFOLU	26.21% = 1st	2nd	25% = 2nd	4th	48.2% = 1st	1st	1st	1st
3	IPPU	21.36% = 2nd	3rd	5.3% = 4th	3rd	9.3% = 2nd	2nd	2nd	3rd
4	Services	0.18% = 4th	4th	9.4% = 3rd	2nd	0.1% = 4th	4th	4th	4th

	'GDP Report Q4 and Full Year 2020' by National Bureau of Statistics
	'Nigerian Sustainable Banking Principles' (July 2012)
	'Nigeria's NDC – 2021 Update'
	'Environmental Statistics – The Situation in the Federal Republic of Nigeria' (FOS/FMEnv Presentation by Dr Solomon Olaye, Mr Phillip Bankole, Mr M. Adeyinka), and 'WHO Urban Air Quality Database – 2016'
	'Growing an Inclusive Economy: Job Creation and Nigeria's Future' by the Nigerian Economic Summit
	'Nigeria Assessment of Climate Policies' Impact on Employment Economy and Emissions (2021)'; and 'Growing an Inclusive Economy: Job Creation and Nigeria's Future' by the Nigerian Economic Summit
	'Five Big Bets for the Circular Economy in Africa – African Circular Economy Alliance (ACEA) Insight Report – April 2021'

Appendix 2: Scenario Analysis: Agriculture, Forestry and Other Land Use (AFOLU)

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
• Poor land Management: e.g., Slash-and-burn agriculture, excessive soil tillage	• Environmental and land degradation resulting in: • Soil erosion • Landslides • Water contamination • Deforestation • Loss of habitat and species • Increase n air pollution and the release of GHG gases into the atmosphere • Destruction of delicate cycles occurring in the ground • Ecosystem instability	• Organic manuring producing facilities; agro seeds business • Investing in climate smart agricultural practices - (increase in total production and higher yields)	• Ecosystem accounts and assigning monetary value (land, water, forestry) • Sustainable land use management practices e.g., agroforestry, conservative tilling, afforestation etc.	• National Policy on the Environment • National Climate Change Policy document • National Policy on Climate Change	• Financial investments for adequate machineries • Capacity building for better farming practices • Training to high tech Agro companies: farmers and traders, handling, processing. • Subsidies and tax incentives. • Government to pursue research and development on low-carbon farming practices. • The minimum tax payments by agro-allied businesses/ companies.	• Land Accounts (forest ecosystems, Agro-ecosystems, Grassland ecosystems) • Biodiversity Accounts

• Food loss/waste in Agric food value chain. • Factors contributing to food loss include: • Harvesting practices • Lack of infrastructure for recycling. • Inadequate storage facilities • Lack of electricity supply • Lack of suitable transport vehicles • Bad roads	• Food loss equals loss in resources used to produce the food (water, land, power, labour, and capital). • Food in landfills contribute to release of ozone-depletin g gases (Methane and Nitrous Oxides) into the environment during decomposition. • Untreated / uncollected waste during the harvesting stage can cause contamination of soil, surface water and groundwater • proliferation and release of disease-causin g organisms.	• Investment in storage facilities. • Investment in processing facilities • a. Manure processing facilities • b. Increase in food processing facilities for preservation. • Bioenergy (converting agricultural waste to produce biofuel) • Investment in adequate transport for agricultural produce to markets • Production and sale of compost to farmers • Manufacture and trade of compost from organic waste for soil use.	• Reuse, Recycle and Recovery of Food Waste.	• Nigeria's Nationally Determined Contribution (NDC) (2021) Aim- support equitable increases in farm incomes, enhance food security and development. • Agriculture Transformation Agenda. Aim - reduce post-harvest losses, add value to local agricultural produce, develop rural infrastructure and development etc. • Nigeria Economic Sustainability plan (2020) • The Agriculture Promotion Policy (2016 - 2020) Aim- provide platform to engage private sector to establish crowd funding for storage facilities. • Nigeria Economic Sustainability plan (2020) Aim - Facilitate access to farms and aid distribution. • National Policy on Solid Waste Management (2020) - Aim: promote clean and healthy environment for sustainable	• Prioritize management of food waste through the food production value chain. • Trainings of local farmers in post-harvest reduction methods and benefits, business and entrepreneurship, prevention, and management of common diseases, sanitation and hygiene practices. • Rehabilitation of agricultural and ancillary social infrastructure. • Financial investments and incentives to encourage recycling. • Government should encourage and promote relevant and appropriate technology options for setting up projects on energy recovery from solid/organic waste.	• GHG Accounts; Water Accounts (Marine ecosystems, Freshwater ecosystems).

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
				socio-economic development.	• Encourage national programs for the recovery of energy from industrial and urban waste. • Financial incentives for supply of garbage, free of charge to waste-to-energy facilities and for promotion, co-ordination and monitoring of waste-to-energy projects. • Development and maintenance of designated landfill sites at relevant locations.	

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
Livestock Waste	● Release of GHG gases ● Pollution	● Biogas from livestock ● Manure	● Methane fodders	● 2050 Long Term vision for Nigeria - Towards the Development of Nigeria's Long-Term Low Emissions Development Strategy (LT-LEDS) ● National Policy on Solid Waste Management (2020) - Aim: promote clean and healthy environment for sustainable socio-economic development.	● Government to pursue research and development on low-carbon farming/animal practices. ● Low methane fodders for livestock. ● Funding and financial assistance for commercial projects on waste-to-energy programmes. ● Encourage and fund research and studies, trainings, workshops, and seminars on waste to energy technologies and programmes, including award of scholarships.	GHG Accounts; Land Accounts

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
Deforestation	soil erosion landslides water contamination Loss of habitat Increase Loss of Species ecosystem instability, altering ecosystem services increase in GHG	Investment in the forestry sector Afforestation/ecolo restoration programme Investment Ecotourism development Establishment Protected area system	Ecosystem accounts and assigning a monetary value (land, water, forestry Sustainable land use management practices e.g., agroforestry, conservative tilling, afforestation etc.	National Forest policy National Policy on Environment National Policy on Climate Change	Financial investments in sustainable forestry Capacity building for sustainable forest management Training on green technology for processing of forest products. Subsidies and tax incentives. Government to pursue research and development on low-carbon practices.	Land Accounts (forest ecosystems, Agro-ecosystems, Grassland ecosystems) Biodiversity Accounts
Land use land cover change (Forest Conversion to other uses	Loss of natural vegetation Soil loss and degradation Watershed degradation	Plantation Establishment Investment Agroforestry Forest valuation	Sustain Sustainable land management practices e.g., agroforestry, conservative tilling, afforestation etcable land management practices e.g., agroforestry, conservative tilling, afforestation etc Sustainable land management	National Forest policy National Policy on Environment National Policy on Climate Change	Financial investments in sforestry Financial investments in sustainable Financial investment in sustainable forestry Capacity building for sustainable forest management Training on green technology for processing of forest products. Subsidies and tax incentives. Research and development in low-carbon practices	Land-cover accounts, the foundation

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
			practices e.g., agroforestry, conservative tilling, afforestation etc		low-carbon practices	
Biodiversity Loss	Alteration/reduction in ecosystem services Loss of genetic materials	Forest valuation Investment in biodiversity conservation and domestication of biodiversity	Sustainable forest management practices e.g., agroforestry, conservation afforestation, protected area management system etc.	National Forest policy National Policy on Environment National Policy on Climate Change	Investments in biodiversity management item Capacity building for sustainable forest management Training on the domestication of NTFPs and NWFP Subsidies and tax incentives. Research and development in low-carbon practices low-carbon practices	Biomass carbon account; Biodiversity Accounts
Agricultural Expansion	Loss of Species Loss of habitat Loss of ecosystem instability, Species	Agricultural intensity CSA	Sustainable land use management practices e.g., agroforestry, conservative tilling, afforestation etc Investment in CSA	National Forest policy National Policy on Environment National Policy on Climate Change	Financial investments for adequate machineries Capacity building for better farming practices Training to high tech Agro companies: farmers and traders, handling, processing. Subsidies and tax incentives. Government to pursue research and development on	Land Accounts (forest ecosystems, Agro-ecosystems, Grassland ecosystems) Biodiversity Accounts

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
					low-carbon farming practices. The minimum tax The minimum tax payments by agro-allied businesses/companies. comp	
Land Degradation	Land use Conflict	Plantation Establishment	Sustainable land use management practices e.g., agroforestry, conservative tilling, afforestation etc	National Forest policy National Policy on Environment National Policy on Climate Change	Investment in sustainable land management (SLM)	Land Accounts (forest ecosystems, Agro-ecosystems, Grassland ecosystems) Biodiversity Accounts

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
Fuelwood/Charcoal Extraction	Destruction of Destruction of forest GHG emission Species extinction	Establishment of fuelwood lot	Investment in renewable energy	National Forest policy National Policy on Environment National Policy on Climate Change	Investments on Sustainable Investment on Sustainable fuelwood management Establishment of fuel wood lot Training on the use of sawdust for the production of briquette	Land and forest Land and forest accounts Land and forest accounts Land and forest accounts
Destruction of the watershed, wetland and mangrove	Siltation of watershed Loss of species; Habitat destruction invasive species; Destruction of aquatic organism; Low water levels	Watershed Forests and Wetland Management; Mangrove conservation; establishment of Integrated Wetland and mangrove management system	Investment Sustainable land use management practices e.g., agroforestry, conservative tilling, afforestation etc. Investment Integrated watershed and mangrove management project	National Forest policy National Policy on Environment National Policy on Climate Change	Investments in biodiversity management Capacity building for sustainable forest management Training on domestication of NTFPs and NWFP Subsidies and tax	Ecosystem/ biodiversity account

Identification of issue	Effects of issues	Opportunities for CE/NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts Accounts Required (Time series for thematic extent and condition accounts)
Unsustainable practices in forestry due to high demand of wood products (timber and fuelwood)	Illegal logging Rapid reduction in forest cover (deforestation and forest degradation). Climate change Erosion Loss of biodiversity	Investment in Investment in clean technology opportunities that convert wood-based biomass into electricity, heat, biofuels, bio-chemicals, and building materials.	Investment in clean technology Investment in sustainable land use management Investment in clean technology Investment in sustainable land use management methods Investment in clean technology Investment in sustainable land use management methods	Nigeria's Agriculture Promotion Policy 2016-2020 Nigerian Economic Recovery Programmes (NERGP) UNCCD National Action Programme (NAP) National Forest policy National Policy on Climate Change National Policy on Environment	Engage stakeholders, private sectors, civil society and communities in a collaborative approach in the use of efficient practices. Upscale of green job opportunities through sensitization Awareness using locally available innovation Support sustainably smart innovative creations within AFOLU	Land and Forest Accounts and F Land and Forest Land and Forest Accounts orest Accounts Land and Forest Accounts

Appendix 3: Green Jobs in Agriculture by Ecological Zone

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
Rainforest Agro Ecozone:	Appropriate Nutrients Management Through: Promoting the Cultivation of cover Crops (Agroforestry). Development of organic manure/composting Converting waste to organic manure.	SMEs for collection and converting waste to Organic manure (carry out composting). This include composting using crop residue, other agricultural waste	Setting up Micro, Small and Medium Enterprises (MSMEs) in waste conversion to manure	Regular waste collection, sorting and branded fertilizer. Private sector involvement in waste management.
	Intercropping with cover cropping with leguminous crops	Small & Medium business for leguminous crops with other crops for the management of soil nutrients	Intensive agriculture	Wider use of green manure by farmers

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
	Converting animal waste to manure	SMEs in collection of animal waste and waste from home, drying and converting and packaging as organic fertilizer	Setting up Micro, Small and Medium Enterprises (MSMEs) in waste conversion to manure	Availability and wider use of organic manure
	Mixed copping	Production of Fodder from leguminous plants	Intensive agriculture	
	Cultivation of vegetable	Vegetable gardening	Intensive Agriculture	Availability of quality vegetables
	Cultivation of green manure	Business for cultivation of Green manure e.g. **Tithonia diversifolia**	Organic Fertilizer production	Availability of green manure
	Cultivation of tree crops and woodlots	Cultivation of spices (Bush Pepper, Bush Onion)	Agro-processing factory	Presence of agro-processing factories in the local communities and processed products in the market
	Conservation of forest trees	Collection and cultivation of seeds such as **Irvingia gabonensis**	Value chain addition and marketing	Available of locally branded forest product
	Establishment of Bamboo Plantation in degraded lands	Business for the production of Bamboo for building.	Alternative building mate	Reduction in the use of woods from the forest for building and other purposes; reduction in forest depletion Availability of certified
	Establishment of fuel woodlots in degraded ecosystem, eroded and badlands	Commercial fuel wood lots business of short matured cycle species	Commercial fuel wood production	Reduction in fuel wood extraction from the forest; increase in forest area
	Cultivation of plantations in degraded areas	Production of poles	Production of building materials	Availability of alternative building materials
	Mixed cropping of arable tree crops with other crops	Cultivation of herbal plants with tree crops	Post-harvest processing	Number of people involved in the cultivation
	Apiculture	Honey production	Investment in honey production	Availability of branded honey in the market, number of people involved

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
	Home gardening	Cultivation of vegetables and fruits	Fruit Juice production	Number of people involved in cultivation of vegetables and availability in the market
	Agro-Processing	Agro-processing industry for fruits and vegetables	Post-harvest processing	No. of persons employed in agro-based factory
		Oil production from Mimusop, Sheanut, Alablankia and others.	Vegetable oil Production	Presence of ago-based factory and No. of persons employed
	Arts and crafts	Making of local crafts and carvings e.g utensils and light furniture	Crafts making	Increase in the number of crafts and people involved
		Manufacture of Briquette	Alternative source of energy	Wider use of alternative energy other than fuel wood
	Domestication of NTFPs	domestication of NTFPs such as Gnetum africanum, Lesianthera africana, Piper guinensis,	Value addition and marketing of NTFPs	No. of people in the value chain of NTFPs and availability in the market
	Snailry	Commercial Snail farming	Snail farming	Availability of snails in the marke
	Domestication of animals	Bush meat rearing business e.g. Porcupine (Hystrix africaeaustralis), Giant rat (Cricetomys gambianus), Grass cutter (Thryonomys Swinderianus)	Domestication of wild games	Increase in the number of rearing source
	Commercial Fish ponds	Fish Farming	Aquaculture	Availability of quality fish ponds
Derived Savanna	Set up of Snailry	Snail farming	Snail farming	Availability of snails in the market
	Dairy farming	Milk and Yoghurt production	Agro-processing	Availability of locally made dairy product

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
	Establishment of Bamboo Plantation in degraded lands	Business for the production of Bamboo for building.	Setting up materials processing factory	Availability of alternative building materials
	Establishment of fuel woodlots in degraded ecosystem, eroded and badlands	Commercial fuel wood lots business of short matured species	Engage the community in fuel wood plantation	No. of fuel wood lots
	Fodder cultivation	Commercial production of Fodder	Feedproduction	Availability of processed feed
	Delineating watersheds, Restocking Legislation enforcement	Raising nursery	Afforestation	Area of restored watersheds
	Aquaculture	Fish farming	Establishment of Aquaculture farm	No of ponds and availability of fish
	Rice farming in marshland with fish Pond	Rice cultivation in marshland with fish pond	Intensive agriculture in Marshland	Production level of the both rice and fish
	Tree propagation, establishment of woodlots	Cultivating vegetables with tree crops	Multiple Agroforestry system	No. of farmers practicing the system
	Establishment of fuel woodlots in degraded ecosystem, eroded and badlands	Commercial fuel wood lots business of short matured cycle species	Alternative fuel/energy	No. of persons using alternative use of energy
	Cultivation of tree crops and woodlots	Cultivation of spices (Bush Pepper, Bush Onion)	Small scale agro-processing factory	No. of agro-based processing factories and availability of locally processed products
		Cultivation of fruits and seeds such as Irvingia gabonensis	Value addition and marketing of agro products	Availability of certified product
	Apiculture	Honey production	Value addition and marketing of Honey	No. of production sources
	Irrigation Facility	Irrigation	Small scale Irrigation facility	Utilization level of facilities No. of farms during dry season
Guinea Savanna Agro-ecozone	Raise nurseries and procure seedlings	Raising Nursery	Establishment of Nursery of diverse plants species	No. of people involved
	Nutrients Management	SMEs for collection and converting waste to Organic manure	Waste conversion technology	Reduction level of waste; Availability and wider use of organic manure

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
	Intercropping with cover cropping with leguminous crops	Small & Medium business for leguminous crops with other crops for the management of soil nutrients	Intensive agriculture	No. of farmers practicing intercropping
	Converting animal waste to manure	SMEs for collection of animal waste and waste from home, drying and converting and packaging as organic fertilizer	Setting up Micro, Small and Medium Enterprises (MSMEs) in waste conversion to manure	Level of utilization of organic manure and reduction in organic waste stream
	Cultivation of tree crops and woodlots	Cultivation of spices (Bush Pepper, Bush Onion)	Agro-processing	Available locally processed products
	Conservation of forest trees	cultivation of seeds such as Irvingia gabonensis	Value addition and marketing	Demand and supply level
	Establishment of Bamboo Plantation in degraded lands	Business for the production of Bamboo for building.	Alternative building materials	Use of alternative building materials
	Establishment of fuel woodlots in degraded ecosystem, eroded and badlands	Commercial fuel wood lots business of short matured cycle species	Commercial fuel wood production	involved in commercial fuel wood production; reduction in the collection of fuel wood from forest
	Fodder cultivation	Commercial production of Fodder	Processing and marketing of feed	No. of farmers utilizing locally processed feed
		Commercial cultivation of grains	Intensive agriculture	Level of shift in cultivated land
	Irrigation system	Commercial cultivation of grains	Intensive agriculture	No. of farmers practicing all season farming
	Cultivation of fodder plants	Production of fodder	Feed stuff factory	Availability of locally processed feedstuff
Swamp / Mangrove Forest Agro-Ecozone	Bamboo cultivation	Cultivation of Bamboo for poles and building material	Alternative building materials	Level of utilization of alternative building materials
	Surveillance and patrol. Provision of energy efficient technologies such as the choker smoking kines	Manufacturing and marketing of energy efficient stoves	Energy efficient technology	Level of utilization of alternative energy
	Establishment of Fuel wood lots	Cultivation of mangrove in a degraded area	Afforestation programme	Extent of degraded area restored
	Cultivation of Pandanus, Raphia Palm, rattan palm and others	Weaving of baskets, mats and other crafts for commercial purpose	Local craft factory	No. of people involved in local crafts
		Integrated farming		No. of famers

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
				practicing integrated farming
	Raising nursery and restocking	Collection of shell fish such as periwinkles	Marketing of sea foods	Quality of sea foods
Montane Forest Agro- Ecozones (Obudu – Sankwala Region)	Educate and sensitize communities on the need for land use planning. Show how to develop and implement rural / community land use plans Train on key competences required for land use planning	Cultivation of spices from bush pepper, bush onion, piper guineense	Small scale agro-processing	Availability of locally processed spices
	Set up and /or update met. stations with weather data equipment	Bamboo cultivation for alternative building materials	Establishment of building poles and raw materials wood factory	Availability of alternative building materials
	Engage the community in participatory management	Fuel wood lots	Wood fuel factory	No. of people utilizing fuel wood from woodlots
	Train local community on resource management Raise community resource management groups	Cultivation of poles	Wood fuel factory	
		Cultivationherbal plants such as Alablankia	Raw material extraction	Marketing chain of raw material
		Cultivation of Irish Potatoe and other temperate crops such as lettuce,	Intensive agriculture	No. of farmers involved and the level of productivity
		Dairy farming	Value addition and marketing of dairy products	Availability of dairy farm and products
		Rangeland management	Rangeland management through intensive agriculture	Reduction in the free ranching of cattle
	Apiculture	Honey production	Value addition and marketing of Honey	No. of production sources and availability of locally branded honey
2. PRIME ECOSYSTEM AND BIODIVERSITY HOTSPOTS				

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
Rainforest	Develop NTFPs (Bush Mango, Afang, Raffia cane, etc.) Nursery Development and distribution Community based eco-tourism development anchored on benefit sharing domestication of selected wild life,	Vegetable cultivation	Sustainable harvesting of forest products	No. of farmers involved in the domestication of NTFPs; value added market chain; establishing community institutions to build capacity for sustainable market chain,
Mangrove Ecosystem	Ornamental horticulture	Horticulture Ornamental	cropping	Level of productivity of ornamental crops
	Personal care, botanical and food & beverage industries	Local beverage	Production of local tea	Availability of locally made
	Agricultural seeds	Seed Nursery		No. off nursery established
	Pharmaceuticals	Alablankia cultivation	Raw material extraction	Value chain of raw materials
	Clearance of Nypa palms, Regeneration of mangrove(planting of mangrove seedlings)	Raising mangrove seedlings	Afforestation	Area of mangrove restored
		Mangrove wood lots preferably *Rhizophora racemosa* for the use of root	Sustainable management of fuel wood lots	No. of people involved in the establishment of fuel wood lots; level of regeneration of the mangrove ecosystem
	Aquaculture			
		Use of Nypa Palm for extraction of fuel such as ethanol	Small scale raw material extraction	Presence of processing plants for extraction of products from Nypa palm
		Arts and crafts using Nypa seedlings		Availability of local craft from Nypa palm
	Establishment of Carbon Forest Reserves	Private forestry	Estimation of carbon stocK	Amount of carbon stock in the foresT
3. CRITICAAL WATERSHED				

Agro-Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
Forest Watershed (Rainforest)	Set up community laws and local enforcement units		Community forest guard	Level of reduction in deforestation
Partly forested (Derived / Rainforest)	Nursery Raising Planting	Community forestry	Engagement of community in sustainable forest management	Forest area
Severely Farmed	Encourage tree planting Provide incentives for reforestation	Cultivation of multipurpose tree species		Level of adoption of the practice
	Educate and sensitize communities on the need for land use planning. Show how to develop and implement rural / community land use plans Train on key competences required for land use planning	Hydroponic farms		Level of adoption of the practice
	Organize community town meeting with an aim to educate the people.			
4. PRIME ECO-TOURISM AREAS				
	Applicable as in areas of prime ecosystem and biodiversity hotspot			

Appendix 4: Green Jobs in Forestry Sector by Ecological Zone

Forest Sector Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
Tropical Rainforest	Cultivation of NTFPs	Cultivation of Salad and vegetables (Gnetum africana), Lesianthera africana, Piper guinensis, Heinsia Crinata; Vegetables such as Ocimum gratissimum, (African mint) Curry leaf	Domestication of NTFPs and Intensive agriculture	No. of people involved and the availability of products
		Gathering and cultivation of Bush mango with other tree crops		Level of adoption of the system
	Processing of local gin for value addition	Palm boost and dry gin processing from palm Wine	Local factory for the production of gin	Availability of locally made boost and gin
	Production of oil and spices	Processing of nuts, seeds and oil-Shea nuts, Bitter kola, Kolanut, Locust beans (Dawadawa), Bush pepper, Bush Onion, Piper guineense (African Black Pepper), Alablankia	Micro, Small and Medium Enterprises for the production and export of oil and spices	Level of production of the oil and spices
	Local craft	Arts and crafts from ropes and canes	Micro, Small and Medium Enterprises for local craft	No. of persons involved in arts and craft
		Cultivation of, Alligator Pepper, Pepper fruit and other medicinal plants	Raw material extraction for Pharmaceuticals	Value chain and marketing of products
	Utilization of Non-wood and non-fuel fibers and resins	Processing of Alablankia for export	Extraction of raw materials	Value chain and marketing of products
		Mushroom	Value addition and marketing	Value chain and marketing of products
		Eco-therapy	Eco-therapy	Level of patronage
		Cultivation of ornamental crops	Establishment of parks, lawns and gardens	Level of patronage
Guinea Savanna, Derived Savanna	Cattle rearing, piggery, goatery	Processing of skins of cattle, deer, pig, snakes or other animals	Establishment of meat factory	No. of people involved

Appendix 5: Green Jobs in Renewable Energy by Ecological Zone

Renewable Energy Ecological Zones	Activities/Interventions/ Strategies	Green Jobs	Green Investment	Indicators
Tropical Rainforest	Bio-gas technology	Production of Biogas from organic waste	Bio-gas factory	No. of people involved and Level of patronage
	Cultivation of Jatropha in degraded land	production of ethanol and bio-diesel fuels using Jatropha, such as corn, sugarcane, soy, canola, sunflower and palm oil	Bio-gas extraction industry	Availability of bio-fuel
Savanah and montane	Technology for wind and solar energy	wind and solar power generation	installation and operation of low-emission renewable energy	Level of patronage
Mangrove	Extraction of fuel	Production of bio-fuel from Nypa Palm	Investment in Extractive industry	Availability and level of patronage of bio-fuel
	Mini-hydropower generation	Generation of micro hydropower and wind power	installation and operation of low-emission renewable energy	Level of patronage

Appendix 6: Some of Nigeria's International Treaties related to Waste Management (IEA Database Project, 2020)

International Treaty/ Convention	Year Adopted
Ships carrying dangerous chemicals	2018
The Stockholm Convention on Persistent Organic Pollutants	2001
Framework Convention on Climate Change	1994
UN Framework Convention on Climate Change	1992
United Nations Conference On Environment And Development (UNCED) -The Earth Summit	1992
Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention)	1990
Basel Convention on the Control of Trans Boundary Movements of Hazardous Wastes and their Disposal	1989
Protocol on Substances that deplete the Ozone Layer (Montreal Protocol)	1989
Convention for the Protection of the Ozone Layer (Vienna Convention)	1989
UN convention on the Law of the Sea	1982
The Bamako Convention of Hazardous Wastes in African Countries	1981
Vienna Convention on the Law of Treaties	1980
Convention on the Prevention of Marine Pollution By Dumping of Wastes and Other Matter (London Convention)	1976
London Convention on Sea Pollution	1972
African Convention on Conservation of Nature and Natural Resources	1968

Appendix 7: Selected Key Waste Management Initiatives in Nigeria

S/n	Waste Management Initiative	Description	Originator/ Current Partners	Status	Natural Capital; Natural Capital; Circular Economy feature	Private Sector Opportunities
1	Extended Producer Responsibility (EPR) program	Retrieval and recirculation Retrieval and recirculation of waste from certain sectors (e.g., packaged plastic, e-waste, lead batteries) for further use nationwide.	NESREA/ Waste producers, collectors, recyclers	Ongoing	Reduction of landfills and polluted land/water bodies; utilization of waste materials for other purposes	Collection and processing of waste materials, sale of processed waste
2	National Plastic Recycling Program	Use of plastic recycling facilities to process plastic waste at 26 sites with capacities of 1000kg/cycle.	Federal Government/ Ecological Funds Office, State Governments	Dormant	Reduction of landfills and polluted land/water bodies; utilization of plastic waste materials	Acquisition/ management of plastic recycling plants; establish new facilities at other sites
3	National Hospital Intervention Scheme	Use of biomedical incinerators to process medical waste up to 100kg/hr at 23 sites.	Federal Government/ FMOE, FMOH	Only 10 operational	Prevention of the release Prevention of the release of hazardous medical waste into the natural environment; energy recovery via incineration	Acquisition/ management of biomedical incinerators; establish new facilities at other sites
4	National Scrap Metal Recycling and Recovery Programme	Recycling of scrap metals Recycling of scrap metal at designated plants with capacities of 2 tonnes/hr at 3 locations nationwide	Federal Government/ State Governments	1 1 operational, 2 yet to be completed	Prevention of release of Prevention of the release of metallic waste into landfills; recycling of scrap metals	Acquisition/ management of scrap metal recycling plants; establish new facilities at other sites
5	Briquette Plants	Manufacture of briquette at 4 locations nationwide.	Federal Government/ State Governments	2 operational, 2 yet to be completed	An eco-friendly energy An eco-friendly alternative to firewood thereby reducing deforestation; energy recovery	Acquisition/ management of scrap metal recycling plants; establish new facilities at other sites
6	Integrated Waste Management Initiatives	. Waste-to-Wealth i. Waste-to-wealth Compost Plant in Ikorodu, ii. a Landfill Waste to Energy (WTE) Olusosun with Landfill Gas Capturing Facility and Biogas Plant which uses market waste iii) a Nylon Buyback scheme iv) Intermediate Waste Disposal	Lagos State, PPPs/ Private investors, UNEP, CCI, financial institutions, World Bank/IBRD, USEPA	Operational	Reduction of landfill sites and pollution to the natural environment; waste recycling and recovery of energy	Invest in the PPPs; engage in waste value chain components; develop similar facilities at other locations

S/n	Waste Management Initiative	Description	Originator/ Current Partners	Status	Natural Capital; Natural Capital; Circular Economy feature	Private Sector Opportunities
		Facilities v) Medical Waste Treatment Plant, Oshodi				
7	Integrated Solid Waste Management Facility	Waste facilities located at Epe and Methane Gas Capture and Utilization Project at Abule–Egba and Solous Landfills.	Lagos State, PPPs/CCI	Operational	Reduction of landfill Reduction of landfill sites and pollution to the natural environment; waste recycling and recovery of energy sites and pollution to the natural environment; waste recycling and recovery of energy	Invest in the PPPs; engage in waste value chain components; develop similar facilities at other locations
8	Lagos State Blue Box Program	Scheme designed to separate waste at source using colour coded bags for waste disposal in Lagos	Lagos State, PPPs	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	With an estimated $200 million to be generated from this scheme, investing in this PPPs or replicating similar schemes in other locations can be lucrative.
9	Recycling Banks	Collection of waste in sorted bins for recycling at designated centres in Lagos	Lagos State PPPs	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Provision of similar services in various commercial, industrial and residential parts of the State. This scheme can also be replicated in other locations.
10	Earthcare Solid Waste Composting Plant	Fertilizer processing plant processed from organic waste with capacity to produce 200,000 tonnes of fertilizer per annum in Lagos	Earthcare Nigeria Limited (ENL)	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in value chain of compost plant; form a consortium to replicate similar projects in other locations
11	Lafarge Geocycle	Provision of professional waste management services to different sectors including industrial waste, municipal solid waste, tyres and biomass. Plants are in Sagamu and Ewekoro.	Lafarge Africa	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste and energy recovery	Invest in value chain of Geocycle waste plants at their various locations; replicate the provision of professional waste services

S/n	Waste Management Initiative	Description	Originator/ Current Partners	Status	Natural Capital; Natural Capital; Circular Economy feature	Private Sector Opportunities
						in other parts of the Nigeria
12	Hinckley E-waste Recycling	Processing and recycling of e-waste in Lagos	Hinckley Group Nigeria	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste Reduction of landfill sites and pollution to the natural environment; recycling of waste	Training of e-waste recyclers; investment in e-waste value chain; establishment of registered e-waste plants;
13	Ibeto Battery Manufacturing and Recycling	Lead acid batteries recycling plant with capacity to produce the following per annum: 300,000 units of lead acid batteries, 120,000 units of sealed maintenance free batteries, 5,500 tonnes of lead, 500 tonnes of accessories and 1,500 tonnes of friction parts.	Ibeto Group	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of wa Reduction of landfill sites and pollution to the natural environment; recycling of waste	Investment in battery waste value chain; training of battery waste recyclers; establishment of registered battery waste plants in other parts of the country;
14	E-terra Technologies Recycling	Processing and recycling of e-waste in Lagos	E-Terra Technologies	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Training of e-waste recyclers; investment in e-waste value chain; establishment of registered e-waste plants;
15	West Africa ENRG Materials Recovery Facility (MRF)	Processing of non-recyclable waste to electricity via patented innovation; recovery and recycling of waste materials in Lagos	West Africa Engrg	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in value chain of waste plants; replicate waste to energy schemes at viable sites;
16	Wecyclers and Recyclers Recycling Schemes	Purchase and processing of plastic waste and subsequent sale of recycled plastics	Wecyclers and Recyclers Firms	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in plastic recycling facilities for onward sales of products; training/ empowerment of community in plastic value chain businesses

S/n	Waste Management Initiative	Description	Originator/ Current Partners	Status	Natural Capital; Natural Capital; Circular Economy feature	Private Sector Opportunities
17	Initiates Recycling	Provision of waste management services in Rivers State including e-waste processing, industrial and municipal waste management	Initiates Plc	Operational	Reduction of landfill sites and release of pollutants into the natural environment; recycling of wa Reduction of landfill sites and release of pollutants into the natural environment; recycling of waste	Establishment of unique or multiple waste management services to cater for industrial and commercial centers
18	Alkem Recycling	Processing of plastic waste bottles into production feed of furniture and building accessories	Alkem Nigeria Limited/ Nigerian Bottling Company	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in plastic recycling facilities for onward sales of products; training/ empowerment of community in plastic value chain businesses
19	Project ReflexNG	Purchase of plastic waste using cash, call credits and household items	Dow Chemicals/ Omnik Ltd, Recycle Points Ltd, Lagos Business School	Operational	Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in plastic value chain of the process
20	Engee PET Recycling	Recycling of PET plastic bottles into sustainable plastic resin raw materials	Engee PET Manufacturing Company	Operational	Reduction of Reduction of landfill Reduction of landfill sites and pollution to the natural environment; recycling of waste	Invest in plastic value chain of the process
21	Waste Museum	Museum and art gallery in Ibadan, Oyo State highlighting how humans, animals and plants can coexist without generating waste (Omoregbe, 2022)	Ms. Jumoke Olowookere	Operational	Awareness Awareness and implementation of circular economy activities and sustainable practices on natural capital assets	Partnership with the tourism sector on waste museums and galleries nationwide

Appendix 8: Federal Legislative Committees Related to Waste Management

	Senate Committees
1.	Senate Committee on Environment
2.	Senate Committee on Ecology and Climate Change
3.	Senate Committee on Sustainable Development Goals
4.	Senate Committee on National Planning
5.	Senate Committee on Finance
6.	Senate Committee on Power
7.	Senate Committee on Industry
8.	Senate Committee on Agriculture
	House of Representatives Committees
1.	House Committee on Environment
2.	House Committee on Water Resources
3.	House Committee on Industries"

Appendix 9: SWOT Analysis of the Waste Sector: Natural Capital & Circular Economy Assessment

Waste Sector Component	Strengths	Weaknesses	Opportunities	Threats	NC /CE Level of NC/CE Level of compliance Green Growth-Colour Matrix for Waste Sector
Policies	• Existing waste management policies which support businesses Long term strategies • Modern practices incorporated in legislation	• Absence of sector specific policies e.g. policies on e-waste, textile waste, organic waste, battery, industrial waste • Inadequacy of regulatory institutions	• Establishment of waste management businesses which has legislative support • Creation of innovative waste management hubs and Research Centres to develop alternatives to hazardous materials e.g. in the health and chemical sectors • Capacity-building trainers and educators who will train various of levels of waste management stakeholders	• Lack of implementation by key stakeholders due to political will, alternative resources • Slow process of passing relevant legislation (bills) • Inadequate attention to the sector due preferences for other sectors	Complaint
Regulations	• Existing waste management regulations which support businesses • Large scope of waste regulations which are NC/CE inclined.	Inadequacy of regulatory institutions	• Establishment of waste management businesses which has legislative support • Creation of innovative waste management hubs and Research Centres to develop alternatives to hazardous materials e.g. in the health and chemical sectors • Capacity-building trainers and educators who will train various of levels of waste management stakeholders	Inadequate attention to the sector based on preferences for other key sectors leading to poor allocation of resources and implementation of legislation.	Complaint

Waste Sector Component	Strengths	Weaknesses	Opportunities	Threats	NC /CE Level of NC/CE Level of compliance Green Growth-Colour Matrix for Waste Sector
Institutions	• A visible and identifiable government regulatory agency-NESREA • Initiation of NC/CE programs such as the Extended Producer Responsibility (EPR) program by NESREA • Presence of environmental agencies in most states of Nigeria • Presence of private sector participation in waste management especially in Lagos	• Absence of regulatory agencies to cover all LGAs in Nigeria • Lack of adequate and skilled manpower in relevant regulatory institutions • Lack of institutional resources to properly execute key programs across the country e.g. LGAs carrying out waste management in their localities , EPR program carried out by NESREA across the country. • Absence of NC/CE waste management businesses across the country	• Natural Capital/ Circular Economy consultants who can aid State Governments develop their Environmental Master Plans and advise them on sustainability matters. • Capacity-building trainers and educators who will train various of levels of waste management stakeholders • Establishment of regulatory businesses by the private sector which would compliment NESREA and other enforcement bodies across the country • Promotion of the adoption of NC/CE oriented practices in waste management businesses driven by the availability of grants, low-interest loans, technical support, and capacity building granted by institutions and funding partners. • Synergy with international organizations to fund international enforcement activities	• Absence of security and safety in some parts of the country • Absence of funding due to economic recession • Absence of agencies to compliment NESREA in sector specific enforcement	Partially complaint

Waste Sector Component	Strengths	Weaknesses	Opportunities	Threats	NC /CE Level of NC/CE Level of compliance Green Growth-Colour Matrix for Waste Sector
		• Absence of online visibility of Nigerian waste management stakeholders thereby leading to an absence on global presence to receive aid e.g. private sector, State Governments			
Projects/ Initiatives	• Establishment of informal waste management sector all over the country • Variety of established waste management businesses showing the viability of various waste streams • Establishment of waste management PPPs e.g., in Lagos State	• Unsustainable practices carried out by the informal waste sector • Lack of awareness on the requirements to access sustainable funds • Absence of online visibility of Nigerian waste management stakeholders	• Promotion of the adoption of NC/CE oriented practices in waste management businesses driven by the availability of grants, low interest loans, technical support, capacity building granted by institutions and funding partners. • Capacity building and delivery of skills acquisition training to beneficiaries in various localities • Creation of online/ social media management firms for waste management organisations to give the global appeal and be updated on latest trends.	• Absence of security and safety in some parts of the country • Absence of basic amenities and services like power, water, road network for waste projects	Not compliant

Waste Sector Component	Strengths	Weaknesses	Opportunities	Threats	NC /CE Level of NC/CE Level of compliance Green Growth-Colour Matrix for Waste Sector
		thereby leading to an absence on global presence to receive aid e.g. private sector			

Strategic Documents	• Proposals to use CE in waste sector. • Existing legislation that supports natural sector and circular economy features in the waste sector • Availability of finance mechanisms such as 'Green bonds' for waste schemesPlans to stimulate the growth of MSMEs in non-oil sectors • Creation of Feed-in-tarrifs to enhance renewable energy generation	• Lack of waste data across Nigeria with data of mostly Lagos available • Lack of support of local capacity to aid the development of bankable waste projects with features such as pipeline development, concept notes, funding proposals, • Lack of synergy among relevant agencies for waste management including harmonizing data • Reluctance to undertake ratification of hazardous waste legislation such as the Bamako Convention.	• Development of bankable proposals to attract investment in the waste sector, • Provision of grants and loans to good business cases to aid their transition from informal to formal sector • Capacity building businesses that can train entrepreneurs, government agencies, communities and schools on the benefits of sustainable practices and businesses and highlight routes to access sustainable financing • Partnerships involving funding agencies and local communities to develop waste management empowerment schemes such as climate smart agricultural schemes • Waste data acquisition and analysis which can be developed and financed as a business • Industrial waste management opportunities as 90% of the industrial solid decomposable waste makes its way to the unmanaged dump sites with about 10% unaccounted for due to collection inefficiencies. • Establishment and upgrade of Research Centres and Institutions to develop NC/CE solutions for use e.g. wood mill residues and wood waste as alternatives to burning these waste • Establishment of waste water treatment plants to compliment public water supply agencies • Establishment of solar installation businesses to meet targets of 3,000 MW of solar systems over the next 4	• Absence of security and safety in some parts of the country • Absence of funding due to economic recession • Lack of international support directed at building and retaining long-term organizational and institutional capacity • Lack of international cooperation regarding the influx of hazardous waste materials	Partially complaint

Waste Sector Component	Strengths	Weaknesses	Opportunities	Threats	NC /CE Level of NC/CE Level of compliance Green Growth-Colour Matrix for Waste Sector
			years and solar lamps as replacement for kerosene lamps ● Licensed landfill entrepreneurial businesses can be set up at community and local levels who will create only engineered approved landfill sites. ● Establishment of certified hazardous waste disposal businesses with emphasis on the e-waste, medical waste and industrial waste. ● Use of agric waste as waste-to-energy scheme such as the National Biofeuls Program (8 Projects) from agric waste		

Appendix 10: Waste Management Policies with their Natural Capital, Circular Economy and Private Sector Opportunities

S/n	Policy Name	Summary of Policy Objectives	Natural Capital Features	Circular Economy Features	Private Sector Opportunities
1	National Policy on Environmental Sanitation (2005)	Promotes sustainable methods of waste disposal.	● Reduction of animal grazing in urban areas by 75% in 2010. ● review and synchronization federal and state sanitation legislation. ● mobile courts for sanitation enforcements. ● education and awareness of sanitation consciousness and the natural environment.	● Creation of a data bank on environmental sanitation which will track and document details of waste materials. ● Involvement of private sector with the formulation and offer of economic incentives to stimulate investments. ● Socio-cultural and behavioural changes by creating awareness on environment sustainability.	● A targeted increase of private sector participation by 75% by 2010. ● Funding donors to boost investmen

S/n	Policy Name	Summary of Policy Objectives	Natural Capital Features	Circular Economy Features	Private Sector Opportunities
					t in initiatives.
2	National Policy on Chemical Management (2010)	Regulates the use of chemicals to avoid environmental pollution.	• Synergy of stakeholders to ensure the sound management of chemicals to avoid their release into the environment. • incorporate chemical and waste management into national development programmes	• Rethinking the use of hazardous chemicals and promotion of substitute materials. • Refuse to use harmful chemicals by developing preventive strategies and communicating them accordingly. • Chemical management information systems to track and store information of chemicals	• Capacity building of private sector in managing hazardous chemicals in private and workplaces.
3	National Healthcare Waste Policy (2013)	This involves the effective management of healthcare waste (HCW) which is harmful to the natural environment, and rethinking alternatives and reduction of HCW by efficient practices in the health sector.	• Proper disposal of HCW using more sustainable methods. • Use of standard constructed landfills and pits for various HCW.	• Development of a catalogue and inventory of information to track and store information on medical waste, equipment, and details of their disposal. • Implementation of the 3R concept of reduce, reuse, and recycle before disposal at in medical stations. • Substitution of toxic and hazardous substances with sustainable materials. install medical waste incinerators in each state in Nigeria.	• Creation of guidelines for the privatisation of HCW management.
4	National Policy on Environment (2016)	Aid the enforcement of sustainable waste practices across the economy as well as promoting circular practices in the Nigerian environment	• Improvement in the tracking of trace pollutant emissions released into the environment. • Development of control mechanisms to curb the release of pollutants and toxic waste into ecosystems. • Establishment of sanitary centers for the human and solid waste management. • Registration of all major land disposal sites. • Enforcement the prohibition of plastic bags. • Utilization of sustainable practices in the disposal of toxic wastes.	• Refusal to use hazardous materials by controlling their production. • Encourage the establishment of the 'waste to wealth' projects at all strata of society	• Investment in Integrated Waste Management projects by synergy with the private sector. • Collaboration of government with the private sector on other waste management projects at

S/n	Policy Name	Summary of Policy Objectives	Natural Capital Features	Circular Economy Features	Private Sector Opportunities
			• Expansion of the capacity of community based waste management initiatives to cover larger areas.		various levels in Nigeria.
5	National Policy on Solid Waste Management (2018)	Promotion of eco-friendly waste management activities in addition to facilitating the R-framework circular economy conceptions.	• Development of approved engineered landfills and upgrading of dumpsites. • Establishment of approved hazardous waste collection facilities and solid waste storage centres	• Implementation of the R concept of reduce, repair, reuse, recycle and recover in the solid waste management sector. • Development of a unified database for monitoring waste management processes. • Design and implementation of the Extended Producer Responsibility (EPR) program. • Pilot initiatives for waste separation at source. • Reduce waste generated from household, commercial centers and industries by 10%, increase waste processing and recycling processes by 15%. • Establishment of waste to energy facilities for energy recovery. • Encouragement of the initiation and expansion of waste to wealth schemes.	• Policy supports the engagement of private sector waste management service providers who would work with State and Local Government authorities, form PPPs where necessary and invest in sustainable waste management systems creating jobs and opportunities beneficial to various localities.
6	National Policy on Plastic Waste Management (2020)	This policy incorporates a full range of circular economy features and aims to reduce environmental pollution by the sustainable management of plastics.	• Decrease the global warming and greenhouse effects throughout the lifecycles of plastics by 60% in the year 2030.	• Reduction of production of plastic waste by 50% of the 2020 baseline figure in 2025. • Reduction of the amount of plastic waste generated by 50% of the 2020 baseline figure in 2025. • Removal of single use plastics from the market in stages. • Prohibition of the use of four kinds of single use plastics on the go by	• Synergy with the private sector throughout the lifecycle of plastic materials including importers and exporters and in various parts of the value chain. engagement of

S/n	Policy Name	Summary of Policy Objectives	Natural Capital Features	Circular Economy Features	Private Sector Opportunities
				January 2025 which are plastic bags, cutlery, styrofoam and straw. ● Conversion of plastic materials and waste into a resource. ● Enforcement of all plastic packaging which satisfies at least two conditions of the following: recycleable, biodegradable, compostable, or reusable by 2030. ● Substitution of single use plastics products with eco-friendly alternatives. ● Work with stakeholders to develop a database to track plastic products throughout their lifecycles. ● Transit from a linear plastic economy to a circular one.	private sector waste management.

Appendix 11: Lifecycle Impact Assessment of the Plastic Packaging Waste Value Chain

	Extraction Extraction	**Processing/ Processing/Production of plastics**	**Consumption Consumption and Waste**	**Packaging– Baseline Packaging – Baseline Scenario without NC/CE measures**	**Packaging – with NC/CE Packaging – with NC/CE measures (R- framework)**	**SDGs associated with NC/CE measures SDGs associated with NC/CE measures**
Climate Climate	Use of Use of fossil fuel resources	Use of Use of fossil fuel resources; Emissions from petroleum processing	Emissions from Emissions form open burning	Emissions due to fossil Emissions due to fossil fuels used during production; Landfills open burning dumping	Carbon pricing to reduce use of Carbon pricing to reduce use of fossil fuels (Rethink Reduce); Recovery using waste to energy schemes (Recovery); Reduced landfill sites (Reduce)	• SDG = Gender equality; • SDG 7 = clean and affordable energy; • SDG 8 = Decent work and economic growth; • SDG 9 = Innovation and Infrastructure; • SDG 10 = Reducedequalities; • SDG 12 = Responsible consumption and production
Ecosystem Ecosystem	Pollution Pollution of offshore and onshore habitat	Production Production waste disposed into the environment.	Degradation Degeneration of non-biodegradable materials in environment on land and water	Increased landfill sites Increased landfill sites Pollution of air land and water bodies due to the degradation of non-biodegradable plastics	Reduced sizes of landfill sites (Reduce); Use of biodegradable materials as plastic alternatives (Refuse Rethink); Reuse of plastics waste materials after production and products use stages (Reuse)	• SDG 14 = Life below water; • SDG 15 =
Energy Energy Use	High amount High amount of energy required	High High amount of energy required		High amount of energy High amount of energy required for the production of plastics	Energy efficient measures used Energy-efficient measures used in plastic production (Reduce); Use of renewable energy resources (Recover)	Life below land; SDG 16= Peace justice and strong Life below land; SDG 16= Peace justice and strong • Life below land; • SDG 16 = Peace justice and strong institutions
Water Use Water Use	High amount High amount of water used in extraction	High High amount of water used in plastic production		High amount of water used High amount of energy is required for mineral exploration.	Water efficiency in textile Water efficiency in textile production (Reuse Recycle); Use of alternative innovative methods which use less water (Rethink)	

Human Human Health	Exposure to Exposure to hazardous gases; materials and chemicals leading to respiratory issues	Exposure Exposure to harmful chemicals	Leaching of Leaching of Chemicals from plastic packaging into food/beverages.	Continuous exposure Continuous exposure of workers to harmful chemicals and hazardous substances during plastic production	Use of biodegradable materials Use of biodegradable materials as plastic alternatives (Refuse Rethink); Improve working systems used for production (Rethink)	
Social Social Issues	Gender Gender inequality	Gender Gender inequality Child labour in factories Low wages				

Appendix 12: Lifecycle Impact Asessment of the Organic Waste Value Chain

Production Processes	Agricultural Produce	Food Processing	Consumption and Waste	Organic waste disposal – Baseline Scenario without NC/CE measures	Organic waste disposal with NC/CE measures (R-Framework)	SDGs associated with NC/CE solutions
Climate	• Release of methane emissions from livestock • Release of nitrous oxide emissions from fertilizer	• Use of fossil fuel resources for power and transport	• Release of methane emissions from landfills	• Emissions due to agricultural production and processing	• Recovery using waste to energy schemes (Recovery) • Reduced use of fossil fuels (Reduction) • Carbon pricing to reduce use of fossil fuels (Rethink, Reduce)	• SDG 1 = No Poverty • SDG 2 = Zero Hunger • SDG 3 = Good health and well-being • SDG 5 = Gender equality • SDG 6 = Clean water and sanitation • SDG 7 = Clean and affordable energy • SDG 8 = Decent work and economic growth • SDG 9= Industry, innovation, and infrastructure • SDG 10 = Reduced equalities • SDG 11 = Sustainable cities and communities • SDG 12 = Responsible consumption and production • SDG 13 = Climate action
Ecosystem	• Use of land for farming activities • Use of chemicals and fertilizers • Water pollution with chemicals used.		• Landfill sites • Harm to wildlife • Alteration in food chains due to excess food waste	• Increased sizes of landfill sites • Environmental pollution using chemicals at farms and during production	• Reduced land use (Reduce) • Reduction of landfill sites (Reduction) • Production of compost as an alternative to hazardous fertilizer (Refuse, Rethink)	SDG 14 = Life below water • SDG 14= Life below water
Energy Use		High amount of energy required	High amount of energy required	High amount of energy used in agricultural processing	• Energy efficiency along value chain (Rethink, Reduce) • Develop alternative systems with low energy consumption (Rethink, Reduce)	• SDG 15 = Life on Land • SDG 16 = Peace, Justice and Strong Institution

Production Processes	Agricultural Produce	Food Processing	Consumption and Waste	Organic waste disposal – Baseline Scenario without NC/CE measures	Organic waste disposal with NC/CE measures (R-Framework)	SDGs associated with NC/CE solutions
					• Use of renewable and waste to energy schemes (Recovery)	
Water Use	High amount of water used in farming activities	High amount of water used in food processing	High amount of water used in food consumption	High amount of water used for farming and food processing	• Water efficiency from farming to food consumption (Rethink, Reduce, Recycle)	
Human Health	Exposure to hazardous chemicals during farming	• High likelihood of injury • Poor working conditions	• Disease due to exposure of food waste. • Land and air pollution	• Continuous exposure to hazardous chemicals • Unsafe practices during food processing	• Use of compost as an alternative to hazardous chemicals (Refuse, Rethink) • Sustainable practices for food processing which is safe to human health (Rethink)	
Social Issues	• Gender inequality • Child labour on farm • Low wages	• Gender inequality • Child labour for conversion		• Gender inequalities • Child laabour during food production	• Improve techniques of food production safe to human health with new technological approache (Rethink) • Prohibit and enforce childlabour laws (Refuse)	

Appendix 13: SWOT Analysis of Governance Landscape

S/n	Asset/capital	Strength	Weakness	Opportunity	Threat
1	Policies	Related Policies are available	Obsolete and need urgent restructuring	Policy reforms can be initiated via PPP and donor support	Political willingness
2	Institutions	Government institutions within the two-tier of governance, i.e., federal and state. But local government institutions are left out	Informal and NGOs non-existent	Institutional strengthening programs	Multiplicity of water-related institutions with similar roles
3	Infrastructure	Some exist	Investment Gap, Inadequate and non-existent infrastructure. Gap for improved services is about 64.1% (USAID)	PPP and Donor agencies can fund upgrade of infrastructure and provisions of irrigation systems	Funding Upgrade
4	Annual budget/finance		Not clearly stated in any of the policies/Act. at best inadequate. For instance, Nigeria requires 1.7% of current GDP to WASH (UNICEF)	Donors and global alliance can support WASH activities within communities that lack access to potable water	Political Willingness
5	Human/Social Group	Vast human capital with a population > 180 million	Low private sector involvement. Penalties for unsustainable use of resource is grossly inadequate. both for individual and corporate offenders	PPP can partner with government to develop incentives for sustainable use of resource and capacity to manage introduced modern infrastructure. Also build capacity within informal/community institutions for water management	
6	Natural Capital	Vast coverage: 333 billion m3 of surface water and 88 billion m3 of Ground water	Not properly accounted for in SNA. underutilized and unutilized assets.	Donors, PPP could invest in research and development, appropriate technology use and transfer, data acquisition and monitoring.	

Appendix 14: SWOT Analysis of Fishery/ Aquaculture sector

S/n	Asset/capital	Strength	Weakness	Opportunity	Threat
1	Policies	Available for fisheries	Aquaculture policies lacking	Advocacy campaign for growing aquaculture sub-sector	Lack of enforced fishing regulations
2	Institutions	Relevant research and development		Strengthening research and development institutes	
3	Infrastructure	Available	Expensive fishing equipment. Inadequate power supply to preserve fresh fish. Lack of appropriate hygienic equipment for wholesalers/retailers. High transportation costs. The high cost of plant biomass (charcoal) and the high cost of processing equipment for small-scale processers	Provision of services near markets such as cold rooms/ice making, boat maintenance etc. Investment in value added products, like canned fishery products	Prevailing climate change. ASLR will damage rudimentary and non-climate smart equipment and technology
4	Finance/Annual Budget	contributes to national GDP	Lack of start-up capital and credit facilities; Market is supply driven and actors are unable to meet demands. Lack of access to high-end markets and exports	Microcredit schemes. insurance schemes and incentives for selective fishing and aquaculture	Weak purchasing power of fishermen. increasing inflation rates. lack of tax rebates
5	Human/Social Group	Traditional Fishing skills passed on through generations to a willing workforce. Source of livelihood and income for over 6million people	Lack of procedures/processes to maintain fish quality and freshness	Training in aquaculture as alternative to capture fishing	Competition with large-scale commercial fisheries
6	Natural Capital	Fish readily available	Populationpressure. overfishing of some species	Traditional/micro-meso institutional strengthening in modern fishing tools	Climate change (ASLR), high tides and migratory patterns of some fish species. Pollution of the Waters. Reduction in national players in industrial fishing

Appendix 15: Scenario Analysis: Services

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
Packaging						
Plastics made from non-renewable resources (e.g., crude oil)	Pollution of offshore and onshore habitat	Reuse, recycle of material produced	Adoption of natural capital accounting to put value on natural resources and enable efficiency and sustainability	National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector) Regulations, S. I. No. 17, 2011	Businesses should adopt new strategies to safely deliver their products without use of plastics	Natural Resource Stock Accounts
High amount of water used in mineral exploration, extraction and production of plastics.	Production waste disposed into the environment.	Investments can be made in the development of biodegradable alternatives to plastics such as eco-friendly bags, glassware, beeswax bags, glass jars, cotton bags etc.		Nigeria's Nationally Determined Contribution (NDC)	Investments in sustainable packaging	
High energy consumption for plastic production	Degradation of non-biodegradable materials in environment on land and water	Entrepreneurs can engage in sales, maintenance and repairs of modern packaging equipment which are more efficient and consume less resources: water, materials, energy; at various locations in the country.			Education and awareness for populace on the negative environmental effects of single use plastics	
	Distribution of marine ecosystem and biodiversity				Green taxes and fines to manufactures/ producers of Single use plastic products	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
	Increased landfill sites				Training institutes and schools to established to train the necessary manpower required in sustainable packaging processes and standard HSE practices to reduce human, material, and energy losses.	
	Pollution of air, land, and water bodies				Establishment of renewable energy installation companies to provide sustainable energy solutions to packaging firms to ensure electricity stability	
	Degradation of non-biodegradable plastics					
	Respiratory issues from exposure to hazardous gases, materials and harmful chemicals					
	Refineries and processing plants can cause increase in GHG emissions					
High volume of plastic waste	Energy loss	Collection of reusable plastics for sale in local markets.	Reuse, Recycle and	National Policy on Plastic Waste Management (2020):	Producer responsibility – EPR: allmanufacturers and producers of goods	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
			Recovery of plastic waste		should be encouraged to track, recover and reuse their end-of-life products and packaging	
Poor waste management practices	Loss of land for use as landfill sites	Sale of recycled plastics or metal granules				
	Environmental Degradation	Conversion of processed waste to industrial commodities			Encourage waste-to-wealth initiatives	
	Nonbiodegradable materials end up filling landfills	Design and construction of secured final disposal dumpsites			Watse-to-energy schemes can be established close to waste generation sites which can convert plastic waste to energy using techniques such as pyrolysis.	
	Open burning emissions of GHGs.	Management of designated dumpsites				
	Air Pollution					
	Pollution of offshore and onshore habitat					
	Environmental litter					

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
	Plastic litter block drainage system					
Electronics						
Raw material extraction from non-renewable resources	Soil degradation	Reuse, recycle of materials produced	Adoption of natural capital accounting to put value on natural resources	National Environmental (Electrical/Electronic Sector) Regulations, S. I. No 23, 2011	Training institutes with specialist on extraction of minerals can be established to train and build capacity of certified miners and raw minerals extractors who will undertake sustainable extraction processes.	Natural Resource Stock Accounts
	Water loss/shortages	Investments can be made in the sales, repairs and maintenance of equipment used to extract necessary minerals and raw materials.		National Environmental (Hazardous Chemicals and Pesticides) Regulations, S. I. No 65, 2014	Water recycling businesses can be established to recycle wastewater for extraction processes for further use especially in water scarce areas.	
	Biodiversity loss	Investment in water treatment and recycling			PPPs can be formed as collaboration between the private sector businesses, relevant regulatory authorities, and foreign manufacturers to regulate the electronics market and ensure standards are	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
					maintained with the use of non-hazardous electronic materials only.	
	Damage to ecosystem functions					
	Global warming exacerbation					
E-waste	Loss of precious metals and useful material	E-waste processing businesses can be established to acquire e-waste for reuse, repurpose and recycling and subsequent sale of processed products and parts		The Harmful Wastes Special Criminal Provision Act No42 of 1988 (1998)	E-waste Training Consultants who can carry out technical training and certification of e-waste recyclers on efficient and safe practices.	
	Loss of land resources due to landfill sites			National Environmental (Electrical/Electronic Sector) Regulations, S. I. No 23, 2011	Individuals and organisations can develop skills in proposal writing and partner with e-waste business to apply for grants at an agreed fee given the high level of interest in the sector and the impact of POPs on humans and the environment.	
	Release of POPs and other toxic materials			National Environmental (Hazardous Chemicals and Pesticides) Regulations, S. I. No 65, 2014		

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
	Health Hazards from Improper processing of e-waste					
Organic Waste						
Food loss/waste	Land loss for landfill sites	Production and sale of compost to farmers		National Policy on Solid Waste Management (2020) – Aim: promote clean and healthy environment for sustainable socio-economic development.	Organise workshops and trainings for for organizations and the general populace on practical solid waste management practices and techniques	
	Energy waste	Biogas based power generation from sludge		National Environmental (Food Beverages and Tobacco Sector) Regulations, S. I. No. 33, 2009	Waste-to-energy schemes can be developed to provide energy for surrounding settlements	
		Production and sale of processed organic feed stocks from solid waste			Resource Consultants to advice agricultural firms and individuals on the utilization and reuse of resources such as water, energy, and other materials across the lifecycle of agricultural products.	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
		Compost facilities and animal feed businesses can be established at large farms and markets where agricultural waste from crops, livestock and food items can be processed into manure and fertilizer and sold to the public.			NGOs can be created with various niches with the aim of tackling issues such as child labour, food waste awareness, eating habits/healthy eating etc. NGOs can apply for funds from donor agencies for education sponsorship, incentives to parents/guardians, food waste awareness.	
		Establishment of agricultural processing businesses to convert agricultural raw materials into processed foods and products and this industry can also utilise renewable energy resources to provide power supply.				
		Renewable energy providers would be a feasible business which would supply electrical power, heating, and cooling to various segments from farm processes to recycling activities.				

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
Water Supply						
Unsustainable use of water.	Water pollution	Water treatment facilities	Adoption of natural capital accounting to put value on natural resources	National Water Policy (2014)	Improve service delivery through optimal public private partnerships (PPP) in investment, management and delivery of water services.	Inland/Marine Water Accounts.
	Marine ecosystem and biodiversity loss	Reuse, Recycle and Recovery of wastewater	Determine all available water resources including boundary conditions of both surface and underground waters	Harmful Waste (Special Criminal Provisions,) Act 1998.	Privatize water supply and wastewater services (where feasible)	
Untreated wastewater disposed into water bodies	Health impacts of population			National Policy on Chemical Management (2010): Aim: This policy's objective is to prevent the release of harmful chemical waste into the environment by proper management throughout their lifecycles		
					Ensure good quality standards (including WHO standards for water quality) are maintained by water supply undertakings.	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
					Prevent wasteful water use and control water leakages through special awareness campaigns and standards set for the water supply service providers.	
					Carry out programmes to reduce “commercial losses” on private, industrial and administrative consumption	
					Promote social marketing of water saving devices.	
					Encourage private community ownership of water supply facilities	
					Carry out programs to combat illegal connections.	
					Create public awareness about water conservation and management.	
Poor Sanitation and Hygiene	Open defection - leads to diseases	Investments of less than 6.5million to build latrinet		National Water Supply and Sanitation Policy 2000	Create public awareness about proper sanitation and hygiene.	
	Faeces contaminate	Water reuse (wastewater) and sludge reuse drives			Infrastructure development	

Identification of issue	Effects of issues	Opportunities for CE / NCA business	Strategies to promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts **required (Time series for thematic extent and condition accounts)**
	drinking water sources	processes and product design, (biological cycle/biocycle).				
	Death from diseases	An approach to the circularity of toilet resources is being blended with food and farm “waste”, plus compostable items, such as packaging.				
		Investment in self-sustaining facilities and operations				

Appendix 16: Energy Policy Enablers Relevant for the CE and NCAA

Energy Policy enabling conditions components	Policy Measures	Relevance for the CE and NCAA legal institutional capacity
Legal Framework	• National Energy Policy provides a workable framework for sustainable energy development in Nigeria with the overall objective of providing clean, affordable, adequate and reliable energy with the active participation of the private sector. • The National Energy Policy provides guidelines for the protection of the environment and the exploitation of Nigeria's fossil fuels. The emphasis is on low carbon pathway thus encouraging the exploration of renewable and alternative energy sources, primarily solar, wind and biomass.	• Enabling provisions for the creation of a legally binding and workable framework for sustainable energy development in Nigeria
Institutional Framework	• The National Energy Policy document pinned on the institutional arrangement and stated under the Policy on Energy Utilization as part of its short-term strategy in item (iii) that: • There is need to Strengthen institutional arrangements to ensure energy conservation and efficient use of energy in industries. • To achieve the stated policy objectives and successfully implement the strategies, various instruments including economic and legislative measures, information, education and institutional arrangements need to be used. Policy programme realization is often hampered by bureaucratic bottlenecks. These problems have to be effectively addressed for the successful implementation of the National Energy Policy. • Institutional arrangement is considered fundamental and part of priority policy actions in the National Energy Policy. This action is very important towards achieving a robust circular economy and natural capital accounting in the in the energy sector.	The institutionall arrangement is considered fundamental and part of priority policy actions in the National Energy Policy. This action is very important towards achieving a robust circular economy and natural capital accounting in the in the energy sector.
Capacity Development	• Beyond the energy related data, there are other indirect data that NEP has considered very important such as: • Human resources - under the short-term strategy (item i) of the Manpower Development and Training section: • Establishing a national human resources data base in the energy sector • Gender Issues - under the short-term strategy (item iv). • Developing a reliable gender responsive statistical data	• Availability of national experts for collation of energy related data. • Also there is the availability of reliable gender responsive statistical data
Information	• Energy Planning: For the purpose of energy planning, the NEP has also considered emphatically by stating in its short-term strategy items (iv and v) that:	

Energy Policy enabling conditions components	Policy Measures	Relevance for the CE and NCAA legal institutional capacity
	• Establishing a national energy information management system which will involve consistent data gathering and processing of energy resource inventory, consumption patterns, energy technologies, and other relevant socio-economic parameters. • Submitting energy data and information as may be required by the Energy Commission of Nigeria to carry out its monitoring, coordination, and data banking functions at specified intervals, by the sub-sectoral agencies that generate or collect the primary data. • As part of making data availability a critical requirement for driving NEP, data is considered as part of the principal strategies across the short, medium, and long term. This is stated in item (12 and 21)	
Research and Development	• It is considered under the item (iv) of the short-term strategy for the Petroleum policy of the NEP: • Expanding and promoting research and development activities in the country, including improved access to available data for Research and Development institutions and universities. • The importance of data cannot be over emphasized as it is very critical in petroleum industry as a way of managing efficiently the petroleum product resources. • In the renewable energy (hydro resources), data are critical for proper management of water resources, the energy policy under the short-term strategy item (iii) of the hydro policy of the NEP states: • Generating and updating data on all rivers, identifying possible locations for hydropower projects, and facilitating detailed survey of the potential small hydro power sites • Similarly, for the wind energy resource, a principal tool for designing and managing wind energy resource is data. The NEP envisaged this and had considered this in its short- and medium-term strategy (items iv and xi): • Intensifying work in wind data acquisition and development of wind maps • Development of wind data acquisition for wind farm development	Enabling provisions for the CE and NCAA-related technical capacity (e.g. monitoring technology, collection of data, scenarios needed to evaluate mitigation and adaptation measures and their effects, etc.)
Mainstreaming Energy Policy into National Development	One of the typical energy consuming sources in Nigeria is the household sector being one of the largest consumers of total delivered final energy in the economy. Despite efforts to transit the households in the country from the traditional and other biomass consumption in the country, the rural and semi urban	Enabling the provisions for the mainstreaming of NDC implementation and transparency-related activities in the national and sectoral planning and development policies.

Energy Policy enabling conditions components	Policy Measures	Relevance for the CE and NCAA legal institutional capacity
	areas still significantly utilize the traditional biomass for national energy consumption.; As part of the long-term strategy for the NEP on energy efficiency and conservation is to reduce 15% of emissions from energy related utilization.	
Roles and Responsibilities of institutions	The NEP realises the importance for collaboration in the policy document and is determined to collaborate with the Nigerian Meteorological Agency (NiMet) for provision of Meteorological services and information which includes real-time meteorological data – observations of temperature, wind velocity, rainfall, solar radiation, and satellite imagery.	The importance of collaboration between NiMet for example could be for the production of meteorological data useful for the identification of mitigation action related to renewable energy. There are windows of collaboration with other critical stakeholders in the RE and EE space. This certainly is very helpful in our drive towards CE and NCAA paradigm.

Appendix 17: Relevant National Energy Policy Implementation Strategies and Actions for the CE and NCAA Legal Institutional Framework

Implementation strategies and actions of the NCCP	Policy measures	Relevance for the CE and NCAA legal institutional capacity
Mainstreaming Energy Policy into National Development	One of the typical energy consuming sources in Nigeria is the household sector being one of the largest consumers of total delivered final energy in the economy. Despite efforts to transit the households in the country from the traditional and other biomass consumption in the country, the rural and semi urban areas still significantly utilize the traditional biomass for national energy consumption.; As part of the long-term strategy for the NEP on energy efficiency and conservation is to reduce 15% of emissions from energy related utilization.	Enabling the provisions for the mainstreaming of NDC implementation and transparency-related activities in the national and sectoral planning and development policies.
Roles and Responsibilities of institutions	The NEP realises the importance for collaboration in the policy document and is determined to collaborate with the Nigerian Meteorological Agency (NiMet) for provision of Meteorological services and information which includes real-time meteorological data – observations of temperature, wind velocity, rainfall, solar radiation, and satellite imagery.	The importance of collaboration between NiMet for example could be for the production of meteorological data useful for the identification of mitigation action related to renewable energy. There are windows of collaboration with other critical stakeholders in the RE and EE space. This certainly is very helpful in our drive towards CE and NCAA paradigm.

Appendix 18: NCCP Enabling Policy Measures Relevant for the CE and NCAA Legal Institutional Capacity

NCCP enabling conditions components	Policy Measures	Relevance for the CE and NCAA legal institutional capacity
Legal framework	Facilitate the passage of an Act (Nigeria Climate ChangeFramework Act) that will serve an overarching legal instrument for integrated climate change governance in the country.; Ensure harmonization of sectoral regulations to align with the proposed Climate Change Act and their implementation .; Promote sector specific legislative and regulatory amendments to establish and/or strengthen the enabling frameworks for mitigation and adaptation actions . and; Accelerate the domestication of relevant international instruments, treaties, agreements that deliver climate co-benefits and/or enhance the attainment of the nation's obligations under the UNFCCC.	Enabling provisions for the creation of a legally binding mandate or legislative power to the institutional arrangements for the transparency under the Convention and the Paris Agreement at all levels of governance; Enabling the provisions for the mainstreaming of NDC implementation and transparency-related activities in government planning and development policies
Institutional framework	Alignment and strengthening the capacity of relevant institutions to manage climate-related challenges . ; Encourage the implementation of mitigation and adaptation initiatives at all levels of governance. And; Promoting the roles of States and Local Governments in climate change governance	
Capacity development	Strengthen national and sub-national government capabilities of mainstreaming climate actions and implementation, including linkages ; Enhance the skills and capabilities of staff in relevant and participating institutions including capacities to mainstream gender concerns into national response to climate change ; Ensure high level political commitment for enhanced capacity development; Facilitate public and private sector investments in capacity building programmes for sustained response to climate change	Availability of national experts for the mainstreaming of NDC implementation and transparency-related activities in government planning and development policies at all levels of governance.; Stakeholder engagement including the involvement of those from national government, local government, the private and public sector
Private Sector	Encourage information sharing that support the raising of awareness of the private sector to understanding climate-related risks and opportunities, including the business case for climate mitigation and adaptation.; Provide enhanced technical and institutional capacities for private sector actors to scale up adaptation and mitigation actions that are gender-responsive and socially inclusive; Promote economic incentives to catalyze low-carbon investments	Private sector engagement in the implementation of the NDC and transparency-related activities
Research and Development	Ensure availability of observations, monitoring, and infrastructure for critical data collection and analysis.; Enhance the development and use of scenarios	Enabling provisions for the CE and NCAA-related technical capacity (e.g. monitoring technology, collection of data, scenarios needed to evaluate mitigation and adaptation measures and their effects, etc.)

Appendix 19: Relevant NCCP Implementation Strategies and Actions for the CE and NCAA Legal Institutional Framework

Implementation strategies and actions of the NCCP	Policy Measures	Relevance for the CE and NCAA legal institutional capacity
Mainstreaming Climate Change Concerns into National Development	Institutionalize inclusive governance and integrated approach to climate change management by explicitly identifying and integrating mitigation and adaptation considerations in all sectors; Institutionalize strategic climate change assessments and management approaches to all policies, programmes and plans	Enabling the provisions for the mainstreaming of NDC implementation and transparency-related activities in the national and sectoral planning and development policies.
Roles and Responsibilities of institutions	Strengthen the capacity of the DCC in collaboration with other relevant technical Departments in the FME to play the oversight role of monitoring the implementation of the policy; Develop and implement legal and institutional frameworks for cooperative and collaborative management of climate change between the FME and other MDAs ; Strengthen the capacity of the educational system to provide pertinent climate education and research	Support the provision for the designation of the DCC as the national focal point on the NDC implementation and the climate reporting ; Support the provision for the formalization of the necessary collaboration and supply of data and expertise across government entities, with the DCC as the coordinating body.; Strengthening the educational system to provide pertinent climate education and research will contribute to the availability of human resources needed to perform tasks and functions related to the CE and NCAA in mitigation and adaptation actions.
Public Participation and Partnerships	Build public support through mass education and awareness; Develop and implement strategy on partnership and stakeholder involvement to enhance climate change management. ; Develop and implement strategy for building capacities and capabilities among the various stakeholders to effectively manage climate change	Engagement with stakeholders for the collection of data and the use of outputs; Availability of a team of national experts to perform a range of tasks and functions related to the CE and NCAA of mitigation and adaptation actions

Appendix 20: Envisaged Institutional Arrangement by the NCCFL and their Relevance for the CE and NCAA Legal Institutional Capacity

Envisaged Organs	Functions and Powers	Relevance for the legal institutional capacity for the CE and NCAA
Secretariat of the National Council on Climate Change	Powers of the Secretariat; Request reports, data, documents, or any information necessary to perform its function under this Act. ; Establish and manage a national registry for capturing mitigation and adaptation actions by public and private entities.; Visit the premises of MDAs, and private and public entities for the purposes of monitoring, verifying, and reporting of emission profile or the collection of any other data necessary to undertake the functions and duties prescribed in this Act	
Federal Ministry responsible for Environment, Federal Ministry responsible for National Planning	The Federal Ministry responsible for Environment shall on consultation with the Federal Ministry responsible for National Planning -; Set carbon budget for Nigeria, to keep average increases in global temperature within 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. and by an Order -; set the carbon budget and budgetary period, and; Periodically revise the carbon budget, in line with Nigeria's NDCs and with a view to complying with Nigeria's international obligations.; FME –; May by an Order publish Guidelines for MRV for CE and NCAA of national emissions that will serve as the basis for the setting and annual review of the carbon budget.	The setting of carbon budgets for five-year cycle will lay the foundation for the revision of the longer-term 2030 emission pledge set by the NDC of Nigeria.; The MRV for CE and NCAA of emissions procedural arrangement may benefit from the provision for the development of guidelines for MRV for CE and NCAA of national emissions that will serve as the basis for the setting and annual review of the carbon budget
Ministry responsible for Finance, Budget, and National planning	Shall ensure that all budget proposals submitted by MDAs have been properly vetted and costed for climate change considerations, and that adequate allocation is provided for them under appropriate sub-heads in the annual budget.	Enabling provision for the domestic funding of the mainstreaming of the climate change and the implementation of CE and NCAA
Director-General of the NCC (Secretary)	The Director-General shall, within one year of formulating the Action Plan for the first five-year cycle, and for subsequent other cycles, submit to the Council and National Assembly Committees on Climate Change, a detailed a detailed report on the state of the nation with regard to climate change; The Director-General shall, within three months after the end of every financial year, publish publicly and submit to the National Assembly, an evaluation report on performance of climate change duties by private and public entities.	Provisions supporting the timely development of international reports on emissions and mitigation measures (BUR, BTR, NCS, national GHG inventory report) alongside with nationally determined reporting requirements, the engagement of various stakeholders (private and public entities).; Support the designation of the Secretary as the national CE and NCAA coordinator
Principal Officers of the Council	The Council shall appoint; Six Zonal Coordinators from the six geo-political zones of Nigeria.; State Directors for each state of the Federal Republic of Nigeria	Provisions supporting the establishment of a climate change management focal point in each State with a legal mandate to perform a range of tasks and functions related to different types of CE and NCAA.; Provision supporting the creation of a Coordinator of CE and NCAA-related activities per
MDAs	Establish a climate change desk to be supervised by an officer not below the Directorate cadre, who shall be responsible for ensuring integration of climate change activities into their core mandate.; The Desk Officer referred to in subsection (1) of this section shall ensure adequate planning and budgeting for all climate change programmes, projects and activities.; Adhere to the annual carbon emission reduction targets, in line with the Action Plan and carbon budget made pursuant to this Act.	Formalization of the MDAs climate change desk .; The mainstreaming of the climate change management related activities in the MDAs mandate; Establishment of a climate change management focal point in each MDA with a legal mandate to perform a range of tasks and functions related to different types of CE and NCAA.

Envisaged Organs	Functions and Powers	Relevance for the legal institutional capacity for the CE and NCAA
Private Entities	Any private entity with employee numbering 50 and above, shall –; put in place measures to achieve the annual carbon emission reduction targets in line with the Action Plan. And; designate a Climate Change Officer or an Environmental Sustainability Officer, who shall submit to the Secretariat, through the State Director, annual reports on the entity's efforts at meeting its carbon emission reduction and climate adaptation plan.; Notwithstanding the provisions in this Act, the Council may by notice in the Gazette, require a private entity under this Act -; to prepare reports on the status of its performance of its climate change obligations, and prescribe the period for reporting.	Involvement of the private sector in the implementation and the reporting of mitigation and adaptation actions.

Appendix 21: NESREA's Functions and their Relevance for the Legal Institutional Capacity for the Circular Economy and Natural Capital Accounting in Nigeria

NESREA's Functions	Relevance for the legal Institutional Capacity for the CE and NCAA
Enforce compliance with laws, guidelines, policies and standards on environmental matters.	NESREA's legal functions support the coordination of the enforcement of most of the climate change-related legal framework including those related to the CE and NCAA process by this institution.
Coordinate and liaise with stakeholders, within and outside Nigeria on matters of environmental standards, regulations and enforcement.	Enabling provision for the NESREA to ensure compliance with standards and regulations inclusive of those that apply internationally such as Paris Agreement of the United Nations.
Enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment including climate change, biodiversity conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, marine and wild life, pollution, sanitation and such other environmental agreements as may from time to time come into force.	Enabling for NESREA for the generation of data through environmental audit and the establishment data bank on the legal enforcement.
Enforce through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector.	Stakeholder engagement including the public and private sector compliance with CE and NCAA legal framework by NESREA.
Create environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector.	
Create public awareness and provide environmental education on sustainable environmental management, promote private sector compliance with environmental regulations other than in the oil and gas sector and publish general scientific or other data resulting from the performance of its functions.	

Appendix 22: Decarbonization Initiatives and Projects In The Energy Sector

S/n	Name of Initiative/Project	Government MDA or NGO	Description	Net Zero Affiliated Targets
1.	Presidential Power Initiative (PPI)	Federal Ministry of Power	This program (formerly Nigeria Electrification Roadmap) is a partnership between Nigeria and Germany formed to tackle issues in the power sector and increase capacity. It is facilitated by Siemens Energy to obtain financing from Euler Hermes AG- a German Export Credit Agency and other financers.	7GW operational capacity in 2021; 11GW in 2023; 25GW in 2025.
2.	Hydropower Project	Federal Ministry of Power	This is Nigeria's largest proposed power plant located on Dongo River close to Baruf, Taraba State undergoing construction with a 3.05GW hydroelectric installation to produce an estimated 4.7 billion kWh of electricity annually. It is expected to be launched in 2030.	3.05GW to start generation in 2030; 4TWh per year
3.	Renewable Energy Market	Federal Ministry of Environment	This market is currently being developed to encourage the adoption of renewable energy and enhance the growth of its trade and technologies in Nigeria.	
4.	Nigeria 2050 Calculator	Energy Commission of Nigeria	The Nigeria Energy Calculator 2050 (NECAL 2050) is a second version of a tool developed by the United Kingdom to aid Nigeria's NDC and its Sustainable Energy for All Action Agenda (Vision 2030). It is being used by more than 30 countries and is supported by International Climate Finance (ICF) in the United Kingdom.	
5.	SEf or All Country Action Agenda	Non-governmental organisations	This collaboration between governments, private sector and the civil society aims to provide energy services across the world, increase the rate of energy efficiency by twice the current rate, and increase the amount of renewable energy by 100%. The African Hub of the initiative consists of African countries working with AfDB, African Union Commission, UNDP and NEPAD Planning and Coordinating Agency.	30GW of power capacity by 2030 with 30% from renewables
6.	National Gas Expansion Program (NGEP) – Track 1	Federal Ministry of Petroleum	NGEP Track 1 was developed to make CNG the primary fuel for transportation. The CBN has provided N250 billion to facilitate the associated gas value chain.	Use of 1 million CNG cars by the end of 2021
7.	National Gas Expansion Program (NGEP) – Track 2 (LPG)	Office of the Vice-President	NGEP Track 2 was developed to make LPG the primary fuel for cooking and independent electricity generation, while gas-based industries such as petrochemicals will be enhanced to support large factories and agricultural applications.	Production of 5 million tonnes of LPG in 2027 for the domestic market
8.	Nigeria Gas Flare Commercialization program (NGFCP)	Federal Ministry of Petroleum Resources	This initiative was launched at the end of 2016 with the objective to putting an end to gas flaring through feasible gas projects which have been developed to be competitively bided for by third parties.	Flare out complete by 2030 with commercialization of flare gas through competitive and transparent bidding
9.	Solar Power Naija	Rural Electrification Agency (REA); Ministry of Power	This is a program developed by the Federal Government to provide 5 million households or 25 million citizens with access to energy services in the rural areas and vulnerable urban locations. $24 million has been made available by the Nigeria Sovereign Investment Authority (NSIA).	Solar House Systems: 5 million off-grid solar systems for homes not connected to grid by 2023

S/n	Name of Initiative/Project	Government MDA or NGO	Description	Net Zero Affiliated Targets
10.	Nigeria Electrification Project (NEP)	Rural Electrification Agency (REA)	This initiative is funded by AfDB to provide more than 600,000 people with an estimated 100,000 households, 70,000 MSMEs and 8 universities to receive new or improved access to electricity services. It consists of 250 mini-grid systems; 24,500 solar PVs installed; mini-grid systems provided at the universities; and building organizational capacity benefiting REA and the environment.	Off-grid new or improved electricity connections for 2.5 million persons inclusive of 500,000 households and 70,000 MSMEs by 2023
11.	Energizing Education Program (EEP)	Rural Electrification Agency (REA)	The first phase of ths project is undertaken by the REA and fully funded by the Federal Government to provide 28.5MW clean power. This is for 9 Federal Universities and 1 Teaching Hospital while assisting 127,000 students, 28,000 University staff, and 4,700 Hospital staff with electricity in addition to	
12.	Universal Green Energy Access Program (UGEAP)	Non-governmental organisations	The programme which was approved in 2016 strives to fund decentralized energy organizations so they can offer mini-grid and off-grid solutions to rural communities. Over $500 million will be availed over 5 years to be delivered in two phases. The project's lifespan is 15 years.	
13.	National GHG inventory and submissions to the UNFCCC, NDC	Federal Ministry of Environment	This comprises of yearly submissions to the UNFCCC of a National Inventory Report (NIR) which highlights quantitative data of all GHG emissions and activity data. Nigeria's data is yet to be published on the UNFCCC website.	
14.	Nigeria Deep Decarbonization Pathways Project (DDP)	Federal Ministry of Environment	The objective of this research program which is focused on country-specific low emission measures and policies is to stimulate stakeholder engagement and knowledge sharing with an international outlook. The collaboration is with the French Development Agency (AFD) and the Foundation Institut du development durable et des relation internationals (IDDRI).	
15.	Nigeria Energy Database	Rural Electrification Agency (REA)	The initiative aims to develop an online database of the energy data from the national grid and communities collected by various public and private stakeholders.	
16.	Climate Finance Accelerator program (CFA)	Non-governmental organisations	The CFA is a UK government-led international collaborative effort which seeks to provide investment support for feasible projects in the private sector that will facilitate changing NDCs into Climate Investment Plans. This project has also led to the development of a Nigeria Climate Finance Mapping project which highlights financial and capacity building resources including a database of key stakeholders.	
17.	2050 Pathways Platform	Non-governme ntal organisations	This initiative which consists of various countries started at COP22 to assist them prepare long-term, net zero GHG emissions, climate resilient and sustainable development roadmaps.	

Appendix 23: Scenario Analysis: Energy

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
Oil and Gas						
Unsustainable use of unrenewable energy sources	Climate, air and land pollution	Exploiting renewable energies in the country (solar, wind, hydro etc.)	Preserve and enhance natural capital by monitoring finite stocks and balancing renewable resource stocks.	National Energy Policy. Aim: of provide clean, affordable, adequate and reliable energy with active participation of private sector	Zero waste initiatives – promoting the reuse of equipment and materials wherever possible.	Natural Resource Stock Accounts
	Health effects on population	Recycling and reusing produced and flowback water	Diversification of economy to reduce strain on fossil fuels and unrenewable resources.	National Climate Change Policy	Incentives/subsidies to provide alternative clean energy development and use e.g., tax credits for the use of solar panels, electric cars, or other alternative-energy options	
	Drilling accidents/ oil spills– negative effect on biota ad ecosystem health.	Investment in waste to energy businesses		Nigeria Climate Change Framework Law	Change customer, investor, and employee expectations – i.e., increase demand for renewable energy sources	
		Flared gas a by product can be used to power water treatment facilities		Renewable Energy Policy Guidelines (REPG) (2006)		
		Diversification of economy to include		Nigeria Biofuel and Incentives		

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
		new streams of revenue from renewable energy				
				The Environmental Guidelines and Standards for the Petroleum Industry in Nigeria		
Lack of sustainable practices	Damage to ecosystem	Reduce freshwater water usage	Decrease freshwater usage	National Environmental Standards and Regulations Enforcement Agency	Investments in small-scale waste-oil micro-refinery units	Natural Resource Stock Accounts; Land Accounts; Inland Water Accounts
	Contamination to soil, air and water	Recycling and reusing water for operations	Green Tax		Implementation of green taxes	
	Negative impacts on health and safety of population	Used/inactive oil can be transformed into diesel fuel	Use of 3D modelling to analyze and assess viability of dig sites and structural integrity of oil wells.		Put pressure on companies to focus on sustainable practices	
					Information and technology	
Power (Electricity)						
High carbon electricity system	High carbon footprint/emissions	Investments in renewable energy technologies	Monitoring of Carbon reserves	Electric Power Sector Reform Act 2005	Incentives to drive up private sector participation	Natural Resource Stock Accounts
	Release of GHGs into environment		Development of low, zero or	National Renewable		

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
			negative carbon energy technologies.	Energy and Energy Efficiency Policy		
			Research and development in bioenergy to promote decarbonisation	National Energy Efficiency Action Plans (NEEAP) (2015–2030)		
Loss of essential energy(wasted) (e.g., specifically flared gas and produced water)	Release of ozone depleting gases into environment	Gases produced as by products (what process) can be captured and used.		National Environmental Standards and Regulations Enforcement Agency	Government should encourage and promote relevant and appropriate technology options for setting up projects on energy recovery.	
		Recycling and reusing produced and flowback water			Government should promote waste to energy schemes and set up waste to energy plants.	
Transport						
End-of -life tires (waste)	End up in landfills – become breeding grounds for mosquitoes, rats etc.	Investment in recovery/recycling facilities	Environmental/ ecological fees	National Policy on Solid Waste Management (2020) – Aim: promote clean and healthy environment for sustainable socio-economic development.	Innovation and infrastructure development	
	Open burning - increase GHG emissions, air pollution,	Recycling ELT to Rubber modified asphalt	Less dependency on fossil fuels/unrenewable	National Environmental (Motor Vehicle and	Source reduction – i.e., reduce demand of tire products in Nigeria (e.g., promoting use of	

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
	contamination of soil, surface and ground water.		natural resources to produce tires	Miscellaneous Assembly) Regulations, S. I. No 35, 2013	public transport, car-pooling)	
	Health implications	Redesigning/designing innovative wheels/tires to extend useful life/ enhance use.			Assess the demand and supply (viability) of circular management of ELTs in Nigeria market.	
		Energy recovery from incineration			Improve public transport infrastructures (High occupancy vehicle lanes, railways systems).	
		EPR Programmes				
		Pyrolysis for energy (fuel) recovery				
Energy consumption from Transportation systems	GHG emmisions Resource depletion	Investment in non-fossil dependent, clean energy efficient modes of transportation (e.g., electric/hybrid cars and buses)	Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource stocks. Foster system effectiveness by uncovering and designing out negative externalities	National Energy Policy – Aim: To reduce energy consumption and greenhouse gas (GHG) emissions from transportation systems National Environmental (Motor Vehicle and Miscellaneous Assembly) Regulations, S. I. No 35, 2013	Tighten legislation to put new pressures on material engineers to innovate vehicle designs for greater performance and reduction in fuel consumption. Investment in public infrastructures, roads and electricity supply	

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
	High carbon footprints				Encourage the use of public transport to reduce vehicle usage.	

Appendix 24: Scenario Analysis: Industrial Processes and Product Use (IPPU)

Identification of Issue	Effects of Issues	Opportunities for CE/NCA Business	Strategies to Promote NCAA	Policy response (how to solve NCA/CE problem)	Policy review (how to adapt the policies?)	Accounts required (Time series for the thematic extent and condition accounts)
Construction						
Waste	Air pollution	Reuse of Local Excavated Earth to Make Eco-Friendly Building Material	Develop Develop approved engineered landfills and upgrading of dumpsites	Environmental Impact Assessment Act (EIA) – Aim: identify and assess the potential impacts of a proposed project.	Promoting mass use of timber in construction industry (wood is more recyclable)	
	Resource depletion	Investment in initiatives targeted at transforming waste to new resources.		National Environmental National Environmental Standards and Regulations Enforcement Agency Act (NESREA Act)- Aim: To regulate the effect of a project on the environment.	Develop clear market push-and-pull policies that will accelerate the implementation of CE principles in construction	
	Power consumption	Reuse/Refurbishment of old buildings instead of demolition		National Policy on Solid National Policy on Solid Waste Management (2020) – Aim: promote clean	Projects that have significant environmental effects should be subject to green/ environmental taxes.	

				and healthy environment for sustainable development.		
	Land use deterioration	Use of regenerative approaches to manage solid waste and wastewater			Entrepreneurs can undertake the Entrepreneurs can undertake the training and certification of technicians, artisans, and builders in efficient practices to reduce material losses who would then be preferred to other personnel in the industry	
		Upcycling plastic waste for formal and informal built environment construction materials			Waste-to-energy schemes can be Waste-to-Energy schemes can be established using construction and demolition waste as feedstock. This can then provide energy services for targeted communities.	
		Repurposing and refurbishing construction materials such as fixtures and fittings			Grant applications specialists who Grant applications specialist who can develop sustainable waste management proposals for the purpose of obtaining funding from donor organizations.	
		Use of second-hand building Use of second-hand building materials.				
		Use of waste from construction sites to produce building blocks and tiles				

High energy consumption	GHG emissions	Energy recovery/ recycling for asphalt roads.	Restoring Natural capital by using renewable energy sources	National Building Code – National Building Code - Aim: makes provisions for environmental issues relating to building construction.	Incentives to increase interests among supply chain players Incentives to increase interests among supply chain players	
	Resource depletion	Use of energy efficient equipment	Use of reclaimed/ Use of reclaimed/remanufactured elements to limit demand for raw resources	Environmental Impact Environmental Impact Assessment Act (EIA) – Aim: identify and assess the potential impacts of a proposed project.	Promotion of the construction of green buildings to increase their sustainability Promotion of the construction of green buildings to increase their sustainability	
	Land use deterioration	Refurbishments of construction materials	Use of biomaterials		Research and development of sustainable ways to reduce energy consumption throughout supply chain esearch and development of sustainable ways to reduce energy consumption throughout supply chain	
		Mobilizing construction Mobilizing reconstruction debris to make tiles and bricks.				
Fashion/Textile						
Extractive production from raw materials e.g., synthetic materials from crude oil, natural fibers)	Over farming	Big businesses exploring green initiatives to reduce environmental impact of their apparel supply chains through	Use of Adoption of natural capital accounting to put value on natural resources and enable efficiency and sustainability	National Environmental (Textile, Wearing Apparel, Leather and Footwear Industry)	Raising awareness and educate audiences to care for and repair their clothes, research and development of sustainable ways to reduce energy	Natural Resource Stock Accounts

and use of chemicals		collaborations (e.g., making clothes and shoes designed to be recycled).		Regulations, S. I. No. 34, 2009	consumption throughout supply chain	
	Human and health concerns				Designers encouraged to create cuts that minimize waste.	
	GHG emissions				Manufacturers and suppliers should be held accountable for performance shortfalls i.e., fined, taxed.	
	Labour abuse				Possible collaboration with Dutch textile manufacturer Vlisco to support recycling initiatives.	
	Non-biodegradable waste				Incorporate chemical and waste management into national development programmes	
Shorter product life cycles = high volume of textile waste/wastewater	Climate Change	Circular material flows – valorizing waste	Adoption of natural capital accounting to put value on natural resources and enable efficiency and sustainability	National Policy on Solid Waste Management (2020) – Aim: promote clean and healthy environment for sustainable	Investment in recycling technologies/infrastructures.	
	Biodiversity loss	Servitization strategies (shift from selling products to selling product service systems) to extend life of garment.	measurement and valuation of biodiversity.	National Policy on Chemical Management (2010)	Introduction of mainstreamed, up-scaled processes and know-how to collect and sort textiles by type	
	Land use Change	Fashion remanufacturing (remaking clothes using	Synergy of stakeholders to ensure the sound management of chemicals to avoid their		More flexibly meet demand by providing more options for the way clothes are sold or rented, to break free from	

		reclaimed/recycled fabrics)	release into the environment.		their increasingly disposable nature.	
	Freshwater Consumption	Investment in infrastructure and processes for waste collection and sorting.			Foreign investors set up a recycling facility in the six geo-political zones of the country	
	Chemical Pollution	Investment in commercial viable recycling technologies for low-grade textiles fraction			Conversion of textile waste into low-grade products such as insulation and carpeting	
	Water pollution	Selling of reusable textile wastes to companies like RecyclePoint and Wecyclers				

Appendix 25: Waste Efficiency Analysis of Representative Focus Industries

S/n	Information	Packaging	Electronics	Food Systems	Built Environment
1.	Major Stakeholders in Value Chain (Producers, Consumers, Regulators)	Members of the Manufacturers Association of Nigeria such as NBC, Nestle, Unilever, Flour Mills, Dangote Group, Dufil Prima, UAC Foods, Beloxxi, Seven –Up, water bottling and sachet companies, FBRA. egulatory agencies such as NESREA, NAFDAC, SON, General Public.	• Electrical and electronic importers and businesses, EPRON, ARBR. • Electronics consumers. NESREA, SON	• Farmers, ranchers, agricultural retailers. food processors, commercial food vendors/eateries, domestic homes, • General public. NESREA, NAFDAC	• Architects, Engineers, Builders, Quantity and Land Surveyors etc. • NESREA, Federal Ministry of Works and Housing
2.	Major Waste Production Processes	Indiscriminate disposal of waste packages, bottles, wraps, bags, containers, fishing nets etc.	End of usage of electronic products, upgrade in lifestyles, advancement in technologies.	Animal Husbandry, subsistence and commercial farming, aquaculture, food processing, cooking etc.	Concrete works, Bricks works, Ceramic and Tilling works, Glass installation works, Plastic/Thermoplastic works, Ferrous Metal works, Quarry activities, road construction
3.	Major Losses during Production Lifecycle	Extraction: • Loss of lives during material extraction • Water losses due to amount and status of water used for extraction. • Land contamination • Loss of clean air • Biodiversity losses Production: • Material losses during plastic production. • Product Use and Disposal: • Loss of land due to landfills • Material losses of end-of-life plastics • Material losses due to lack of recycling • Loss of good quality air • Loss of habitats	Extraction: • Loss of lives during mining • Water losses due to amount of waste water, pollution, water poisoning etc. • Land contamination • Loss of clean air • Biodiversity losses Production: • Material losses during electrical and electronics production. Product Use and Disposal: • Material losses of precious metals and useful materials • Loss of land due to landfills • Loss of habitats • Loss of human health	Farming Activities: • Crop losses/waste • Animal waste/dung • Water losses on farms • Loss of land due to excessive use of chemical fertilizer Processing: • Water losses • Food waste during processing • Food storage losses Consumption and Disposal: • 1. Loss of land for landfills • 2. Food waste generated after consumption	Extraction: Extraction; • Loss of lives and adverse effect on human health • Water losses due to amount and status of water used for extraction • Land losses due to contamination • Loss of clean air due to air pollution from particle emissions • Biodiversity losses due to water, land and air pollution Products Manufacture: • Material losses during production • Water losses • Loss of clean air during manufacture. Product Use and Disposal: • Material losses from waste

					• Loss of good quality air • Loss of habitats • Loss of land due to landfills
4.	Major type of wastes generated	Containers and packaging consisting of plastic, aluminium, paper and paper boards, glass, wood, steel materials.	Household appliances, IT equipment, lighting, medical equipment such as televisions, refrigerators freezers, washing machines, pressing irons, bulbs, phones, laptops, printers, monitoring equipments etc.	Crop waste, animal waste, processed/packaged food waste, raw and cooked food items.	Insulation materials, bricks, concrete, tiles, ceramics, cement, metallic waste, Stones and Stone dust, Plastic and Thermoplastic waste, Paints, Glasses, Aluminium, Timber, Bitumen and other chemicals.
5.	Current waste disposal techniques/processes	Open dumpsites, landfills, dumpsters/skips, open burning, water bodies (sea, rivers, lakes) and drainage networks.	Open dumpsites, landfills, dumpsters/skips, open burning, water bodies (sea, rivers, lakes) and drainage networks.	Open dumpsites, landfills, dumpsters/skips, open burning, water bodies (sea, rivers, lakes) and drainage networks.	Landfills, open burning. dumpsters/skips. open dumping. garbage heaps.

Appendix 26: Links between NCAA and SDGs

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
Land	Asset	% of land under sustainable agriculture						SDG 12. Sustainable production and consumption			
Energy	Asset							SDG 12. Sustainable production and consumption			
	Material FLow			% of potential from different sources				SDG 12. Sustainable production and consumption			
	Economic			% of population with access to energy - % of renewable energy consumption – energy intensity				SDG 12. Sustainable production and consumption			
	Emission			% of emissions from different sources				SDG 12. Sustainable production and consumption			

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
Water	Asset		% of water in stocks					SDG 12. Sustainable production and consumption			
	Material FLow		% of population using water/ sanitation services - water use efficiency - time spent on water collection – % of waste water treated Asset accounts# % of water resources used					SDG 12. Sustainable production and consumption			
	Economic		% of water resources used					SDG 12. Sustainable production and consumption			
Minerals	Asset							SDG 12. Sustainable			

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
								production and consumption			
	Material Flow							SDG 12. Sustainable production and consumption			
	Economic							SDG 12. Sustainable production and consumption			
	Emission							SDG 12. Sustainable production and consumption			
Aquatic resources	Asset							SDG 12. Sustainable production and consumption			
	Material Flow							SDG 12. Sustainable production and consumption			
AFOLU	Asset							SDG 12. Sustainable production			

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
								and consumption			
	Material flow							SDG 12. Sustainable production and consumption			
	Economic							SDG 12. Sustainable production and consumption			
	Emission							SDG 12. Sustainable production and consumption			
	Waste							SDG 12. Sustainable production and consumption			
Ecosystem	Asset							SDG 12. Sustainable production and consumption			
	Conditions							SDG 12. Sustainable production and consumption			

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
	Services							SDG 12. Sustainable production and consumption			
Biodiversity	Asset							SDG 12. Sustainable production and consumption			
	Conditions							SDG 12. Sustainable production and consumption			
	Services							SDG 12. Sustainable production and consumption			
IPPU	Asset							SDG 12. Sustainable production and consumption			
	Material Flow							SDG 12. Sustainable production and consumption			
	Economic							SDG 12. Sustainable			

Type of natural capital or economic domain	Type of account	SDG 2. Zero hunger (agriculture)	SDG 6. Clean water and sanitation	SDG 7. Affordable and clean energy	SDG 8. Decent work and economic growth	SDG 9. Industry, innovation and infrastructure	SDG 11. Sustainable cities and communities	SDG 12. Sustainable production and consumption	SDG 13. Climate action	SDG 14. Life below water	SDG 15. Life on land (ecosystem)
								production and consumption			
	Emission							SDG 12. Sustainable production and consumption			
	Waste							SDG 12. Sustainable production and consumption			
Waste								SDG 12. Sustainable production and consumption			
								SDG 12. Sustainable production and consumption			
								SDG 12. Sustainable production and consumption			

Appendix 27: Checklists for CE & NC Roadmap in Services Sector

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
1.	Implementation of existing NC/CE affiliated legislation by private sector	NC (Water) & CE (Waste)	Business that would aid waste management, business access funds via proposal writing etc.;- Awareness creation on accessing funds	Improvement of internet and communication facilities							
2.	Absence of safety and security in certain parts of the country	NC (Water) & CE (Waste)	Establishment of security outfits							Work with security agencies on their increased presence at facilities	
3.	Inadequacy of regulatory institutions	CE (Waste)	Partnership of private sector with govt to improve skill set and for national coverage				Provision of funds via loans by financial institutions- Partnership with international donor agencies to provide grants		Ensure NC/CE projects are given priority	Ensure NC/CE projects funding are given priority	

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
4.	Absence of sector-specific policies	CE (Waste)	Creation of sector specific businesses to harness waste stream potentials- Form partnerships with existing regulatory institutions to enforce legislation nationwide	Creation of policies on specific waste streams such as e-waste, textile waste, organic waste, battery, industrial waste	Include viability of waste stream businesses potentials					Highlight socio-economic benefits in strategic plans of the development of such sectors	
5.	Multiplicity and lack of synergy among govt stakeholders	NC (Water) & CE (Waste)	Capacity building organisations for training MDAs regarding skills and communications					Deployment of up-to-date of up-to-date communication networks and gadgets for easier		Improvement of inter-MDA communications and regular updates	
6.	Absence of relevant country-specific data	NC (Water) & CE (Waste)	Entrepreneurial researchers can create databases- Development of a NCAA tool					websites and domains for easy hosting of databases- Development of data acquisition and transfer applications		Harmonizing of data by relevant MDAs	Implementation of MRV system
7.	Absence of finance and technical support for govt and external agencies	NC (Water) & CE (Waste)	Establishment of PPPs		Highlight investment potential of relevant projects	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes			Creation of business models for pilot programmes	

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
8.	Absence of available basic amenities service like power, water, road network for projects and high costs of alternatives	CE (Waste)	Establishment of businesses to provide amenities		Include viability of business potentials	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes		Facilitate private sector participation in providing relevant infrastructure		
9.	Lack of resources/capital for private stakeholders	NC (Water) & CE (Waste)	Waste, water & Fisheries				Import waivers and tax incentives for CE affiliated equipment				
10.	Abandoned water infrastructures across state water boards and river basin authorities	NC (Water)			Highlight investment potential of relevant projects	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes				
11.	Absence of private	NC (Water)	Establishment of waste water treatment plants to	Development of legislation for private sector	Include viability of	Marketing of projects to attract	Provision of funds for		Facilitate private sector	Highlight socio-economic	

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
	sector water utilities organisations		compliment public water supply agencies- Investment/ construction of artificial wetlands for rainwater harvesting	driven water utilities	business potentials	potential PPP investors	viable schemes		participation in providing public water services	benefits in strategic plans	
12.	Absence of sustainable practices in fish harvesting, processing and packaging	NC (Water)	Creation of businesses which utilize sustainable practices- Creation of capacity- building firms which train personnel on sustainable techniques	Development of aquaculture legislation to aid business development	Include viability of business potentials			Use of technological applications to access new and foreign markets		Highlight socio-economic benefits in strategic plans	
13.	Pollution of water bodies/resources and facilities by water vessels	NC (Water) & CE (Waste)	Establishment of cleaning services				Provision of funds for viable schemes			Enforcement of relevant regulations at ports and vessels	
14.	Implementation of pilot models of renewable energy projects e.g. methanol,	CE (Waste)	Establishment of PPPs with MDAs on relevant projects		Highlight investment potential of relevant projects	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes	Research & development of relevant gas capture, methanol production, & anaerobic digestion applications			

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
	anaerobic digestion										
15.	Use of Climate Adaption Decision Support for MDA owned projects	NC (Water) & CE (Waste)	Establishment of PPPs with MDAs on relevant projects		Highlight investment potential of relevant projects	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes			Creation of business models and template for relevant projects	
16.	Resuscitation of National Plastic Recycling program		Purchase of lease of facilities installed at 26 locations across Nigeria- Establishment of plastic waste -to-energy plants		Highlight investment potential of relevant projects	Marketing of projects to attract potential PPP investors	Provision of funds for viable schemes				

Appendix 28: Checklists for CE & NC Roadmap in Energy Sector Oil Gas, Power & Transport

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
1	Implementation of renewable energy policies	CE (Power)	Business that would build and generate renewable energy and improve energy efficiency	Already existing	Inclusion of viability of such schemes nationwide	Aid growth of privately owned & PPP renewable energy generators	-Provision of start-up grants and soft loans for registered businesses -Awarenes s creation on accessing funds	Development of modern power infrastructure and facilities	Deployment of power infrastructure and facilities		
2.	Absence of relevant country-specific data	NC/CE (Oil/Gas, Power & Transport)	Entrepreneurial researchers can create databases - Development of a NCAA tool				Provision of funding by sector specific or umbrella organisations based on interest in particular data	-Development of a countrywide NCAA tool -Creation of websites and domains for easy hosting of databases - Development of data acquisition and transfer		-Harmonizing of data by relevant MDAs -Partnership with international organizations for knowledge and data sharing	Implementation of MRV system
3.	Lack of capital/funding to facilitate the growth of energy	CE (Power, transport)	Power and transport business which can provide services nationwide - Organisations which facilitate the successful			Incentives for registration and incorporating sustainable practices	-Provision of funds by financial institutions -Import waivers and tax	Subsidies for purchase of modern equipment and	Rent, tax, and import incentives for NC/CE infrastructure growth	Partnership with international organizations for grants	

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
	private sectors members		applications of gtants				incentives for CE affiliated equipment	sustainable processes			
4.	Adoption of pilot models of renewable energy projects e.g. methanol, anaerobic digestion	CE (Power, transport)	Manufacture, import and/or sale of energy efficiency equipment and devices for residential, commercial and industrial uses - PR firms for the awareness and education of the general populace on benefits of such schemes	Already existing				Research & development of relevant gas capture, methanol production, & anaerobic digestion applications			
5.	Incorporation of NC/CE measures in new modular refineries	NC & CE (Oil/Gas)	-Capacity building organisations for training of refinery workers - Manufacture, import and/or sale of recycled equipment and devices for refinery uses	Already existing	Inclusion of viability of such schemes nationwide	Aid growth of refineries which incorporate sustainable NC/ CE measures	-Provision of start-up grants and soft loans for registered refineries -Awarenes s creation on accessing funds	Development of relevant sustainable infrastructure and facilities	Deployment of relevant infrastructure and facilities		

S/n	Issues/Challenges	Natural Capital or Circular Economy	Business/Investment Opportunities	Policy & Legislative Options/Reforms (NCPE)	Investment Plan (NCEIP)	Business Strategy (CEBS)	Finance & Projects (CEF, CEPs)	Technology applications (CETs)	Infrastructure (CEI)	Planning Process & Mainstreaming	MRV, NCA & National Natural Capital Strategy (NNCS)
6.	Public health and safety due to handling/logistics of gas facilities	CE (Oil/Gas)	-Establishment of HSE outfits -Establishment of authorized wholesale and retail gas installations -Skilled gas personnel	Already existing		PPP to facilitate gas increased gas deployment	Easy access to funding for HSE start ups	Use of modern sustainable gas equipment and practices	Development of gas infrastructure in residential, commercial and industrial locations across the country	Enforcement of certified approved infrastructural plans	
7.	Absence of security in key locations	CE (Oil/Gas, Power & Transport)	Establishment of security outfits							Work with security agencies on their increased presence at facilities	
8.	Multiplicity & lack of synergy among govt stakeholders in harmonizing energy projects	CE (Oil/Gas, Power & Transport)	-Capacity building organisations for training MDAs -regarding skills and communicatio					-Deployment of up-to-date communication networks and gadgets for easier inter -MDA communication		-Improvement of inter -MDA communications and regular updates	

Appendix 29: Policy Framework for MRV in support of Natural Capital Accounting, Circular Economy, and Green Growth

Policies and Laws	Key Points of the Policy in Relation to NCAA, CE and GE	Key Areas Directly or Indirectly Related to MRV in relation to NCAA, CE and Ge	MRV and CE tools
Constitution of the Federal Republic of Nigeria, 1999	The federal government is empowered to protect and improve the environment and safeguard water, air and land, forest and wildlife	Determine and protect the Natural capital stocks and conditions	LULC* AFOLU Carbon Calculator
National Climate Change Policy Response and Strategy, 2012	The goal of the NCCPRS is to foster low-carbon high economic growth and build a climate resilient society, through the following main objectives: ; Implement mitigation to promote low carbon sustainable high economic growth. ; Enhance national capacity to adapt to climate change. ; Increase public awareness. ; Involve the private sector to address CC challenges.	Implement the GHG reduction options and transition to low-carbon pathways	Qualitative evaluation of policy implementation
Nigeria National Biofuels Programme	Enhancing just transition to lower carbon fuels and creation of green jobs	Accounting for low carbon energy	The Low Emissions Analysis Platform (LEAP) model
The Minerals and Mining Act LFN 2007	Exclusion of lands constituting National Parks from minerals exploration and exploitation Promote environmentally sustainable development by supporting the protection, conservation, maintenance, and rehabilitation of natural habitats and their functions.	Environmental Assessment involves measurement to improve decision-making, to ensure that project options under consideration are sound and sustainable.	Assessment of Policies and Measures (P&M)* SWOT Analysis
Environmental Impact Assessment Act Cap E12 LFN 2014	EIA is a requirement for project agriculture, infrastructure, logging and conversion of forest to other land use, mining, and housing. Legislation in the field of Environmental Impact Assessments*	Measurement of level of pollution and other environmental impacts Promote environmentally sustainable development by supporting the protection, conservation, maintenance, and rehabilitation of natural habitats and their functions	Assessment of Policies and Measures (P&M)* SWOT Analysis
National Park Service Act Cap N65 LFN, 2004	Protection and Preservation of ecosystem natural capital and biodiversity	Accounting for ecosystem natural capital and biodiversity	LULC
Regulations of the National Environmental Standards and Regulations Enforcement Agency (NESREA)	Regulation of access to natural capital Establishment of the National Environmental Standards and Regulations Enforcement Agency	Enhance individual and organizations to account for natura capital extraction	
National Policy on Environment, 1999	Promote the sustainable use of natural capital * restore and maintain the ecosystem and ecological processes and preserve biodiversity.	Enhance accounting for ecosystem and natural capital, waste and pollution	
National Forest Policy, 2006	The overall objective of the National Forest Policy is to achieve sustainable forest management that would	Enhance accounting for ecosystem and natural capital	

Policies and Laws	Key Points of the Policy in Relation to NCAA, CE and GE	Key Areas Directly or Indirectly Related to MRV in relation to NCAA, CE and Ge	MRV and CE tools
	ensure sustainable increases in the economic, social and environmental benefits from forests and trees for the present and future generations including the poor and the vulnerable groups.		
National Biodiversity Strategy and Action Plan (NBSAP)	It provides frameworks foraddressing biodiversity conservation* sustainable use of the biological resource.	Provides a strategic framework for ecosystem and biodiversity account	
National Agricultural Policy, 2001	Introduction of Climate Smart Agriculture to also help in GHG emission reduction through improved land and nutrient management, improved livestock management and through agroforestry practices.	Account for GHG emission reduction in agriculture sector	The Agriculture and Land Use Greenhouse Gas Inventory using Analysis Software Tool (ALU)* The Global Livestock Environmental Assessment Model (GLEAM)
National Renewable Energy and Energy Efficiency Policy (NREEEP), 2015	Sustainable low carbon and clean energy	Reduction GHG emission in energy sector and accounting for efficient energy delivery	
National Action Plan to Reduce Short-Lived Climate Pollutants	Reduction of methane emission from Enteric Fermentation		
National Environmental Regulations, 2009* 2011	Legal Framework for the adoption of sustainable practices in environmental sanitation and waste management to minimize pollution	Imports of near end-of-life and waste electric and electronic equipment are banned.	
Policy Guidelines on Solid Waste Management, 2005	This document provides a good overview of how solid waste management should be organized in Nigeria, which organization is responsible for what etc.	Waste management through sorting and classification	

Appendix 30: Relevance of the Nationally Determined Climate Change Management Reports and Action Plan in Nigeria for the CE and NCAA Implementation

Envisaged national **reports and legal instruments**	**Action plan and reporting -related provisions**	**Relevance for the legal institutional capacity for the MRV**
National Climate Change Action Plan	The Action Plan shall; Serve as a basis for; Identifying the activities aimed at ensuring that the national emissions profile is consistent with the carbon budget goals; Prescribe measures and mechanisms for–; Setting out actions for mainstreaming climate change responses into sector functions,; Identifying actions for adaptation and mitigation against climate change,; Setting out a structure for public awareness and engagement in climate change actions,; Identifying strategic areas of national infrastructure requiring climate proofing, ; To enhance energy conservation, efficiency and use of renewable energy in industrial, commercial, transport, domestic and other uses, ; For reviewing levels and trends of greenhouse gas emissions, and; For achieving Nigeria's climate change goals. ; Make provision for research, planning, and action on climate change mitigation and adaptation	Enabling provision for mainstreaming the NDC and transparency-related activities in government planning.
National Climate Change Action Plan	The components of the Action Plan shall include; an articulated carbon budget for the five-year cycle, consistent with the carbon budget.; an articulated annual carbon budget for each of the years that make up the five-year cycle.; past, current and projected GHG emission profile of GHG emission sectors of the economy.; details of past, current and proposed climate mitigation and adaptation actions across the sectors of the economy including the rationale, costs, funding source and benefit of such action.; details on the level of compliance with international climate commitments. and; proposed incentives for private and public entities, which achieve GHG emission reduction.	Enabling provisions for the implementation transparency-related activities including the development of the historical and baseline scenario emissions, evaluation of mitigation actions and their effects, and the evaluation of the NDC progress.
Report on the state of the nation with regard to climate change	The report shall include; Progress on the implementation of the national action plan.; The extent to which GHG emission profile is consistent with annual carbon budget.; The identification of GHG mitigation and adaptation potential. ; The identification of options, prioritization of appropriate mitigation and adaptation measures for joint projects of national, state, and local governments as well as the private sector.; Identification of the efforts being made by public and private entities in attaining the carbon budget. ; Incentives granted private and public entities for their efforts towards transiting to clean energy and sustaining a reduction in GHG emissions, and; Fines issued against private and public entities for non-compliance with the provisions of this Act.	Provision for the generation of the outputs required from the transparency of mitigation actions (BUR, BTR, NCs, national GHG inventory report) alongside with nationally determined reporting requirements, the engagement of various stakeholders (private and public entities)

Appendix 31: SWOT Analysis of Legislation and Governance Landscape

S/N	ASSET/CAPITAL	STRENGTH	WEAKNESS	OPPORTUNITY	THREATS
1.	POLICIES	Related Policies are available	Most are obsolete and need urgent restructuring	Policy reforms can be initiated via PPP and donor support	Political willingness
2.	INSTITUTIONS	Government institutions within the two-tier of governance, i.e., federal and state. But local government institutions are left out	Informal and NGOs are barely present; hence low community involvement and participation	Institutional strengthening programs	Multiplicity of water-related institutions with similar roles
3.	INFRASTRUCTURE	Some exist	Investment gap; Inadequate/obsolete and non-existent infrastructures; Gap for improved services is about 64.1% (USAID)	PPP Donor agencies can fund upgrade of infrastructure and provisions of irrigation systems	Funding for upgrade
4.	ANNUAL BUDGET/FINANCE	In 1991, budgetary allocation was (0.03%) of annual federal budget, by 2002, it increased to (3.3%)	Low budgetary allocation; Not clearly stated in any of the policies/Act; at best inadequate. For instance, Nigeria requires 1.7% of current GDP to WASH (UNICEF)	Donors and global alliances can support WASH activities within communities that lack access to potable water	Political willingness and community acceptance
5.	HUMAN/SOCIAL GROUP	Vast human capital with a population > 180 million	Low private sector involvement: Penalties for unsustainable use of resources is grossly inadequate; both for individual and corporate offenders	PPP can partner with government to develop incentives for sustainable use of resource and capacity to manage introduced modern infrastructure. Also build capacity within informal/community institutions for water management	Disregard for community power structure and functions
6.	NATURAL CAPITAL	Vast coverage: 333 billion m3 of surface water and 88 billion m3 of Ground water	Weak database, Not properly accounted for in SNA; underutilized and unutilized assets	Donors, PPP could invest in research and development, appropriate technology use and transfer, data acquisition and monitoring	Natural disasters e.g., Climate change

Appendix 32: SWOT Analysis of
Legislation and Governance Landscape

S/N	NAME OF ACT/POLICIES	YEAR OF GAZETTE	PURPOSE/GOAL	SOME FUNCTIONS	SOME RELEVANT PENALTIES
1.	National Inland Waterways Authority Act (NIWA)	1997, NO.13	Most are obsolete and need urgent An Act to establish the National Inland Waterways Authority with responsibility, among other things, to improve and develop inland waterways for Navigation	To ensure the development of infrastructural facilities for a national inland water- ways network connecting the creeks and the rivers with the economic centres using the river-ports as nodal points for inter-model exchange	Where an offense under this Act has been committed by a body corporate or firm or association of individuals, it shall be liable upon conviction to a tine of N200,000 and in the case of a continuing offence, to an additional fine of N1,000 for every day or part of a day that the offence continues.
2.	National Water Resources Institute Act (NWRIA)	1985, NO. 3	An Act to establish the National Water Resources Institute for the promotion and development of training programmes and courses in water resources and to advise the Government on water resources training needs and priorities and other matters ancillary thereto	To promote the establishment of a uniform national data collection system relating to surface and subsurface water resources	
3.	Oil in Navigable Water Act (ONWA)	1968, NO. 34	An Act to implement the terms of the International Convention for the Prevention of Pollution of the Sea by Oil 1954 to 1962 and to make provisions for such prevention in the navigable waters of Nigeria.	applies to the discharge of Crude oil, fuel and lubricating oil and heavy diesel	A person guilty of an offence under section I, 3 or 5 of this Act shall, on conviction by a High Court or a superior court or on summary conviction by any court of inferior jurisdiction, be liable to a fine: Provided that an offence shall not by virtue of this section be punishable on summary conviction by a court having jurisdiction inferior to that of a High Court by a fine exceeding N2,000
4.	Territorial Water Act (TWA)	1967	An Act to determine the limits of the territorial waters of Nigeria and for other matters connected there with	By this act, the terminal water limit of Nigeria waters is defined as; "The territorial waters of Nigeria shall for all purposes include every part of the open sea within twelve nautical miles of the coast of Nigeria (measured from low watermark) or of the seaward limits of inland waters".	

S/N	NAME OF ACT/POLICIES	YEAR OF GAZETTE	PURPOSE/GOAL	SOME FUNCTIONS	SOME RELEVANT PENALTIES
5.	Water Resources Act (WRA)	1993, NO. 101	An Act to promote the optimum planning, development and use of the Nigeria's water resources and other matters connected therewith	It vest right and control of the nation's waters to the Federal Government, as stated in section 1, "The right to the use and control of all surface and groundwater and of any watercourse affecting more than one State as described in the Schedule to this Act, together with the bed and banks thereof, are by virtue of this Act and without further assurance vested in the Government of the Federation for the purpose of, inter alia, promoting the optimum planning, development and use of Nigeria's water resources	Any person who contravenes or fails to comply with any provisions of this Act, or any regulation made thereunder, commits an offence and is liable upon conviction to a fine not exceeding N2,000 or to a term of imprisonment not exceeding six months or to both such fine and imprisonment, and, in the case of a continuing offence to an additional fine not exceeding N 100 for every day or part of a day that the offence continues
6.	Territorial Water Act (TWA)	1967	An Act to determine the limits of the territorial waters of Nigeria and for other matters connected there with	By this act the territorial water limit of Nigeria waters is defined as; "The territorial waters of Nigeria shall for all purposes include every part of the open sea within twelve nautical miles of the coast of Nigeria (measured from low watermark) or of the seaward limits of inland waters".	
7.	National Environmental Standards and Regulations (NESREA)	ACT, 2007 And Regulations (2009 -2011)	NESREA was created to replace the defunct Federal Environmental Protection Agency (FEPA)	The agency is authorized to to enforce compliance with laws, guidelines, policies and standards of environmental matters. Such standards would include the federal water quality standards and air quality standards	National Environmental (Wetlands, River Banks and Lake Shores) Regulations, 2009: In terms of structure and content, these Regulations have been divided into three parts and five schedules

S/N	NAME OF ACT/POLICIES	YEAR OF GAZETTE	PURPOSE/GOAL	SOME FUNCTIONS	SOME RELEVANT PENALTIES
8.	River Basin Development Authority (RBDA) (TWA)	1990	Section 4(1) (a)-(d) of the RBDA Act vest the authorities with the legal powers to undertake comprehensive development of both surface and underground water, to construct and maintain dams' irrigation and drainage system, to supply water to all users, and to construct and maintain infrastructural services including roads and bridges across project sites	The act established 12 RBDAs and empowered them to develop and manage surface and groundwater resources within their jurisdiction to promote agricultural development and provide domestic water supply.	
9.	Nigeria's Nationally Determined Contribution (NDC)	2021 UPDATED	The NDC, outlines the cross-sectional nature of the water sector, putting into context inter-ministerial relationship amongst several agencies responsible and in control of water resources in the nation	Gives details on the geospatial coverage of the resource and the impact of climate change	
10.	State Water Edicts (SWE)	Specific to each State	Each state including the FCT has policies uniquely tailored to meet the water needs of their respective localities		
11.	National Water Resources bill (NWRB)	Passed by the National Assembly, 2020	Bill seeks to provide equitable and sustainable development of water resources and to regulate its use, management and conservation	Aims at ensuring the nation's water resources are adequately protected from degradation and pollution in order to enhance citizen's rights of access to clean Water, Sanitation and Hygiene (WASH)	
12.	National Water Resources Masterplan (NWRM)	1995, Revised 2013	Drafted for promotion of appropriate administrative management of water resources		
13.	National Water Supply and Sanitation Policy (NWSSP)	2000	Encourages private sector participation and envisions institutional and policy reforms at the state level		
14.	National Water Policy (NWP)	2004	Recognizes the need to balance water uses, water allocation and water protection carefully through a regulatory system of river basin-based management and a participatory approach	The NWP seeks to achieve amongst others things; clear and coherent regulations, clear definitions of	The NWP seeks to achieve amongst others things; clear and coherent regulations, clear

S/N	NAME OF ACT/POLICIES	YEAR OF GAZETTE	PURPOSE/GOAL	SOME FUNCTIONS	SOME RELEVANT PENALTIES
				functions and relationships of sector institutions, better funding, reliable and adequate data for planning and projections	definitions of functions and relationships of sector institutions, better funding, reliable and adequate data for planning and projections

Appendix 33: Employment and Type of Fishery in Nigeria

Type of Fishery				
Year	Aquaculture	Capture		Total Employment
1980	-	-	409.07	467.07
1990	-	-	490	490
2000	-	716.62	460.69	1177.31
2010	0.01	831.54	688.08	1519.64
2014	-	713.04	764.62	1477.65
2015	-	782.75	782.61	1565.36
2016	-	652.6	537.9	1190.5

Circular Economy and Natural Capital Business funding and investment opportunity is available under four broad categories

1. Public Sector Financing, technical assistance, advisory programmes, and initiatives.
2. Blended Finance.
3. Impact Investing by the private sector.
4. Philanthropy, grant and risk capital [158].

Appendix 34 below provides ongoing funding and investment opportunities in Nigeria for Circular Economy and Natural Capital Businesses across the four broad categories earlier mentioned.

Appendix 34: Circular Economy & Natural Capital Business Funding & Investment Opportunity

Organization	Description	Website
Afriplast Challenge	The challenge seekse the the creation of new or the development of early-stage products, technology and/or services to encourage the reduction or elimination of plastic usage across Sub-Saharan Africa. ● First Place: £750,000 ● Second Place: £250,000 ● Third Place: £100,000	https://afri-plastics.challenges.org/ https://afri-plastics.challenges.org/partners/
Solar Impulse Foundation	The Solar Impulse Label is granted to innovative circular economy solutions that meet high standards of sustainability and profitability. Each solution goes through a strict assessment process performed by independent experts.	https://solarimpulse.com/
Global Investment Fund	The Global Innovation Fund (GIF) is a non-profit innovation fund headquartered in London that invests in the development, rigorous testing, and scaling of innovations targeted at improving the lives of the world's poorest people.	https://www.globalinnovation.fund

Ellen MacArthur Foundation (EMF)	Provides support to solve big problems like climate change, waste, and pollution. EMF believes It's time to rethink how we design, make, and use the things we need, from the food we eat to the clothes we wear.	https://ellenmacarthurfoundation.org/
Circular Lagos	Circular Lagos is a programme launched by Lagos State in collaboration with CEIP that seeks to grow the market for "Circular Economy" products and services in ways that benefit producers, consumers, and communities across Lagos.	https://circularlagos.com/
Circular Economy Innovation Partnership	The Circular Economy Innovation Partnership (CEIP) promotes Circular Economy business innovation and investment in Nigeria through research, advocacy, and programme facilitation. CEIP works in close partnership with individuals and organizations who share the goal of building a cadre of local entrepreneurs that have both the capabilities and opportunities to develop successful Circular Economy ventures.	https://ceipafrica.org
Lagos Recycle Initiative	The Lagos waste management authority recently launched the Lagos recycle initiative which is aimed at encouraging separation of waste from the point of generation for recycling purposes and encourage waste to wealth	https://www.lawmaacademy.com/news/lagos-recycling-initiative
African Development Bank Circular Economy Trust Fund	This is a trust fund that will channel finance and de-risk innovative circular economy business models beyond waste management. It will support the country-led African Circular Economy Alliance (ACEA) in integrating the circular economy into African green growth strategies.	https://www.afdb.org/en/news-and-events/press-releases/african-development-bank-group-launches-dedicated-trust-fund-circular-economy-51948
Institute for European Environmental Policy (IEEP)	Working with stakeholders across EU institutions, international bodies, academia, civil society and industry, our team of economists, scientists and lawyers produce evidence-based research and policy insight.	https://ieep.eu/news/trade-in-support-of-circular-economy-opportunities-for-nigeria-and-the-eu
Finish Innovation Fund (SITRA)	SITRA collaborates with partners from different sectors to research, trial and implement bold new ideas that shape the future.	https://www.sitra.fi/en/
European Union (EU)	The European Union is providing several **funding programmes** in order to support the transition to a circular economy, such as the European Structural and Investment Funds, Horizon 2020 and Switch2Green and the LIFE programme.	https://circulareconomy.europa.eu/platform/en/financing-circular-economy https://www.switchtogreen.eu/home/switchafricagreen/
The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) is	An executive body of the Dutch Ministry of Economic Affairs and Climate Policy. RVO helps business owners run sustainable, agricultural, innovative or international businesses.	https://english.rvo.nl/ https://businessday.ng/news/article/nigeria-the-netherlands-to-strengthen-ties-in-circular-economy-horticulture-renewables/
British Council	British Council's Innovation for African Universities (IAU) program is supporting a project of collaboration between academics from the Pan-African University Life and Earth Sciences in Nigeria (PAU-LESiN), De Montfort University in the UK, and Co-Creation Hub in Nigeria, which aims to encourage people in Nigeria to explore opportunities for turning waste into wealth.	https://www.britishcouncil.org.ng/about/press/innovation-for-african-universities

Co-Creation Hub	CcHUB is Nigeria's first open living lab and pre-incubation space designed to be a multi-functional, multi-purpose space where work to catalyze creative social tech ventures take place. The HUB is a place for technologists, social entrepreneurs, government, tech companies, impact investors and hackers in and around Lagos to co-create new solutions to the many social problems in Nigeria.	https://cchubnigeria.com/sail-accelerator-prorgamme/ https://cchubnigeria.com/circular-plastic-innovation-hub/

Stakeholder Participation Lists

Appendix 35(a): NCEP VALIDATION WORKSHOP (Abuja) - List of Stakeholder Participants (In-person)

S/N	Name	Organization
1	Engr. Omolade .M. Esan	Waste Management Society of Nigeria
2	Uwabor Blossom	Fed. Min. of Env./Dept of Desertification, Land Degradation & Drought Management.
3	Garba Aboulrahman Muhammad	Fed. Min. of Env/Dept of Climate Change
4	Obonogwu John Michael	Fed. Min. of Env./PCEH
5	Vandu Jumai	Fed. Min. of Env./PCEH
6	Faith John	Fed. Min. of Env./PCEH
7	Adetunji Adenekan	Fed. Min. of Env./PCEH
8	Ajibola A. A	Fed. Min. of Env.
9	Ogbnefi Chima F.	RMRDC
10	Hon Iselema Gbaranbiri	Ministry of ENV
11	Kenneth Otamiri	Kedris
12	Farinu Temidayo	Fed. Min. of Env./PCEH
13	Nomnso Okeke	Clean Technology Hub
14	Onyekachi Chukwu	Clean Technology Hub
15	Iloka A. U	Fed. Min. of Env./PCEH
16	Jennifer .C. Okeke	Fed. Min. of Env./PCEH
17	Funmi Eyeoyibo	AGDF
18	Francis Bisong	AGDF
19	Asuquo Etim Okon	AGDF
20	Elizabeth Andrew Essi	AGDF
21	Vincent Leo	AMAC
22	Afolabi Adewunmi	FMENV
23	Amadu Jibrin	FMENV
24	Ato Jeremiah	RIJEDASE NIG LTD
25	Foluso Adejoro	Netherlands Embassy
26	Sherifat A. Ibrahim	ECN
27	Subulade Tobiloba	FMENV
28	Eddo Teyehte B	FMENV
29	Stella Omeli	NOA
30	Anthony Ogbre	P&A Env Service LTD
31	Eno Anwana	AGDF
32	Murtala Umoru	FMENV
33	Kasim Molid	FMENV
34	Ibifuro Tolofari	NESREA
35	Samuel O.Adeyemi	FMENV
36	Dorathy Ukemezia	FMENV/Eco green Africa
37	Desmond Idu odache	FMITI
38	Ambi Zinta D	E.C.N
39	Oke Emmanuel	FMWR
40	Engr Chukwudi	NESREA

41	Chief Ibok Edfon	FMSTI
42	Atim Kwaghfa	NESREA
43	Mbah E. K	FMENV
44	Popoola Esther	FMITI
45	Victor Tmevbore	NIG ENV Society
46	Akumefula Quinta	FMENV
47	Gomwalk E. E	FMENV
48	Johnbull Accrah	FMPOWER
49	Ibukum Faluyi	EPRON
50	Chris Abari	NASWAMSA
51	Boyejo Ayotunde	Enaxis Intl.Consult
52	Eng Ned Jessup	P&A Env Solution
53	Eke Oliver Ejiofor	Lift Humanity Foundation
54	Usman Abdulrazaq	FMENV
55	Psila Yovwe	Gini Recycling
56	Ikebuche Perpertual I.	MBS
57	Etuk A. E	Min of Pet.Resources
58	Decent Adebayo	FMENV
59	Dangiwa Ewa Orume	FMENV
60	Mumeen G.Bolakale	FMBNP
61	Kalu Lawrence Okevchukwu	FMENV
62	Kasimu Bayero	Abana Consults
63	Kelani Oyedeji	FMENV
64	Charles Nzeto	AEPB
65	Okafor.C. Charles	FCTA/AEPB
66	Eng Musa Nurudeen	FMENV
67	Dikpo Agboola	Min.Petrol.Res
68	Okafor Nonso	NOSDRA
69	Agashua Mark	NOSDRA
70	Uzoma Adanna	NOSDRA
71	Albert Oye	NOSDRA
72	Edith Abonta	FMENV
73	DR. Peter Ekweozah	FMSTI
74	Agada Precious	FMENV
75	Hon. Iselema Gbarabiri	Bayelsa State Ministry of Environment.

Appendix 35(b): NCEP VALIDATION WORKSHOP - List of Registered Stakeholder Participants (Online / Virtually)

S/N	Name	Organization
1	Yusuf Adelodun	National Oil Spill Detection and Response Agency
2	Dr. Jane Chukwudebelu	Federal Institute of Industrial Research Oshodi (FIIRO)
3	Aliyu	NESREA
4	Olusola Akinyemi	Federal Ministry of Environment
5	Oluwakemi Ajakaiye	African Circular Economy Network (Nigeria Chapter)
6	Adedayo Adebayo	Lagos State Environmental Protection Agency (LASEPA)
7	Abiodun Animashaun	Federal Ministry of Environment
8	Atanda	Federal Ministry of Environment
9	Richard Nwaeze	Federal Ministry of Environment
10	Ipinyemi Johnson	Abuja Environmental Protection Board (AEPB)
11	Emelone Tochukwu Edwin	Eteicon Recyclers
12	Eunice Sampson	Ernst & Young
13	Dr. Uzo Egbuche	Nigerian Economic Summit Group
14	Etteh Isaiah	Eco Upcycler and Recycling Association

15	Ubaidurrahman Sulaiman	Brycoal Nigeria Limited
16	Morayo Oyefesobi	Recyclan
17	Chime Okwuokenye	Recyclan
18	Adegboyega Lawal	Federal Ministry of Environment
19	Rosanne van Miltenburg	Harvest Waste
20	Oteruku Elizabeth	Federal Ministry of Environment
21	Sha'aya'u Abdulkadir Jibrin	Ministry of Environment
22	Natalie Beinisch	Circular Economy Innovation Partnership
23	Annika Green	World Economic Forum
24	Oluchi Nwankwu	Ministry of Environment
25	Olukunle Babatunde	Obed Green Technology Limited
26	Chinagozi Daniel	Innovation Growth Hub
27	Onovughakpo Sonia Odije-Fajusigbe	Consulate General of the Kingdom of the Netherlands
28	Emelone Tochukwu Edwin	Eteicon
29	Agharese Onaghise	Food and Beverage Recycling Alliance
30	Satoko Takenoshita	United Nations Industrial Development Organization
31	Femi Idowu-Adegoke	Ecoviridis Environmental Technology
32	Deji Omoniyi	Panocean
33	Sustainability Team	Ampak Nigeria Limited
34	Nafisat Yakubu	Federal Ministry of Environment
35	Luuk Rietvelt	Harvest Waste
36	Mufidat Mamman	Federal Ministry of environment
37	AYODEJI AJAYI	FEDERAL MINISTRY OF ENVIRONMENT,ABUJA
38	Chris Abetianbe	AGDF
39	Taiwo Enilolobo	P&A Environmental Solutions. Akwa Ibom State
40	Peter Ekweozoh	Federal Ministry of Science, Technology and Innovation
41	Oluwafemi Idowu-Adegoke	Ecoviridis Environmental Technology
42	Yusuf Hassan Mohammed	Federal Ministry of Industry Trade and Investment
43	Innocent Onah	African Development Bank
44	Orezime Omojefe	Transformationn Home Africa
45	Jicenta Nchangnwie Foncha	Pan African Institute for Development West Africa
46	Cynthia MC-Sojachukwu	Federal Ministry of Environment
47	Agatha	Federal Ministry of Environment
48	Felix Odimegwu	Anambra State Ministry Of Environment
49	Bintu mohammed	NESREA
50	Joy Atsa	AGDF
51	Clem Ugorji	Circularium Africa Advisory/WEF-GPAP
52	Oluwayemisi Adeyemi	Ministry of Environment
53	ADENIYI ADEBANKE	African Marine Environment Sustainability Initiative (AFMESI)
54	Peter Tarfa	LCEDev Nigeria
55	Omotunde Adeola	WAMASON
56	Aina Gbenga	Waste up today
57	Ayomide Arowosegbe	Greentility Limited
58	Agwu Abu	Nigerian Building and Road Research Institute
59	James Ogunleye	Carbon-Limits Nigeria
60	Ifeoluwapo Olowu	Newcross Petroleum Limited
61	Aishat A Barde	Department of climate change, Fed Min of Environment
62	Onyinyechi Ndubuaku	Federal Ministry of Environment
63	Nkechi Ikemefuna	Federal Ministry of Environment
64	Joseph Olayande	Energy Commission of Nigeria

65	Temofe Mgbejime	MG Temofe LLC
66	Adedamola OGUNSESAN	Nigerian Conservation Foundation
67	Tracy El Achkar	Green Industry Platform / GGKP
68	Ruth OYEKUNLE	Carbon Limits Nigeria
69	Bisong Robert	Federal Ministry of Environment
70	Lawrence Ogbimi	Federal Ministry of Environment, Environmental Assessment Department
71	Ekeoma Onuoha	AfDB
72	Oluchi Nwankwu	Ministry of Environment
73	Obisesan Oreoluwa	Federal Ministry of Environment
74	Ruth Oyekunle	Carbon Limits Nigeria
75	Usen Akpabio	National Orientation Agency
76	Chinasa Uttah	University of Calabar
77	Oje Eno	Carbon Limits Nigeria
78	Matthew Kure	Standards organisation of Nigeria
79	Kelani Oyedeji	Federal Ministry of Environment
80	Chigozie Ejimogu	Verod Capital Management
81	Inga Stefanowicz	EU Delegation to Nigeria and ECOWAS
82	Onyinyechi Ndubuaku	Federal Ministry of Environment
83	Gerald Esambe Njume	AfDB
84	Kenneth I. Woghiren	Ministry of Environment and Sustainability
85	DR AISHA USMAN MAHMOOD	Central Bank of Nigeria
86	BUNMI	Lecturer
87	Gboyega OLORUNFEMI	Programmes Officer
88	Msurshima Gwatse	Business development officer
89	Titilayo	Suatainability/Business Developmwnt officer
90	Zainab Abdulrasheed-Adegoke	MD
91	Eromhonsele Okooboh	Environmental Officer
92	Rantiola Akinola	NATURAL ECO CAPITAL
93	Jeremiah Noah	Production Supervisor
94	Victor Aibaengbee	Consultant
95	Meshach Ojile	Head of Department Environmental Management
96	Ogenyi Timothy Emenike	Environmental Officer
97	Ajai	Professor, Head Dept. of Strategy
98	Funso Akande	COO
99	Edith Iyalomhe	Project Manager Circular Economy
100	Ayobami Lemo	ESMS
101	Eugene itua	Ceo
102	Jasper Ndubuisi Ikegwu	E&S safeguard officer
103	Alyssa	Project Coordinator
104	Martie	DlRECT0R, Trustee

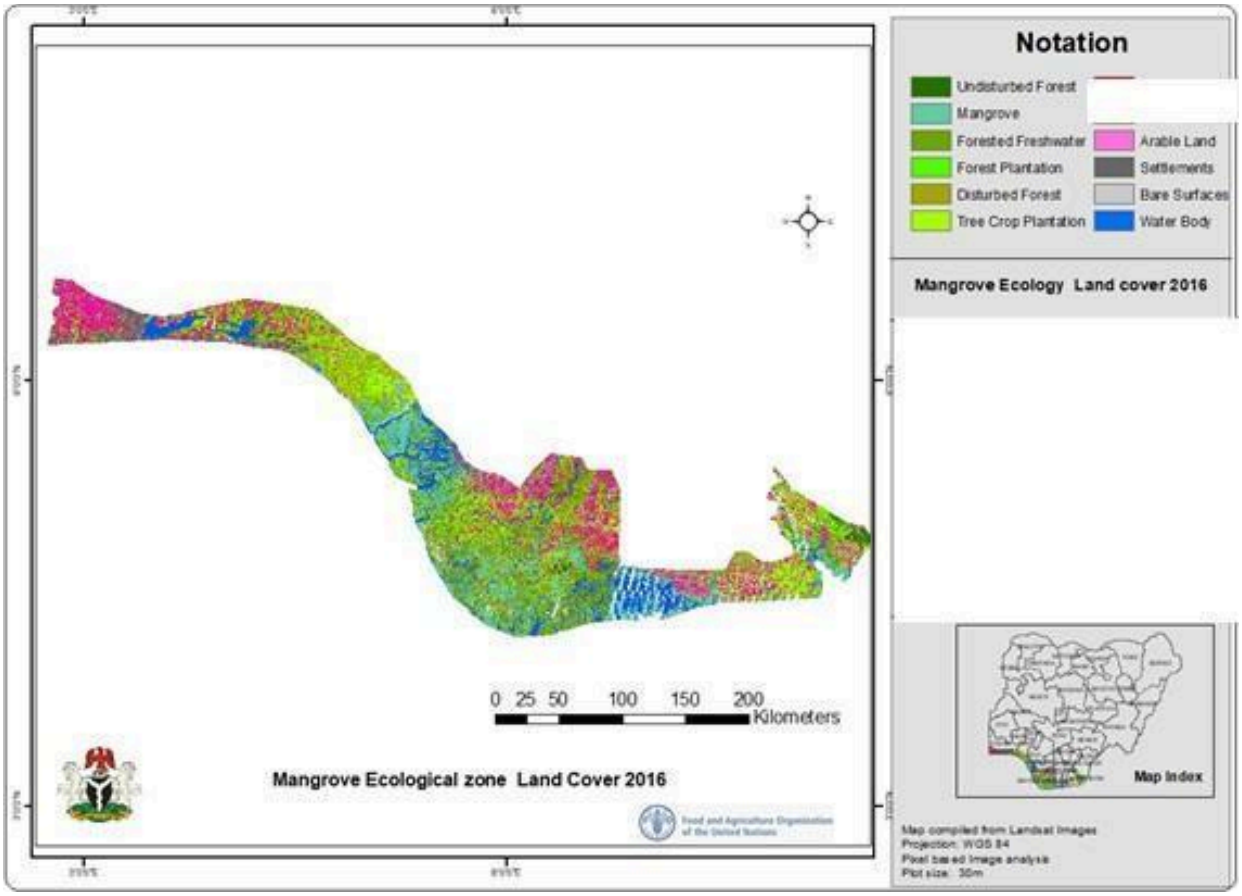
Appendix 36

Attendance sheet - CE training Workshop for MDAs organized by FMEnv. in Collaboration with UNEP. Lagos (13th – 14th April)

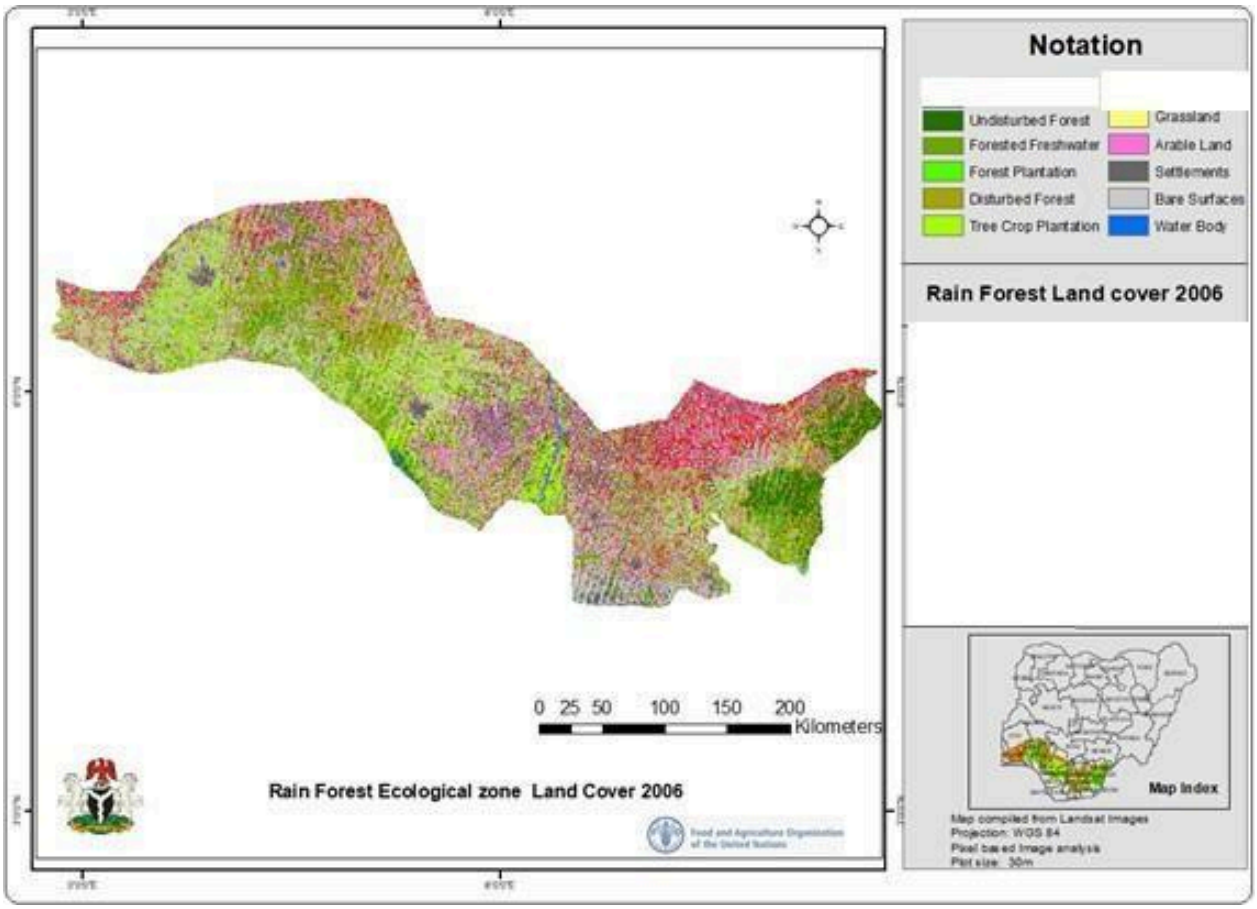
S/N	Name	Organization
1.	Dr. Ikiah	FMENV, Abuja
2.	DANGIWA Ewa Orume	FMENV, Abuja
3.	SAMUEL O. Adeyemi	FMENV, Abuja
4.	AGBENLA Oluwatoyin	FMENV
5.	ADEOLA Omotunde	FMENV
6.	ADENAIKE Olabimpe O	FMENV
7.	AKINYEMI Olusola	FMENV
8.	ROWLAND Ngeme	FMENV
9.	EMENIKA Olivia	FMENV
10.	KAZEEM Afeez	FMENV

11.	MARTHA Akinola-K	NESREA
12.	GLORIA Nwanosike	NESREA
13.	Engr. Yusuf Adelodun	NOSDRA
14.	NORAH Mujita	UNEP
15.	SYLVIA Munuke	UNEP
16.	PATRICK Mwerigye	UNEP
17.	AKINBODE Akinola	LMOE&WR
18.	ADEMOLA Elizabeth	LAWMA
19.	AKINBULO Ayobami	LAWMA
20.	ADENLE OF.	LASEPA
21.	DAYO Adebayo	LASEPA
22.	MUIBI Hammed A.G	LASEPA
23.	AJANAKU Kolawole S	IKEJA LGA
24.	KEHINDE Moses O	APAPA LGA
25.	ADEYEMI O.A	OGMENV
26.	KOTILA Adebola	EKITI STATE MIN of ENVIRONMENT
27.	ATIGAN Francisca Aritetsoma	DELTA STATE MIN of ENVIRONMENT
28.	NWANKWU Oluchi T	MIN of ENVIRONMENET, ANAMBRA STATE
29.	Temitope George	REA-NEP
30.	Prof. V.E BISONG	AGDF

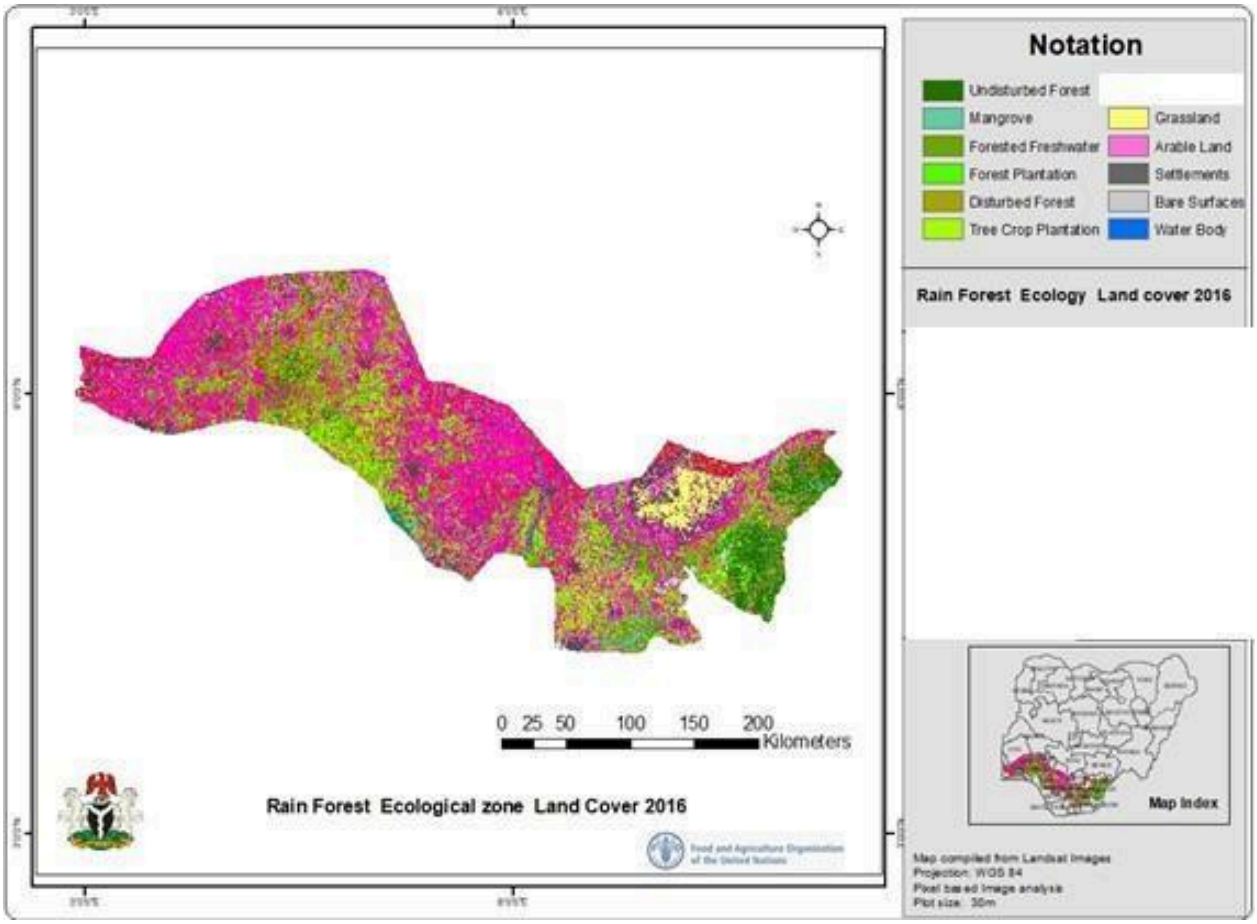
Appendix 1: Ecological Zones: Land Use in the Mangrove Ecological Zone 2006



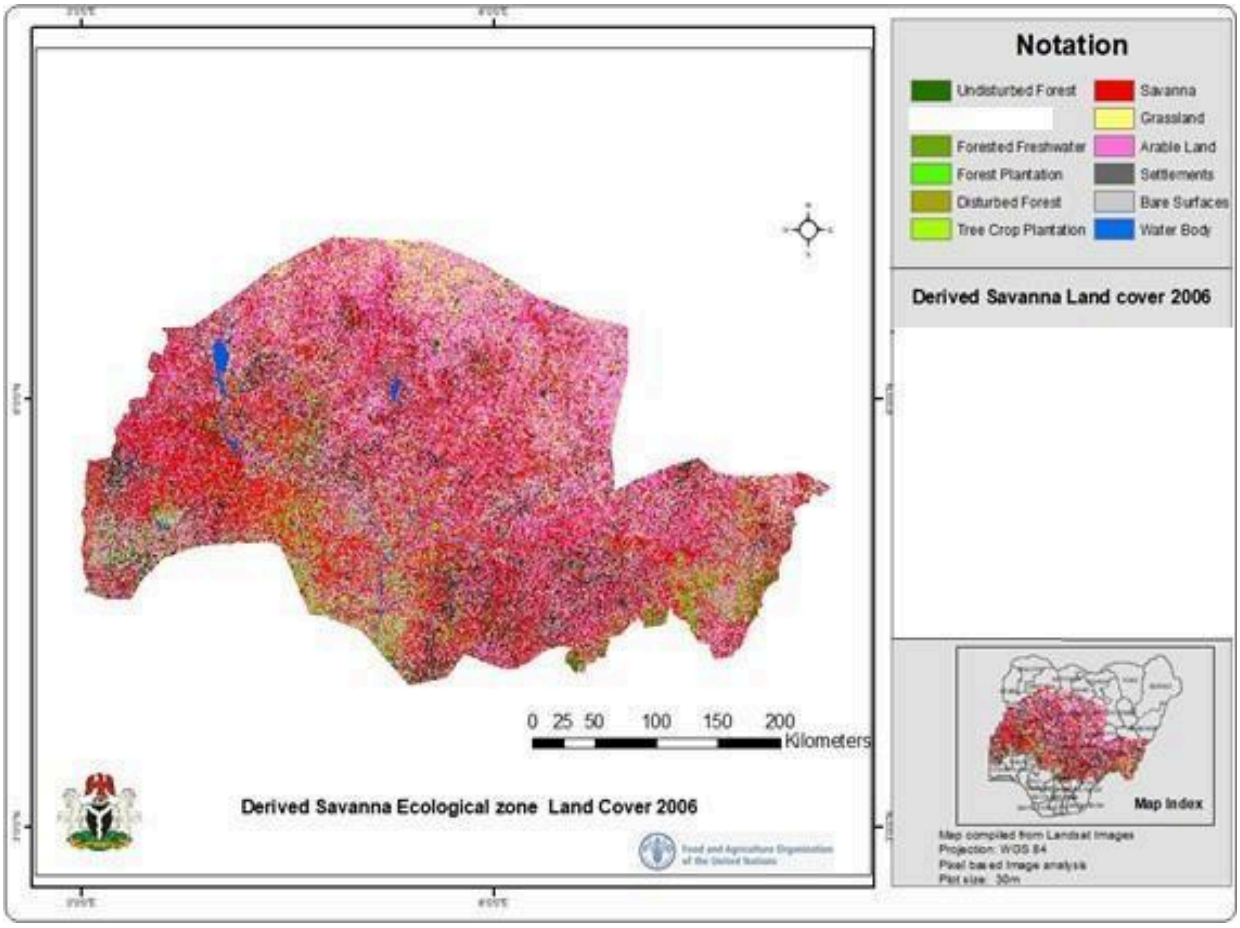
Appendix2: Ecological Zones: Land Use in the Mangrove Ecological Zone 2016



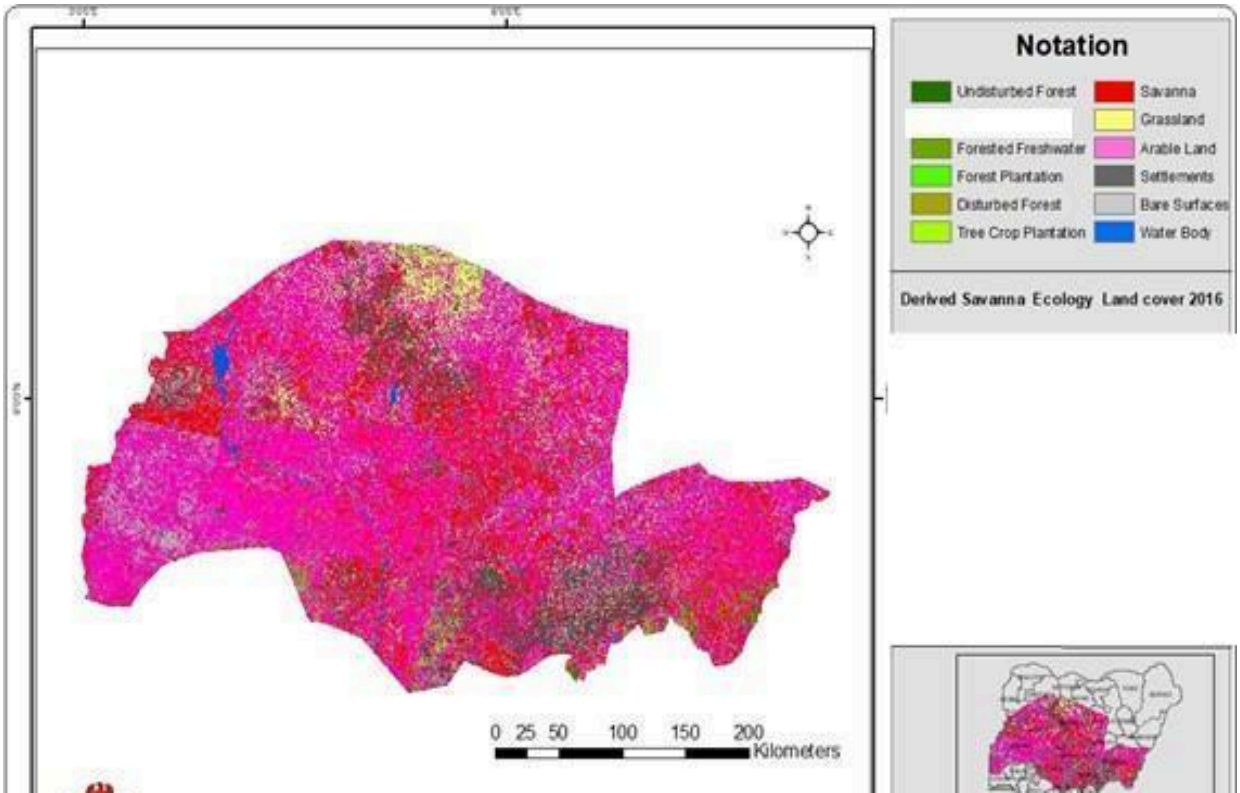
Appendix 3: Lowland Rain Forest Land Cover 2006.png



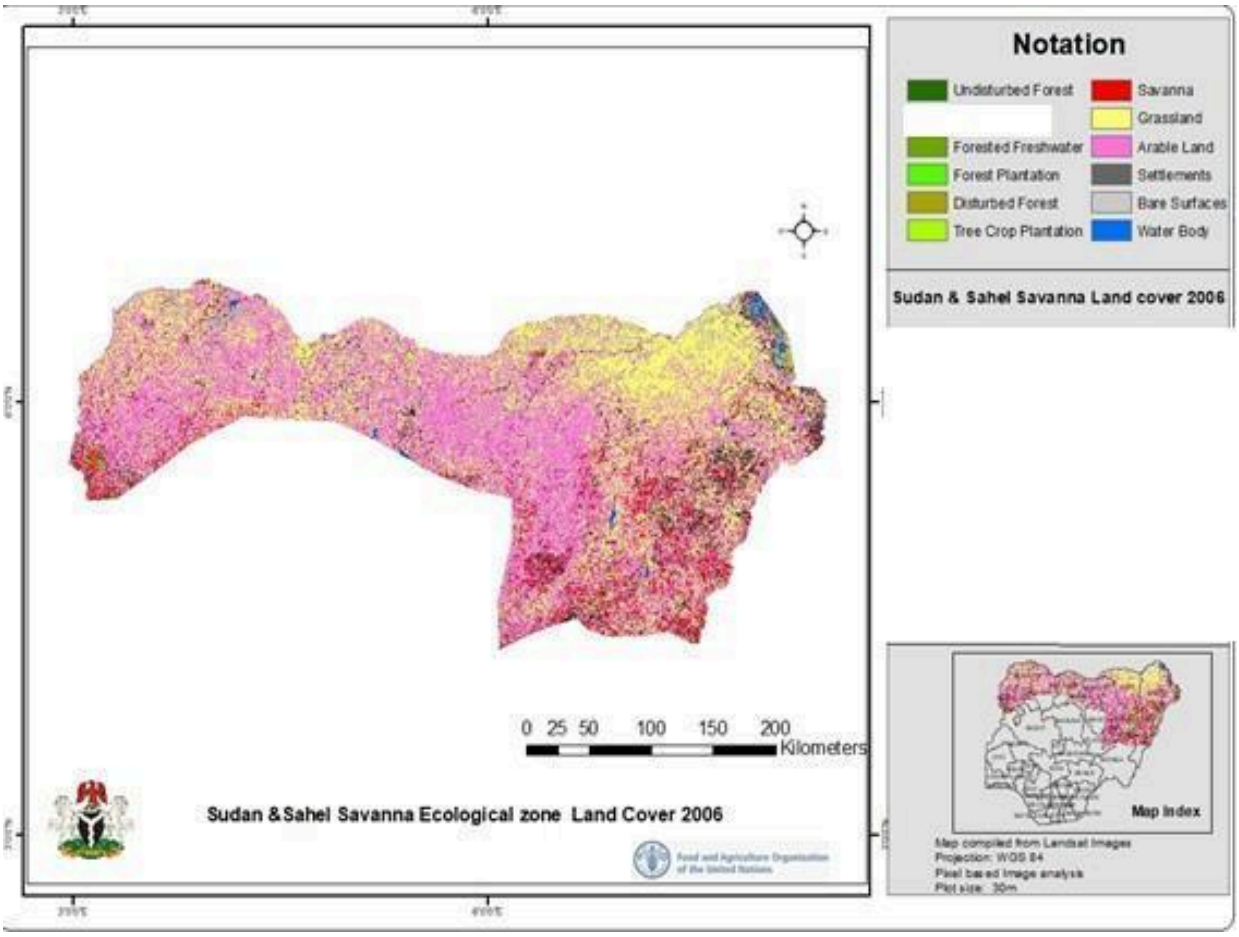
Appendix 4: Lowland Rain Forest Land Cover 2016



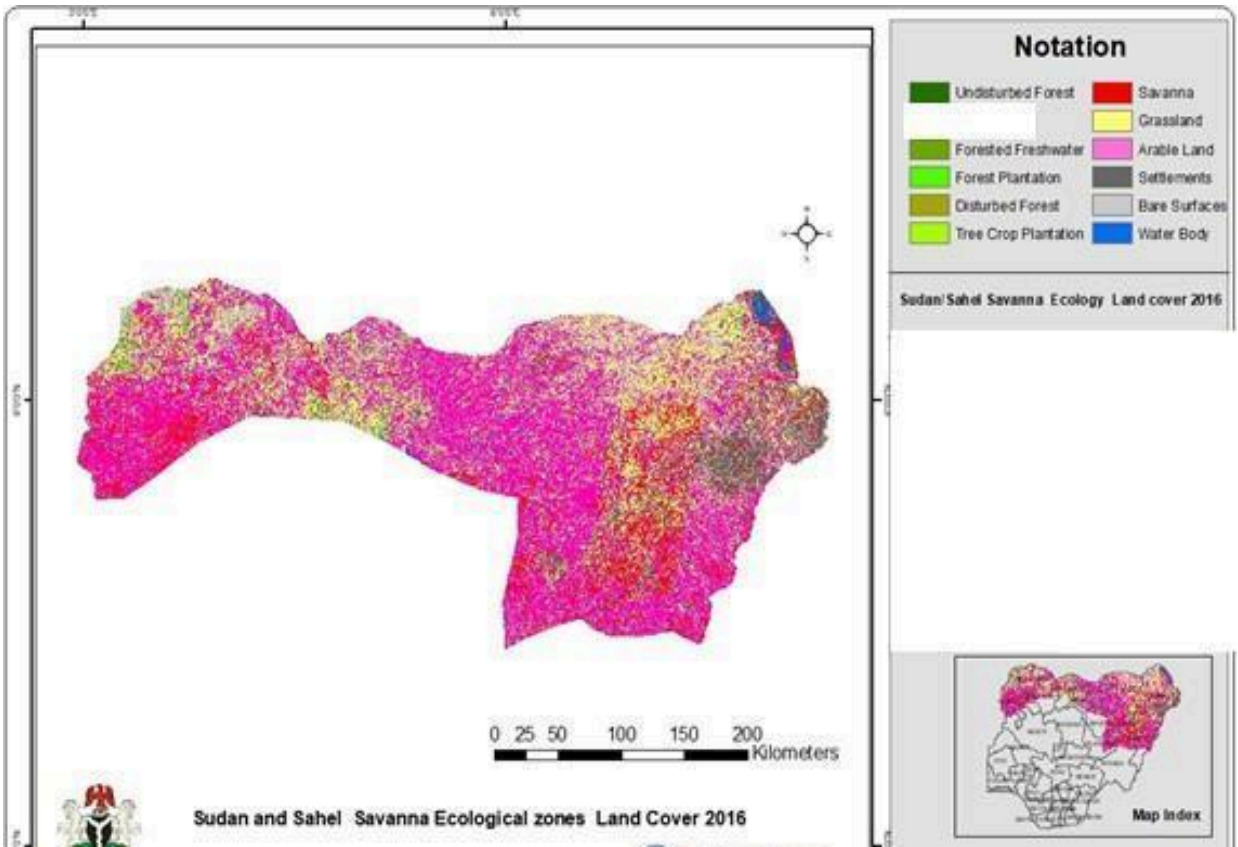
Appendix 5: Derived Savanna Land Cover 2006



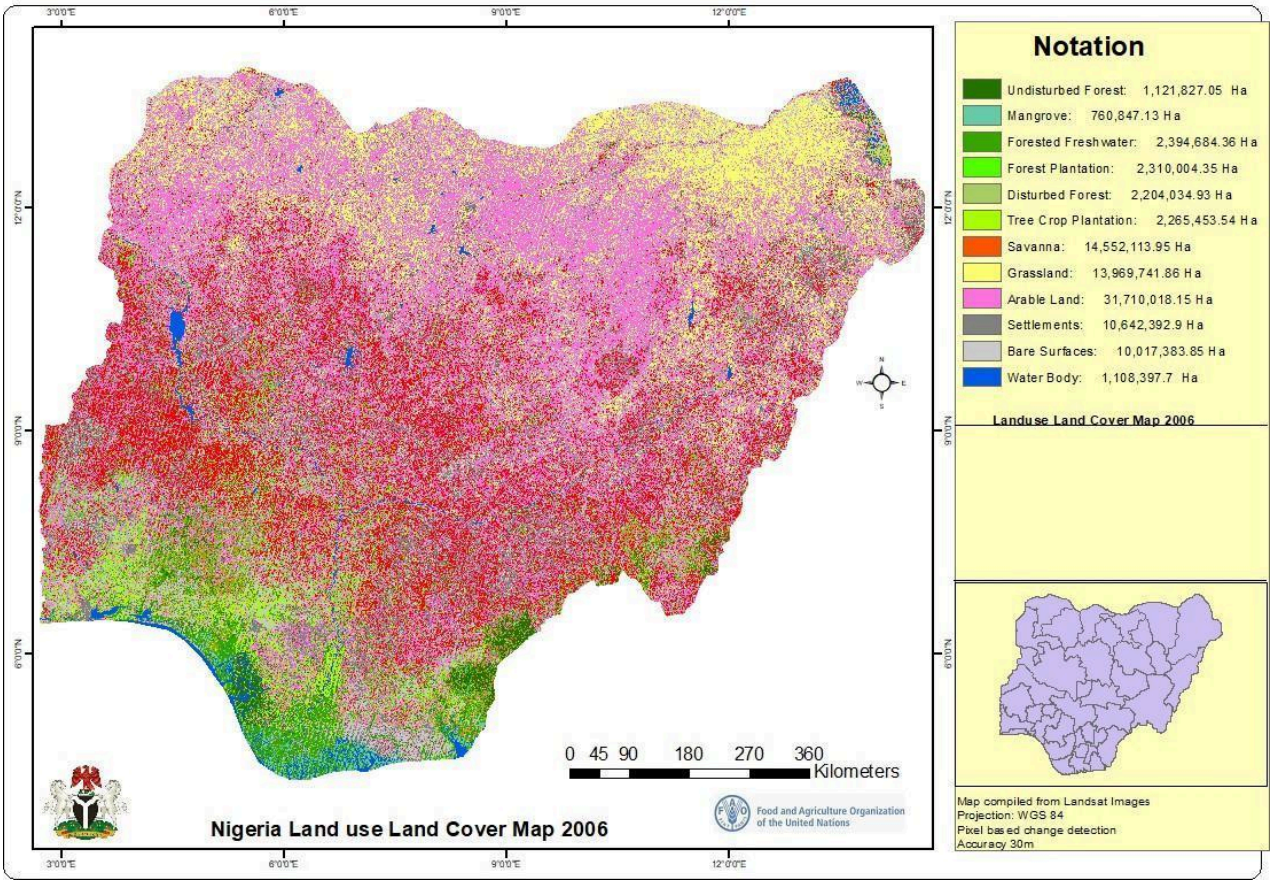
Appendix 6: Derived Savanna Land Cover 2016



Appendix 7: Sudan and Shael Savanna Ecological Zones Land Cover 2006

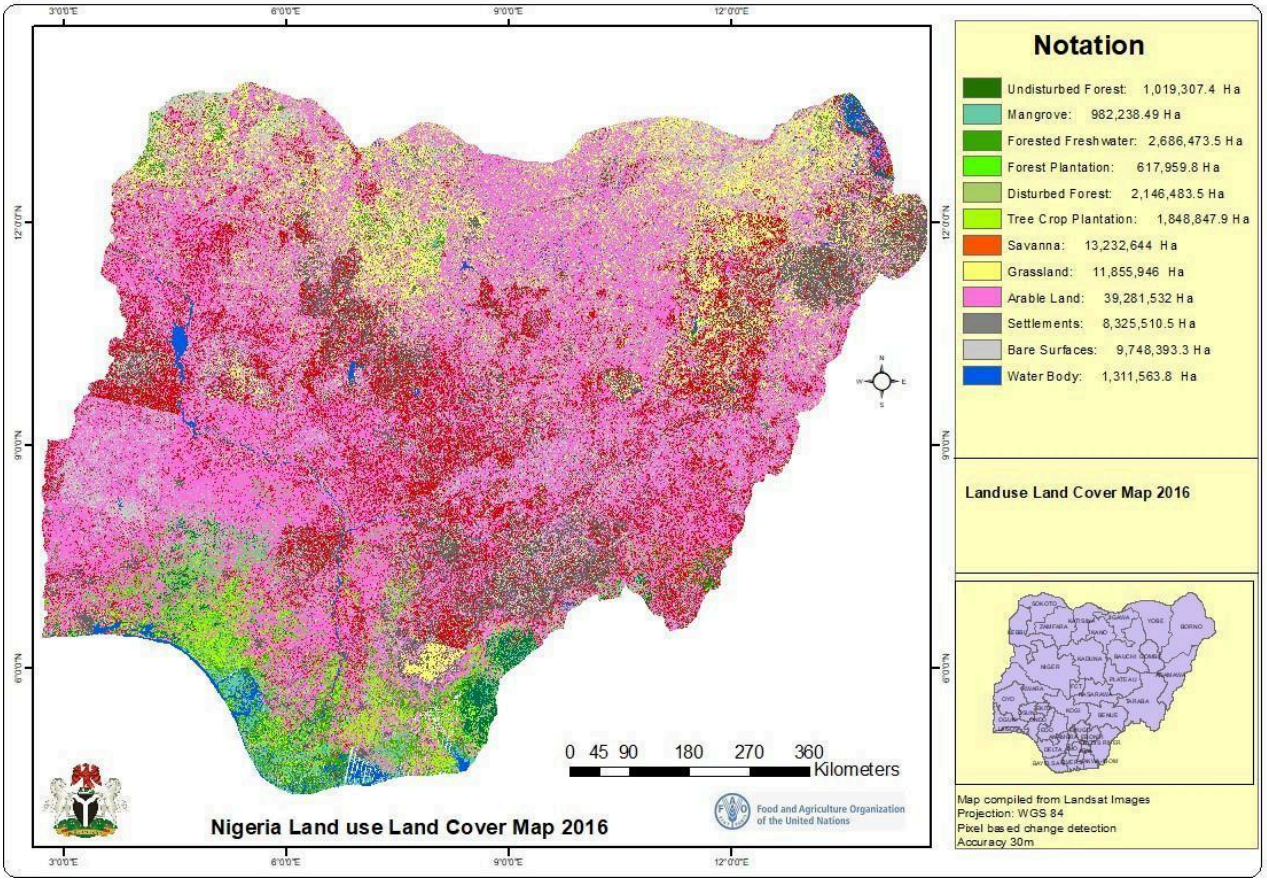


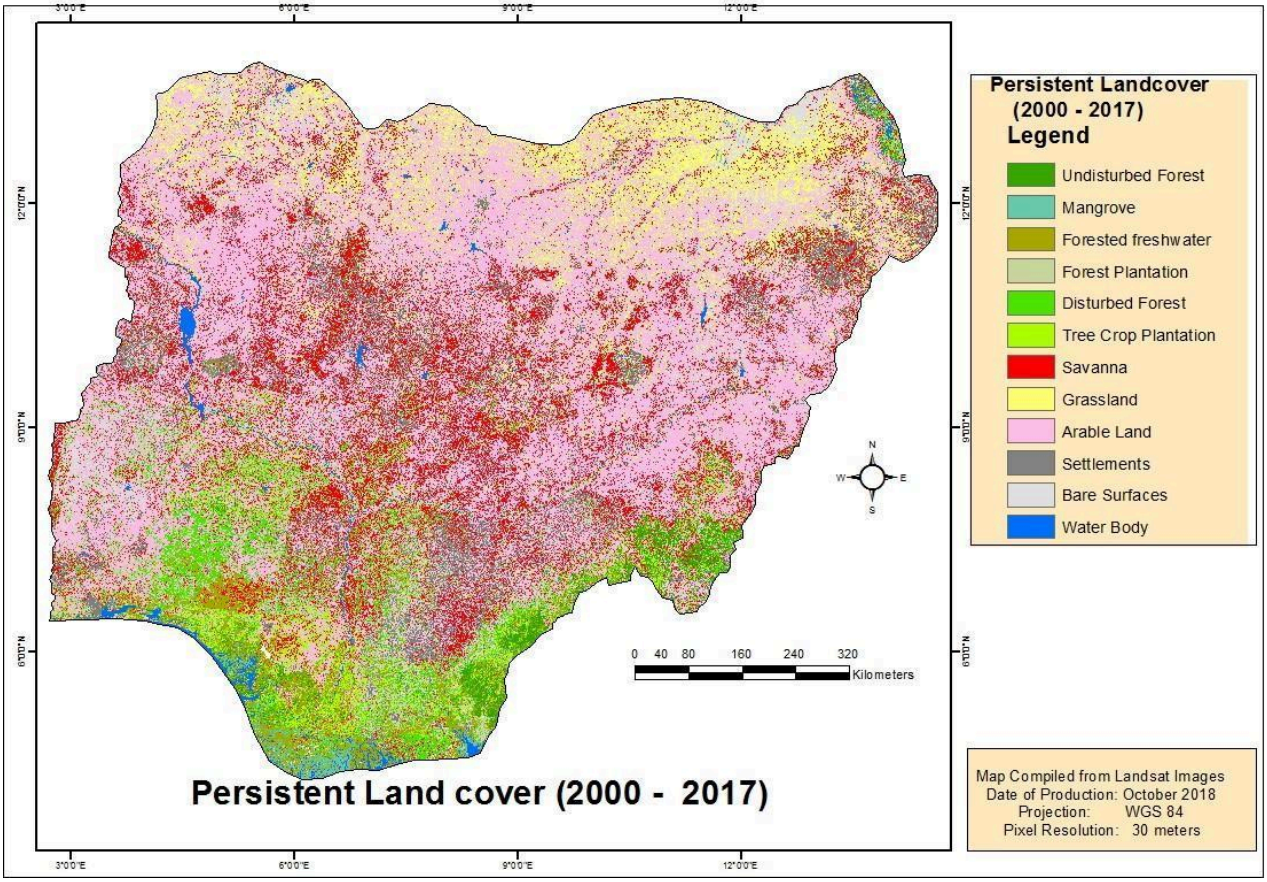
Appendix 8: Sudan and Shael Savanna Ecological Zones Land Cover 2016



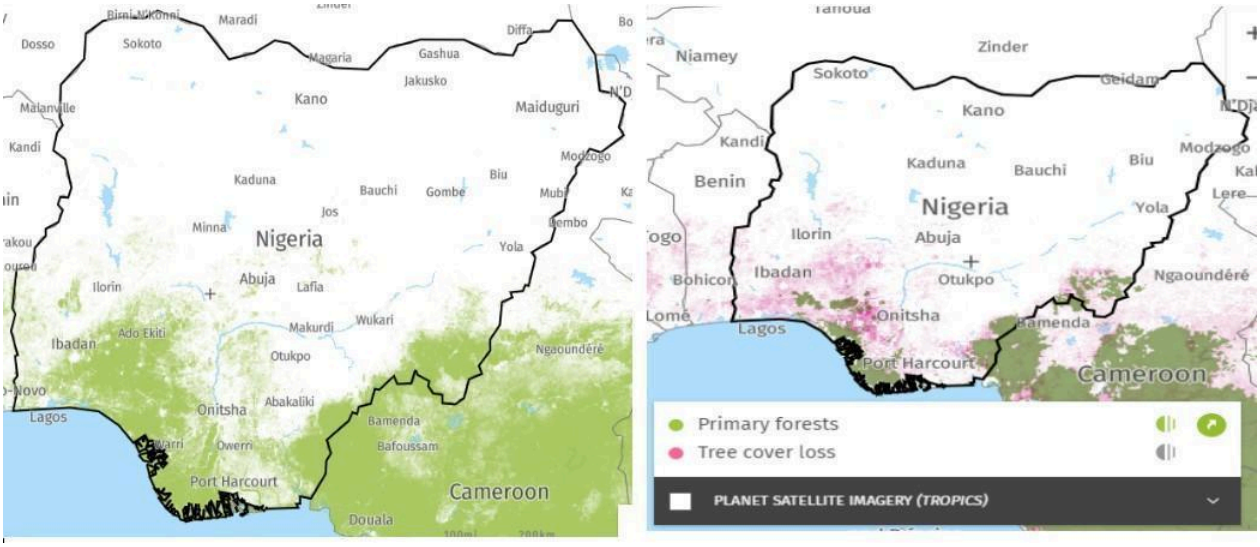
Appendix 9: Nigerian Land Covers 2006

Appendix 10: Nigerian Land Covers 2016

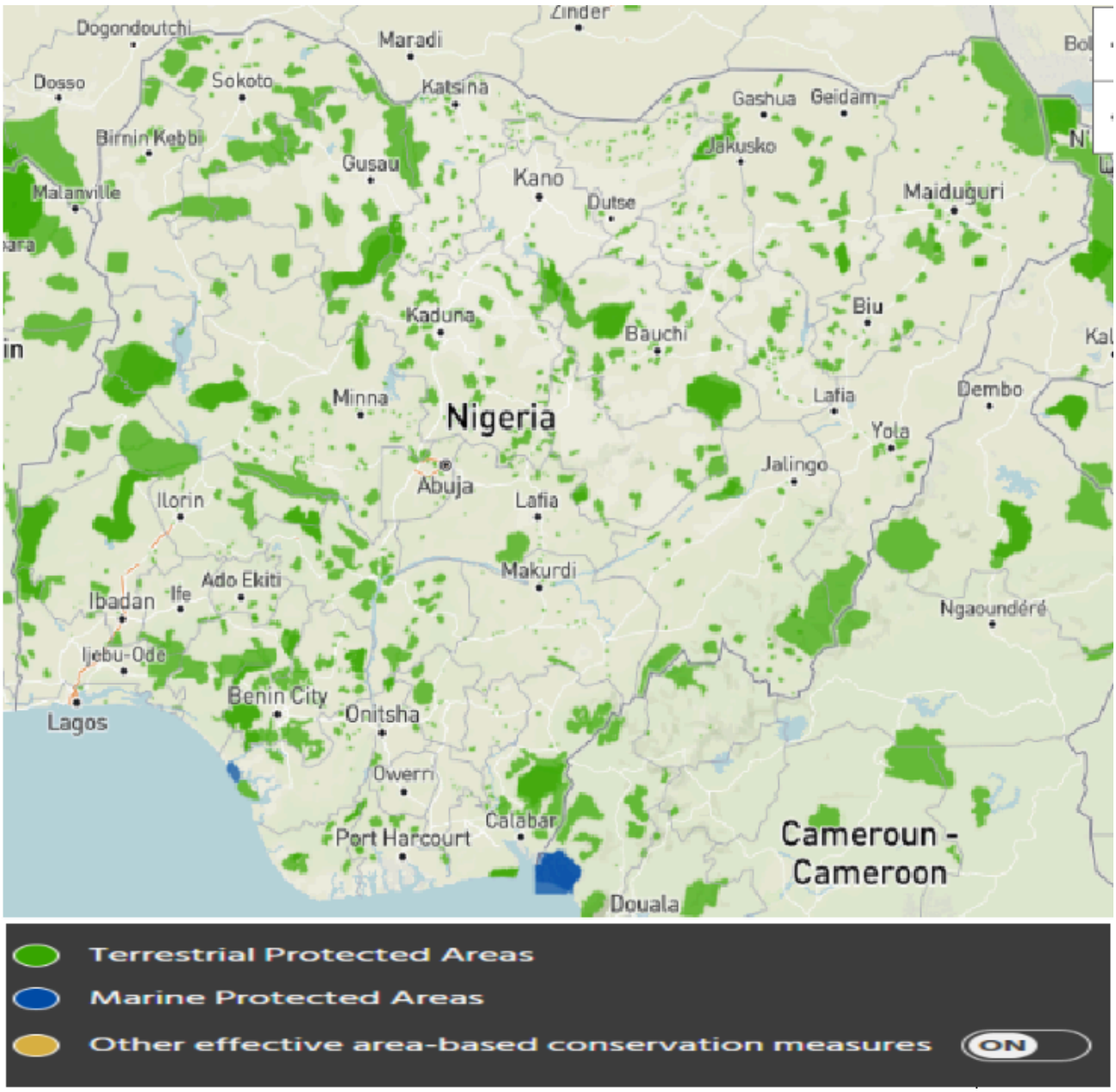




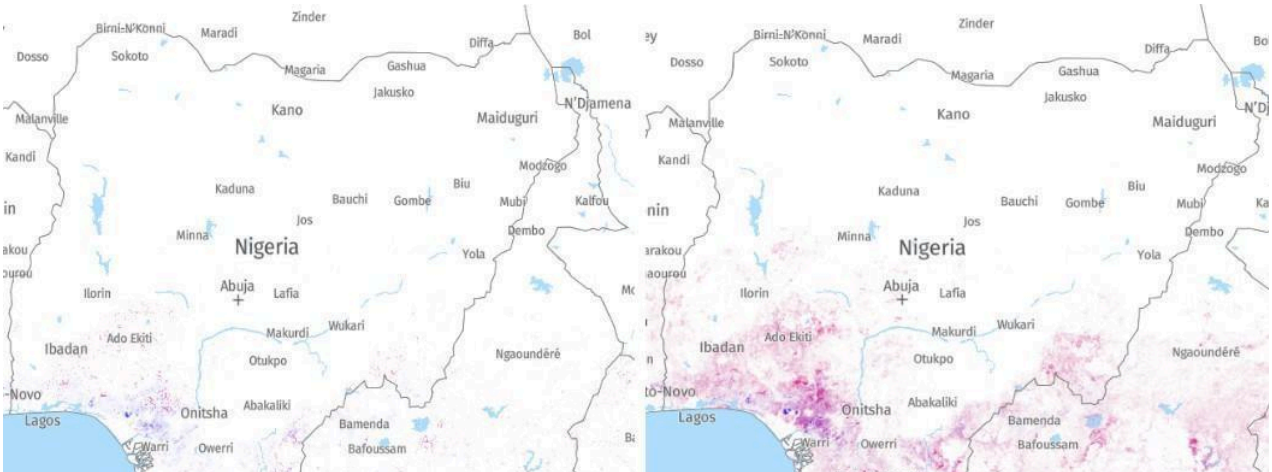
Appendix 11: Persistent Landcover Between 2000 and 2017



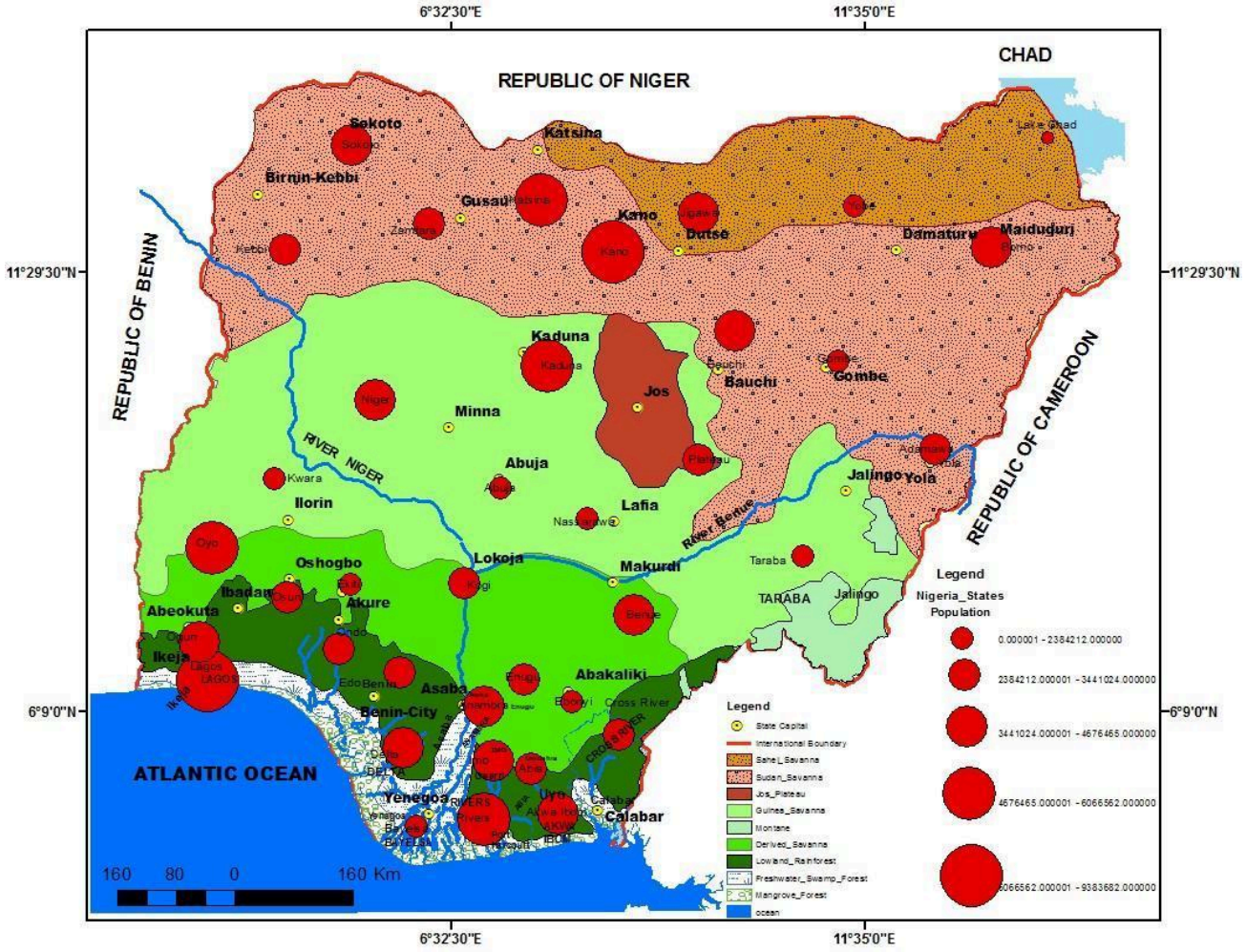
Appendix 12: Primary Forest Cover, 2000 Primary Forest Cover, 2020 Source: Global Forest Watch, 2021



Appendix 13: Protected Area Source: Global Forest Watch, 2021



Appendix 14: Tree Cover Loss 2000 (left), Tree Cover Loss 2020 (right)



Appendix 15: Population by Ecological Zone Source: Global Forest Watch, 2021

Bibliography

1. World Economic Forum. Five big bets for the Circular Economy in Africa – insight report. African circular economy alliance (ACEA). https://www.weforum.org/reports/five-big-bets-for-the-circular-economy-in-africa-african-circular-economy-alliance, 2021.
2. International Bank for Reconstruction and Development (IBRD)& World Bank. Nigeria- food smart country diagnostic. world bank publications, 2020.
3. The Food and Agriculture Organization (FAO). Review of world water resources by country, Rome, Italy. https://www.fao.org/3/Y4473E/y4473e.pdf, 2021.
4. International Labour Organisation (ILO). Decent work in the management of electrical and electronic waste (e-waste). sectoral policies department, international labour organisation, Geneva, 2019.
5. Economics of Sanitation Initiative. What are the economic costs of poor sanitation and hygiene? economics of sanitation initiative water and sanitation program (WSP) the world bank, Washington dc. https://www.wsp.org, 2007.
6. World Health Organization (WHO). Cholera-Nigeria. https://www.who.int/news-room/fact-sheets/detail/cholera, 2017.
7. United Nations Children's Fund (UNICEF). Press release, Abuja 21, 2021. https://www.unicef.org/nigeria/press-releases/nearly-one-third-nigerian-children-do-not-have-enough-water-meet-their-daily-needs#:~:text=Although%20about%2070%20per%20cent,available%20to%20a%20Nigerian%20daily., 2021.
8. P Ekins, T Domenech, P Drummond, R Bleischwitz, N Hughes, and L Lotti. The circular economy: What, Why, How and Where. In Background paper for an OECD/EC Workshop on, volume 5, 2019.
9. Yuliya Kalmykova, Per E-O Berg, João Patrício, and Vera Lisovskaja. Portable battery lifespans and new estimation method for battery collection rate based on a lifespan modeling approach. Resources, Conservation and Recycling, 120:65–74, 2017.
10. Adam Sulich and Letycja Sołoducho-Pelc. The circular economy and the green jobs creation. Environmental Science and Pollution Research, 29(10):14231–14247, 2022.
11. Qian Liu, Hui-ming Li, Xiao-li Zuo, Fei-fei Zhang, and Lei Wang. A survey and analysis on public awareness and performance for promoting circular economy in China: A case study from tianjin. Journal of Cleaner Production, 17(2):265–270, 2009.
12. Christoph Böhringer, Edward J Balistreri, and Thomas F Rutherford. The role of border carbon adjustment in unilateral climate policy: Overview of an energy modeling forum study (emf 29). Energy Economics, 34:S97–S110, 2012.
13. Walter R Stahel. The business angle of a circular economy–higher competitiveness, higher resource security and material efficiency. A new dynamic: Effective business in a circular economy, 1, 2013.
14. Yong Geng, Joseph Sarkis, Sergio Ulgiati, and Pan Zhang. Measuring China's circular economy. Science, 339(6127):1526–1527, 2013.
15. Elmar Kriegler, John P Weyant, Geoffrey J Blanford, Volker Krey, Leon Clarke, Jae Edmonds, Allen Fawcett, Gunnar Luderer, Keywan Riahi, Richard Richels, et al. The role of technology for achieving climate policy objectives: Overview of the emf 27 study on global technology and climate policy strategies. Climatic Change, 123(3):353–367, 2014.
16. National Bureau of Statistics. Statistics. https://www.nigerianstat.gov.ng/, 2021.
17. Robert Costanza, Ralph d'Arge, Rudolf De Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V O'neill, Jose Paruelo, et al. The value of the world's ecosystem services and natural capital. nature, 387(6630):253–260, 1997.
18. United Nations Environmental Program (UNEP). Nigeria turns the tide on electronic waste. https://unep.org/news-and-stories/press-release/nigeria-turns-tide-electr onic-waste, 2019.
19. UN Environment Programme, Finance Initiative. (2022). Natural Capital Declaration. https://www.unepfi.org/natural-capital-declaration/
20. IUCN UNEP, WRI TNC, et al. Green Infrastructure: Guide for water management. 2014.

21. Bárbara Unmüssig, Lili Fuhr, and Thomas Fatheuer. Economía verde:¿ la nueva fórmula mágica?Envío: publicación mensual del Instituto Histórico Centroamericano, 35(412):40–43, 2016.
22. Kes McCormick and Niina Kautto. The bioeconomy in Europe: An overview. Sustainability, 5(6):2589–2608, 2013.
23. World Bank Group. What a waste 2.0- a global snapshot of solid waste management to 2050, 2018.
24. Shoubo Xu. The concept and theory of material flow. Information Systems Frontiers, 10(5):601–609, 2008.
25. Jian Zhong Chen. Material flow and circular economy. Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research, 26(2):269–278, 2009.
26. European Economic and Social Committee. Circular economy strategies and roadmaps in Europe. https://www.eesc.europa.eu/sites/default/files/files/qe-01-19-425-en-n.pdf, 2019.
27. African Circular Economy Alliance. “five big bets for the circular economy in Africa.” insight report. https://www.afdb.org/en/documents/five-big-bets-circular-economy-africa, 2021.
28. A Martínez-Rocamora, Jaimer Solís-Guzmán, and Madelyn Marrero. Lca databases focused on construction materials: A review. Renewable and Sustainable Energy Reviews, 58:565–573, 2016.
29. Michael Z Hauschild, Mark Goedkoop, Jeroen Guinée, Reinout Heijungs, Mark Huijbregts, Olivier Jolliet, Manuele Margni, An De Schryver, Sebastien Humbert, Alexis Laurent, et al. Identifying best existing practice for characterization modeling in life cycle impact assessment. The International Journal of Life Cycle Assessment, 18(3):683–697, 2013.
30. United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA). Technical Recommendations in support of the System of Environmental-Economic Accounting (2012). https://seea.un.org/sites/seea.un.org/files/technical_recommendations_in_support_of_the_seea_eea_final_white_cover.pdf
31. IIED Briefings. Cop 13 briefings and opinion papers. Development, 2007.
32. Sudhir Sharma. Nationally appropriate mitigation action: Understanding the mrv framework for developing countries. 2014.
33. Hubert Fudjumdjum, Walter Leal Filho, and Desalegn Yayeh Ayal. Assessment of barriers to food security in north-eastern Nigeria. Handbook of Climate Change Resilience. Cham. https://doi. org/10.1007/978-3-319-71025-9_99-1, 2019.
34. Central Bank of Nigeria. Annual report 2019, 2020.
35. CC Bassullu, Ahmet Tolunay, et al. Analysis on traditional homegarden involving animals’ practices and its importance classification of usage purposes in rural areas of isparta region of turkey. Asian Journal of Animal and Veterinary Advances, 5(7):450–464, 2010.
36. Antonio Santoro, Martina Venturi, Remo Bertani, and Mauro Agnoletti. A review of the role of forests and agroforestry systems in the fao globally important agricultural heritage systems (giahs) programme. Forests, 11(8):860, 2020.
37. Mauro Agnoletti, Yenia Molina Pelegrin, and Alejandro Gonzalez Alvarez. The traditional agroforestry systems of sierra del rosario and sierra maestra, cuba. Biodiversity and Conservation, pages 1–38, 2022.
38. Rebecca Ashley Asare and Yaw Kwakye. A guide to implementing REDD+ in Ghana: criteria and modalities for developing a REDD + project. Ghana: Ghana Forestry Commission, pages 9–12, 2013.
39. NDC Nationally Determined Contribution. Submitted to the United Nations framework convention on climate change (UNFCCC). https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined- contributions-ndcs, 2021.
40. InforMEA. Third national communication (TNC) of the federal republic of Nigeria. https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/187563_Nigeria-NC3-1-TNC%20NIGERIA%20-%2018-04-2020%20-%20FINAL.pdf, 2020.
41. Federal Government of Nigeria (FGN). National policy on environment (revised 2016), 2016.
42. Climate development and knowledge network (CDKN). ndc implementation: Measuring, reporting and verification (MRV). https://ndc-guide.cdkn.org/book/planning-for-ndc-implementation-a-quick-start-guide/measuring-reporting-and-verification/, 2015.
43. Technical report. Federal republic of Nigeria (FGN, 2012). great green wall for the Sahara and Sahel initiative national: Strategic action plan. Nigeria: Federal ministry of environment. https://landportal.org/lib rary/resources/lex-faoc151052/great-green-wall-sahara-and-sahel-initiative-national-strategic, 2012.

44. Federal ministry of environment (2020). Third National Communication (TNC) of the federal republic of Nigeria. https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/187563_Nigeria-NC3-1-TNC%20NIGERIA%20-%2018-04-2020%20-%20FINAL.pdf, 2022.
45. Nigeria: Federal Ministry of Environment. 2050 long-term vision for Nigeria (ltv-2050) -towards the development of Nigeria's long-term low emissions development strategy (lt-leds). https://unfccc.int/documents/386681, 2020.
46. Centre for the Study of the Economies of Africa. Agenda for sustainable economic transformation post-covid-19 in Nigeria. https://ng.boell.org/en/2021/02/25/agenda-sustainable-economic-transformation-post-covid-19-nigeria, 2021.
47. Food and Agriculture Organization of the United Nations. MRV. https://www.fao.org/global-soil-partnership/intergovernmental-technical-panel-soils/gsoc17-implementation/mrv-guidelines/en/, 2018.
48. Ojemire B. Daniel. Climate change and farmers-herders conflict in Nigeria. new security beat. https://www.newsecuritybeat.org/2021/11/climate-change-farmers-herders- conflict-nigeria/, 2021.
49. Environment and urbanization, 22(2):433–450, 2010.
50. United Nations Environment Programme. Forestry and macroeconomic accounts of Nigeria: The importance of linking ecosystem services to macroeconomics. https://wedocs.unep.org/20.500.11822/33378., 2017.
51. Indufor Oy. The state of forest plantation investments in Africa – overview of volumes and investment patterns, working conference forests for the future – new forests for Africa, Accra, Ghana. http://newforestsforafrica.org/wp-content/uploads/2016/03/16_03-Petri- Lehtonen-Indufor.pdf, 2016.
52. African Development Bank Group. How forestry contributes to the african development bank's high 5 priorities: challenges and opportunities. African natural resources centre. African development bank. Abidjan, Côte D'ivoire.
53. African Natural Resources Centre (ANRC). Wood processing and trade of wood products in Africa. African development bank. Abidjan, Côte D'ivoire. https://www.afdb.org/en/documents/wood-processing-and-trade-wood-products-africa, 2021.
54. [Dalia D'Amato, Simo Veijonaho, and Anne Toppinen. Towards sustainability? forest-based circular bioeconomy business models in finnish smes. Forest policy and economics, 110:101848, 2020.
55. IK Adewumi, MO Ogedengbe, JA Adepetu, and YL Fabiyi. Planning organic fertilizer industries for municipal solid wastes management. Journal of Applied Sciences Research, 1(3):285–291, 2005.
56. Lilibeth A Acosta, Prapti Maharjan, Hugo M Peyriere, and Rusyan Jill Mamiit. Natural capital protection indicators: Measuring performance in achieving the sustainable development goals for green growth transition. Environmental and Sustainability Indicators, 8:100069, 2020.
57. Federal Republic of Nigeria (FRN). National policy on environment (revised). federal ministry of environment, 2016.
58. Federal Republic of Nigeria (FRN). Waste/circular economy (CE) analysis for the enhancement of Nigeria's nationally determined contribution (NDC) 2021-2025. federal ministry of environment (FMOE), 2021.
59. National Environmental Standards and Regulations Enforcement Agency (NESREA). Laws and regulations. https://nesrea.gov.ng/publications-downloads/laws-regulations/, 2021a.
60. Federal Government of Nigeria. Bouncing back: Nigeria economic sustainability plan. https://media.premiumtimesng.com/wp-content/files/2020/06/ESC-Plan-compressed-1.pdf, 2020.
61. World Population Review. Lagos population 2021. https://worldpopulationreview.com/world-cities/lagos-population, 2021.
62. Energy for growth hub. how big is Nigeria's power demand? https://www.energyforgrowth.org/memo/how-big-is-nigerias-power-demand/#:~:text=Context%3A%20Nigeria%20has%20Africa%27s%20largest,as%20much%20as%20South%20Africans, 2019.
63. Casper Boongaling Agaton, Charmaine Samala Guno, Resy Ordona Villanueva, and Riza Ordona Villanueva. Economic analysis of waste-to-energy investment in the Philippines: A real options approach. Applied Energy, 275:115265, 2020.
64. The circular fashion ecosystem, 2020.

65. Beatrice Abila and Jussi Kantola. Municipal solid waste management problems in Nigeria: Evolving knowledge management solution. In Proceedings of World Academy of Science, Engineering and Technology, number 78, page 292. World Academy of Science, Engineering and Technology (WASET), 2013.
66. Powering job census 2019: Focus on Nigeria. https://www.powerforall.org/application/files/8415/6311/0434/Powering-Jobs-Census-2019-Nigeria.pdf, 2019.
67. Bioenergy Consult. Solid waste management in Nigeria. https://www.bioenergyconsult.com solid-waste-nigeria/, 2021.
68. Netherlands (NL) Enterprise Agency. Business opportunities in Nigeria's waste and circular economy sector. ministry of foreign affairs, the Netherlands enterprise agency, 2021.
69. KPMG. To ban or not to ban the complex challenge posed by plastic and its alternatives. https://assets.kpmg/content/dam/kpmg/uk/pdf/2019/06/to-ban-or-not-to-ban-v6.pdf, 2019.
70. Coca-Cola Nigeria. Recycling in Nigeria. coca-cola.com.ng/sustainability/world-without-waste/recycling-in-nigeria, 2021.
71. J. Erunke. Ncic, coca cola Nigeria launch plastic recycling project.' Nigerian vanguard. https://punchng.com/fg-establishes-sdgs-innovation-hubs-to-boost-states-social- financing/, 2022.
72. International Telecommunication Union (ITU). The global e-waste monitor 2020. https://ww w.itu.int/myitu/-/media/Publications/2020-Publications/EN-Global-E-Waste- Monitor-2020.pdf, 2020.
73. Florin-Constantin Mihai. E-Waste in Transition: From Pollution to Resource. BoD–Books on Demand, 2016.
74. Federal Government of Nigeria (FGN). Waste/circular economy (CE) analysis for the enhancement of Nigeria's nationally determined contribution (NDC) 2021-2025, 2016.
75. United States Environmental Protection Agency (EPA). Food recovery hierarchy. https://www. epa.gov/sustainable-management-food/food-recovery-hierarchy, 2021.
76. Earthcare Nigeria Ltd. Earthcare Nigeria ltd. https://earthcarecompostplus.com/about.h tml, 2021.
77. WestAfricaENRG. Westafricaenrg. https://westafricaenrg.com/en/, 2021.
78. S Chen, TV Ogunnubi, AO Onakoya, PO Yakubu, OS Akpan, and CB Nwabufo. Evolution of settlement pattern in otigba computer village, lagos state and its challenges to urban planning. Advances in Multidisciplinary & Scientific Research, 5(2), 2019.
79. The Ibeto Group. Union autoparts manufacturing co. ltd. https://ibeto.com/IBETO-page.a sp?P=20, 2017.
80. Tanaka Mandy Mbavarira and Christine Grimm. A systemic view on circular economy in the water industry: learnings from a Belgian and Dutch case. Sustainability, 13(6):3313, 2021.
81. UN Water. Water and sanitation interlinkages across the 2030 agenda for sustainable development. UN Water: Geneva, Switzerland, 2016.
82. World Health Organization et al. Progress on household drinking water, sanitation, and hygiene 2000-2020: five years into the sdgs. 2021.
83. The Food and Agriculture Organization (FAO). Review of world water resources by country, Rome, Italy. https://www.fao.org/3/Y4473E/y4473e.pdf, 2021.
84. Ben U Ngene, Christiana O Nwafor, Gideon O Bamigboye, Adebanji S Ogbiye, Jacob O Ogundare, and Victor E Akpan. Assessment of water resources development and exploitation in Nigeria: A review of integrated water resources management approach. Heliyon, 7(1):e05955, 2021.
85. [ACC Ezeabasili, BU Okoro, and AI Ezeabasili. Water resources: management and strategies in Nigeria. AFRREV STECH: An International Journal of Science and Technology, 3(1):35–54, 2014.
86. National Water Resources Masterplan. The project for review and update of Nigeria national water resources masterplan. vol. 4. federal republic of Nigeria, federal ministry of water resources, Japan international cooperation agency (jica). https://openjicareport.jica.go.jp/pdf/121465 44.pdf, 2013.
87. UN Water. Un-water analytical brief on unconventional water resources. UN Water: Geneva, Switzerland, 2020.
88. A Delgado, DJ Rodriguez, CA Amadei, and M Makino. Water in circular economy and resilience (wicer). World Bank, Washington, DC. Available online, 2021.
89. United Nations Environment Programme (UNEP). Tglobal environment outlook 2000. united nations environment programme, UNEP, Nairobi, Kenya and Earthscan U.K. https://www.unep.org/resources/global-environment-outlook-2000, 2000.
90. WaterAid Briefing Note. Water and sanitation in Nigeria: A briefing on national policy water and sanitation in needs and national development plan (NDP). https://www.wateraid.org/where- we-work/nigeria, 2022.

91. DE DEVELO PP LA BANQUE AFRICAINE and AFRICANDEVELOPMENT BANK GROUP. The Africa water vision for 2025: Equitable and sustainable use of water for socioeconomic development. Economic Commission for Africa: Addis Ababa, Ethiopia, 2000.
92. Giorgio Mannina, Luigi Badalucco, Lorenzo Barbara, Alida Cosenza, Daniele Di Trapani, Giuseppe Gallo, Vito Armando Laudicina, Giuseppe Marino, Sofia Maria Muscarella, Dario Presti, et al. Enhancing a transition to a circular economy in the water sector: The EU project wider uptake. Water, 13(7):946, 2021.
93. Toilet Board Coalition. Sanitation in the circular economy—transformation to a commercially valuable, self-sustaining, biological system. A thought piece from the Toilet Board Coalition, 2016.
94. United Nations Environment Programme (UNEP). Global waste management outlook. https://www.unep.org/resources/report/global-waste-management-outlook, 2015.
95. C Rose, Alison Parker, Bruce Jefferson, and Elise Cartmell. The characterization of feces and urine: a review of the literature to inform advanced treatment technology. Critical reviews in environmental science and technology, 45(17):1827–1879, 2015.
96. Cecilia Tortajada and Ishaan Bindal. Water reuse in Singapore: The new frontier in a framework of a circular economy? Water Reuse within a Circular Economy Contex, 2, 2020.
97. E. Akpabio. Wastewater production, reuse, and management practices in Nigeria. in: UNESCO and unesco i-wssm. water reuse within a circular economy context (series ii). global water security issues (gwsi). pg. 155-163.
98. Emily Corcoran. Sick water? the central role of wastewater management in sustainable development: a rapid response assessment. UNEP/Earthprint, 2010.
99. Luigi Rizzo, Wolfgang Gernjak, Pawel Krzeminski, Sixto Malato, Christa S McArdell, Jose Antonio Sanchez Perez, Heidemarie Schaar, and Despo Fatta-Kassinos. Best available technologies and treatment trains to address current challenges in urban wastewater reuse for irrigation of crops in eu countries. Science of the Total Environment, 710:136312, 2020.
100. Susanne M Scheierling, Carl Bartone, Duncan D Mara, and Pay Drechsel. Improving wastewater use in agriculture: An emerging priority. World Bank Policy Research Working Paper, (5412), 2010.
101. Mohanna Zarei. Wastewater resources management for energy recovery from circular economy perspective. Water-Energy Nexus, 3:170–185, 2020.
102. UNESCO, International Centre for Water Security, and Sustainable Management (IWSSM. Water Reuse within a Circular Economy Context (Series II). Global Water Security Issues (GWSI) Series – No.2,.
103. Abetianbe C. Bisong E. Adediran T. Bisong, F. E. and C. Bisong. Waste/circular economy (ce) analysis for the enhancement of nigeria's nationally determined contribution (ndc) 2021-2025. a report submitted to the federal ministry of environment, nigeria. https://climatechange.gov. ng/wp-content/uploads/2021/08/NDC_File-Amended-_11222.pdf, 2021.
104. James Rotimi Adewumi and Abiose Matthew Oguntuase. Planning of wastewater reuse programme in Nigeria. Consilience, (15):1–33, 2016.
105. Cecilia Tortajada and Pierre van Rensburg. Drink more recycled wastewater, 2020.
106. Valuing Water Initiative. 4 ways the circular economy can help us manage water. https://valuingwaterinitiative.org/4-ways-the-circular-economy-can-help-us-to- manage-water/, 2022.
107. ICLEI-Local Governments for Sustainability. Turku Finland. https://circulars.iclei.org/ turku-finland/, 2022.
108. Marco Ravina, Sergio Galletta, Augustin Dagbetin, Omama Ahmed Hussein Kamaleldin, Madalitso Mng'ombe, Lameck Mnyenyembe, Alemayehu Shanko, and MariaChiara Zanetti. Urban wastewater treatment in African countries: Evidence from the hydroaid initiative. Sustainability, 13(22):12828, 2021.
109. Center for international forestry research (CIFOR) and world agroforestry (ICRAF) (2022). the circular bioeconomy: Knowledge guide. cifor-icraf. https://www.cifor.org/knowledge/publicat ion/7970/, 2022.
110. World Bank. Wastewater: From Waste to Resource-The Case of Durban, South Africa. World Bank, 2018.
111. The Federal Ministry of Water Resources. (FMWR). "National water supply and sanitation policy." federal ministry of water resources (FMWR), department of water supply and quality control, Abuja. https://pdf.usaid.gov/pdf_docs/PNADO937.pdf, 2000.
112. Kevin Ejike Chukwu. Water supply management policy in Nigeria: challenges in the wetland area of Niger delta. European Scientific Journal, 11(26), 2015.
113. [AY Atta, M Aminu, N Yusuf, ZS Gano, OU Ahmed, and OO Fasanya. Potentials of waste to energy in Nigeria. J Appl Sci Res, 12(2):1–6, 2016.

114. International Energy Agency. IEA. (2022). Coal Fired Electricity. Retrieved from: https://www.iea.org/reports/coal-fired-electricity
115. Van Gelder, J. W., & German, L. (2011). Biofuel finance: global trends in biofuel finance in forest-rich countries of Asia, Africa and Latin America and implications for governance (Vol. 36). CIFOR.
116. WRI CAIT. (2017). Emissions including Land-Use Change and Forestry. Global Warming Potentials are from the Intergovernmental Panel on Climate Change Second Assessment Report.
117. Nigeria Energy Transition Plan, NETP. Nigeria's pathway to achieve carbon neutrality by 2060 (2022). Retrieved from https://energytransition.gov.ng/
118. Planet3R. Woven fabrics. https://www.planet3r.com/, 2021.
119. Moses Manuel. Mendelow's matrix. http://zeritenetwork.com/mendelows-matrix/, 2019.
120. Teresa Curristine. Performance information in the budget process: Results of the OECD 2005 questionnaire. OECD Journal on Budgeting, 5(2):87–131, 2006.
121. Michael E Porter et al. Clusters and the new economics of competition, volume 76. Harvard Business Review Boston, 1998.
122. Mark Freel. Book review: Pontus Braunerhjelm and Maryann Feldman (eds) cluster genesis: Technology-based industrial development. newyork: Oup, 2006. isbn 0—1992—0718—6,£ 58 (hbk),£ 22.50 (pbk). International Small Business Journal, 26(3):391–395, 2008.
123. Örjan Sölvell, Christian Ketels, and Göran Lindqvist. Industrial specialization and regional clusters in the ten new eu member states. Competitiveness Review: An International Business Journal, 2008.
124. Christian Ketels. Cluster mapping as a tool for development. Institute for Strategy and Competitiveness-Harvard Business School: Boston, MA, USA, 52, 2017.
125. Mustapha Gajibo. Electric vehicles. https://punchng.com/i-dropped-out-from-unimaid-to-pursue-dream-of-building-electric-vehicles-borno-man-gajibo/, 2022.
126. Africa Collect Textiles. Textile collection for re-use and recycling in Lagos, Nigeria: Context, constraints, and opportunities. a feasibility study, phase 1. https://africacollecttextile s.com/wp-content/uploads/2021/07/ACT_Lagos_Final-Report-Feasibility-Study- P1.pdf, 2021.
127. The Sustainer. waste to energy. https://www.thesustainer.in/wastmanagement.php, 2020.
128. European Commission. Eu agricultural outlook 2020-30. https://ec.europa.eu/info/newseu-agricultural-outlook-2020-30-agri-food-sector-shown-resilience-still-covid-19-recovery-have-long-term-impacts-2020-dec-16_en, 2020.
129. Saheed A Tijani, Akinwale O Adeyemi, and Olusegun J Omotehinshe. Lack of maintenance culture in nigeria: the bane of national development. Civil and Environmental Research, 8(8):23–30, 2016.
130. K Aziz. Material losses in cost accounting, 2015.
131. European Environment Agency (EEA). Resource efficiency and waste. http://www.eea.euopa. eu/themes/waste/intro, 2019.
132. Statista. Distribution of packaging materials used in Nigeria in 2016. www.statista.com/stati stics/1192671/packaging-material-used-in-nigeria/, 2021.
133. DO Omole, IT Tenebe, PraiseGod C Emenike, AS Umoh, and AA Badejo. Causes, impact and management of electronic wastes: Case study of some Nigerian communities. ARPN Journal of Engineering and Applied Sciences, 10(18):7876–7876, 2015.
134. Michael Vardon, Steve Bass, Sofia Ahlroth, Arjan Ruijs, et al. Forum on natural capital accounting for better policy decisions: Taking stock and moving forward, 2017.
135. World Bank. The Little Green Data Book 2007. The World Bank, 2007.
136. World Bank. The Little Green Data Book 2017. The World Bank, 2017.
137. Soong Sup Lee. The little green data book 2010. Technical report, The World Bank, 2010.
138. Food and Agriculture Organization of the United Nations. Natural capital accounting & circular economy. http://faostat3.fao.org/faostat-gateway/go/to/home/E, 2021.
139. Nigeria Extractive Industries Transparency Initiative. Solid minerals audit (sma). https://eiti.org/files/documents/2018_sma_report_finalised.pdf, 2018.
140. Potgieter J. Aigbokhan G. Felgenhauer K. Smit T.A.B Hemkhaus M. Ahlers J. Van Hummelen S. Chewpreecha-U. Smith A. & McGovern M. Rajput, J. Circular economy in Africa-EU cooperation. https://www.adelphi.de/en/publication/circular-economy-africa-eu-cooperat ion-0, 2016.

141. Arjan Ruijs, Martijn van der Heide, and Jolanda van den Berg. Natural capital accounting for the sustainable development goals: Current and potential uses and steps forward. Technical report, PBL Netherlands Environmental Assessment Agency, 2018.
142. C Bann. Natural capital accounting and the sustainable development goals. waves, 2016.
143. World wildlife fund (WWF), 2018). https://www.worldwildlife.org/pages/living- planet-report-2018, 2018.
144. InforMEA. Nigeria - nbsap. https://www.informea.org/en/action-plan/nigeria- nbsap-v2-2015, 2015.
145. Liste Des Participants. Good practice guidance and uncertainty management in national greenhouse gas inventories. Order, 2001.
146. Federal ministry of environment, (2021). Nigeria energy calculator 2015. Nigeria: Energy commission of Nigeria. http://necal2050.energy.gov.ng/pathways/1111111111111 11111111111111111111111111111111/primary_energy_chart/comparator/111111111110 11111001111111010111111010111, 2015.
147. Natural capital coalition. 2016. “natural capital protocol”. https://capitalscoalition.org/ capitals-approach/natural-capital-protocol/?fwp_filter_tabs=guide_supplemen t, 2016.
148. Natural capital coalition. 2016. “natural capital protocol”. https://capitalscoalition.org/ capitals-approach/natural-capital-protocol/?fwp_filter_tabs=guide_supplemen t, 2016.
149. United Nations. Un world population prospects (2019 revision). http://population.un.org/ wpp/, 2019.
150. International water management institute. after the flush: How a project in Ghana is turning human waste into an economic resource. https://www.iwmi.cgiar.org/2020/11/after-the- flush-how-a-project- in-Ghana- is- turning-human-waste-into- an- economic- resource/., 2020.
151. GIZ. Capacity development for the monitoring, reporting and verification of greenhouse gas emissions. https://www.giz.de/en/worldwide/53189.html, 2020.
152. Fairbrass, A., Mace, G., Ekins, P., & Milligan, B. (2020). The natural capital indicator framework (NCIF) for improved national natural capital reporting. Ecosystem Services, 46, 101198.
153. Dalia D’amato and Jouni Korhonen. Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. Ecological Economics, 188:107143, 2021.
154. World Bank. Natural capital. https://www.worldbank.org/en/topic/natural-capital#1, 2021.
155. Global green growth institute (gggi, 2015). green growth index 2020 December 2020 gggi technical report no. 16 measuring performance in achieving SDG targets. https://www.researchgate.n et/publication/348651254_Green_Growth_Index_2020_-_Measuring_performance_i n_achieving_SDG_targets, 2015.
156. Global Forest Watch. GHG emissions. 2021. Retrieved from https://data.globalforestwatch.org/datasets/gfw::forest-greenhouse-gas-emissions/explore
157. Ayoola Brimmo. A window into nigeria’s recycling industry. https://cycled.no/a-window-into-nigerias-recycling-industry, 2018.
158. Schroeder et. al. (2021) Circular Economy in Africa [Finance]: Examples and opportunities. Ellen Macarthur Foundation.
159. Energy saving trust. generating energy from waste: How it works. https://energysaving trust.org.uk/generating-energy-waste-how-it-works/#:~:text=There%20are%20n umber%20of%20ways,digestion%20and%20landfill%20gas%20recovery., 2019.
160. Heat calorific value estimation- municipal solid waste. http://woimacorporation.com/heat-calorific-value-estimation-msw/, 2022.
161. Ibidun O Adelekan. Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria.
162. LJ Brasser. Solid waste disposal in the Netherlands. Journal of the Air & Waste Management Association, 40(10):1364–1367, 1990.
163. European Commission. Circular economy in africa-eu cooperation: Country report for Rwanda. European commission, brussels, 2020.
164. Nigeria Department of Climate Change, Federal Ministry of Environment. 2050 long-term vision for Nigeria (ltv-2050). https://unfccc.int/sites/default/files/resource/Nigeria_L TS1.pdf, 2021.
165. Circle Economy. The circularity gap report 2020, 2020.
166. HS Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara, and Kiyoto Tanabe. 2006 ipcc guidelines for national greenhouse gas inventories. 2006.

167. Land Degradation Neutrality Target Setting Programme (LDN-STP) Federal Government of Nigeria, United Nations Conference to Combat Desertification (UNCCD). Final report of the land degradation neutrality target setting program. Nigeria: International union for conservation of nature, joint research centre of the European commission, soil leadership academy, united nations development programme, united nations environment programme, world resources institute. https://www.unccd.int/sites/default/files/ldn_targets/Nigeria%20LDN%20TSP%2 0Country%20Report.pdf, 2018.
168. Ellen Mac-Arthur Foundation. Circular economy introduction. https://ellenmacarthurfoun dation.org/topics/circular-economy-introduction/overview, 2013.
169. Martin Geissdoerfer, Paulo Savaget, Nancy MP Bocken, and Erik Jan Hultink. The circular economy–a new sustainability paradigm? Journal of cleaner production, 143:757–768, 2017.
170. HM Government. Skills for a green economy:a report on the evidence. https://assets.publi shing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/32373/11-1315-skills-for -a-green-economy.pdf, 2011.
171. Sustainability Guide. Finnish roadmap to a circular economy 2016-2025 – leading the cycle. https://sustainabilityguide.eu/?guide=roadmap-to-a-circular-economy#:~: text=The%20world's%20first%20national%20circular,transition%20to%20a%20circ ular%20economy., 2018.
172. Ignite. 4 circularity metrics essential to measure your success in 2022. https://www.1gnite.c om/the-most-important-4-circularity-metrics/, 2022.
173. Khanjan Ajaybhai Kalyani and Krishan K Pandey. Waste to energy status in india: A short review. Renewable and sustainable energy reviews, 31:113–120, 2014.
174. Abhishek Nandan, Bikarama Prasad Yadav, Soumyadeep Baksi, and Debajyoti Bose. Recent scenario of solid waste management in india. World Scientific News, (66):56–74, 2017.
175. Oxford Biodiversity Network. Biodiversity technologies. http://www.biodiversity.ox.ac.uk/researchthemes/biodiversity-technologies/assessing-ecological-value-of-landscapes-beyond-protected-areas-left, 2021.
176. Federal Government of Nigeria. Sectoral action plans for nigeria's nationally determined contribution (ndc) to the united nations framework convention on climate change (unfccc). http://dhq.climatechange.gov.ng/Documents/final-nigeria-ndc-sector-action- plans.pdf, 2017.
177. F Oluseyi and O Joseph. Comparative analysis of spatial extent and population sizes of cities in nigeria: Implications for urban space administration. J His Arch & Anthropol Sci, 3(1):00070, 2018.
178. Innocent Onah. What's next for nigeria's green economy agenda? https://blogs.afdb.org/climate-change-in-africa/whats-next-for-nigerias-green-economy-agenda-319, 2021.
179. Nathalie Remy, Eveline Speelman, and Steven Swartz. Style that's sustainable: A new fast-fashion formula. Technical report, McKinsey Global Institute, 2016.
180. Duncan Rouch. Fashion and clothing textiles: how to reduce the environmental and social impacts. 02 2021.
181. Gustav Sandin, Sandra Roos, Björn Spak, Bahareh Zamani, and Greg Peters. Environmental assessment of swedish clothing consumption—six garments, sustainable futures. Mistra Future Fashion http://mistrafuturefashion. com/wp-content/uploads/2019/08/G. Sandin-Environmental-assessment-of-Swedish-clothing-consumption. MistraFutureFashionReport-2019.05. pdf, 2019.
182. National Environmental Standards and Regulations Enforcement Agency (NESREA). Our offices. https://nesrea.gov.ng/our-offices/, 2021b.
183. Gratien Twagirayezu, Olivier Irumva, Abias Uwimana, Jean Claude Nizeyimana, and Jean Paul Nkundabose. Current status of e-waste and future perspective in developing countries: Benchmark rwanda. Energy and Environmental Engineering, 8(1):1–12, 2021.
184. Industry UNEP, Division of Technology and Economics. Energy efficiency for building. https:// www.euenergycentre.org/images/unep%20info%20sheet%20-%20ee%20buildings.pdf, 2021.
185. Heidi Vanhanen Yemi Katerere, Peter A. Minang. Making sub-saharan african forests work for people and nature: Policy approaches in a changing global environment. nairobi, kenya: Special project on world forests, society and environment of the iufro, icraf, cifor, and the finish forest research institute.

186. Oger, A., Blot, E. (2022). ‘Trade in support of circular economy – Opportunities between Nigeria and the EU, case study. Institute for European Environmental Policy, Brussels / London.