Climate Transition, Decarbonization Framework and Energy Sustainability in Ecowas Region

Nwaobi, Godwin

QUANTITATIVE ECONOMIC RESEARCH BUREAU, NIGERIA

1 April 2025

CLIMATE TRANSITION, DECARBONIZATION FRAMEWORK AND ENERGY SUSTAINABILITY IN ECOWAS REGION

GODWIN CHUKWUDUM NWAOBI

PROFESSOR OF ECONOMETRICS

gcnwaobi@quanterb.org

gcnwaobi@gmail.com

+2348035925021

QUANTITATIVE ECONOMIC RESEARCH BUREAU

P.O. BOX 7173, ABA, ABIA STATE,

NIGERIA, WEST AFRICA

www.quanterb.org

AND

VISITING PROFESSOR OF ECONOMICS

NIGERIA BRITISH UNIVERSITY

ABIA STATE, NIGERIA

www.nbu.edu.ng

ABSTRACT

Critically, the world is clearly facing a triple crisis of three interconnected issues (development, climate and nature) while correct levels of climate action are insufficient. In other words, countries are not reducing emissions and building resilience fast enough while natural resources are being depleted and putting hard-non development progress at risk. Specifically, the opportunity to cap global warming at 1.5^{o}C is rapidly escaping. Although West African countries and companies across various industries are increasingly addressing this challenge as well as adopting measures to calculate and reduce their carbon footprint; they still face fundamental barriers. These include high upfront costs, technological limitations, regulatory uncertainty, fragmented constraints, unskilled work force, insufficient infrastructure, limited financial access and resistance to change. Therefore, breaking the barriers to buy in, business case, carbon calculated and mitigation across value chains and green business growth is critical for ECOWAS companies seeking to reach net-zero objectives. However, as more efforts are required to reach not zero; public-private collaboration is pivotal in overcoming key barriers as well as providing the condition and signals for businesses to advance their climate actions in West African region. Again, as a technical adjustment, transitioning toward strengthened risk governance in the energy sector through risk informed approach will mark a shift in priorities and decision making in ECOWAS. Yet, with targeted efforts to overcome policy, financial and technical barriers; Nature – Based solutions (NBS) can be transformative in protecting regional natural resources, reducing disaster risk as well as building climate resilience in the region. Similarly, an operational West African Carbon Markets can be a pivotal development pillar that can unlock much needed climate finance across the sub-continent. Consequently, this paper recommended that nations can create a legacy of positive impact for generations to come as well as climate resilient economies. However, international support that is tailored to country-specific requirements must be reinforced to direct sufficient financing to West African countries (ECOWAS).

KEY WORDS: Climate, Policy, Adaptation, Mitigation, ECOWAS, Carbon Market, Climate Finance, Sustainability, Carbon Footprint, West African, Paris Agreement, United Nation, Africa, Environment, Pollution, Emissions, Carbon Dioxide, Green House Gases.

JEL NO: D20, D62, F30, H22, H23, I31, L51, L59, O13, O30, O44, Q01, Q20, Q40, Q50, Q55, Q58, Q57, Q56.

1.0. INTRODUCTION

Indeed, societies have always depended on the environmental climate but are now coming to the grips with the fact that the climate also depends on their actions. In other words, not only does climate affect development but development also affects the climate. Therefore, development that meets the needs of the present without compromising the ability of future generations to meet their own needs is desirable. Notably, the use of natural resources (such as fossil fuels) has been supporting improvements in wellbeing but when accompanies by resource degradation and climate change; such use is no longer sustainable. In fact, climate change will affect numerous sectors and productive environment (such as agriculture, forestry, energy and coastal zones) in developed and developing countries. However, it is anticipated that developing economics will be more affected by climate change because of their low adaptive capacity as well as their greater exposure to climate shocks. Yet, no country is immune (World Bank, 2010).

Therefore, economic assessments of climate change policies must factor in the uncertainties about the size and timing of adverse impacts as well as the feasibility, cost and time profiles of mitigation efforts. Even without considering these catastrophic risks, substantial uncertainties remain around climate change's ecological and economic impacts (Gjerde, et al, 2009; Nwaobi, 2013). Yet, these uncertainties will only increase with the pace and amount of warming. But without inertia and irreversibility uncertainty would not matter so much. This is because decisions could be reversed and

adjustments could be smooth and costless. However, tremendous inertia (in the climate system and built environment as well as in the behavior of individuals and institutions) makes it costly and impossible to adjust in the direction of more stringent mitigation. Thus, inertia greatly increases the potential negative implications of climate policy decisions under uncertainty.

In fact, structural forces (technological geostrategic, climate and demographic spheres) will continue to form the backdrop to the global risks that play out over the subsequent decades. Basically, structural forces are those long-term shifts in the arrangement of (land relationships between) the systemic elements of the global landscape. In other words, these forces have the potential to materially impact the speed, spread or scope of global risks.

Perhaps, while several force may have global ramifications, climate change are more multidirectional in their development (which could allow for several potential futures).

Specifically, climate change encompasses the range of possible trajectories of global warming and their consequences to earth systems.

Clearly, table 1.1 shows the composition of those environmental forces that constitutes severe global risk (WEF, 2025). Indeed, climate change is proving to be more severe than ever. Evidently, global temperatures have reached 1.5^{o}c above pre-industiral levels in recent times. Critically, this is an unprecedented streak highlighting the accelerating pace of global warming.

TABLE 1.1 ENVIRONMENTAL FORCES COMPOSITION: RISK FACTORS

S/N	SPHERES	DESCRIPTIONS
(A)	**BIODIVERSITY LOSS AND ECOSYSTEM COLLAPSE**	Severe consequences for the environment; human kind and economic activity due to destruction of natural capital stemming from species extinction or reduction; spanning both terrestrial and marine ecosystems
(B)	**CRITICAL CHANGE TO EARTH SYSTEM**	Long-term (Potentially irreversible and self-perpetuating changes to critical planetary systems as a result of breaching a critical climatic or ecological threshold or tipping point at a regional or global level. These include sea level rise from collapsing ice sheets; carbon release from thawing permafrost as well as disruption of ocean or atmospheric currents.
(C)	**EXTREME WEATHER EVENTS (SUCH AS FLOODS, HEAT WAVES, ETC)**	Loss of human life; damage to ecosystems; destruction of property and financial loss due to extreme weather events (such as land based wild fires and water based floods); Atmospheric and temperature-related events (such as heat waves).
(D)	**NATURAL RESOURCE**	Supply shortages of food or water for human, industry or

	SHORTAGES (SUCH AS FOOD, WATER)	ecosystem use; manifesting as food and water insecurity at a local, regional and global level stemming from human over exploitation and mismanagement of critical natural resources; climate change such as drought and desertification as well as lack of suitable infrastructure
(E)	**NON-WEATHER RELATED NATURAL DISASTERS (SUCH AS EARTHQUAKES, VOLCANOES, TSUNAMIS, SOLAR FLAMES, ETC.)**	Loss of human life; damage to ecosystems; Destruction of property and financial loss due to non-weather related natural disasters which includes land-based (such as earthquakes, volcanoes and water based (such as tsunamis) as well as extra-terrestrial-based (such as asteroid strikes and geomagnetic storms) events.
(F)	**POLLUTION (SUCH AS AIR, SOIL, WATER ETC)**	Introduction of harmful materials into the air, water, and soil stemming from human activity; resulting in impacts to and loss of human life, financial loss and damages to ecosystems. These includes household and industrial activities, environmental accidents (such as oil spills) as well as radioactive contamination

Again, evidence has shown that the global tipping points indicate that eight critical tipping points are on the verge of being crossed. These include the potential collapse of the Greenland and west Antarctic ice sheets; dieback of the Amazon rainforest as well as the thawing of permafrost (which collectively could lead to irreversible changes in the earth's climate system). Therefore, the urgency of achieving net-zero emissions has never been more critical and yet the speed (and scale) of emissions abatement are insufficient.

Notably, the ongoing drive to reduce greenhouse gas emissions in some African countries has focused more on the other sectors than on industrial processes that involve substantial emissions of carbon dioxide and other potential contributors to global warming. Specifically, short-lived climate pollutants such as black carbon and methane are accelerating the pace of climate change. Again, fresh water and ocean pollution are severally impacting human and ecosystem health (with antimicrobial pollution emerging as an increasing concern. Also nitrogen and waste pollution are becoming more costly by way of generating a range of health and ecosystems impacts.

Indeed, pollution poses greater risks in specific geographies (such as in West African region) and disproportionately affects vulnerable groups of the population that are exposed to higher levels of pollution. Clearly, marginalized communities, urban areas and industrial zones encounter the large brunt of its impacts due to proximity to sources of emissions (such as waste disposal sites and limited green spaces). However, anthropogenic activities are the key drivers of the several

types of emissions. Unfortunately, these activities are expected to increase over the next decade unless a different course of action is taken. In other words, the compounded effects of these emissions threaten to erode ecosystem resilience while diminishing its ability to sustain life and deliver essential services.

Although, there is a concerning common denominator of West African countries, green transition pathways: explicit and comprehensive plans for tackling the mounting health and ecosystem impacts of emissions are critically missing. Therefore, the fundamental questions policy options for the climate resilience and sustainability in ECOWAS. Finally, section seven concluded the paper.

How can different industrial decarburization pathways interact with other policy goals (such as climate resiliency, energy transition, competitive and dynamic efficiency) in the West African region (ECOWA). The rest of the paper is divided into six sections. Section one discusses climate change challenges in the world. Review of ECOWAS economies are presented in section three while section four illustrates the energy transition framework. Section five analyses decarburization processes and carbon markets performances.

Climate finance strategies are identified in section six while section seven highlights.

2.0. CLIMATE CHANGE CHALLENGES

Conceptually, Samuelson (1954) developed the theory of public goods which is fundamental to environmental economics and applies as well to climate change. Here, we can speak of negative externality or public bad in the form of greenhouse gas (GHG) emissions as compared to a public good of improved knowledge. Yet, climate change is particularly theory externality given its global nature.

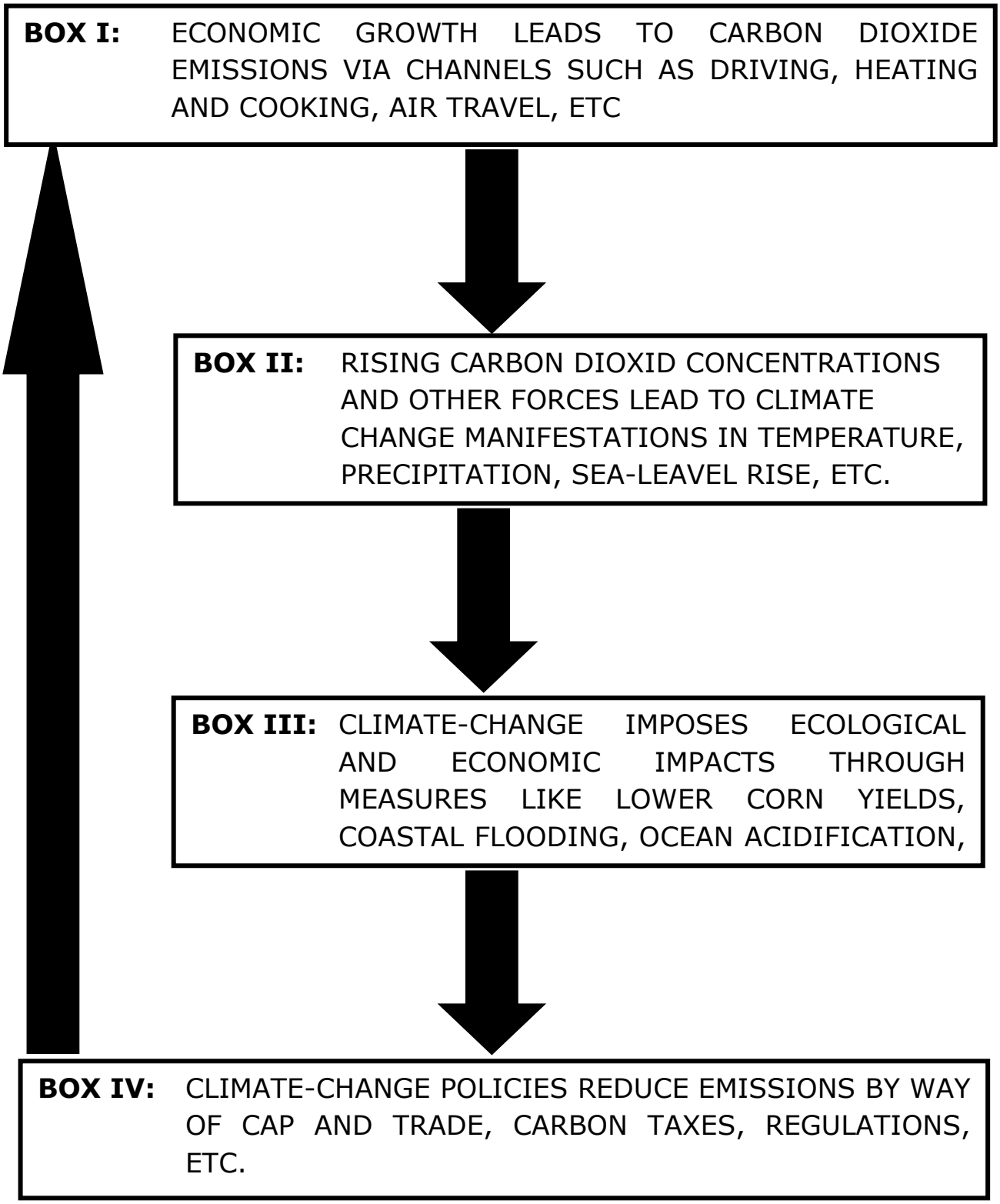
In fact global externalities are different from local or national public goods since they often resist the control of both markets and national governments. Notably, global warming is the most significant of all environmental externalities (by way of menacing our planet and looms over our future). In other words, since the industrial revolution, the earth has warmed badly due to the anthropogenic emission of greenhouse gases (such as carbon dioxide known as $C^{o}2$ emitted from the burning of fossil fuels).

Indeed, the consequences of the anthropogenic climate change (manifested in the higher frequency of wild fires, droughts, floods and hurricanes, are critically being felt in several parts of the world. Again, the vast availability of carbon-based energy sources (such as oil, gas and coal) with relatively low exploitation costs implies that without policy action, continued carbon dioxide emissions are likely to further endanger our precious planet as well as lowering social welfare. Naturally, the effects of climate change might critically be severe as physical science predicts that the frequency and intensity of extreme events increase with rising temperatures (Massion-

Delmutte, et al. 2021; Russo and Domeison, 2023; Villaverde, et al, 2024). Therefore, there is a broad censorious that substantial greenhouse gas emission reductions are required. Recently, the natural science community has called for limiting the rise of global mean surface temperature to $1.5^{o}C$ (which is the goal of the Paris 2015 agreement). Thus, many governments and institutions are aggressively trying to lower greenhouse gas emission. These include United Nations (2015) sustainable development goals and European commission climate emissions reduction measures. However, countries pledges to reduce emissions are critically short of limiting global warming to the Paris target as well as substantial uncertainty about future emission reductions trajectory.

Consequently, economic knowledge can provides instruments for understanding how to reach the goals for greenhouse gas emission reduction in ways that are efficient and feasible. In others words, the economics of climate change can be defined as an interdisciplinary domain that examines the economic determinants and consequences of climate change through economic lens. Essentially, this approach involves understanding how climate change impacts economic growth, development, technological changes, globalization as well as the exploration of the economic underpinnings of climate related policies while unearthing unintended consequences (stern, 2008; Villaverde, 2024). Specifically, an integrated assessment analysis and models can be very useful (which can be defined as approached that integrate knowledge from several domains into a single framework). Clearly, Figure 2.1.

FIGURE 2.1 GLOBAL WARMING: INTERROGATION FLOW



display the logical circular flow from emissions to climate to impacts and tent to policies and closing the circle back to emissions (Nordhaus, 1975, 1977, 2019).

Here, we can observe the logical flow from emissions to climate to impacts and then closing back to emissions. Notably, the global warming problem starts at the first box (where economic growth and distorted price signals lead to rapidly rising emissions of carbon dioxides into the atmosphere). The arrow then moves to the second box (where the carbon dioxide concentrations and other forces lead to major changes in the climate system.

Consequently, the changing climate will produce impacts on human and natural systems as shown in the third box. However, the fourth box shows societal responses to the climate change threats. Clearly, the arrows in the above figure represent the linkages between the different parts of the economy-climate-impacts-politics-economy nexus. Notably, there are less effective international agreements (as of today) to limit the emissions of carbon dioxide and other greenhouse gases. Thus, if we continue along the current path of less effective policies; the globe will continue in the dangerous path of the unrestrained global warming. Indeed, global warming is a major threat to humans and natural world. In other words, economic growth is producing unintended but dangerous changes in the climate and earth systems. In fact, these changes will lead to enforceable consequences. Therefore, development that is socially, economically and environmentally sustainable is a critical challenge (even without global

warming). But failing to safeguard the environment eventually threatens economic and social achievements.

Indisputably, the critical and enduring source of global warming is the burning of fossil or carbon-base fuels such as coal, oil and natural gas which inevitably leads to emissions of carbon dioxide. Unfortunately, these greenhouse gases such as carbon dioxide emissions accumulate in the atmosphere as well or staying for a long time.

Therefore, higher atmospheric concentration of greenhouse gases lead to surface warming of the land and oceans while the initial warming effects are amplified through feedback effects in the atmosphere, oceans and ice-sheets. Here, the resulting impacts include charges in temperature as well as impacts on temperature extremes, precipitation patterns, storm location and frequency, snow packs, river run off, water availability and ice. Naturally, each of these will have profound impacts on the biological and human activities that are sensitive to climate.

Consequently, a pollution-conscious green transition is needed. But some of the pollutants that must be accounted for in that transition are newer or emerging (not well understood) or do not yet have enough evidence of their potential impacts. Yet different pollutants tend to come under the regulatory spotlight given the awareness of their profound long-term impacts on health ecosystems. Therefore, better understanding of these pollutants and their impacts is a fundamental step towards both targeted polices and strategies. Clearly, table 2.1 shows

TABLE OF 2.1 CLASSIFICATIONS OF GENERAL POLLUTIONS

S/N	TYPES	COMPOSITION DESCRIPTIONS
(A)	**AIR POLLUTANTS**	**(AI)** Long-lived pollutants include particulate matter, Nitrogen oxide, Q zone, sulphur Dioxide and carbon Monoxide. Indeed, exposure to these pollutants constitutes severe health risk for vulnerable populations, such as children, pregnant women, elderly as well as people with chronic health conditions. These pollutants also significantly reduce work productivity and thus leading to increased sick days with commensurate economic losses.
		(AII) Short-lived pollutants or super pollutants are a group of pollutants that remain in the atmosphere for relatively short period gases. These pollutants include block carbon, methane, Hydrofluoric carbons and Tropospheric Ozone. Notably, they are responsible for significant percentage of near-term global warming but have disproportionately higher impact on air quality. Specifically, BLACK CARBON (KNOWN AS SOOT) Consists of tiny black particles that can be carried for thousands of kilometers. As a component of particulate matter, it is formed by the incomplete combustion of fossil fuels. Regrettable, these particles can penetrate the blood

		stream through the alveoli in lungs to transport toxic compounds around the body. In fact, it has been linked to a wide range of health implications such as chronic respiratory conditions, strokes, heart attacks and cancer as well as early childhood development issues. Again, the particles of black carbon affect the ecosystem by increasing plant surface temperature interfering with rainfall and diminishing sunlight (which has significant effect on crop losses). Similarly, the main sources of methane emissions include fossil fuels, agriculture and waste. Although it has a relatively short atmospheric life time, it is a major precursor to ground-level ozone (which is an air pollutant that poses health risks, decreases agricultural yields and stresses ecosystem. Unfortunately, failure to reduce methane emissions has been recognized as one of the most significant short term risks for limiting near-term global temperature rise.
(B)	**WATER POLLUTANTS**	**(BI)** PER AND POLYFLUORO ALKYL SUBSTANCES (PF AS) are forever chemicals that are used in consumer products to make them water, grease or stain resistance. But despite their usefulness in many industries, they are currently being detectable in drinking water, soil, air and food. Consequently, they pose a significant threat to people's health since they do

		not easily break down and are toxic at extremely low levels. Notably, exposure to certain levels of PFAS can lead to significant health impacts such as decreased fertility in women, developmental delays in children, increased risk of certain cancers as well as reduced body ability to fight infections.
		(BII) MICRO AND NANOPLASTICS includes plastic pollution in aquatic environments such as pollution from shipping and fishing. Specifically, micro plastics include primary micro plastics such as micro beads, industrial plastic powders, and pellets. It also includes pieces of plastic that have resulted from the degradation and fragmentation of larger items (such as plastic bottles, synthetic textiles and tyres. Again, micro plastics affect the soil ecosystem and restrict growth of plants (in marine and fresh water settings). Similarly, NANO PLASTICS (representing pieces of plastic smaller than micro plastics) are high risk areas with an increased chance of them being ingested, in hailed or absorbed. Notably, chemicals present in plastics are endocrine disrupting, interfering with hormone actions in the body. In fact, these chemicals found in plastics are endocrine disrupting (interfering with hormone actions in the body

		which can be released during the entire life cycle. Regrettably, these endocrine – disrupting chemicals are linked to significant health effects (such as infertility, obesity, cancer. thyroid problems and developmental issues).
		(BIII) PHARMACEUTICAL includes all contaminants, personal care products, sunscreen, insect repellents and detergents. They tend to be long lived as well as accumulating at low levels over long periods of time in the environment. Again, ANTIMICROBALS are medicines that are used to treat infections in people, animals and plants. However, these antimicrobials (such as antibiotics, antiviral, antifungal, antiparasitics) when released into water from manufacturing waste, health care facilities, farming and consumers can remain in the environment.
(C)	**NITROGEN AND WASTE DISPOSAL**	**(CI) Nitrogen Pollution** is a major contaminant of soil, water and air since industrial agriculture is dependent on nitrogenous fertilizers to increase productivity. Unfortunately, the more these fertilizers are used to increase crop yields; the more is cost to the environment by way of escaping into water and the atmosphere. In fact, if ground water becomes contaminated with nitrogen; it can become a serious health issue. Specifically, high nitrate levels in drinking water can

		cause reproductive problems, methemoglobinemia, colorectal cancer, thyroid disease and neural tube defects. Similarly, nitrogen in river flows generates various seawater health issues. Furthermore, livestock manure and fertilizer use can lead to nervous oxide production (potent greenhouse gases) which is the most important substance for the depletion of the stratospheric ozone layer. Clearly, this has implications for the increased occurrence of skin cancer.
		(CII) Waste disposal which includes municipal solid waste, industrial waste, hazardous waste, organic waste, e-waste, and healthcare wastes. Critically, improper waste disposal can lead to the spread of infectious diseases, release of methane as well as exposure to pollutive chemicals released through landfills, organic waste and waste burning. Specifically, exposure to improperly managed hazardous waste and its components can release a wide range of different chemical particles into the environment; which can have multiple adverse health and developmental impacts (such as in young children and pregnant women).

the various categories and compositions of these pollutants (WEF, 2025). Yet, in reality, projecting impacts is the most difficult task which has the greatest uncertainties of all the processes associated with global warming. However, many human and natural systems are unmanaged or unmanageable as well as highly vulnerable to climate-sensitive physical systems. Thus the potential damages are likely to be most heavily concentrated in natural systems as well as in low-income regions such as tropical Africa. Here, vulnerable system includes rain-fed agriculture; coastal communities impacted by sea-level rise; river runoffs; forest erosion and fires as well as natural ecosystems. Clearly, there is potential for serious impacts in these areas.

Consequently, as the impacts of anthropogenic climate change accelerate, adaptation should play an increasing critical role in shaping human well-being (presently and into the future). While adaptation often refers to decisions that ameliorate the adverse impacts of climate changes; adaptive behaviour can equally include actions that allow individuals to exploit beneficial opportunities that arise with an evolving climate (Cerleton, et al 2024). In other words, these adaptation decisions usually occur within a broader socio-economic, fabric in which many environmental, economic, political and cultural conditions shape the constraints and opportunities that individuals, communities and governments face as they navigate climate change. Indeed, addressing physical climate risks is no longer optional. Critically, businesses and governments (policy makers) must take decisive action to integrate resilience into planning process while ensuring long-term stability given the face of accelerating climate impacts in developing countries (such as West African region).

3.0. **ECOWAS ECONOMIES REVIEW**

As the second largest continent, Africa is characterized by plateau land, mountain ranges and narrow coastal plain. It is surrounded by the Mediterranean Sea to the north (both the Suez Canal and red sea along Sinai Peninsula to the north east); Indian Ocean to the south east and Atlantic Ocean to the western region. However, six major drainage networks exist in Africa. These include Nile River (Northeastern region), Lake Victoria (eastern region), Niger River (western region), Zambezi River (south eastern region), Vaal River (southern region), Zaire River (Central region) as well as Lake Chad. And because most of the continent has not been covered by seas; soils have developed locally (mainly by weathering) while few areas have benefited from soils transported by rivers or ocean currents.

Horticultural, the most fertile soils include mollisols or chemozems or black soils (of eastern region) and the alfisols or podzolic soils (of western and southern region). Generally, Africa has uniform climate but several climatic zones can be distinguished. These include tropical rain forest climate zone, tropical savanna climate zone and Mediterranean climate zones. As regard mineral resources, Africa possesses most of the well-known mineral types (although with uneven geographical distribution). Essentially, these minerals include fossil fuels (such as coal, petroleum, natural gas), gold, diamonds, copper, bauxite, manganese, nickel, platinum, cobalt, radium, germanium, lithium, titanium, phosphates, iron ore, chromium, tin, zinc, lead, thorium, zirconium, antimony,

beryllium, clays, mica, sculpture, salt, matron, graphite, limestone and gypsum.

Politically, by the end of the 1970s, almost all of Africa nations were independent. However, Zimbabwe gained legal independence in 1980 while Namibia attained independence in 1990. And by geographical classification, Africa can be subdivided into five regions: North Africa, central Africa, East Africa, Southern Africa and West Africa. Apart from the formation of Africa union (formerly organization of Africa unity) several sub regional groupings exist. These include Economic community of central African states (ECCAS), East African Community (EAC), Community of sahel-saharan states (CEN-SAD), Common market for Eastern and Southern Africa (COMESA), Intergovernmental Authority for Developmental (IGAD), Union du Maghreb Arabe (UMA), Southern Africa Development Authority (SADC) and Economic Community of West African States (ECOWAS).

Specifically, ECOWAS (CEDEAO) is a regional political and economic union of the countries of West Africa. The union was established in 1975 with the signing of the Lagos treaty (with its stated mission of promoting economic integration across the region). Subsequently, the revised version of the treaty was agreed and signed in 1993 at Cotonou. Basically, the goal of ECOWAS is to achieve collective self-sufficiency for its member states by creating a single large trade bloc as well as building a full economic and trading union. In other words, ECOWAS have the main objectives of promoting economic cooperation and integration with a view to achieving an economic and monetary union; to raise the living standards of

the community citizens; to ensure economic growth; to foster relations among member states and to contribute to the progress and development of the African continent (Ecowas, 2012). However, these objectives are guided by the fundamental principles of equality and interdependence; inter-states cooperation; solidarity and collective self-reliance. Similarly, other abiding principles include harmonization of policies and integration programmes; non-aggression between member states; maintenance of regional peace, stability and security; peaceful settlement of disputes; respect, promotion and protection of human rights; promotion and consolidation of democracy or good governance as well as accountability, economic and social justice.

Clearly, table 3.1 shows the membership composition of ECOWAS with their individual countries identity. Operationally, ECOWAS consists of two operating institutions that implement policies: ECOWAS commission (EC) and ECOWAS Bank for investment and Development (EBID). Other related institutions include community court of justice, community parliament, West Africa Health Organization (WAHO) and inter-Governmental Action Group against money laundering and Terrorism Financing in West Africa (GIABA). Furthermore, ECOWAS includes two sub-regional blocks known as West African Economic and Monetary Union (UEMOA) and West African Monetary Zone (WAMZ). While UEMOA shapes a customs and currency union, WAMZ plans to work towards adopting their own common currency as soon as possible. As a transformed commission, ECOWAS operates the following departments: Human Resources Management; Education,

TABLE 3.1 ECOWAS: MEMBERSHIP COMPOSITION

S/N	COUNTRY	AREA (54.KM)	CURRENCY	INCOME RATING	STATUS
1.	BENIN	114,763	CFA FRANC	MIC	ACTIVE
2.	BURKINAFASO	272,967	CFA FRANC	LIC	EXITED
3.	CAPE VERDE	4,033	ESCUDO		ACTIVE
4.	COTE D'IVNRE	322,463	CFA FRANC	LIC	ACTIVE
5.	THE GAMBIA	11,295	DALASI	LIC	ACTIVE
6.	GHANA	238,533	CEDI	MIC	ACTIVE
7.	GUINEA	245,857	FRANC	MIC	SUSPENDED
8.	GUINEA BISSAU	36,125	CFA FRANC	LIC	ACTIVE

9.	LIBERIA	111,369	DOLLAR	LIC	ACTIVE
10.	MALI	1,240,192	CFA FRANC	LIC	EXITED
11.	NIGER	1,267,000	CFA FRANC	LIC	EXITED
12.	NIGERIA	923,768	NAIRA	MIC	ACTIVE
13.	SENEGAL	196,712	CFA FRANC	MIC	ACTIVE
14.	SIERRA LEONE	72,300	LEONE	LIC	ACTIVE
15.	TOGO	56,785	CFA FRANC	LIC	ACTIVE

NOTE: LIC = LOW INCOME COUNTRIES USING WORLD BANK (2025) CLASSIFICATION

MIC = MIDDLE INCOME COUNTRIES USING WORLD BANK (2025) CLASSIFICATION

Science and Culture; Energy and Mines; Telecommunications and Information Technology; Industry and Private Sector development as well as finance and administration.

Structurally, apart from the extremely low level of development, there was considerable variation in the distribution of income wealth in West Africa. This observed income disparity made living conditions difficult in some places such as among rural populations. Notably, the overall economic performance in West Africa was only 3.2% in 1998 (slightly higher than the population growth rate of 2.9%). Again, West Africa's annual growth rate between 2001 and 2004 was projected at approximately 5% in real terms (implying an increase in per capita income of about 2.2%). However, these figures presupposed a conducive external environment and did not take into account a number of risk factors such as unfavourable climatic conditions, economic policy setbacks and resurgence of civil strife (Ecowas, 2000). Therefore, the above realities and economic conditions (coupled with the small and fragmented national economics with limited scope of economics of scale) underscored the importance of regional integration in West Africa. Consequently, to achieve broader objectives, the ECOWAS authority adopted a resolution in 2007 to introduce the transformational ECOWAS vision 2020. Basically, the vision was aimed at setting a clear direction and goal to significantly raise the standard of living of the people through conscious and inclusive programmes that will guarantee bright future for West Africa as well as shaping the destiny of the region in subsequent years. Clearly, the vision was an embodiment of

views and aspirations of the citizens of ECOWAS and their abiding conviction that economic cooperation and regional integration offered the best avenue for achieving economic development and poverty reduction in the region (ECOWAS, 2010). Indeed, West Africa has been characterized by high economic growth despite vulnerability to external shocks. Specifically, during 2000-2018, the growth rate of Gross Domestic product (GDP) averaged 5.9% as shown in table 3.2 (African union, 2019, IMF, 2019; World Bank, 2018). Subsequently, there has been growth slowdown in several member countries as shown in table 3.3 World Bank, 2025). Again, demographic growth, GDP per capita grew at significant rate since year 2000. Notably, as exporter of unprocessed raw materials, West Africa depends on the global economy and remains vulnerable to external shocks. In other words, the observed high GDP growth rates in some members' countries have not translated into real productive transformation. In fact, these countries lag behind in terms of industrialization, competitiveness and moving up the value chain. However, rapid growth underpinned by domestic reforms (and benign global environment) have allowed some of the West African countries to attain middle income status recently. Subsequently, the rate at which these member countries are graduating to middle income status has slowed down. In fact, the prospects for member countries appear much more challenging in recent times. Notably, per capita growth has been anemic amid critical levels of conflict and fragility as well as adverse global developments. In other words, member.

TABLE 3.2 WEST AFRICAN REGION: ECONOMIC INDICATORS

S/N	INDICATORS	2000-2004	2005-2009	2010-2014	2015-2018	2019-2022
(A)	REAL GDP GROWTH	07.30	06.50	06.40	04.90	05.60
(B)	POPULATION GROWTH RATE	02.70	02.70	02.80	05.50	04.00
(C)	GDP PER CAPITA GROWTH RATE	04.50	03.60	03.60	-00.60	01.60
(D)	EXPORTS (PERCENTAGE OF GDP)	25.80	26.00	22.80	17.70	18.70
(E)	IMPORTS (PERCENTAGE OF GDP)	22.30	22.90	23.50	21.40	22.40

NOTE: GDP = GROSS DOMESTIC PRODUCTS

TABLE 3.3 WEST AFRICAN COUNTRIES: MACRO ECONOMIC INDICATIONS

S/N	COUNTRY	GNP FOR CAPITA	GNP PER CAPITA	REAL GDP GROWTH AT MARKET PRICES (%)				
		2,000	2024	2022	2023	2024	2025(F)	2026(F)
(1)	**BENIN**	470	1,440	6.30	6.40	6.30	6.40	6.30
(2)	**BURKUNA FASO (EX)**	260	850	1.50	3.00	3.70	3.90	4.10
(3)	**CAPE VERDE**		-	17.40	5.10	5.20	4.90	4.80
(4)	**COTE D'IVORE**	640	2,670	6.20	6.20	6.50	6.40	6.60
(5)	**GAMBIA**	570	830	4.90	5.30	5.60	5.80	5.40
(6)	**GHANA**	330	2,340	3.80	2.90	4.00	4.20	4.90
(7)	**GUINEA**	590	1,360	4.00	6.70	5.30	6.00	6.40

(8)	**GUINEA BISSAU**	410	900	4.20	5.20	5.00	5.00	5.00
(9)	**LIBERIA**	190	730	4.80	4.70	5.30	5.70	5.80
(10)	**MALI (EX)**	280	860	3.50	3.50	3.70	4.00	4.50
(11)	**NIGER (EX)**	220	600	11.50	2.00	5.70	8.50	4.60
(12)	**NIGERIA**	-	1,930	3.30	2.90	3.30	3.50	3.70
(13)	**SENEGAL**	670	1,660	3.80	4.60	6.10	9.70	6.00
(14)	**SIERRA LEONE**	140	560	5.30	5.70	4.30	4.70	4.70
(15)	**TOGO**	430	1,030	5.80	6.40	5.30	5.40	5.80

Note: (a) Monetary measurements in Dollars

(b) F represents forecast

(c) Ex represents exit

countries are more susceptible to domestic shocks (such as those related to climate change) economically growth in West Africa has been projected to increase in subsequent years; driven primarily by improvements in the outwork for industrial – commodity exporting countries. However, high government debt and elevated interest rates have narrowed fiscal space, prompting fiscal consolidation efforts in some ECOWAS countries whereas financing needs remain high. And despite the projected pickup in growth, per capita income gains will remains inadequate to make significant progress in reducing extreme poverty in the region. Furthermore, the notable risks include weaker global growth due to heightened uncertainty and potential for adverse changes in trade policies; increased regional or global instability (which could drive up energy and food price inflation in the region); increased risk of government distress amid possibility of higher for longer global interest rates; as well as greater frequency and intensity of adverse weather events (World Bank, 2025) Environmentally, the ECOWAS region has considerable ecological and agronomical potential with complementary natural ecological areas. The region is also promoting natural resource and environmental management through the implementation of regional and international conventions, treaties and agreements, regional development, training and research programmes (in natural resource management).

Unfortunately, while West Africa contributes significantly to global public good for tackling climate change with its vast resources of natural capital; its vast natural capital has been undervalued. In other words, when the value of West Africa's vast forest and environmental services (as well as natural capital) are properly valued; the size of the rebased gross domestic product will be much higher. Consequently, it is time for West Africa's green environmental assets to be properly priced so as to allow the sub-continent to turn its massive green assets into wealth.

Essentially, this will raise massive financial resources for the member countries, spur greater green investments and provide better policies for the greening of West African economies for sustainable development (including debt sustainability).

4.0. ENERGY TRANSITION FRAMEWORK

Essentially, developing countries need reliable and affordable energy to grow and extend service to her people without electricity and clean cooking fuels. Then the challenge has been how to provide reliable and affordable energy services for economic growth and prosperity without compromising the climate. Clearly, **figure 4.1** show that the statistical background of energy sources, demand and supplies in ECOWAS regions while **figure 4.2** shows the dimensions of energy emitted carbon dioxides in the same region (World Bank, 2010). Notably, effective inclusive and accountable governance of the energy sector is fundamental in shaping countries socio-economic development. Therefore, in this context, energy transition presents both risks and opportunities. While the proposed transition may introduce challenges; the far greater risk lies in failing to transition. Thus, a well-managed shift offers unparalleled opportunities for innovation, sustainability and resilience which make it a crucial pathway to a secured energy future. Yet to navigates this complex landscape; a broader flexible and forward looking approach to energy governance is essential to anticipate and manage the multitude of context-specific risks as observed. Indeed, this risk informed approach addresses the underlying and structural vulnerabilities that contribute to and fuel systemic risks. And when applied to the energy sector; it can result in the transformation of energy systems by reducing their inherent risk levels. In other words, the energy sector operates within a complex landscape of inter connected and

TABLE 4.1A ECOWAS: ENERGY STATISTICAL BACKGROUND

S/N	COUNTRIES	ELECTRICITY CONSUMPTION PER CAPITA		ELECTRIFICATION RATE %	POPULATION WITHOUT ELECTRICITY (MILLIONS)	TOTAL PRIMARY ENERGY SUPPLY (MT OF OIL EQUIVALENT	
		2004(kh)	1990-2004 (%)	2000-2005	2005	1990	2005
1.	**BENIN**	81	72.30	22	06.50	01.70	02.60
2.	**BURKINAFASO (EX)**	31	55.00	07	12.40	-	-
3.	**CAPE VERDE**	-	-	-	-	-	-
4.	**COTE D'IVOTRE**	224	07.70	50	09.10	04.40	07.80
5.	**GAMBIA**	98	30.70	-	-	-	-
6.	**GHANA**	289	-22.30	49	11.30	05.30	08.90
7.	**GUINEA**	87	03.60	-	-	-	-
8.	**GUNIEA BISSAU**	44	04.80	-	-	-	-
9.	**LIBERIA**	-	-	-	-	-	-

10.	**MALI (EX)**	41	36.70	-	-	-	-
11.	**NIGER (EX)**	40	-13.00	-	-	-	-
12.	**NIGERIA**	157	-01.90	46	71.10	70.90	103.80
13.	**SENEGAL**	206	70.2	33	07.80	02.20	03.00
14.	**SIERRA LEONE**	24	-54.70	-	-	-	-
15.	**TOGO**	102	01.00	17	05.10	01.40	02.00

NOTES: (A) Country data refer to the most recent year available during the period specified as regards electrification rate.

(B) Ex represents exist membership from ECOWAS

(C) Total primary energy supply is made up of indigenous production + imports – exports – international marine bunkers.

TABLE 4.1B ECOWAS: ENERGY STATISTICAL BACKGROUND

S/N	COUNTRIES	FOSSILE FUELS COAL (% OF TPES)		FOSSIL FUELS: OIL (% OF TPES)		FOSSIL FUELS: NATURAL GAS (% OF TPES)		RENEWABLE: HYDRO SOLAR, GEOTHERMAL (%)		RENEWABLE: BIOMASS AND WASTE %		OTHERS: NUCLEAR (%)	
		1990	2005	1990	2005	1990	2005	1990	2005	1990	2005	1990	2005
1.	BENIN	00.00	00.00	05.80	33.30	00.00	00.00	00.00	00.00	93.20	64.70	00.00	00.00
2.	BURKINA FASO (EX)	-	-	-	-	-	-	-	-	-	-	-	-
3.	CAPE VERDE	-	-	-	-	-	-	-	-	-	-	-	-
4.	COTE D'IVOTRE	00.00	00.00	24.80	23.90	00.00	17.80	02.60	01.60	72.10	58.30	00.00	00.00
5.	GAMBIA	-	-	-	-	-	-	-	-	-	-	-	-
6.	GHANA	00.00	00.00	18.90	28.70	00.00	00.00	09.20	05.10	73.10	66.00	00.00	00.00
7.	GUINEA	-	-	-	-	-	-	-	-	-	-	-	-

8.	**GUNIEA BISSAU**	-	-	-	-	-	-	-	-	-	-	-	-
9.	**LIBERIA**	-	-	-	-	-	-	-	-	-	-	-	-
10.	**MALI (EX)**	-	-	-	-	-	-	-	-	-	-	-	-
11.	**NIGER (EX)**	-	-	-	-	-	-	-	-	-	-	-	-
12.	**NIGERIA**	00.10	-	15.00	13.90	04.60	07.50	00.50	00.70	79.80	78.00	00.00	00.00
13.	**SENEGAL**	00.00	03.10	39.20	55.30	00.20	00.40	00.00	02.00	60.00	38.20	00.00	00.00
14.	**SIERRA LEONE**	-	-	-	-	-	-	-	-	-	-	-	-
15.	**TOGO**	00.00	00.00	15.60	18.20	0.00	0.00	00.60	00.30	62.60	79.40	00.00	00.00

NOTES: **(A)** Coal represents coal and coal products

(B) Oil represents crude, natural gas liquids, feed stocks and petroleum products

(C) Total primary Energy supply (TPES) is a measure of commercial energy consumption; it is made up of indigenous production + imports – exports – international marine bunkers

TABLE 4.2 ECOWAS: ENERGY EMISSIONS OF CARBON DIOXIDES

S/N	Countries	CO_2: TOTAL EMISSIONS (MT)		CO_2 EMISSIONS: ANNUAL CHANGES (%)	CO_2 EMISSIONS : PER CAPITA		CARBON INTENSITY OF ENERGY USE		CARBON INTENSITY OF GROWTH (PER UNIT OF GDP)	
		1990	2004	1990 - 2004	1990	2004	1990	2004	1990	2004
1.	BENIN	0.70	2.40	16.70	0.10	0.30	0.43	0.96	0.16	029
2.	BURKINA FASO (EX)	1.00	110	00.70	0.10	0.10	-	-	0.13	0.08
3.	CAPE VERDE	-	-	- -	-	-	-	-	-	-
4.	COTE D'IVOTRE	5.40	5.20	-00.30	0.50	0.30	1.22	0.74	0.26	0.20
5.	GAMBIA	0.20	0.30	03.60	0.20	0.20	-	-	0.12	0.12
6.	GHANA	3.80	7.20	06.50	0.30	0.30	0.71	0.86	0.15	0.16
7.	GUINEA	1.00	1.30	02.30	0.20	0.10	-	-	0.09	0.07

8.	**GUNIEA BISSAU**	0.20	0.30	02.10	0.20	0.20	**-**	**-**	0.21	0.24
9.	**LIBERIA**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
10.	**MALI (EX)**	0.40	0.60	02.40	**-**	**-**	**-**	**-**	0.07	0.05
11.	**NIGER (EX)**	1.00	1.20	01.10	0.10	0.10	-	-	0.16	0.13
12.	**NIGERIA**	45.30	114.0	10.80	0.50	0.90	0.64	1.15	0.59	0.92
13.	**SENEGAL**	3.10	5.00	04.20	0.40	0.40	1.40	1.81	0.28	0.28
14.	**SIERRA LEONE**	0.30	1.00	14.30	0.10	0.20	-	-	0.10	0.27
15.	**TOGO**	0.80	2.30	14.80	0.20	0.40	0.52	0.86	0.13	0.29

NOTE: CO_2 = Carbon dioxide emission stemming from consumption of solid, liquid and gaseous fossil fuels as well as from gas flaring and the production of cement

dynamic risks (both within and beyond the sector) which can manifest in various forms as shown in Table 4.3 below structurally, the transition towards a low-carbon sustainable energy future is a complex undertaking filled with inherent risks. In other words, while this transition presents many opportunities, it also bring significant social and economic challenges such as potential job losses and displacement in traditional energy sectors; ensuring equitable and affordable access to clean energy for all as well as addressing competitiveness and trade disruptions. However, embracing renewable energy sources can reduce the devastating impact of climate change; improve public health outcome; foster economic growth and innovation as well as promoting greater energy security and independence. Thus, while transitioning to a sustainable energy future (shifting away from fossil fuels toward renewable energy sources) is crucial for sustainability; a risk informed approach ensures that potential risks and unintended effects are effectively addressed. Consequently, in a landscape marked by complexities and uncertainties, the path forward should be clear. In facts, it is time for all stakeholders across the value chain (spanning supply demand and distribution inclusive of both public and private sectors) to take practical actions. In other words, by harnessing the momentum of the energy transition, West African stakeholders can chart the course towards an equitable, secure and sustainable energy future.

Operationally, the energy transition Index (ETI) framework offers a comprehensive assessment of countries energy systems with consistent methodology while allowing decision

TABLE 4.3 ENERGY TRANSITION: RISK FACTORS AND COMPOSITIONS

S/N	RISK TOPOLOGIES	RISK FACTORS	RISK COMPOSITIONS
(A)	**ENVIRONMENTAL RISK (ER)**	**(AI)**ENERGY DISRUPTIONS: EXTREME WEATHER EVENTS; GREENHOUSE GAS EMISSIONS **(AII)**NUCLEAR DISASTER RISK: FOSSILS DEPENDENCY: CLIMATE CHANGE IMPACT	EXCESSIVE MINING FOR CLEAN ENERGY TECHNOLOGIES (CET) AND POOR MANAGEMENT OF CET WASTES SIGNIFIES CRITICAL ENVIRONMENTAL CHALLENGES.
(B)	**ECONOMIC RISK (ECR)**	**(BI)**INVESTMENT UNCERTAINTY ECONOMIC DISRUPTIONS. **(BII)** STRANDED ASSETS	FLUCTUATIONS IN ENERGY PRICES, ELITE CAPTURE, MARKET VOLATILITY CORRUPT PRACTICES AND INVESTMENT

		BUDGETARY COST	UNCERTAINTIES CRITICALLY IMPACT PROJECT VIABILITY AND CONSUMER AFFORDABILITY
(C)	**TECHNOLOGICAL RISK (TR)**	**(CI)**TECHNOLOGICAL UNCERTAINTIES AND CYBER SECURITY THREATS. **(CII)**TECHNOLOGICAL GAPS AND DIGITAL DIVIDE.	SUPPLY CHAIN DISRUPTIONS (IN RAW MATERIALS SUPPLY AND ENERGY DEMAND DUE TO MARKET UNCERTAINTIES) AND CYBER SECURITY THREATS CAN CAUSE ASCADING EFFECTS ON ENERGY PRODUCTION, DELIVERY AND REUSABILITY.
(D)	**Social risk (SR)**	**(DI)**EMPLOYMENT DISRUPTIONS AND ENERGY POVERTY **(DII)** SOCIAL EQUITY AND COMMUNITY RESISTANCE	SOCIAL INEQUALITIES, JOB DISRUPTIONS, DISPLACEMENT POTENTIAL HEALTH IMPACTS FORM POLLUTION OR ACCIDENTS; SOCIETAL

			RESISTANCE TO RENEWABLE ENERGY PRODUCTS AS WELL AS AFFORDABILITY AND ACCESSIBILITY OF ENERGY SERVICE CONCERN
E	**POLITICAL RISKS (PR)**	POLITICAL UNCERTAINTY, GEOPOLITICAL TENSIONS AND REGULATORY CHALLENGES	PUBLIC OPPOSITION, SHIFTING POLITICAL PRIORITIES, REGULATORY CHANGES AND GEOPOLITICAL TENSIONS THAT CAN DISRUPT TRANSFORMATION IN THE ENERGY SECTOR OR CREATING INSTABILITY TOWARDS SUSTAINABLE ENERGY FUTURE.

makers to compare and track progress. Basically, country decision makers are confronted with two critical questions in the energy transition:

(I) What is needed to accelerate improvements in countries energy systems

(II) And how can the right conditions are established to capitalize on opportunities arising from the transition?

Therefore, addressing the above questions necessitates a transparent framework to foster understanding of the performance and readiness of the various national energy systems for the transition. Again, it will help decision makers understand and navigate the complexities inherent in the energy transition. Notably, the transition index score is a composite of its scores on the two sub-indices of system performance and transition readiness. Comparatively, system performance is equally weighted across equity, security and sustainability while transition readiness is spitted into two groups: Core enablers and enabling factors. Specifically, core enablers include regulations and political commitment as well as finance and investment. On the other hand, enabling factors include innovation, infrastructure as well as education and human capital. Indeed, a country's progress in energy transition is determined by its transition readiness (representing the extent to which a robust enabling environment can be created). As shown in table (4.4), West African countries were scored across forty six indicators covering the most important aspects across those dimensions of energy transitional WEF, 2024). Statistically, the energy transition index adopts a minimum maximum method to

TABLE 4.4 ECOWAS: COMPARATIVE ENERGY TRANSITION SCORES

S/N	COUNTRIES	ETI SCORES (2024)	SYSTEM PERFORMANCE SCORES (2024)	TRANSITION READINGS SCORES (2024)
1.	**BENIN**	**-**	**-**	**-**
2.	**BURKINA FASO (EX)**	**-**	**-**	**-**
3.	**CAPE VERDE**	**-**	**-**	**-**
4.	**COTE D'IVOTRE**	**51.20**	**59.20**	**39.10**
5.	**GAMBIA**	**-**	**-**	**-**
6.	**GHANA**	**50.90**	**62.10**	**34.10**
7.	**GUINEA**	**-**	**-**	**-**
8.	**GUNIEA BISSAU**	**-**	**-**	**-**
9.	**LIBERIA**	**-**	**-**	**-**
10.	**MALI (EX)**	**-**	**-**	**-**
11.	**NIGER (EX)**	**-**	**-**	**-**
12.	**NIGERIA**	**46.90**	**59.40**	**28.20**

13.	**SENEGAL**	**46.60**	**53.30**	**36.50**
14.	**SIERRA LEONE**	**-**	**-**	**-**
15.	**TOGO**	**-**	**-**	**-**

NOTES: (A) Ex represents exit membership

(B)ETI Global average score = 56.50

normalize indicator scores on a scale from O to 100 (with the highest global performance score of hundred). However, it is important to interpret national rankings within the context of each country's unique circumstances. As shown in the energy transition table, some West African countries are actively transitioning towards a more balanced energy system. Perhaps, this evolution is characterized by significant advancements in equity, security and sustainability factors. In fact, such progress may indicate a strategic shift towards a more secured energy landscape in those countries.

Indeed, to achieve an effective energy transition, nations must navigate a delicate balance across the equitable, secure and sustainable dimension. In fact, the imperative for achieving an equitable energy transition is rooted in the pivotal role of the energy sector in driving socio economic growth. Essentially, this involves affordable access to modern and clean forms of energy for all; supporting the continuity of economic development as well as ensuring that the benefits and opportunities of transitioning to a clean energy system are accessible to all or shared among all segments of the society. In other words, equity efforts aim to prevent historically marginalized communities from bearing a disproportionate burden of negative impacts. Again, the energy transition offers the potential to create new jobs and economic opportunities, improve livelihoods and empower individuals, communities and societies. Yet, if not managed properly, it can risk exacerbating costs and inequalities; impacting vulnerable populations. Therefore, advancing and equitable energy transition is critical in prompting policymakers to implement targeted programs. However, this transition will involve the collective efforts of multiple stakeholders which require strengthening and expanding various

measurement mechanisms. And by responsibly and sustainably adopting next-level technologies (Such as generative artificial intelligence); the energy industry can reinvent its very core as well as accelerating and de-risking the energy transition.

But specifically, West African region faces a significant equity challenge that requires urgent improvements in energy access, affordability and ensuring a fair energy transition. Here, despite low energy intensity, improving equity takes precedence over sustainability. Thus, decentralized renewable energy solutions (such as mini grids) can help eradicate energy poverty in West Africa by increasing energy access as well as establishing an electricity market. Again, these solutions can also improve supply reliability as well as reducing local pollution from diesel use. In other words, accelerating energy efficiency improvements can deliver significant amount of carbon dioxide emission reductions in a pathway aligned with reaching net zero emissions by 2050.

Indeed, the success of the energy transition (particularly in West African economies) depends on building a strong business case within the context of a well-established economic-case. In fact, achieving this requires coordinated effort across the entire value chain (with governments and business aligning their goals and working together). Specifically, governments should lead by defining and quantifying economic case and broader socio-economic benefits by making these visible and tangible to the public. Therefore, this foundation (supported by clear and effective policy measures) will enable companies to build a compelling business case that ensures profitability while advancing long-term energy transition plan. Similarly, businesses must actively engage with governments

through regular, structured dialogues, articulated policy questioning and incentives needed to unlock clean energy investments. Essentially, this collaboration will align public policy and private sector objectives by making clean energy projects more attractive to investors as well as allowing for more predictable returns on investment.

Strategically, governments can also support important projects though targeted interventions (such as investment incentives, risk mitigation mechanisms and strong regulatory frameworks) that build investor confidence. Therefore, striking the right balance between regulation and collaboration will help establish a common vision and allow for course connections as needed to sustain progress towards shared goals. Again, while collaboration and engagement are foundational; a stronger focus on innovation (in financing models, technology development, business strategies and policy frameworks) will be the key differentiating factor to break through traditional barriers and accelerate transitional progress across regions and sectors of West African Economies.

Operationally, critical mineral and their derived products are necessary for clean energy technology such as electric vehicles and solar panels. Notably, demand growth for these critical minerals continues to increase while some mineral may still face significant supply shortage. Therefore, securing the critical materials needed to enable the net-zero transition is fundamental to achieving the goals of the Paris agreement. Essentially, the balance between the supply and of critical materials involve managing supply chain disruptions, long lead times between exploration and production, complex orebodies, surges in commercial needs as well as the concentration

of supply in some geographies. Consequently, several global and local initiatives could be established to provide technical assistance, promote industry standardization and share knowledge through research and analysis. Here, necessary innovations in clued new and more efficient ways to produce and use critical minerals, which cloud help to make the energy system more secured, equitable and sustainable (as its decarbonizes). In other words, throughout the value chain, innovations could contribute to a just transition by improving critical minerals availability while reducing costs, increasing safety and minimizing environmental pressures (as shown in table 4.5). Yet, while there are barriers to incentivizing industry players and other key stakeholders to invest and innovate; targeted policy initiatives and collaboration could help overcome these obstacles and unlock critical minerals as shown in table 4.6. Notably, in recent times, West African governments have been taking steps to implement policies that accelerate energy efficiency progress. Specifically, the African Energy Commission and European Union are developing African Union Energy Efficiency strategy, with goals for the African continent (collectively). Basically, the strategy includes plans for each sector of the energy system as well as aims to increase energy productivity by 50% (by 2050) so as to ensure long-term developing of economic growth from energy consumption. Yet, for some millions of people in Africa (including ECOWA region), they still lack access to the essential opportunities electricity provides.

Consequently, the World Bank Group and African Development Bank are committed to delivering electricity to three hundred African by 2030 (which is an initiative called mission 300). Other key partners

TABLE 4.5 ENERGY TRANSITION: CRITICAL MINERAL VALUE CHAIN

S/N	INNOVATIONS	VALUE CHAINS	CHAIN ACTIVITIES
(A)	**SUPPLY-SIDE INNOVATIONS**	(AI) PRIMARY SUPPLY: EXPLORATION	IDENTIFY DEPOSITS MORE QUICKLY AND COST-EFFECTIVELY INCLUDING DEPOSITS WITH HIGHER-GRADE ONES AND IN-DEPTH DEPOSITS
		(AII) PRIMARY SUPPLY: MINING AND EXTRACTION	IMPROVE PRODUCTIVITY, REDUCE WASTE AND MINIMIZE NEGATIVE ENVIRONMENTAL IMPACTS
		(AIII) PRIMARY SUPPLY: PROCESSING	ADAPT, IMPROVE OR REPLACE EXITING PROCESSING METHODS AND IMPROVE EFFICIENCY
		(AIV)SECONDARY SUPPLY: RECOVERY	PRODUCE MINERALS FROM UNCONVENTIONAL SOURCES SUCH AS MINE TALLINGS
		(AV) SECONDARY SUPPLY: RECYCLING	REPROCESS PRE-CONSUMER AND END-OF-LIFE WASTE MORE EFFICIENTLY AND ACHIEVE BETTER METAL QULITY

(B)	**DEMAND-SIDE INNOVATIONS**	(BI)DEMAND: INTENSITY REDUCTION	MINIMIZE THE AMOUNT OF MATERIALS NEEDED TO PRODUCE CLEAN ENERGY TECHNOLOGIES.
		(BII) DEMAND: MATERIAL SUBSTITUTION	REPLACE CONSTRAINED CRITICAL MINERALS IN A TECHNOLOGY WITH MORE READY AVAILABLE INPUTS.
		(BIII) DEMAND: TECHNOLOGY SUBSTITUTION	REPLACE CLEAN ENERGY TECHNOLOGY THAT IS CONSTRAINED BY MINERALS WITH OTHER TECHNOLOGIES.
(C)	**CROSS-CUTTING INNOVATIONS**	(CI) OTHERS	INNOVATIONS TO REDUCE CARBON EMISSIONS OR IMPROVE VALUE CHAIN TRACEABILITY.

TABLE 4.6 ENERGY TRANSITION: BARRIERS AND UNLOCKS FOR CRITICAL MATERIALS

S/N	OPERATIONAL BARRIERS	UNLOCK ACTIVITIES
(1)	HIGH AND UNCERTAIN CAPITAL EXPENDITURES ESPECIALLY FOR EARLY STAGE MINING PROJECTS	FINANCIAL SUPPORT FOR NEW MINING PROJECTS AND MEASURES TO REDUCE CAPITAL EXPENDITURES
(2)	INSUFFICIENT BUSINESS CASE FOR RAPIDLY SCALING INNOVATIONS	FINANCIAL SUPPORT TO IMPROVE THE BUSINESS CASE FOR INNOVATION SCALE UP
(3)	FINANCIAL RISKS RELATED TO EARLY-STAGE INNOVATION	FINANCIAL SUPPORT FOR RESEARCH AND DEVELOPMENT
(4)	LONG PERMITTING TIMELINES FOR NEW MINE DEVELOPMENT	STREAMLINED PERMITTING TO FACILITATE MINE DEVELOPMENT
(5)	COUNTRY-LEVEL POLICY COMPLEXITY AND LACK OF STABILITY	POLICY STABILITY AND ENGAGEMENT WITH THE PRIVATE SECTOR TO REDUCE POLICY COMPLEXITY
(6)	COMMUNITY CONSIDERATIONS AND PERCEPTIONS OF THE MINING INDUSTRY	INFORMATION CAMPAIGNS AND INCLUSIVE STAKEHOLDER ENGAGEMENT PROCEDURES

(7)	LACK OF SUPPORTING INFRASTRUCTURE FOR MINERALS EXTRACTION	PROVISIONING SUPPORTING INFRASTRUCTURE IN AREAS CONDUCIVE TO EXTRACTION
(8)	LACK OF AVAILABLE SKILLED LABOUR FOR THE MINING SECTOR	SUPPORTING MINING EDUCATION TO BOOST AVAILABLE SKILLED LABOUR
(9)	INSUFFICIENT CLARITY IN DEMAND-SIDE SIGNALS TO INDUCE PRODUCTION AND INNOVATION IN PRODUCTION	COMMUNICATING CLEAR DEMAND-SIDE SIGNALS TO INDUCE PRODUCTION AND INNOVATION
(10)	INSUFFICIENT CLARITY ON PRIORITIZED INNOVATION NEEDS THROUGHOUT THE VALUE CHAIN	DEFINING INNOVATION PRIORITIES, INCLUDING BY ESTABLISHING ACCELERATOR PROGRAMMES
(11)	LACK OF STANDARDIZATION AND ENFORCEMENT ACROSS JURISDICTIONS	JOINT INITIATIVES WITH PUBLIC ENTITIES, VALUE CHAIN ACTORS AND OTHER STAKEHOLDERS TO CREATE HARMONIZED STANDARDS ACROSS JURISDICTIONS AND BOOST CAPACITY

(12)	RISKS IN THE EVOLVING EXTERNAL ENVIRONMENT RELATED TO TRADE AND THE AVAILABILITY OF SPECIALIZED KNOWLEDGE	INTERNATIONAL COLLABORATION TO ADDRESS RISKS IN THE EVOLVING EXTERNAL ENVIRONMENT
(13)	COMMERCIAL RISKS ASSOCIATED WITH SCALING AND DEPLOYING INNOVATORS	PUBLIC-PRIVATE PARTNERSHIPS AND INITIATIVES TO REDUCE COMMERCIAL RISKS IN SCALING AND DEPLOYING INNOVATIONS
(14)	LOW AVAILABILITY, TRANSPARENCY AND TRACEABILITY OF DATA TO AID UNDERSTANDING OF MINERAL FLOWS ACROSS THE VALUE CHAIN AND SUPPORT PRODUCTION AND INNOVATION SCALE-UP	STAKEHOLDER COLLABORATION TO INCREASE DATA AVAILABILITY, TRANSPARENCY AND TRACEABILITY ACROSS THE VALUE CHAIN

include Rockefeller Foundation, Global Energy Alliance for people and planet (GEAPP). Energy sector management Assistance Program (ESMAP), sustainable Energy Fund for Africa (SEFA) and sustainable Energy for All (SE for ALL). Essentially, their efforts focus on mobilizing public and private financing; building government capacity; engaging key stakeholder as well as streaming processes to drive progress. In fact, given its scale, Mission 300 is impact driven and provides broad partnership framework. And by focusing on both on-grid and off-grid solutions; the initiative aims to deliver electricity access to some of the most remote and vulnerable communities in African region. Operationally, the approach will involve expanding national electricity grids while deploying min-grids and standalone solar systems for regions grid expansion is not immediately feasible. For the sake of prioritizing reforms and actions, African governments are setting measurable targets in five areas:

(A) Expanding cost-effective power generation through competitive procurement of new generation assets as well as switching to lower-cost sources of supply;
(B) Boosting regional power integration through cross-border trade that shares the benefits of lower cost generation;
(C) Scaling up last-mile electrification with distributed renewable energy solutions as well as grid extension and densification;
(D) Unlocking private investment through supportive regulatory frameworks and
(E) Strengthening utilities with transparent financial management to achieve operational cost recovery.

Notably, the energy compacts are set targets to scale up electricity access through renewable energy, expand clean cooking solutions as well as strategies to boost regional integration and attract private sector investment. In other words, critical reforms will be needed to expand the share of renewable; improve utility performance utilities, ensure transparency in licensing and power purchase agreement as well as establishing predictable tariff regimes that reflect production costs. Financially, several global partners have pledged billions to boost energy access in African. Indeed, Mission 300 will combine increased infrastructure investment and comprehensive policy reforms across the entire electricity supply chain so as to transform lives and improve livelihoods and communities across the continent.

5.0. DECARBURIZATION PROCESSES

Clearly, the excessive accumulation of carbon dioxide in the atmosphere is one of the primary contributors to climate change which poses significant threat to ecosystems and earth's biological balance. In fact, as the global need to reduce carbon foot prints intensifies; the development and adoption of carbon capture technologies have become essential for promoting environmental sustainability. Technically, carbon capture and storage or carbon sequestration is the process of trapping carbon emissions produced by fossil fuel power plants or other industrial processes before entering our atmosphere by storing them deep underground. In other words, as a process to capture and store carbon emissions from the atmosphere or industrial emissions; it helps to mitigate climate change by reducing greenhouse gases. However, carbon capture should not be seen as an alternative to green energy transition. Rather, it can be proposed as a way to tackle emissions from sectors that are difficult to decarbonize. Operationally, carbon dioxide can be removed from the atmosphere or industrial sources through the following methods:

(A) DIRECT CAPTURE which involves extracting carbon dioxides directly from air and

(B) INDIRECT CAPTURE which focuses on capturing emissions at their source before reaching the atmosphere.

In fact, the above strategies are integral to global efforts aimed at reducing greenhouse gas concentrations and mitigating climate change impacts. However, carbon capture

technologies are generally classified into three main types as follows:-

(I) PRE-COMBUSTION CAPTURE PROCESS where fossil fuels are converted into a mixture of hydrogen and carbon dioxide before combustion thereby enabling efficient carbon dioxide separation.

(II) POST COMBUSTION CAPTURE which is widely used technique to capture carbon dioxides from exhaust gases generated by fossil fuel combustion and thus making it a viable solution for integration with existing infrastructure

(III) Oxy-fuel combustion capture which involves burning fuel in an oxygen-rich environment instead of air and thereby producing an exhaust stream primarily composes of carbon dioxide and water vapor (which facilitates easier separation and capture).

Essentially, these technologies serve as a cornerstone in the pursuit of carbon neutrality and the reduction of environmental impacts caused by industrial activities. Surely, continues advancements in these technologies (Coupled with supportive policies and strategic investments) will play a crucial role in accelerating the transition toward a more sustainable (Carbon-free) future. Specifically, table 5 (shows the tabular representation that illustrates these technologies and their various applications. Similarly, carbon removal is the process of removing greenhouse gas emissions from the atmosphere through natural solutions such as reforestation and soil

TABLE 5.1 CAPTURE TECHNOLOGIES: CARBON DIOXIDES EMISSION

S/N	INDIRECT CAPTURES	DIRECT CAPTURE: POINT SOURCES	DIRECT CAPTURE: AIR	DIRECT CAPTURE: POST COMBUSTION
(I)	CARBON CAPTURE AND UTILIZATION	(AI)PRE-COMBUSTION CAPTURES	(BI)AIR CAPTURES	(CI)ABSORPTION
		(A2) OXY-FUEL COMBUSTION CAPTURES		(CIA)CHEMICAL ABSORPTION
				(CIB)PHYSICAL ABSORPTION
(II)	BIO ENERGY WITH CARBON CAPTURE			(C2)CRYOGENICS
(III)	OCEAN-BASED CAPTURE			(3)MICROBIAL OR ALGAL SYSTEM
(IV)	Natural-based capture			(C4) MEMBRANE PROCESS

management or technological solutions like enhanced mineralization. In other words, as the climate crisis intensifies, innovative carbon dioxide removal solutions are emerging as presented below:

A. Resorting wetlands and peat lands can absorb and store significant amount of carbon dioxides as well as boosting biodiversity and reducing flood risks.
B. Improving land management practices can enhance carbon dioxides uptake in soils. In other words, agro forestry which integrates tress into agricultural landscapes offers a dual benefit of carbon sequestration and increased agricultural productivity.
C. Reforestation and a forestation involve planting trees on deforested or never-forested land. Even though there methods increase biodiversity and ecosystem resilience, they may require careful planning to avoid monoculture risks.
D. Blue carbon management focuses on enhancing carbon uptake in ocean and costal ecosystems like mangroves and seagresses. Here, the ecosystems not only store carbon but also improve marine biodiversity and coastal resilience.
E. Biochar and bio-oil (produced from bio mass) can improve soil quality and store carbon
F. As a storage technique, soil amendments can enhance soil to absorb and store carbon dioxides.
G. As an artificial injection, carbon dioxides can be injected into depleted oil and gas reservoirs, deep aquifers and coalmines.

H. As innovative solution, for ponds with bacteria, microorganism naturally capture and store carbon dioxides.

Indeed, as clearly shown above, carbon sequestration reduces carbon footprint; enhances soil health and productivity; and mitigates climate risks by stabilizing atmospheric carbon dioxide levels. Consequently, as central to the Pairs agreement, Nationally Determined Contributions (NDG) embodies each country's commitment to reducing national emissions and adapting to climate change. Basically, NDCs serve as countries self-defined pledges to reducing greenhouse gas (GHG) emissions while aligning with the global goal of limiting temperature rise to 1.5^{o}C (UNIDO, 2025). In other words, they are climate action plans submitted by countries under the Paris agreement. Here, each country sets its own targets based on its unique capacities, circumstances and goals. Specifically, every five years, member countries are expected to update and enhance NDCs as appropriate. Typically, NDCs include mitigation (reducing emissions), adaptation (resilience strategies) as well as financial needs (climate action funding). However, article thirteen of the Paris agreement establishes the enhanced transparency framework (ETF) to build trust and confidence that all countries are contributing their share to the global effort. Using this framework, all parties are requires to report on several information elements (including data to track progress in implementing and achieving their NDCs).

Operationally, the industrial sector is defined as those economic activities related to the production and processing of intermediate and final goods. And during these industrial processes, emissions can occur at various stages which make it important to account for them using detailed definitions and principles (as provided in the 2006 intergovernmental panel on climate change (IPCC) Guidelines for National Greenhouse Gas (GHG). Inventories practically, the industrial sector includes all emissions occurring from industrial processes; from the use of greenhouse gases in products as well as from non-energy use of fossil fuel carbon. Specifically, these include fuel combustion for the manufacturing of goods as well as the use and processing of products (inclusive of chemicals in industrial processes and related emissions). Then, as stipulated in the IPCC guidelines, countries are required to account for GHG emissions and removals within the national territory as well as their offshore areas with jurisdiction. And using IPCC guidelines, the industrial sector covers emissions and activates categorized under the following GHG inventory sectors: Manufacturing industries and construction, mineral industry, chemical industry, metal industry, non-energy products from fuels and solvent use, electronics industry as well as toner product manufacture and use. Therefore, to ensure a systematic process, member counties should establish as structured approach to plan, implement and track industrial decarburization. Here, these approaches or systems are usually referred to as MRSV (Mentioning reporting and Verification) systems. Clearly, reporting and verification play a critical role in promoting transparency, ensuring good

governance, enhancing accountability as well as establishing the credibility of result while building confidence that resources are being used efficiently and effectively. Therefore, as a starting point, countries should evaluate their existing approaches by considering the questions shown in table 5.1. But for those without established systems, the same questions can serve as a foundation for developing MRV arrangements. Furthermore, industrial statistics are also critical for understanding the emissions profile of a country's industrial sector (which often represents a significant portion of total GHG emissions). Therefore frameworks like the International Recommendations for industrial statistics (IRIS) should guide the collection of industrial data which is essential for the understanding of inter-sectoral linkages. But given the industrial sectors dependence on energy, the integration of energy and industrial statistics is key to developing strategies of decarburization. In order words, national statistics will serve as a key data sources for GHG inventories. Yet, one of the primary ways to enhance industry target within NDCs is by broadening the scope to encompass comprehensive range of industrial activities as well as all relevant greenhouse gases. Critically expanding the scope involves considering emissions across diverse industrial sub-sectors (such as manufacturing, cement, steel and chemicals) and accounting for various greenhouse gases inducing methane, nitrous oxide and other industry related emissions (in addition to carbon dioxide). Therefore, member countries can ensure that their NDC targets reflect the full extent of industrial emissions by creating a more inclusive and accurate picture of their

TABLE 5.1 ESTABLISHING MRV SYSTEM: KEY QUESTIONS

S/N	QUESTION TYPES
1.	WHAT TYPE OF INFORMATION AND DATA SHOULD BE COLLECTED?
2.	THROUGH WHAT PROCESSES SHOULD INFORMATION AND DATA BE COLLECTED?
3.	HOW OFTEN SHOULD INFORMATION AND DATA BE COLLECTED?
4.	WHO IS RESPONSIBLE FOR COLLECTING AND PROCESSING INFORMATION AND DATA?
5.	WHO COMMUNICATES THE INFORMATION AND WHAT INFORMATION AND HOW AND TO WHOM AND WHEN?
6.	HOW IS QUALITY CONTROLLED AND ASSURED?
7.	WHO COORDINATES AND MANAGES MRV ACTIVE
8.	HOW CAN THE QUALITY OF INFORMATION PRODUCED AND MRV PROCEDURES BE IMPROVED OVER TIME?
9.	HOW CAN THE MRV SYSTEM BE FORMALIZED?

NOTE: MRV represents monitoring reporting and verifications

decarbonization efforts. Then the ultimate progression within this enhancement area will be the adoption of the economy-wide emission reduction targets. That is, moving from industry specific targets to economy-wide commitments signifies a high-level of ambition which reflects as holistic approach to emissions reduction. In fact, economy-wide targets integrate emissions reductions across all major sectors (such as industry, energy, transport, agriculture and waste) fostering cross-sectoral coordination that maximizes national climate impact. Thus, in general, country practitioners can identify the enhancement areas that best align with their national context; adopt a systematic approach to inform the NDC enhance process and facilitate the effective implementation of NDC commitments as shown in table 5.2 (UNIDO, 2025).

BUILDING DECARBONIZATION: Indisputably, buildings are among the largest contributors to greenhouse gas emissions and accounts for significant percentage of energy-related carbon dioxide emissions. Clearly, these reflect emissions from operational use as well as emission related to energy to energy use in the construction of buildings including significant indirect emissions related to the upstream production of construction materials. Notably, these non-operational emissions (including those related to demolition) are collectively relented to as Embodied carbon or Embodied Emissions which are projected to account for half of the carbon footprint of new buildings (OECD, 2025). However, operational carbon (emissions related to the use phase of a building such as heating, cooling and powering) has traditionally been the

TABLE 5.2 NDC ENHANCEMENTS: FRAMEWORK STEPS

PREPARATION	ENHANCEMENT	VALIDATION	IMPLEMENTATION
STEP 1 INDUSTRIAL CARBONIZATION COUNTRY ASSESSMENT	**STEP III** STRENGTHENING INSTITUTIONAL MECHANISMS FOR DESIGN, IMPLEMENTATION AND TRACKING	**STEP 6** CONSULTATION AND VALIDATION	COUNTRY IMPLEMENTATION APPROACH
STEP II NDC WORKPLAN FOR INDUSTRIAL DECARBONIZATION	**STEP IV** IMPROVING DATA ACCURACY AND CONSISTENCY		
	STEP 5 INCREASING THE AMBITION OF TARGETS		

focus of decarbonization efforts. Yet, decarburizing the urban built environment is a complex task that involves many different stakeholders and interests across multiple levels. Structurally, buildings are inherently local infrastructure subject to different climate zones historical contexts and social conditions. Therefore, decarbonization solutions should be tailored to local needs. Geographically, there are varying decarburization needs of existing buildings with respect to energy use between rural and urban areas in a given locality. Technically, decarburizing buildings requires global co-ordination of efforts and innovation in terms of materials, design and energy use.

And by sharing research, technology and strategies that have proven effective; West African countries can avoid duplication of efforts, and speed up the adoption of sustainable practices as well as making more efficient use of resources. Again, it is essential to implement circularity principles in the built environment so as to reduce embodied carbon and by embracing a circular approach, entails maximizing resources utilization and minimizing waste across a building's entire lifespan. In other words, a circular economy approach entails both the construction stage (by utilizing recycled materials) and the demolition stage by salvaging materials that can be used in the future). However, building information modeling (BIM) is a digital technology that creates detailed 3D representations of buildings; enhancing the construction, maintenance and management phases of building life-cycles. Essentially, these software tools enable precise architectural design, simulations and evaluations; optimizing both designs

and construction processes. In fact, as a tool for initial planning, BIM plays a crucial role in addressing sustainability challenges in the construction industry. Again, training and education for both industry stakeholders and regulatory authorities are crucial for building the capacity needed to effectively implement whole life-cycle carbon regulations for buildings. GHG REMOVAL ROADMAP: Generally, we can classify carbon offsets into fire distinct categories that are based on whether they reduce or remove carbon as well as how securely the carbon is stored. These include the following:-

i. Avoided Emission Reduction without storage (Renewable energy replacing coal and no long term storage).
ii. Emissions Reduction with short lived storage (Preserving carbon in biomasso or soil and cost effective but carbon can de re-release overtime).
iii. Emission Reduction with long-lived storage (captured carbon from industrial processes and stored underground which is more permanent but needs advanced tech.)
iv. Carbon Removal with short-lived storage (Nature-based solutions like reforestation which is affordable with ecological upsides but at higher risk from wild fires or land use changes).
v. Carbon Removal with long-lived storage (where direct air capture locked into geology or mineralized rock which is the most secure and often the priciest).

Consequently, the above classification implies that African buyers and policy makers should gauge credibility,

permanence and additionality. However, to mitigate global warming and the resulting impacts; the world has mobilized various efforts to reduce GHG emissions. These include fossil fuel phase-out, deployment of renewable energy generation; reducing emissions from agriculture and food; reducing deforestation; electrification of energy and uses; increases in energy efficiency as well as decarburization of industries. Essentially these efforts must remain the top priority for achieving long-term climate goals and achieving them will be possible only if there is a significant and rapid reduction of emissions. Yet, reductions of emissions will not produce residual emissions that will be difficult or expensive to abate; and these abatement activities might not be completed as quickly as needed. In fact, the air and oceans are already filled with excess legacy emissions that will continue to drive warming (even if the future emissions are eliminated). Therefore, it will be necessary to ultimately remove greenhouse gas emissions (GHG) from the atmosphere at scale with approaches that are collectively referred to as GHG removal (GHGR). Here, the full list of technological GHGR approaches considered are grouped into four CDR technology area (CDR using air, ocean, land and rock methods) as well as fifth category for non-carbon dioxide GHGR (Kahsar, et al. 2024). These approaches are defined as follows:-

A. **AIR-CDR** includes all technological CDR approaches that directly extract carbon dioxides from the atmosphere using a machine-based filtering process and then concentrate that carbon dioxide to be stored.

B. **OCEAN – CDR** includes all technological CDR approaches that take place in aquatic environments. Specifically, it includes open system approaches such as growing microalgae or cultivating microalgae in open water and sinking it by alkaline materials to water to reduce acidity and increase ocean capacity for carbon dioxide absorption from the atmosphere as well as approaches that use electricity to remove carbon dioxide directly from water in conjunction with waste water treatment or desalination facilities.

C. **LAND-CDR** includes technological CDR approaches that remove carbon dioxides through photosynthetic biomass into more stable forms such as bio-oil, biochar or biomass construction materials as well as activates that convert photosynthetic biomass into carbon dioxides and then store that carbon dioxides (and bio-energy) with carbon capture and sequestration. Also inclusive are activities such as synthetic biology that enhance the plants themselves by making them grow faster, store more carbon, resist pests and pathogens and exhibit increased durability.

D. **ROCK-CDR** includes all technological CDR approaches that remove carbon dioxides from the atmosphere by reacting it with alkaline minerals. Typically, these approaches seek to accelerated naturally occurring reactions of certain types of rock (such as basalt or other alkaline materials) to form either solid carbonate minerals or dissolved bicarbonates.

E. Non-Carbon Dioxide (GHGR) describes the atmospheric removal of methane and nitrous oxide.

Indeed, the major determinant of the scope of GHER in the proposed road map is in the types of GHGs that are considered for removal clearly, the IPCC (2022) includes several categories of greenhouse gases that are reported under the common reporting format of the United Nations framework convention on climate change (UNFCCC). Environmentally, most of these gases are present only in small concentrations in the atmosphere, even though with high warming potentials. Specifically, methane and nitrous oxide are those non-carbon dioxide gases with the most significant combination of warming potentials and atmospheric concentrations. In other words, because their contribution to global warming is significant and growing; it may be desirable to remove them (if possible). Therefore, the proposed road map of emissions reduction includes methane and nitrous oxides removal and combines them in a category called non-carbon dioxide (GHGR) removal. Operationally, this roadmap is a tool for aligning actions and investments across sectors and stakeholders. Then, to accomplish something of this magnitude will require buy-in, commitments and execution from actors across GHGR ecosystem. Essentially, this includes government actors at all levels, funder, GHGR communities, industry, researchers, journalists and media as well as non-profits and civil society organizations.

As clearly shown in table 5.3, the proposed roadmap is global and inclusive of a broad range of stakeholders and actions required (Kahsar, et al, 2024). Furthermore, it includes socio-behavioral and communities, finance and

markets, policy and regulation as well as science and technical areas. In addition to carbon dioxide removal, it also includes methane and nitrous oxide removal. While focusing on technological (rather than nature based) GHGR; it excludes approaches that reduce emissions and sets a specific goal for CDR in 2050. Critically, these goals are established as follows:

GOAL I: To grow carbon dioxide removal to 10 GTCO2 per year of durable technological removals in 2050.

GOAL II: To advance the science of non-carbon dioxide removal such that decisions can be made by the early 2030s about future development and deployment.

Surely, the above goals will represent one of the most ambitious technological scaling taken on by humanity. And given the anticipated challenges, work towards these goals is critically urgent and must begin soonest. However, it will require a step change in the speed and scale of technological advancement as well as focused, coordinated efforts by stakeholders across thematic areas (such as science and technology, socio-behavioral and communities, finance and markets as well as policy and regulation). Therefore, the ECOWAS region must respond immediately for the sake of climate resilience and sustainable future. Yet, such an ambitious (global) undertaking cannot be achieved unilaterally. In fact, coordination and collaboration will be critical. In other words, all GHGR stakeholders should pursue communication coordination and cooperation across initiatives and interdependencies. And since the impacts of global warming has become increasingly evident; these goals are what is needed to ensure that sufficient GHGR is available to serve its essential role in the portfolio of climate solutions.

TABLE 5.3 TECHNOLOGICAL GHGS REMOVAL SCALING ROAD MAP INITIATIVES

S/N	CATEGORIES	EMERGENCE (2024-2030)	ADOPTION (2031-2040)	EXPANSION (2041-205)
1.	RESEARCH AND DEVELOPMENT	TECHNOLOGY SEARCH INCUBATION AND TESTING	TECHNOLOGY ADOPTION AND PRIORITIZATION	TECHNOLOGY SCALING
2.	DEPLOYMENT	SUCCESSFUL DEMONSTRATIONS AND FIRST PROJECTS	COMMERCIAL DEPLOYMENT	GLOBAL IMPLEMENTATION
3.	COMMUNITY ENGAGEMENT	FRAMEWORKS FOR COMMUNITY DESIGN	COMMUNITY PLAY BOOKS BASED ON SUCCESSFUL DEPLOYMENT	JUST DEPLOYMENTS IN NEW COMMUNITIES
4.	SOCIAL SCIENCE	COMMUNITY CONCERNS, TRUST AND CONTEXT	ENGAGEMENT PRACTICES SHAPED BY RESEARCH	-

5.	PUBLIC ENGAGEMENT	EVIDENCE BASED JOURNALISM	LOCAL COALITION BUILDING	GLOBAL COALITION BUILDING
6.	WORK FORCE	APPROACH-SPECIFIC TRAINING	EXPANDED WORKFORCE DEVELOPMENT	WORKFORCE SCALING
7.	INFRASTRUCTURE	STRATEGIC SITTING	REGIONAL BACKBONE INFRASTRUCTURE	UPDATING INFRASTRUCTURE
8.	PERMITTING	ESTABLISHED AND CLEAR PERMITTING STRUCTURES	AGILE AND CLEAR PERMITTING STRUCTURES	-
9.	FINANCING	GOVERNMENT BACKED CAPEX FINANCING	COMMERCIAL CAPEX FINANCING AT SCALE	COMPETITIVE GLOBAL MARKET FOR CAPEX FINANCING

10.	STANDARD SETTING	REGULATORY STANDARDS FOR SAFETY AND MRV	GLOBAL MRV ESTABLISHED	-
11.	MARKET INFRASTRUCTURE	MARKET INFRASTRUCTURE DEVELOPMENT	CERTIFIED MARKETS FOR GHGR	-
12.	DEMAND	VOLUNTARY PURCHASES AND FRAMEWORKS FOR PROCUREMENT	PUBLICLY MANDATED PROCUREMENT	INTERNATIONAL STANDARDS, MARKETS AND PROCUREMENT
13.	FIELD BUILDING	CONTINUED FIELD BUILDING FOR GHGR INCLUDING CONVENING, WORKING GROUPS, COMMUNITIES OF PRACTICE AND REGULAR EFFORTS TO UPDATE THE GOALS OF THE FILED		

NOTE: MRV represents monitoring, reporting and verifications
GHG represents greenhouse gases
GHGR represents GHG removal.

6.0. CLIMATE FINANCE AND MARKET OPERATIONS

Structurally, finance and markets involve the economic and commercial aspects of greenhouse gases reductions and removals (GHGR) development and deployment. Operationally, these include the creation, development and scaling of GHGR market infrastructure as well as the creation and scaling of GHGR demand through voluntary markets, compliance markets, public procurement and other mechanisms for in incentivizing, mandating or directly deploying greenhouse gases removal. On the other hand, they also include public and private financing for GHGR projects; funding for the build-out of critical infrastructure; development of traceable global supply chains as well as initiatives designed to support effective MRV (Monitoring, reporting and verification) upon which much of the GHGR ecosystems relies. However, for the sake of clear distinctions and practical understanding, this section is subdivided into two parts: Carbon market operations and climate finance operations.

CARBON MARKET OPERATIONS: Basically, carbon markets are trading systems in which carbon credits are bought and sold. And by selling carbon credits, entities developing activities that remove, reduce or avoid greenhouse gases (GHG) emissions generate an additional revenue stream which improves the overall commercial viability and financial sustainability of their projects. Here, these entities can be private project developers, companies, non-government organizations, governments and other actors. As an important vehicle to support climate action, carbon markets function as a source of

non-debt (result-based) financing that does not require prior assets or collateral and potentially enabling enterprises that struggle to access other sources of climate finance to grow. In other words, it has the potential to attract commercial and concessional capital and thereby making carbon markets a financial tool that can expand the pool of funding available for climate activities. Historically, these activities have relied on public and philanthropic funding.

Essentially, by providing companies and their customers a financial compensation (to move away from environmentally unsustainable activities or to engage in more sustainable activities) carbon markets offer financial incentive to advance climate action. However, carbon credits are instruments that provide the right to emit carbon while ensuring overall emission reduction. In other words, a carbon credit represents one metric ton of carbon dioxide or its equivalent that was avoided, reduced or removed from the atmosphere. Essentially, the projects that generate carbon credits include the following:

(A) PLANT TREES (SUCH AS MANGROVES) which involves reforestation or afforestation projects. Here new trees are planted to absorb carbon dioxide from the atmosphere and these projects can generate carbon credits by quantifying the amount of carbon sequestered as the trees grow.

(B) PRESERVE SEAGRASS which involves protecting and restoring coastal ecosystems that can sequester significant amount of carbon. Ecologically, our seas are natural carbon sinks.

(C) CONVERT AGRICULTURAL WASTE INTO CARBON STORAGE which involves turning crop residues into biochar or long lasting products. Here, credits reflect carbon dioxides kept out of the atmosphere by preventing decomposition emissions (as certified via pryrolysis yield calculations)

(D) GENERATE RENEWABLE ENERGY which involves generating renewable energy (solar, wind) to replace fossil fuel power. Essentially renewable energy projects can earn carbon credits by displacing green-house gas emissions from fossil fuel power plants. Numerically, these credits are calculated based on the amount of clean energy produced and emissions avoided.

(E) SEQUESTER CARBON DIOXIDE THROUGH DIRECT AIR CAPTURE which involves machine chemically extracting carbon dioxide from the air and storing it underground.

(F) SEQUESTER CARBON DIOXIDE THROUGH REGENERATIVE AGRICULTURE practices that enhance soil carbon storage. Here, farming practices (such as no-till, cover crops) boost soil carbon storage. Here, credits are based on soil carbon increases measured via sampling or remote sensing.

(G) REPLACE WOOD – BURNING STOVES TO EFFICIENT STOVES which involves replacing wood or charcoal stoves with cleaner-burning alternatives. Here, credits are based on reduced wood consumption (avoided deforestation) and lower carbon dioxide emissions.

(H) PROTECT TREES which involves conserving forests at risk of deforestation, Here, credits equal the carbon dioxide emissions prevented and calculated using historical deforestation rates and satellite monitoring

(I) CAPTURE METHANE which involves trapping methane from landfills, forms or mines before entering atmosphere. Here, credits are earned by destroying methane via combustion or anaerobic digestion tracked through gas flow meters.

(J) BUILD ELECTRIC VEHICLE INFRASTRUCTURE which involves installing charging stations to enable fossil fuel free transport and manufacturing electric vehicles (EVs). Here credits correlate with miles driven by EVs using regional emission factors and charging data.

Indeed, harnessing the potential of carbon credits and understanding their types will empower us to navigate the realm of carbon markets and contribute to a more sustainable future. In other words, embracing the power of carbon credits offers diverse pathways for businesses to actively participate in the fight against climate change. Therefore, by incorporating carbon credits into the sustainability strategy, we can effectively manage and mitigate organizations footprint. That is, the use of carbon credits demonstrates environmental responsibility; attracts likeminded partners and customers as well as strengthening brand's reputation as a leader in sustainability. Comparatively, three types of carbon credits can be distinguished.

I. REDUCTION CREDITS which are generated through projects that actively reduce greenhouse gas emissions. Here, these initiatives focus on implementing innovative technologies, Optimizing processes or adopting cleaner energy sources to minimize carbon footprints. In fact, by supporting reduction projects, businesses can demonstrate their commitment to sustainability while taking immediate action to mitigate climate change. In other words, reduction credits enable organizations to offset a portion of their emissions while making a tangible and measurable impact on their environmental performance. Typical examples include regulatory carbon Emissions Allowance and Energy efficiency.

II. REMOVAL CREDITS also known as carbon dioxide from the atmosphere or prevent its release into the environment. Basically, these projects involve activities such as reforestation, afforestation or sustainable land management surely, by investing in removal projects, companies can actively contribute to the long term removal of carbon dioxide from the atmosphere and thereby helping to combat climate change. Again, helping to combat climate change. Again. Removal credits offer a unique opportunity to restore ecosystems. Enhance biodiversity and create lasting positive impacts on the planet. Typical examples include carbon

capture, utilization and storage, direct Air capture and afforestation.

III. PROTECTION CREDITS are generated through projects that preserve and protect existing natural ecosystems (such as forests, wet lands, or grass lands). Ecologically, these initiatives focus on preventing deforestation, habitat destruction and degradation of natural resources. In fact, by supporting protection projects, organizations play a crucial role in safe guarding biodiversity; enhancing ecosystem services as well as preventing the release of stored carbon into the atmosphere. Therefore, protection credits not only mitigate climate change but also contribute to the preservation of our planet's invaluable natural heritage. Again, typical examples include reforestation and ocean conservation.

Operationally, the supply of carbon credits is represented by the issuances from carbon crediting mechanisms and including the following:-

1. Those established in international crediting mechanisms or established under international treaties (such as Kyoto Protocol and Paris Agreement);
2. Domestic crediting mechanisms established by regional, national or subnational governments;
3. And independent crediting mechanisms or standards that are managed by non-governmental entities such as gold standard.

On the other hand, there are various sources of demand which includes the following:

(A) Voluntary demand (mostly from private entities purchasing emission reduction to meet voluntary targets (such as net zero);

(B) Domestic compliance demand for companies seeking credits to meet their obligations under a domestic scheme (such as emissions trading scheme or carbon tax);

(C) International Compliance demand inclusive of countries purchasing emission reductions to meet their mitigation targets under the Paris Agreement an Art lines purchasing credits eligible for meeting their obligations under the carbon off setting and reduction scheme for international aviation; and

(D) Result based climate finance where governments or international organizations incentivize climate action by purchasing carbon credits.

Fundamentally, carbon market will continue to play a central role in reducing global emissions and are used by most businesses to go beyond on-going efforts to decarbonize. Technically, there are key differences between the various types of carbon markets as distinguish and distinguished below.

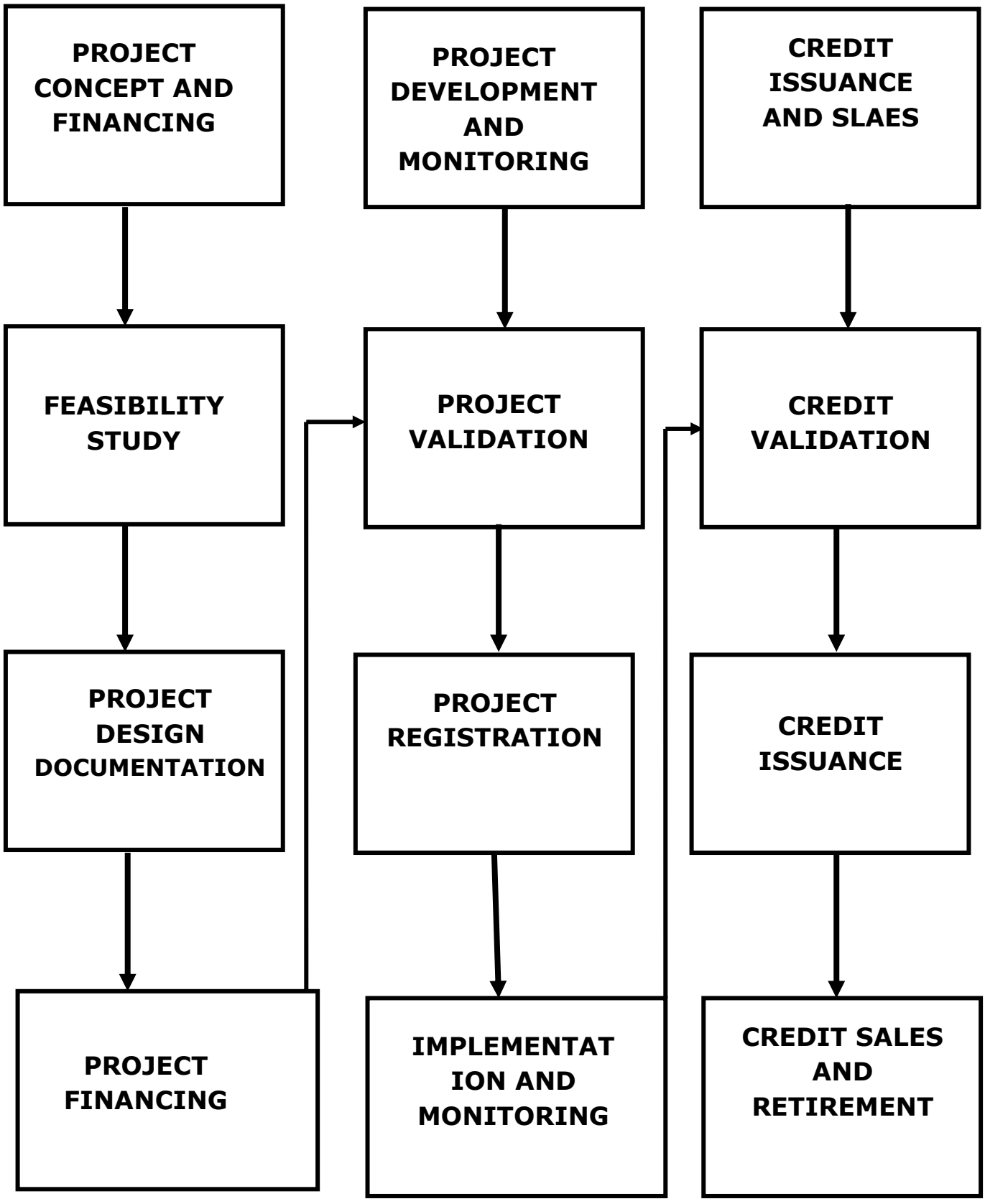
(I) Voluntary Carbon Markets (VCM) allows carbon emitters to purchase carbon credits voluntarily to offset their emissions. In other words, individuals and companies voluntarily choose to purchase carbon credits that

finance projects which avoid or sequester emissions such as nature-based solutions, clean cook stoves or renewable energies. That is, as fragmented markets, private corporations, individuals and other actor's issue, buy and sell carbon credits. Formally, VCM serves as a platform for trading carbon credits outside of regulated or mandatory carbon pricing instruments. Specifically, participants in the market use it to finance activities aimed at mitigating greenhouse gas (GHG) emissions across productive sectors such as industry, transportation, energy, built environment, agriculture, forestry, etc. Technically, in the voluntary markets, a project developer sets up a project that avoids certain emissions or remove carbon dioxide from the atmosphere, subsequently, the projects are validated by an independent validation (verification) body to meet a set of requirements provided by a standard shelter. And once certified carbon credits are issued to the project (in a quantity that is equivalent to the mitigation impact achieved. Then, the developer sells the carbon credits to companies, governments and individuals. However, these carbon credits can be traded multiple times on secondary markets (via intermediaries or agents). Essentially, a credit exists until it is retired and this retirement occurs when an organization uses the carbon credit towards its climate targets or claiming the climate impact towards its goals therefore, at high level, carbon projects can go through four phases: Feasibility, project Design Document, implementation and operations. However, as

clearly shown is figure 6.1, the life cycle of carbon projects follow three key fundamental stages. These include project conceptualization and financing; project development and monitoring as well as credit issuance and sales (World Bank, 2024). Yet financing for carbon projects are made up of a varied ecosystem of capital providers; ranging from equity investments to pre-purchases off take agreements and completely concessional to commercial return expectations. In other words, carbon finance is the collection of investment mechanisms available to fund carbon projects which commonly refers to the use of capital committed or provided up front by a carbon credit buyer (or off taker) in return for carbon credits. Indeed, carbon finance has the potential to help fill the financing gap that philanthropic and traditional forms of capital cannot do it on its own. In fact, carbon projects long pay back periods (less certain cash flows given varying carbon price projections and project execution complexity) are cases of why carbon projects may not match the expected returns and typical terms of traditional investors (such as banks and private equity funds). In contrast, carbon finance is driven by a new source of capital. That is, the budgets associated with corporate and government commitments to offset greenhouse gas emission

(II) Compliance Carbon Markets (CCM): These are markets which limit the purchase of carbon credits and have jurisdictional restrictions. Basically, it regulates carbon

FIGURE 6.1 CARBON PROJECT: LIFE CYCLE EVOLUTION



reduction emissions by imposing legal binding emissions reduction targets on companies. In fact, these can be created at the industry level in which a governing industry body implements a framework for its member's organizations to reduce emissions. In other words, it involves government regulations that require certain industries to limit their carbon emissions through financial incentive. Formally, these can take the form of a tax or an emissions trading system. Consequently, companies can trade emissions credits to comply with those regulations. Although compliance carbon markets are the largest type of carbon markets; they primarily exist in developed economies and allow very limited use of carbon credits to offset emissions. However, when they allow participants to use carbon credits; they have strict eligibility criteria that restrict geography of origin and project type. Therefore, this makes the compliance markets a limited opportunity for developing economies such as Africa

(III) INTERNATIONAL TRADING OF CARBON CREDITS THROUGH ARTICLES 6 (ITC): Technically, Article 6 of the Paris agreement provides a mechanism for the trading of emissions reductions between countries.

In fact, once traded, the reductions are known as 'internationally traded migration outcomes (ITMOs). That is, countries that are not able to economically meet their nationally Determined Contribution (NDCs) can opt to purchase emissions reductions from other countries that have

a lower marginal cost of abatement. In other words, nations sign bilateral agreements under Article 6 of the Paris climate agreement to trade carbon credits; and the acquiring country can use the credits towards their climate targets as stipulated in NDCs. Notably, Article 6 of the Paris Agreement includes two market based mechanisms for the international trade of carbon credits to support countries in achieving their NDCs. These frameworks are Article 6.2 and Article 6.4. Again, Article 6 creates a frame work that allows countries to deploy capital or require companies to deploy capital into carbon credit purchase (which can increase the amount of capital available to carbon projects). However, for the applications of Article 6 and corresponding adjustments, countries are still in their various stages of developing regulatory frameworks. Consequently, carbon project developers need to follow the evaluation of local frameworks in the project's host country closely. Clearly, Article 6 stipulates that once a credit is sold, the host country of the project must take a corresponding Adjustment to ensure that the country is not double counting that credit by counting it toward their own nationally determined contributions (United Nations, 2016; World Bank, 2024; ACMI, 2024).

INTEGRITY INITIATIVES AND SOLUTION PLATFORMS: Generally, high quality carbon credits have the potential to significantly enhance climate action and bridge the gap between existing commitments and the much needed decarburization processes. In contrast, the effectiveness of climate action is compromised if carbon credits are of low environment and social integrity. Therefore, it is critical to

provide reliable and practical advice to assist purchasers in an ever more complex carbon markets. Essentially, such guidance will empower buyers to differentiate between high-quality and low quality credits. Notably, there are different tools and initiatives available that can provide an assessment of carbon credits. These include the following:-

(1) CARBON CREDIT QUALITY INITIATIVE (CCQI) which is an online scoring tools to assess different types of carbon credits
(2) VOLUNTARY CARBON MARKETS INTEGRITY INITIATIVE (VCMI) which deals on how companies can make voluntary use of carbon credits as part of credible, science aligned net zero decarbonization pathways.
(3) INTEGRITY COUNCIL FOR THE VOLUNTARY CARBON MARKET (ICVCM) which seeks to create a benchmark to raise the quality of carbon credits that channel finance towards real and additional greenhouse gas reductions and removals.
(4) PUBLIC ACTORS (Such as governments and regulatory bodies enforce regulations to govern carbon markets.
(5) LEGISLATIVE ACTIONS AND DIRECTIVES (such as EU green claims directive) seeks to protect consumers from green washing
(6) MARKETING AND ADVERTISING AGENCIES also take steps to provide guidance to monitor carbon neutral or net zero claims being made.

However, several digital solution tools for the carbon market operations exist as listed below:-

(A) PACHAMA (FORESTS)/SYCLVERA (REDD+) ensures carbon projects deliver verified emissions reductions. Using artificial intelligence, it is possible to process vast satellite/internet of thing data faster than humans while detecting subtle environmental changes. Their impact includes increased trust and reduced verification errors.

(B) IBM BLOCK CHAIN/ CLIMATE TRADE'S AUDIT ALGORITHMS prevent fake credits and double counting through pattern recognition. Using artificial intelligence, it is possible to identify complex transactional anomalies invisible to manual audits. Their impact includes blocking of several suspicious trades.

(C) XPANSIV GBL/AIR CARBON EXCHANGE ensures fair pricing reflecting real time risks and demand. Using artificial intelligence, it is possible to analyze thousand variables (such as weather and regulations) simultaneously. Their impact include Xpansiv's AI reduced price spreads recently (as a dynamic pricing model)

(D) MICROSOFT AI FOR EARTH/SALES FORCE NET ZERO MARKET PLACE which guide buyers to high impact and credible projects. Using artificial intelligence, it is possible to evaluate several project criteria such as biodiversity and community impact at scale. As a project selection tool, their impact includes cutting of junk credit purchases by significant percentages using Microsoft's AI tools.

(E) WATERSHED/PERSEFONI simplifies disclosure of voluntary credit purchases for environmental sustainability goals reports. Using artificial intelligence, it is possible to aggregate data from registries (such as Verra and Gold standard) as well as corporate carbon accounting systems. As automated reporting tool, their impact include Persefoni's AI cut reporting time for voluntary market participants.

(F) TOUCAN PROTOCOL/KLIMADAO which create transparent histories of voluntary credit issuance and retirement using artificial intelligence, it is possible to detect double – counting and ensures credits are retired properly as credit tracking tools, their impacts include Toucan's prototype reduced double counting errors in voluntarily tech projects.

(G) PATCH'S DEMAND PREDICTION TOOLS which predict shortages or surpluses of popular voluntary credit types using artificial intelligence, it is possible to analyze corporate net-zero pledges and project pipeline data. As supply and demand forecasting, tool, their impact include improved inventory planning for nature based credits developers.

(H) CLOVERLY/PATCH TOOLS which match buyers with credits that align with their industry and values as well as creating personalized voluntary offset portfolios. Using artificial intelligence, it is possible to analyze buyer – specific emissions data and sustainable development goals (SDG) priorities. As personalized portfolio tool, their impact includes artificial intelligence increased small

and medium enterprise participation in voluntary market by significant percentage.

(I) JUPITER INTELLIGENCE'S CLIMATE RISK platform which evaluates climate risks (such as wild fires) to nature based credit projects. Using artificial intelligence, it is possible to model complex interactions between climate patterns and project viability. As risk assessment tool, their impact includes reduced insurance premiums by significant percentage for voluntary forest projects.

(J) CARBON DIRECTS ARTIFICIAL INTELLIGENCE GUIDES which educate new participants on voluntary credit quality. Using artificial intelligence, it is possible to generate plain language explanation of project methodologies and co-benefit.

As education for education for buyer tool, their impact include carbon directs catboat reduced buyer on boarding time.

West Africa Carbon Markets: Historically African countries (ECOWAS) have backed behind in carbon markets operations but have shown growing interest in scaling their engagements in the nearest future. Notably, in the voluntary carbon market, demand for African – originated carbon credits has been growing at a compound annual rate of 36% between 2016 and 2021 (World Bank, 2024). Yet, the value of these credits remains low with the retirement value of African carbon credit standing at only $123 Million (Dollars) in 2021. In fact, compared to other developed economics; only a handful of African countries (ECOWAS) and companies have been able to

benefit from voluntary carbon market to date. Clearly, the voluntary carbon markets in African (ECOWAS) are fragmented); with a significant number of global players across the value chain. Regrettably, project developers are generally small scale and limited in number while focusing on similar types of projects. Statistically about ninety-seven percent of African carbon credits are issued in forestry and land use; renewable energy and household devices. Again, there is limited local validation and verification body and almost all credits from Africa are certified by independent standards (such as VERRA and GOLD STANDARD). Yet, demand for African credits is largely driven by major international companies (such as WILDUFE Works CARBON, CARBON GREEN INVESTMENTS, OROMIA FOREST and WILDLIFE ENTERPRISES, IMPACT CARBON, CO2 BALANCE, RELIEF INTERNATIONAL, VESTERGARRED FRANDSEN GROUP, CLEAN AIR ACTION CORPORATION, MY CLIMATE FOUNDATION, C1 ENERGIES, NORTHERN RANGELAND TRUST, TOYOTA ENERGY SERVICES, BIOCARBON PARTNERS, ETC). However, the region's participation in carbon markets has been projected to be well below its technical potential (representing only about two percent of Africa's maximum annual potential for carbon credit generation. Similarly, a small portion of credits generated in African region have also been sold in compliance markets (issued through the clean development mechanism.

Indeed, several West African nations are increasingly participating in the voluntary carbon market initiatives implementing projects such as reforestation, renewable energy

and sustainable agriculture to generate carbon credits. Essentially, these activities not only contribute to mitigating climate change but also offer economic and social co-benefits to local communities. Therefore, if implemented with robust standards and overarching national priorities; voluntary carbon market activities in ECOWAS region can serve as a valuable mechanism for promoting sustainable development as well as fostering green economy of the member countries. Notably, as at 2022, West Africa hosted about 254 registered activities across the clean development mechanism, Gold standard and Verra (Maggiore, et,al. 2024). Clearly, these activities encompass both standalone projects and component project activities included within larger programs of activities. Specifically, Burkina Faso leads with the highest number of active initiatives that primarily focus on decentralized (small-scale) endeavours such as in field of efficient cook stoves. Similarly, Nigeria and Senegal followed with those initiatives emphasizing decentralized interventions at the household level. However, as regards new initiatives in the pipeline; these were several activities undergoing validation in the region (with staggering high percentage of them falling under voluntary carbon market. In fact, Nigeria leads in this category but followed by Barkina Faso and Togo. Here, (as similar to registered initiatives) majority of the validated projects pertain to activities related to safe water and efficient cook stoves that are integrated into existing programs.

Critically to tap into its full carbon market potential, West Africa must seize the momentum behind the global market opportunities with specific relevance for the sub-continent:

(I) Greater focus on integrity
(II) Favourable government regulation
(III) Increased trading under Article 6 and
(IV) Increasingly ambitious climate action wrong businesses

Operationally, Verra's work to update its methodologies for both cook stoves projects and REDD+ projects in very critical for high-integrity West African credits (since these credit types comprise greater percentage of African credit supply in the previous years). Therefore, working to adopt these new standards will greatly boost West African projects integrity and benefits for all.

Furthermore, some West African countries are actively seizing the momentum behind exporting carbon credits under Article 6. In other words, some of the country-to-country agreements signed in the previous years have involved West African countries. Specifically, Ghana has taken a leading role in these initiatives while Senegal and Nigeria have also made substantial progress. Clearly table 6.1 shows the carbon market participation rate of some countries in ECOWAS region (World Bank, 2024). However, harnessing these market opportunities can benefit the entire value chain of West African carbon market players while building on the significant growth momentum of the previous years. In other words, unlocking ECOWAS potential will see the sub-continent become a major player in carbon markets by 2030 and beyond (while delivering significant benefits along the way and propelling its role in global green growth.

CLIMATE FINANCE OPERATIONS

Conceptually, climate finance can be regarded as any local, national or transnational funding that supports climate action and which can also be sourced from public, private and

TABLE 6.1 ECOWAS: CARBON MARKET PARTICIPATION RATES

	GHANA	**SENEGAL**	**NIGERIA**
❖	Published an administrative structure and Draft law for the country's participation in Bilateral Trading of credits under Article 6.2 of the Paris Agreement	Validated a National strategy for trading carbon credits under Article 6 including a Budgeted Medium – Term Roadmap for establishing the infrastructure to trade credits internationally.	Project that Avoids Deforestation in one of the world's 36 Biodiversity hotspots while benefiting over 300 House holds
❖	Established the Ghana Carbon Registry (online Database) for verifying and tracking projects, GHG emissions, Reductions and Associated Carbon credits.		
❖	Signed an Agreement with Singapore whereby Singaporean companies can use High-Integrity Ghanaian credits to compensate up to 5% of their Domestic Carbon Tax payment Requirements		

alternative financing mechanisms. Essentially, climate finance issued for climate change mitigation and adaptation as well as being a subset of green finance that caters to broader environment goals (beyond climate action). However, green finance falls under sustainable finance that supports investments considering environmental, social and governance (ESG) factors. Initially, developed countries are primarily responsible for providing climate finance after the 1992 Rio declaration formally introduced the polluter-pays principle (which stated that those responsible for environmental damage should bear the cost of addressing it). In other words, this declaration talked about cooperation among countries as well as the responsibilities of developed countries given the pressures that their societies place on the global environment (and of the technologies and financial resources as commanded). Subsequently, the United Nations Framework Convention on Climate Change (UNFCCC) came into force in 1994 and agreed to support climate change activities in developing countries including Africa) by providing financial support for action on climate change. In fact, at the climate conference (COP 15) in 2009; developed countries agreed to mobilize billions of dollars annually to support climate action in developing nations till 2020. However, in 2015 (under Paris agreement) parties agreed to extend this goal to 2025 (and with a new climate finance goal after 2025). Yet, there are emerging opportunities to diversify funding sources and leverage a range of financial instruments for climate-based projects. These include Dedicated Taxes, certified Green Bonds, Debt-for-Nature swaps or climate conversions as well

as payments for Ecosystem services although applied with varying frequently; these instruments are already in use by regional actors whose expertise can be leveraged to structure and support climate based projects. In other words, these instruments can be combined to maximize their effectiveness. Clearly, table (6.2) and (6.3) examines the various instruments that can be replicated and scaled; broaden capital access and diversify funding sources for the various climate – based projects as desirable.

Specifically, climate investment fund (CIF) stands as one of the largest and most active climate finance mechanisms to date. In fact, operating across several developing countries, CIF has invested in several significant projects. Operationally, CIF works through six Multilateral Development Bank (MDBs) and partners with several stakeholders such as governments, civil society organizations, private sectors and academia. Currently the CIF programs include the following:

(A) CLEAN TECHNOLOGY FUND (CTF) which supports fossil fuel dependent countries with the deployment of low carbon technologies with significant potential for reducing long term greenhouse gas emissions. Again, it provides concessional financing to large-scale renewable energy, energy efficiency and sustainable transport projects.

(B) SCALING UP RENEWABLE ENERGY PROGRAM IN LOW INCOME COURTIERS (SREP) supports the deployment of renewable energy solutions (such as solar, geothermal and wind) in order to increase energy access for those communities with no access to power. Operationally, it is

TABLE 6.2 CLIMATE FINANCE: FUNDERS AND INSTRUMENTS

S/N	FUNDING TYPES	FUNDERS	INSTRUMENTS	SUB-INSTRUMENTS
(I)	**PUBLIC FUNDING** ↕	1)Government	A)Non-Repayment Instruments	AI)Grants A-Z) Direct Contributions
		2)Multilateral Donor	B)Fiscal And Regulatory Instructions	BI)Taxes, Fees, Subsidizes
		3)Bilateral Donor	C)Debt Financing instruments	CI)Market and Concessional Loans C2) Blue and Green Bonds C3) Debt For Nature Or Climate Conversations
		4)Multilateral Development Banks (MDB)	D) Market-Based Instruments	DI) PAYMENT FOR ECOSYSTEM SERVICES. D2) Carbon Credits
		5)National Finance Institution	E) Risk-Sharing G Instruments	EI) Guarantees E2) Insurance
		6) Infrastructure operator (Utility)	F) Equity	F1)Private Equity F2) Venture Capital
		7)Non-Governmental Organization		
		8)Corporate Actor		
		9)Commercial Bank		
		10)Institutional Investor		
(II)	**PRIVATE FUNDING**			

TABLE 6.3 CLIMATE FINANCE: INSTRUMENT CLASSIFICATION AND OPERATIONS

INSTRUMENTS	APPLICATIONS	SUB-INSTRUMENTS	OPERATIONS
(A) FISCAL AND REGULATORY INSTRUMENTS	❖ USE TAXATION, SUBSIDIES AND PUBLIC SPENDING TO INFLUENCE ECONOMIC BEHAVIOUR ❖ RAISE REVENUE ❖ PROVIDE FINANCIAL INCENTIVES TO PROMOTE DESIRED ACTIONS AND POLICY OUTCOMES	❖ DEDICATED TAXES ❖ FEES ❖ FISCAL POLICIES	❖ GOVERNMENT-IMPOSED FINANCIAL MECHANISMS SPECIFICALLY DESIGNED TO RAISED FUNDS FOR ENVIRONMENTAL STEWARDSHIP AND CONSERVATION EFFORTS ❖ COUNTRIES WITH STRONG GOVERNANCE STRUCTURES.
(B) DEBT – FINANCING	❖ RAISE SUBSTANTIAL	❖ MARKET AND CONCESSION	❖ BORROWING MONEY UP FRONT WITH REPAYMENT

INSTRUMENTS	CAPITAL UP-FRONT BY BORROWING AGAINST FUTURE REVENUE STREAMS OR SPECIFIC PROJECT OUTCOMES	AL LOANS ❖ CERTIFIED GREEN, BLUE, FOREST, BIODIVERSITY AND SUSTAINABLE BONDS ❖ DEBT-FOR-NATURE OR CLIMATE CONVERSION	TERMS AND INTEREST. ❖ BOND FOR PROJECTS THAT ARE EARMARKED FOR CLIMATE FOCUSED OR ENVIRONMENTAL BENEFITS ❖ FINANCIAL ARRANGEMENTS WHERE A PORTION OF A NATION'S FOREIGN DEBT IS FORGIVEN IN EXCHANGE FOR COMMITMENTS TO ENVIRONMENTAL OR CLIMATE RELATED PROJECTS ❖ COUNTRIES THAT LACK UP FRONT CAPITAL BUT HAVE HIGH CREDIT RATINGS ❖ COUNTRIES WITH HIGH DEBT AND INDEED OF CONSERVATION OR CLIMATE RESILIENT INDUSTRIES
(C) MARKET – BASED INSTRUMENTS	❖ LEVERAGE ECONOMIC INCENTIVES AND	❖ PAYMENTS FOR ECOSYSTEM	❖ MARKETS BASED APPROACH WHEREBY BENEFICIARIES OF ECO-SYSTEM SERVICES

	MARKET SIGNALS BY ASSIGNING MONETARY VALUES TO GOODS AND SERVICES; ENCOURAGING BEHAVIOUR CHANGE THROUGH FINANCIAL BENEFITS OR COST	SERVICES CARBON CREDITS	COMPENSATE THOSE WHO MANAGE THESE SERVICES SUSTAINABLY. ❖ MARKET BASED APPROACH WHEREBY REDUCTIONS IN CARBON DIOXIDE OR OTHER GREENHOUSE GAS EMISSIONS ARE ACHIEVED THROUGH CARBON PROJECTS WHICH CAN BE SOLD AS CREDITS TO INDIVIDUALS COMPANIES OR GOVERNMENTS TO OFFSET THEIR OWN EMISSIONS.
(D) RISK SHARING INSTRUMENTS	❖ REDUCE FINANCIAL EXPOSURE OF LEDERS OR BORROWERS BY LOWERING THE PERCEIVED	❖ GUARANTEE INSTRUMENTS ❖ INSURANCE INSTRUMENTS	❖ FINANCIAL INSTRUMENTS THAT PROVIDE A BACKSTOP OR ASSURANCE TO LEANDERS WHILE REDUCING THE RISK ASSOCIATED WITH INVESTING IN ENVIRONMENTALLY

	RISKS.		FOCUSED PROJECTS. ❖ FINANCIAL PRODUCTS DEISGNED TO TRANSFER AND MANAGE THE RISKS ASSOCIATED WITH IMPLEMENTING AND MAINTAINING CLIMATE – BASED PROJECTS WHILE PROVIDING COVERAGE FOR POTENTIAL LOSSES DUE TO OPERATIONAL CHALLENGES AND THEREBY ENSURING FINANCIAL STABILITY AND SUSTAINABILITY FOR THE PROJECTS. ❖ COUNTRIES WITH LOWER CREDIT RATINGS OR PROJECTS WITH HIGHER RECEIVED RISK.

one of the biggest global funders of mini-grids, with projects in several countries.

(C) FOREST INVESTMENT PROGRAM (FIP) tackles deforestation and forest degradation by empowering indigenous groups and developing countries to sustainably manage their natural resources and preserve the forest as a carbon sink so as to prevent total carbon dioxide emissions.

(D) PILOT PROGRAM FOR CLIMATE RESILIENCE (PPCR) supports the world's most vulnerable countries in integrating climate resilience into strategic development planning as well as implementing the plans through innovative climate solutions.

(E) GLOBAL ENERGY STORAGE PROGRAM (GESP) is a funding window under clean technology fund that supports clean energy storage technologies to expand integration of renewable energy into developing countries.

(F) ACCELERATING GOAL TRANSITION INVESTMENT PROGRAM (ACTIP) offers a comprehensive toolkit to support countries in transitioning away from coal by way of supporting the development of new coal plants and accelerating retirement of exiting coal assets.

(G) INTEGRATION OF RENEWABLE ENERGY AND POWER SYSTEMS (IREPS) supports the integration of renewable energy into power systems through different flexible solutions.

(H) INDUSTRY DECARBONIZATION PROGRAM (IDP) supports those countries where industries constitute a growing

share of their overall emissions by aiming to decarbonizes industrial practices and change behaviours in the sector.

(I) NATURE, PEOPLE AND CLIMATE (NPC) aims to harness the land management experiences and capacities of indigenous groups for climate action and accelerate sustainable practices. Similarly, it seeks to work with key national, regional and local stakeholders to adapt to climate change across diversity of land uses and ecosystems as well as mitigating its effects.

(J) CLIMATE SMART URBANIZATION (CSU) help countries undergoing challenges from rapid urbanization to support their newly emerging cities so as to ensure that their growth is managed in climate-smart, green, inclusive and sustainable ways.

(K) TECHNICAL ASSISTANCE FACILITY (TAF) aims to provide funding to support upstream activities that lead to the strengthening of policy and regulatory environments; building of human and institutional capacities as well as design of market facing solutions (Such as innovative instruments and business models). Operationally, these activities have the overriding goal of accelerating downstream clean-energy investments in client countries.

(L) CTF CAPITAL MARKETS MECHANISM (CCMM) is the ground breaking financial mechanism that will enhance the clean technology fund capacity to attract private sector capital and expedite the availability of climate funding through the issuance of bonds in the capital

market. Operationally, the proceeds from CCMM bonds will flow into the CTF trust fund and deployed as concessional finance across new pipeline of low-carbon technologies to help eligible developing countries in meeting its climate mitigation goals. Notably, CTF stands out as the first (pure-play) capital market issuer in the context of a global climate finance facility. Therefore, this pioneering approach will create a new fundraising platform for multiple multilateral development banks from private capital markets through a unified plat form. This channel will also enable private sector investors to support the climate transition in developing countries (which is crucial to increasing private sector mobilization).

(M) ADAPTATION BENEFITS MECHANISM (ABM) is a results-base finance mechanism that aims to mobilize public and private sector funding for projects and programs enhancing the resilience of communities and ecosystems to the negative impacts of climate change. Operationally, the ABM can contribute to implementing the national determined contributions (NDC under the Paris agreement, such as addressing the needs and priorities of developing countries for adaption requiring international cooperation and support).

As a non-market mechanism, no international trading of mitigation or adaption outcomes is involved. Yet, the ABM certifies the benefits of adaptation action through a robust approval process while delivering verified and

largely quantified evidence of progress made towards resilience and associated climate finance.

(N) AFRICA GREEN BANKS INITIATIVE (AGBI) continues to play critical role in advancing green and sustainable growth across African countries. Practically, in championing climate and environmental action, the AFDB has identified the Green Bank model as representing a broad opportunity for Africa to turn the climate financing gap per year into an investment opportunity. Consequently, local public or private banks have the capacity to bridge the national climate and environmental finance gap without burdening foreign debt by facilitating access to international and domestic financial resources to further green projects.

(O) JUST TRANSITION INITIATIVES (JTI) is a framework based on procedural and distributive justice, which highlight the concepts of intention and the notion of reform and transformation as ways to conceptualize a just transition. Basically, the development of a national just transition framework is to present a development pathway that reduces vulnerability, poverty, inequalities and ensures that no one is left behind as the country transitions to a low-carbon, climate – resilient economy. Operationally, with technical and financial support from CIF, AFDB is implementing several initiatives to advance its just transition agenda in promoting equitable access to the benefits and sharing of the costs of sustainable development. Indeed, and aligned with its commitments and those of the climate investment Fund (CIF), the AFDB remains focused in mobilizing climate finance as well as

effectively aiding African countries in achieving their sustainable development goals. Again AFDB in partnership with other MDBs and CIF are also formulating a new CLIMATE resilience program (CRP); which aims at bolstering support for developing nations to enhance investment (Public and private) in climate adaptation. Operationally, the key components of the proposed CRP are as follows (World Bank, 2024):

(A) Under taking climate resilience diagnostics and developing a holistic adaptation investment strategy;

(B) Financing investments that enable and drive adaptation action and

(C) Building country systems to manage residual risks.

Regrettably, African countries (ECOWAS region) is still facing large and persistent climate finance gap. To remedy this situation, decision makers need to know which financial actors and types of finance are relevant to closing climate investment gaps in specific geographies and industries. Consequently, climate finance roadmaps can help public and private capital allocators (as well as researchers and policy makers) to identify and prioritize climate interventions while mobilizing finance for such actions at scale. In other words, climate finance are best suited to close the investment gap in different sectors and geographies as well as identifying and prioritizing interventions to mobilize climate finance at large scale.

Specifically, the proposed climate finance roadmaps can help to identify the following:

(I) The most suitable investors in different markets based on investors preference and characteristics, risk profile of each sector and geography as well as availability of private capital;

(II) The financial instruments required to close the investment gaps most effectively and based on technology as well as financial market maturity;

(III) The policy and regulatory measures needed to overcome investment barriers and attract climate investments at the scale required;

(IV) As well as the robust methodology for closing climate finance gaps that can be applied by various actors in local and regional contexts.

Indeed, climate finance roadmaps can help the ECOWAS public and private capital allocators to understand their potential roles in different countries and sectors; thinking through their various investment challenges; coordinating actions as well as ultimately directing capital more effectively to collectively achieve net zero pathway. Furthermore, these roadmaps can support the development of more accurate net-zero investment plants which can be integrated in Nationally Determined Contributions (NDCs) as well as other national strategies and plans. Clearly, table (6.4) shows the scheme of the climate finance roadmap for the West African countries (CPI, 2024).

TABLE 6.4 CLIMATE FINANCE: ROADMAP SCHEME FOR ECOWAS

S/N	OPERATIONAL STEPS	ACTIONABLE ACTIVITIES
(A)	**TO IDENTIFY FINANCING GAPS BASED ON THE SCOPE OF ANALYSIS**	ESTABLISHING REGIONAL AND SUB-SECTORAL SCOPE OF ANALYSIS AND FATAL CLIMATE FINANCE NEEDS AND GAPS FOR THE SELECTED COUNTRY/REGION SECTOR.
(B)	**TO ASSESS INVESTMENT RISKS AND ATTRIBUTES**	ASSESSING THE RISK PROFILE AND KEY CHARACTERISTICS OF EACH COUNTRY /REGION /SECTOR/ SUBSECTOR COMBINATION ALONG THE VARIOUS RISKS AND ATTRIBUTES IDENTIFIED AS RELEVANT FOR INVESTMENT DECISIONS.
(C)	**TO ASSESS INVESTOR CHARACTERISTICS AND PREFERENCES**	ASSESSING THE KEY CHARACTERISTICS AND PREFERENCES FOR THE VARIOUS TYPES OF INVESTORS WHILE ALIGNING WITH THE INVESTMENT RISKS AND ATTRIBUTES AS IDENTIFIED
(D)	**TO MATCH INVESTMENT RISKS AND ATTRIBUTES WITH INVESTOR PREFERENCES**	ASSESSING THE SUITABILITY OF EACH INVESTOR TYPE AGAINST EACH COUNTRY/SUBSECTOR BY MATCHING INVESTOR PREFERENCES WITH INVESTMENT RISKS AND ATTRIBUTES.
(E)	**TO IDENTIFY**	ESTIMATING THE FINANCE TYPE (DEBTOR

	REQUIRED CAPITAL MIX	EQUITY OR CONCESSIONAL FINANCE) AND SOURCE (PRIVATE OR PUBLIC) REQUIRED IN THE COUNTRY/SECTOR/SUBSECTOR BASED ON TECHNOLOGY AND FINANCIAL MARKET MATURITY.
(F)	**TO ESTIMATE THE POTENTIAL FUTURE CLIMATE FINANCE MIX**	❖ IDENTIFYING THE TYPES AND AMOUNTS OF CAPITAL THAT COULD BE PROVIDED BY DIFFERENT INVESTOR TYPES. ❖ ESTIMATING POTENTIAL FUTURE CAPITAL MIX AND SOURCES REQUIRED IN THE COUNTRY/SECTION BY COMBINING THE TYPES OF CAPITAL REQUIRED AND THE RESULTS OF THE SUITABILITY ASSESSMENT. ❖ QUANTIFYING THE AMOUNT OF CAPITAL REQUIRED FROM EACH INVESTOR BASED ON THE INVESTMENT GAPS ESTIMATED
(G)	**TO DEVELOP THE CLIMATE FINANCE ROADMAP**	DEVELOPING A DATA-DRIVEN NARRATIVE BASED ON THE FINDING FROM THE PREVIOUS STEPS AND IDENTIFYING KEY ACTIONS AND OPPORTUNITIES FOR POLICY MAKERS AND CAPITAL ALLOCATIONS TO CLOSE THE FINANCING GAP IN THE COUNTRY/SECTOR/SUB-SECTOR

7.0 POLICY OPTIONS: ADAPTATIONS, MITIGATIONS AND FUNDING

Indeed, to meaningfully address climate change, there is critical need to integrate development concerns and climate change. In fact, the climate problem arises from the joint evolution of economic growth and greenhouse gas emissions (Nwaobi, 2004; 2013). Therefore, an effective regime must provide the incentives to reconsider trajectories of industrialization and unravel the ties that development to greenhouse gas emissions (World Bank, 2010). Consequently, United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in 1992 (and operational in 1994) set an ultimate objective of stabilizing atmospheric concentrations of greenhouse gases (GHG) at levels that would prevent dangerous human interference with the climate system (UNFCCC, 2005). However, the ultimate decision making body is the conference of the parties (COP) which meets every year and reviews the implementation of the convention; adopts decisions to further develop the convention's rules as well as negotiating substantive new commitments. Yet, as non-annex parties, developing countries (including Africa) undertake general obligations to formulate and implement national programs on mitigation and adaptation. Operationally, African adaptation efforts must extend well beyond the climate framework. Essentially, adaptation concerns and priorities must be integrated across the full breadth of economic and development planning as well as decision making. Specifically, the role of the international climate regime lies with catalyzing international support and

facilitating national adaptation efforts. In other words, how can adaptation be best promoted and facilitated under the international climate regime in ECOWAS region? Notably, under the UNFCCC, all parties have committed to undertake national adaptation measures and to cooperate in preparing for the impacts of climate change. However, special consideration is given to the least developed countries (such as West African countries) for their special needs to cope with adverse effects of climate change. In fact, ECOWAS as region are encouraged and supported under the convention to prepare a National Adaptation Program of Action while identifying priority activities that respond to their urgent and immediate needs to adapt to climate change.

Technically, climate adaptation is generally regarded as any behavior, investment or other decision taken in direct response to realized or anticipated changes in the climate. Thus, while adaptation often refers to decisions that ameliorate the adverse impacts of climate change; adaptive behavior can also include actions that allow individuals to exploit beneficial opportunities that arise with an evolving climate. In other words, these adaptation decisions occur within a broader socioeconomic fabric in which many environmental, economic, political and cultural conditions shape the constraints and opportunities that individuals, communities and governments face as they navigate climate change (Carleton *et al*., 2024). Therefore, it is important to incorporate climate change and adaptation routinely into fiscal risk analysis and debt sustainability analyses as well as analyzing the benefits of adaptation for fiscal space, fiscal

resilience and sovereign credit ratings. Again, the development of an appropriate adaptation taxonomy (or integration of adaptation within a green taxonomy) that is aligned with national goals is highly recommended. Furthermore, policy makers should integrate adaptation within sustainable budgeting approaches, project procurement and project appraisal as well as using sustainability budgeting approaches as a tool to identify where public expenditures could be more strongly aligned with national adaptation and nature goals (World Bank, 2010). Indeed, working through the national development process is essential to encourage early planning to strengthen climate resilience and discourage investments that heighten climate vulnerability. However, international process can complement and facilitate this process in the following ways:

i) Creating comprehensive national adaptation strategies in West African countries would establish frameworks for action and strengthen national capacities. They would also build on the National adaptation programs of Action (which target urgent priorities) to map out comprehensive long-term plans identifying climate risks; existing and needed adaptation capacities as well as national policies and measures to fully integrate climate risk management into development decision making.

ii) Yet, in addition to organizing national adaptation efforts, these strategies could serve as a basis for targeting implementation assistance through climate regime or other active channels.

iii) Sharing experiences and best practices as well as coordinating programmatic approaches to support national, regional and local systems for adaptation and resilience. Basically, this effort would provide guidance to countries on vulnerability assessments as well as how to integrate adaptation activities into sectional and national development planning and policies (while helping in accessing technology for adaptation)

iv) Clearly, the West African membership of the UNFCCC provides a unique forum for countries, organizations and private entities to exchange experiences and learn from each other. Therefore, bringing national development agencies to participate in this process is critical to success.

v) Again, apart from using the United Nations process to disseminate information; it may be useful to establish regional centers of excellence for catalyzing local, national and regional activities. Operationally, these regional centres (with international support) can promote capacity building and best practices.

vi) To provide reliable funding to assist countries in implementing high priority measures identified in their national adaptation strategies. In other words, finding additional sources of adaptation finance and packaging them with existing development finance are essential for effective adaptation.

vii) Similarly, a new body under the United Nations may be needed to provide guidance to the parties as well as

assessing national adaptation strategies while developing criteria for allocating resources.

viii) Ecologically, the growing frequency and severity of climate-related events are placing assets in high-risk regions under significant threat. And without adequate adaptation strategies, businesses and government face escalating economic losses. Therefore, tools such as the climate bonds initiative resilience taxonomy offer a framework to standardize investments in climate resilience and adaptation. In fact, resilience bonds and other mechanism are emerging as key solutions while enabling organizations to secure resources for addressing climate vulnerabilities. Essentially these tools offer pathways to strengthen resilience while meeting the increasing demand for transparency.

ix) Again, private sector interest in climate adaptations is expected to grow (with organizations aligning strategies to address disclosure requirements and public expectations). Thus, investments in resilience not only safeguard assets but also enhance the ability to navigate evolving regulatory landscapes and climate challenges.

MITIGATION POLICY OPTIONS:

As already noted, adaptation involves adjusting to the effects of climate change that are already happening or expected (which includes strategic actions like coastal protection, better water management, disaster preparedness and ecosystem restoration). Essentially, the adaptation aim is to reduce the damage from unavoidable climate changes. On the other hand,

mitigation focuses on reducing or preventing the causes of climate change (mainly by cutting greenhouse gas emissions). Basically, this includes transitioning to renewable energy; improving energy efficiency as well as protecting natural carbon sinks like forests. Clearly, the goal is to limit future warming and climate impacts. In other words, mitigation tackles the root causes of climate change (emissions) while adaptation focuses on responding to its effects. Again, mitigation has long term (global) scope while adaptation focuses is more immediate and localized. However, both strategies are essential for a sustainable future. That is, mitigation helps reduce the severity of future climate impacts while adaptation ensures resilience in the face of current challenges. Surely, both strategies are inevitable for building a more resilient and sustainable ECOWAS region.

Operationally, stringent climate change mitigation will require fundamental changes in energy policy (and in international cooperation). Yet, without fundamental market-based reform, the world will not avoid dangerous climate change. Consequently, Net zero accelerator initiative has developed a framework to inspire strategic level decisions and structure the dialogue between private and public sector stakeholders which facilitates further collaborations and acceleration of decarbonization journey. Clearly, table 7.1 shows the possible public-private collaboration opportunities to accelerate industry net-zero emissions (WEF, 2025).

TABLE 7.1: NET-ZERO ACCELERATION: INDUSTRIAL STRATEGIES

S/N	STRATEGY	OPERATIONS	ACTION LEVER (A)	ACTION LEVER (B)
			Making the most of existing collaboration mechanism	**Responsibly engaging in net zero policies design**
1	Buy-in	Making the business case for net zero	Understanding and leveraging public annual mechanism for net-zero	Engaging your sector to co-develop financial mechanisms for net-zero
2	Calculation	Calculating carbon emissions accurately	Facilitating carbon tracking adoption within your value chain	Contributing to improve and harmonize carbon accounting standards
3	Mitigation	Supporting value chain decarbonization	Proactively support net-zero solutions implementation across your value chain	Collaborating with governments to shape the policies for value chain decarbonization
4	Green business	Investing in climate	Co-investing in climate	Helping to create the

	growth	technologies, infrastructure and market creation	technologies development. Infrastructure and market creation	policy conditions for climate technologies adoption

Furthermore, despite the notable progress in the energy transition, concerted efforts are needed to ensure continuity in the ECOWAS region. These actions should include the following:

A. While West African countries must adapt to their specific circumstances, strong political commitment is needed to ensure progress and continuity in decarbonization policies. Essentially, these actions include enabling policies for renewable energy expansion carbon pricing, green stimulus packages and reduction of fossil fuel subsidies. Clearly, these measures can help to integrate centralized and decentralized renewable energy sources while enhancing energy security and equity.

B. It is crucial to deliver energy equity for vulnerable households (such as social safety nets and compensatory measures like cash transfers and temporary basic income initiatives) to alleviate energy-related costs. In fact, these measures are critical to ensuring fair access to energy across different socio economic groups as well as preventing energy poverty.

C. There is critical need to increase investments in clean energy infrastructure. In other words, West African Countries need high-income countries to offer support while also ensuring a

good environment for investment in key areas (such as clean fuels, electricity and energy storage).

D. ECOWAS countries should try to invest in energy efficiency solutions so as to meet conference of parties (COP) target of doubling energy efficiency by 2030. In other words, private energy efficiency, implementing strong governance process with clear top-level ownership and operationalizing the value chain through effective collaboration. Here, some of these measures include awareness, building, mindset shifts as well as technology sharing or awareness. ECOWAS governments also need to prioritize policy interventions in the space to enable private sector investments and energy saving behavior.

E. Operationally, West African Countries should upgrade grid capabilities for more efficient energy distribution. Clearly, with increasing electrification and proliferation of decentralized energy; grids need to maintain reliability while connecting variable loads from renewable sources.

F. ECOWAS should enhance collaboration between sectors and nations by way of implementing initiatives to attract capital for clean energy projects as well as enhancing the effectiveness of those investments.

G. In view of the fact that fossil fuels are likely to continue contributing significantly to the overall energy mix in the future years; coal-to-gas switching (focusing on lighter oil products and minimizing oil and gas extraction emissions) could help reduce fossil fuel emissions intensity.

H. Technically, ECOWAS policy makers should drive research and development as well as adoption of new technologies (which includes new battery technologies, offshore wind and green

ammonia-based hydrogen for shipping and steel production). Similarly, investing in digital adoption is critical to build data management capabilities that are essential for accurate product-level emission reporting and green standards. In other words, scaling Artificial Intelligence (GENAI) use cases can drive efficiency and productivity in the energy system.

I. In order to accelerate the decarbonization of hard-to-abate sectors, technology, market and regulatory environments need to deliver cost reduction of green technologies by defining clear standards.

J. Operationally, as jobs in carbon-intensive energy sectors are expected to decrease in the coming decades; West African companies and policy makers need to facilitate reskilling of employees to transition to clean energy jobs.

K. In the spirit of promoting resilience and sustainability, ECOWAS should establish risk-informed energy governance frameworks. That is, develop robust frameworks that not only integrate multidimensional risk assessments but also critically examining existing paradigms and assumptions (underlying energy governance).

L. It is also critical to address the negative environmental externalities of energy systems (such as pollution, habitat disruption and resource depletion). Consequently, ECOWAS governments should prioritize making energy value, chains more circular and sustainable. In other words, implementing circular economy principles such as using renewable energy technologies (that are less resource-intensive) and ensuring end-of-life recycling for components (like batteries and solar panels) will contribute to environmental sustainability.

M. Due to the trans-boundary nature of energy risks, regional and international partnerships are crucial for addressing global challenges. Thus, West African Governments and policy makers should actively engage in multilateral initiatives and dialogues to facilitate the exchange of knowledge on risks, share best practices as well as foster innovation in sustainable energy technologies and governance models.

N. Furthermore, as every system become more complex and interconnected with other critical infrastructures (such as transportation, water and communication network); the challenge of understanding and managing these interactions grow. Therefore, regional policy makers must develop comprehensive models and simulation that capture these interdependencies; enabling them to anticipate and manage potential risks across multiple sectors as well as ensuring the reliability and security of the energy supply.

O. Again considering the integration of digital technologies like artificial intelligence and Internet of things, can enhance real-time monitoring and predictive analytics as well as allowing for quicker response to disruption and more effective coordination across multiple sectors.

P. Generally, enabling sustainable artificial intelligence in West Africa countries will require comprehensive approach consisting of actions across the following areas:

- ❖ Regulatory and policy enablers for establishing policies and frameworks that promotes responsible digital (artificial intelligence) development and use as well as ensuring compliance with environmental standards and energy policies.

- ❖ Financial incentives enablers that can provide funding and investment mechanisms to support sustainable artificial intelligence initiatives.
- ❖ Technological innovation enablers that focused on promoting research and development to drive cutting edge technologies that enhance sustainability in digital technology applications.
- ❖ Market development enablers that can create a conducive environment for sustainable digital solutions; encourage collaboration among stakeholders as well as facilitating adoption of green technologies.

Q. Operationally, partnerships between digital developers, energy stakeholders and policy makers in ECOWAS region can help reduce inefficiencies, address regulatory gaps and promote regional decarbonization. However, global alignment with localized solutions will be crucial for driving transparency, building acceptance and creating pathways for artificial intelligence driven energy innovations.

Consequently, proactively monitoring the evolving intersection of artificial intelligence and energy will be critically important for understanding emerging challenges and transformative opportunities in ECOWAS region.

FUNDING POLICY OPTIONS:

Indeed, financial flow can help West African countries to reduce their greenhouse gas emissions as well as adapting to the effect of climate change. However, mitigation, adaptation and Technological deployment to the ECOWAS region are extremely critical. In other words, the funding requirements for mitigation, adaptation and technology are very massive. Thus, compared with mitigation (where emphasis has been on private finance from carbon markets)

adaptation finance has a strong focus on official flows (World Bank, 2010). Notably, the African Development Bank's Adaptation Benefits Mechanism (ABM) piloted across Africa (since 2019) has become the first non-market approach registered on the United Nations Framework Convention on Climate Change (UNFCCC) non-market approach platform. Practically, the ABM certifies and quantifies adaptation benefits using rigorous methodologies and independent verification as well as providing transparent data on resilience improvements, co-benefits and associated finance. Essentially, this information supports pans agreement reporting, Sustainable Development Goal (SDG) tracking and Environmental, Social and Governance (ESG) frameworks. Therefore, through adaptation benefits supply agreements with users of the information generated (via ABM); the mechanism enables project developers to monetize certified benefits and access capital markets (while making adaptation costs transparent). In other words, it is time for adaptation finance to benefit from incentive mechanism such as the ABM. That is, tapping into new funding sources and engaging new actors through the ABM will accelerate and scale up the dissemination of the myriad of new and already existing adaptation technologies and solutions (that are not easily affordable) to West Africa countries.

Furthermore, ECOWAS government funding is especially critical because most greenhouse gas reduction (GRGH) approaches are still nascent and lack a clear market for long term success as well as raising the risk profile for private investors. However, funding policy is needed to protect people and the environment; ensure that GHGR communities are actively engaged as well as shaping GHGR research and deployment projects. Yet, policy and regulation will require actors from every level to engage and this includes local sitting decisions, regional planning, national funding and mandates by ECOWAS governments as well as global standards setting by international partners. However, sustainability (ability to provide for present needs without compromising future needs); is a blue print for countries and sectors (companies) to conduct their businesses responsibly, environmentally and economically, for the long-term. In

other words, it is an imperative element for the long-term success of sectors (companies); in West Africa.

Thus, the strategy involves dedicated and concerted efforts to mobilize large and influential sectors (companies) in each country of ECOWAS region. By leveraging their extensive supply chains, this approach aims to create broader impact while simultaneously offering an enhanced value proposition. Generally, within the West Africa context, connecting with the United Nations Global compact offers several advantages to large companies (sectors). Here, the UN Global compact provides a recognized regional and global platform as well as accompanying opportunity to network and foster partnership. Again, the platform will allow the companies (sector) to shape policy and national financial planning through their seat at the table with National Government and United Nations. Specifically, these companies and sectors can access financial opportunities to engage with peers on the continent primarily through the Africa Business Leaders Coalition (ABLC) as well as beyond their immediate business ecosystems through Global Africa Business Initiative (GABI). Indeed, as enabling financial initiatives, the ABLC and GABI can provide specific (financial) value for West African businesses and should continue being resourced to expand their valuable reach and impact.

Yet as the representative of the United Nations Global compact, Africa Hub helps to coordinate operations of local networks and expansion countries. In other words, the Hub will align the local networks and expansion countries with central global and expansion countries with central global priorities as well as helping to achieve strategies financial goals and maintaining quality (climate) standards.

8.0 CONCLUSION

Clearly nations are waging a suicidal war against nature and we risk crossing irreversible thresholds as well as accelerating crisis that could take centuries or even millenniums to reverse. Yet, our climate, environment and planet are critical global commons that must be protected for all people (at present and future). Unfortunately, we are already at 1.2 degrees Celsius above pre-industrial levels and still rising rapidly. In facts, the Inter-Governmental Panel on Climate Change (IPCC) has recently warned that we are at imminent risk of hitting the dangerous threshold of 1.5 degrees Celsius in the near term (United Nations, 2024). Notably, every fraction of a degree represents lost lives, livelihoods, assets, species and ecosystems. Therefore, nations should be dramatically reducing emissions each year (towards forty-five percent reduction by 2030 and net-zero emissions by 2050) as made clear by IPCC, yet, temperatures continue to rise. However, the Paris agreement can be regarded as a singular achievement by way of bringing all nations into common cause to combat climate change and adapt to its effects. Specifically, to meet the demands of science and goals of Paris agreement; nations need the parties and all stakeholders to present more ambitious 2030 national climate plans as well as delivering on concrete policies actions aligned with a net-zero future. Operationally, these include no new coal after 2021, shifting fossil fuel subsidies to renewable energy as well as setting carbon price. But the implementation of these policies still proves difficult. In fact, their success depend not just on new finance and technology but also on complex and context-

specific social, economic and political factors (or institutions). Which are the formal and informal rules affecting policy design, implementation and outcomes. In other words, achieving results in tackling the climate challenge requires going beyond the international mobilization of finance and technology; rather by addressing the psychological, organizational and political barriers to climate action. Notably, these barriers stem from the way people perceive and think about the climate problem; the way bureaucracies work as well as the interests shaping government action. Therefore, policy change requires shifting political incentives and organizational responsibilities. In otherworld's, it requires the active marketing of climate policies; tapping into social norms and behaviors so as to translate the public's concern into understanding and understanding into action.

Furthermore, education is a powerful but under-used instrument for climate action and hence channeling more climates funding to education could significantly boost climate mitigation and adaptation. In other words, as the single strongest predictor of climate change awareness, education can play a catalytic role in climate change mitigation and adaptation by reshaping mindsets, behaviors, skills and innovation. Therefore, West African Governments can act now to adapt schools for climate change in cost-effective ways. In fact, ECOWAS educations system need to be adapted for greater resilience through education management, adjustments to infrastructure, prioritizing learning continuity as well as mobilizing students and teachers as change agents.

Notably, even with our planet undergoing rapid and dangerous change; economic models continue to assume endless expansion and growth while overlooking the broader systems that sustain life and well-being. Thus, nations need a pathway that protects people and planet while allowing for sustainable development. This implies broad shift in what prosperity and progress mean as well as how to incentivize and measure them including evaluation of policies. Therefore, nations must urgently find measures of progress that complement Gross Domestic Product (GDP). Statistically, GDP fails to account for human well-being, planetary sustainability and distributional dimensions of economic activity. Regrettably, GDP rises when there is overfishing, forests cutting or fossil fuel burning. Here, even though we are destroying nature, nations usually count it as increase in wealth. Unfortunately, such accounting act has been going on for decades. And without fundamental shift to complementary measurements, the targets fixed in relation to biodiversity, pollution and climate change will not be achievable. Therefore, any new process should bring together statistical agencies, policy experts and other stakeholders to identify a complement or complements to GDP that will measure inclusive and sustainable growth and prosperity. Similarly, the new process would also need to agree on pathways for national and regional accounting systems to include additional measurements as well as establishing systems for regular statistical reporting. However, the ECOWAS region can begin implementation of the recent System Environmental Economic Accounting (SEEA); Ecosystem Accounting (EA) and the System for Population and

Social Conditions (SPSC). They should also consider existing complements or alternatives to GDP and these include Human Development Index (HDI), Inclusive Wealth Index (IWI), and Genuine Progress Indicator (GPI). Multi-Dimensional Poverty Index (MPI) and Inequality Adjusted Human Development Index (IA-HDI).

Indeed, West African states have at their disposal an organization whose very purpose is to solve regional problems through cooperation. However, while the fundamental purposes and principles of ECOWAS endure, the organization must evolve in response to a changing world to become more networked, inclusive and effective. Therefore, West African countries must combine the best of their past achievements with the most creative look to the future; if they are to deepen solidarity and achieve a breakthrough for people and planet. Again, just as the founders of ECOWAS came together determined to save succeeding generations from the scourge of war; West African nations must come together to save succeeding generation from climate change and host of risks that we may not yet foresee entirely. Truly, the time is now without further delays.

Finally, by developing a robust, transparent and sustainable mechanism through which a carbon credits market can yield attractive income and development opportunities for West African communities at the frontlines in the fight against climate change; ECOWAS will align incentives among polluting producers and request ration enterprises to achieve net zero industrializations and shared green prosperity.

REFERENCES

Acemoglu, D et al (2012) "The environment and directed technical change". American Economic Review, 102:131 – 166.

ACMI (2024) Africa Carbon Markets Status and Outlook, ACMI: Africa Carbon Market Initiatives (www.africacarbonmarkets.org).

AFDB (2024) Financing Climate Action in Africa, Abidijan: African Development Bank (AFDB).

African Union (2019) Africa's Development Dynamics, Addis Ababa: African Union Commission (AUC)

Alkire, S et al (2015) Multidimensional Poverty measurement and Analysis, Oxford: Oxford University Press.

Aligishier, Z et al. (2022) "Macro-Fiscal Implications of Adaptation to climate change", IMF Staff Climate Note (512769).

Arrolakis, C and C. Walsh (2023) "Clean Growth", NBER Working Paper 31615.

Auffhammer, M. (2018) "Quantifying Economic Damages from Climate Change. *Journal of Economic Perspectives*, 32(4): 33 – 52.

Bilal, A and D.R. Kanzig (2024) "The Macroeconomic Impact of Climate Change: Global Vs Local Temperature, NBER Working Paper 32450.

Cline, W.R. (1992) The Economics of Climate Change, Washington: Institute for International Economics.

Collins, N. B. et al. (2024) Growing Resilience: Unlocking the potential of Nature-Based solutions for Climate Resilience in Sub-Saharan Africa, Washington: World Bank/World Resources Institute.

Conte, B. (2023) Climate Change and Migration: The case of Africa, Cesifo Working Paper 9948.

Costanza, R and H. Doly (1987) "Toward an Ecological Economics", Ecological Modeling, 38: 1–7.

CPI (2024) "Climate Finance Roadmaps: Methodology Framework to fill climate investments gaps", *Climate Policy Initiative (CPI) Mono Report.*

Desmet, K and E Rossi-Hansberg (2024) "Climate Change Economics over time and space", *Annual Review of Economics* 16: 271 – 304.

Dietz, S. (2024) Introduction to Integrated Climate Economics Modeling In: L Barrage and S. Hsiang (eds.) Handbook of Economics of Climate Change, Vol. (1).

Dietz, S. and F. Venmans (2019) "Cumulative Carbon emissions and economic policy: in search of general principles", Journal of Environmental Economics and Management, 96:108-129.

ECOWAS (2000) Interim Report of the Executive Secretary, Abuja: Economic Community of West African States (ECOWAS).

ECOWAS (2010) ECOWAS Vision 2020, Abuja: Economic Community of West African States (ECOWAS).

ECOWAS (2012) ECOWAS Reference Manual, Abuja: Economic Community of West African States (ECOWAS).

Fried, S. (2022) "A Quantitative Macro Study of Climate Adaptation". The Review of Economics studies 89(**6**): 3303 – 3344.

Fried, S.K. et al. (2018) "The Distributional Effects of a Carbon Taxon current and future generations", Review of Economic Dynamics, 30:30-46.

Gillinghan, K. and J.H. Stock (2018) "The Cost of Reducing Greenhouse Gas Emissions", *Journal of Economics Perspectives,* 32: 53 – 72.

Gjerde, J. et al. (2009) "Optimal Climate Policy under the possibility of a catastrophe", *Resources and Energy Economics"* 21(**3**): 289 – 317.

Hassle, J. and P. Krusell (2018) "Environmental Macroeconomics". The case of Climate change in P. Dasgupta et al. (2018). Handbook of Environmental Economics, Vol. (4): 333 – 394.

Hillebrand, E. and M. Hillebrand (2019) "Optimal Climate Policies in a dynamic multicounty equilibrium theory. 179: 200 – 239.

IMF (2019) World Economic Outlook, Washington: International Monetary Fund (IMF).

IPCC (2014) Fifth Assessment Report of the Intergovernmental Panel on Climate Change, New York: Cambridge University Press.

IPCC (2022). "Mitigation of Climate Change", Sixth Assessment Report, Working group III, Intergovernmental Panel on Climate Change (IPCC), Bonn, Germany.

IPCC (2023). Climate Change Synthesis Report: Summary for Policy Makers Geneva: Intergovernmental Panel on Climate Change (IPCC).

Kashsar, R. et al. (2024). Scaling Technological Greenhouse Gas Removal: A Global Roadmap to 2050, Bezos Earth Fund (www.bezosearthfund.org)

Kotlikoff, L. et al (2021). Making Carbon taxation a generational win-win", *International Economic Review* 62: 3 – 46.

Maggiore, M.D. et al. (2024). "What is the status and role of the VCM in West Africa" WAACMCF Information note (March).

Mathison, C.T. et al (2021) "Climate change: The physical science basis", Sixth Assessment Report of the Intergovernmental Panel on Climate change, 2 (2391).

Miftakhova, A. (2021). "Global, sensitive analysis for optimal policies: finding what truly matters". *Economic modeling, 105*

Moore, F.C (2024). "Learning Catastrophic Risk and Ambiguity in the climate era" NBER Working Paper 32684.

Nordhaus, W. D. (1975) "Can we control Carbon dioxide?" IIASA Working Paper WP 75 – 63.

Nordhaus, W. D. (1977) Economic Growth and Climate: The Carbon dioxide Problem. *American Economic Review* 67(**1**): 341 – 46.

Nordhaus, W.D. (2019) "Climate Change: The Ultimate Challenge for Economics". *American Economic Review* 109(**6**): 1991 – 2014.

Nwaobi, G. C. (2004) "Emission Polices and Nigerian Economy: Simulations from Dynamic General Equilibrium Model, Energy Economics 26 (No. 5) pp. 921 – 936.

Nwaobi, G.C. (2013) The Economics of Climate Change and Science of Global Warming debate: African perspectives, University Library of Munich, MPRA Paper 46807.

OECD (2025) Zero-Carbon Buildings in cities: A whole life cycle Approach, Paris: OECD Publishing.

Pindyck, R.S. (2013) "Climate Change Policy: What do the models tell us"? *Journal of Economic Literature,* 51:860 – 872.

Ranger, N. et al. (2025) Enabling Adaptation: Sustainable Fiscal Policies for Climate Resilient Development and Infrastructure, Oxford: Resilient Planet.

Russo, E and D. Domeisen (2023) "Increasing intensity of extreme heatwaves: The crucial role of metrics". *Geophysical Research Letters*, 50.

Samuelson, P.A (1954) "The Pure Theory of Public Expenditure", *Review of Economics and Statistics,* 36(**4**): 387 – 389.

Stern, N. H. (2007) "The Economics of Climate Change". *American Economic Review*, 98: 1 – 37.

Traeger, C.P. (2023) "Analytic Climate Economy (ACC)". *American Economic Journal: Economic Policy,* 15: 372 – 406.

UNFCCC (2005) Caring for Climate: A Guide to the Climate Change Convention and the Kyoto Protocol, Bonn: United Nations Framework Convention on Climate Change (UNFCCC).

UNFCCC (2024) "COP 29 UN Climate Conference Agrees to triple finance to developing countries protecting lives and livelihoods", New York: United Nations.

UNIDO (2025) NDC 3.0 Guide Book for Industrial Decarbonizations, Vienna: United Nations Industrial Development Organization (UNIDO).

United Nations (2007) Human Development Report, New York: United Nations.

United Nations (2015) Transforming our World: The 2030 Agenda for Sustainable Development, New York: United Nations.

United Nations (2016) UNFCCC – Paris Agreement: Article 6, Paris United Nation Framework Convention on Climate Change (UNFCCC) Secretariat.

United Nations (2024) UN Global Compact Africa Strategy, New York: United Nations.

Villaverde, J. F. et al. (2024) "Climate Change through the lens of Macroeconomic modeling", NBER Working Paper Series, 32963.

WEF (2024) Fostering Effective Energy Transition, Geneva: World Economic Forum (WEF).

WEF (2025A) Global Risk Report, Geneva: World Economic Forum (WEF).

WEF (2025B) Securing Minerals for the Energy Transition, Geneva: World Economic Forum (WEF).

World Bank (2010A) Understanding the link between climate change and development, Washington: World Bank.

World Bank (2010B) World Development Report, Washington: World Bank.

World Bank (2018) World Development Indicator, Washington: World Bank.

World Bank (2023) Climate Change and Development Report, Washington: World Bank.

World Bank (2024) A Carbon Market Guide Book for Kenya Enterprises, Washington: World Bank.

World Bank (2025) Global Economic Prospects, Washington: World Bank.

Zappala, G. (2024) "Adapting to Climate Change Accounting for Individual beliefs, *Journal of Development Economics,* 169.