IJAAR PUBLISHING®

African Journal of Environment and Sustainable Development | ISSN: 3027-2718
Vol. 3, Issue 4 (2025) | www.ijaar.org

Between Promise and Uncertainty in Carbon Emission Reduction: An investigation into the Implementation of Clean Development Mechanism in Nigeria and Malaysia

Corresponding Author: Jude Chidiebere Anago
Department Banking and Finance, Faculty of Business Administration
University of Nigeria, Enugu Campus
Email: jude.anago@unn.edu.ng
ORCID: 0000-0001-5457-7604

Naomi Tanko Agbu
Ministry of Energy and Economic Development
Taraba State, Nigeria
Email: naomit.agbu@yahoo.com

Ifeoma Nwakoby
Department Banking and Finance, Faculty of Business Administration
University of Nigeria, Enugu Campus
Email: Ifeoma.nwakoby@unn.edu.ng

Abstract: *Carbon emissions are a global concern, especially in global north; yet, each nation's response to the danger and evaluation of novel reduction strategies is context-dependent. Although compliance is essential, strategy should be of paramount importance. This case analysis review seeks to understand the implemented CDM project characteristics, barriers and challenges in two global south countries of Nigeria and Malaysia and juxtapose both countries in a bid to establish contextual factors capable of shaping the sustainability and effectiveness of CDM initiatives, which provide the background to make recommendations on how to enhance CDM design, implementation, and impact to policymakers in both countries in order to resolve the uncertainties that impede efforts to adopt carbon reduction techniques. The study findings from case analyses of five projects indicate that Nigeria and Malaysia require enhanced strategic redesign, transparency, regulatory consistency, regional collaboration, and reliable institutional support.*

Keywords: Carbon Emission Reduction, Clean Development Mechanism, Climate Finance, Malaysia, Nigeria, Kyoto Protocol

Anago, J. C., Agbu, N. T. & Nwakoby, I. (2025). Between Promise and Uncertainty in Carbon Emission Reduction: An investigation into the Implementation of Clean Development Mechanism in Nigeria and Malaysia. *African Journal of Environment and Sustainable Development. 3*(4), 89-114. DOI: https://doi.org/10.5281/zenodo.18139170

1. Introduction

Alongside energy efficiency, the current sustainable development goals require more sustainable approaches to mitigate carbon emissions, as the United Nations Framework Convention on Climate Change (UNFCCC) contends that climate change is intensified by human activities such as agriculture, industrialisation, transportation, deforestation, and open burning (Nguyen et al., 2020; Lim & Lam, 2014). As a result, many national regulations and international environmental agreements, like the Kyoto Protocol (KP), were established, integrating adaptable strategies for developed countries to reduce greenhouse gas (GHG) emissions. The KP classifies countries into Annex I and non-Annex I categories. The Annex I countries must play crucial roles in reducing their carbon dioxide emissions through mechanisms such as international emissions trading (EIT), joint implementation (JI), and clean development mechanisms (CDM), which have proven effective in lowering emissions from both Annex I and non-Annex I countries.

The CDM is one of KP's three options for carbon reduction and is considered the most cost-effective, project-orientated approach designed to provide efficient alternatives for carbon emission reduction (Pacagnella Junior et al. 2025; Lo and Cong, 2022; Burian and Arens, 2014; Mulenga and Oeba, 2019; Zainuddin et al. 2017). The two primary objectives are to assist Annex I countries in meeting their emission reduction obligations and to promote sustainable goals in developing nations, referred to as non-Annex I, which are predominantly global south countries(Lo and Cong, 2022). Essentially, the CDM role is to enable Annex 1 countries to produce and acquire carbon offsets units (certified emission reductions (CER) through investments in GHG mitigation projects in non-annex 1 countries, in bid to reduce, avoid or sequestrate one metric ton of CO2 that would otherwise be emitted into the atmosphere (Lo and Cong, 2022). Then Annex 1 would then use CERs to meet their emission reduction obligation or targets under the KP. To be eligible for the CDM, a project must meet two essential criteria: additionality and sustainable development. In this context, additionality requires that the project's carbon reductions exceed those that would occur under a "business as usual" scenario. A project must not only diminish emissions but also achieve this reduction by measures that would not occur under typical company practices (Pacagnella Junior et al. 2025). Moreover, CDM initiatives must yield tangible, quantifiable, and enduring advantages for climate change mitigation (Burian and Arens, 2014). The guarantees of sustainable development in CDM projects ensure that these efforts promote the sustainable advancement of the host nations (Lo and Cong, 2022). The host nation, designated as a developing country in global south, is responsible for establishing its standards and evaluation protocols. The utilisation of CDM is increasing in wealthier nations, while there has been a reduced focus on CDM implementation in global south countries.

Against this backdrop, this study aims to achieve three key objectives: first, to understand the barriers and challenges of CDM implementations in two global south countries of Nigeria and Malaysia; second to juxtapose both countries in bid to establish contextual factors capable of shaping the sustainability and effectiveness of CDM initiatives. This will then provide the background upon which the study will provide recommendation (the third objective) on how to enhance CDM design, implementation and impact to policymakers. The study contribution to knowledge include strengthening literature with practical insights into the operational realities of carbon offset mechanisms in the global south. Also, this study can enhance national growth prospects and identify specific areas favourable to sustainable technologies for countries designated as KP non-annex countries (not obligated to reduce emissions).We believe doing so will provide timely and policy-relevant evidence that can inform ongoing debates on CDM reform. The paper thereby bridges empirical evidence with

policy imperatives, which is a dual contribution to literature and international climate policy design.

The rest of the paper is organised as follows: The literature overview is located in Section 2, case study analyses are in Chapter 3, discussion: barriers and recommendations are in Section 4, and the conclusion is in Section 5. Each section comprises multiple subsections that augment this study and provide a thorough overview of its subjects.

2. Literature Review

2.1 Carbon Emission Triggers

Climate change is attributable to both natural and anthropogenic factors. Natural phenomena, including volcanic eruptions, alterations in the Earth's orbit, and solar activity (Meng et al., 2024; EPA, 2012), with anthropogenic influences that elevate greenhouse gas (GHG) concentrations in the atmosphere (Raza et al., 2025), result from significant developments in civilisation. A layer of greenhouse gases functions as a thermal blanket for the Earth, absorbing heat and maintaining a life-sustaining average temperature of approximately 15°C (NASA, 2016). The greenhouse gases include water vapour, methane, nitrous oxide, carbon dioxide (CO2), and chlorofluorocarbons (EPA, 2012). A significant rise in the concentration of these greenhouse gases in the atmosphere and its consequent effects indicate that the climate has changed (Met Office, 2015). The EPA (2012) identified a correlation between volcanic eruptions and historical climate change. Since the onset of the industrial age, human activities have resulted in substantial increases in greenhouse gas emissions, thereby impacting the climate. The principal greenhouse gas generated by human activity is CO_2, resulting from land clearance for agriculture, industrial operations, and predominantly, the combustion of fossil fuels, with gas flaring playing a substantial role. The primary contributors to CO_2 emissions from human activities are transport, coal, natural gas, and fossil fuels, with the emissions recorded in tonnes from 2018 to 2023 presented in Table 1.

Li et al. (2025) identified multiple avenues through which the transport sector contributes to carbon emissions. Initially, there is the advancement of transport, encompassing the instruments utilised for constructing transport networks. Secondly, the energy consumed in transportation results in increased carbon emissions. Third, transport infrastructure contributes to carbon emissions as a result of activities associated with economic expansion and substantial populations. Coal continues to be the most carbon-intensive fossil fuel and a significant source of global carbon emissions, particularly through conventional technologies that generate over 15 billion tonnes of carbon emissions each year (Liu et al. 2024; Wang et al., 2024).

Table 1 indicates that Malaysia utilises a greater quantity of coal compared to Nigeria. Malaysia has frequently relied on coal for electricity generation, constituting a significant portion of its energy supplies. Conversely, Nigeria and the remainder of Africa utilise minimal coal. Global coal emissions are projected to increase from 4,407 billion metric tonnes in 2023 to 4,740 billion metric tonnes by 2040, and thereafter to 4,954 billion metric tonnes by 2050 (Raza et al. 2025). In addition to coal, natural gas and fossil fuels are acknowledged as the predominant energy sectors worldwide, with China, the USA, India, Russia, and Japan identified as the leading major energy consumers overall (Rahman et al., 2024). In Africa, natural gas constitutes a predominant component of the energy mix, possessing the greatest percentage of installed capacity (Raza et al. 2025). Notably, the utilisation of natural gas and fossil fuels primarily occurs in metropolitan regions; hence, Zhang et al. (2024) contended that these locations are the foremost contributors to worldwide fossil fuel carbon emissions. This encompasses industrial operations.

Table 1. Major Sources of CO_2 Emissions in Nigeria and Malaysia between 2018-2023

Category	Nigeria (Unit: 000 tonnes)						Malaysia (Unit: 000 tonnes)					
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Transport	54,990.8	58,838.9	50,513.5	57,213.5	56,657.8	57,203.1	60,829.6	64,780.0	50,161.5	49,011	51,965.7	55,169.3
Natural gas	30,757.9	30,959.8	31,684.9	31,839.2	31,974.4	32,101.2	62,010.2	64,063.8	59,927.6	69,096.1	69,981.8	70,721.6
Fossil fuel	97,189.8	101,411.4	93,741.2	101,461.5	101,995.5	102,068.5	228,144.6	231,601.5	225,868.7	225,860.3	225,574.8	224,821.4
Coal	6,569.5	6,645.1	5,738.9	6,116.5	6,059.9	5,986.7	88,299.8	83,829.9	98,647.9	90,969.2	91,302.9	92,237.0

***Unit in tonnes (000)**

Source: Euromonitor Passport International from Energy Information Administration of the US Government, International Energy Agency, (2024)

In light of this, there is an urgent need to transition away from the above carbon emission contributors to meet global climate goals, particularly with the aim to limit global warming to 1.5°C. Approaches to achieve this remain dynamic and controversial. However, the majority consider renewable energy as a credible option, which often sees the substitution of coal and natural gas with a wide variety of alternative energy sources such as solar and wind, hydropower, biofuels, and nuclear energy (Rahman et al. 2024). In contrast, Rahman et al. (2024) equally argued that it is ambiguous that the use of renewable energy sources exclusively drives the increase and decrease of carbon emissions. In their study, Rahman et al. (2024) found varied results about how using renewable energy affects carbon emissions in major fossil fuel-consuming countries from 1990 to 2020. It points out that using less renewable energy doesn't always mean carbon emissions go up. This means there are other important factors that also affect carbon emissions along with the changes in renewable energy use. This uncertainty led to this study's focus on a dual-control (energy efficiency and carbon emission market) approach to effectively manage carbon emissions.

2.2. Carbon Emission Mitigation Strategies

Carbon Emission Market

Decarbonisation is the process of diminishing and eliminating carbon dioxide and other greenhouse gases from the environment. This is a vital reaction to climate change, facilitating the extraction of carbon from the atmosphere, either at the source of emissions (point source capture, PSC) or directly from the air (direct air capture, DAC). The gas flaring capture pattern may involve the capture and reinjection of gas into the oil reservoir, the capture and transportation via pipeline to an end user, or the capture and conversion of gas into liquids, liquefied natural gas (LNG), gas to liquid (GTL), or liquefied petroleum gas (LPG), which can be distributed and sold domestically or internationally (ICF International, 2006). A carbon market was established as the financial mechanism enabling companies to trade emissions allowances in order to achieve reduction targets. The predominant portion of money from carbon markets is designated for initiatives that extract carbon from the atmosphere via either natural climate solutions (NCS) or DAC. Zavyalova and Li (2024) contend that the carbon emission market functions as a primary mechanism to promote more avenues for the active reduction of carbon emissions. It offers a platform to sell this right, so promoting more avenues to decrease overall emissions (United Nations, 2015).

Zavyalova and Li (2024) asserted that the operation encompasses multiple processes, including the centralised reporting of carbon emissions by all emitters to regulatory authorities, facilitating third-party verification and the submission of a verified report to the authority that confirms the accuracy of the data declared by the emitters. The regulatory authority thereafter aggregates the total emissions from all units within the region, ascertained from the compendium of emissions across various industries and locations. Emissions from each source are quantified using three primary methods: quota allocations, which provide a fair emission value for the unit; the industry benchmark technique; and the historical intensity method, which involves analysing past total emissions. Moreover, they asserted that this indicator ought to have been lower in prior years to incentivise emission sources to implement management or technical measures for emission reduction. Subsequently, we go to the free trade phase, which permits emission entities to sell any surplus reductions in emissions they have accomplished above the established target, although for a restricted duration. Failure to achieve the total emission reduction objective, may result to mandatory acquisition of carbon emission credits from other market participants. The concluding procedure entails compliance liquidation or clearing, enabling

the competent authority to verify whether each emitter has achieved the emission target through self-reduction or by acquiring allowances.

While not all emitters mitigate their emissions by acquiring carbon credits from carbon markets, some may choose to enhance emissions efficiency through technological methods, such as energy efficiency, which falls outside the purview of this study. Others may mitigate emissions by enhancing corporate governance. Although various methods are available, Figure 1 illustrates that more industrialised nations globally are employing carbon market trading systems. A multitude of individuals contend that these systems are the primary means to incentivise various areas and sectors to reduce carbon emissions. In 2023, the revenue from the global ETS indicated that the EU ETS was predominant, likely the largest carbon market, which has seen tremendous evolution since its inception over 20 years ago. This revenue also includes emitters who surpassed their emissions reduction targets and chose to sell excess emissions through the carbon market for profit, significantly incentivising each emitter's endeavour. In summary, enterprises that do not achieve emission objectives are required to purchase carbon credits in the carbon market or face substantial financial penalties. Burke et al. (2021) elucidated that enterprises surpassing the reduction objective will garner supplementary earnings from the selling of carbon credits.

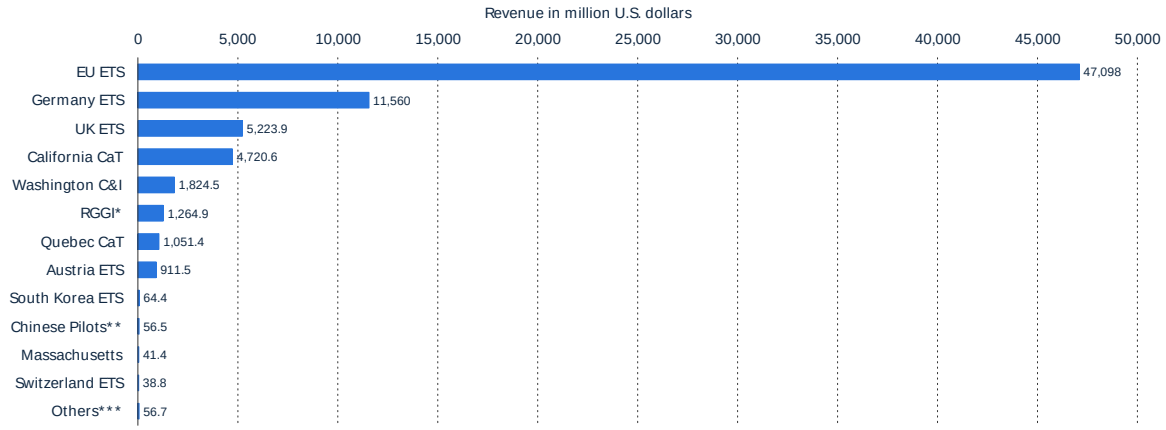

Figure 1: Revenue generated by ETS worldwide in 2023 by jurisdiction (In million U.S. dollars)
Source: Statista (2023)

The carbon market is categorised into compliance carbon markets and voluntary carbon markets. Compliance carbon markets (CCM) are financial markets in which required national, regional, or worldwide institutions engage in the trading and regulation of carbon allowances, representing the permissible carbon emissions for a company or entity (McKinsey, 2024). These marketplaces assume an increasingly prominent role in global endeavours to mitigate emissions. The market is anticipated to have a value above $100 billion and an annual trade turnover surpassing $250 billion as of 2021. In contrast, voluntary carbon markets (VCM) enable the purchase, sale, and exchange of carbon credits to offset greenhouse gas emissions. Organisations with net-zero pledges often acquire carbon credits to mitigate their greenhouse gas emissions. Despite the voluntary carbon market being in its infancy, valued at approximately $300 million in 2022, McKinsey (2024) underscored that its growth will significantly enhance climate action efforts.

Carbon markets are crucial instruments for addressing climate change by facilitating emissions offsetting, enabling companies to significantly contribute to atmospheric carbon

removal and attain the global net-zero emissions target established in the 2015 Paris Agreement on climate change. A considerable number of governments are urging organisations inside their borders to adopt long-term carbon reduction programs and utilise carbon markets to ensure accountability for their immediate carbon footprints. The demand for carbon credits, which certify the removal of a specific quantity of greenhouse gas emissions from the atmosphere, is projected to rise 15-fold by 2030 and 100-fold by 2050, with the total market for carbon credits anticipated to exceed $50 billion (McKinsey, 2024). A carbon sector that can implement both nature- and technology-based removal solutions may reach a valuation of $1.2 trillion by 2050 (McKinsey, 2024), necessitating prompt steps within nations to realise this potential. This underscores the study's purpose, which is to examine carbon removal strategies in Nigeria and Malaysia.

2.3 Policies and Governance of CDM carbon emission reduction in Nigeria and Malaysia

Nigeria's carbon emission reduction

According to Article 12 of the Kyoto Protocol (KP), a party in Annex B with an emission-reduction or limitation commitment may execute an emission-reduction project in developing nations such as Nigeria and Malaysia. Such projects can provide tradable Certificate Emission Reduction (CER) credits that assist in achieving Key Performance objectives, with each target representing one tonne of CO_2. Within this framework, two mechanisms for balancing emissions under the KP were established: the CDM and the JI despite the KP encompassing three market-oriented approaches for achieving carbon emission reduction targets, the third being International Emissions Trading. For JI, it is inapplicable to developing nations such as Nigeria. Nigeria can utilise the CDM, as specified in the KP, by collaborating with Annex I nations to implement emission reduction projects within Nigeria (a non-Annex I country), thereby using the accrued credits to fulfil its responsibilities. Boyd et al. (2009) proposed that the CDM enabled poor nations to engage in trade by selling carbon credits, referred to as CERs, to entities required to comply with emission restrictions.

Nigeria became a member of the KP in 2004, hence qualifying for the implementation of carbon reduction projects and the acquisition of CDM carbon credits. Nigeria established a Designated National Authority (DNA) for the UNFCCC, represented by the Presidential Implementation Committee on the Clean Development Mechanism (PIC-CDM) in 2005, to coordinate CDM initiatives in the country. This adheres to CDM regulations requiring each nation to establish a national authority for CDM operations. This committee operates under the federal Ministry of Environment and is tasked with supervising CDM activities and sanctioning qualifying projects. The Ministry of Environment oversees comprehensive policy and national issues pertaining to the CDM. The PIC-CDM verifies the project's eligibility to the CDM Executive Board, which grants a CER following the completion of a project eligibility evaluation (ICF International, 2006; Akinyele et al., 2014). Consequently, the PIC-CDM and the Ministry of Environment serve as the foundational elements in Nigeria, with approximately 750 prospective CDM projects recognised inside the nation (ICF International, 2006). Nigeria is positioned ninth globally for its potential in CDM projects, with an estimated yearly capacity of 4,693,552 CER units. This is the greatest in Africa and constitutes 1.03% of the global total (Mohammed 2020).

While the predominant CDM projects in Nigeria pertain to the oil and gas sector, the nation can be regarded as a work in progress regarding carbon emission reduction targets. The CDM

is the only initiative deemed effective, as it successfully addresses gas flaring and associated CO_2 emissions (Mohammed, 2020). This may suggest the government's inadequacy in advancing alternative mechanisms and executing energy efficiency measures designed to diminish carbon emissions. Despite governmental difficulties, the mechanism has achieved some progress, although contradictory figures persist. Emem (2016) states that Nigeria achieved its inaugural CDM project via the Kwale Oil-Gas processing plant, anticipated to diminish 1.9 million tonnes of CO2 equivalent annually and yield around $200 million USD over the subsequent decade (2016-2026), of the project's duration. Emem (2016) subsequently enumerated the gas-powered Geometrics power facility in Aba, projected to produce 142 megawatts of energy, the Afam power project with a capacity of 926 megawatts to mitigate roughly 2 million tonnes of emissions, along with 22 further unlisted projects. This study utilised UNFCCC records to summarise CDM projects in Nigeria, as illustrated in Table 2 below. It was determined that just 12 active projects exist, notwithstanding the various forms of CDM programs throughout the country.

Table 2: CDM Registered Projects in Nigeria and their characteristics

Registered Date	Title	Host parties	Other parties	Reductions
09/11/2006	Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant, Nigeria	Nigeria	Italy	1496934
12/10/2009	Efficient Fuel wood stoves for Nigeria	Nigeria	Germany	31309
16/10/2010	Recovery and marketing of gas that would otherwise be flared at the Asuokpu/Umutu Marginal Field, Nigeria	Nigeria	Norway	256793
12/07/2012	LFG Project Nigeria	Nigeria	France	129932
07/11/2012	Distribution of Fuel-efficient improved cooking stoves	Nigeria	Sweden, Netherlands	46717
18/12/2012	Lafarge WAPCO Partial Substitution of Alternative Fuels in Cement Facilities Project in Nigeria	Nigeria	France	166557
24/12/2012	Recovery and Utilisation of Associated Gas from the Obodugwa and neigbouring oil fields, Nigeria	Nigeria		288147
28/12/2012	Kainji Hydropower Rehabilitation Project, Nigeria	Nigeria	Belgium, Germany, Sweden, Italy	873474
31/12/2012	Energy Efficiency of Nigeria's Residential Lighting Stock by Distributing up to 40 Million Compact Fluorescent Lamps (CFLs) to Residential Households Connected to the National Grid	Nigeria	United Kingdom of Great Britain and Northern Ireland	28892

25/04/2013	Distribution of Improved Cook Stoves in Sub-Saharan Africa	Nigeria and others	Netherlands, Republic of Korea	39114
18/03/2016	Cable Propelled Mass transit Projects in Nigeria	Nigeria	-	24059
04/11/2020	Replacement of higher carbon fuels by natural gas in the industrial and power sector in Nigeria	Nigeria	-	-

Source: UNFCCC, (2024)

In sharp contrast to the aforementioned, Agbonifo (2015) contended that the contribution of CDM to sustainable development in Nigeria is purely rhetorical, reliant on project design documents and assessments of project implementation. The report contended that job creation from the CDM projects for the numerous unemployed youths in host oil and gas-producing towns is predominantly insignificant. The author indicated that flaws exist due to the absence of consensus on the project. The intricate procedure of negotiating and obtaining approval for CDM projects results in a sluggish implementation process. Agbonifo (2015) associated this with the limited number of CDM projects (12), despite the significant environmental challenge posed by oil and gas flaring in Nigeria. The research indicated that Nigeria derived minimal benefits from the CDM's anticipated average yearly CERs. This casts question on the efficacy of the CDM in enhancing air quality and mitigating emissions and environmental degradation in Nigeria.

Malaysia Carbon Emission Reduction

Malaysia is a signatory of the Kyoto Protocol and a member of the Group of 77 and many climate change organisations. It is experiencing fast industrialisation and substantial investment in industry and infrastructure development; hence, it faces significant energy consumption demands. Malaysia has recently strengthened its decarbonisation strategy by committing to attain carbon neutrality by 2050 and has highlighted carbon capture as a key solution for carbon removal from its energy sector by that year (Nasir and Go, 2024; Susskind et al., 2020). Weber et al. (2024) identified the decarbonisation of the power sector, comprehensive electrification, enhancements in energy efficiency across buildings, transport, and industry, alongside the implementation of advanced technologies such as hydrogen and carbon capture, as principal factors for emission mitigation in Malaysia. This move follows their commitment to decrease GHG emissions by reaffirming their NDC on emission reduction at the UN Climate Change Conference 2021 (COP26) to mitigate global warming and its detrimental effects (Nasir and Go, 2024). As a participant in the Net-zero 2050 initiative, Malaysia declared a net-zero target by 2050 in the RMK-12 in September 2021. A collaborative research conducted by BCG, WWF, and the Malaysian government indicated that Malaysia has attained net positive emissions since 2004, attributed to progress and development (WWF Malaysia and Boston Consulting Group, 2021; Abd Rahman et al., 2022).

Malaysia voluntarily participated in the CDM as a non-Annex I nation following its accession to the UNFCCC on June 9, 1993, and its formal ratification in 1994. The nation joined the protocol on September 14, 2002. Malaysia initiated its endeavours to reduce carbon emissions in 2006 through a series of policies and strategies designed to diminish carbon intensity. These policies encompass the incorporation of biodiesel into diesel fuel, the

establishment of a Sustainable Energy Development Authority (SEDA) to advocate for renewable energy in power generation, the promotion of public transport while restricting private vehicle ownership, and the encouragement of "green" technology adoption. Chua (2010) posited that Malaysia endorses the CDM as it seeks to assist industrialised nations in mitigating their emissions while also fostering sustainable development in underdeveloped countries. Zainuddin et al. (2017) concisely claim that CDM provides a framework that integrates the diverse interests of stakeholders, facilitating modern nations in fulfilling their obligations. Moreover, they determined that CDM is highly attractive to Malaysia due to participation in the mechanism being motivated by financial self-interest. The CDM provides members from nations with high emission reduction costs an economical method to fulfil international commitments. In instances where governments cannot resolve issues through conventional methods of force and control, market tools like the CDM facilitate a redistribution of responsibilities by including all stakeholders in the problem-solving process.In contrast to Nigeria, which has about 12 CDM-recognized projects, Malaysia has successfully registered numerous CDM projects (refer to table 3). The inaugural project was the Biomass Energy plant in Lumit, boasting a capacity of 1600 MW, while the Jana Manjung project, with a capacity of 2100 MW utilising biomass and coal, was the first large-scale CDM project in Malaysia (Zainuddin et al. 2017, citing Ahmad et al. 2011). A significant number of projects, particularly in the palm oil sector, which is categorised under agriculture, along with forestry and energy, have been registered as CDM projects, as certified by the UNFCCC (1997). Hamzah et al. (2019) indicated that by 2015, the aggregate investment of around USD 1,530 million in CER transactions and holdings in Malaysia's pending account amounted to 2,789,528 CER. Biomass production constituted 80.1% of the CDM pipeline and 76.9% of all registered projects. In 2015, project operations encompassed the processing of residual materials from oil palm, the production of biofuel, methane capture, and co-composting utilising solid or liquid waste. Malaysia is promoting palm oil carbon trading to achieve the overarching goal of reducing global emissions, regardless of the sector or country from where the carbon reductions originate. The obstacle of registering and validating expenditures within the Malaysian palm oil business should no longer persist. This has encouraged several corporate sectors in the country, including power manufacturing, waste management, forestry, oil and gas production, agriculture, and transportation, to actively engage in CDM project applications (Lim and Lam, 2014).

Bursa, a wholly-owned subsidiary of Bursa Malaysia Berhad, recently conducted the Bursa Carbon Exchange (BCX), the much-anticipated auction of its inaugural Malaysian carbon credits on July 25, 2024 (Bursa Malaysia Berhad 2024; Yin and Yep, 2024). The auction of carbon credits from the Kuamut Rainforest Conservation project represents a pivotal achievement for BCX, encompassing the provision of its inaugural Malaysian Nature-based carbon credits plus (MNC+) derived from a domestic forestry initiative and the diversification of BCX’s product portfolio to incorporate local carbon credits alongside global carbon credits. This is expected to stimulate increased interest from local and international corporate sectors to engage in further carbon projects in Malaysia, considering the favourable prospects for both nature- and technology-driven carbon project development.

Table 3: CDM Registered Projects in Malaysia and their characteristics

Registered Date	Title	Host parties	Other parties	EER***
10/06/2006	LDEO Biomass Steam and Power plant in Malaysia	Malaysia	Canada, Switzerland, Germany, Denmark	208871
10/06/2006	SEO Biomass Steam and Power Plant in Malaysia	Malaysia	Canada, Denmark, Germany	216831
02/09/2006	Johor Bundled Biomas Steam Plant in Malaysia	Malaysia	Canada	130505
02/09/2006	Bentong Biomass Energy Plant in Malaysia	Malaysia	Canada, Germany	380934
04/09/2006	ENCO Biomass Energy Plant in Malaysia	Malaysia	Canada, Germany	70316
03/03/2007	Factory energy-efficiency improvement project in Malaysia (MAPREC, PRDM, PSCDDM, PAVCJM, PCM)	Malaysia	Japan	1312
03/03/2007	Factory energy-efficiency improvement project in Malaysia (PHAAM, PCOM, (PJ), PCOM (SA), PEDMA, MEDEM)	Malaysia	Japan	6474
08/04/2007	Kim Loong Methane Recovery for Onsite Utilisation Project at Kota Tinggi, Johor Malaysia	Malaysia	Switzerland	57656
20/05/2007	Landfill Gas utilisation at Seelong Sanitary Landfill, Malaysia	Malaysia	Denmark	108335
08/11/2007	Methane recovery and utilisation project at United Plantations Berhad, Jendarata Palm Oil Mill, Malaysia	Malaysia	Denmark	20271
30/11/2007	Factory energy efficiency improvement in compressed air demand and supply in Malaysia	Malaysia	Japan	173
21/12/2007	Biomass thermal energy plant- Hartalega Sdn. Bhd, Malaysia	Malaysia	United Kingdom	128587
01/05/2008	Inno-Malsa-Palm Oil Mill Waste Recycle Scheme, Malaysia	Malaysia	Switzerland, United Kingdom	103693
17/06/2008	Methane Recovery in Wastewater Treatment, Project AMA07-W-01, Perak, Malaysia	Malaysia	Switzerland, Netherlands	57094
22/10/2008	Methane Recovery for Oniste Utilisation Project at Desa Kim Loong Palm Oil Mill, Sook, Keningau, Sabah, Malaysia	Malaysia	Switzerland, Germany	38340
26/01/2009	Methane Capture and On-site Power Generation Project at Syarikat Cahaya Muda Perak (Oil Mil) Sdn. Bhd. In Tapah, Perak	Malaysia	Switzerland, Germany	67133
26/01/2009	Methane Capture and On-site Power	Malaysia	Switzerland,	78962

	Generation Project at Sungai Kerang Palm oil mill in Sitiawan, Perak, Malaysia		Germany	
19/02/2009	Methane Capture and utilisation through organic wastewater treatment in Malaysia	Malaysia	Japan, Sweden	43152
19/03/2009	Methane recovery and utilisation project at TSH Sabahan Palm Oil Mill, Sabah, Malaysia	Malaysia	United Kingdom,	53439
20/03/2009	Methane recovery and utilisation project at TSH Lahad Datu Palm Oil Mill, Sabah, Malaysia	Malaysia	United Kingdom	33356
28/08/2009	Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor in Malaysia	Malaysia	Switzerland, Japan, Netherlands, United Kingdom	219625
03/11/2009	Taman Beringin Integrated Landfill Management Project, Kuala Lumpur, Malaysia	Malaysia	Canada	53089
12/11/2009	AMA08-W-22, Methane Recovery in Wastewater Treatment, Johor, Malaysia	Malaysia	Switzerland, Netherlands	17646
12/11/2009	AMA08-W-21, Methane Recovery in Wastewater Treatment, Johor, Malaysia	Malaysia	Switzerland, Netherlands	21671
12/11/2009	AMA08-W-24, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland, Netherlands	26568
12/11/2009	AMA08-W-25, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland, Netherlands	35472
13/11/2009	Methane Recovery in Wasteland Treatment, Project AMA07-W-07, Kedah, Malaysia	Malaysia	Switzerland, Netherlands	44248
13/11/2009	MY08-WWP-26, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland, Netherlands	30692
13/11/2009	Methane Recovery in Wastewater Treatment, Project AMA07-W-05, Pahang, Malaysia	Malaysia	Netherlands	35174
13/11/2009	AMA08-W-23, Methane Recovery in Wastewater Treatment, Sarawak, Malaysia	Malaysia	Switzerland, Netherlands	20002
16/11/2009	MY08-WWP-36, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland, Netherlands	22092
25/11/2009	MY08-WWP-34, Methane Recovery in Wastewater Treatment, Pahang and Negeri Sembila, Malaysia	Malaysia	Switzerland, Netherlands	30472
21/12/2009	AMA08-W-10, Methane Recovery in Wastewater Treatment, Kedah, Malaysia	Malaysia	Switzerland, Netherlands	5392
02/02/2010	Inno-Kwants Mewah- Palm Oil Mill Waste Recycle Scheme, Malaysia	Malaysia	United Kingdom	95762
08/10/2010	Sungei Kahang POME Biogas Recovery for Energy Project in Johor, Malaysia.	Malaysia	Japan	65883
25/01/2011	Felda Kalabakan and Jerangau	Malaysia	United	33409

	Composting Project In Malaysia		Kingdom	
05/03/2011	MY08-WWP-30, Methane Recovery in Wastewater Treatment, Pahang, Malaysia	Malaysia	Switzerland, Netherlands	26983
23/06/2011	Abedon Enviro Bio-Waste Composting Project, Malaysia	Malaysia	United Kingdom	26963
15/07/2009	Residual Organic Waste to Steam & Electricity Project in Nilai, Malaysia	Malaysia	United Kingdom	12735
17/04/2012	Leluasa Biomas Steam Plant in Lahad Datu, Sabah, Malaysia	Malaysia	Canada	20526
12/06/2012	Sungai Rek Mini Hydro, Kuala Krai, Kelantan, Malaysia	Malaysia	United Kingdom	12926
12/07/2012	Bionersis LFG Project Malaysia (Penang)	Malaysia	France	292200
23/08/2012	Biopower Climate Care POME Biogas Capture and Utilization Project in Palong, Malaysia	Malaysia	Japan, France	32500
28/09/2012	Nittsu Fuel Efficiency Improvement with Digital Tachograph Systems on Road Freight Transportation CDM Project in Malaysia	Malaysia	Japan	239
02/10/2012	Methane Capture and Utilization Project at Carotino Palm Oil Mill, Malaysia	Malaysia	Australia	27394
02/10/2012	Methane Capture and Utilization Project at Melewar Palm Oil Mill, Malaysia	Malaysia	Australia	44715
02/10/2012	Methane Capture and Utilization Project at Asia Palm Oil Mill, Malaysia	Malaysia	Australia	40466
04/10/2012	Biogas and electricity generation in Kuala Sungai Baru, Malaysia	Malaysia	Japan	33621
22/10/2012	Magenko Renewables (Penang) Wastewater Methane Avoidance and Energy Generation Project, Malaysia	Malaysia	United Kingdom	39068
30/10/2012	Kretam Wastewater Biogas Recovery and Utilisation Project, in Sandakan, Sabah Malaysia	Malaysia	Japan	32636
08/11/2012	Magenko IYO Alam Sekitar Bercham Landfill Gas to Energy Project in Ipoh, Malaysia	Malaysia	United Kingdom	23972
18/12/2012	Small hydro project at Sungai Brooke in Lojing, Gua Musang in Kelantan State in Malaysia	Malaysia	Ireland	47094
27/12/2012	Myagri Bio-organic Plant at Kg. Gajah in Perak, Malaysia	Malaysia	United Kingdom	27848
31/12/2012	FELDA Biogas Plant (Methane Recovery and Utilisation) at Sungai Tengi Palm Oil Mill, Malaysia	Malaysia	Australia	26711

Source: UNFCCC, (2024)

EER***Estimated Emission Reductions in metric tonnes of CO2 equivalent annually (as stated by project participants)

Overall, the CDM project activities have become one of the mitigations and emission reduction strategies in Malaysia (Hamzah et al. 2019). However, the existing policy is perceived as not joined up. First, the legal dimension is seen as muddled up with no regulations to dictate that the palm oil industry should implement carbon trading (Hamzah et al. 2019). The cruciality of the legal dimension has affected the ability to meet the sustainable palm oil standard and development in palm oil plantation areas, as governments with different views on carbon trading's commodification influence the outcome. Regulation factors, such as the policy framework for carbon trading and strategic approaches, must provide certainty and confidence for organizations to invest in and address climate actions (Zainnudin and Hamzah, 2023). Besides legal uncertainties, the Standard and Industry Research Institute of Malaysia (SIRIM) noted that the Malaysian Palm Oil Council (MPOC, 2017) believes the slow growth of carbon trading in Malaysia is due to a lack of understanding and uncertainty in the carbon market. This has created many questions and challenges for the carbon market related to the palm oil industry. All these issues are considered integrated with regulative factors since credible regulation can optimise improved adoption of environmental projects.

3. Case Study of Select Projects in Nigeria and Malaysia and their characteristics

This case study became cardinal to explore a comparative analysis of CDM implementation in Nigeria and Malaysia with focus on the readiness of the institutions and sustainable outcomes post implementation, a gap that are scarcely addressed in the literature. Looking at Table 4, We presented 6 cases studies, three from each country. While Malaysia and Nigeria enjoy similar baseline conditions, their outcomes differ greatly. Turning first to the case of Malaysia, they consistently generate high-quality CERs due to improved upscaling and project continuity. Whereas, the bulk of Nigeria's projects lack established CERs. In circumstances where data is accessible, it regularly remains inferior to the levels recorded in Malaysia. Turning now to the funding for CDM in Malaysia, which primarily originates from domestic sources, public-private partnerships, and other dependable financial arrangements. This contrasts with the scenario in Nigeria, which primarily relies on donor funding.

Table 4: Comparative Analysis of Select CDM Projects in Nigeria and Malaysia

	Nigeria CDM Projects			Malaysia CDM Projects	
Project Name	LFG Project Nigeria	Energy Efficiency of Nigeria's Residential Lighting Stock by Distributing up to 40 Million Compact Fluorescent Lamps (CFLs) to Residential Households Connected to the National Grid	Kwale Gas Gathering & Processing (GGP) Phase 1	Bukit Tugar Gas Landfill recovery	Biogas Recovery (POME)

Project Type	Landfill gas collection	Energy Efficiency of Nigeria's Residential	Fossil fuel switch/ Gas flaring reduction	Gas-to-energy landfill	Biogas from Palm oil
Registration Status	Registered (Low CERs generated)	Registered (Low CERs)	Registered	Registered and verified	Registered and generating CERs
Technology deployed	Gas collection flaring system	Energy efficient lighting	Gas gathering compression, processing, NGL extraction, Gas utilisation	Gas engines and power generation	Anaerobic gidesters with electricity generation
Ownership/operation	Private and public partnership	ICIMI + Government+	Niger Delta Petroleum Resources (NDPR)	Government linked Company (GLC)	Palm oil industry Consortium Plus Private
CERs Issued	50,000 or less	100,000 or less	Uncertain	Over 400,000	Over 300,000
Funding Sources	Government and International Donor	Unclear	NDPR, Carbon Finance	CDM/Domestic Carbon funds	Commercial banks, CDM Finance, PPP
Monitoring and verification	Irregular M&V	Unclear approach	International organisation	Regular verification by DOE	M&V is external through international firms
Institutional support	Not optimal from DNA	Multiple inter-agency support	Fragmented (NDPR, Federal Ministry of Environment as DNA)	Efficient DNA support and CDM Help desk	Efficient integration of policy through palm oil sectors
Scalability/Replicability	Limited within Lagos	Limited at Pilot	Moderate to other small/ medium independent projects	Model replicated in other landfills	Scaled across palm clusters

Source: Authors

Impressively, Malaysia has strengthened CDM governance and policy support, alongside improved and consistent monitoring and measurement via regular MRV processes related to national GHG, to tackle the problem of over-reporting of CERs. In contrast, Nigeria presents a different scenario. Project monitoring in Nigeria is inconsistent in specific project and completely absent in many others. Another area in which Malaysia's CDM outperforms Nigeria's is project scalability, as the majority of Malaysian projects are scalable and have enhanced replicability. Nigerian attempts, on the other hand, lack in this regard. This may be

linked to the CDM designs, as Malaysia benefits from long-term CDM frameworks that facilitate scalability, while Nigerian solutions are poorly integrated and fragmented.

Both countries demonstrate desire to have credible institutional support. While Nigeria has growing institutional support; yet, it faces ongoing bureaucratic challenges. Conversely, Malaysia benefits from improved institutional support for its CDM activities, including administrative help and technical support. The principal reason Nigeria lacks a clear strategic direction and sectoral concentration is its contrast with Malaysia, which is progressing in high-impact industries such as palm oil and forest sequestration.

4. Discussion: Barriers and Recommendations

Achieving a low carbon Nigeria and Malaysia by 2050 depend on the development choices and political commitment of the governments of both countries towards this goal. We consider that effective realisation of this would warrant a policy trade-off between fossil fuel production and carbon reduction. For instance, Nigeria possesses substantial oil and gas reserves. However, the extraction and utilisation of these resources significantly contribute to carbon emissions from gas flaring (Mohammed, 2020). Sustaining this extraction and utilisation deviates from carbon reduction principles and is inconsistent with Nigeria's Climate Change Act objectives, ratified in 2021. Thus, Nigeria is faced with tough policy decisions: to maintain a clear intention to decarbonise and reduce oil and gas exports, leading to a drop in economic growth forecasts, especially where over 60% of the population lives below the poverty line and 45% lack access to energy, compounded by the lowest health and education outcomes globally. Alternatively, the country could continue to produce and explore fossil fuels, which would continue to contribute to environmental degradation and potentially miss the 2050 carbon reduction target.

Irrespective of the fact that there are no easy choices for Nigeria, government efforts must be seen to demand fossil fuel reduction policies, which would be focused on the demand side, while the supply side should remain focused on carbon emission mechanisms like CDM. Achieving any of the two above would require not only citizen dedication and behavioural changes but also a serious upgrade of policies and technical know-how. Carbon emission reduction demand is not straightforward considering that the transport sector that provides options for such an approach still depends mostly on fossil fuel, particularly in Nigeria; government is driving snail speed policies in this regard, especially with the implementation of the Electric Buses Rollout Programme, which the government highlighted as a key initiative for generating carbon credits (DGB Group, Feb, 2024). While this is a step at the right direction, regrettably, the cost of these vehicles is high, and achieving compliance would pose a significant challenge for 60% of Nigerians who still live in poverty. Therefore, policies that would demand the shift to biofuels, electricity, or compressed natural gas (CNGs) and fuel cell vehicles must put into consideration, the affordability factor.

Even though the carbon reduction mechanism has benefits like flexibility, market incentives, and the ability to work across regions and industries, there are some concerns that may slow down its progress. For instance, there has been concern that companies that use CDM carbon credits to reduce their carbon footprint will delay reducing their actual GHG emissions (Bernama, 2024). Equally, Zavyalova and Li (2024) argued that the carbon market may suffer from unreasonable trading prices and limited participants because of its market-based operation. The price of carbon equivalents in the market is primarily determined by supply and demand. Therefore, if the market sells too many units of carbon emissions, the price per

unit tends to decrease. When few are available for sale, the price per unit will likely be too high. The price is only reasonable when the supply is reasonable. Likewise, they established that the carbon market may encounter the problem of low motivation among carbon emission units to participate. To put it differently, when companies do not cooperate or are not motivated to participate in the carbon market, the carbon market will not have the desired effect. This problem will also affect the construction of the whole market. The capability of carbon market managers is also considered here, mainly in terms of guiding enterprises to join the carbon market to reduce carbon gradually in some beneficial ways.

The carbon market may also be subject to manipulation by speculators, as in any other market, which means that it is equally important to regulate it. For instance, Oh and Chua (2010) identified serious flaws in the checking system regarding the actual achievement of GHG reductions due to abuse. As we are aware, a CDM project needs to demonstrate potential to drop GHG and that it would not have been economically viable without the additional capital generated by carbon trading. However, investigation showed that approximately 20% of the carbon credits issued did not match genuine reductions, thus risking creating a false sense of security in the system. In fact, owners of large-scale hydropower plants, which remain environmentally controversial, have been accused of manipulating the CDM process.Nigeria presents a significant market for CDM implementation; however, there are market and institutional obstacles, including an underdeveloped domestic market for CDM projects that may struggle to regulate speculators manipulation. It is imperative for the government to establish appropriate mechanisms to eliminate this barriers and foster opportunities in carbon reduction initiatives.

As evidenced earlier and confirmed by Zainuddin et al. (2017), Malaysia does not have regulations that dictate companies to perform environmental management practices. While carbon trading can help support sustainability, having the right policies and regulations is essential for encouraging green growth. However, Malaysia currently lacks strict environmental regulations. This is significant since regulatory quality, one of the governance indicators, is concerned about the government's ability to formulate and implement policies and regulations that permit and promote private sectors in the countries to implement CDM projects. Even though CDM projects are considered a cost-effective approach, which is market-orientated, in the early stage of development, the environmental regulations remain vital and play a critical role in developing such kinds of projects. This gap makes sense, especially in a country where the main reasons for CDM are business profit and other benefits, rather than market pressure, ethical values, or green technology (Zainuddin et al., 2017). Therefore, such oversights are to be expected.

Zinuddin and Hamzah (2023) identified the cost and suitability of the technology involved as one huge hurdle limiting many mitigation actions in carbon trading projects. Transaction costs are closely associated with the formalisation, validation, and implementation verification of environmental projects. Depending on their size, development projects require a large financial investment. In monitoring and evaluating carbon projects, actions to optimise environmental performance and reduce transaction costs are in conflict. Often, regulation is considered unable to meet the carbon reduction targets specified in the trading proposal, due to the pressure between low transaction costs and the environmental efficiency of cap-and-trade schemes (Donald, 2015).

Translating these observations into actionable strategies requires a focus on policy relevance considering the fact that our evaluation of emission reduction in Nigeria and Malaysia

through CDM reveals good and serious shortcomings as carbon reduction mechanism. On the positive side, Nigeria is already implementing CDM in gas flaring and energy sector, however, they should consider the modest advancements Malaysia has made in promoting the CDM not only energy sectors, but also in other sectors like palm oil, forest sequestration and raising domestic carbon pricing. For example, the recent fit achieved with the Bursa Exchange carbon price improved institutional capacity in the area of CDM and equally improved the general investment climate, making it comparable to the status of Annex I countries. An improved CDM track record, including policy strengthening, is more likely to attract more CDM investment than those with limited CDM projects. Such an advantage creates a vicious cycle where the highest performers get better, and the ones that lagged behind continue to be ignored by countries in Annex I. While it is clear that CDM implementations are still in their infancy in Nigeria and growing in Malaysia, key lessons learnt from both countries efforts to decarbonise through CDM should either be strengthened or, better still, revised because GHG emissions reductions have not improved, as Table 1's fossil fuel component in Nigeria and natural gas component in Malaysia indicate. With this in mind, three serious concerns and recommendations are consolidated for policymakers: Limited government technical know-how to enforce CDM (carbon pricing challenge); uncertainty about the dedicated unit in charge of CDM; lack of international finance and technical support; and strengthening the CDM designs in Nigeria.

4.1 Limited institutional framework

The implementation of CDM in Nigeria is significantly impeded as a result of structural deficiencies. Key to this issue is inadequate institutional coordination among DNA under the Ministry of Environment, other relevant bodies and key government agencies like the Power Ministry and the Nigerian National Petroleum Corporation. This fragmented relationship creates uncertainty, especially in regulation, and makes room for role duplication and bureaucratic bottlenecks. Beyond this observation, there is the issue of monitoring, which would have been easier if there were a national database that tracked emission reduction in real time and project performance over time to improve monitoring, reporting and verification (MRV). Without a national database, the credibility of CDM projects will not be highly regarded or appealing to investors.

Another different, yet related concern is the federal structure as practised in Nigeria. This further exacerbates institutional weaknesses, as it induces layers of complexity in environmental governance, as there are always the issues of jurisdictional mandates among the three tiers of government (federal, state and local governments). Cases of policy incoherences, conflicts and delays in policy direction, or outright refusals to endorse or implement federal directives due to differences in political ideologies, rent-seeking or divergent priorities at a given time have been reported. This is more pronounced in gas flaring and waste management sectors where instant economic returns trump long-term environmental sustainability among stakeholder demands. There is also the case of elite capture and corruption implicated in the allocation and distribution of CDM-related resources. This happens because of a lack of transparency in institutions, which harms CDM projects by undermining fairness and inclusiveness that the Kyoto Protocol aims for, thus reducing the benefits of CDM involvement in Nigeria.

An additional issue with Nigeria is poor enforcement and accountability mechanisms. For instance, regulators have not developed the autonomy and compliance tools to enforce CDM guidelines or to sanction project developers that are not performing or being unethical in their

reportage. This lack of enforcement capacity means identified non-compliance won't get corrective measures. For instance, a cardinal assessment criterion like environmental impact assessment (EIA) is not considered a foundational or substantive evaluative exercise for CDM project validation but a mere procedural formality. This action undermines CDM's project integrity and triggers widespread efficacy scepticism. While this insight is compelling, it opens the door to a broader inquiry on the limited involvement of civil society and academia in Nigeria's CDM despite their potential roles in providing oversight and technical support. The best interpretation of this is a weak design of CDM policy with a carbon reduction claim, not necessarily the major aim of embarking on the project, but the revenue that accrues to CERs, hence the lack of involvement of those who will scrutinise the process for quality endorsement. As a result, the CDM project remains disjointed and lacks scalability; reflecting challenges that occur when the institutional framework is weak, fragmented, and poorly aligned with international best practices. This limits Nigeria's capacity and increases the risk in deploying CDM as a sustainable development and climate resilience vehicle.

In contrast to Nigeria, Malaysia's CDM implementation would be considered more advanced but still constrained institutionally. Notable strides have been witnessed in their formal institutional architecture, as well as their robust designated national authority under the Ministry of Natural Resources, Environment and Climate Change. However, the efficacy of CDM is hampered by pockets of persistent institutional framework weaknesses such as bureaucratic rigidity. For instance, their CDM application process is intricate, characterised by inadequate local permit processing for electricity generation and energy efficiency enhancements, elevated implementation costs for CDM projects, substantial consulting fees, protracted project approval durations, and ambiguity regarding return on investment (Hamzah et al. 2019; Tiong et al. 2009).This challenge understandably affects the efficiency of project approval and implementation.No doubt, Malaysia enjoys a more advanced standard procedure compared to Nigeria; delays in hierarchical decision-making processes and excessive administrative scrutiny make the entire process cumbersome. This contributes to dissuading private sector participation, especially for smaller firms with limited resources to navigate the protracted approval process. There is also the nagging delay problem when climate policy intersects with economic or land use policy; as inter-ministerial coordination suffers delays, exhibiting extreme suboptimality. Evidence of a weak, unified regulatory approach results in conflicting inter-ministerial coordination with consequences such as conflicting policy signals that complicate project planning and erosion of investors confidence in the CDM landscape.

Furthermore, Malaysia enjoys more registered CDM projects than Nigeria, but this is equally a deeper governance challenge as regards transparency, accountability and public participation. Instances abound where project design and approval processes follow a top-down and technocratic approach, with affected communities, non-governmental organisations or academia not having engagement contributions. This undermines the social legitimacy of CDM projects and increases the chances of stakeholder risks during implementation. They are also the issue of lack of robustness and rigorous checks from independent validation when it comes to sustainability assessments of CDM projects. This is a reflection of a broader compliance culture issue, where substantive obligations like complying with regulation are considered a box-ticking exercise. Consequently, Malaysia's CDM mechanism finds it difficult to align with emission reduction and sustain the dual mandate of development, especially in ecologically sensitive or otherwise marginalised areas.

Equally vital is the fact that the post-implementation stages of CDM projects, which require MRV practices are good because of the establishment of formal MRV guidelines. Curiously, they are inconsistently applied and their enforcement is weak, causing reported and actual emission reduction discrepancies. Cases of overstating outcomes to secure higher volumes of CERs abound with near zero regulatory repercussions. Such behaviour puts a blemish on Malaysia's international credibility in climate governance and the environmental integrity of the CDM. Overall, the study found that Malaysia's institutional framework functions more robustly than Nigeria's, challenges with enforcement and transparency remain a big challenge in Malaysia and limit CDM transformative potential in securing long-term environmental and equitable sound development outcomes.

4.2 Uncertainty about the dedicated unit in charge of CDMand their technical know-how on CDM designs

The PIC-CDM is the primary entity accountable for CDM in Nigeria; nevertheless, the procedures and designs lack clarity. A definitive master plan delineating eligible CDM projects, investment mechanisms for these projects, and coordination strategies for the relevant industries is lacking. The ambiguity arises from Nigeria's deficiency in explicit and pragmatic regulations or recommendations concerning the opportunities offered by the CDM mechanism and the advantages for CDM investors. The condition of CDM investment in the country is dire, attributed to inadequate technical expertise and potential ambiguities in roles, coupled with ineffective coordination and communication of CDM regulations and standards. This ambiguity over the return on investment (ROI) frequently results in a decline in investor trust. This inherently explains Nigeria's need on external consultants due to insufficient expertise in carbon market operationalisation, particularly in calculating emission reductions and demonstrating that projects would not succeed without CDM incentives.

This insufficient expertise is particularly evident when preparing for and ensuring the effective identification of CDM projects that will yield CERs, or when seeking to enhance CERs and VERs. It becomes a hurdle to develop a robust framework considering the fact that the success of CERs in Nigeria hinges on the nation's ability to develop a robust project pipeline, necessitating the “mandatory” collaboration with foreign consultants that has the expertise to achieve this. The lack of such advisors results in considerable delays in project approvals, exasperating potential investors interested in engaging in carbon markets. Equally essential is the necessity for advanced expertise to broaden CDM implementation across additional projects that will produce CER beyond the existing emphasis on oil and gas.

Malaysia benefits from strong administrative assistance and technological support. However, they still require improved CDM design and technical know-how to develop their forest CDM project. Susskind et al. (2020) contended that despite Malaysia's extensive forests in both the Peninsula and East Malaysia, which contribute to carbon absorption and mitigate approximately 90% of the nation's annual GHG emissions, they are ineffective in combating climate change due to the inadequacies of the CDM design stemming from insufficient technical expertise. The nation presently lacks an adequate quantity of CDM or operational ETS projects, they submitted. Agarwal et al. (2022) indicated that merely two CDM projects are operational, suggesting an inadequate system for their execution. They further contended that due to the significance of forest-based carbon sequestration, Malaysia ought to implement more than two active initiatives in this domain, rather than relying on inadequately designed nature-based conservation efforts, which might facilitate the country's attainment of carbon neutrality. To connect this reasoning to wider policy implications, it is

clear that establishing a separate unit for CDM, staffed with qualified specialists will enhance coordination and communication, hence mitigating concerns arising from many organisations addressing CDM matters without defined roles. This would assist investors in obtaining necessary information more swiftly, therefore circumventing delays, contradictory responses, and inadequate enforcement of regulations and standards.

4.3 Lack of domestic funding structuring and international finance support

The effective implementation of the CDM in Nigeria and Malaysia faces a significant obstacle due to ongoing deficiencies in domestic finance mechanisms and limited access to international financial help. The fundamental causes and effects of this insufficiency present distinctively in Nigeria and Malaysia. For Nigeri, there is lack of a customised domestic financing framework for CDM projects, which has significantly diminished private sector participation and investor trust. The unstable macroeconomic landscape resulting in recurrent currency devaluation, along with an immature green financing framework, discourages long-term investors in emission reduction initiatives. Moreover, legal incentives such as tax reliefs or concessional loans that encourage domestic co-financing of CDM projects are notably lacking. CDM initiatives in Nigeria rely significantly on donor funding; nonetheless, multilateral donors and carbon credit buyers cite institutional opacity, regulatory uncertainty, and bureaucratic obstacles as impediments to ongoing cooperation. This has caused a persistent increase in the mobilisation of both local and external capital challenges, resulting in a narrow focus of CDM activities on oil and gas flaring reduction.

Conversely, Malaysia, which is somewhat more adept at obtaining CDM investment, continues to encounter difficulties in reconciling its long-term low-carbon development objectives with local financial frameworks. Although Malaysia possesses a more resilient financial system and a better regulatory framework than Nigeria, there is a discernible risk aversion towards CDM-type investments in its financial market, as these are predominantly regarded as unpredictable and unbankable. This study observed that, despite Malaysia's middle-income classification and enhanced institutional frameworks, there has been a prolonged loss in access to concessional international finance, particularly within the climate adaption and mitigation context. Global climate funds changing eligibility criteria, now favour least-developed nations.

To connect this with wider policy implications, both nations must initiate the development of strategic novel financial mechanisms to enhance the viability of the CDM. Nigeria necessitates blended finance incorporating de-risking additionality, a public-private partnership model, and the transformation of its national climate finance policy. Malaysia, conversely, would gain by reorganising its financial market to effectively utilise blended finance and incorporate sustainability strategies. Both will equally benefit from improved openness, regulatory consistency, and regional cooperation. To expedite the execution of CDM, it is essential to access unutilised cash resources.

5. Conclusion, study limitations and future research direction

This article examines the existing approach of the CDM in Nigeria and Malaysia on its application and policy direction. This research demonstrates that CDM has emerged as a progressively favoured approach for carbon mitigation in the Global South. The analysis indicated that the current implementation methods are at odds with Malaysia's superior stability relative to Nigeria. Policymakers must swiftly enact substantial adjustments to align

with best practices for addressing climate change over the next 25 years. The research demonstrates that domestic funding, international financial and technical support, as well as the formulation of explicit CDM policies, and the availability of a committed team with local expertise will improve the effectiveness of CDM in both countries, thereby facilitating a decrease in carbon emissions through the CDM mechanism. This study's limitation is the singular emphasis on CDM as the only carbon emission mitigation strategy, neglecting the roles of energy efficiency, renewable energy sources including solar and hydro energy, and green technology in reducing carbon emissions. Future study may fill this gap by investigating policy uncertainty concerning energy efficiency in both countries or by performing a comparative analysis of the CDM policies across other nations in sub-Saharan Africa and Asia as this would enhance the understanding of CDM's growth in both jurisdiction.

Reference:

Abd Rahman, I.Z., Abang Hasbollah, D.Z., Mohd Yunus, N.Z., Kasiman, E.H., Mazlan, A. N., (2022). Carbon dioxide storage potential in Malaysian sandstone aquifer: an overview. In: IOP Conference Series: Earth and Environmental Science. IOP Publishing Ltd. https://doi.org/10.1088/1755-1315/971/1/012022.

Agarwal, V., Arredondo, J.C., Chen, L.K., Dua, V., Evans, S. and Jain, R. (2022). How Carbon markets can help Malaysia achieve its climate targets, McKinsey & Company sustainability practice

Agbonifo, P.E. (2015). Reforming the clean development mechanism (CDM) to tackle the environmental policy gap in the Nigeria oil and gas industry, Journal of Sustainable Development in Africa, Vo. 17 (2), 65-76

Ahmad, S., Ab Kadir, M.Z.A., Shafie, S., (2011). Current perspective of the renewable energy development in Malaysia. Renew. Sustain. Energy Rev. 15 (2), 897e904.

Bernama (2024). Well-designed carbon market offers scalable solution for climate change – Bursa Chairman, online https://www.bernama.com/en/news.php?id=2326845

Boyd, E., Hultman, N., Roberts, J.T., Corbera, E., Cole, J., Bozmoski, A., … and Liverman, D.M. (2009). Reforming the CDM for sustainable development: lessons learned and policy futures. Environmental Science and Policy 12 (7): 820–831.

Burian, M. and Aren, C. (2014), The clean development mechanism: A tool for financing low carbon development in Africa? *International Journal of Climate Change Strategies and management,* Vol. 6 (2)

Bursa Malaysia Berhad (2024). Bursa Malaysia Carbon Exchange to Launch in July, online https://www.marketsmedia.com/bursa-malaysia-carbon-exchange-to-launch-in-july/

DGB Group (2024), Nigeria launches plan for a $2.5 billion carbon market, online, www.green.earth/news/nigeria-launches-plan-for-a-2.5-billion-carbon-market

Donald, B.A. (2015). Ethical issues raised by carbon trading. The Rock Ethics Institute. Climate Ethics, PennState College of the Liberal Arts

Emem, O. (2016). Building an effective implementation process to Nigeria's climate change policies and intended nationally determined contribution (INDC). Available at SSRN 2843279

EPA [US Environmental Protection Agency] (2012). Causes of climate change: The greenhouse effect causes the atmosphere to retain heat. Retrieved from https://www3.epa.gov/climatechange/science/causes.html#greenhouseeffect

Euromonitor Passport International (2024), Economies and Consumers Annual Emissions, https://www.euromonitor.com/solutions/passport (accessed on 15 December 2024).

Hamzah, T.A.A.T., Zainuddin, Z., Yusoff, M.M., Osman, S., Abdullah, A., Saini, K.M. and Sisun, A. (2019). The conundrum of carbon trading projects towards sustainable development: A review from the Palm oil industry in Malaysia, Energies, vol. 12, 3530; doi:10.3390/en12183530

ICF Internation (2006), Nigeria: Carbon Credit Development for Flare Reduction Projects, Guidebook, online, https://documents1.worldbank.org/curated/en/235131468100147211/text/713830WP0Box370riaGGFRGuidebook0ICF.txt [23/10/2024]

Lema, A. and Lema, R. (2013), Technology transfer in the clean development mechanism: Insights from wind power, Global environmental change, vol. 23 (1), pg. 301-313

Li, J., Huang, Y., Zhang, C. and Yao, D. (2025), How does public transport development contribute to carbon emission reduction? Transportation Research Part A (2025), 104327

Lim, Z.L. and Lam, W.H. (2014), Review on Clean Development Mechanism (CDM) implementation in Malaysia, Renewable and Sustainable Energy Reviews, 29 (2014) 276-285

Liu, T., Zhao, G., Qu, B., Gong, C., (2024). Characterization of a fly ash-based hybrid well cement under different temperature curing conditions for natural gas hydrate drilling. Constr. Build. Mater. 445, 137874.

Lo, A.Y. and Cong, R. (2022), Emission reduction targets and outcomes of the Clean Development Mechanism (2005 – 2020), *PLOS Clim* 1 (8): e0000046.

Meng, W., Li, S, and Yang, J. (2024). Mitigating disaster risks caused by carbon emissions, *Economics Letters* 241 (2024), 111817

Met Office. (2015). What is climate change? Retrieved from http://www.metoffice.gov.uk/ climate-guide/climate-change

Mohammed, S.A. (2020), Clean Development Mechanism and carbon emissions in Nigeria, *Sustainable Accounting Management and Policy Journal*, Vol. 11 (3), pp. 523-551

MPOC. (2017). Promoting a Sustainable Way Forward for Oil Palm Cultivation. 2017. Available online: http://www.mpoc.org.my/ (accessed on 18 January 2024).

Mulenga, F. and Oeba, V.O. (2019), An evaluation of determinants affecting design and implementation of CDM and REDD+ in Africa, International Forestry Review Vol. 21 (SI),

Nasir, E. and Go, Y.L. (2024). Carbon capture and storage at Malaysia power plants: Evaluation of its feasibility and requisite enablers, Journal of Cleaner production 469 (2024) 143173

Nguyen, H.T., Hoang, T.G., Nguyen, L.Q.T., Le, H.P. and Mai, H.X. (2020). Green technology transfer in a developing country: mainstream practitioner views,

International journal of Organisational Analysis, vol. 30 (3), 2022, pp. 699-720, DOI 10.1108/IJOA-11-2019-1941

McKinsey (2024). What is decarbonization? Online, https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-decarbonization?stcr=9B89B0D48AEF4B50ABA2C611FE1AB74A&cid=other-eml-alt-mip-mck&hlkid=f1a7512717ac4c50b98ffe92875ef627&hctky=15861563&hdpid=36325aaa-122b-467d-b1fd-90e21dd989fa [25/10/2024]

NASA [National Aeronautics and Space Administration] (2016). A blanket around the earth. Retrieved from http://climate.nasa.gov/causes/

Oh, T.H. and Chua, S.C. (2010). Energy efficiency and carbon trading potential in Malaysia, *Renewable and Sustainable Energy Reviews,* Vol. (2010) 2095-2103

Omukuti, J. (2020), Country ownership of adaptation: Stakeholder influence or government control? Geoforum 113, 26-38

Pacagnella junior, A.C., Marcondes de Moraes, G.H.S., Lucas de Silva, A., Putti, F.F, and Bortoletto, W.W. (2025), Clean development mechanisms in Latin America: Efficiency analysis of energy-generating projects, Environmental Progress and Sustainable Energy, DOI:10.1002/ep.70023

Raza, M.A., Karim, A., Aman, M.M., Al-Khasawneh, M.A., and Faheem, M. (2025), Global progress towards the coal: tracking coal reserves, coal prices, electricity from coal, carbon emissions and coal phase-out, Gonwana Research, Vol. 139, 43-72 DOI:10.1016

Rahman, A., Woahid Murad, S.M., Mohsin, A.K.M. and Wang, Xiaowen, W. (2024). Does renewable energy proactively contribute to mitigating carbon emissions in Major fossil fuels consuming countries, Journal of cleaner production, 452 (2024) 142113

Shidiq, M. Htet, H. Rakhiemah, A., Abdullah, A., Pradnyaswari, I. and Suryadi, B. (2024). How effective is the carbon pricing implementation in ASEAN Member States to reduce regional emissions, 3rd ASEAN International Conference on Energy and Environment, IOP Conference Series: Earth and Environment Sciences 1395 (2024) 012032, DOI;10.1088/1755-1315/1395/1/012032

Simire, M. (2011), A fresh, green colour

Statista (2023), Revenue Generated by ETS Worldwide in 2023, online, www.statista.com [11/November, 2024]

Susskind, L., Chun, J., Goldberg, S., Gordon, J.A., Smith, G. and Zaerpoor, Y. (2020). Breaking Out of Carbon Lock-In: Malaysia's Path to Decarbonization. Front. Built Environ. 6:21. doi: 10.3389/fbuil.2020.00021

Tiong TC, Pereira JJ, Pin KF. 2009. Stakeholder consultation in the development of climate change policy: Malaysia's approach. Paper presented at KDI School of Public Policy and Management – Seoul, 2009.

United Nations (2015) The Paris agreement (adopted by UN climate change conference (COP21) on December 12, 2015). Paris, France. Retrieved from https://www.un.org/en/climatechange/paris- agreement. Accessed 23 Sept 2024

UNFCCC (2024), Clean Development Projects, online, http://cdm.unfccc.int/ProgrammeOfActivities/registered.html [11/09/2024]

UNFCCC, (1997). Kyoto Protocol to the United Nations Framework Convention on Climate Change. Article 12.

Wang, Y., Quan, S., Tang, X., Hosono, T., Hao, Y., Tian, J., et al., (2024). "Organic and inorganic carbon sinks reduce long-term deep carbon emissions in the continental collision margin of the southern Tibetan Plateau: Implications for Cenozoic climate cooling," Journal of Geophysical Research: Solid. Earth 129 e2024JB028802.

Weber M, Pressburger L, Chau LW, Khan Z, Waite T, Westphal MI, Ling GHT, Ho CS and Evans M (2024), Carbon neutrality in Malaysia and Kuala Lumpur: insights from stakeholder- driven integrated assessment modeling. Front. Energy Res. 12:1336045. doi: 10.3389/fenrg.2024.1336045

WWF Malaysia and Boston Consulting Group, (2021). SECURING OUR FUTURE: NET ZERO PATHWAYS FOR MALAYSIA.

Yin, I. and Yep, E. (2024). Interview: Voluntary carbon market firt step for Malaysia toward carbon pricing: Bursa Malaysia CEO, online, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/081523-interview-voluntary-carbon-market-first-step-for-malaysia-toward-carbon-pricing-bursa-malaysia-ceo [12th October, 2024]

Zainuddin, Z. and Hamzah, T.A.A.T. (2023). Chapter 14: Carbon trading and sustainable development goal 13: The Malaysia Perspective, in W.Leal Filho et al. (eds), Climate Change Strategies: Handling the challenges of adapting to a new changing climate, climate change management, DOI. 10.1007/978-3-031-28728-2_14

Zainuddin, Z.B., Zailani, S., Govindan, K., Iranmanesh, M. Amran, A. (2017), Determinants and outcome of a Clean Development Mechanism in Malaysia, *Journal of Cleaner Production*, 142 (2017) 1979-1986

Zavyalova,E.B. and Li,J. (2024). Chapter 14: Carbon Emission Tax or Carbon Emission Market: Which is Better? in B. S. Sergi et al. (eds.), Ecological Footprint of the Modern Economy and the Ways to Reduce It, Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-031-49711-7_13

Zhang, Z., Feng, S., Chen, Y., Liu, Q., Ju, W., Ziao, W., huang, C., Wang, Y., Wang, H, Jia, M, Wang, X. and Jiang, F. (2024), Development of a regional carbon assimilation system and its application for estimating fossil fuel carbon emissions in the Yangtze River Delta, China, Science of Total Environment, 957 (2024) 177720