CARBON CAPTURE, UTILISATION AND STORAGE (CCUS) IN NIGERIA'S ENERGY TRANSITION: CLOSING LEGAL GAPS AND DESIGNING POLICY PATHWAYS

ABSTRACT

As the global community advances towards Net-Zero targets, with efforts to limit global warming to 2°C also intensifying, countries have begun to adopt climate adaptation and mitigation technologies. One of such technologies is Carbon Capture, Utilisation and Storage (CCUS) given its potential to reduce greenhouse gas emissions, especially from hard-to-abate sectors. Several developed economies including Norway and the United States have begun to leverage CCUS, developing coherent legal and fiscal frameworks that support the adoption of this technology. The United States in particular leads the charge with the highest number of publicly announced projects. This level of adoption is however not replicated in developing economies, particularly Africa, despite being one of the most vulnerable and least resilient regions to climate change. In Nigeria particularly, while there is some policy enthusiasm, especially with references to the adoption of the CCUS in the country's Energy Transition Plan (ETP), the development of the technology in Nigeria is still largely theoretical. The main thrust of this article will be to examine the legal, policy, and institutional dimensions of deploying CCUS within Nigeria's energy transition framework. This is especially important considering the prime role that the country plays in Africa's climate future given its large population, extensive coastline and its legacy as one of the continent's most important country, politically and economically. The article situates its analysis within Nigeria's peculiar emissions profile and developmental constraints, arguing that the country's heavy reliance on fossil fuels, continued gas flaring, and structural energy poverty makes the adoption of CCUS important if it were to achieve its Net-Zero target. The article finds that although Nigeria possesses significant geological potential for CO_2 storage, the absence of comprehensive geological surveys, a clear liability regime, and enabling legislation undermines investment confidence and project viability. The article further demonstrates that existing instruments contain only fragmented references to CCUS and are therefore insufficient to move the adoption of the technology from policy rhetoric to regulatory reality. It recommends the enactment of a dedicated CCUS statute defining subsurface ownership and liability, instituting rigorous monitoring, reporting and verification (MRV) standards, and integrating CCUS within the ETP. By addressing these legal and policy gaps, Nigeria can establish a credible pathway for operationalising CCUS as an important tool for decarbonisation, sustainable energy governance, and climate accountability.

Keywords: Energy Transition; Decarbonisation; Carbon Capture, Utilisation and Storage (CCUS); Climate Change Law; Regulatory Reform; Net-Zero Emissions; Nigeria.

INTRODUCTION

According to Davidson & Kemp (2024), climate change has become an imminent crisis requiring action on a global scale. It is no longer an abstract future event but a lived reality for a significant part of the world population with increasingly devastating consequences. The IPCC (2022) found that with climate change, changing weather patterns and rising global temperatures have intensified the frequency and severity of natural disasters, including heatwaves across Europe, wildfires in North America and Australia, as well as catastrophic flooding and hurricanes in South Asia and Africa, with attendant socio-economic and human costs. For instance, South Sudan is in its sixth year of flooding resulting in extreme food scarcity and forcing several South Sudanese families to depend on wild foods like water lilies to survive. It is in fact estimated that about 7.7 million out of 12 million people in the country (64% of the country's population) is experiencing severe hunger (World Food Program USA, 2023). In the same vein, Afghanistan is currently experiencing its worst drought in 27 years with intense flooding in some parts of the country diminishing food production (IRC, 2023). The Climate Risk Index (2025) ranking also indicates that between 1995–2024, Dominica, Myanmar, and Honduras were the countries most affected by extreme weather events' impacts.

Nigeria is not exempt from these global realities. Extreme weather events have increased in frequency across the country, with increasing desertification in the north and record coastal erosion in the South. Most notably, Lagos State, Africa's largest megacity, has in recent years been experiencing recurrent flash flooding, displacing residents, destroying businesses, and leading to failure of already deteriorating infrastructure (Chang & Ross, 2024). Also, in September 2024, a flood killed 230 people in Borno state in Northern Nigeria and led to the displacement of over 600,000 people (UN News, 2025). This was following an even more horrific event in 2022 where severe flooding across the country impacted 34 out of the 36 states, killing hundreds and displacing more than 1.3 million. There were also significant economic losses estimated at US$9.12 billion (World Bank, 2022). More recently in June 2025, flash flooding in Mokwa, Niger State led to the death of over 150 people and 3000 people displaced with more than half of these figures being children agreed 12 and under (UN News, 2025).

These events highlight both Nigeria's vulnerability to climate change and the urgent need for a multi-faceted response that incorporates both adaptation and mitigation strategies to address the climate crisis. They also bring to fore the fact that Nigeria is plagued by what Lawrence,

Lawrence & Ballard (2020) calls the energy trilemma, referring to the often-conflicting challenge of energy security, equitable access to energy, and environmental sustainability. In terms of energy security and equitable access to energy, Nigeria occupies a prime place as Africa's largest oil producer, heavily relying on hydrocarbons for its energy needs as well as its exports for fiscal revenue and foreign exchange (Nduokafor, et al., 2024; Felix, 2024). However, in terms of environmental sustainability, Joarder, et al., (2025) note that these hydrocarbons contribute significantly to the scourge of climate change considering the energy-intensive processes and potential leaks that release methane and other gases during extraction and refining. Similarly, gas flaring still remains a major part of the country's extractive industry resulting in the release of large quantities of greenhouse gases including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). In the same vein, as a signatory to the Paris Agreement, Nigeria has made commitments to achieve Net Zero emissions by 2060 (Federal Government of Nigeria, 2021). Addressing this energy trilemma requires innovative approaches that facilitate continued energy development but also help contribute to decarbonisation and manage the climate crisis. Carbon Capture, Utilisation, and Storage (**"CCUS"**) technology has been identified as one of such approaches being explored globally, and now increasingly in Nigeria.

However, there has been several concerns around CCUS adoption with many noting that the technology cannot simply be accepted as a silver bullet. In Nigeria particularly, there are questions about whether CCUS technology represents a genuine market opportunity that enables decarbonisation, or is another mirage in the country's long history of unfulfilled energy reforms? Flowing from this, the main thrust of this article would be to critically assess Nigeria's readiness to embrace CCUS as part of its decarbonisation strategy. The article contextualises Nigeria's CCUS ambitions within global climate trends, evaluates the country's emissions profile and storage potential, analyses legal and regulatory gaps, explores financing issues, and assesses the implications for both domestic and international energy markets.

UNDERSTANDING CCUS TECHNOLOGY AND ITS GLOBAL OUTLOOK

As noted by the LSE (2023), CCUS refers to a suite of technologies designed to enable the mitigation or removal of carbon dioxide (CO2) emissions from large point sources like gas-fired power plants, steel mills, cement plants, refineries and other industrial facilities that burn fossil fuels and other hydrocarbons as fuel. A similar technology is Direct Air Capture (DAC) technology that facilitates the direct capture of CO2 from the atmosphere.[1] With CCUS, the captured emissions are either used as raw materials for other applications including building materials and fertilisers (utilisation) or permanently injected thousands of feet below the surface (storage) (Chevron, 2022).

At its core, the goal of CCUS is the cost-effective mitigation of the climate impact of hard-to-abate sectors by preventing large volumes of CO_2 from entering the atmosphere (IEA, 2023). The technology is also useful in the production of low-carbon electricity and hydrogen, which contributes to the decarbonisation of various activities. According to LSE (2023), the various roles of CCUS can also help make energy supply more diverse and flexible which in turn contributes to energy security, a growing priority for governments around the world. It is noteworthy that unlike renewable energy, CCUS does not replace fossil fuels but rather regulates their carbon footprint, establishing itself as a “bridging” technology in the global energy transition (Greig & Uden, 2021).

According to de Araujo, et al., (2024), CCUS found international political legitimacy within the framework of the Paris Agreement. Although the Agreement does not explicitly endorse CCUS technology, its ambition of limiting global warming to 1.5°C assumes the development of a portfolio of mitigation strategies that includes negative emissions technologies (Rogelj et al., 2018). This has made room for CCUS as part of “net zero” approaches, especially for hard-to-abate sectors. Crucially relevant is Article 6 of the Paris Agreement, which creates the framework for international carbon markets, thereby providing a lifeline for CCUS financing. In theory, CCUS projects can produce tradeable credits if they verifiably cut or eliminate emissions, as permitted under the new sustainable development mechanism (Article 6.4) or cooperative processes (Article 6.2), which allow nations to trade carbon credits (Michaelowa et al., 2021).

Notably, the idea of CCUS is not new. According to Global CCS Institute (2022), the first commercial-scale project dates back to 1972 in Texas, where CO_2 captured from natural gas processing was used for enhanced oil recovery (EOR), injecting CO_2 into depleted oil reservoirs to increase crude production. Since then, there have several CCUS projects initiated globally, with 45 commercial facilities currently in operation, and more than 700 projects in

[1] Direct air capture (DAC) technologies extract CO2 directly from the atmosphere at any location, unlike carbon capture which is generally carried out at the point of emissions, such as a steel plant. Simply, CCUS prevents new emissions, whereas DAC cleans up past emissions already in the air. While they are different, DAC can be considered a specific type of capture technology within the broader CCUS framework (IEA, 2022).

various stages of development (World Economic Forum, 2023). The US currently leads the charge in the development of this technology with more CCUS projects than any other country (LSE, 2023).

Recent years have seen a renewed wave of investment in CCUS, spurred by increased Net Zero commitments and the awareness that certain sectors cannot be decarbonised only through renewable energy sources. For example, the United States, through the Inflation Reduction Act of 2022, has increased tax incentives for CCUS projects, further driving and incentivizing large-scale deployment (LSE, 2023). In 2021, the Northern Lights Project in Norway, a collaboration between Equinor, Shell, and TotalEnergies, became the first cross-border, open-access CO_2 storage and transportation project. The project involves the transportation of liquefied CO_2 from industrial sources via ships to a terminal in Norway, where it is subsequently piped 2,600 meters beneath the seabed for permanent storage. The first phase of the project, completed in 2024 is operational, with the capacity to store 1.5 million tonnes of CO_2 per year, and a second phase expected to increase capacity to at least 5 million tonnes annually (TotalEnergies, 2025).

Despite these developments, there is some scepticism about the capacity of CCUS to effectively help achieve net-zero, deliver carbon removals, and provide low-cost solutions. For one, it is argued that the current pace of the technology is insufficient with minimal impact on global emissions. At present, CCUS only collects about 0.1% of the 40 gtpa global annual GHG emissions (Greig & Uden, 2021; Miao, et al., 2025). It has also been argued that CCUS risks enabling the continued use of fossil fuels, while diverting investment away from renewable energy and energy efficiency, thus serving as a band-aid over what is the real problem which is limiting to the minimum, reliance on fossil fuels and curtailing the emissions that emanate from their exploitation (Bala, et al., 2025; Lebling, et al., 2025). According to Yao et al. (2021), there is also the challenge about the high cost of capturing, transporting, and storing CO_2, whether building new stand-alone facilities or retrofitting already existing infrastructure, raising questions regarding economic feasibility. In the same vein, Cao, et al., (2020) have also argued that CCUS facilities are not foolproof to leakages and in the event of CO_2 leakages from storage sites, such could lead to possible environmental damages and the reversal of intended emissions savings.

What these indicate is that while the adoption of CCUS shows promise, it is impeded by key challenges. This is because in spite of its potential to support carbon neutrality in industrial (hard-to-abate) sectors, it is faced with political, technological, and financial hurdles that make its use as a climate solution difficult.

CCUS IN THE FACE OF NIGERIA'S EMISSIONS PROFILE AND DECARBONISATION OBJECTIVES

Beyond the general promise and pitfalls of CCUS technology globally, the question of CCUS viability in Nigeria cannot be divorced from the country's emissions profile, developmental limitations, and decarbonisation objectives. This section considers these key points ahead of the more detailed examination of the technical, economic, and financial feasibility of CCUS in the country.

To begin with, Nigeria currently ranks 26th among countries with high GHG emissions, producing an average of 0.8% of global greenhouse gas emissions (CCPI, 2025). The country's domestic emissions profile reflects its acute reliance on fossil fuels and inefficiencies in the nation's energy transition. According to the IEA (2022), oil & gas, power generation, industry, transportation, and agriculture are the five main sectors that contribute to Nigeria's emissions. Of these five, the oil and gas industry is the most contributory to GHG emissions in the country considering, for example, that despite several regulatory deadlines for flare-out, gas flaring continues in the industry presently in addition to decades of gas flaring resulting in the release of millions of tonnes of CO_2 and methane yearly (Ogbonnaya et al., 2021). Another significant emitter is the power sector, which mostly relies on diesel and gasoline generators to cover gaps in the unreliable nation grid. As also noted by Hong, et al., (2021), industry and transport are also growing sources of emissions, while agriculture, particularly through land-use change and livestock, accounts for a smaller but persistent share of the emissions mix.

As a response to the country's emissions challenge, the Nigerian government announced its Energy Transition Plan (ETP), pledging to achieve net-zero by 2060, and with it, repositioned Nigeria in international climate diplomacy (Federal Government of Nigeria, 2021). The ETP serves as a long-term strategy and as a vehicle for transitioning Nigeria to Net-zero Pathway by 2060. It identifies natural gas as a "transition fuel" in the country's journey to a carbon neutral future while also emphasising electrification, and renewable energy development. Notably as well, the plan specifically references CCUS as key in achieving net-zero by 2060.

However, these ambitions are shadowed by the stark reality that more than 80 million Nigerians still lack access to reliable electricity and 170 million relying on biomass for cooking, demonstrating Nigeria's dilemma to support international climate goals without perpetuating domestic energy poverty. Adding a layer of complexity is Nigeria's historical entanglement with the resource curse which according to Savoia & Sen (2021) refers to the "tragedy" where vast hydrocarbon wealth in a country does not translate into broad-based development. Instead, the assets that should bring wealth and stability lead to corruption and poverty. The resource curse also causes the government to neglect other economic sectors such as infrastructure, industry, science/technology, services and agriculture. This effectively captures Nigeria's situation being a petroleum-rich nation with hydrocarbon exports being the mainstay of the country's economy. Aside perpetuating the resources curse, Nigeria's oil dependency could also limit opportunities to focus on the developing renewable energy and clean technologies (Oruwari, et al., 2024). It is within this broader narrative that the adoption of CCUS in Nigeria uneasily sits.

Currently, there are no commercial CCUS projects in operation in Nigeria, despite the ETP's reference to the technology and the country's commitments under the Paris Agreement. Industry signals however suggest that there are potential projects in the pipeline. For one, Nigeria Liquefied Natural Gas (NLNG) Limited has initiated studies and begun preliminary work on a CCUS project (Terungwa, 2025). Another private sector participant is reportedly at the financing and technical studies stage. These laudable initiatives however face significant hindrance with the absence of a comprehensive regulatory framework, structured and bespoke financing models, and seamless integration into the carbon pricing mechanisms under the Paris Agreement. Without these factors in place, there is a real risk of CCUS adoption becoming a political gimmick in Nigeria, as is many other similar initiatives, which is only announced in speeches and policy documents but never delivered in practice.

Having considered Nigeria's emissions profile and its broader decarbonisation ambitions, it is now important to critically examine the technical, financial, and economic feasibility of implementing CCUS in Nigeria. This is considered in some detail in the next section.

TECHNICAL, FINANCIAL AND ECONOMIC FEASIBILITY OF CCUS IN NIGERIA

As acknowledged by Bassey & Oboh (2024), the feasibility of the commercial deployment of CCUS projects in Nigeria is determined by technical, financial, policy and economic considerations, which together determine whether the technology can move beyond policy rhetoric to commercial reality. From a technical standpoint, Adepehin, et al., (2025) notes that pilot studies already demonstrate promising geological storage performance CO_2, for CCUS projects especially in the Niger Delta Basin with several depleted oil and gas fields, saline aquifers, sand aquifers, and coal seams. These vast underground formations could serve as reliable storage sites for captured emissions (Audu et al., 2022). In addition, EOR techniques, particularly gas injection methods, already in use Nigeria indicate that the technical knowledge and expertise required for the adoption of CCUS are not entirely alien to Nigerian operators (Olajide, et al., 2025).

Additionally, industrial application is another technical consideration in the discussion about CCUS deployment in Nigeria (Osu et al., 2022). Nigeria is often cited as the world's seventh largest gas flarer, flaring about 5.318 billion cubic meters per annum, equivalent to an average of $2.5 billion in lost revenue (Ezinna, Ugwuibe & Okwueze, 2024). This makes CCUS adoption attractive, providing the much-needed solution to Nigeria's gas flaring problem. Instead of being flared into the atmosphere, gases could be captured with CCUS technology and used to generate commercial by-products, such as synthetic fuels and industrial chemicals. Other than gas flaring, CCUS also has significant application in the "hard-to-abate" sectors such as cement and fertiliser productor, given the volume of emissions recorded in the energy processes of these industries (Velan, et al., 2021).

However, high capital expenditure requirements for CCUS technology and associated infrastructure create a level of risk that is hard for a developing country such as Nigeria to overcome. The capital-intensive nature of CCUS is connected to high cost of capture facilities, dedicated CO_2 pipelines, and long-term storage infrastructure, usually requiring billions of dollars in upfront expenditure. Relatedly, considering that the technology is still untested commercially in the country, the return on investment is uncertain, in spite the significant financial commitment. It is also impacted by factors such as regulatory certainty, financial incentives, carbon pricing, and access to stable markets (Global CCS Institute, 2023; Davies, Wishart and Swarbrick, 2025). These factors in addition to limited public finance affect the bankability of these projects. For a country already contending with fiscal deficits, high debt servicing obligations, and competing social expenditure needs, the possibility of mobilising domestic capital for CCUS in Nigeria is remote. As also noted by Felix (2024), the financial system of Nigeria, typically defined by short-term commercial lending, does not provide instruments capable of sustaining the scale and tenor of financing required for CCUS infrastructure, thereby revealing a structural financing gap.

Furthermore, the financing gap highlighted above amplify the role of development finance institutions (DFIs) and climate funds. The World Bank Group, for instance, with its long record of engagement on methane reduction has signalled increasing interest in supporting CCUS as part of its climate portfolio (World Bank Group, 2023). The Green Climate Fund, established within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and currently the world's largest dedicated multilateral climate fund, has also begun providing funding for CCUS activities across the world. The fund is also the main multilateral financing mechanism to support developing countries in addressing the climate crisis. In addition, to support the accessibility of funds, the Climate Policy Initiative has advocated for blended finance models, referring to a structure where private funding is combined with public, development or philanthropic funding (Climate Policy Initiative, 2023). Such models could, in principle, allow Nigeria to attract financing for early-stage CCUS deployment. This is however not without some limitations, the most prominent being the opportunity cost of deploying scarce international climate finance into Nigeria. Potential donors currently are likely to finance renewable energy and adaptation projects that demonstrate the capacity to yield clearer development dividends.

Flowing from the above, it is clear that the financing challenge for CCUS in Nigeria is a complex matter involving several issues including weak domestic financial markets, high capital costs, and capital scarcity. These issues can only be resolved through institutional reforms that attract the required financing to commercialise CCUS initiatives in the country. Without these issues sufficiently addressed, financing for CCUS may be limited to small-scale pilot projects, leaving large-scale deployment merely aspirational.

In spite of the financing and economic issues highlighted, global shifts in energy demand provide new incentives that could encourage CCUS adoption in Nigeria. Of particular note is the growing international demand for low carbon liquefied natural gas (LNG), blue hydrogen, and blue ammonia which production, according to Adekoya, et al. (2024), are a key step toward decarbonising natural gas. CCUS can be leveraged to capture the CO_2 byproduct, turning them into low-carbon products that meet international market demand. Similarly, the Nigerian Upstream Petroleum Regulatory Commission[2] (NUPRC)'s focus on gas flare commercialisation aligns with CCUS, as it aims to capture flared gas, reduce emissions, and create a valuable resource for energy and industrial purposes (NUPRC, 2023). Additional factors such as Nigeria's participation in voluntary carbon markets under Article 6 of the Paris

[2] The NUPRC is established under the Petroleum Industry Act 2021 as the Nigerian government agency responsible for the technical and commercial regulation of Nigeria's upstream petroleum industry.

Agreement could also drive CCUS adoption in the country (Omotuyi, 2025). Article 6 promotes innovative financing and cross border collaboration by establishing carbon trading frameworks, that allow countries to transfer mitigation outcomes across borders and generate internationally transferable mitigation outcomes (ITMOs). This opens the possibility of structuring CCUS projects to produce high-quality carbon credits, which could then be traded to attract international finance and technology partnerships.

REGULATORY AND LEGAL FRAMEWORK ANALYSIS

One of the central findings of this paper is that CCUS has begun to receive policy attention by the Nigerian government. However, there is no comprehensive legal and regulatory framework that governs the adoption of the technology, leaving a significant gap. In comparison to jurisdictions such as Malaysia that has recently adopted a bespoke legislation, the Malaysian Carbon Capture, Utilisation and Storage Act of August 2025, Nigeria currently relies on fragmented climate and energy policies that do not explicitly regulation the peculiar aspects of CCUS. This regulatory gap limits investor confidence, complicates project development, and reflects very poorly on the credibility of Nigeria's decarbonisation commitments. The current framework is examined in some detail below.

Current Nigerian Laws and Policies

As previously highlighted, Nigeria's legal and policy framework for climate change and emissions management has developed incrementally over the past decade, however, it remains fragmented, with no direct legislation tailored to CCUS. At present, the key instruments relevant to CCUS are the Climate Change Act 2021, the Petroleum Industry Act 2021 (PIA), and several subsidiary policies such as the National Gas Policy (2017), the National Energy Transition Plan (2022), and the NUPRC Acreage Management, Drilling and Production Regulation 2024.

- *The Climate Change Act (No. 10, 2021)*

Nigeria's 2021 Climate Change Act is the country's first legislative document that is specifically designed to address climate change. The Act provides for an ambitious framework for mainstreaming climate actions in line with national development priorities and sets a net-zero target for 2050-2070. (Climate Change Act, 2021). It also applies to both public and private entities within Nigeria's territorial jurisdiction and directs both to implement mechanisms geared towards fostering a low-carbon emission, environmentally sustainable, and climate resilient society.

One of the Act's central achievements is the statutory establishment of the National Council on Climate Change (NCCC) with powers to make policy and to oversee implementation (Climate Change Act, 2021, Ss. 3–4). The Council's enumerated functions are wide-ranging, including approving and supervising the National Climate Change Action Plan; administering the Climate Change Fund; coordinating sectoral targets; and, importantly, acting as the focal point for designing fiscal instruments such as a carbon tax and for collaborating on carbon emission trading mechanisms (Climate Change Act, 2021, s. 4). In principle, these provisions create the institutional entry points through which complex interventions, CCUS among them, could be enabled, financed and overseen.

However, the Act is only enabling instead of being prescriptive, which is the core of its limitation for CCUS. Although the NCCC is empowered to "collaborate with the Federal Inland Revenue Service to develop a mechanism for carbon tax" and to "develop and implement a mechanism for carbon emission trading" (Climate Change Act, 2021, Ss. 4 (i)–(j)), the Act does not itself create an emissions trading system, or define the technical rules that would make industrial-scale CCUS financially viable (e.g., eligibility, permanence, additionality). In other words, the statute authorises design work but defers the hard legislative and regulatory choices to future rulemaking. This is particularly concerning in the context of technologies such as CCUS considering that investor confidence depends on long-term predictability and legally enforceable rights and liabilities, this delegation creates acute investment risk.

For CCUS specifically, the Act is conspicuously silent on several crucial legal questions. It does not address ownership, access to, or leasing of subsurface pore space[3] for CO_2 storage; it does not set out rules for long-term liability for leakage, monitoring, or site closure; and it fails to provide for any technical monitoring, reporting, and verification (MRV) protocols[4] tailored

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[3] Subsurface pore space refers to the naturally occurring, empty voids or gaps within underground rocks, soil, and sediments that can hold fluids like water, oil, or gas, and are utilized for carbon capture and storage. This network of interconnected pathways, also known as porosity, allows for the collection and flow of these substances and is gaining attention as a valuable property interest for storing carbon dioxide (Chevron, 2023).

[4] According to the World Bank (2022), Measurement, Reporting, and Verification (MRV) refers to the multi-step process to measure the amount of greenhouse gas (GHG) emissions reduced by a specific mitigation activity, such as reducing emissions from deforestation and forest degradation, over a period of time and report these findings to an accredited third party. The third party then verifies the report so that the results can be certified and carbon credits can be issued. Summarily the steps involve: **Measuring** the amount of emissions or reductions, **Reporting** this data transparently to stakeholders, and **Verifying** the data's accuracy by an independent party to ensure its reliability and integrity.

to geological storage permanence, which are matters that are determinative for investor underwriting and for environmental safety. These gaps are particularly acute for CCUS. Without explicit statutory provisions governing the ownership of injected CO_2, the responsibilities of operator's post-injection, and the allocation of liability after site closure, CCUS projects risk entering a regulatory void precisely at the point where capture activities transition into permanent geological storage (Pereira, et al., 2025).

- *Petroleum Industry Act 2021*

The Petroleum Industry Act (PIA) 2021 was designed primarily to modernise Nigeria's oil and gas legal regime, clarify fiscal terms, and reorganise sectoral governance. It is therefore natural to consider whether its provisions inadvertently or deliberately create legal space for CCUS. In relation to CCUS specifically, the PIA contains provisions that touch on matters proximate to the technology, notably gas infrastructure, flaring prohibition and penalties, environmental obligations, and institutional competence for subsurface operations. However, the Act stops short of providing the explicit rights, licences and liability regimes that large-scale CO_2 injection and long-term storage or utilisation require. What this implies is that while the Act's framework provides useful entry points for CCUS policy, it simultaneously creating uncertainty that must be resolved by targeted regulation or supplementary legislation.

One of the key features of the PIA is the Act's treatment of gas and associated infrastructure. The Act overhauls and reorganises midstream governance by establishing a new regulator for the sector – the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA). It also establishes mechanisms such as the Midstream and Downstream Gas Infrastructure Fund (MGIF) intended to finance gas infrastructure development (PIA, 2021, S. 52). While the MGIF could theoretically be adapted to support CO_2 transport networks or shared storage facilities, the statutory language confines the Fund's stated purpose to gas infrastructure without explicit reference to CO_2 transport or storage.

Furthermore, the PIA's prohibition of routine gas flaring and its penalty framework are arguably of immediate relevance to CCUS. By prohibiting routine flaring and imposing obligations on operators to commercialise associated gas, the Act creates both regulatory pressure and a policy rationale for capture technologies (PIA, 2021, Ss. 104-105). However, the PIA frames flaring primarily as a compliance and remediation issue rather than as an opportunity to integrate CO_2 capture and utilisation at scale. There is no statutory mechanism that converts a flaring compliance obligation into a pathway for a company to receive regulatory credit or preferential treatment for investing in capture and storage. As such, operators may face a disjointed choice between paying penalties, investing in on-site small-scale reinjection, or pursuing CCUS, the latter of which currently lacks a clear permit pathway, reimbursement mechanism, or crediting structure under the Act itself.

Closely related is the PIA's reallocation of regulatory functions to the NUPRC and the NMDPRA. These bodies now oversee licensing, field development and midstream operations. However, the PIA's regulatory remit is focused on petroleum hydrocarbons, and fails to expressly create a licensing category for CO_2 storage operations. It also fails to set out the technical standards for reservoir characterisation, site selection, or injection permits, creating a practical lacuna. In the absence of express PIA provisions, regulators must either stretch existing petroleum licensing frameworks to fit CCUS or await supplementary regulation, both of which generate time-inconsistent risks for investors and communities alike. For instance, the NMDPRA has issued the Midstream and Downstream Operations Regulations (2023) and the Petroleum (Transportation and Shipment) Regulations (2023), both of which provide for the treatment, storage and transportation of natural gas and its derivatives, respectively. Whilst CO_2 is not clearly listed as a regulated product, it can be argued that the definition of "gas derivatives as products derived from the processing or blending of natural gas or gas products including urea fertilizer, methanol, hygrogen, etc" in the Regulations can be extended to include CO_2.

The question of subsurface rights and pore space is among the most legally fraught areas for CCUS under the current PIA regime. The Act provides for public ownership and regulatory control over minerals and hydrocarbons in many respects, but it is silent on whether and how pore space for permanent storage may be allocated, leased, or licensed. As noted by Hill (2024), secure and enforceable access to subsurface pore space is indispensable for CCUS projects as it underwrites long-term stewardship obligations, enables contractual assignment of storage liabilities, and determines whether an operator can monetise stored CO_2 (e.g., via carbon credits or storage fees). The PIA's silence on the point therefore creates a legal black hole. Parties would therefore be forced to rely on ad hoc contractual arrangements or uncertain administrative approvals, which are unlikely to satisfy lenders or international buyers of carbon credits who demand clear title and long-term enforceability.

Finally, although the PIA implies potential mechanisms for financing and infrastructure support, it does not address market and crediting questions central to CCUS commercialisation. The Act does not define whether captured CO_2 can be commodified for sale (for instance, as a feedstock for enhanced oil recovery or industrial utilisation) or whether storage services can be treated as regulated assets with tariff recovery (a regulated asset base model). Without statutory clarity on whether and how CCUS revenues (from storage fees, carbon credits, or by-product sales) can be recognised and protected, investors lack both legal certainty and a clear route to recover capital costs.

- *Energy Transition Plan*

As already noted, the ETP is the most comprehensive articulation of Nigeria's strategy towards achieving the 2060 net zero target. The ETP was initially created with a 2050 net-zero target but was extended to 20260 given the significant financial, social and technological requirements to achieve decarbonization. The Plan is a home-grown, data-backed, multipronged strategy developed for the achievement of net-zero emissions in terms of the nation's energy consumption and is framed around balancing economic growth, energy access, and decarbonisation. It also sets out a timeline and framework for the attainment of emissions' reduction across key sectors including power, cooking, oil and gas, transport and industry, while also highlighting a significant investment requirement. Although the Plan acknowledges the role of low-carbon technologies – even referencing carbon capture and storage technology – in achieving this trajectory, its treatment of CCUS is very limited.

As this article has established, the ETP acknowledges that gas will play a critical role as a "transition fuel" in Nigeria's net-zero pathway. This further amplifies the importance of CCUS technology considering that on exploitation of natural gas and other fossil sources cannot be reconciled with net-zero pathways without large-scale deployment of capture and storage technologies to manage emissions generated during the extraction and refining process. However, the Plan's reference to CCUS as part of Nigeria's mitigation toolkit, particularly in hard-to-abate sectors are merely cursory, presented largely as future possibilities rather than concrete policy commitments that the government is currently working towards establishing. Compared to other jurisdictions including the European Union, with its Net-Zero Industry Act that mandates scaling of CCUS infrastructure, or the United States, where the Inflation Reduction Act provides direct tax credits for CO_2 storage, Nigeria's ETP does not establish measurable milestones or binding obligations for CCUS deployment.

Finally, the ETP fails to address liability, monitoring, and long-term stewardship for CO_2 storage. While it outlines high-level governance arrangements through the Office of the Vice President and sectoral ministries, it does not address the allocation of responsibilities for regulating subsurface storage, verifying captured emissions, or managing post-closure obligations. These omissions are significant because CCUS credibility depends not only on technological feasibility but also on institutional trust and environmental safeguards.

- *National Gas Policy*

The National Gas Policy (NGP), adopted in 2017, aims to make Nigeria economy gas-based, prioritising local demand, legal separation of gas infrastructure, and a transitional pricing framework. A key feature of the policy is highlighting the Nigerian government's commitment to end routine gas flaring and promote gas utilisation for power generation, petrochemicals, and export (Federal Government of Nigeria, 2017), aligning with the potential deployment of CCUS.

However, similar to what currently obtains under the PIA and other associated legal and regulatory instruments, the NGP's treatment of flaring and emissions reduction is primarily framed in economic and energy security terms rather than as part of a climate mitigation strategy. The policy emphasises penalties for routine flaring and incentives for gas-to-power and gas-based industries, but does not provide a framework for integrating CCUS technologies into gas development projects. It also fails to establish mechanisms to incentivise carbon capture as part of Nigeria's broader transition agenda. By contrast, international practice increasingly links gas development with mandatory or incentivised CCUS deployment, especially where long-term reliance on natural gas is anticipated.

In all, while the policy rightly prioritises utilisation over flaring, it fails to account for the emissions profile of expanded gas use, leaving Nigeria vulnerable to lock-in of high-carbon infrastructure.

- *NUPRC Acreage Management, Drilling and Production Regulation 2024*

Under Regulation 37(2) of the Acreage Management Regulations, a lessee, that is, a holder of a Petroleum Mining Lease ("PML"), may, with the approval of the NUPRC, provide carbon capture and storage services within reservoirs located in their lease area. It is however noted that a lessee may require further approvals to provide carbon capture and storage services as these services were not contemplated in the initial grant of the lease (which typically only empowers and permits the lessee to win, work, carry away and dispose of crude oil, condensates and natural gas from the lease area, subject to terms and conditions to be imposed and contained in the licensing documentation). In other words, the provision of CCUS services is not a default or automatic right granted to a lessee under a PML. Rather, it is a permissible activity that can only be carried out within a lease area, subject to regulatory consent. This is a notable development given that it is the first regulation in the Nigerian oil and gas industry that formally integrates carbon capture and storage into the regulatory framework for petroleum mining leases.

However, the regulation's approach is cautious and restrictive. The provision makes clear that CCUS is not an automatic or inherent right of a lessee under a PML. Instead, it is a discretionary, regulated activity that can only be undertaken with NUPRC's explicit consent. This limitation is grounded in the legal character of the lease itself, which traditionally confers rights limited to "winning, working, carrying away, and disposing" of hydrocarbons (PIA 2021, S. 70(1)(c)). Since CCUS activities fall outside these core extractive rights, a lessee must seek fresh approval or a variation of its lease terms before engaging in such services.

Nonetheless, while the regulation acknowledges the possibility of CCUS within existing petroleum acreages, it leaves crucial gaps unaddressed. The most fundamental of these is the absence of a clear definition of "carbon capture and storage services." Without definitional clarity, the scope of permissible activities, whether it includes capture, transportation, injection, monitoring, or only storage, is uncertain. This ambiguity could create regulatory hesitation or even conflict with future CCUS-specific legislation, especially where multiple actors (such as emitters, storage operators, and transporters) are involved.

POLICY RECOMMENDATIONS

Nigeria's CCUS ambitions cannot succeed through fragmented policy alone. The analysis above demonstrates that piecemeal references to CCUS across the Climate Change Act, the PIA, the ETP and the National Gas Policy create uncertainty that deters investment and risks reputational harm. If Nigeria is serious about turning CCUS from rhetorical promise into operational reality, it must adopt a sequenced, comprehensive and bankable program of reform. The recommendations below are practical, mutually reinforcing, and grounded in lessons from jurisdictions that have moved beyond policy signalling to regulatory delivery.

1. **Enact a dedicated CCUS statute or package of subsidiary regulations.** A stand-alone legal instrument (or a clearly identified schedule within existing Acts) should establish licensing categories for capture, transport, utilisation and both onshore and offshore storage; prescribe the conditions for assessment permits and storage licences; and vest competence in a single lead agency or a well-defined inter-agency cluster. Malaysia's recent CCUS Act (2025) and the UK's licensing approach illustrate the value of statutory clarity as investors require explicit title to storage rights, transparent application processes, and predictable decision timelines. Nigeria's statute must therefore set out licensing criteria, thresholds for technical competency, and timelines for agency decisions.
2. **Define subsurface rights and a clear liability regime.**
   Projects cannot be bankable without certainty over who owns or controls pore space, how long storage rights last, and who bears post-closure obligations. The PIA's silence on pore space must be corrected either through amendments or a CCUS Act that expressly grants time-limited, transfer-able storage rights and prescribes staged liability transfer. This could be mirrored against the EU CCS Directive model but adapted to Nigerian fiscal and judicial realities. Complementary financial assurance instruments (e.g., bonds, trust funds, post-closure stewardship funds) should be mandatory to internalise remediation risk and protect public finances.
3. **Mandate rigorous MRV standards linked to crediting and market participation.** High-integrity MRV is the sine qua non of any CCUS value proposition, especially for compliance markets, voluntary buyers, and sovereign accounting under Article 6 of the Paris Agreement. Nigeria must adopt technical MRV protocols consistent with international best practice, publish standardised reporting templates, and establish an independent verification regime (third-party auditors authorised by the lead agency). By designing MRV to meet Article 6 guardrails, Nigeria will protect its carbon assets from accusations of "paper decarbonisation" and enable CCUS projects to generate tradable outcomes that attract international finance (Nwaobi, 2025).
4. **Design fiscal and market incentives that de-risk investment while safeguarding public interest.**
   Given CCUS's intense capital requirement, Nigeria should deploy a calibrated mix of incentives including tax credits or investment allowances tied to verified tonnes stored (akin to the U.S. Section 45Q mechanism), regulated asset base (RAB) models to enable cost recovery for essential CO_2 transport and storage infrastructure, and targeted grants

or concessional loans for early-stage pilots. Any incentive framework must include sunset clauses and performance conditions (e.g., minimum permanence, MRV compliance) to avoid indefinite subsidy of uneconomic projects (Global CCS Institute, 2023).

5. **Embed CCUS within the ETP with binding timelines and pilot commitments.** The ETP should be revised to convert high-level aspirations into concrete deliverables including a national CCUS roadmap with staged targets (e.g., number of demonstration projects by 2027, commercial clusters by 2032), clear roles for regulators, and pre-approved pilot corridors (industrial/port clusters) where permitting, grid-connection and land access are streamlined. Pilot projects should prioritise high-emission, commercially viable sectors such as LNG export facilities, cement plants and fertilizer complexes which are areas where CCUS both maximises emission reductions and creates commercial by-products (blue hydrogen, feedstocks).

CONCLUSION

In conclusion, this article has attempted a comprehensive examination of CCUS technology as part of Nigeria's energy transition framework to achieving net-zero emissions and meeting its climate obligations under the Paris Agreement. One of the most critical findings is the need to construct a comprehensive domestic regulatory regime that situates CCUS within Nigeria's wider energy and climate architecture, while simultaneously leveraging regional and international frameworks to overcome barriers to adoption. Equally important is the financing consideration for CCUS, especially considering that domestic capital alone cannot support the deployment of the technology in a country already constrained by high sovereign risk and weak policy credibility. The role of development finance institutions, climate funds, and strategic partnerships with international oil companies is therefore indispensable, though such arrangements must be carefully designed to avoid perpetuating dependency or external capture of Nigeria's energy transition agenda. The absence of such an integrated approach would leave Nigeria trapped in an unsustainable trajectory in which the country is too dependent on fossil fuels to industrialise, yet too unprepared to mitigate the global climate risks to which it is acutely vulnerable. In all, decisive regulatory innovation, underpinned by strong political will, could transform CCUS from a peripheral consideration into a cornerstone of Nigeria's just and sustainable energy transition.

REFERENCES

Adekoya, O. O., Adefemi, A., Tula, O. A., Umoh, A. A., & Gidiagba, J. O. (2024). A comprehensive review of Liquefied Natural Gas (LNG) market dynamics: Analyzing the current trends, challenges, and opportunities in the global LNG market. *World Journal of Advanced Research and Reviews*, *21*(1), 58-74.

Adepehin, D. S., Ogunmoye, K. A., & Odudu, A. I. (2025). Geophysical Approaches to Carbon Capture Utililization, Storage, Sequestration in Nigeria: Leveraging Physics for Sustainable Development. *Int. J. Sci. Res. in Physics and Applied Sciences Vol*, *13*(3).

Bala, R., Kaur, M., Thakur, H., Kashyap, P., Karnwal, A., & Malik, T. (2025). A Sociotechnical Review of Carbon Capture, Utilization, and Storage (CCUS) Technologies for Industrial Decarbonization: Current Challenges, Emerging Solution, and Future Directions. *International Journal of Chemical Engineering*, *2025*(1), 7195300.

Bassey, M., & Oboh, I. O. (2024, August). Reviewing the roadmap: feasibility studies on CCUS implementation in Nigeria. In *SPE Nigeria Annual International Conference and Exhibition* (p. D031S018R002). SPE.

Boruah, A. (2025). *CO2 Geosequestration: Capturing Carbon for a Sustainable Future: Carbon Dioxide Storage in Geological Media*. Springer Nature.

Brix Georgsen, K. (2025). Managing Carbon, Managing Futures: A Study of Sociotechnical Imaginaries in the Rollout of CCUS in Denmark. *Master Thesis Series in Environmental Studies and Sustainability Science*.

Cao, C., Liu, H., Hou, Z., Mehmood, F., Liao, J., & Feng, W. (2020). A review of CO2 storage in view of safety and cost-effectiveness. *Energies*, *13*(3), 600.

Carbon Capture, Utilization and Storage (CCUS) Act 2025 (Act 870). Laws of Malaysia.

Chang, H., & Ross, A. R. (2024). Lagos, Nigeria. In *Climate Change, Urbanization, and Water Resources: Towards Resilient Urban Water Resource Management* (pp. 83-95). Cham: Springer International Publishing.

Chevron (May, 2022). *Explainer: what is carbon capture, utilization, and storage?* https://www.chevron.com/newsroom/2022/q2/what-is-carbon-capture-utilization-and-storage

Climate Policy Initiative. (2024, October). *Understanding global concessional climate finance 2024: Enhancing its scale and efficiency for climate action.* https://ppp.worldbank.org/sites/default/files/2025-06/Understanding%20Global%20Concessional%20Climate%20Finance%202024.pdf

Davidson, J. P., & Kemp, L. (2024). Climate catastrophe: The value of envisioning the worst-case scenarios of climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *15*(2), e871.

Davies, L., Wishart, A., & Swarbrick, E. (2025). Financial Considerations for CCUS Developments. In *Carbon Capture Utilization and Storage: Law, Policy and Standardization Perspectives* (pp. 87-123). Cham: Springer Nature Switzerland.

de Araujo, I. L., Marcelle, Y., Makuch, Z., & de Medeiros Costa, H. K. (2024). Designing Brazilian institutional framework for Carbon Capture, Use and Storage (CCUS) activities: the role of competent authority. *Revista Jurídica da Presidência*, *26*(138), 44-74.

Emission Index (July 2024) *Greenhouse Gas Emissions in Nigeria* http://emission-index.com/countries/nigeria#:~:text=What%20percentage%20of%20global%20greenhouse,27th%20largest%20emitter%20since%201990.

European Parliament and Council. (2009). Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006. Official Journal of the European Union, L 140, 114–135.

Federal Government of Nigeria. (2021). *Nigeria's energy transition plan*. Abuja: FGN.

Felix, A. V. (2024). Financing the nigerian oil and gas industry in the energy transition: Challenges and prospects. *International Journal of Economics, Business and Social Science Research*, *2*(6), 74-102.

Global CCS Institute. (2022). *Global status of CCS 2022.* https://status22.globalccsinstitute.com/wp-content/uploads/2022/11/Global-Status-of-CCS-2022_Download.pdf

Global CCS Institute. (2023). *Global status of CCS 2023: Scaling up through 2030*. Retrieved from https://res.cloudinary.com/dbtfcnfij/images/v1699421934/CD7557_Global-Status-of-CCS-Report-Updated-08-11-23/CD7557_Global-Status-of-CCS-Report-Updated-08-11-23.pdf?_i=AA

Greig, C., & Uden, S. (2021). The value of CCUS in transitions to net-zero emissions. *The Electricity Journal*, *34*(7), 107004.

Hill, R. J. (2024). The Path to at-Scale Carbon Capture, Utilization, and Storage: Pore Space Ownership. *Hous. Bus. & Tax LJ*, *24*, 50.

Hong, C., Burney, J. A., Pongratz, J., Nabel, J. E., Mueller, N. D., Jackson, R. B., & Davis, S. J. (2021). Global and regional drivers of land-use emissions in 1961–2017. *Nature*, *589*(7843), 554-561.

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change*. Cambridge: Cambridge University Press.

International Energy Agency (IEA) (April, 2022) *Direct Air Capture.* https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/direct-air-capture

International Energy Agency (IEA). (2023). *CCUS in clean energy transitions*. Paris: IEA.

International Energy Agency (IEA). (2024, April 25). *Carbon capture, utilisation and storage*. https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage

Joarder, M. S. A., Islam, M. S., Hasan, M. H., Kutub, A., Kabir, M. F., Rashid, F., & Joarder, T. A. (2025). A comprehensive review of carbon dioxide capture, transportation, utilization, and storage: a source of future energy. *Environmental Science and Pollution Research*, 1-34.

Lebling, K., Gangotra, A., Hausker, K., & Byrum, Z. (2025, May 16). *7 things to know about carbon capture, utilization and sequestration*. World Resources Institute. https://www.wri.org/insights/carbon-capture-technology

London School of Economics and Political Science [LSE] (March, 2023) https://www.lse.ac.uk/granthaminstitute/explainers/what-is-carbon-capture-and-storage-and-what-role-can-it-play-in-tackling-climate-change/

Miao, L., Feng, L., & Ma, Y. (2025). Comprehensive evaluation of CCUS technology: A case study of China's first million-tonne CCUS-EOR project. *Environmental Impact Assessment Review*, *110*, 107684.

Nduokafor, C. F., Ovwighose, C. S., & Nwoye, U. J. (2024). Effect of oil and non-oil revenue of the federal government on the economy of Nigeria. *Journal of Contemporary Issues in Accounting*, *5*(2), 16-40.

Nigerian Upstream Petroleum Regulatory Commission (NUPRC). (2023, November). *Upstream gaze, vol. 5: Energy transition regime – Leveraging investment opportunities in the Nigerian upstream petroleum sector.* https://www.nuprc.gov.ng/wp-content/uploads/2024/02/Upstream-Gaze-Magazine-Vol.-5-20-2.pdf

Nwaobi, G. C. (2025). Climate Transition, Decarbonization Framework and Energy Sustainability in Ecowas Region. Decarbonization Framework and Energy Sustainability in ECOWAS Region (April 01, 2025).

Olajide, O. I., Adedeji, E., Chukwu, E., & Olarinre, S. (2025, August). Integrating Carbon Capture Utilization and Storage (CCUS) Concept into the Petroleum Industry Operations in Nigeria, Benefits and Challenges. In *SPE Nigeria Annual International Conference and Exhibition* (p. D022S026R009). SPE.

Omotuyi, O. (2025). CCUS in Nigeria. In *Carbon Capture Utilization and Storage: Law, Policy and Standardization Perspectives* (pp. 401-421). Cham: Springer Nature Switzerland.

Osu, V., Hupart, R., Adeshina, D., Adeyemo, O., Beck, B., Moore, R. L., & Osu, V. R. (2022, October). An integrated collaborative approach: CCUS development activities in Nigeria. In *Proceedings of the 16th Greenhouse Gas Control Technologies Conference (GHGT-16)* (pp. 23-24).

Pereira, E. G., Omotuyi, O., Righetti, T., & Edwards, H. H. (2025). CCUS: Legal Developments, Policies, and Challenges. In *Carbon Capture Utilization and Storage: Law, Policy and Standardization Perspectives* (pp. 205-234). Cham: Springer Nature Switzerland.

Petroleum Industry Act, 2021 (Act No. 6)

S&P Global (September 2024). CCUS: a viable business model in Asia-Pacific? Available at: https://www.spglobal.com/commodity-insights/en/news-research/blog/energy-transition/093024-ccus-a-viable-business-model-in-asia-pacific

Samuel, S. A. (2025). Carbon pricing mechanisms for reducing greenhouse gas emissions and encouraging sustainable industrial practices. *World J. Adv. Res. Rev*, *25*, 1-24.

Terungwa, D. (2025, March 1). *NLNG advances carbon reduction efforts for a net-zero future at NIES 2025. Majorwaves Energy Report.* https://www.majorwavesenergyreport.com/nlng-advances-carbon-reduction-efforts/

TotalEnergies. (2025, August 25). *Norway: First CO_2 storage in Northern Lights*. https://totalenergies.com/news/press-releases/norway-first-co2-storage-northern-lights

UN News – Global Perspective Human Stories (June 2025), https://news.un.org/en/story/2025/06/1163951#:~:text=In%202024%2C%20a%20flood%20in,displaced%20more%20than%201.3%20million.

Velan, V. K., Wattal, D., & Zhang, J. (2021). Integrated High Impact Innovation in Sustainable Energy Technology–Prefeasibility Analysis for Carbon Capture, Utilization and Storage (Subproject 2).

World Bank (July, 2022). What You Need to Know About the Measurement, Reporting, and Verification (MRV) of Carbon Credits. Available at: https://www.worldbank.org/en/news/feature/2022/07/27/what-you-need-to-know-about-the-measurement-reporting-and-verification-mrv-of-carbon-credits

World Bank Group. (2023, April). *Decarbonizing natural gas through carbon capture, utilization, and storage (CCUS).* https://documents1.worldbank.org/curated/en/099041823103013605/pdf/P1711730c77a380bd0bf340b299f884cf4b.pdf

World Bank. (2022). *Nigeria Floods 2022: Post-Disaster Needs Assessment*. Washington, DC: World Bank.

World Bank. (2023). *Global Gas Flaring Reduction Partnership (GGFR).* https://www.worldbank.org/en/programs/gasflaringreduction#:~:text=GGFR%20evolves%20into%20the%20Global,the%20oil%20and%20gas%20industry

World Economic Forum (August 2023). Climate Action: How (and why) to boost carbon capture, usage and storage to move towards net zero. https://www.weforum.org/stories/2023/08/carbon-capture-usage-and-storage-net-zero/

World Food Program USA (April, 2023). The 8 Countries Most Affected by Climate Change. https://www.wfpusa.org/news/countries-most-affected-by-climate-change/

Yao, X., Yuan, X., Yu, S., & Lei, M. (2021). Economic feasibility analysis of carbon capture technology in steelworks based on system dynamics. *Journal of Cleaner Production, 322*, 129046. https://doi.org/10.1016/j.jclepro.2021.129046