

Public perception and social acceptance of carbon capture technologies in the oil and gas industry: An empirical review

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Abstract

Knowledge on how the Nigerian public and various stakeholders view carbon capture, utilization and storage is limited. Engineering reviews have shown that using amine solvents for absorption is the leading candidate in terms of maturity and use. However, this paper examines the views of the general public, local communities, consumers, experts and other stakeholders on carbon capture, utilization and storage. One hundred empirical studies were reviewed over the last four years. The empirical studies examined perceptions towards carbon capture, utilisation and/or storage. The studies were grouped under thematic headings. The findings indicated that: Awareness of carbon capture among the general public in nearly all countries is poor; Opinion regarding carbon capture is generally unstable and easily influenced by the manner in which information is disseminated; Perceived risk and perceived benefit are stronger influences on acceptance than any other factors; Generalized support for carbon capture often converts to opposition once a specific project is proposed near individuals' residences; Procedural fairness, the extent of prior involvement by local stakeholders and the provision of tangible local economic benefits are significant predictors of whether projects achieve long-term viability; Carbon utilisation is viewed more favorably than carbon storage; Nature-based methods of removing CO₂ from the atmosphere are preferred to engineering based solutions; The willingness of consumers to pay for carbon capture is lower compared to renewable energy. The study also noted that most of the studies reviewed originated from Europe, North America and China while none were exclusively focused on surveys of public opinion from Nigeria. Therefore, recommendations for early and transparent community engagement, reliance on credible sources of information and equitable distribution of benefits associated with carbon capture projects in Nigeria's oil and gas sector are made. An additional recommendation is for further research to be conducted in Nigeria and in other African countries.

Keywords: Carbon capture and storage; Nigeria; Oil and gas industry; Public perception; Social acceptance; Trust.

1. Introduction

Carbon dioxide is the primary green-house gas emitted during combustion of fossil fuels. As a result, carbon capture technologies were created to prevent some portion of this gas from being emitted into the atmosphere. Simply stated, carbon dioxide is removed from flue gases produced by a plant, compressed and either injected deep beneath

the earth or converted into another product. If the gas is stored, the process is referred to as carbon capture and storage (CCS). When the gas is utilized to produce another product, the process is referred to as carbon capture and utilization (CCU) and when both options are available, the process is referred to as carbon capture, utilization and storage (CCUS).

These technologies are important for the oil and gas industry since many of its facilities (e.g., gas processing plants), use fuel in reboilers, heaters and power plants and produce flue gases containing carbon dioxide (Leung et al., 2021).

Engineering research has demonstrated that carbon capture can operate successfully at the scale of individual plants. For instance, reviews of capture technologies have found that amine solvent absorption is the leading capture method for CO₂ capture at this time. Post-combustion capture has also been shown to be a viable retrofit option for many existing power plants (Leung et al., 2014; Wang et al., 2011).

However, technical success does not ensure that a project will be constructed. For instance, the Barendrecht Project in the Netherlands was terminated due to extreme resistance from local residents. Similarly, a potential project was abandoned in northern Netherlands (van Os et al., 2014; van Egmond & Hekkert, 2015). Additionally, Germany rejected CCS for electricity production primarily due to lack of public acceptability and fears related to environmental risks (Vögele et al., 2018). These examples demonstrate that public perception plays an equally significant role as technological feasibility in determining if carbon capture will succeed.

Social acceptance refers to whether people approve, tolerate or reject a technology in general or when it is located in their own region (Wüstenhagen et al., 2007). While social acceptance is an essential factor in determining if a technology will be adopted, it is secondary to public perception. Public perception refers to how people comprehend, think about and evaluate a technology. Both social acceptance and public perception must be considered simultaneously since they occur together. Three levels at which social acceptance affects carbon capture are government approval via policy, market willingness to finance investment in carbon capture and community willingness to allow construction of facilities including pipelines, storage locations and capture facilities (Wüstenhagen et al., 2007; van Os et al.,

2014). Failure at any one of these levels can terminate development of a project.

Nigeria recently passed its Climate Change Act which establishes a net-zero target for Nigeria between 2050-2070 as well as creates a National Carbon Budget (Federal Republic of Nigeria, 2021). Furthermore, Nigeria's Energy Transition Plan also aims to achieve net-zero by 2060 while providing natural gas with a key role in achieving this goal (Federal Government of Nigeria, 2022).

At the same time, Nigeria continues to be one of nine countries responsible for almost three-quarters of global gas flaring, and gas flare rates increased in 2024 (World Bank, 2025). As a result, carbon capture will probably become part of the national debate about how to decarbonize oil and gas operations. However, there is very little information available regarding how Nigerians might react to carbon capture projects.

1.1 Problem Statement

While research on carbon capture has largely been based on cost, engineering design and storage capacity, social science research on public perception has grown. But this research is dispersed over multiple journals, countries and disciplines (L'Orange Seigo et al., 2014; Määttä & de Gooyert, 2025). Therefore, the findings of studies of what influences acceptance cannot easily be compared or applied. Furthermore, the majority of this research comes from developed countries. Developing countries with significant oil and gas industries, vulnerable local populations and developing climate laws are rarely the focus of research. Thus, when introducing carbon capture projects to the public, policy makers and companies operating in these countries often lack sufficient data to inform their approach.

1.2 Research Questions

To address this problem, the review answers the following four research questions.

RQ1: What types of empirical research exist regarding the social acceptance of carbon capture technologies?

RQ2: Which factors affect both public and stakeholder acceptance of carbon capture technologies?

RQ3: Do different perceptions exist among carbon storage, carbon utilisation and carbon removal?

RQ4: What lessons can the evidence provide to Nigeria's oil and gas sector?

2. Literature Review

This section provides explanations regarding carbon capture technologies within the oil and gas industry. This section defines the essential terms used throughout this literature review and outlines theoretical frameworks that explain why individuals accept certain technologies.

2.1 Carbon Capture in the Oil and Gas Industry

There are several methods to implement carbon capture within the oil and gas industry. These include capturing CO₂ before it is burned (pre-combustion), capturing CO₂ after it is burned (post-combustion), and capturing CO₂ through using pure oxygen to burn fuel (oxy-fuel combustion). Post-combustion capture is currently the best option for use in existing plants based on review of capture technology because it can be added to an existing facility without changing the process that produces combustion.

Since post-combustion capture is the most commonly used type of carbon capture for current facilities, it is the most frequently used option since it can be implemented into a facility without making any major changes to the facility. When implementing post-combustion capture, the flue gas that leaves the facility passes through a column called an absorber. The flue gas is passed through the absorber containing a chemical solution known as an amine. The amine captures the carbon dioxide from the flue gas. The amine then goes through a separate column where it is heated. Through heating the amine, the absorbed CO₂ is released from the amine creating a concentrated flow of CO₂. The amine that was used in the absorption process is then recycled back through the absorption process (Leung et al., 2021). Flue gases come from various sources including glycol reboilers, heat medium heaters and on-site

power generation. Typically, the flue gases contain approximately 9 percent by mole of carbon dioxide (Leung et al., 2021). Once captured, the CO₂ must be transported via pipelines or ships and placed in underground geological formations for long-term storage, injected into depleted hydrocarbon reservoirs for enhanced hydrocarbon production or converted into products such as fuels, chemicals, plastics and construction materials. All of these activities involve people external to the plant. Pipelines traverse agricultural lands and urban areas; underground storage sites sit underneath residential areas; products created from captured CO₂ are purchased by consumers. Due to this fact, carbon capture represents a technological system but also a social system (Arning et al., 2019; Oltra et al., 2012a).

2.2 Public Perception and Social Acceptance

Public perception is essentially how much people understand a technology, the perceived advantages and disadvantages, and the emotions associated with it. Social Acceptance is the response based upon those perceptions. Authors who write about the social acceptability of energy technologies generally agree that there are multiple levels of acceptance. There are three dimensions to social acceptability as defined by Wüstenhagen et al. (2007): Socio-Political Acceptance, support of the technology and policy by the public, policymakers and key stakeholders. Community Acceptance, response of local residents to an individual project located within their immediate area. Market Acceptance, willingness of both consumers and investors to utilize the technology. As demonstrated by van Os et al. (2014), studies conducted in the Netherlands and United States have illustrated that although a project may receive high socio-political acceptance, it does not necessarily guarantee success at the community level, conversely, a project could receive high community acceptance but low socio-political acceptance. Table 1 below lists working definitions employed in this review.

Table 1. Key Constructs and Working Definitions Adopted in This Review

Construct	Working Definition	Illustrative Sources
Carbon capture and storage (CCS)	Separation of carbon dioxide from industrial or power plant exhaust gas, followed by transport and permanent storage in deep rock formations.	Shackley et al. (2004)
Carbon capture and utilisation (CCU)	Use of captured carbon dioxide as a raw material for products such as fuels, plastics and building materials.	Arning et al. (2019); Pieri et al. (2023)
Carbon dioxide removal (CDR)	Removal of carbon dioxide already in the air, for example through bioenergy with CCS (BECCS) or direct air capture (DAC).	Cox et al. (2020); Lee et al. (2025)
Public perception	What people know, believe and feel about a technology, including its perceived risks and benefits.	Duan (2010); Yang et al. (2016)
Social acceptance	Support for, tolerance of or opposition to a technology at the socio-political, community and market levels.	Wüstenhagen et al. (2007); van Os et al. (2014)
Trust	Confidence that the organizations responsible for a technology are competent and act with integrity.	Terwel et al. (2009); Liu et al. (2021)

2.3 Theoretical Framework

Theories have been proposed as a way to describe how people develop opinions about whether or not they want carbon capture technologies implemented. All three theories propose that the development of opinion regarding carbon capture occurs through a judgment based upon uncertainty. The first theory is the risk/benefit approach. In this model, individuals compare the risks they believe exist in relation to a new technology versus the perceived benefits for them. If an individual perceives that there will be greater benefits than risks associated with the technology, then they may be more willing to accept the technology. Research has shown that this is true regardless of what country you reside in. Yang et al. (2016) conducted research in China, while Moon et al. (2020) did so in the United States. Both studies found that as the perception of risk increases, acceptance decreases, and as perceptions of benefits increase, acceptance also increases. The second theory is the trust theory. Similar to the risk/benefit approach, but because many people do not know enough to make an

educated decision regarding the potential risks associated with storing CO₂ underground, most individuals will look toward organizations who build and oversee underground storage. These same organizations provide information regarding the safety of underground storage. Terwel et al. (2009) and Liu et al. (2021) developed very similar conclusions to each other by studying different areas and concluded that if one trusts the competency and integrity of an organization providing information regarding underground storage, then their willingness to accept or reject underground storage may depend on the organizations' perception of the risks and/or benefits. However, if one does not trust the organization, then the degree to which one accepts or rejects underground storage may be influenced more heavily by the perceived risks and/or benefits provided by the organization. The third theory is the Integrated Acceptance Framework. This theory was developed by Huijts et al. (2012). In their study, they attempted to combine all prior research into a single framework. Their findings suggest that an individual's

intentions to either support or oppose an energy technology can be determined using four separate variables: social norms, personal norms, perceived control, and attitudes. Attitudes were defined as being influenced by cost, risk, benefit, emotion, trust, and fairness of both the decision-making process and how outcomes are distributed. As stated previously, this framework is consistent with the multi-level view of Wüstenhagen et al. (2007) due to the fact that fairness and trust have less importance at levels beyond the community level where energy projects are typically located. Therefore, these three theories serve as a basis for coding of themes outlined in Section 3.4 and analysis in Section 4.

3. Methodology

This section explains how the review was designed, how the studies were found and selected, and how their findings were coded into themes.

3.1 Review Design

This investigation employs a narrative review of empirical studies. Narrative reviews were selected due to the fact that there are numerous social aspects of carbon capture being researched across multiple disciplines (i.e., economics, psychology, sociology, policy, engineering) using a wide variety of methodologies. As such, a narrative approach enables all forms of empirical evidence to be synthesized and interpreted collectively versus simply quantified. The methodology

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication type	Peer-reviewed journal articles and papers in proceedings journals	Theses, reports, working papers, blogs and news articles
Study type	Empirical studies: surveys, experiments, choice and valuation studies, interviews, focus groups, case studies and media analyses	Literature reviews and purely conceptual papers
Technology	CCS, CCU, CCUS, carbon dioxide pipelines and carbon removal with storage	Studies of other energy technologies that do not report findings on carbon capture
Focus	Perception, acceptance, attitudes, trust, willingness to pay or stakeholder views	Purely technical, cost or modelling studies

employed in this paper follows a recently established format for conducting reviews in management and social sciences (i.e., defining key concepts; developing inclusion/exclusion criteria; extracting relevant information via a standard template; and synthesizing information into themes).

3.2 Search Strategy

All studies were identified via searches conducted in the IDEAS social science/economics database, along with publisher pages; university libraries/repositories; and general internet searches. Searches involved combining search terms for technology-related terminology (i.e., "carbon capture"; "CCS"; "CCUS"; "CO₂ Storage"; "Bio-Energy with Carbon Capture"; "Direct Air Capture"), with terms for social responses (e.g., "public perception," "acceptance," "attitude," "willingness-to-pay," "stakeholders," "media"). All studies found via search were evaluated individually prior to selection.

3.3 Inclusion and Exclusion Criteria

Table 2 details the inclusion/exclusion criteria that were utilized when identifying studies to be part of this literature review. Only empirical studies were included since the purpose of this literature review is to discuss what has been reported as regards public/stakeholder reactions to GMOs, not to discuss what has been theoretically proposed. This means that thesis studies, reports and working papers were excluded as such studies have not undergone a peer-review process.

Criterion	Inclusion	Exclusion
Period	2002 to 2026	Studies published before 2002
Language	English, or German with an English abstract	Other languages

3.4 Data Extraction and Analysis

Each study that was selected was analyzed utilizing a standardized template for extracting data. The template documented the following: author(s), date published, title of publication (journal name), location where study was conducted (country), demographic composition of participants (participant group), methodology used (method), number of participants (sample size) and primary results (main findings). Following data extraction, an analysis of the extracted findings occurred according to Braun and Clark's (2006) six stages of thematic analysis: getting familiar with the data, developing preliminary codes, looking for themes, evaluating themes, assigning labels to the identified themes, and reporting. Preliminary codes were developed based upon the theoretical model detailed in Section 2.3 (risk, benefits, trust, fairness, level of acceptability) and based upon the patterns evident within the extracted data. Once preliminary codes that

represented similar ideas were grouped together, the groups were evaluated against the data that was extracted. Ten unique themes were established after which time no additional themes could be identified. Table 3 identifies each theme along with the corresponding research question. RQ1 is addressed within Section 4.1 regarding the characteristics of the studies included in this literature review, while RQ4 is discussed in Section 4.3. Although most studies address more than one theme, a single main theme was assigned to each study for purposes of counting. A total of 100 studies comprises the final set. Among those studies, 97 were published in journals and three were published in proceedings journals.

Table 3. Coding Framework: Themes, Their Coverage and the Research Questions They Answer

Theme	What the Theme Covers	Research Question
1. Awareness and knowledge	How much people know about carbon capture and how knowledge relates to acceptance	RQ2
2. Framing and information	How the content and framing of information change opinions	RQ2
3. Risk, benefit, trust and values	The psychological and value-based drivers of acceptance	RQ2
4. Local siting and NIMBY responses	Differences between general support and support for a nearby facility	RQ2
5. Fairness and engagement	Decision processes, community involvement and governance of real projects	RQ2, RQ4
6. Carbon utilisation products	Perceptions of products made from captured carbon dioxide	RQ3

Theme	What the Theme Covers	Research Question
7. Carbon removal (BECCS and DAC)	Perceptions of technologies that remove carbon dioxide from the air	RQ3
8. Economic preferences and policy support	Willingness to pay and preferred policy instruments	RQ2
9. Media and communication	How the media present carbon capture to the public	RQ2
10. Expert and stakeholder views	How experts, industry and policy actors view carbon capture and its barriers	RQ2, RQ4

Table 4. Characteristics of the Reviewed Studies (n = 100)

Characteristic	No. of Studies	% of Studies
Region: Europe	43	43%
Region: North America	18	18%
Region: Asia (mainly China)	16	16%
Region: Multi-region or international	10	10%
Region: Australia	2	2%
Region: Latin America	1	1%
Region: Africa	1	1%
Region: Not stated in the study	9	9%
Method: Survey	39	39%
Method: Experiment, choice or valuation study	25	25%
Method: Focus group, deliberative or ethnographic study	10	10%
Method: Case study	9	9%
Method: Interviews and expert methods	8	8%
Method: Media or content analysis	8	8%
Method: Mixed methods	1	1%
Period: 2002 to 2010	14	14%
Period: 2011 to 2015	31	31%
Period: 2016 to 2020	17	17%
Period: 2021 to 2026	38	38%

4. Results and Discussion

This section first describes the reviewed studies (RQ1). It then presents the ten themes (RQ2 and RQ3), discusses the three main findings and what they mean for Nigeria's oil and gas industry (RQ4), and closes with a summary of the answers to the research questions.

4.1 Characteristics of the Reviewed Studies

Reviewed studies were published between 2002-2026. There has been increasing interest in carbon capture research during this time period, as indicated by 38 studies published after 2021 (see Table 4 below for summary features).

Europe represents approximately 43% of the reviewed studies, followed by North American studies representing approximately 18%, and studies from Asia represent approximately 16% of total reviewed studies. Major contributors to European studies include UK, Germany, and Netherlands. China accounted for approximately 80% of the reviewed Asian-based studies. African-based studies consisted solely of a single-country study from South Africa (Ko et al., 2021), along with a multi-country survey/focus group study (Nigeria, Kenya, and South Africa) (Low et al., 2024). Approximately two-thirds (64%) of reviewed studies employ surveys or experimentation. The general public/consumers were examined in 60% of the reviewed studies; experts/stakeholders were examined in 22% of reviewed studies; local community members residing proximal to existing/proposed CCS sites were examined in 11% of reviewed studies; media coverage was examined in 7%.

The shift in interest in the field of CO₂ storage research over time has been substantial as well. Only six of sixty-two (10%) studies prior to 2021 focused on carbon utilization or carbon removal. In comparison, seventeen of thirty-eight (45%) studies published after 2021 examined those topics. Additionally, all seven studies related to awareness of geologic sequestration and thirteen studies related to framing/communication issues have been

conducted prior to 2021. These findings indicate an increased emphasis among researchers on developing uses for captured carbon and removing it from the atmosphere. As such, this indicates a significant move away from discussing whether CO₂ should be stored below ground toward researching how it may be utilized and/or removed.

4.2 Thematic Analysis

The thematic synthesis resulted in the ten identified themes shown in Table 3. The distribution of the included studies is given in Table 5. Themes 1-5 and 8-10 indicate what influences acceptance (RQ2) while Themes 6 and 7 provide a comparison for carbon utilization versus carbon removal with storage (RQ3).

Table 5. Distribution of the Reviewed Studies Across Themes (n = 100)

Theme	Representative Studies	No. of Studies (%)
1. Awareness and knowledge	Miller et al. (2008); Ha-Duong et al. (2009); Duan (2010)	7 (7%)
2. Framing and information	Shackley et al. (2004); de Best-Waldhober et al. (2009); Whitmarsh et al. (2019)	13 (13%)
3. Risk, benefit, trust and values	Terwel et al. (2009); Yang et al. (2016); Liu et al. (2021)	10 (10%)
4. Local siting and NIMBY responses	Krause et al. (2014); Braun (2017); Zhou et al. (2024)	12 (12%)
5. Fairness and engagement	Ashworth et al. (2012); Cuppen et al. (2015); Scott-Buechler et al. (2024)	8 (8%)

Theme	Representative Studies	No. of Studies (%)
6. Carbon utilisation products	Arning et al. (2019); Lutzke and Árvai (2021); Raimi et al. (2024)	11 (11%)
7. Carbon removal (BECCS and DAC)	Wolske et al. (2019); Cox et al. (2020); Low et al. (2024)	12 (12%)
8. Economic preferences and policy support	Kraeusel and Möst (2012); Pianta et al. (2021); Fikru (2025)	7 (7%)
9. Media and communication	Dowd et al. (2012); Jiang et al. (2022); Otto et al. (2022)	7 (7%)
10. Expert and stakeholder views	Johnson et al. (2010); Davies et al. (2013); Romanak et al. (2021)	13 (13%)
Total		100 (100%)

4.2.1 Low Awareness and Knowledge

The majority of citizens surveyed globally had little knowledge of the CCS process. Only 6 percent of French respondents were able to define correctly CCS (Ha-Duong et al., 2009). Only 18 percent of Australian respondents were aware of geological storage of CO₂ (Miller et al., 2008) and few respondents from The Netherlands stated they did not know anything about CCS (de Best-Waldhober et al., 2009). Citizens in the U.S. demonstrated extremely low levels of awareness (Pianta et al., 2021). Of Chinese citizens interviewed approximately 58 percent said they had at least heard of CCS but only 10 percent had a good understanding of CCS (Xie et al., 2023), and CCS has been ranked as having lower public awareness compared to other forms of renewable energy (Duan, 2010; Yang et al., 2016). Lower levels of public awareness of CCS have also been identified in Poland (Rychlicki et al., 2015).

Where there is greater awareness of CCS, generally greater acceptance exists (Duan, 2010; Toma et al., 2014; Rychlicki et al., 2015; Xie et al., 2023).

The data from these studies demonstrate that all of them find that lack of awareness is the beginning of public knowledge regarding carbon capture. Consequently, initial perceptions of a project are generally

determined by who provides the first impression to the public.

4.2.2 Role of Framing and Information

Since most individuals lack sufficient information to form an opinion regarding carbon capture, this opinion will likely be unstable and subject to influence by new information (de Best-Waldhober et al., 2009). For example, prior to receiving information, the majority of UK residents either held no opinion or held a mild negative opinion toward CCS. However, after receiving only limited amounts of information regarding the intended use of the stored CO₂, a significant number expressed a slightly positive opinion toward CCS (Shackley et al., 2004). While information is typically associated with increased support for a particular issue, in Germany providing further information resulted in decreased support for all climate-related measures, including sub-seabed storage (Braun et al., 2018). Furthermore, highlighting the risks and benefits associated with removing CO₂ in the U.S. reduced support for such activities (Wolske et al., 2019) and framing CCS against other climate mitigation strategies made Dutch respondents less supportive (de Best-Waldhober et al., 2009). The manner in which the information is presented also affects how it is received. Associating CCS with natural processes

generated marginally higher levels of positivity (Oltra et al., 2012b) and associating storage with the reuse of CO₂ garnered support across multiple countries (Whitmarsh et al., 2019). On the other hand, mentioning even small cost increases reduced support for CCS (Whitmarsh et al., 2019). Additionally, correcting misperceptions regarding CCS may reduce perceptions of risk however some aspects of the detail provided can increase perception of risk (Wallquist et al., 2011). Further, existing concerns are difficult to overcome through education or provision of information alone (Lock et al., 2014; Riesch et al., 2013).

Therefore, all of these studies agree that information does matter; however, there appears to be disagreement over the type of information. The majority of the literature suggests that providing information about the purpose of carbon capture has been shown to increase levels of support; whereas, providing information about the risks, cost or alternative solutions have lowered levels of support. These findings are consistent with the risk and benefit perspective discussed in Chapter 2.

4.2.3 Risk, Benefit, Trust and Values

Perceived risks are the largest barrier to acceptance, while perceived benefits are a major driver of acceptance (Yang et al., 2016; Xie et al., 2023). Perceived benefits have had a stronger impact on acceptance than perceived risks in China (Liu et al., 2021). People commonly cite leaks and long-term storage safety issues, as well as fears regarding accidents and the ability of institutions to provide oversight during extended periods as reasons for concern regarding storage (Gough et al., 2002; Shackley et al., 2004; Gough et al., 2014). People's level of trust influences how they perceive risks and benefits. Greater trust in organizations involved in CCS increases perceived benefits, decreases worry related to perceived risks, and results in a greater magnitude of influence by both factors upon acceptance (Terwel et al., 2009; Yang et al., 2016; Liu et al., 2021; Xie et al.,

2023). In addition to being influenced by institutional trust, acceptance also depends on broader societal values and cultural norms. For example, the degree to which people value climate protection and the degree to which they trust their government have each been shown to independently predict acceptance in Germany (Braun et al., 2018). Similarly, an individual's worldview has been used as a predictor of acceptance or rejection in the US (Warren et al., 2014; Cherry et al., 2014).

All three perspectives identified within Section 2.3 were supported through the results of these studies: Risk and Benefit Judgments Drive Acceptance; Trust Shapes How Those Judgments Are Formed; And Wider Values Such as Climate Concern Decide How Much Weight Is Given to Each Perspective.

4.2.4 Local Siting and the NIMBY Response

While people tend to express support for carbon capture and sequestration in general, resistance often develops when a specific site is proposed within their own community - i.e., the Not-In-My-Back-Yard (NIMBY) response. An example is a study conducted in coal-producing Indiana where over 80 percent of respondents expressed overall support for CCS; however, almost twenty percent of these supporters opposed building a facility in their immediate area (Krause et al., 2014). Studies conducted in Germany revealed that individuals residing nearby proposed storage locations as well as those located in coal mining areas tended to be much less accepting (Braun, 2017). In a large-scale survey among Chinese citizens, the NIMBY effect was identified as the single greatest contributor to the acceptance or rejection of a CCS facility (Zhou et al., 2024).

Similar patterns have been found for pipeline construction (Gough et al., 2014; Wallquist et al., 2012), for industrial carbon capture facilities in seven European countries (Kashintseva et al., 2018), and

for carbon utilization facilities in the United States (Raimi et al., 2024). Onshore and nearshore carbon sequestration received some of the lowest ratings from Danish respondents when evaluating climate technologies (Ladenburg et al., 2024); however, transporting carbon dioxide across international borders has led to decreased acceptance of carbon capture in Europe and Canada (Anders et al., 2024). While the NIMBY phenomenon appears to be an international trend, it is not universally applicable. Terwel and Daamen (2012) indicated that initial local resistance to a carbon sequestration facility in the Netherlands was due less to a typical "not-in-my-backyard" reaction and more so to distrust of the government and concerns related to the safety of the facility. Lee et al. (2025) reported that there was little or no "NIMBY" effect regarding direct air capture in six different European countries. Similarly, Mabon et al. (2014) demonstrated that offshore carbon sequestration does not automatically result in greater public acceptance simply because it occurs farther away from populated areas.

In summary, the research demonstrates that proximity affects perception, but that its influence will depend on factors such as trust, safety concerns, and anticipated local benefits rather than mere physical distance.

4.2.5 Fairness, Engagement and Governance

Real-world experience clearly demonstrates how decisions about whether to implement specific CCS projects can have equal if not greater impact on public perception than the technology itself. At Barendrecht, the project was presented from its inception as primarily an engineering/economic matter with virtually no opportunity for input from local stakeholders regarding fairness in the decision-making process and fairness in terms of the equitable distribution of potential risks and benefits associated with the implementation of CCS (Cuppen et al., 2015). Although the Dutch federal

government had previously determined that CCS would be necessary to reduce greenhouse gas emissions, local public opinion began to develop a negative disposition toward the proposed Barendrecht CCS Project due to a lack of outside support for the project and numerous delays in implementing the project (van Egmond & Hekkert, 2015). Opposition to CCS was stronger locally than nationally, and conflicting opinions among important stakeholders contributed disproportionately to the demise of the Barendrecht CCS Project (van Os et al., 2014). Based on a comparison of five European CCS projects, Oltra et al. (2012a) concluded that project-related attributes, the decision making/engagement process, risk perceptions, actions taken by stakeholders, attributes of the community impacted, and broader societal/political context were all primary influences upon community responses to CCS. Recent studies indicate similar findings. Valsdottir et al. (2026) suggested that Iceland's residents primarily opposed plans to store CO₂ beneath a terminal at Coda based largely on issues related to lack of transparency and lack of representation by residents within the decision-making processes surrounding this project, as well as their perception that the technology itself represented no risk. Community involvement during the planning phase of four direct air capture facilities in America resulted in higher levels of support than those where there was minimal community involvement during planning phases (Scott-Buechler et al., 2024). Factors which contribute to successful experiences with CCS include employing communication professionals early in the process, coordinating efforts between governments and project developers, consideration of relevant local conditions, and flexibility in designing the project (Ashworth et al., 2012; Hund & Greenberg, 2011). Ashworth and Thambimuthu (2009) reported that engaging community members through

community meetings resulted in increased understanding and increased willingness to support a carbon capture/demonstration project in rural Australia. Nonetheless, communication professionals continue to provide lower relative weight to early community engagement than do policy makers and researchers who study public attitudes toward CCS (Xenias & Whitmarsh, 2018).

As a result, both the case studies and surveys demonstrate that procedural fairness, transparency, and local benefits are equally as important as the technology itself, which further supports the fairness aspect of the framework proposed by Huijts et al. (2012).

4.2.6 Carbon Utilisation Products

Generally speaking, individuals view carbon utilization favorably compared to carbon sequestration. Both were evaluated equally by German citizens; however, carbon utilization was assessed as being substantially more positive than carbon sequestration (Arning et al., 2019). Respondents living in Jakarta, Indonesia similarly preferred utilizing carbon dioxide versus storing it; nonetheless, many respondents lacked sufficient information to consider supporting any type of carbon capture development due to concerns regarding safety (Sitinjak et al., 2023). In the United States, roughly two-thirds of U.S. respondents felt that products made from carbon dioxide captured during commercial-scale operations would either be very acceptable or at least somewhat acceptable to them (Lutzke & Árvai, 2021). Additionally, average assessments of carbon utilization were moderate across U.S. respondents (Raimi et al., 2024). When assessing alternative approaches for managing emissions in electric power generation systems, U.S. respondents preferred carbon utilization to other approaches for reducing emissions (Ahmed & Fikru, 2025). Perceptions of products produced from captured carbon depend heavily on what the final product is. Foods/beverages manufactured using

captured carbon dioxide tend to receive lower ratings compared to fuels/building materials created using captured carbon dioxide (Pieri et al., 2023; Lutzke & Árvai, 2021). Concerns relating to health greatly affect consumer purchasing behavior (Simons et al., 2024; van Heek et al., 2017; Arning et al., 2021). Perceived transportation of carbon dioxide along a value chain is considered the least desirable activity among those involved in producing carbon-based products (Schomakers et al., 2025; Offermann-van Heek et al., 2020; Engelmann et al., 2024). Many consumers also express fears that manufacturers will use marketing strategies to make products appear "greener" than they truly are (Haverkämper et al., 2023).

Ultimately, the cumulative research demonstrated here indicates that carbon utilization receives greater amounts of goodwill from the general public compared to carbon storage since individuals can observe a tangible good; however, this goodwill depends on the good being safe to one's health and upon truthful claims made with respect to environmental impacts.

4.2.7 Carbon Removal Technologies

Consistent preferences exist among individuals regarding nature-based methods for removing carbon versus engineered methods. Afforestation and improving soil carbon quality have consistently been rated more favorable than bioenergy with carbon capture and storage (BECCS) and direct air capture across studies conducted in the United States, the UK, Switzerland, Germany and six European countries (Merk et al., 2023; Wolske et al., 2019; Wenger et al., 2021; Bellamy, 2022; Lee et al., 2025; Sweet et al., 2021). National surveys conducted in the US revealed that support for afforestation exceeded support for BECCS and direct air capture by wide margins (e.g., afforestation = 73%, BECCS = 32%, Direct Air Capture = 25%) (Sweet et al., 2021).

BECCS has been considered as "tampering with nature," because it works very slowly or as a moral hazard that would reduce efforts to immediately cut greenhouse-gas emissions. Wolske et al. (2019); Cox et al. (2020); Satterfield et al. (2023); Sloot & Bostrom (2024) Focus Groups conducted across 22 Countries demonstrated this perception of concern toward BECCS and indicated regional differences in concern. Focus group participants in Nigeria and Kenya expressed concern regarding competition for food production and security of oil and gas infrastructure for related BECCS operations in Nigeria (Low et al., 2024). The method of funding for removals matters as well, since payment for each tonne of CO₂ removed were accepted into law while price guarantees were rejected (Bellamy et al., 2019). Climate negotiations gave little attention to BECCS (Fridahl, 2017), however perceptions toward both fossil CCS and BECCS became increasingly positive over time (Romanak et al., 2021).

Furthermore, all of the studies reviewed above indicate that the public evaluates carbon removal based on its naturalness as well as whether it supplements or supplants reductions in emissions, which creates an unfair competitive environment for engineered technologies such as BECCS and Direct Air Capture.

4.2.8 Economic Preferences and Policy Support

Individuals are willing to spend significantly less money for carbon-capture technologies than for renewable-energy technologies. Research studies in Germany (Krausel & Möst, 2012; Holm et al., 2015) and in the United States (Ahmed & Fikru, 2025) demonstrated that individuals' willingness to spend more money for additional carbon-capture in electricity was less than their willingness to spend for increased amounts of renewable-content. Studies in Denmark (Kim & Ladenburg, 2024) show that individuals who were familiar with Carbon-Capture-and-Sequestration (CCS) had greater

willingness-to-pay for these technologies. Individuals prefer different policies. National surveys of the United States population revealed that approximately 47 percent of respondents prefer direct reduction of GHG emissions while 19 percent prefer subsidized CCS, 17 percent private-funding CCS, and 17 percent penalize GHG emissions. U.S. residents also prefer banning new fossil-based electrical generation plants to either tax or subsidizing them, and support for CCS decreases as the cost increases (Pianta et al., 2021). Public support is influenced by perceived job opportunities and economic impacts locally (Krause et al., 2014; Warren et al., 2014), and local economic interest influence the level of support for deployment far more than they do support for research funding (Cherry et al., 2014). Collectively, these studies suggest that the public views carbon capture less favorably than renewable energy; however, increased familiarity with the technology combined with expectations of local economic growth increases levels of support.

4.2.9 Media and Communication

Public perceptions of carbon-capture are shaped by media coverage of the topic. A study of 1138 international articles concluded that most were neutral or balanced and contained limited information about how the process worked (Dowd et al., 2012). Neutral/balanced articles represented the majority of news coverage of CCS during the period between 2017 and 2019 in the Netherlands, but the number of negative articles exceeded the number of positive articles (ter Mors et al., 2023). Articles published in newspapers in China supported carbon capture at a rate of 71.3 percent (Jiang et al., 2022). A comprehensive review of about 4000 articles about CCS published in Germany over the course of 20 years indicates that CCS maintained a negative reputation associated with coal-based electrical generation (Otto et al., 2022). Voices of politicians reframed CCS from a risk to an opportunity in Saskatchewan

(Hurlbert & Osazuwa-Peters, 2023) and media portrayals of CCS and biomass as being beneficial to society in the United States (Feldpausch-Parker et al., 2015). Media coverage of carbon utilization in German-speaking countries tends to be largely positive (Fürst & Strunge, 2024). Lastly, the various studies reviewed above indicated that media portrayals differ from nation-to-nation, and typically reflect domestic policy debates; therefore, help explain why varying levels of public opinion exist among countries examined above.

4.2.10 Expert and Stakeholder Views

The general consensus among experts regarding carbon capture appears to be much more optimistic than among the public. Experts involved in carbon capture believe the technology will work, albeit some may believe that confidence could result in overestimation of uncertainty concerning costs, sequestration capacity and permanence (Hansson & Bryngelsson, 2009; Evar, 2011). Expert opinions in the United States pointed out several barriers including cost, no carbon-pricing mechanism, long term liability, and inadequate regulation as major obstacles to widespread use (Davies et al., 2013). Expert opinion in China emphasized high cost, technical uncertainty, and necessity for policy and institutional reform (Liang & Wu, 2009; Liang et al., 2011). Brazilian experts felt that carbon capture can provide emissions reductions, but expect commercial-scale implementation to occur only when appropriate market structure, policies, and regulations exist (Machado et al., 2021). Stakeholders from developing countries in Asia point out regulatory issues including obtaining licenses, acquiring land etc., as necessary initial steps before implementing large scale projects (Abdullah et al., 2021). The economic conditions surrounding the development also play a role. Projects moved forward in resource rich provinces like Alberta while similar projects did not succeed in other locations like the UK due

to the presence of resources (Kern et al., 2016). Power dynamics between existing players like incumbents can hinder development as evidenced by South Africa's case (Ko et al., 2021). Business groups tend to favor carbon capture far more than environmental organizations across regions (Johnson et al., 2010; Romanak et al., 2021), but there are also vast differences in views among stakeholders based on location within individual nations (Setiawan & Cuppen, 2013).

Finally, all of the studies reviewed above concluded that experts believe that major obstacles to deployment include economic and institutional issues; and, therefore, the chasm between expert optimism regarding deployment and public skepticism toward deployment represents another significant barrier to successful deployment.

4.3 Discussion

Three key findings were identified in the thematic synthesis of evidence relating to acceptance of carbon capture technology. These findings are discussed below.

Finding One: Acceptance is Based on Trust and Fairness Processes, Rather Than Just the Provision of Information

Evidence collected demonstrates that the primary factors used by individuals in determining their perceptions of carbon capture technology are based upon the level of trust placed in those promoting it and the fairness of the decision-making process. While information plays an essential role in allowing individuals to form perceptions regarding carbon capture technology, there is little evidence to suggest that providing information automatically increases levels of public support for carbon capture technology. Furthermore, in some cases, information has been shown to decrease levels of support (Braun et al., 2018; Wolske et al., 2019). Conversely, failed projects demonstrate that opposition increased when host communities did not feel included in decision making processes. On the other hand, successful projects

demonstrated inclusionary practices with host communities from the outset (Ashworth et al., 2012; Cuppen et al., 2015; Valsdóttir et al., 2026). As with Barendrecht and Iceland, when a decision was made by authorities prior to engaging with the local community then opposition will increase (Cuppen et al., 2015; Valsdóttir et al., 2026). The findings for these cases support Huijts et al.'s (2012) model in which perceived risk/benefit factors and level of trust/fairness influence public perception, and Wüstenhagen et al.'s (2007) point of view that whether or not a project is accepted by a local community is based upon how the project is approved as well as what it is. This finding is particularly relevant for the case of Nigeria.

Additionally, perceived risks and perceived benefits have significant impacts on these attitudes. Importantly for Nigeria, these finding highlights that where there is little trust in government and/or industry, information campaigns alone will likely be unsuccessful in developing public support for carbon capture technology. To overcome potential public resistance, fair processes must be adopted along with transparent risk management and active community involvement.

Finding Two: Supporting the Concept Does Not Equate to Supporting the Facility

A number of people generally agree on the idea of Carbon Capture however are opposed to having a facility located in their immediate area (Krause et al., 2014; Braun, 2017; Zhou et al., 2024). As a result, there appears to be an unacceptable difference in acceptance of carbon capture technologies as measured through National Surveys versus Local Publics. The magnitude of the differences varies. For example, approximately 1 in 5 supporters of carbon capture technology in Indiana switched from supporting the concept to opposing it after a project was proposed for construction nearby (Krause et al., 2014); whereas in China the NIMBY (Not in my

back yard) effect outweighed all other factors (Zhou et al., 2024). When public trust in Government was high early reactions to carbon capture proposals were less based upon being directly impacted (Terwel & Daamen, 2012). As such local acceptance of carbon capture projects will have to be built at each location and will require consideration of local impacts, local benefits and local histories. In Nigeria, where many gas processing facilities and potential carbon sequestration locations are located in close proximity to communities hosting these facilities, this research supports the design of carbon capture projects in collaboration with affected communities. Further, this research supports the distribution of the benefits associated with carbon capture projects to those local communities hosting the facilities. Support for carbon capture is increased when individuals perceive they will benefit from job opportunities or other economic benefits generated by carbon capture projects (Krause et al., 2014; Scott-Buechler et al., 2024), which is important in the Nigerian context given the number of localities that could potentially host carbon capture facilities.

Finding Three: A Significant Majority of the Existing Body of Research Relates to Developed Countries

The majority of data has been collected from Europe, North America and China. There are very few examples of African countries involved, and a specific study of public perception of carbon capture technology in Nigeria could not be identified.

A major reason why this is significant is because each country will have its own unique driver for acceptance of carbon capture technology based upon their local environment. For example, Low et al. (2024) stated that Nigerian focus group participants expressed some concern regarding food security as well as the safety and security of oil and gas infrastructure, while these were rarely mentioned by other locations.

Therefore, findings from Germany or the United States should not be presumed to be applicable in Nigeria. In addition, the form of carbon capture that Nigeria is likely to implement is also influenced by where studies of carbon capture have taken place. Examples of studies located in Germany and the United States discussed carbon capture in relation to coal fired power plants (Krause et al., 2014; Braun, 2017; Otto et al., 2022).

On the other hand, Nigeria's oil and gas industry will be more likely to implement carbon capture at the gas processing facility level and through enhanced oil recovery. Rychlicki et al. (2015) are the only researchers who conducted a public survey that included questions about using carbon dioxide for enhanced oil recovery.

4.4 Summary of Answers to the Research Questions

This section pulls together how the review has addressed each of the four research questions outlined in Section 1.2. For the first research question, the nature of the studies included in the review, it was determined by the reviewer that there were 100 empirical studies conducted on carbon capture and published during the years 2002–2026. It was noted that almost half (43%) of all the studies reviewed were conducted in European countries; 18 percent were in North American countries; 16 percent were in Asian countries. Additionally, as a general category, over two-thirds (67%) of the studies reviewed were either surveys or experiments. Only one single-country study in this area of research was from an African country. As recent studies have focused increasingly upon the use of captured CO₂ (carbon utilization) and removing CO₂ from the atmosphere (carbon removal), both areas of interest will likely be examined in future studies.

The second research question examined what determines whether or not individuals accept carbon capture. The reviewer identified that several factors contribute to determining an individual's willingness to

accept carbon capture including awareness/knowledge of the technology, how information about carbon capture is framed, an individual's perception of the risks associated with carbon capture and its potential benefits, whether or not an individual trusts government and/or business to implement carbon capture responsibly, and a person's broader personal values. In addition to these factors, proximity to existing facilities implementing carbon capture, a sense of fairness surrounding decisions related to carbon capture, anticipated local economic benefits resulting from carbon capture implementation and how media frames carbon capture also impact acceptance.

The third research question assessed differences in how individuals perceive carbon storage, carbon utilization and carbon removal. While carbon utilization is seen more favorably than carbon storage, within the overall value chain for carbon capture and storage (CCS), transportation of CO₂ is the least accepted activity and storing CO₂ near residential locations is the least acceptable location. When it comes to carbon removal methods, respondents prefer nature-based solutions compared to bioenergy with carbon capture and storage (BECCS) and direct air capture.

In addressing the fourth research question regarding practical recommendations based upon the results of the review for Nigeria's oil and gas sector, there are some obvious conclusions. The most important recommendation would be for host communities to be involved at an early stage in development planning, and for the companies developing CCS projects to build trust with them through fair and transparent processes. Also, any local benefits arising from project implementation should be shared fairly among impacted stakeholders. Clear regulations governing where and how CO₂ can be stored long-term and how liable parties are for environmental harm caused by improperly implemented CCS projects

need to be established. There are also significant gaps in the current body of literature. There does not appear to exist a dedicated survey specifically examining Nigerian public attitudes toward CCS. Gas processing and EOR (enhanced oil recovery) activities have largely been studied from the perspective of engineers, scientists and policymakers rather than that of ordinary citizens.

5. Conclusion

This systematic review examined 100 empirical studies focusing on public perception and social acceptance of carbon capture technologies. Public awareness of carbon capture technology is generally low across all countries examined and opinions formed around carbon capture technology tend to be unstable and influenced by presentation methods. The major drivers of acceptance include perceived risks associated with carbon capture technologies, perceived benefits derived from its use and trust in both government and industry. Additionally, general support for carbon capture tends to convert into opposition when proposals for facilities are made locally. Thus, processes that are deemed equitable, early engagement of affected parties and provision of tangible benefits to communities are all critical factors in determining the feasibility of carbon capture projects. Carbon utilization is viewed more favorably than carbon storage, preference exists for nature-based solutions to remove CO₂ compared to engineered options, and individuals appear to be unwilling to pay a premium for carbon capture technology relative to renewable energy. Experts exhibit greater optimism regarding carbon capture technology than the general public. Experts view regulatory frameworks, costs associated with deployment and liabilities created by operation as being among the greatest barriers to the implementation of carbon capture technology. A significant contribution of this systematic review is to compile a comprehensive body of

literature from multiple disciplines and countries, demonstrating that social acceptance is just as critical to achieving success with carbon capture technology as technological performance. A significant limitation of this systematic review relates to the fact that a large proportion of the evidence examined originated from developed countries. Additionally, this systematic review focused on cross-sectional surveys/experiments; therefore, application limitations exist concerning applicability to countries like Nigeria.

Recommendations

Based on the findings, recommendations are made below for policy and practice in Nigeria and for future research.

Recommendations for Government Agencies and Oil & Gas Companies

- i. Nigeria's government agencies and all oil and gas companies working there should have ongoing dialogue with host communities before they begin looking at potential project locations.
- ii. Nigeria's government agencies and oil and gas companies need to provide their host communities information regarding carbon capture including both the positive impacts (benefits) and negative impacts (risks), from credible sources (e.g., Nigerian universities, independent scientists or recognized community leaders).
- iii. Benefits associated with carbon capture projects (jobs, new roads, housing etc.) should go directly to host communities.
- iv. Nigeria's National Council on Climate Change and regulatory agencies responsible for the oil and gas sector should establish regulations to govern: a) carbon dioxide storage; b) long-term liability associated with carbon capture; c) ongoing monitoring activities.
- v. Lack of clear regulations may reduce levels of trust among stakeholders and slow down investment.

Recommendations for Carbon Utilization Projects Future Research

- i. Wherever possible, companies engaged in the carbon utilization process should prioritize utilizing captured carbon dioxide

into commercially viable products. The majority of citizens view carbon utilization much more favorably than other methods of capturing CO₂. ii. All health and environmental claims made by companies engaged in carbon utilization should be substantiated.

Suggested Research Opportunities

- i. Research should be conducted across various communities within Nigeria to measure the public's perception of carbon capture technology and specifically those residing in areas surrounding oil production facilities and gas processing plants.
- ii. Future research studies should investigate what factors influence the level of acceptance of carbon capture technologies in Nigeria and potentially

in other African countries. Such factors could include past experiences with the oil and gas industries, trust levels established with local governments, and perceived benefit levels received by host communities.

- iii. Some future research studies will utilize longitudinal study methodologies that allow researchers to assess changes in opinion over multiple years, while others will incorporate qualitative methodologies to better understand the daily lives of host communities.
- iv. Future studies should also investigate if differences exist in public perception regarding carbon storage, carbon utilization and enhanced oil recovery technologies in Nigeria.

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