

Community Perspectives on Direct Air Capture and Storage in Kenya's Rift Valley

A Qualitative Case Study

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Abstract

The IPCC's Illustrative Mitigation Pathways achieving below 2°C of global warming increasingly rely on Direct Air Capture and Storage (DACCS). Research has largely concentrated on techno-economic aspects, while community perspectives have been almost exclusively focused on in the Global North. This thesis presents the first empirical case study of a commercial DACCS facility in Africa. Drawing on eighteen semi-structured interviews in Gilgil, Kenya, this research analyzes community perspectives through Social License to Operate and Environmental Justice frameworks. This study finds that a social license has been formed, built on trust, perceived net benefits, and substantive engagement, but remains fragile under partial technical understanding and the company's role as sole information source. This case shows distributive and procedural justice, while containing community-internal recognitional failures, as respondents delegitimized dissent. These findings sharpen mitigation deterrence concerns and call for sustained attention to host communities as DACCS scales across the Global South.

Keywords: Carbon Capture; Social License to Operate; Environmental Justice; Africa; Mitigation Deterrence; Carbon Markets

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List of Abbreviations

BECCS	Bioenergy with Carbon Capture and Storage
CBO	Community-Based Organization
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization and Storage
CO₂	Carbon Dioxide
DAC	Direct Air Capture
DACCS	Direct Air Capture and Storage
EJ	Environmental Justice
ERW	Enhanced Rock Weathering
IPCC	Intergovernmental Panel on Climate Change
NEMA	National Environment Management Authority
SDG	Sustainable Development Goal
SLO	Social License to Operate
TRL	Technology Readiness Level

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1 Introduction

1.1 General Introduction

All of the IPCC's Illustrative Mitigation Pathways limiting global warming to below 2°C by 2100 include some form of carbon dioxide removal (Babiker et al., 2022). Among these carbon dioxide removal methods, Direct Air Capture and Storage (DACCS) is projected to scale from current low kiloton levels (S. Smith et al., 2024) to gigaton levels by mid-century in IPCC pathways (Babiker et al., 2022; Realmonte et al., 2019). However, the gap between modeled deployment and operational reality has prompted critical scholarship questioning whether the prospect of large-scale DACCS is causing mitigation deterrence, hindering the required decarbonization (Carton et al., 2023; Markusson et al., 2018).

The conditions under which DACCS scales will shape whether the technology delivers on its modeled promise. While much of the academic and policy debates have focused on technical feasibility, cost reductions, and energy requirements, empirical research on the social conditions of deployment remains limited (Nielsen et al., 2022). Community acceptance, however, has historically been an important factor in whether large infrastructure projects proceed, are delayed, or completely cancelled (Moffat et al., 2016), with the concept of Social License to Operate (SLO) emerging as a central analytical lens for examining how acceptance is built between project developers and host communities. Beyond questions of acceptance, Environmental Justice (EJ) scholarship raises further questions about how benefits and risks are distributed, how decisions are made, and whose voices are recognized as legitimate (Schlosberg, 2007), questions that take on an important role in DACCS deployment in the Global South to produce carbon removal credits sold to international buyers in the Global North (Stuart et al., 2020). Whether large-scale carbon dioxide removal with DACCS can be deployed in ways that are socially legitimate and environmentally just remains an open question, particularly in Global South contexts.

1.2 Thesis Aim and Research Question

The empirical literature on community perspectives on Carbon Capture, Utilization and Storage (CCUS) projects is geographically and technologically narrow, with research concentrated in Western Europe, North America, and Australia, and focused predominantly on point-source CCS (Nielsen et al., 2022). DACCS deployments in the Global South have so far attracted no published community-level empirical

study. This thesis addresses that gap through a qualitative case study of Project Hummingbird in Gilgil constituency, Kenya, the first commercial DACCS facility in Africa, through these research questions:

- 1) How do residents of Gilgil sub-county perceive the benefits, risks, and impacts of DACCS?
- 2) What is the relationship between climate change knowledge, technical understanding of DACCS and acceptance of the project among Gilgil residents?
- 3) How do Octavia Carbon's engagement practices shape community acceptance of Project Hummingbird?
- 4) How do the Social License to Operate and Environmental Justice frameworks together inform the analysis of community acceptance in this case?

To answer these research questions eighteen semi-structured interviews with residents, employees, community leaders, and a regulatory officer, are analyzed through hybrid deductive-inductive thematic coding. Findings are then situated within the broader international CCUS and mitigation deterrence literature and theoretical frameworks of SLO and EJ.

2 Background

2.1 Direct Air Capture and Storage within the Landscape of Negative Emission Technologies

DACCS is one of several Negative Emissions Technologies (NET) included in scenarios consistent with the Paris Agreement's 1.5 to 2°C warming targets. DACCS consists of three main steps: 1) capture through chemical sorbents or solvents to extract CO₂ from ambient air, 2) regeneration of the sorbent or solvent (through heat, moisture or pressure) to release the CO₂, and 3) compression and injection of CO₂ into geological formations for permanent storage, with storage duration of 1000+ years (Babiker et al., 2022). Based on Illustrative Mitigation Pathways (IMPs) that limit warming to 2°C or lower, cumulative DACCS deployment reaches 29 GtCO₂ until 2100, with a range from 0-339 GtCO₂ (Babiker et al., 2022). In aggressive scale-up scenarios, DACCS would need to grow at around 1.5 GtCO₂/year, requiring up to 300 EJ/year of energy input by 2100 (Realmonte et al., 2019), equivalent to ~50% of current global energy supply (Babiker et al., 2022). Current deployment remains far below the scale climate pathways assume. As of 2026, 38 DAC plants are operational around the world, centered in the US, Europe and Canada, with only seven plants capturing 1,000 tCO₂/year or more (Direct Air Capture Coalition, n.d.). The Climeworks Mammoth plant in Iceland is the largest DACCS plant in operation, with a nameplate capacity of 36,000 tCO₂/year (Climeworks, 2022), however their smaller

4,000 tCO₂/year Orca facility has failed to capture 1,000 tCO₂/year since inception, due to mechanical issues (Niranjan, 2025).

To evaluate which form of carbon dioxide removal is best suited to achieve 1.5°C, a variety of factors are crucial. Within NETs, DACCS has a unique profile in terms of resource use, energy requirements and investment costs (P. Smith et al., 2016). For every GtCO₂/year captured, DACCS has lower water and land requirements compared to Bioenergy and Carbon Capture (BECCS) or afforestation, but higher energy requirements and investment needs (ibid). However, Enhanced rock weathering (ERW) is superior to DACCS across all relevant categories, with lower water, energy and investment costs, while having similarly low land requirements (ibid). Therefore, both DACCS and ERW avoid the food, water, and biodiversity trade-offs associated with biomass-based approaches like BECCS, which has been criticized especially in Global South contexts (Prütz et al., 2026). In order to assess the likelihood of actual CO₂ removal, technology readiness levels (TRL) is an important indicator of maturity. The IPCC ranks CDR methods on a scale from 1 (conceptual research) to 9 (proven), with afforestation at TRL 8-9, DACCS at TRL 6, BECCS at TRL 5-6, and ERW at TRL 3-4 (Babiker et al., 2022). The methods with the strongest durability and storage permanence are situated at the lower-mid TRL range, still far from the commercial maturity required for large scale deployment. For DACCS specifically, there are two factors determining the actual climate impact, which are the availability of renewable electricity and the proximity of geological storage (Realmonte et al., 2019).

2.2 Community Perspectives on CCUS: State of the Literature

Empirical research on community perspectives on site-specific CCUS projects has expanded substantially since the early 2010s but remains conceptually fragmented. Nielsen et al. (2022) provide the most comprehensive synthesis, reviewing 53 peer-reviewed empirical studies of site-specific CCUS projects published between 2009 and 2021. To assess the state of the community-perspective CCUS literature, a structured literature review was conducted for 2021 to 2025. The search combined the terms “carbon capture”, “utilization”, “storage”, “community”, “engagement”, “acceptance”, “perception”, “risks”, and “benefits” across Scopus and Google Scholar. This search was restricted to peer-reviewed, site-specific studies published in English, identifying eight relevant studies. From the 53 studies identified by Nielsen et al. (2022), 75% used qualitative designs with interviews. Over half of the case studies investigated CO₂ storage projects, with the Barendrecht CCS project in the Netherlands featuring prominently across the literature (Brunsting et al., 2011; Terwel et al., 2012; Van Egmond & Hekkert, 2015). Out of these eight studies published more recently, only two focused exclusively on the CO₂ storage component (Von Rothkirch et al., 2024; Wojakowski et al., 2024), while

the remaining studies analyzed integrated CCS and CCUS systems. This marks a considerable shift from isolated analysis to a more comprehensive assessment of carbon capture technologies. Across all studies there is a general lack of clarity about which specific carbon capture technology is analyzed. The majority of studies assessed some form of point-source capture, while only very few included technological details in their research design (Mabon et al., 2015; Markusson et al., 2011; Witt et al., 2020). Studies focused on non-storage applications almost exclusively examined point-source carbon capture at coal-fired power plants, oil refineries or gas plants, while only one study actively explored BECCS (Thomas et al., 2018) and one to a small degree touching upon DACCS in the context of the UK's Net Zero clusters (Sovacool et al., 2024).

Across the 61 case studies, four patterns recur consistently. Firstly, acceptance is rarely defined explicitly and is most often inferred from observable proxies, particularly the absence of public protest, with Nielsen et al. (2022) noting that several papers associated quiet tolerance with acceptance even where capacity to resist was constrained, as in Otway, Australia, where local communities lacked the resources to engage with project partners and remained passive despite emerging dissatisfaction (Anderson et al., 2012). Secondly, communities are typically identified through geographic proximity to project infrastructure, with internal heterogeneity and procedural inclusion seldom interrogated. Wong-Parodi & Ray (2009) showed in two communities near Sacramento that the socially and economically disadvantaged community held similar risk concerns to the wealthier one but expected its voice to be ignored, while in the United Kingdom a study excluded local residents entirely in favor of institutional respondents (Sovacool et al., 2024). Thirdly, engagement with communities remained largely instrumental. Project proponents typically initiated, framed, scheduled and sometimes controlled engagement topics. In the later cancelled Barendrecht project in the Netherlands, questions about the necessity of CCUS and its alternatives were treated as outside the legitimate scope (Brunsting et al., 2011; van Egmond & Hekkert, 2015). Lastly, the knowledge-deficit assumption that increased technical knowledge translates into greater acceptance is empirically weak. At the Tomakomai CCS demonstration in Japan, communities with high technical awareness continued to express concerns about seismicity and long-term liability (Mabon et al., 2017). In two English focus groups, providing more information heightened concerns by surfacing unresolved uncertainties rather than dispelling them (Gough et al., 2018). Where the eight more recent studies depart from the earlier corpus is in their increasing attention to procedural fairness and to distributive justice framings. Icelandic respondents framed local storage of CO₂ captured outside Iceland as "*waste dumping*" (Von Rothkirch et al., 2024).

To date there are only two case studies from the Global South (Figure 1), offering somewhat different insights compared to the Global North cases. Research on a CO₂ storage location in Brazil's Recôncavo Basin found that decades of oil industry exposure produced acceptance through familiarity, and organized resistance, as unmet expectations led residents to demand local jobs and pollution control (Netto et al., 2020). At the Gundih CCUS pilot in central Java local opinions were shaped primarily by perceived economic benefits, while local government was perceived as a trusted communicator. Both studies focus on point-source CCS.

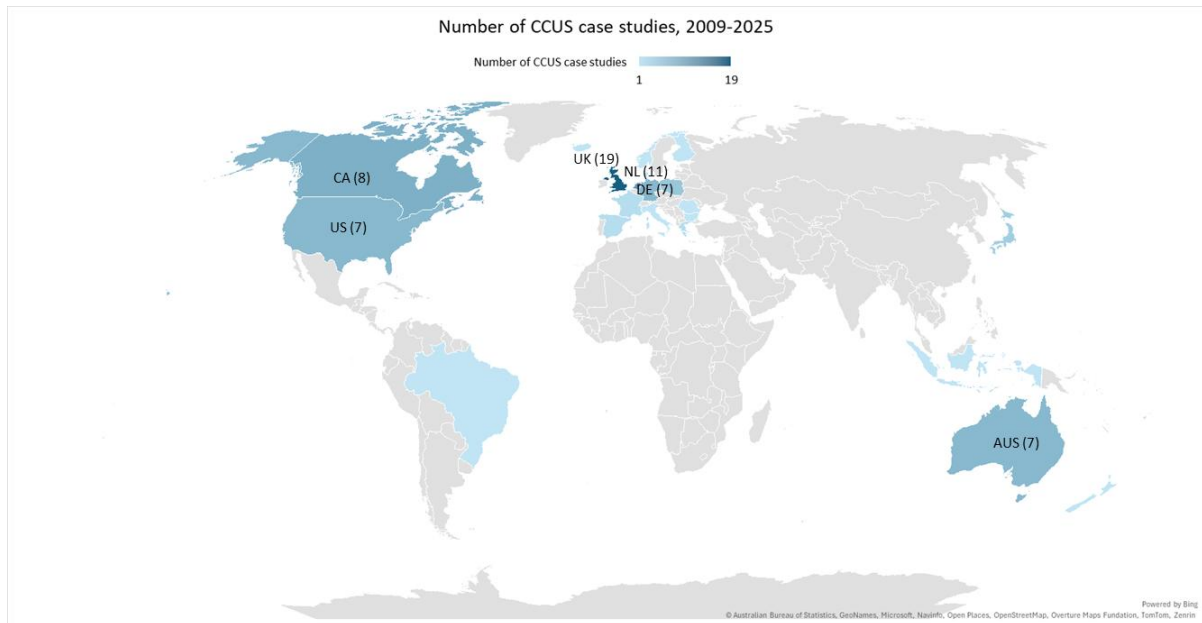


Figure 1. Frequency of CCUS case studies globally between 2009 and 2025, based on data from (Nielsen et al., 2022) for 2009-2021 and eight further case studies between 2021-2025. Map created by author.

DAC-specific public perception research is slim, with survey-based work showing that public acceptability is shaped by how DACCS is framed. Satterfield et al. (2022) found that Canadian respondents weighed climate urgency against moral hazard concerns, supporting carbon removal as necessary while worrying it might delay emission reductions. Participants also evaluated the DACCS chain as a whole, judging the system by its weakest link. Keeley et al. (2025) extended this work in Japan with a survey of 3,139 respondents, finding that technology acceptance was a stronger driver of support for DACCS than environmental awareness. Malakar et al. (2025) found Australian support driven by institutional trust and perceived benefits, and decreased support by perceptions of tampering with nature and strong environmental self-identity.

DACCS-specific community studies have only been conducted with hypothetical or planned DACCS deployments in the US. Scott-Buechler et al. (2024) combine a national survey with focus groups across four US cities, finding conditional support for DACCS deployment, with procedural justice elements,

particularly community involvement in planning and implementation, and anticipated community benefits in the form of local infrastructure and workforce development, as the most important determinants of support. Scott-Buechler and Wang (2025) extend this to Gulf Coast communities in Texas and Louisiana, finding that support for DACCS is largely conditional on its relationship with the fossil fuel industry. Here legacy energy industries posed barriers to alternative climate industries, with participants expressing strong preferences for specific project features, particularly energy sources and ownership structures, alongside a widespread misperception of DAC's local environmental benefits like air quality improvement. Both DACCS community studies emphasize procedural justice and just-transition framings absent from the broader CCUS literature.

2.3 Kenya in the Global DACCS and Carbon Market Landscape

Kenya has emerged as a suitable DACCS location outside the Global North, due to abundance of renewable electricity and CO₂ storage (Barbe, 2025). The Kenya Rift forms approximately one third of the East African Rift System, with extensive basaltic formations whose mineralogy makes them efficient hosts for permanent CO₂ sequestration through mineral carbonation (Okoko & Olaka, 2021). Okoko & Olaka (2021) identify nineteen basalt groups in the Kenya Rift with a total estimated volume of approximately 9,000 km³, ranking the central region of the Kenya Rift Valley (location of this case study) highest in suitability owing to the combination of basalt porosity, the rift's exceptionally high geothermal gradient (>200°C/km), and proximity to existing geothermal infrastructure. Okoko and Olaka (2021) flag three storage related risks for CCS projects in Kenya. Firstly, leakage of CO₂ through wells, caprock fractures or reactivated faults. Secondly, induced seismicity, though three decades of deep geothermal operations in the Kenyan Rift have only produced seismic activities below magnitude two. Thirdly, potential corrosion of injection equipment through Sulphur compounds present in the Rift's geothermal systems. Kenya is a global leader in terms of renewable electricity, with over 90% of Kenya's electricity being generated from renewable sources, with geothermal capacity at 43% (IEA, 2024), providing low-carbon energy required for DACCS operations. Two Kenyan DAC facilities currently operate in this corridor: Octavia Carbon, a Nairobi based DACCS company, whose pilot Project Hummingbird is the focus of this study, and Sirona Technologies, a Belgian DACCS company with operations in Belgium, Kenya and the Middle East. In 2023, Climeworks, announced plans for a DACCS facility in Kenya (Twidale, 2023), however has not followed up on this announcement to date.

3 Theory

This thesis draws on two theoretical frameworks: Social License to Operate (SLO) and Environmental Justice (EJ). Together, they provide complementary analytical lenses for examining how community acceptance of DACCS is constructed, sustained, and contested. SLO offers a relational framework for understanding how project legitimacy is built through trust and engagement beyond formal regulatory consent. While EJ provides normative insights on questions of benefit and risk distribution, and whose voices are recognized as legitimate within those processes.

3.1 Social License to Operate

The concept of SLO originated in the mining industry in the 1990s as a way to capture informal community approval required for extractive projects to operate beyond formal legal permits (Gough et al., 2018; Nelson & Scoble, 2006). Since then, it has been extended across energy, fishing, and agriculture (Gough et al., 2018; Moffat et al., 2016; Stephens, 2024). There exists no universally accepted definition of the SLO term, but broadly SLO refers to the ongoing acceptance and approval granted by host communities and local stakeholders to a project (Moffat et al., 2016).

A closely related concept is Social Acceptance, originating in the renewable energy literature, which conceptualizes acceptance across socio-political, market, and community dimensions (Wüstenhagen et al., 2007). Because this study focuses on a single operating facility, the project-based SLO concept is more directly applicable than Social Acceptance's broader and multidimensional framing (Minadakis & Vega-Araújo, 2024).

SLO scholarship moves beyond simple public acceptance of local communities. Firstly, SLO has to be considered across multiple scales (Syn, 2014). Project developers should strive to establish SLO on local project, national and even international level (Parsons & Moffat, 2014). Secondly, stakeholder relationships between local communities, project operators and government actors are essential in achieving a SLO. Here, if communities perceive the technology to be net beneficial the project is more likely to be viewed positively (Zhang & Moffat, 2015). Thirdly, a SLO is a dynamic condition rather than a one-off approval (Dowd & James, 2014). Therefore, a continuous relationship with the community is key in maintaining a SLO (Gough et al., 2018). Lastly, trust, risk perception and confidence in government and industry are central cornerstones for successful SLO establishment (Gough et al., 2018). The role of science and technical expertise are important factors in facilitating SLO, although scientific evidence appears to be insufficient in establishing public acceptance on its own (Dowd et al., 2015).

Although the majority of SLO research has been focused on developed nations, some scholars have analyzed differences of SLO in developing countries. Firstly, in high-poverty contexts a risk exists, that public acceptance is formed in favor of benefits and through understatement of risks (Zhang & Moffat, 2015). Secondly, comparative SLO research in developed vs. developing contexts found that the influence of procedural fairness was less pronounced for developing countries, regardless of the industry (mining vs. non-mining) (Jin et al., 2024). Here, authors hypothesized that community members favored distributive justice aspects, including equal benefit sharing, over process inclusion (Jin et al., 2024). Including environmental benefits into SLO research has been a focus of renewable energy research. However, research on onshore windfarms in Scotland and South Africa found that SLO was formed in the South African context, largely due to investments into the community by the project company, while the windfarm itself and the role of wind energy appeared unimportant to community members (Stephens & Robinson, 2021). Contrastingly, environmental benefits were the main drivers of SLO formation in a Moroccan Solar Power Plant project, despite a low level of project knowledge of community members (Hanger et al., 2016). Similarly to global north contexts, community trust in developers has been shown to facilitate SLO formation in onshore windfarm projects in Tunisia (Hammami et al., 2016).

SLO has only been applied to a limited extent within the CCUS context. These includes the CO2CRC Otway Project in Australia, where community consultations were considered as fundamental in establishing a SLO (Steeper, 2013). Furthermore, Hall et al. (2015) found in interviews of CCS industry representatives that the absence of historical community engagement and low public awareness of CCUS, undermined SLO formation. Mulyasari et al. (2021) demonstrate in the Gundih CCUS pilot in Indonesia, that obtaining an SLO depends on positive framing of project benefits, capacity building, sustained communication via local media, local leaders, and community events, and the active addressing of stakeholder concerns through engagement. Similarly, Dowd and James (2014) found that engineers and managers' understanding and application of SLO in the CCS context varied, while also finding that a lack of public understanding of CCS might inhibit the creation of a SLO.

For the present case, SLO offers analytical value on three questions: how the DACCS companies engagement practices contribute to or undermine the establishment of an SLO, what kind of acceptance is being formed under conditions of an emerging technology in a Global South context, and how robust such an SLO is likely to be over time.

3.2 Environmental and Climate Justice

Environmental Justice emerged in the United States in the 1980s as both a social movement and an academic framework (Bullard, 2000). Since then, EJ has developed from a narrow concern with the inequitable siting of hazardous facilities into a global framework for analyzing the political processes through which environmental burdens, benefits, and decision-making power are distributed across populations (Schlosberg, 2007).

The framework consolidated by Schlosberg (2007, 2013), identifies three interrelated dimensions of justice, distributive, procedural and recognitional justice, which taken together form substantive EJ. Distributive justice is concerned with the allocation of environmental goods and harms, identifying who is exposed to risks, who receives benefits, and how these are distributed across communities. Procedural justice targets who can and does participate in environmental decisions, on what terms, and with what capacity to influence outcomes. Lastly, recognitional justice is concerned with whose values, knowledge, and identities are acknowledged as legitimate within the decision-making process. The three dimensions are distinct in a conceptual sense but linked in empirical settings. Often distributive injustices arise from procedural exclusions, which reflect deeper failures of recognition (Schlosberg, 2013).

EJ has been increasingly applied in the CCUS literature, with the most focus on distributive, procedural and recognitional justice. Recognitional justice questions are especially relevant when looking into disadvantaged communities. The only CCUS site-specific study doing this assessed a disadvantaged community in California, finding that they held similar risk perceptions as the wealthy community, while expecting to not have their concerns being heard due to lower sense of empowerment (Wong-Parodi & Ray, 2009). Across multiple CCUS studies project developers actively controlled what topics and questions could be discussed during engagement activities, raising procedural justice questions (Mabon et al., 2015; Nielsen et al., 2025). Storage of CO₂ and connected leakage risks have been discussed widely due to distributive justice concerns of local communities. In an Enhanced Water Recovery project using CO₂ injection into deep aquifers, community members who expected to bear the risk of compromised groundwater quality raised distributive justice concerns (Witt et al., 2020).

Climate Justice extends the EJ framework specifically to climate change, based on historical responsibility for GHG emissions, intergenerational equity, and the uneven distribution of climate impacts between Global North and Global South (Schlosberg & Collins, 2014; Sultana, 2022). Climate Justice questions have also been applied to CCUS literature. A study analyzing CO₂ storage from

continental Europe in Basalt formations in Iceland states that local communities framed this form of cross-border CO₂ storage as “*waste dumping*”, raising distributional justice concerns about leakage risks (Von Rothkirch et al., 2024). Furthermore, Stuart et al. (2020) raise the question of whether large-scale carbon geoengineering technologies challenge or reproduce fossil-based political economy, which produced the climate crisis in the first place.

SLO and EJ are used together because they offer a complementary analytical lens for this case. SLO assesses whether and how community acceptance has been formed, while EJ examines how benefits and risks are distributed, how engagement is conducted, and whose voices are recognized in DACCS deployment. Climate Justice then situates these local questions within a wider political economy in which the Global South increasingly cleans up the historical emissions of the Global North, with the carbon removed sold as a commodity to international buyers. Together the two frameworks allow the case to be read both descriptively and normatively.

4 Methodology

4.1 Research Method

This research is based on a single qualitative case study in Gilgil constituency, Kenya, to analyze community perspectives on the first commercial DACCS project in Africa. In line with the previous 61 CCUS case studies, the research was focused on the key concepts of *knowledge*, *benefits*, *risks*, *engagement practices* and *acceptance*, in order to analyze the case and to provide a meaningful contribution to the literature.

Semi-structured interviews were selected as the most suitable research method to elicit community members personal perspectives and lived experiences (Knott et al., 2022). The majority of questions were posed as open-ended questions to allow participants to freely express their beliefs and provide the flexibility to explore adjacent topics if desired (Knott et al., 2022).

Based on the research method and chosen topic, this research adopts a social constructivist perspective, assuming that social reality is shaped and constructed by human interpretations and social interactions (Mann & MacLeod, 2015) and that knowledge produced through inquiry is co-created between researcher and participants rather than discovered as an independent fact (Guba & Lincoln, 1994).

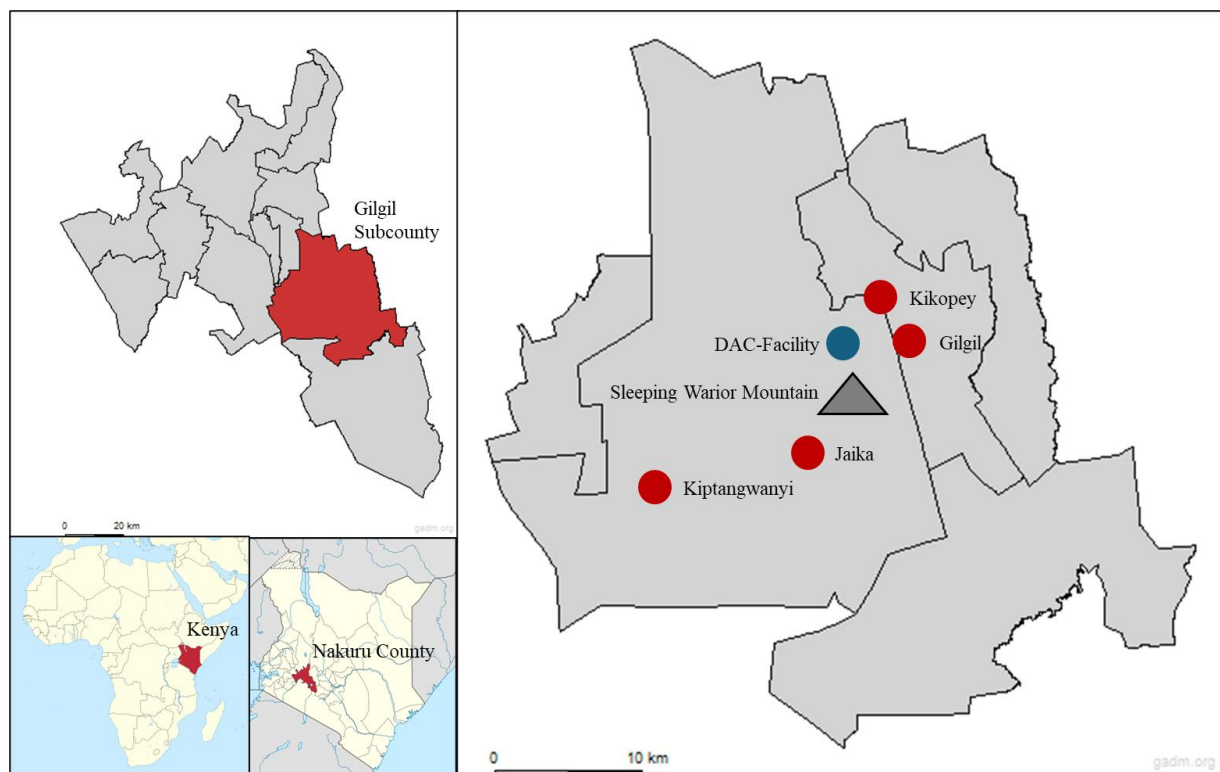
4.2 Case Description

This research was conducted in Gilgil constituency, one of the eleven constituencies in Nakuru County, located in Kenya's central Rift Valley. Nakuru is Kenya's second largest county economy, contributing 5.7% to national GDP, with mixed agriculture as its largest industry (Kenya News Agency, 2025). Despite this economic position, 38.2% of Nakuru's population is classified as poor and 26.2% as food-poor (KNBS, 2024). Within Nakuru, Gilgil constituency covers an area of 1,075 km² with a population of 185,209 in 2019, distributed across five wards and largely rural, with mixed farming as the main economic activity (Gilgil Constituency, n.d.). The area has semi-arid climate with mean temperatures of 15.9 to 17.8 C° and two rainy seasons, from April to June and October to November (Awange et al., 2013), but with recently more extreme weather events and irregular rainfall (Mara et al., 2023). The local context is shaped by a long history of deforestation, as Gilgil constituency has lost 5% of its total forest cover from 2001-2025 (Global Forest Watch, 2026). Additionally, the Eburu Forest bordering Gilgil constituency to the south-west, lost significant tree cover since the 1990s due to unauthorized logging, charcoal production, and fires (Rhino Ark, n.d.). However, tree-planting initiatives in Kenya including the Green Belt Movement founded in 1977 by Nobel laureate Wangari Maathai (Hunt, 2014) with significant tree planting in the Rift Valley (Green Belt Movement, 2025), and the national Jaza Miti program launched in 2022, aiming to plant 15 billion trees by 2032 (Ministry of Environment, Climate Change & Forestry, 2022) have tried to reverse the local and national deforestation.

The social and ecological character of the area is shaped by its colonial history. Through the Maasai Agreements of 1904 and 1911, pastoralist communities were forcibly relocated out of the central Rift Valley to open the highlands to European settlers (Hughes, 2006). Post-independence redistribution proceeded primarily through land buying companies rather than restitution, leaving contested land tenure legacies across the region (Boone, 2012).

Gilgil constituency is the site of Project Hummingbird, the pilot DACCS facility operated by Octavia Carbon in collaboration with Cella Mineral Storage (Octavia Carbon, n.d.-a). Octavia Carbon, founded in 2022, is a Nairobi-based DACCS company from Kenya, with their facility starting operation in 2024 (Octavia Carbon, n.d.-b). At full scale the facility aims to capture 1000 tCO₂/year, powered by geothermal energy and using basalt rock formations as belowground storage. Project Hummingbird is the first commercial DACCS facility in Africa (Direct Air Capture Coalition, n.d.). Octavia Carbon's activities are governed by Kenya's environmental and public-participation framework. The Environmental Management and Coordination Act (The Environmental Management and Co-Ordination Act, 2022) and the Land Act (The Land Act, 2012) require Environmental and Social Impact

Assessment (ESIA) and Free, Prior and Informed Consent (FPIC) procedures, with the National Environmental Management Authority (NEMA) as the principal regulator. Octavia Carbon reports that an ESIA was completed before construction began, with focus on erosion control and rehabilitation of disturbed areas, and ongoing audits conducted by NEMA (Octavia Carbon, 2025). Octavia Carbon’s community engagement program operates through formal local-government structures (chiefs, sub-chiefs, Nyumba Kumi committees) and barazas (town hall meetings), and includes apprenticeship programs, partnerships with technical colleges, sponsorships of community programs addressing period poverty, sports sponsorships, and zero-interest community loans (Octavia Carbon, 2025)



Map 1. Gilgil constituency. Red pins mark research sites. Blue pin marks the Direct Air Capture facility. Maps used from GADM (2018) and Wikimedia Commons (2011)

4.3 Interview Sites

Eighteen interviews were conducted across five locations in Gilgil constituency during February 2026. The locations were selected with the support of a facilitator employed by the DACCS company, who identified sites where the company was actively conducting community engagement. The facilitator’s employment and presence carries methodological implications that are addressed in the positionality and limitations sections.

Four interviews were conducted at Gilgil Technical and Vocational College (Picture 1) in Kiptangwanyi, where students pursue education in subjects such as engineering, business, fashion or hospitality.



Picture 1. Gilgil Technical and Vocational College in Kiptangwanyi. In total four interviews were conducted, of which two were conducted with students and two with teachers.

The second set of interviews were conducted in Jaika village. Here, two representatives of a female group (Picture 2) were interviewed. The group of ten females is part of a livelihood engagement project, that included the provision of chickens.



Picture 2. Female group in Jaika which received support from DACCS company in form of 200 chickens to increase livelihood of 10 families.

In Jaika a second stakeholder group was interviewed, consisting of two members of the local football club (Picture 3).



Picture 3. Football pitch and local football team in Jaika village.

The next two interviews were conducted with workers at the DACCS facility (Picture 4), with employees that live in Gilgil constituency. Another seven interviews were carried out in four different locations in Kikopey. This city marks the main location of community engagement for the DACCS company, as it is the largest and closest location to the DACCS facility. In Kikopey, the local chief, the founder of a community-based organization (CBO), two teachers, and three students were interviewed (Picture 5).



Picture 4. DACCS facility, located between Lake Elemantiata and the Sleeping Warrior Mountain.



Picture 5. Kikopey Primary School (left) and Kikopey Secondary School (right).

Lastly, two more interviews were conducted to further understand and contextualize the other sixteen interviews. The first one was conducted with the officer of the National Environment Management Authority (NEMA) of Nakuru County, to understand changes in climate and environment in the whole county. The second interview was conducted with a local from Gilgil town, that was not part of community engagement activities from the DACCS company and had no prior knowledge of DAC.

4.4 Interview Sample

The interview sample includes five women and fourteen men with an average age of 36 years. All participants are living within Gilgil constituency, with the exception of respondent 18, who however is responsible for Gilgil constituency as an officer of the National Environmental Management Authority. Mostly purposive sampling (Knott et al., 2022) was used, aided by the local facilitator, to identify respondents that had been in engagement activities with the DACCS company and were living in the study area. Most interviews were arranged before arrival with the engagement groups, like schools, the female group or the football club. However, the specific respondents were selected after arriving at location based on availability and respondent's willingness to participate. Interview settings included schools, homes, public spaces or were done via phone. This sampling approach, mediated by a facilitator employed by the DACCS company, carries methodological implications that are addressed in the positionality and limitations sections.

Research Site	Interview Setting	Number of interviews	Gender ratio (m f)
Kiptangwanyi	Gilgil Technical and Vocational College	4	4 0
Jaika	Homestead of female group	2	0 2
	Football pitch	1	2 0
Sleeping Warrior Mountain	DACCS facility	2	1 1
Kikohey	Chief Office	1	1 0
	CBO office	1	0 1
	Kikohey Secondary School	1	1 0
	Kikohey Polytechnical College	3	1 0
	Kikohey Primary School	1	1 0
Gilgil town	Hotel	1	1 0
Phone	Phone	1	1 0

Table 1. Interview details of the 18 semi-structured interviews conducted for this study.

4.5 Interview Method

In line with the analytical framework, the questionnaire (Appendix 1) was split into six sections, *demographics, knowledge and identity, benefits, risks, engagement, and acceptance*. During the interviews the actual order of questions followed the natural flow of the conversations. Interviews 8, 9, 17 and 18 had different structures. For the two DACCS company employees as well as the control-respondent, the *engagement* section was omitted. For the NEMA officer (I18) the interview guideline was slightly modified, in order to fit the position better (Appendix 2). Interviews lasted between 15 and 36 minutes and were recorded, after approval from each participant. Additionally, notes were taken during the interview for key details. Out of the eighteen interviews, only one was conducted in Swahili and translated through a translator. All remaining interviews could be conducted in English. Before each interview each respondent was assured of data confidentiality, with each respondent being provided a written consent form in both English and Swahili, informing on the researcher, the research aim and the respondent's rights.

4.6 Data Analysis

The interview data was analyzed using a thematic coding approach following Clarke and Braun (2017). A primarily deductive coding framework was developed from the research framework to guide the analysis while leaving space for inductive insights, as described in Fereday & Muir-Cochrane (2006). This combination enabled a structured but flexible interpretation of the data. Codes were organized into five families: *knowledge and identity, benefits, risks, engagement, and acceptance*. Sub-codes were added iteratively as patterns emerged during coding. All eighteen interviews underwent

systematic re-verification against the transcripts, with presence and absence decisions justified by quoted excerpts. This step was introduced to correct earlier inconsistencies and to establish uniform coding rules across the dataset. NVivo was used for computer-assisted qualitative data analysis to support the organization, comparison, and refinement of codes across interviews (Jackson & Bazeley, 2019).

4.7 Positionality

As this research adopts a social constructivist perspective, I am aware that the knowledge produced in this work is the result of exchange between me, my facilitator, and the interviewees. My role was not only to collect narratives through semi-structured interviews but also to interpret them through constant reflection on my positionality, my cultural background, and my potential influence on the research context. As a German master's student with no prior experience in Kenya, I approached the fieldwork aware that my understanding of life in Gilgil would always remain partial. I could only view the information shared by the participants through my own self.

Conducting fieldwork in a rural Kenyan context required an awareness of social, cultural, economic, and historical dynamics, including legacies of colonialism, language differences, and power imbalances between a European researcher and residents of a community. Seventeen of the eighteen interviews were conducted in English. One interview was conducted in Swahili and translated by my facilitator, and I am aware that translation shapes meaning as well as conveys it.

A further consideration concerns access, as my local facilitator was an Octavia Carbon employee. This arrangement enabled access to respondents across a range of engagement channels, including technical college students, secondary school teachers, community leaders, employees, and the NEMA regulatory authority. It also shaped the sample in ways that must be acknowledged. Respondents were identified through networks connected, directly or indirectly, to Octavia's outreach, which means the sample overrepresents people who have been engaged by the company and who may hold more favorable views as a result. To reduce the risk of self-censorship, the facilitator was not present during interviews, except the translated one. I introduced myself as an independent Lund University researcher and explained that the conversation would be anonymous and would not be shared with Octavia. Nonetheless, some respondents may have perceived a connection between me and the company, and this possibility is treated as part of the conditions under which the data were produced rather than as a deficiency to be eliminated. One interview (I17) was conducted with a resident who had no prior exposure to Octavia and had never heard of carbon capture before the interview. This case functions as a partial control for engagement effects on expressed perceptions.

No expert interviews were conducted beyond a single interview with an officer of the National Environment Management Authority (I18), which provided a regulatory perspective alongside the community accounts. The absence of further expert interviews is a limitation of the present study.

5 Results

5.1 Knowledge and Identity

Half of the respondents expressed a personal relationship with nature, based on spiritual, religious, recreational or functional connection to nature, with no dominant theme emerging across the dataset. Although, some respondents mentioned either sacred places within nature or utilizing the peacefulness of forests religiously, this was the exception rather than the rule. No pattern emerged between respondents who moved to the study area and those born and raised there. However, some non-local participants evaluated Gilgil's nature and climate against their former home. Respondent 1 (male, 23, student), who previously lived close to the border of South Sudan shared that *"For example, where I come from it is very hot. But when I came here, I found it [the climate & nature] very friendly."*

Each participant was familiar with climate change, although to varying degrees. Interestingly, two completely contrasting views emerged on how the local climate had changed. The first group stated that the climate has become worse, with hotter dry seasons, less or more unpredictable rain and seasonal shift. Respondent 7 (male, 31, farmer), stated the most detailed account of local climate change due to his work as a farmer: *"It used to be 200 mm of rain every season. And now its below 100."*, highlighting the increasing difficulties of sustaining himself and his family through agriculture alone. Together respondents attributed deforestation, increasing settlement in the area, charcoal burning (picture 6) and local industry as the causes of climate change. Contrastingly, the other group of participants claimed that the climate had become cooler and reported increased rain quantity and frequency. These respondents attributed this climate improvement to reforestation and the DACCS companies' carbon capture activities. This stark divide highlights the impact of lived experiences and causal reasoning, when assessing climate change and its causes. When asked about if the climate has changed, respondent 11 (female, 53, CBO director) answered: *"completely and especially when Octavia came. It has changed. We are having a lot of rains. Before there were no rains. Before it was completely dry."* Across all interviews no respondent identified GHG emissions in the Global North or any other context outside of Kenya as the root cause for climate change. All voiced causes and effects of climate change were either locally or in the national context.



Picture 6. Artisanal charcoal burning in Gilgil town, as a cause of local deforestation and provision of income.

Except for the control case, all participants showed awareness of carbon capture, as all were in active engagement activities with the DACCS company. However, some participants stated that they previously heard about carbon capture, mainly from Global North countries or through other carbon credit projects in Kenya. Most participants conceptually understood the basic process of removing carbon dioxide and its desired purpose to reduce CO₂ levels. However, no participant was able to identify other carbon capture technologies besides DACCS, making critical judgement difficult for local community members to situate DACCS within other NETs.

The level of understanding of DACCS varied significantly across the sample. Some respondents were able to provide a detailed description of all the processes: *“they use vacuums, trap the air, then there's some chemicals in a certain cube of which traps the CO₂ and then allows the oxygen to escape to the air, then they process it. Then they set it to a well, where they can use it in another means.”* (I15: male, 19, student). Other respondents were able to provide information on site specific variables, like the basalt rock used as a CO₂ storage medium: *“So when they capture the carbon is directed underground where we have that kind of stone, it has some air spaces, so when they store it there it can affect nothing.”* (I16: female, 57, teacher). However, most respondents had a more rudimentary understanding of DACCS, mostly reproducing descriptions of the capture process, while remaining unsure about storage or utilization of the CO₂. Besides the control interview, there were also two respondents (I5, I8) which had been actively engaged with the DACCS company and could not provide any description of the DACCS process. Across the dataset it was evident that students and teachers displayed the strongest understanding of DACCS processes.

5.2 Benefits

All but one respondent identified environmental benefits. The most frequent benefit was the improvement of atmospheric CO₂ levels, often linked to economic and livelihood improvements. Respondent 12 (male, 40, teacher) stated: *“the livelihood of those small-scale farmers improves. Because now when there is drought, they cannot sell their products, because they will consume them.”*, emphasizing that improved climatic conditions will create agricultural and financial surplus. Six respondents (I8, I11, I13, I15, I16, I17) reported increased rainfall, longer rainy seasons, or cooler temperatures, caused by DACCS. Four respondents (I1, I3, I10, I14) linked carbon capture to improved air quality, citing pollution from nearby factories, charcoal burning, dust and vehicle emissions. Respondent 14 (male, 20, student) positioned the technology as compensating for local deforestation, describing DACCS as performing CO₂ capture *“faster than the trees”*. Only participant 5 (female, 25, small business owner) in the data set could not identify a specific environmental benefit linked to carbon capture, although being confident that there were some environmental benefits. Based on conversations with the DACCS company’s community engagement employees, building knowledge was often challenging in areas with lower educational backgrounds.

Throughout the interviews and immersion in the study area, it became evident that the area is characterized through economic hardship and an overall lack of job opportunities. Respondent 17 (male, 25, small business owner) claimed: *“You don’t get a job easily here in Kenya.”*. Unsurprisingly, in fourteen interviews potential job creation was viewed as a strong economic benefit. These potential job opportunities ranged from jobs directly created by the DACCS company, like welding, construction or office jobs (I1, I2, I8, I9), to jobs indirectly created through possible improvement of the climate, like farming, plumbing, and water drainages construction (I9, I13). Furthermore, participants voiced that more jobs and income through direct and indirect jobs will create surplus income, benefitting the wider economy through trickle-down effects (I2, I3, I4, I7, I12, I18). Respondent 12 (male, 40, teacher) stated: *“Most people are farmers [...]. So when they have produced more, that means they sell the surplus, they have something left. So, they can improve, they can buy what they require in their homes. So that way they have something to give to the economy and then the economy develops.”*. This argument was often supplemented through the wish of economic development and industrialization. Only two respondents (I4, I18) connected the DACCS operations to carbon credit markets, while highlighting that financial revenues should flow back to local communities. However, respondent 4 (male, 56, teacher) framed the carbon credit market as a positive opportunity for Gilgil: *“By buying some credit from Octavia Carbon [...] it brings awareness to the world. And people gather income and the economies improve by their activity of carbon capture.”*.

Similarly, all participants agreed that the DACCS operations had social benefits for the communities. The most common social benefit was connected to community engagement activities, including financial sponsorship of students (I1, I2, I3, I4, I13, I14, I15), providing female sanitary products for young girls (I11, I12, I16), livelihood provision through livestock provision (I5, I6), climate change education (I12, I16), sponsoring a local football club (I7), and taking young girls to STEM fairs in Nairobi (I10, I12). Furthermore, three respondents (I3, I15, I16) stated that the DACCS company was providing resources for the community to pursue projects and implement ideas. The topic of mental health was only addressed by one respondent (I18: male, 47, NEMA officer), highlighting that local residents will feel mental ease, as someone is tackling the task of dealing with climate change. An interesting social benefit connected to the desire for economic development was the fact that six respondents displayed a sense of pride and wonder. Respondent 1 (male, 23, student) stated: *“the first time I heard it was in Gilgil, I couldn’t believe it because I used to see [this only] in huge towns, the huge machines. [...] So when I went there [the capture facility] I was very happy. I saw that this thing is here. Very advanced machine.”*.

Fourteen respondents claimed equal benefit sharing, with justifications of meritocratic distribution based on school performance, or highlighting that benefits were shared equitably, considering communal inequalities (I4: male, 56, teacher). The remaining four participants claimed unequal benefit sharing (I9, I12, I17, I18). Respondent 9 (male, 36, welder) stated that the benefits were shared *“just a bit”* unequally, while respondent 12 (male, 40, teacher) claimed that unequal benefit sharing was caused through a lack of knowledge of new technologies and trends. Respondent 17 (male, 25, small business owner), which previously had no prior contact or knowledge with the DACCS company, stated employees received the most benefits, while others gained less. The NEMA officer (I18) was the only respondent to touch upon the topic of capital interests, stating that investors are the ones profiting the most, so that benefits can never be fully shared equally.

5.3 Risks

Nine respondents identified risks from DACCS operations. Across all risk types, environmental risks were mentioned most frequently (I1, I3, I4, I8, I12, I13, I18). Chemical pollution was named four times (I1, I3, I12, I13), with participants voicing concerns that chemicals from the capture and storage process might leak into the environment, causing environmental and health issues for local residents in close proximity. Respondent 13 (male, 19, student) stated: *“So I was wondering, because after capturing that CO₂, they direct it down. So, what if that chemical maybe mixes with water? So, what will happen?”*. Secondly, CO₂ storage safety and permanence was brought up by three participants (I4, I12,

I13). Furthermore, participant 4 (male, 56, teacher) voiced concerns around leakage through seismic activity, connecting the Rift Valley's seismic activity to a potential for storage permanence risks: *"It will increase also the risk of storage. What about the underground movement? [...] And when we are in the Rift Valley, at times there are some volcano actions, underground movement, among others. What is the risk of such?"*. This participant also touched upon the geopolitical risk of CO₂ storage being actively targeted in warfare.

Only four respondents (I1, I4, I14, I17) voiced economic risks of DACCS operations. Although all respondents were asked if job impermanence was an issue, only two participants (I14, I17) stated that temporary jobs could be an issue. All other respondents deflected this argument by highlighting that jobs are desired and that even a temporary job is viewed as a great benefit. Respondent 7 (male, 31, plumber) stated that: *"It's not a disadvantage, because the moment maybe I'm given that job. I'll be able to maybe save my capital, then I'll take the money and go and start something else."*. Besides jobs, competition and long-term trends were discussed as economic risks (I1, I4), with respondents asking how international DACCS competition would impact the Gilgil facility, a risk inherent to an emerging industry. Furthermore, respondent 4 (male, 56, teacher) questioned what would happen to the facility if CO₂ levels stabilized and what this would imply for Gilgil. Operational risks tied to the capture and storage process were raised by two participants (I1, I3). However, here respondents did not identify any DACCS or CCUS specific risks but rather compared the potential for job accidents to other proximate industrial plants, like cement production.

Social risks were the least prominent risk discussed by interviewees. Only respondent 12 (male, 40, teacher) identified social risks tied to a lack of understanding: *"One is people do not understand too much, lack of information. So not all people understand the whole process, because it's something new."*. However, when respondents were asked what impacts a future expansion of the DACCS facility would have on the local community, almost all respondents not only denied a negative impact but favored these plans, motivated by more benefits: *"Because actually, they will be able to support and contribute more. The company is trying to educate, something the government is trying to do. So actually, I guess their impact can be more positive."* (I2: male, 23, student). The local chief (I10) acknowledged that some residents do perceive an industrial company entering the area as a source of insecurity but claimed that through official audit and verification channels with the National Environmental Management Authority (NEMA) as well as dialogue with the community these insecurities are quickly resolved.

Half the respondents claimed equal risk distribution, with less strong justifications. Respondent 12 (male, 40, teacher) claimed that through the airborne nature of CO₂, a potential leakage would affect

everyone similarly. While respondent 1 (male, 23, student) stated that through the involvement of the government, any potential job accident would be treated in a government hospital, leading to equal treatment across the community. The group voicing unequal risk distribution, identified the residents in closest proximity to the capture and storage location as the most vulnerable. When asked who would be most affected, respondent 3 (male, 54, teacher) stated: *“Of course the immediate workers and the immediate environment.”*. An interesting subject no other interviewee touched upon, was the topic of international unequal risk distribution, stating: *“I would say some groups are more exposed. [...] And when we capture carbon dioxide, it means some other flow of wind and air will come from elsewhere. So, we are cleaning air from other areas of the world. But the risk is under the storage, which is localized. And therefore, the risk is not equitably distributed”* (I4: male, 56, teacher).

5.4 Engagement

Only fifteen interviews included engagement insights, as two respondents were DACCS company employees (I8, I9) and one the control case (I17). Half of respondents came into first contact with the DACCS company in 2024, while the rest in 2025, putting the total engagement length between one and two years at the time of the interviews. All participants, except the NEMA officer (I18), stated that during their first contact the DACCS company introduced themselves, the topic of DACCS, and potential benefits for the community. Only two respondents (I5, I6), randomly came across the DACCS company in the Jaika city center, where the company presented themselves to local residents. All other respondents were being actively approached by the company. Respondent 16 (female, 57, teacher) highlighted that she first learned about the DACCS company at the Chiefs Baraza, a community gathering to debate local topics.

Five engagement types could be identified, including financial sponsorship, female sanitary product sponsorship, educational activities, livelihood improvement, and skills-based training. Financial sponsorship included payment of school fees, with students and teachers highlighting the impact of such. Respondent 4 (male, 56, teacher), the principal stated: *“they have sponsored some of our students with difficulty of fees payment. Through that interaction, by Gods grace, they were able to identify the challenge and they sponsor such students.”*. Financial sponsorship also included the funding of equipment for a local football club in Jaika (I7). Furthermore, female sanitary products were provided to young girls in Kikopey (I12: male, 40, teacher). Educational engagement was centered around climate change and carbon capture education, an engagement practice present across all interviews, as it was combined with other engagements. Livelihood improvement materialized through livestock provision of chicken to the female group in Jaika (I5, I6). Respondent 5 (female, 25, small

business owner) stated: *“they bought for us the chickens. Like, they are doing everything, even for the food, the water. So, for us, it's only to take care of them.”*. The skills-based training was only present among the students at technical colleges, where the DACCS company brought equipment and machinery to the colleges and instructed the students in welding. During the interviews students proudly showed self-constructed metal benches and chairs. The teachers at these technical colleges highlighted the need for corporations to collaborate and educate students with practical skills, wishing for other companies to follow in the DACCS companies' footsteps.

The frequency of engagement activities ranged between one to four months, with monthly visits most frequently. Every respondent characterized the nature of engagement as *“open”* and *“eye-to-eye”*, describing conversations as dialogical. Respondent 15 (male, 19, student) described the interactions as follows: *“We interact in a way that you feel at ease and no one is forcing you or asking you question that you can't be able to answer”*. Half the respondents reported engagement improvements over time, stating that educational and skills-based training were becoming more complex and community members eagerly awaiting engagement activities. Respondent 12 (male, 40, teacher) stated: *“Actually now our students are impatient. They are expecting them to come monthly or doubly. So they are always asking me, when are they coming, when are they coming. So I think that relationship is improving.”*. Three respondents characterized the engagement activities as stable, while two respondents voiced a decreasing interaction over time. Respondent 10 (male, 56, Chief) noted that earlier DACCS representatives had *“vanished”* but expressed satisfaction with the current ones. Respondent 5 (female, 25, small business owner), a beneficiary of the livelihood program, was concerned because engagement visits had discontinued after the chicken delivery. However, at the recording of the interview, the chicken delivery had been 1.5 months away.

The community members' power in engagement planning, activities, and the actual project varied significantly. First, only three respondents reported having no influence in scheduling engagements, however two were students whose teachers decided on their behalf. All others described engagement planning as a mutual activity with the DACCS company. Eight respondents voiced influence over engagement activities through suggestions, including specifics of welding classes, what type of livestock to choose, as well as initiating the entire sanitary product engagement. Furthermore, four respondents claimed to have actively influenced the actual planning of the capture facility. Central claims were around the expansion of the facility, with the desire for more environmental, economic and social benefits (I14, I15).

Some engagements were mediated through intermediaries, with four teachers on the institutional side, and one Chief and one Community Elder representing community leadership. The role of

community leaders was especially interesting, as they represent a much larger share of Gilgil constituencies population, exerting significant influence over public perceptions on the DACCS company.

5.5 Acceptance

Community members' trust in corporations was very conditional on transparency, regulatory conformity, openness of corporations to the public, and benefit sharing. Only respondent 1 (male, 23, student) shared that other industrial companies in the area had negatively influenced his trust through a lack of transparency and poor environmental practices. Trust in government was a much more sensitive topic, which not all respondents felt comfortable talking about during the recorded interview. However, through informal discussion throughout the fieldwork it became evident that overall trust in national and local government was low, due to a general lack of action and corruption. Respondent 12 (male, 40, teacher) stated that: *"My only worry when I finally realize that maybe there's a minister or a government official who has vested interest, that's where I start putting the issue marks because of corruption."*, clearly highlighting the impact corruption has on local contexts. Secondly, respondents stated that the trust in companies like the DACCS company were increased due to a lack of local action and missed promises through the government (I7: male, 31, farmer).

All eighteen respondents expressed a high level of acceptance for the DACCS project and the DACCS company in Gilgil. When asked to select their level of acceptance of the DACCS project, between *"strongly disapprove"*, *"somewhat disapprove"*, *"neither approve nor disapprove"*, *"somewhat approve"*, or *"strongly approve"*, all respondents selected the last option. Interestingly, this included participant 17, who previously had not heard or engaged with the DACCS project and company. Several respondents highlighted that their approval was conditional on a set of factors, as the majority of respondents was at first skeptical of the DACCS company and their operations. The most commonly named conditions achieving high acceptance was knowledge building from the DACCS company on carbon capture. This was followed by environmental benefits, job creation and general benefits for the community. When asked about opposition in the wider community against the DACCS project, six participants stated that there were people opposing the project. However, these participants delegitimized this opposition through two pathways. Either this dissent against the DACCS project was labeled through a lack of education and understanding or through a bad mindset. Respondent 16 (female, 57, teacher) stated: *"Most of them could not understand what is carbon capture. They cannot understand because most of them are not educated that much."*.

6 Discussion

This chapter discusses the findings in five parts: (1) SLO and the formation of community acceptance, (2) EJ across distributive, procedural, and recognitional dimensions, (3) positioning within the site-specific CCUS literature, (4) the case within the broader DACCS landscape, drawing on mitigation deterrence literature, (5) contribution to Sustainability Science, and (6) methodological limitations.

6.1 Applying the Social License to Operate Framework

Broadly, SLO is defined as the ongoing acceptance and approval granted by host communities and local stakeholders to a project (Moffat et al., 2016). Based on this definition, this case study represents an active SLO granted to the DACCS company by the community in Gilgil constituency. The key drivers to achieving the SLO are trust in the DACCS company, perceived net benefits, as well as quality and continuity of engagement.

Trust in the DACCS company was high across the sample, based on the perceptions of transparency, openness, professionalism and active community presence. This trust was mediated by the Kenyan governance context, where respondents articulated low trust in the Kenyan government, citing corruption, missed promises, and a general lack of local action. The trust in the DACCS company is likely inflated due to this “*governance vacuum*”. This contrasts previous findings, where high trust in government was positively linked to SLO, in both developed (Gough et al., 2018) and developing countries (Mulyasari et al., 2021).

Perceived net benefits were a key factor in forming acceptance through three benefit categories: economic, environmental, and social. Community members expressed gratitude for the current community benefits as well as the desire for further benefits, connecting a DACCS facility expansion to an increase of benefits. This finding aligns with African SLO research on renewable energy, where low-economic contexts center community benefits to acceptance and SLO formation (Stephens & Robinson, 2021). Jobs emerged as the key economic benefit, aligning with SLO research in Morocco (Hanger et al., 2016) and the UK (Gough et al., 2018). Reduced CO₂ levels and clean air, were key environmental benefits in driving acceptance, aligning with Hanger et al. (2016), but contrasting Stephens & Robinson (2021). Perceived benefits strongly outweighed perceived risks, with environmental risks connected to storage leakage, contamination and seismicity, mentioned most often, while economic and social risks were almost absent in this study.

The quality and continuity of engagement emerges as the third driver in SLO formation. Respondents characterized the quality of engagement as dialogical, eye-to-eye and open, while highlighting the

continuous nature of engagement. Almost all respondents claimed to have influenced the engagement activities. Here, the findings partially depart from Jin et al.'s (2024) observation that procedural fairness was less relevant for successful SLO formation. The Gilgil case suggests that procedural fairness can be substantially present and analytically central to acceptance, even in Global South contexts.

However, the SLO formed under these conditions is fragile. Respondents demonstrated uneven technical understanding of the DACCS process and its associated risks, and several attributed increased rainfall and cooler local temperatures to DAC operations. This causal claim is empirically implausible, as regional rainfall only become more irregular and average temperatures rose by 1°C (Mara et al., 2023). The mismatch illustrates how thin the knowledge base underpinning acceptance is. The CCUS SLO literature is consistent that an SLO formed under conditions of low technical understanding remains highly provisional (Dowd & James, 2014; Hall et al., 2015), particularly where the project proponent is also the primary source of information about the technology, as in the Gilgil case. Whether the SLO is robust enough to survive future incidents, expansions, or shifts in benefit and risk distribution is beyond the scope of this research.

6.2 Applying an Environmental Justice Lens

EJ is structured around three interrelated dimensions: distributive, procedural, and recognitional justice (Schlosberg, 2007). Through an EJ lens, the Gilgil case looks more complicated than the SLO assessment alone suggests. Engagement is substantive, but critical voices are few and dissent is treated in a particular way within the community.

Across the sample, benefits were perceived as more equally distributed compared to risks. Respondents identified residents in closest proximity to the DACCS facility as the most vulnerable and exposed to leakages and seismic activity. This spatial-proximity distributional justice aligns with findings of Witt et al. (2020) in the Enhanced Water Recovery CCUS project in Australia. Only one respondent (male, 56, teacher) articulated international distributive justice concerns, observing that carbon capture was cleaning Global North emissions, while storage risks remained localized. This framing is structurally identical to the “*waste dumping*” framing that Icelandic respondents used to describe local storage of CO₂ transported from continental Europe (Von Rothkirch et al., 2024). Although the parallel is striking, this framing was only mentioned once, while broader climate justice framings were fully absent. That no respondent attributed climate change to Global North emissions or positioned the case in historical responsibility terms is a key finding of this case (Schlosberg & Collins, 2014; Sultana, 2022).

The SLO discussion established that procedural quality is substantively present in this case, with mutual planning, influence of community members on engagement activities, and a dialogical nature of communication. Community members highlighted that the DACCS company went through formal regulatory channels, as well as informal ones like the *Baraza*, with community members giving Free Prior and Informed Consent (FPIC). However, the existence of the project itself, its connection to international carbon markets, and core operational decisions were not on the table for discussion, based on the findings of this case. There are some similarities with other CCUS literature, where the project necessity was outside the scope of engagement activities (Mabon et al., 2015; Nielsen et al., 2025). Nevertheless, it has to be noted that no participant questioned the existence or necessity of the DACCS project. How the DACCS company would engage with such questions if raised is beyond the scope of this research.

One of the most analytically distinctive findings of this case sits within the recognitional justice dimension. When respondents acknowledged that limited community concerns exist, they consistently delegitimized it through a perceived lack of education or a “*bad mentality*” (I13: male, 19, student). Concerned community members were denied recognition not by the researcher or project company, but by other community members. This represents a recognitional justice failure operating internally within the community, rather than externally imposed. However, this study could not verify findings of Wong-Parodi and Ray (2009), that disadvantaged communities anticipate voicelessness.

Taken together, SLO and EJ produce a more complete picture of community acceptance. The SLO assessment shows that an active social license has been formed in Gilgil through trust, perceived net benefits, and substantively dialogical engagement, but is fragile due to partial technical understanding and the company’s role as the primary information source. EJ shows that this fragility coexists with limited articulation of distributive concerns, especially at the international and intergenerational level, and with an internal recognition failure in how community concerns are treated. Schlosberg (2007, 2013) argues that the three dimensions of EJ are mutually reinforcing, and the case in Gilgil illustrates this. Success in distributive and procedural justice aspects do not produce robust EJ when recognition fails internally. Whether and how the DACCS company shapes this internal treatment of dissent is an open question for future research. The combined assessment indicates substantive SLO and partial EJ, but whether both will hold over time remains to be seen.

6.3 Contributions to Site-Specific CCUS Literature

This represents the first site-specific CCUS case study in Africa. This case therefore provides the first empirical foundation for comparative work on CCUS deployment in Africa, with insights into how

disadvantaged communities make sense of carbon capture, weigh benefits and risks, build or withhold trust, experience engagement, and form acceptance.

Secondly, this marks the first community perspective research on an active DACCS facility globally, as previous research was based on hypothetical or planned deployment (Malakar et al., 2025; Satterfield et al., 2022; Scott-Buechler et al., 2024; Scott-Buechler & Wang, 2025). There, respondents evaluated DACCS based on information from researchers and project developers, while this case's respondents share perceptions based on actual multi-year interactions. Gilgil's community members did not articulate any fossil fuel industry framings, which was strongly present among previous CCUS research (Nielsen et al., 2022), and DACCS research in fossil fuel proximity (Satterfield et al., 2022; Scott-Buechler & Wang, 2025).

Thirdly, this case advances the conceptual rigor of acceptance and community in the CCUS literature. Nielsen et al. (2022) note that acceptance was rarely explicitly defined and communities were defined without proper boundaries or being represented through proxies. This study defines acceptance through explicit self-reported levels of respondents. It also defines the community living within Gilgil constituency, identified through purposive sampling, mapping onto the DACCS companies' actual outreach, while supplementing this with a control case (I17).

Fourthly, this case demonstrated the analytical value of applying SLO and EJ to DACCS research. Nielsen et al. (2022) note that due to the interdisciplinary nature of the CCUS literature, most cases were studied through mid-range concepts like trust, fairness, or risk perceptions. The application of SLO and EJ demonstrate that a substantial social license can coexist with internal recognitional justice failures and climate justice framing absence. This provides a methodological model for future CCUS research.

Lastly, this case surfaces a finding previous CCUS literature has not documented, which is the delegitimization of concerns by community members. Existing studies have examined how project developers or researchers have used a knowledge-deficit framing to manage community concerns (Nielsen et al., 2022). Whether this pattern generalizes to other Global South or DACCS contexts should be assessed by future research. Furthermore, acceptance did not vary with technical understanding, reinforcing a weak knowledge-deficit assumption from previous literature (Nielsen et al., 2022).

6.4 Mitigation Deterrence and the Political Economy of DACCS

This section situates the case within the political economy of DACCS, drawing on the mitigation deterrence literature (Carton et al., 2023; Markusson et al., 2018) and recent critical scholarship on the origins and trajectory of negative emission technologies (Carton & Malm, 2025).

The first observation investigates this case's relation to fossil fuels and fossil capital. The historical literature positions the origins of DACCS in efforts to "*maintain the competitiveness of coal energy*" (Lackner et al., 1997, as cited in Malm & Carton, 2025), and connects the emergence of many DACCS companies through Big Oil. This includes the three largest DACCS players, with Carbon Engineering acquired by Occidental (Valle & Bose, 2023), Climeworks contracting with the California Resources Corporation (Calma, 2023), and Global Thermostat partnering with ExxonMobil (Soltoff, 2019). Octavia Carbon's capital structure departs sharply from this pattern, with funding originating from African-focused venture capital, philanthropic actors and climate funds (Njanja, 2024). However, there are two aspects to consider. Octavia Carbon recently joined the Carbon-to-Value Initiative, whose leadership council includes Shell and TotalEnergies (Africa Digest News, 2025), suggesting that these startup accelerator pipelines are still impacted by fossil fuel capital. Secondly, the CO₂ storage partner Cella Mineral Storage recent injection demonstration used a water-alternating-gas technique borrowed from enhanced oil recovery, while Cella's advisory board includes the former CTO of Halliburton (Jacobs, 2026). Although Octavia's captured CO₂ mineralizes in basalt rather than feeding enhanced oil recovery, the subsurface expertise remains concentrated in fossil-industry networks, so even technologically and financially clean DACCS inherits institutional dependencies on it.

Mitigation deterrence refers to the process by which the prospect of negative emission technologies enables the continuation of emissions that would otherwise be reduced (Markusson et al., 2018). Illustrative Mitigation Pathways have shown that DACCS availability delays the phase-out of fossil fuels and results in larger emissions until around 2070 (Realmonte et al., 2019). For Octavia, mitigation deterrence is not a domestic concern, as Kenya's per-capita emissions of roughly 0.3 tCO₂ are among the lowest globally (IEA, n.d.), with no significant national fossil industry whose continuation Octavia Carbon could legitimize. The mitigation deterrence concern sits in international carbon markets, where Octavia's credits are sold to Global North buyers who may use them to offset rather than supplement emission reductions. However, this represents the inherent market structure of carbon markets, compared to the intentions of Octavia's operations.

Scale ties directly into mitigation deterrence, as Project Hummingbird targets 1,000 tCO₂/year (Ranevska, 2024), which compared to Kenya's 17.7 MtCO₂ annual emissions from fuel combustion (IEA, n.d.) represents only around 0.06%. The project's contribution to climate change mitigation is in quantitative terms therefore minimal, though this is not unique to Octavia, as the entire global DACCS industry operates several orders of magnitude below modeled requirements. The more meaningful question is whether early commercial pilot projects such as the Gilgil case contribute to the learning, cost reduction, and institutional development that DACCS scale-up would require. Whether DACCS can

achieve the cost reductions required to compete with cheaper durable removal alternatives such as biochar (~\$177/tCO₂), or enhanced rock weathering (~\$200+/tCO₂), against current DACCS prices in the \$500 to \$1000+ range (Sylvera, 2026), remains an open empirical question.

A final reflection concerns the role of the Kenyan state. The identified “*governance vacuum*” at the local level, has a structural counterpart at the national level. The Kenyan government has actively positioned the country as an export hub for carbon credits, framing them as Kenya’s next significant export (Mbenywe, 2023), as well as the project developer Great Carbon Valley, aiming at rebranding the Great Rift Valley into a hub for DACCS deployment (Kruzman, 2025). This positioning carries Climate Justice implications that the EJ discussion did not fully resolve. A country like Kenya with negligible historical responsibility for climate change becomes a host for the carbon removal industry, with the captured carbon sold to Global North buyers. Whether this represents a fair allocation of mitigation efforts, a viable development pathway for Kenya, or a reproduction of extractive relationships under a new commodity logic depends largely on how the political economy of international carbon markets evolves. Situating the Gilgil case within the broader DACCS landscape shows that even a project structurally distinct from the fossil-capital model remains to a certain degree embedded in market dynamics that shape its final climate effect. However, regardless of the broader structural verdict, Octavia Carbon’s community engagement is currently producing material benefits in Gilgil that meaningfully improve people’s lives. The depth and quality of this engagement offers a model from which other DACCS companies could draw, especially as the industry expands into communities with limited prior exposure to the technology.

6.5 Contribution to Sustainability Science

Sustainability science is concerned with the analysis of complex socio-environmental challenges that cut across scales, disciplines and forms of knowledge (Jerneck et al., 2011). Climate mitigation through Carbon Dioxide Removal (CDR) sits within the discipline of Sustainability Science. While DACCS is framed in international policy and modeled pathways as a technology to achieve global temperature targets, its deployment is local, with capture facilities, CO₂ storage, jobs, risks and engagement activities all situated in specific communities. The disconnection between the global framing of DACCS and the local conditions under which it exists has so far attracted little empirical attention, particularly in the Global South.

Furthermore, this thesis engages with the Sustainable Development Goals (SDGs) 10, 13, and 16 (UN DESA, n.d.). SDG 13, climate action, provides the justification for studying DACCS as a NET. SDG 10, reduced inequalities, is addressed through the focus on a Global South host community and the

distribution of benefits and risks. SDG 16, peace, justice and strong institutions, is addressed through the procedural and recognitional justice dimensions of the analysis, and through how community engagement is structured.

6.6 Limitations

Several limitations shape this study's findings. Firstly, respondents were identified through the DACCS company's community engagement. This enabled access to a meaningful range of engagement channels but overrepresents residents who have been engaged by the company and may hold more favorable views as a result. The single control case (I17) provides only a partial check and cannot substitute for a systematic comparison sample. Findings on approval and engagement quality should therefore be read as descriptive of an engaged sub-population rather than the wider Gilgil community.

Secondly, beyond the interview with the NEMA officer (I18), no further regulators, Octavia leadership or academic specialists, were interviewed. Community accounts of engagement, regulatory oversight, and benefit distribution could not be cross-checked against external perspectives. Where respondents make factual claims about Octavia's operations or regulatory processes, they should be read as community understanding rather than verified accounts.

Thirdly, interviews captured perceptions during a single fieldwork period in February 2026. Although respondents reflected on how their engagement had evolved, the study cannot speak to how perceptions will develop over longer periods, or shift in response to incidents, expansions, or changes in carbon market dynamics.

Fourthly, as this is a single qualitative case study, the findings are not generalizable to other Kenyan, African, or global contexts in relation to DACCS or CCUS projects more broadly. Patterns identified here may apply analytically to other contexts, but each case will be shaped by its own conditions. The contribution is to provide a first empirical study for future comparative work.

Lastly, one interview was conducted in Swahili and translated by the local facilitator, who was also an active DACCS company employee. Translation shapes meaning as well as conveys it, and this dual role is acknowledged as a methodological constraint.

7 Conclusion

This thesis examined community perspectives on Project Hummingbird, the first commercial DACCS facility in Africa, through eighteen semi-structured interviews and Social License to Operate and

Environmental Justice frameworks. The case demonstrates that an active social license has been formed in Gilgil through trust, perceived net benefits, and dialogical engagement, but remains fragile under conditions of partial technical understanding and the DACCS company as a single source of information. The Environmental Justice analysis reveals that distributive and procedural justice coexists with an internal recognitional failure, in which community members themselves delegitimize dissent through knowledge-deficit framings. Acceptance did not vary with technical understanding, reinforcing previous weak knowledge-deficit findings. Situated within the wider political economy of carbon removal, the case raises questions about how Global South DACCS deployment articulates with international carbon markets and the structural risk of mitigation deterrence. As commercial DACCS facilities expand into the Global South, the perspectives of host communities deserve sustained empirical and analytical attention.

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9 Appendix

9.1 Semi-Structured Interview Guide

#	Guiding questions
1. Demographics	
1.1	○ How old are you?
1.2	○ What is your gender?
1.3	○ What do you do for a living? ○ For how long? ○ What before?
1.4	○ Where do you live? ○ How long have you lived here?
2. Knowledge & Identity	
2.1	○ What relationship do you have with the environment in Gilgil? ○ Can you share a personal story that shows your relationship with this place? ○ Did your ancestors live here and tell you stories about the mountains, etc.? ○ Do you often go into the mountains, etc.? ○ Are there important cultural sites there?
2.2	○ How do you understand and talk about climate change? ○ Everyone talks about Climate change. What do you think about it? ○ Do you observe changes in the climate? ○ What is CO ₂ ? ○ What/Who causes it?
2.3	○ Did you hear about Carbon Capture? ○ Where have you heard about it? ○ How do you understand the basic idea of CC? ○ Have you heard of different CC methods? ○ What is the purpose of CC?
2.4	○ What do you know about Direct Air Capture? ○ Basics of DAC? ○ What is done with the captured CO ₂ ?
3. Benefits	
3.1	○ Do you think DAC is beneficial for the environment/economy/social?
3.2	○ How are the benefits shared (equally, not equally)? ○ What could be done to share the benefits equally?
4. Risks	
4.1	○ Do you think DAC is risky for the environment/economy/social? ○ Does DAC change anything within the communities?
4.2	○ How are the risks shared (equally, not equally)?
5. Engagement	
5.1	○ Do you trust the local government, local companies? ○ If not, what is this lack of trust based on?
5.2	○ When did you first learn about Octavia Carbon (DAC company)?
5.3	○ When did you first come in contact with Octavia Carbon (DAC company)?
5.4	○ What happened during the first contact with Octavia Carbon (DAC company)?
5.5	○ What types of engagement practices did you participate in?

	○ How did you like them?
5.6	○ What did you learn from engagement with Octavia Carbon (DAC company)?
5.7	○ How has the interaction/engagement developed over time with Octavia Carbon (DAC company)?
5.8	○ Where you involved into planning process of the DAC facility? ○ If yes, how? ○ If not, who was?
5.9	○ Who decides how engagement usually takes place?
5.10	○ Are there topics that you felt could not be discussed?
5.11	○ Did engagement feel like listening, informing or persuading? ○ What could have been better?
6. Acceptance	
6.1	○ Under what conditions would this project be acceptable or unacceptable to you?
6.2	○ Do you overall support the project?
6.3	○ Has that view changed over time? ○ Have you been supporting it from the start?
6.4	○ At any time, did you have concerns? ○ If yes, how did you voice those concerns? ○ Did someone respond to those concerns?
6.5	○ Are there parts of the project you accept and others do not?
6.6	○ What could have been better?

9.2 Semi-Structure Interview Guide for NEMA Officer

#	Guiding questions
1. Demographics	
1.1	○ Age
1.2	○ Gender
1.3	○ What do you do for a living?
1.4	○ Where do you live? ○ How long have you lived here?
2. Knowledge & Identity	
2.1	○ What relationship do people have with the environment in Nakuru (e.g. spiritual or religious)?
2.2	○ How has the climate changed in Nakuru? ○ What are the main causes? ○ How does it affect the people? ○ Is the topic of climate change discussed in public?
2.3	○ What role does Carbon Capture/Direct Air Capture have in Nakuru?
3. Benefits	
3.1	○ Do you think Direct Air Capture is beneficial for the environment/economy/social?
3.2	○ How are the benefits shared (e.g. equally or not equally?) ○ If not equally: what could be done to improve it?
4. Risks	
4.1	○ Do you think Direct Air Capture has risks for the environment/economy/social? ○ Does DAC change anything within the communities?
4.2	○ How are the risks shared (e.g. equally or not equally?)
5. Engagement	
5.1	○ When did you first learn/get in contact with Octavia Carbon?

5.2	○ What happened during the first contact with Octavia Carbon?
5.3	○ What were your initial thoughts on Octavia carbon and Direct Air Capture?
5.4	○ How do you mainly interact with Octavia Carbon?
5.7	○ How has the interaction/engagement developed over time with Octavia Carbon?
5.8	○ Where you involved into planning process of the DAC facility? ○ If yes, how? ○ If not, who was?
6. Acceptance	
6.1	○ Do you overall support the project?
6.2	○ If yes, why do you support it?
6.3	○ At any time, did you have concerns? ○ Where your concerns answered appropriately.
6.4	○ Is there resistance against Direct Air Capture or Octavia Carbon within the public in Nakuru?
6.5	○ What aspects of Octavia Carbons work would you like to see improve?

9.3 Detailed Information of Interview Participants

Interview	Age	Gender	Role	Engagement channel
I1	23	M	Engineering student	Technical college
I2	23	M	Engineering student	Technical college
I3	54	M	Deputy principal	Technical college
I4	56	M	Principal	Technical college
I5	25	F	Businesswoman	Livestock program
I6	43	F	Sub-chief / farmer	Livestock program + authority
I7	31/31	M/M	Plumber + farmer	Football sponsorship
I8	26	F	Office assistant (kitchen)	Employment
I9	36	M	Welder	Employment
I10	56	M	Chief of Kikohey	Local authority
I11	54	F	Community organization director (HURUMA)	Community organization
I12	40	M	Secondary school teacher	Secondary school
I13	19	M	Mechanics student	Technical college
I14	20	M	Mechanics student	Technical college
I15	19	M	Mechanics student	Technical college
I16	57	F	Deputy head teacher	Secondary school
I17	25	M	Small business owner	None (control case)
I18	47	M	NEMA Nakuru County Officer	Regulatory