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Managing Hype for Sustainability

Exploring Carbon Dioxide Removal Technologies in Organizational Contexts

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Abstract

While hype is widely studied, the management of its implications remains an emerging domain. Even less is known about how organizations manage hype at the firm level despite its recurring presence, especially in sustainability contexts. In these settings, the implications of hype are inherently complex: some argue that it can advance certain climate objectives while others suggest that it can hinder broader sustainability. Managing these adverse sustainability implications is therefore timely yet underrepresented in the literature. This study focuses on carbon dioxide removal (CDR) technologies in Finland, where hype is particularly pronounced.

Drawing on an abductive qualitative design, this study examines how organizations respond to CDR technology hype, how it may shape sustainability commitments, and potential strategies to manage it. Data were collected through semi-structured interviews with six industry practitioners and analyzed using a Gioia-guided thematic method.

The findings of this exploratory study suggest that organizations respond to CDR hype reflexively through various sensemaking mechanisms and that existing organizational practices function as informal hype management practices at the firm level. Accordingly, hype was rarely reported by the practitioners to explicitly shape decision-making or sustainability commitments, reflecting selective engagement to this phenomenon. Nonetheless, the potential implications of hype are found to be nuanced as its strategic influences may subtly emerge over time. This study also finds that, at a practical level, hype management is viewed as instrumental for sustainability even though current practices remain broadly detached from it. In this context, while organizations systematically evaluate the sustainability aspects of CDR technologies, these considerations rarely extend to the hype surrounding these methods. This suggests that the potentially adverse implications of hype for sustainability remain largely overlooked in practice.

The findings of this study provide insights for managers to further develop hype management at the practical level and to integrate strong sustainability into these considerations. While substantial further research is needed to test the patterns observed in this study, these contributions nonetheless point to the promising role of strengthened hype management in the pursuit of sustainability.

Keywords hype management, carbon dioxide removal technologies, organizational sustainability, strong sustainability, sense-making.

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Table of contents

Abbreviations

CDR	Carbon Dioxide Removal
CO_2	Carbon Dioxide

1 Introduction

1.1 Research Background

Humanity is currently facing a myriad of intersectional crises. This is empirically illustrated by the contemporary reassessment of the planetary boundaries framework, which identifies safe operating spaces for nine necessary processes for the stability of Earth's natural system (Richardson et al., 2023; Röckström et al., 2009). That is, it was recently revealed that six out of nine of these boundaries have been transgressed, which can warrant concern as the previous decade saw the most planetary boundary transgressions since the inauguration of the framework nearly two decades ago (Richardson et al., 2023; Röckström et al., 2009). In a similar light, global carbon dioxide emissions (CO_2) are 60% higher today than they were just 30 years ago despite rampant increases in political, commercial, and commercial activity directed towards addressing this challenge (Stoddard et al., 2021). Organizations often turn to technology-oriented solutions to address these complex, systemic challenges as they are broadly perceived to be able to address the triple bottom line, otherwise known as economic, environmental, and social issues (Chovancová et al., 2023). In the domain of carbon emissions reduction, technology-oriented approaches are often preferred for their efficiency in addressing carbon emissions reduction challenges (Frisch, 2023).

In this context, carbon dioxide removal (CDR) technologies have emerged as methods for addressing the challenge of decarbonization. Included under this umbrella term are a variety of carbon removal methods such as direct air capture, carbon capture and storage, bioenergy, and carbon sequestration (Von Rothkirch et al., 2024; Frisch, 2023). Climate scientists have outlined with high confidence that CDR technologies will be needed for wide-scale carbon emissions reduction, and to advance net-zero pathways (IPCC, 2023; Fuhrman et al., 2023). Other researchers similarly argue that the utilization of CDR technologies will be necessary to achieve a 1.5°C pathway (Fuhrman, 2023). As a potential result of this framing, the CDR technology sector has experienced exponential growth in just the past decade (Gosalvez, 2024).

Regardless of this anticipation, the widespread implementation of CDR technologies remains at an early stage (Von Rothkirch et al., 2024). Given the nascency of CDR technologies, many researchers argue that there is market hype and inflated expectations about their future capabilities (Ampah et al., 2024; Von Rothkirch et al., 2024; Asayama & Ishii, 2017; Fridahl

et al., 2023). That is, Castree (2020) argues that CDR technologies exist *"more in the realm of discourse than reality"* (p. 1), as current understandings about their performance rely on speculation and forecasts. In order to better understand this context, it may be helpful to examine how the sociology of expectations describes the function of expectations and hype in technology development pathways (Brown, 2003; Borup et al., 2006). To begin with, expectations about an emerging technology can be described as *"real-time representations of future technological situations and capabilities"* (Borup et al., 2006, p. 286). With this in mind, hype can then be broadly defined as a "*peak of positive expectations*" (Bakker & Budde, 2012, p. 553). Technology hype may also be described as a phase of anticipation and excitement for emerging technologies that is generally embodied by bold statements or exaggerated claims about its future capabilities and potential (Bareis et al., 2023). As some researchers point out, a central configuration of hype patterns is their ability to result in disappointment, lost reputation, and trust from these unmet inflated expectations (Kari et al., 2023; Intemann, 2022; Brown, 2003).

In the context of CDR technologies, several researchers present caution about the sustainability implications of hype. That is, they argue that in these settings, hype can crowd out non-technical alternatives and create unintended sustainability implications, such as intergenerational injustices and environmental damage (McLaren, 2020; Markusson et al., 2018; Fuhrman, 2023; Von Rothkirch et al., 2024). In regard to resource efficiency for addressing complex sustainability challenges, Funk (2019) argues that hype may divert resources and time from *"more plausible pathways for improving productivity or solving social problems"* (p. 41). Other researchers remain skeptical about the alignment between current CDR technologies and the planetary boundaries (Asayama, 2021). In this regard, hype can misinform organizational decision making regarding CDR technologies and shape the outcome for their sustainability commitments (Van Lente et al., 2013; Simakova & Coenen, 2013).

1.2 Research Problem

While expectations and hype have been widely studied by the sociology of expectations, fewer studies have examined how organizations may strategically navigate and manage this phenomenon in practice (Logue and Grimes, 2022; Von Rothkirch et al., 2024; Gosalvez, 2024). One of the primary studies in the field of hype management was conducted by Bakker

and Budde (2012), who studied the concept of expectations management as a way of strategically navigating the benefits and limitations of hype. An increasing number of research studies have since examined various conceptions of hype management in organizational contexts (Maghazei et al., 2022; Fuhrman et al., 2023; Asayama & Ishii, 2017; Goldfarb & Kirsch, 2020). Yet, despite the growing prominence of hype management studies, a majority of them remain detached from practice, with limited empirical insight on how organizations perceive and engage with hype, and a limited understanding of the extent to which it may already be managed at the organizational level. With this in mind, the concept of hype management itself lacks a standardized understanding across the literature (Logue & Grimes, 2022).

Alongside its detachment from practice, the greater part of hype management literature resides outside of the context of sustainability. That is, the intersection between hype management and sustainability remains understudied, despite literature on hype highlighting the possible sustainability implications of the phenomenon (Fuhrman, 2023; Von Rothkirch et al., 2024). That is, the unintended consequences of hype may create adverse sustainability impacts, which may have compounding implications on collective sustainable progression (Asayama, 2021). This creates an observable gap in understanding of how technology hype and its management align with organizational sustainability, especially given the pivotal role of technology solutions in these processes (Simakova & Coenen, 2013). In light of these considerations, there is arguably a need to explore how practitioners at the firm level perceive their relation to hype and how, either intentionally or not, they engage with it or manage its unintended effects in the context of sustainability.

In this regard, the context of carbon dioxide removal technologies emerges as particularly relevant for studying the intersection of hype management and sustainability. This is as CDR technologies are both surrounded by legitimized hype, and increasingly included in organizational sustainability strategies (Gosalvez, 2024). The literature additionally points to limited empirical understanding of how organizations respond to or reflect the hype surrounding CDR technologies, or how the hype may shape certain managerial decision-making processes (Wade et al., 2020; Gosalvez, 2024). The absence of this understanding points to a gap in knowledge of how the influences of hype occur at the practical level and the extent to which they may impact sustainability commitments.

Finland serves as a particularly relevant setting for studying this phenomenon. This is as several international NGO's have highlighted the current challenges that Finland faces in meeting climate objectives defined by national and EU regulations, especially those regarding carbon neutrality (Greenpeace, n.d.). Carbon dioxide removal technologies have simultaneously evolved as approaches that are characterized as able to support Finland's ability to address its carbon neutrality targets (Ministry of Economic Affairs and Employment, 2023). As net-zero targets have evolved as a focus in climate policy, this likely reinforces the industry demand for CDR technologies (Brad et al. 2024). As a potential result of these outlined targets, several industry actors have proposed upcoming carbon removal projects (Finnish Bioenergy Association, 2024). Through the context of CDR technologies in Finland, this study aims to provide empirical insight into how hype may impact sustainability commitments, as well as extend hype management literature into organizational sustainability settings.

1.3 Research Objectives

This study will use an exploratory, abductive qualitative research design to empirically examine the identified gaps in the current hype management literature, namely, its detachment from practice and sustainability considerations. Drawing on six interviews with practitioners engaging with various CDR technologies in Finland, this study aims to examine how organizations navigate CDR technology hype landscapes, how hype may influence the sustainability commitments of organizations, and what strategies they use or could use to manage hype in practice. In studying these dynamics, this thesis aims to contribute to emerging hype management literature by extending current understandings on how organizations perceive, respond to, and can potentially manage the hype surrounding CDR technologies, particularly in a sustainability context. Furthermore, this thesis aims to empirically examine how practitioners perceive the relevance of strategically managing hype for sustainability, since this perspective can be considered valuable for further developing the theoretical intersection between hype management and sustainability. Therefore, this study aims to address the following research questions:

1. How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?

The aim of the first research question of this study is to uncover the processes and strategies that organizations use to navigate CDR technology hype. Evident by its phrasing, this research question is specifically interested in understanding the potential sensemaking practices that may occur in hype contexts, as well as how organizations position themselves to bold claims surrounding CDR technologies. That is, this research question aims to understand how organizations interpret and position themselves within hype landscapes to better understand how organizations conceptualize this phenomenon at the practical level. This research question also aims to understand how organizations may respond to hype as a means to examine the extent to which it may influence strategic decision-making. With these considerations in mind, this question strives to explore how hype is perceived at the organizational level and the extent to which organizations engage with it. An understanding of how organizations perceive and relate to hype is also an arguably necessary perspective that can inform the further conceptualization of emerging hype management theories at the practical level.

2. In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?

The second research question of this study strives to understand the extent to which technology hype may strategically influence and prioritize the sustainability commitments of organizations. This research question is derived from the literature on CDR technologies that argues that its influence can, for instance, push decarbonization objectives to the long-term at the expense of near-term action (McLaren, 2020**)**. This question is interested in exploring how technology hype may reframe sustainability objectives at the organizational level, as well as clarifying its potential role in the context of organizational sustainability. Overall, this research question aims to understand the enabling and hindering potential of hype and the impact it may have on how organizations pursue sustainability.

3. What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?

The aims of the third research question of this study are twofold, as it aims to understand how organizations may already employ hype management, in addition to potential practices that could be developed, particularly in the context of sustainability. In this sense, this question is both descriptive and normative. That is, it strives to understand how hype management already manifests and the extent to which it intersects with sustainability at the organizational level, while also conceptualizing prospective strategies that organizations could apply. This question is also motivated by the idea that hype management practices may potentially address the sustainability implications of hype.

1.4 Structure of the Thesis

This research study is composed of six sequential sections. The first section, *Introduction*, outlines the background, research problem, research objectives, and research questions of this study. This section introduces and contextualizes the relevance of studying organizational engagement to and management of CDR technology hype. The second section, *Literature Review*, explores research on hype dynamics, CDR technologies, organizational sustainability, sensemaking theory, and hype management. Fundamentally, this section aims to specify how existing literature addresses the research questions of this study, while also uncovering the gap that this study aims to address. The third section, *Research Methodology*, describes the methodological approach and qualitative research tradition applicable to this study, in addition to explicating the research design that it applies. That is, this section explains the data collection process, analysis method, and the ethical considerations of the research design. The fourth section, *Results*, presents the empirical findings from the thematic analysis conducted on the practitioner interviews. This section is organized around the aggregate dimensions from the thematic analysis, namely "*Motivation and Expectations*", "*Organizational Responses and Perceptions of Hype*", "*Navigating CDR Technologies*", and "*Hype Management*". The fifth and following section, *Discussion*, explores my interpretations of the findings while also situating them in the literature. The final section, *Conclusion*, summarizes the main contributions of this study, discusses managerial implications, presents limitations, and suggests directions for future research.

2 Literature review

2.1 Hype Dynamics, Organizational Engagement with Hype, and Sensemaking Theory

This section aims to develop a theoretical foundation for the first research question of this study, "*How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?*". To address this question, this section will explore technology hype dynamics as illustrated by the sociology of expectations to understand how this phenomenon occurs and why it persists (Brown, 2003). This section will also examine the literature on how organizations engage with, and position themselves, in relation to hype. Drawing on sensemaking theory, which describes how organizations interpret and navigate ambiguities (Weick, 1995), this section further seeks to understand how organizations make sense of hype surrounding emerging technologies.

2.1.1 Understanding Technology Hype

To begin understanding the role of technology hype in sustainability contexts, it may be valuable to examine the role of expectations as described by the sociology of expectations (Brown, 2003). The sociology of expectations has widely examined the creation and subsequent implications of expectations within innovation pathways, recognizing the essential role they play in the development landscapes of emerging technologies (Borup et al. 2006; Simakova & Coenen, 2013; Pollock & Williams, 2010). Borup et al. (2006) have provided a frequently referenced definition for technology expectations that describes them as *"real-time representations of future technological situations and capabilities*" (p. 286). That is, a collective understanding of an emerging technology's future capabilities is described to be based on imagined perceptions during the early stages of the innovation process (Ramiller, 2006).

In this context, technology hype is widely referenced in the literature as collective expectations about the future performance of emerging technologies (Bakker & Budde, 2012). As Kari et al. (2023) suggest, technology hype is based on the development of promises regarding the long-term potential of emerging technologies. As Logue and Grimes (2022) outline, this shared vision of a prospective future creates a setting "*around which attention, excitement, and*

expectations increase over time" (p. 1056). Scholars have outlined that hypes may be propelled by both optimistic and pessimistic expectations, depending on the given emerging technology (Kriechbaum, 2021; Gosalvez, 2024). Researchers, such as Fox (2018), suggest that expectations that create hypes are usually positive, or even strongly positive, in their framing of the future capabilities of the respective technology. Other scholars, such as Intemann (2022), argue that hypes are driven by exaggeration to the extent that this is viewed as a defining feature of this phenomenon. Nonetheless, many researchers agree that hypes involve inflated expectations about the potential of a developing technology (Logue & Grimes, 2022; Goldfarb & Kirsch, 2020; Bareis et al., 2023; Frisch, 2023).

Current literature highlights the performative nature of expectations as one of the central components in studying hypes (Van Lente et al., 2013). Borup et al. (2006) originally defined the performative characteristic of expectations through its ability to shape and influence the actions and decisions of other actors. That is, Borup et al. state that expectations can capture the attention of necessary stakeholders and create mutually binding obligations and objectives among them. Similarly, Van Lente et al. (2013) argue that hype has a "*performative capacity in the present*" as they highlight its ability to mobilize resources, create legitimacy, coordinate initiatives between actors, and drive competition (p. 1626). Van Lente et al. add that although the expectations that propel hype rarely materialize as projected, they can still hold a fundamental role in determining how the technology emerges. In this regard, hype studies have been of particular interest to academia due to the identified role that collective expectations hold within innovation processes (Konrad, 2006).

Pollock and Williams (2010) expand on the notion of performative expectations by arguing that expectations rarely require an empirical foundation for them to become commonly accepted understandings of technology capabilities. This argument may suggest that collective belief can outweigh the necessity for empirical validity in hype settings. In a similar vein, Ramiller (2006) asserts that exaggeration about technology capabilities occurs during a unique point of its development pathway, where it has yet to be widely dispersed. In this regard, they argue that its lacking materiality is able to continue the spread of unvalidated claims, which can uphold the hype surrounding the emerging technology. In fact, Fox (2018) argues that exaggeration is an inherent aspect of technology development, asserting that overpromising is inevitable during the primary stages of the hype cycle. Together, these findings suggest that the claims conveyed through hype may be promotional rather than accurate, which in a

sustainability setting can misguide organizations in their sustainability decision-making processes. For the context of this study, these findings can imply that organizations may be indifferent to explicitly managing hype if it is regarded as an inherent component of market activity.

Other researchers disagree on the extent of hype's performative capacity and its ability to influence organizational action. For instance, the findings from Wade et al. (2020) found no correlation between hype and disruption occurring in their industry of study, which suggests that the long-term impacts of hype on industry activity are minimal. Hoppman et al. (2020) argue that even reliable actors of influential coalitions face limitations in the extent to which they can exaggerate the expectations they circulate, such as the material properties of the emerging technology. This suggests that there are some existing constraints on the extent to which claims about future technology capabilities can be exaggerated, which disagrees with the aforementioned perspective of Pollock and Williams (2010). Yet, when the material properties of a technology are still emerging in the primary stages of its development trajectory, it remains rather unclear how this factor may moderate claims. In this regard, Berkhout (2006) argues that it may be an oversight to read expectations too literally, as systemic validation of future visions and claims remains poorly established. For this study, these findings present diverging perspectives on the extent to which hype can enable industry disruption. At the same time, they suggest that in hype settings, organizations are faced with navigating and interpreting empirically unsound claims in the early stages of technology development.

To further understand the dynamics of hype, it may be valuable to examine its cyclical properties. The sociology of expectations recognizes that expectations about emerging technologies occur in cyclical patterns that are characterized by positive expectations after which periods of disillusionment generally follow (Brown, 2003; Dedehayir & Steinert, 2016). One representation of this cyclical pattern may be observed through the formalized and influential Gartner Hype Cycle Model, which was developed in 1995 by the Gartner Consultancy Group (Bakker and Budde, 2012). In short, the Gartner Hype Cycle model illustrates a pathway of five sequential phases that expectations follow for a given technology over time (Bakker and Budde, 2012; Linden & Fenn, 2003). In general, the Gartner Hype Cycle model illustrates that hype follows a rather standardized pattern of an exponential rise in expectations that result in hype, which is then followed by disappointment from unmet

expectations (Bakker and Budde, 2012). Expectations are acknowledged to gradually recover and rise as the technology begins to be deployed in the market (Bakker and Budde, 2012).

However, some hype scholars argue that hype dynamics occur differently from those illustrated by the Gartner Hype Cycle model. For instance, a confirmatory evaluation conducted by Konrad (2006) found that expectations for e-commerce in 2000 followed the conventional hype-cycle model, while expectations of interactive television did not correspond to it. Successive confirmatory analysis by Järvenpää and Mäkinen (2008) provided rather similar findings. Konrad et al. (2012) later found that the hype dynamics in the development of fuel cell innovations underwent multiple cycles described by the model. In short, these findings may suggest that hypes can adopt various forms that are largely dependent on contextual factors. In the context of this study, the notion that hypes can occur in non-standardized and context-dependent patterns may potentially impact how organizations are able to identify and navigate these dynamics in practice, if they are inclined to do so. At the outset, its irregular form may make it challenging for organizations to differentiate hype from optimism for emerging technologies.

Van Lente et al. (2013) explore other potential factors that can impact the manifestation and longevity of hype patterns. For instance, they find that the extent of disappointment, as well as the length of the hype period altogether, can impact the shape of the hype curve. They also identify moderating variables that may impact the nature of hype patterns. That is, although Van Lente et al. argue that specialized technologies are less likely to experience expectation recovery after disappointment. They add that certain contextual factors, such as available funding and favorable regulatory environments, may positively influence expectations recovery. These findings suggest that hype patterns are specific to the actors involved and the nature of the emerging technology. Perhaps as a result of the influence of these factors, periods of hype are suggested to last between two and twenty years, depending on the given technology (Steinert & Leifer, 2010). Nonetheless, the understanding that hype generally occurs in recurring, cyclical patterns may point to the relevance of managing its potential effects.

The literature on hype also acknowledges the potential risk and centrality of disappointment during periods of hype. Van Lente et al. (2013) describe disappointment as an aspect of hype that follows the initial, exponential increase in expectations, occurring specifically when high expectations fail to match the realized outcome of the emerging technology. As Brown (2003)

outlines, the risk of disappointment from unmet expectations may significantly impact industry reputation and credibility. Although Bakker and Budde (2012) characterize the dynamics of disappointment as a significant risk of hype, adding that the risk of disappointment and its following consequences are more likely to result from unmet, inflated expectations rather than from other market competition dynamics (Bakker and Budde, 2012). This finding suggests that the disappointment often seen as inherent to technology development pathways is, arguably, a result of hype dynamics and could therefore be potentially avoided by limiting hype or managing its effects. Particularly for this research, these studies overlook how organizations may position themselves to disappointment and its potential risks.

On the other hand, other researchers, such as Ruef and Mackard (2010), found that disappointment does not always occur in hype sequences. Instead, their results illustrate that as initial media attention begins to decrease, a following reduction in positive expectations does not always occur for the respective technology. This finding points to the various, yet unstandardized forms that hype can have in practice. However, these studies remain focused on the industry and technology-related risks from disappointment, which overlook the implications that disappointment may have on sustainability. With this in mind, the potential implications of unmet expectations in a sustainability context will be further explored in section 2.2.2.

2.1.2 Organizational Engagement with and Responses to Hype

Following the examination of what technology hype is, along with its dynamics and cyclical patterns, it is valuable to explore both how and why organizations may respond to it. Since this research study aims to extend on the literature of how hype can be managed at the organizational level for sustainability, it is valuable to explore potential organizational motivations to engage with hype, as well as how they position themselves in relation to it. At the outset, the literature points out that hype can have a performative role in the development pathways of emerging technologies through its ability to mobilize resources, investment, and information, as well as coordinate actors (Brown, 2003; Pollock and Williams, 2010). With this in mind, it can potentially be recognized that organizations may decide to engage with hype as a means to strategically leverage its outcomes for technology development. This idea is reflected through the findings of Bakker and Budde (2012), as they argue that practitioners involved in emerging technology projects are incentivized by the potential for high rewards to

communicate bold claims and foster hype. In a business context, their findings may implicitly suggest that organizations engage with hype to attain certain competitive advantages in emerging technology markets.

Alkemade and Suurs (2012) also argue that technological expectations are prone to strategic manipulation by organizations and other stakeholders due to the influence they can have on technology development. From their perspective, the potential positive impact of expectations creates an incentive for actors to "*express and influence*" them (p. 450). This idea aligns with the findings of Logue and Grimes (2022), as they view hype as a '*cultural resource'* with the capacity to provide start-up entrepreneurs with valuable resources for early-stage innovation. They argue that entrepreneurs may also strategically engage with hype to leverage the potential long-term benefits of hypes, such as stakeholder engagement (Logue and Grimes, 2022). These ideas signal that organizations may perceive hype as a business opportunity rather than as an imminent operational or societal risk. At the same time, these findings argue that hype is rather easily identifiable by organizations, which runs contrary to the contentions of Van Lente et al. (2013) and Steinert and Leifer (2010) who argue that it can adopt a variety of forms.

Bakker and Budde (2012) nonetheless acknowledge that the possibility of organizational rewards from hype engagement relies on whether other actors engage with hype or remain modest in their claims about the given technology, represented through the "*enactor's dilemma*" (p. 557). This dilemma, as they illustrate, argues that organizational responses to hype and the outcomes of these actions depend on the course of action of other actors, as well as other factors like sector stability and the characteristics of involved actors (Bakker & Budde, 2012). For instance, they highlight that sectors experiencing rigid resource mobilization and stakeholder groups that have invested in the given emerging technology may be more inclined to generate overpromises about the technology's capabilities. For this study, these findings suggest that organizational engagement with hype is determined more by external factors than by internal consideration, which points to rather limited agency organizations exert in hype settings. Their findings suggest that organizations may respond to technology hype independent of its immediate relevance for their internal strategic needs.

On the other hand, Ramiller's (2006) approach to understanding organizational motivations for engaging in bold claims centers on the notion of "*knowledge needs*". That is, Ramiller argues that technology enactor organizations strategically identify and target certain information gaps

of prospective adopter organizations in the promotion of emerging innovations. In practice, this may be realized by enactor organizations including information in their claims about emerging technology capabilities that adopter organizations may lack access to (Ramiller, 2006). Ramiller's findings align with those of Bakker and Budde (2012) as well as Alkemade and Suurs (2012), as each argues that exaggeration in hype settings may be intentional and dependent on the characteristics of potential adopter groups. In a similar vein, Intemann (2022) argues that studying hype requires a strengthened understanding to be able to distinguish and classify what is an exaggeration to justify claims about its adverse implications.

Kaniadakis and Linturn (2022) provide alternative insights on how technology adopter organizations respond to hype. They argue that organizations respond to technology hype through a 'technology push' approach, which they describe as adopter organizations trying to find internal issues that the emerging technology can address, rather than starting at the problem itself. This finding highlights the potential strategic influence of hype, as organizations are assumed to adapt their internal processes to align with hyped technologies. Kaniadakis and Linturn also highlight the role, and subsequent influence, of senior management in depicting how an organization responds to hype. They argue that hype ultimately imposes technology adoption pressure on senior management, who in turn ultimately determine how its influences shape organizational processes.

In a similar vein, Konrad et al. (2012) studied how adopter organizations respond to hype in the context of fuel cell hype. Their analysis found that as expectations rise, organizations typically respond to the momentum by adjusting their strategies and scaling related activities. Their analysis also found that even if an organization does not respond to hype through explicit strategic alignment, it may expand other related operations to benefit from the momentum. In this context, Konrad et al. add that the way in which organizations respond to hype also depends on their characteristics. For instance, the capabilities and resources of an organization were found to influence how they strategically respond to hype. In the context of this study, these findings suggest that organizations generally don't position themselves to hype as an inherent risk. Instead, the literature broadly argues that organizations respond to hype rather favourably to strategically leverage some degree of its momentum.

This section has explored potential motivations for organizations engaging in and responding to technology hype. At the outset, this section explored how organizations may strategically

engage with hype given its potential influence in resource mobilization, garnering attention, and engagement for emerging technologies (Pollock & Williams, 2010; Bakker & Budde, 2012; Alkemade & Suurs, 2012; Logue & Grimes, 2022). External factors, as well as investments made in the technology, were found to potentially impact how, and the extent to which, organizations respond to hype (Bakker & Budde, 2012). This section also found that organizations may perceive hype as an inherent business tool (Ramiller, 2006; Pollock & Williams, 2010), in addition to the role of senior management in determining how hype shapes strategy (Kaniadakis & Linturn, 2022).

2.1.3 Sensemaking Theory

Drawing on sensemaking theory can provide a useful framework for further understanding how organizations understand and develop meaning in hype settings amidst complex and ambiguous sustainability challenges. This perspective is particularly meaningful for this study as it can illustrate the processes organizations employ to interpret hype. With this in mind, sensemaking theory can be viewed as a descriptive theory that originates from the domain of organizational studies, which depicts how organizations process information and translate it to action (Weick et al., 2005; Demastus & Landrum, 2023). As the literature recognizes, sensemaking generally begins with ambiguity, uncertainty, or contradictions, which is followed by an effort to incorporate this novel information into the existing organizational structure and identity (Weick et al., 2005; Demastus & Landrum, 2023). Organizations may use sensemaking as a means to draw from the past to process the future and subsequently share this interpretation through future-oriented visions with others (Demastus & Landrum, 2023). Especially regarding sustainability, Angus-Leppan et al. (2010) argue that sensemaking enables organizations to better understand the social and environmental demands of their stakeholders. That is, they argue that organizational sense-making allows actors to better align their differing understandings of various aspects of sustainability to created shared value.

Weick (1995) argues that a key aspect of sensemaking is its subjective nature, since its processes are considered sufficient when interpretations become plausible to the organization, instead of empirically accurate. In other words, this can mean that the outcomes of sensemaking may be relevant only to the given organization, as they reflect what the organization considers plausible rather than what is scientifically validated. To some extent, this idea may illustrate the persistence of hype, as organizations may respond to claims that appear credible even if

they lack necessary evidence. Landrum (2018) argues that this worldview then guides corporate decisions and actions that inevitably determine sustainability practices. In this sense, sensemaking may also be a relevant component of organization visioneering that embodies expectations and hype.

In the landscape of hype, organizations arguably apply sensemaking processes through the utilization of imagined business futures. Beckert (2021) outlines imagined business futures as a mechanism through which organizations interpret, frame, and convey business desirability in times of uncertainty. Frisch (2023) argues that imagined business futures have evolved as a mechanism used by organizations to respond to the pressures of decarbonization. In this context, imagined business futures refer to ideas on how businesses foresee their operations in a decarbonized economy (Frisch, 2023). Indeed, visions may hold a central role in the mobilization of resources and capabilities towards emerging technologies, in addition to the advancement of necessary market-based measures (Borup et al., 2006). Since emerging technologies lack established technology properties, their development remains largely reliant on these future-oriented visions (Mulder et al., 2011).

This section has explored technology hype dynamics, organizational responses to hype, and sensemaking theory as a lens for organizational engagement with hype. While the literature on hype has provided a theoretical foundation for understanding the phenomenon, the majority of these studies remain outside the context of practice and sustainability. With this in mind, it still remains unclear how technology hype is perceived at the practical level and how it may impact sustainability decision-making processes, pointing to the relevance of further exploring this gap through the multifaceted role of CDR technology hype.

2.2 Carbon Dioxide Removal Technology Hype

This section will explore how hype is understood and situated in the context of CDR technologies to better understand its potential implications in a sustainability setting. In this regard, this section aims to explore the second research question of this study, namely, "*In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?*". This section will therefore examine the multifaceted role of CDR technology hype in the pursuit of sustainability, while also exploring its potential ramifications on organizational sustainability commitments. This exploration is particularly relevant, and perhaps even challenging, considering that there is limited empirical understanding of how organizations respond to or reflect the hype surrounding CDR technology methods (Gosalvez, 2024).

To preface, hype scholars have observed hype to have a complex role in sustainability contexts. Vaskelainen et al. (2022) argue that hype in sustainability settings is especially relevant as it may enable niche, sustainability-oriented products to compete with mainstream alternatives. In their view, hype is important in sustainability contexts as it can have long-term positive effects in the mainstreaming of sustainability-oriented products and services. In a similar vein, Kriechbaum et al. (2021) state that hype cycles hold an important role in transitional landscapes where expectations for emerging sustainability technologies compete with existing methods. Additionally, Borup et al. (2006) and Logue and Grimes (2022) recognize that hype can mobilize attention towards sustainability issues, which may facilitate positive social change. Other scholars similarly argue that hype is valuable in sustainability contexts as it can create long-term stakeholder engagement, which can be valuable in addressing the long-term horizons of many climate objectives (Goldfarb and Kirsch, 2020).

The context of carbon dioxide removal (CDR) technologies presents an arguably interesting setting for the study of hype and its potential implications within sustainability contexts. At the outset, CDR technologies include an array of technologies intended to extract atmospheric CO_2 and store it permanently in reservoirs situated underground, on land, or in the ocean (Gosalvez, 2024). Despite CDR technologies being homogenously grouped together in this single term, in practice, it includes a spectrum of distinct methods such as direct air capture, carbon capture and storage, biochar, and carbon sequestration (Von Rothkirch et al., 2024; Frisch, 2023).

On a further note, a majority of CDR technologies are positioned as necessary components of organizational emissions mitigation pathways, despite their widespread rollout remaining in infancy (Von Rothkirch, 2024; Grubert and Talati, 2023). As some researchers argue, this technological immaturity has enabled speculation and inflated expectations about CDR technology costs, capacity, and future scalability (Field & Mach, 2017). In reference to the hype cycle, Gosalvez (2024) has specifically outlined that current expectations for CDR technologies reside at the highest point of the curve, at the peak of inflated expectations. With this in mind, it may therefore be valuable to explore the implications of the hype surrounding these technologies, and the extent to which organizational engagement with them aligns with sustainability.

2.2.1 Productive potential of CDR technology hype

Scholars have highlighted the productivity of CDR technologies in various decarbonization pathways. Fridahl et al. (2023) argue that carbon emissions removal is a central component for addressing climate change, therefore advocating for the urgent deployment of CDR technologies within the European Union. In fact, the IPCC's Sixth Assessment Report (2023) has positioned CDR technologies as key components for reducing residual carbon emissions in modelling future 1.5 °C and 2 °C emissions reduction pathways. Other researchers have similarly acknowledged the urgency of further developing and deploying CDR technologies to support approaching climate objectives and to reduce carbon dioxide emissions from hard-to-abate industries (Ampah et al., 2024; Asayama, 2021; Field & Mach, 2017). For instance, Strefler et al. (2021) argue that early availability of CDR can positively impact long-term carbon neutrality objectives by significantly reducing the economics costs of achieving the 1.5°C pathway. Specifically, they argue that early deployment of CDR helps by distributing emissions mitigation responsibilities and by lowering overall levels of atmospheric CO_2. In the context of this study, it may arguably be considered that the framing of necessity and urgency by scientific communities surrounding CDR technologies may potentially shape how organizations prioritize these technologies in their sustainability commitments.

Regarding the outlined role of CDR technology availability in the domain of carbon neutrality, it can then be necessary to explore how the hype surrounding these methods can potentially advance their development. Indeed, the sociology of expectations has outlined that expectations can have a significant role in industry creation and in the development of technologies Van

Lente, 2011). In this regard, both Gosalvez (2024) and Von Rothkirch et al. (2024) argue that the inclusion of CDR technologies in IPCC reporting has created hype for these methods in industry. In the view of Von Rothkirch et al., the IPCC's advocacy for CDR methods has specifically led stakeholders to validate the employment of these technologies through concepts of necessity and accountability. They argue that this validation has supported the legitimation of CDR technologies and the mobilization of resources toward their continued development (Von Rothkirch et al., 2024). However, while these perspectives provide an essential understanding of how industry actors may respond to CDR technology hype, they also overlook the potential broader sustainability implications that may result from this momentum.

As a potentially positive outcome, McLaren (2020) found that in favorable scenarios, mobilizing resources for the development of CDR technologies could even generate technical synergies that can further accelerate the rate of emission reductions. Although this can be valuable in addressing approaching emissions targets, this idea overlooks the potential sustainability risks that may result from over allocating resources towards one specific climate approach, especially if those resources are mobilized away from other sustainability initiatives. In the context of this study, this may be reflected in the sustainability commitments of organizations, as CDR technology hype may overtly steer resources towards emissions reductions at the expense of other sustainability issues. However, Logue and Grimes (2022) have acknowledged that there is still limited theoretical understanding of the broader societal role that hype can have.

2.2.2 Adverse Implications from CDR Technology Hype

Other perspectives present more caution on the role of CDR technologies in sustainability transitions and the subsequent implications of CDR technology hype in promoting their deployment. The literature on CDR technologies has indeed pointed to the paradoxical role that these technologies could hold in achieving various carbon emissions reduction targets (Asayama, 2021; Ampah et al., 2024). That is, they outline the potential land-water-energy nexus challenges (Buck et al., 2023), land-use changes (Ampah et al., 2024; Field & Mach, 2017), and risk of increased emissions (McLaren, 2020). More specifically, in response to IPCC's Sixth Assessment Report, Von Rothkirch et al. (2024) assert that the outlined scale of CDR technologies required to achieve the modelled carbon emissions reductions is "*technically, economically, and socially*" unfeasible (p. 2). In a similar vein, Ampah et al.

(2024) found that CDR capacity would need to increase by over 1500 from its current level to satisfy the aforementioned modelled pathways. Therefore, Ampah et al. characterize reliance on these technologies as dependence on unpredictable CDR scalability that may result in significant environmental challenges.

Other researchers, such as Grubert and Talati (2023), point out that CDR technologies are constrained by resource limitations. In their view, there is a clear gap between what is promised about CDR technologies and what is materially possible. In the added view of Gosalvez (2024), current expectations about CDR technology capabilities are inflated and overly optimistic, which has led to confusion and misunderstandings among involved actors. However, Gosalvez's study overlooks how the inflated expectations about CDR capabilities may have impacted practical-level decision-making and resource allocation, especially in light of sustainability action. This may warrant concerns about the extent to which inflated expectations over CDR technology capabilities may impact how organizations progress with their sustainability commitments in practice.

In a similar vein, Intemann (2022) highlights that inappropriate exaggerations can occur when exaggerations hinder the overarching objectives of its audience or when understandings of a technology lack necessary evidence. In their view, inappropriate exaggerations can impact the accuracy of assessments and forecasts that actors are able to make about emerging technologies. In the context of CDR technology hype, expectations about the required, extensive scale of these methods may contain inappropriate exaggerations that hinder the decarbonization potential of involved actors (McLaren, 2020). In the context of this study, inappropriate exaggerations of CDR technology may skew organizational decision-making regarding these technologies. In this light, Bareis et al. (2023) argue that assuming hyped claims at face value can lead actors into lock-in scenarios and create path dependencies that primarily promote technological approaches. In the context of this study, this suggests that organizations engaging with the hype surrounding CDR technology methods may overlook plausible non-technical alternatives to meet their sustainability commitments. This may be represented by sustainability strategies that focus on technology-oriented solutions as the primary means to address sustainability challenges, rather than employing nature-based solutions or sufficiency-based measures (Landrum, 2018).

On the question of sustainability-oriented technologies, Mulder et al. (2011) argue that these approaches may fall short in their ability to address sustainability when their development is targeted towards addressing a specific issue at the expense of creating new ones. In this view, some researchers have recognized the potential for climate delay or deferral from the overreliance on technological options in the pursuit of sustainability (Lamb et al., 2020). Within the context of CDR technologies, this may be specifically observed through the phenomenon of mitigation deterrence, which is defined as *"the prospect of reduced or delayed mitigation resulting from the introduction or consideration of another climate intervention*" (Markusson et al., 2018, p.1). This idea suggests that organizations may relax their current carbon emissions reduction efforts in anticipation of upcoming technologies in the long-term, alluding to the idea that the hype surrounding emerging sustainable technologies may result in a reduction in climate action in the interim (Markusson et al., 2018).

From another perspective, McLaren (2020) highlights that mitigation deterrence may arise if the imagined future availability of novel technologies leads to reductions in current action without established substitution systems. Empirically, Ampah et al. (2024), find that a carbon removal pathway that is heavily reliant on CDR technologies may inadvertently increase fossil fuel use subsequent emissions. For this study, these findings suggest that the sustainability commitments of organizations with a diversified portfolio of methods, spanning various time horizons, may be less vulnerable to the adverse effects of hype. These perspectives highlight that mitigation deterrence is more likely to occur when organizations are dependent on a single climate approach. In this sense, Ashby et al. (2023) argue that while a narrow articulation of sustainable technology can match corporate interests, it may in turn limit sustainability progress in the long-term.

Advancing CDR technologies at the expense of other alternatives may also threaten the development trajectories of other ambitious decarbonization efforts (Von Rothkirch et al., 2024). That is, natural, social, and financial resources may be diverted from the development of alternative measures to the development of CDR technologies as a result of the promises made about their future potential (Von Rothkirch et al., 2024; Bäckstrand et al., 2011). In this view, Olsson et al. (2017) argue that a portfolio of diverse technologies and approaches is necessary to achieve genuine systems-level change, rather than relying on any single method. The literature also shows that technology hype can determine which broader sustainability issues receive organizational attention. That is, Bareis et al. (2023) argue that the hype

surrounding emerging technologies can lead to other societal challenges being overlooked. In the context of this study, this can be interpreted as organizations overly focusing on carbon removal issues, which may result in the dismissal of other environmental challenges.

Savasta-Kennedy (2014) explores this idea through the concept of "*carbon reduction tunnel vision*", which they define as selective attention towards carbon reduction that excludes related environmental and social impacts (p. 8). In their view, carbon reduction tunnel vision overlooks the complexity of sustainability issues, while also omitting necessary perspectives and populations from decision-making processes. As a result of this, Savasta-Kennedy argues that this tunnel vision perspective limits the effectiveness of sustainability strategies and may cultivate additional environmental issues. This may also be viewed through the idea that CDR technologies "*preserve the status quo of fossil fuel use*" by narrowly focusing on mitigating carbon emissions (Asayama, 2021, p. 6). For this study, these findings together suggest that hype may oversimplify sustainability challenges, which in turn, may limit how organizations can capture and address their complexities in practice. Taken together, these considerations highlight the potential consequences of technology hype for sustainability commitments at the organizational level, which may point to the relevance of identifying contexts where its outcomes are especially harmful in practice (Bareis et al., 2023).

Alternatively, Ho (2023) argues that the claims surrounding CDR technologies can be particularly harmful in light of the forecasted increase in available climate financing. In their view, this climate financing may be disproportionately directed towards advancing CDR technologies at the expense of other alternatives as a result of the promises surrounding these methods. Other researchers argue that in the context of sustainability-oriented technologies, unmet expectations can result in reputational risks for the sector that significantly influence the development of the technology altogether (Gosalvez, 2024; Brown & Michael, 2003; Bakker and Budde, 2012). For the umbrella term of CDR technologies, which includes a variety of methods, this finding suggests that reputational risks associated with one method may have potentially compounding impacts across the others. Logue and Grimes (2022) highlight that in the sustainability context, the reputational risks following unmet expectations can result in reduced resource flows for sustainable progressions altogether. In their view, this can negatively impact the rate of innovation directed at addressing broader, systemic challenges altogether. Together, these findings suggest that resource flows to sustainable development are

particularly volatile and responsive to unmet expectations, which can highlight the relevance of identifying their presence in practice.

From another perspective, Von Rothkirch et al. (2024) argue that unmet expectations about CDR technologies may result in intergenerational inequities in the long run. That is, their study suggests that the responsibility for carbon removal may be placed on future generations if the expectations about CDR potential reduce current emissions reduction efforts. For this study, the adverse sustainability implications that may result from unmet or overestimated expectations about CDR technologies, such as reputational risks, reduced resource flows for climate initiatives, and intergenerational inequities, highlight the relevance of critically evaluating the impacts of hype where it emerges. Taken together, these findings highlight the potential value in assessing the claims about the future potential of CDR technologies in order to enable well-informed sustainability decision-making.

As Alkemade and Suurs (2012) argue, hype is nonetheless subject to market forces, which they view as intrinsically unable to encourage development toward a sustainable socio-technical regime. In a similar vein, Asayama (2021) argues that the limitations of CDR technologies are not specific to these methods, but rather the product of systemic carbon lock-ins arising from the current fossil-fuel-based energy system. These findings may then suggest that hyped technologies are presumably limited in their ability to enable genuine sustainability, signaling that solutions that may address complex sustainability issues are not favored by current market forces. For this study, these ideas point to the potential merits of searching for alternatives for addressing sustainability commitments that reside outside of hype settings. Bakker and Budde (2012) similarly argue that radical innovation becomes increasingly challenging within the domain of eco-innovations that are currently bounded by contemporary market logic. They assert that while genuine disruptions may be valued from an environmental and social perspective, their development may, inevitably, be impacted by a lack of market incentives (Bakker & Budde, 2012). As a function of market incentives, hype is therefore considered by some to surround less disruptive approaches needed to address sustainability issues, making critical engagement with it increasingly relevant at the practical level.

2.2.3 Critical Engagement with CDR Technology Hype

As a result of the multifaceted role that CDR technologies and their hype are found to have in sustainability settings, it may be valuable to explore how the literature considers methods for minimizing their adverse impacts. That is, some researchers advise limiting over-reliance on any specific CDR technology pathway, as they suggest the uptake of diverse sustainability strategies (Ampah et al., 2024; Fuhrman et al., 2023). Some of these alternative approaches may include other efficiency or even sufficiency-related measures that account for non-technical approaches (Ampah et al., 2024; Von Rothkirch et al., 2024). For instance, Field and Mach (2017) call for the appropriate scaling of CDR technologies as a means to approach decarbonization targets while also minimizing risks and harmful impacts from ungrounded, widespread deployment. That is, they argue for a pluralist approach that utilizes CDR technologies while also remaining committed to current carbon emission reduction efforts. In their added view, CDR technologies need to be appropriately scaled to minimize the risk of inflated expectations surrounding these methods, which they highlight as the assumption that they can be widely deployed at low costs and with limited environmental impacts (Field and Mach, 2017). Asayama (2021) additionally suggests that the broader development of CDR technologies should be aligned with systemic challenges, such as measures that address the decline of fossil fuel production. In the context of this study, these findings argue that organizations could align their sustainability commitments with greater sustainability challenges that extend beyond their own operations, while also identifying how they can appropriately scale these technologies.

The varied promises surrounding CDR technologies may also indicate the presence of diverging and potentially contradictory expectations surrounding the development and integration of these methods. For instance, Palm and Nikoleris (2021) analyzed the expectations and visions surrounding carbon capture and utilization technologies, which are methods that occasionally arise under the umbrella of CDR methods. They found that the expectations surrounding these methods simultaneously promise that the technologies are compatible with the market status quo, while also highlighting their transformative potential. In the view of Palm and Nikoleris, these realities are mutually exclusive and have therefore led to conflicting expectations among actors, as the hype surrounding CDR promises that the current fossil energy system can persist while also mitigating climate impacts (Palm & Nikoleris, 2021). Although they argue that conflicting expectations seldom hinder the actual

development of the technologies themselves, Palm and Nikoleris stress that the financing and realization of inconsistent visions can lead to opposing outcomes in future carbon emissions levels.

In the context of this study, contradictory expectations surrounding CDR technology methods may also contribute to the ambiguities that organizations navigate and interpret in sustainability landscapes, which may misguide decision-making processes. Different understandings of the role of CDR technologies in organizational sustainability pathways may also result in inconsistencies in how organizations address broader sustainability challenges. In this regard, Markusson et al. (2018) point out that it remains unknown what is currently being deterred as a result of the expectations surrounding CDR technologies. This may, in turn, reinforce the idea of intergenerational inequities if understandings of the adverse implications of unmet CDR expectations emerge only in the long-term.

Together, this section has examined the multifaceted, yet arguably nuanced role of CDR technology hype in the context of sustainability. CDR technologies have been outlined as necessary approaches for achieving rigorous decarbonization targets (Strefler et al., 2021; Logue & Grimes, 2022; Ampah et al., 2024; Gosalvez, 2024). In this view, CDR technology hype was found to have a potentially important role in mobilizing resources and attention to the development of these methods, while also legitimating their deployment across industry actors (Von Rothkirch et al., 2024). On the contrary, an overreliance on the future carbon emission reduction capacity of these technologies may result in mitigation deterrence and hinder the development of non-technical alternatives (Markusson et al., 2018; Bareis et al., 2023; Von Rothkirch et al., 2024). The potential risks from unmet expectations were also considered, such as the loss of reputation and trust for CDR technologies, reduced resource flows, intergenerational inequities, and declining rate of innovation (Von Rothkirch et al., 2024; Bareis et al., 2023; Logue & Grimes, 2022). Given its nuanced role of hype in sustainability contexts, it may therefore be necessary to explore how the management of its unintended outcomes can better align with sustainability.

2.2.4 Strong Sustainability Theory and Organizational Sustainability

This section will examine technology hype through the lens of strong sustainability theory as a means to better understand how technology hype may impact organizational sustainability commitments. In this sense, strong sustainability theory identifies "*criteria for distinguishing sustainable and non-sustainable paths*" (Ott et al., 2011, p. 15). This theory assumes a spectrum of sustainability action and understanding that ranges from 'very weak' to 'very strong' sustainability understandings (Landrum, 2018). As a result of the differences in how organizations may interpret sustainability issues, the scale and objectives of the following actions can vary greatly in their ability to address sustainability (Landrum, 2018). An understanding of strong sustainability is arguably valuable for this study, as it may highlight the extent to which engagement with CDR technology hype fosters sustainable action that addresses broader, systemic issues, as well as how hype management can be used as a mechanism for better aligning with sustainability.

In the view of strong sustainability theory, weak or even very weak sustainability assumes a technocentric worldview that is aligned with contemporary neoclassical economic principles (Landrum, 2018). At the firm level, weak or even very weak sustainability may be realized through management strategies that prioritize economic growth or technological development (Landrum, 2018). In the view of Ott et al. (2011), weak sustainability relies on the assumption that humans can treat nature as a form of capital and prioritize technological solutions over their natural counterparts. On the other hand, strong sustainability presumes that "*economic activity is bounded by environmental limits"* (Landrum, 2018, p. 291). Under this perspective, the substitutability of natural resources is not recognized, which in turn limits the replacement of natural resources with technological alternatives (Landrum, 2018). In light of these understandings, it may then be argued that strong sustainability theory potentially undermines the sustainability promises surrounding CDR technologies as an approach for meaningful sustainable change.

An understanding of how sustainability is framed at the organizational level may illustrate how organizations address complex sustainability challenges. On an aggregate level, several researchers argue that the current economic system advances business-as-usual sustainability action (Barry, 2016; Bryden & Gezelius, 2017; Brozovic, 2020). This can align with the idea of corporate sustainability, which is broadly defined as addressing current stakeholder demands

without compromising the ability to satisfy the needs of future stakeholders (Nguyen & Kanbach, 2024). From the view of corporate sustainability, organizations are seen to approach complex sustainability issues through considerations of social, economic, and environmental gain, commonly known as the triple bottom line (Nguyen & Kanbach, 2024; Florez-Jimenez et al., 2025; Angus-Leppan et al., 2010). From the perspective of strong sustainability theory, triple bottom line informed sustainability action aligns with weak sustainability tendencies, as it fosters climate action that is "*guided by economic incentive instruments*" (Landrum, 2018, p. 293). For this study, this suggests that CDR engagement that is guided by corporate sustainability principles may be inherently misaligned with the action required to achieve strong sustainability outcomes.

The realization of strong sustainability at the practical level would require the organization to shift its sustainability approach from minimizing adverse environmental impact to creating significant positive outcomes for society (Dyllick & Muff, 2016). In turn, this would require organizations to constrain economic initiatives within the bounds of natural resources, which is argued by some to reside outside current business logic (Landrum, 2018). That is, organizations would need to restructure the objectives of their current sustainability commitments to reflect zero economic growth and prioritize resource regulation, which runs against current market logic (Landrum, 2018). However, researchers acknowledge that there is still a limited understanding of how strong sustainability can be applied within business models (Brozovic, 2020; Landrum, 2018).

When examining organizational engagement with CDR technologies through the lens of strong sustainability theory, these solutions may embody weak sustainability principles. That is, current promises of prospective CDR technology capabilities may occur at the expense of current emissions mitigation initiatives or the development of other non-technical alternatives (Ampah et al., 2024; Von Rothkirch et al., 2024; Asayama, 2021; Markusson et al., 2018). That is, overreliance on technological options may enforce the position that natural capital is substitutable with manufactured alternatives, which aligns with the principles of weak sustainability (Dyllick & Muff, 2016). On the other hand, Barry (2016) argues that there is "*nothing inherent in technology*" that prevents it from being genuinely applied to address sustainability challenges (p. 3). In the context of this study, this sentiment suggests that the way organizations frame CDR engagement in their broader sustainability commitments may influence their ability to use these emerging technologies as part of a larger effort to address

complex sustainability challenges. That is, navigating CDR technology hype through a weak sustainability lens may presume that technology innovation in itself is adequate to address broader sustainability issues.

Furthermore, Barry (2016) argues that in the current economic system, organizations generally navigate sustainability challenges with techno-optimism, which they define *as an exaggerated* (…) *belief in human technological abilities to solve problems of unsustainability while minimizing* (…) *the need for large-scale transformation*" (p. 3). In this context, organizations aim to solve systemic issues primarily through technological innovation that may simultaneously foster the business case (Barry, 2016; Landrum, 2018). When considering if a technology itself is sustainable, Mulder et al. (2011) argue that there are no set or inherent design characteristics that can determine whether a technology is sustainable. Instead, Mulder et al. argue that the sustainability of a technology is determined by the extent to which it can enable socio-technical change. When applied to the context of this study, this idea suggests that the sustainability outcomes of CDR technologies relies on the intentions of the systems around it.

Strong sustainability theory may also be applied together with sensemaking theory to evaluate the potential impact of business sustainability initiatives. In their study, Demastus and Landrum (2023) apply both of these theories to evaluate different business sustainability schemes, which are defined as internal practices used to address overarching sustainability issues. In applying sensemaking theory, Demastus and Landrum argue that scheme developers in organizations view sustainability as a source of competitive advantage and conformity, rather than as a genuine means to address environmental problems. In light of strong sustainability theory, Demastus and Landrum argue that organizational sustainability schemes are broadly aligned with weak sustainability since a majority of business efforts result in additional environmental damage and failed sustainability outcomes. These ideas are valuable in consideration of hype, as they may provide insight into the aspects of hype engagement that its management could address to avoid weak sustainability. In this regard, Landrum (2018) calls for a need to understand how strong sustainability can be realized at the firm level and the measures necessary to realize its principles.

Taken together, this section has examined strong sustainability theory and sustainability action at the organizational level. Additionally, this section has considered how strong sustainability

theory may align with the various implications of CDR technology hype, and the way this momentum may shape the outcomes of sustainability commitments. The following section will examine hype management and consider how it may be applied to align organizational engagement with hype and sustainability.

2.3 Hype Management

In light of the recurring nature of technology hype and its possible implications within sustainability contexts, exploring hype management at the organizational level may therefore be considered valuable for sustainability. As it was demonstrated in the previous section**,** there is growing organizational interest in various CDR technology methods as a means to address decarbonization issues. However, at the same time, the hype surrounding these methods was observed to create a variety of adverse implications for sustainability, which can potentially be addressed by management structures targeted at countering its adverse effects. In this regard, this section aims to understand how organizations manage or could manage hype, particularly in the context of sustainability. This section strives to establish a theoretical foundation for the third research question of this study, *"What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?".* This section will therefore explore how hype management is currently conceptualized in the literature, as well as the different strategies and practicalities that scholars propose for its implementation.

2.3.1 Conceptualizing Hype Management and Implications for Sustainability

While hype has been thoroughly studied, hype management has only recently gained academic attention (Logue and Grimes, 2022; Wade et al., 2020). In this sense, the notion of hype management can be viewed to lack standardization within the literature, which can further highlight the novelty of this construct. A guiding perspective may, however, be adapted from the research of Logue and Grimes (2022), given that their research is one of the first to advance the emerging theory of hype management. Indeed, Logue and Grimes interpret hype management as an approach for strategically leveraging the cultural resources of the phenomena. Bakker and Budde (2012) similarly perceive the management of expectations as a method through which actors can strategically navigate hype.

As Funk (2019) argues, technology hype may divert organizational resources and time away from more feasible pathways for addressing societal problems. They add that in general, organizations experience financial, productivity, and resource losses from hype that could potentially be minimized through improved internal management structures (Funk, 2019). Concerning this, Logue and Grimes (2022) call for a need to better understand how hype can be managed at the venture level. On the contrary, Bakker and Budde (2012) highlight that the existing incentives to promote elevated expectations within current market structures pose challenges in the implementation of expectations management approaches. In this regard, they suggest that expectations management practices may be more beneficial if applied by selectors, rather than enactors, of a respective technology. This assertion may provide some merit for technology selector organizations of CDR technologies to explore the role that such expectations management may provide their organization in pursuit of effective decision-making and sustainability action.

In the context of CDR technology hype, Gosalvez (2024) calls for the need to identify sufficient mechanisms for containing both the formal and informal expectations surrounding CDR technology capabilities. In their view, these mechanisms can allow CDR actors to benefit from "*healthier dynamics and higher credibility,*" which can be particularly valuable for sustainability sectors (p. 12). In the context of this study, this suggests that some researchers consider the management of CDR technology hype as a relevant and timely pursuit; however, the extent to which this view is shared at the organizational level remains unknown. Furthermore, even with the increase in hype management literature, a majority of these studies remain outside the parameters of sustainability. Therefore, this section aims to make formative connections between the literature and sustainability wherever possible.

2.3.2 Identifying Hype and Inflated Expectations

Interpretations of hype and respective imperatives for its management at the organizational level are likely to vary, depending on how they relate to and perceive the phenomenon. In this regard, establishing a clearer understanding of how to identify and address its unintended outcomes may be necessary to allow for more effective sustainability action. With this backdrop, in order to establish management structures around this phenomenon, it may be necessary to explore how hype can be identified. In this regard, Van Lente et al. (2013) argue that a clearer understanding of hype patterns can strengthen the capacity for involved actors to

manage it efficiently. These sentiments likely point to the value in identifying and recognizing hypes and the cyclical implications they entail to better leverage their potential outcomes.

From the perspective of Intemann (2022), identifying hype through empirical methods can be especially complicated given that hype relies on value judgements. In the context of this study, this suggests that defining what hype is or where it occurs can be difficult in practice, given the degree of subjectivity involved in labelling what constitutes hype. However, Intemann suggests that one method for identifying overarching hype tendencies can be realized through evaluations that assess whether current understandings of technology capabilities include both its potential benefits and limitations. In this regard, Intemann (2022) argues for the value in conducting balanced assessments, as well as for the need to identify contexts in which exaggerations of technology capabilities may be harmful for the overarching objectives of the audience. For this study, this implies that as part of hype management, there may be value in organizations identifying the potential harm that hyped claims may impose on their sustainability commitments.

Furthermore, Intemann (2022) argues that in addition to value judgements of what hype is, the identification of its presence may be further complicated by the varying forms that it can uphold. In this regard, they argue that the implications of hype may greatly vary, which may complicate the identification of its patterns at the practical level. The repercussions of different hype patterns at the organizational level can be further explored through the work of Wade et al. (2020). That is, they identify how differing levels of hype may impact decision-making. They argue that under-hyping can result in the risk of emerging opportunities and threats being overlooked, while over-hyping may result in practitioners prematurely discarding current initiatives or overly focusing on potential threats. However, this idea suggests that between the parameters of under-hype and over-hype, there is a desirable, productive level of hype. For this study, this hype management approach may impose challenges for sustainability, as it inherently invites engagement with this subjectively favorable level of hype rather than encouraging management structures to constrain its adverse impacts. Nonetheless, Wade et al. argue that at the firm-level, practitioners should focus on controllable factors such as strategy, while enhancing their understanding of how hype may shape their operations.

Identifying hype and its implications at the practical level may be supported by an awareness of the broader system in which it exists. In the case of CDR technology hype, Von Rothkirch

et al. (2024) argue that there is both an existing systemic *"tolerance to hype"* and a tendency to limit responsibility for *"technology promoters"* to continuously validate their claims (p.7). These considerations point to the inherent embeddedness of, and passivity toward, technology hype that currently exists in innovation pathways, which may suggest that actors may have little incentive to manage its shortcomings. In this regard, to address these systemic conditions that reinforce hype, Funk (2019) suggests that promoters of forecasts of emerging technology capabilities should be held accountable for the quality of their projections. Although they overlook how this responsibility could be achieved in practice, it highlights the need for organizations to apply a more critical stance toward emerging technology claims.

In light of the emerging state of hype management theory, it may be considered that at the practical level, organizations lack formalized tools and frameworks for identifying hype patterns. Although some researchers argue that the Gartner Hype Cycle Model can provide a preliminary means for identifying the various phases of hype, while others contest its empirical grounding (Dedehayir & Steinert, 2016). For instance, Khodayari and Aslani (2018) argue that the Gartner Hype Cycle Model can support managers with investment, and other, operational decisions. In a similar vein, Dedehayir and Steinert (2016) argue that the model can reduce some of the perceived uncertainties surrounding emerging technology capabilities. In the context of this study, these findings suggest the Gartner Hype Cycle Model could be applied as a preliminary tool for identifying different phases of the hype cycle, remaining cautious, however, about its influence on broader organizational strategy. From another perspective, Van Lente et al. (2013) argue that recognizing hype patterns is invaluable to be able to productively manage their unwarranted outcomes. Nonetheless, further research is arguably needed to develop this model into a reliable hype management mechanism for identifying hype, especially for navigating sustainability in practice.

2.3.3 Information Transparency

Information transparency emerges as an arguably essential component of hype management understandings, given that hypes are largely driven by empirically unvalidated claims about technology capabilities (Castree, 2020). In the context of sustainability, management structures centralized around strengthening information transparency can be particularly valuable, since following ambiguous claims may misguide sustainability decision-making and potentially result in risks such as mitigation deterrence (Markusson et al., 2018). To address this aspect of

hype, some scholars advocate for strengthened information transparency in expectations that convey both the potential benefits and consequences of emerging technologies (Bareis et al., 2023; Borup et al., 2006; Funk, 2019; Field et al., 2017). In the view of Bareis et al. (2023), information transparency about emerging technologies is necessary to achieve genuine societal change, as it can improve how organizations are able to coordinate their efforts and establish common ground.

Information transparency may also provide involved actors with the necessary details about CDR technologies to allow them to appropriately redefine their expectations about them (Van Lente et al., 2013). In turn, this can improve the agency that actors experience in hype settings, while also minimizing the risk of disappointment from unmet expectations (Van Lente et al., 2013). These findings suggest that information transparency may hold a valuable role in minimizing the traditional limitations associated with hype, which, when viewed through a sustainability lens, may also minimize reputational risks and resource losses for sustainability caused by disappointment (Von Rothkirch et al., 2024). In the view of Bakker and Budde (2012), balanced statements about technological capabilities may also guarantee that the potential benefits associated with hype, such as increased investment flows, are realized.

These ideas may be expanded on through the notion of uncomfortable knowledge, defined as *"information or understanding that is available to certain parties but cannot be acknowledged by others"* (Rayner, 2012, p. 113). In the view of Rayner, while uncomfortable knowledge is often omitted by industry actors, it contains necessary information for sense-making and for addressing broader systemic challenges. In the context of this study, this suggests that hype management for sustainability may be supported by uncomfortable knowledge. However, this would require a practice of understanding the information that accounts as uncomfortable knowledge, in addition to awareness of when this arguably necessary information is omitted from hype claims. Rayner (2012) suggests that to ensure that uncomfortable knowledge is incorporated into the decision-making processes of organizations and available to other actors, there should be a minimum threshold for diversity in decision-making processes. That is, they suggest that by increasing the specializations of involved actors in decision-making processes, may be able to improve the transparency of conveyed knowledge. The strengthening of diversity within decision-making processes may also support organizations in addressing the aforementioned lock-ins from bold claims (Bareis et al., 2023).

In a similar vein, Simakova and Coenen (2013) argue that exercising responsibility within these settings requires an understanding of the implications of corporate secrecy. In a practical sense, Simakova and Coenen suggest that practitioners could identify the information that is omitted from external communications and diversify internal decision-making processes to counter corporate secrecy. In the view of Funk (2019), transparency is established by conveying factual information about the technology without omitting negative details about its financial performance or improvement issues. Mitroff and Storesun (2020) also suggest that, in addition to challenging idealized assumptions about emerging technologies, there may be merit in outlining how the exact opposite of bold claims could happen. Particularly for this study, this would require a holistic assessment, or mapping, of the sustainability outcomes associated with the various expectations surrounding an emerging technology.

Funk (2019) additionally argues that to enhance decision-making and to encourage reliable information, practitioners should evaluate the outcomes of previous technology projections in addition to remaining critical of current forecasts that lack sufficient evidence. In the context of this study, this may be realized through practical-level awareness and analysis of the implications of previous hype cycles in the industry, and the application of these understandings to currently hyped technologies. That is, as a hype management approach, practitioners could reflect on the outcomes of previously hyped technologies and how the resulting momentum may have shaped their sustainability decision-making. As Bareis argues, hype generally minimizes *"remembrance of the past and likewise, future trajectories to come"* (p. 12), which suggests that there is an absence of reflexivity about the implications of past hypes at the practical level.

On the contrary, Intemann (2022) argues that balanced assessments about a given technology are not enough, when used as isolated methods, to counter the unintended implications of hype. As was mentioned prior, such an assessment would require value judgments on what constitutes a benefit and risk, evaluating their severity, and identifying which are especially impactful for decision-making (Intemann, 2022). In this regard, Intemann argues that accurate and transparent information about a given technology may still fall short in its ability to improve decision-making processes. Instead, they argue that accurate information about a technology needs to be further complemented by accessibility and availability. Together, these findings suggest that information transparency in hype settings not only relies on its content but also on its attainability.

The notion of information transparency may also be examined through the concept of imagined business futures. This concept can be defined as a mechanism through which organizations respond to uncertainty as well as the pressures from sustainability challenges (Frisch, 2023). In hype settings where the capabilities of emerging technology may be challenging to empirically validate, organizations may rely on the information conveyed through imagined futures (Beckert, 2021). In a CDR technology context, imagined futures may hold a sense-making role in illustrating how these methods will be situated in a prospective low-carbon reality (Frisch, 2023). Despite this, Beckert (2021) argues that imagined futures often contain unvalidated expectations and understandings of sustainability that can reinforce the market status quo. That is, in their view, imagined futures remain largely disconnected from addressing systemic challenges, as they are broadly formulated to serve the interests of certain actor groups at the expense of others (Beckert, 2021). In reference to these limitations, Frisch (2023) argues that actors should, instead, uptake imagined desirable futures that are *"shared, desirable, just, and realistic"* (p. 58). That is, Frisch argues that imagined desirable futures could enable conversations surrounding the role of CDR technologies in addressing decarbonization to be more productive. As a hype management practice, implementing the idea of imagined desirable futures would involve organizations outlining how the projected role of CDR technologies, and their engagement with them, align with broader societal needs.

These ideas may align with the contentions of Simakova and Coenen (2013), as they call for a need for assessments on the social desirability of emerging technologies. In their view, technologies currently succeed and are approved of in society without consideration of their widespread desirability. In this case, imagined desirable futures may support the selection and development of methods that address the needs of the greater good. At the organizational level, Rayner (2012) argues that an increase in diversity in decision-making processes may be able to support the development of imagined desirable futures. The notion of diverse decision-making processes, as a potential enabler of information transparency, further aligns with the prior arguments of Bareis et al. (2023) and Simakova and Coenen (2013).

Particularly in the context of sustainability, Von Rothkirch et al. (2024) argue for the need to critically assess assumptions about technologies that prioritize future sustainability achievements over current actions, in addition to identifying contexts where such claims may lead to negative outcomes. In the case of CDR technologies, this sentiment alludes to the

assumption that deployment of these technologies at a large scale will be more productive than reducing emissions through other measures in the interim, which can inversely lead to mitigation deterrence (Von Rothkirch et al., 2024; Ampah et al., 2024). With this in mind, Gosalvez (2024) presents practical methods through which the transparency of CDR capabilities can be further enabled among actors. That is, Gosalvez suggests that the current status of the technologies, in addition to their limitations, should be publicized as a means to normalize failures.

2.3.4 Firm-level Relevance and Evaluating Emerging CDR Technologies

Following the exploration of challenging exaggerations conveyed through hype and identifying contexts where they may be harmful, it may also be helpful for industry practitioners to have practices for evaluating the relevance of emerging technologies for their sustainability commitments. In this regard, practical insight may be drawn from the socio-technical assessment framework developed by Markusson et al. (2012) that supports actors in decision-making processes by identifying uncertainties about the development of future technologies. That is, their study identifies the key uncertainties surrounding CDR methods and indicators for assessing these uncertainties at the firm level. The outcomes of this framework may therefore enable organizations to independently assess claims about the future impacts of emerging technologies (Markusson et al., 2012). This can potentially allow for more well-rounded assessments that are specific to the organization's own needs for the technology (Markusson et al., 2012). For this study, this suggests that firm-level assessments of emerging technology capabilities may have a role in constraining the strategic influence of hype.

Perhaps on a more practical level, the work of Maghazei et al. (2022) provides actors at the firm level guidance on evaluating and adopting emerging technologies that are surrounded by hype. That is, in their study, Maghazei et al. developed a framework for evaluating the firm-level relevance of a given emerging technology, which is assessed through a sequential process of identification, piloting, and scaling the use case (Maghazei et al., 2022). They define the use case approach as a method for identifying the firm-level practicality or feasibility of emerging technologies. In their view, this evaluation method can allow practitioners to better test technologies against their potential value for the organization. In turn, this approach may be able to constrain the implications of ungrounded scalability and challenges associated with implementing emerging methods. In the context of this study, this would require an extension

of these evaluations to consider the sustainability value added by hyped, emerging technologies. This approach nonetheless encourages reflexive decision-making rather than immediate action in response to hype at the practical level.

On the other hand, Asayama and Ishii (2017) argue that emerging technologies should be evaluated more broadly through a *"plural, balanced, and critical"* lens that considers their economic, technical, social, and political desirability (p. 57). Contrary to the firm-level approaches by Markusson et al. (2012) and Maghazei et al. (2022), Asayama and Ishii (2017) instead argue that emerging technologies should be evaluated against their greater desirability for society. In their view, this widespread evaluation that extends the needs of the organization can better balance optimism for emerging technologies with uncertainty. Although this approach may align with strong sustainability principles, it would nevertheless require a shift in logic governing organizational sustainability pursuits. In a similar vein, Simakova and Coenen (2013) argue that responsible innovation should include reflexive examination of assumptions and expectations, especially in light of visionary communication. In practice, they suggest that competing visions should be confronted rather than dismissed in order to make space for alternative methods.

In the context of CDR technology hype, Fuhrman et al. (2023) argue that carbon removal alternatives should be equally represented on a *"level playing field"* (p. 349). That is, they argue that it is necessary to equally evaluate all available approaches against their costs, benefits, risks, and carbon removal potential. While the notion of comparing all alternatives may be able to counter some of the influences of hype surrounding any single method, the methodology and responsibility for conducting such assessments remain overlooked in their analysis. From another perspective, Frisch (2023) recognizes that since the narratives in the domain of decarbonization compete with one another for hegemony, this may in turn impact the ability for alternative approaches to be assessed on even terms, especially if the market forces favor technical methods. In practice, this idea may be reflected in CDR technologies appearing as the only visible, or viable, option for reducing emissions for organizations, since the hype surrounding these methods may crowd out other alternatives. In this regard, Fuhrman et al. (2023) add that conducting widespread assessments on available alternatives is essential for developing an efficient climate action portfolio.

2.3.5 Sustained Stakeholder Engagement and Long-term Alignment

In the study of hype dynamics, a considerable aspect of hype patterns lies in the disappointment from unmet, inflated expectations. In a sustainability context, the risk of disappointment can have potentially compounding impacts on the rate of sustainable progression as necessary resources, investment, and attention are retracted from the advancement of climate initiatives. Additionally, this inherent dynamic of hype may result in short-term alignment between actors, which may have arguably unfavorable implications on the course of climate action that is generally situated in the long term. In the exploration of hype management, it can therefore be valuable to consider how it can be used to facilitate long-term approaches, particularly for sustainability.

On the one hand, Bakker and Budde (2012) highlight the need for expectations to be transformed into stable institutions and long-term commitments in order to minimize the risk of disappointment from hype. They argue that long-term funding structures should be established to support private capital mobilization, which, in their view, provides a "*stabilizing signal within companies*" (p. 556). However, as mentioned prior, inflated expectations can create lock-in scenarios where organizations are faced with delivering on their ungrounded contents, as well as create path dependencies that remain reliant on technological solutions (Bareis et al., 2023). Therefore, while such long-term oriented structures may help mitigate the impacts of hype cycle throughs, they should avoid depending on unvalidated expectations about technology capabilities in practice.

In advancing development toward an emerging theory of hype management, Logue and Grimes (2022) explore various challenges associated with hype in addition to practices for leveraging its momentum for sustained entrepreneurship opportunities within emerging markets. Their research applies a deeper understanding of hype that departs from the general analysis of short-term benefits and long-term consequences. Instead, they identify cultural and relational practices considered necessary to successfully translate hype into social proof, which in their view can provide entrepreneurs with the ability to respond to the expectations conveyed through it. These ideas may also provide practical insight into how organizations can manage the abstractness and diffuseness of hype, which they define as being "*disconnected from specific implementations"* and "*potentially accessible to any actors looking to engage with and mobilize i*t", respectively (p. 1065). Ultimately, these suggestions may provide practitioners at

the venture-level hype management actions to foster strengthened stakeholder engagement (Logue and Grimes, 2022).

This section has explored various understandings and practices for potentially managing hype at the firm level. Some of these approaches include diversifying decision-making processes, incorporating uncomfortable knowledge (Rayner, 2012), desirability evaluations (Frisch, 2023), critically assessing future-oriented claims (Von Rothkirch et al., 2024; Mitroff & Storesun, 2020; Markusson et al., 2012), assessing the firm relevance of emerging technologies (Maghazei et al., 2022), and long-term stakeholder engagement (Logue & Grimes, 2022). While this section has strived to examine how hype management may safeguard sustainability commitments and foster broader sustainable change, it was observed that there is a notable gap in the current literature on the alignment between these concepts. Although one study highlighted the role of evaluating non-technical alternatives as a means of addressing sustainability in hype settings (Fuhrman et al., 2023), a majority of the literature was found to overlook the potential connection between hype management and sustainability. On a further note, there may also be an observable gap in knowledge of how organizations perceive the relevance of hype management in practice. As a result of the novelty of this concept, further exploration is arguably needed to understand how hype management is perceived at the organizational level to better understand how it can intersect with sustainability.

2.4 Summary of the literature review

The literature review has examined hype as a phenomenon, its potential implications in the sustainability context of CDR technologies, and organizational engagement with hype and sustainability. Notably, this thesis does not present or utilize a theory-based research framework; instead, it adopts an abductive, exploratory research design that will iterate between the literature and empirical data. With this approach, although a pre-specified theoretical framework or model is generally expected in student theses, this research study will alternatively remain open to the data to support its abductive position. Nonetheless, it is valuable to revisit the research questions of this study to reflect on how the review of literature has contributed to developing their theoretical understanding. The main findings from the literature review are presented in *Table 1* below.

Research questions	Main literature review findings
How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?	- Incentivized by potential high rewards to engage with hype *(Bakker & Budde, 2012)*. - Organizations may strategically engage with hype because of its performative capacity *(Alkemade & Suurs, 2012; Pollock & Williams, 2010; Logue & Grimes, 2022)*. - Engagement with hype can depend on the actions of other actors and sector characteristics *(Bakker & Budde, 2012)*. - Organizations may adapt internal processes or adjust strategies to align with hype *(Kaniadakis & Linturn, 2022; Konrad et al., 2012; Von Rothkirch et al. 2024; Gosalvez, 2024)*. - Organizations may draw on sensemaking to interpret ambiguities and sustainability challenges *(Weick et al., 2005; Demastus & Landrum, 2023; Angus-Lepann et al., 2010)*.
In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?	- Hype can help niche sustainability approaches compete with mainstream methods *(Vaskelainen et al., 2022; Kriechbaum et al., 2021)* - Hype can mobilize resources towards sustainability initiatives *(Goldfarb & Kirsch, 2020; Borup et al., 2006)* - CDR hype can advance necessary 1.5 °C and 2 °C emissions reduction pathways *(Fridahl et al. 2023; Ampah et al., 2024; Asayama, 2021; Field & Mach, 2017; McLaren, 2020)*. - Hype may result in mitigation deterrence, crowd out non-technical approaches, environmental damage, and intergenerational inequities *(Markusson et al., 2018; Von Rothkirch et al., 2024)*. - Unknown implications of current CDR expectations *(Markusson et al., 2018)* - Hype may result in prioritizing technical approaches to address sustainability commitments *(Ampah et al., 2024; Von Rothkirch et al., 2024; Bäckstran et al., 2011; Alkemade & Suurs, 2012)*. - Hype may result in lock-in scenarios and path dependencies *(Alkemade & Suurs, 2012; Bakker & Budde, 2012; Bareis et al., 2023)*. - Technology-oriented climate action may align with weak sustainability *(Ott et al., 2011; Demastus & Landrum, 2023; Barry, 2016; Dyllick & Muff, 2016)*.
What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?	- Identifying hype claims and understanding where the impacts of hype emerge internally *(Van Lente et al., 2013; Intemann, 2022; Wade et al., 2020)*. - Strengthening information transparency and uncomfortable knowledge *(Markusson et al., 2018; Bareis et al., 2023; Van Lente et al., 2013; Rayner, 2012; Mitroff & Storesun, 2020)*. - Diversified decision-making processes (*Simakova & Coenen, 2013)*. - Balanced understanding of technological capabilities and firm-level relevance *(Markusson et al.; Maghazei et al., 2022; Funk, 2019; Simakova & Coenen, 2013; Gosalvez, 2024)*. - Social desirability assessments *(Asayama & Ishii, 2017)*. - Equal assessments of available alternatives *(Fuhram et al., 2023)*. - Long-term alignment *(Bakker & Budde, 2012; Logue & Grimes, 2022)*. - Critical assessment of future oriented sustainability claims *(Von Rothkirch et al., 2024)*.

Table 1: Main literature review findings for each research question.

The review of literature addressed the first research question, "*How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?*", through sensemaking theory as well as literature on hype dynamics

and CDR technologies. Sensemaking theory can explain how organizations may interpret hype settings and sustainability challenges. That is, the literature argues that organizations may use sensemaking processes to navigate CDR technology hype, which is reflected in the use of past interpretation to make sense of current and future-oriented uncertainties (Weick et al., 2005; Demastus & Landrum, 2023). This literature also acknowledges the prevalence of organizational sensemaking in contexts of sustainability that are characterized by uncertainty and ambiguity (Angus-Leppan et al., 2010).

The literature on hype and CDR technologies can explain why organizations may engage with bold claims and how they position themselves amidst them. Organizations are found to typically respond to hype through adjustment to their strategy or other actions to leverage its momentum (Konrad et al., 2012). Organizations may strategically engage with hype as a result of its performative capacity, namely its ability to mobilize investment, resources, and attention (Alkemade & Suurs, 2012; Pollock & Williams, 2010). Engagement with hype may also be motivated by whether other actors engage with it, as well as sector stability (Bakker and Budde, 2012). The literature also suggests that organizations may amplify or align with the bold claims surrounding CDR technologies (Von Rothkirch et al. 2024; Gosalvez, 2024).

In considering the second research question, *"In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?"* the literature on carbon dioxide removal technologies, hype, and strong sustainability is relevant. The productive potential of technology hype for sustainability commitments lies in its ability to mainstream sustainability technologies (Kriechbaum et al., 2021), align actors in the long-term (Goldfarb and Kirsch, 2020), and advance CDR technology maturation (Von Rothkirch et al., 2024). While the literature shows that hype may shift organizational sustainability commitments to the long-term at the expense of near-term action, result in mitigation deterrence (Von Rothkirch et al., 2024), it also shows that the implications of current CDR expectation remain unknown (Markusson et al., 2018). The literature also shows that hype can result in organizations prioritizing CDR technologies over other plausible alternatives, which may crowd out necessary non-technical solutions (Ampah et al., 2024; Von Rothkirch et al., 2024); and lead organizations to overestimate the future capacity of CDR technologies (Ampah et al., 2024; Von Rothkirch et al., 2024; Bäckstrand et al., 2011), potentially misguiding sustainability strategies. From a strong sustainability theory lens, technology-oriented climate action may

align with weak sustainability tendencies (Ott et al., 2011; Demastus & Landrum, 2023; Barry, 2016; Dyllick & Muff, 2016).

The emerging literature on hype management presents several concepts and practices that organizations could apply in the navigation of hype to address the third research question, "*What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?".* The literature suggests that managing hype may fundamentally require a practice of identifying hyped claims (Van Lente et al., 2013) and developing understandings of how hype can shape organizational performance (Wade et al., 2020). The literature also acknowledges the contested role of the Gartner Hype Cycle model, as some argue that it can assist managers during periods of hype (Khodayari and Aslani, 2018), while others argue that it is empirically inconsistent (Dedehayir and Steinert, 2016).

The literature on hype management emphasizes information transparency, which may be realized in practice by incorporating 'uncomfortable knowledge' (Rayner, 2012), diversifying decision-making processes (Rayner, 2012; Bareis et al., 2023), and communicating balanced statements of technological process (Funk, 2019; Simakova & Coenen, 2013; Gosalvez, 2024). Scholars also point to the value in conducting firm-specific evaluations of technology uncertainties (Markusson et al., 2012), equal assessments of available technical and non-technical alternatives (Fuhrman et al., 2023) and identifying the use case of the technology (Maghazei et al., 2022). Long-term strategies may also mitigate the outcomes of disappointment from unmet expectations by transforming expectations into stable and long-term engagement (Bakker & Budde, 2012), in addition to strategies that translate hype to sustained entrepreneurship opportunities (Logue & Grimes, 2022).

The literature presents limited, implicit connections between hype management and sustainability. Organizations should especially apply practices that scrutinize statements about technologies that prioritize future sustainability gains over current action (Von Rothkirch et al., 2024). Reflexive assessments about the economic, technical, social, and political desirability of a technology are also argued to better balance optimism with uncertainty, which may support sustainability (Asayama & Ishii, 2017). Nonetheless, a clear empirical gap emerges as the literature tends to overlook how organizations perceive and respond to hype in practice, which are necessary perspectives in further constructing an understanding of hype management. Specifically for CDR technologies, there is limited empirical understanding of how

organizations respond to the hype surrounding these methods (Gosalvez, 2024). This practical understanding may reveal whether organizations perceive hype as something that requires active management, the extent to which its impacts may already be addressed at the firm level, and whether current responses support sustainability. This gap is consistent with the contentions of Logue and Grimes (2022) and Wade et al. (2020), who acknowledge the weak theoretical understanding of how hype impacts managerial decision-making processes and therefore call for strengthened conceptualizations of hype management at the organizational level.

Nonetheless, the literature on hype management remains largely dethatched from sustainability, which demonstrates a gap in theoretical understanding of how these strategies can be applied in pursuit of sustainability. This study, therefore, aims to address this gap by examining how organizations perceive, respond to, and make sense of CDR technology hype in practice, as well as how the management of its implications is regarded in a sustainability context. Including how practitioners may engage with hype and whether or not it is managed, especially in light of sustainability considerations.

3 Research Methodology

3.1 Methodological Approach

This research study will apply a qualitative methodology to examine how organizations perceive and respond to CDR technology hype while also aiming to understand potential organizational strategies that can be used to manage hype for sustainability. A qualitative methodology is considered appropriate for this study for several reasons. Firstly, this research aims to identify and explore the emerging field of hype management through interpretation, observation, and generalization beyond the defined context, which are essential components of many qualitative methods (Bansal et al., 2018). A qualitative methodology is further considered suitable for this study as it strives to understand how practitioners interpret and make sense of hype in practice. In this regard, this position reflects a deeper understanding of organizational perspectives and processes than what may be attainable through quantitative methods (Bansal et al., 2018). A qualitative methodology is also considered relevant for this study, particularly as scholars frequently utilize qualitative research methods to study wicked and complex challenges in the context of sustainability (Bansal et al., 2018). In addition, a qualitative research methodology is argued to be suitable in investigating emerging fields of study, as in the case of emerging hype management (Jamshed, 2014). Finally, qualitative methods can also allow researchers to develop new insights that can be beneficial for emerging domains of study (Bansal et al., 2018).

This study will adopt a subjectivist epistemological position, which considers knowledge to be co-constructed "*through transactions between research and participant*" (Poucher et al., 2019, p. 156). A subjectivist epistemological position may also be considered as a transactional position (Poucher et al., 2019). In this regard, this position "*views reality as being socially constructed"* through the acknowledgement of several truths (Eriksson & Kovalainen, 2008, p. 15). This position is appropriate for this study as it aims to capture and understand the various realities associated with hype management. For this study, a subjectivist epistemological position is appropriate since it aims to understand the various realities associated with hype management. This epistemological perspective can be further aligned with an interpretive position (Eriksson & Kovalainen, 2008). In short, the philosophical position of interpretivism is largely engaged with "*subjective and shared meanings*" (Eriksson & Kovalainen, 2008, p. 18). Interpretivism can be especially useful for this study, as it helps to better understand how

hype and hype management are perceived at a firm level. The collection of interview data in this study will require interpretation to develop an understanding of exploratory findings.

In order to evaluate qualitative research that assumes a subjectivist epistemology, Lincoln and Guba (1985) propose criteria that are based on the notions of credibility, transferability, dependability, and confirmability. Taken together, these alternative criteria aim to demonstrate the transparency and trustworthiness of qualitative research, rather than its objectivity (Eriksson & Kovalainen, 2008). For this study, credibility refers to the extent to which my interpretations of the data accurately the expressions of the participants (Korstjens, & Moser, 2018). I showcase credibility by exercising data source triangulation, which includes the collection of data from a range of diverse perspectives to better understand the phenomenon under study (Eriksson & Kovalainen, 2008). Additionally, I explicitly detail my interpretations of the data throughout the Gioia analysis process, while also including data extracts in the *Results* section to support my claims.

Furthermore, for this study, transferability regards the extent to which the findings of this study are similar to those emerging from other research contexts (Eriksson & Kovalainen, 2008). I demonstrate transferability by detailing my research context as well as by specifying how I conducted the participant selection process for this study. In this research, dependability concerns the degree of transparency exerted throughout the research process (Korstjens, & Moser, 2018). I demonstrate dependability by striving for consistency and traceability throughout my analytical approach and *Results* section, and by clearly detailing my decisions and limitations throughout the study. Finally, this study regards confirmability as the extent to which the findings of this study can be supported by other studies (Korstjens, & Moser, 2018). To showcase confirmability, I outline how my position may inform my interpretations in addition to linking my claims in the *Results* section to the interview data.

3.2 Qualitative Research Tradition

This research study will utilize a qualitative interview approach to explore how organizations currently understand and interpret CDR technology hype and hype management. As Warren (2001) states, the overarching purpose of qualitative interviews is to "*understand others' meaning making*" (p. 97). In this sense, qualitative interviews are considered an appropriate method for this research to make sense of the varied organizational interpretations, sense-making processes, and articulations of hype management. In contrast to other qualitative methods, interviews may provide a more open-ended and participant-centered method for collecting primary data (Alshenqeeti, 2014). Similarly, other studies on perspectives surrounding CDR technology hype have also applied this qualitative research tradition, which may signal its relevance in studying this phenomenon (Von Rothkirch et al., 2024).

Although scholars have acknowledged methodological standards for qualitative interviews, specific research traditions for this approach are not yet well defined (Reissner & Whittle, 2022). More specifically, Silverman (2001) provides an influential typology of different interview methods; the most relevant method for this study is 'emotionalist', otherwise referred to as a subjectivist interview study, given this research's focus on different organizational hype management interpretations. That is, Silverman considers this category of interview method to capture the understandings of participants' lived experiences in the process of organizational change or other events impacting the organization. This methodological framework is relevant for this research, as the study aims to capture subjective organizational experiences and interpretations of CDR technology hype and management interventions at the practical level.

3.3 Research Design

This study will be situated within the national context of Finland, as it provides a relevant setting for examining CDR technology hype. That is, Finland has established a national commitment to achieving carbon neutrality by 2035 in addition to positioning itself favorably to the continued development of CDR technologies (Carbon Gap, n.d.). In particular, the Finnish government has established programs for the development of CDR technologies, as they have outlined these methods as necessary components of their collective approach to addressing both industry and national carbon neutrality objectives (Kujanpää, et al. 2023; Carbon Gap, n.d.). The advocacy for CDR technologies may be viewed through a recent

increase in commercialization activities focused on advancing the deployment of CDR technologies (Kujanpää, et al. 2023). In this regard, there is arguably widespread industry anticipation for these methods as a means to address climate change objectives. These aspects may therefore create a setting where organizational responses to and potential management of CDR hype can be studied.

Through the interviews, I aim to understand a variety of different perspectives from practitioners at the firm level as well as from other industry experts directly engaging with or advising the use of CDR technologies. That is, to gain a wider understanding of potential hype management mechanisms, a diversity of informant perspectives will be considered necessary. This could, in turn, allow for strengthened comparison across the collected data, as it would not be confined to a single setting or case.

3.3.1 Data Collection

For this study, I interviewed six practitioners from different sectors with varying degrees of engagement and involvement with CDR technology projects. To search for and select these participants, I applied a non-probability, purposive method where I intentionally selected participants based on their industry experience as well as how this positioning would address the research questions of this study (Miles, 2013). That is, the participants were not randomly selected but instead, I applied search criteria to explicitly find participants who reflect these pre-determined conditions. The inclusion criteria that I upheld in this search process included Finland-based organizations that currently engage with, or will engage with, CDR technologies, as well as experts with experience with CDR technology projects. In the selection process, I focused on identifying participants who align with these criteria through the screening of online sources, such as organization websites, news articles, press releases, sustainability reports, and LinkedIn searches. This online search strategy included systematic keyword searches, including "*carbon removal Finland*", "*CDR technologies Finland*", "*decarbonization Finland*", and "*CDR Finland*".

Participants	Code *P = practitioner*	Perspective
1	P1	Expertise in new decarbonization technologies, actively involved in finding methods to decarbonize energy production, working on an in-house carbon removal technology project that is currently in the engineering phase.
2	P2	Involved with developing an in-house CDR technology approach and has had extensive leading experience in the research and development of such methods.
3	P3	Advisory experience regarding various carbon removal technologies, working on organizational carbon footprint projects and climate roadmaps, navigating voluntary carbon markets and offsetting, and decarbonization actions.
4	P4	Currently involved in the implementation and development of their organization's carbon dioxide removal strategy, also have expertise in the development of organizational climate and nature-related targets.
5	P5	Extensive experience in leading carbon dioxide removal advisory, specifically in the field of permanent carbon removal and carbon markets.
6	P6	Involved with their organization's CDR technology methods that operate three R&D facilities, in addition to holding specific expertise in the CDR technology regulatory, policy, and strategic landscapes.

Table 2: Table of participants, their responding codes, and their perspectives.

The selected participants, as represented by *Table 2*, cover different industries, roles, years of experience with carbon removal methods, and relation to CDR technology implementation at the organizational level. A specific distinction between the participants was reflected in their organizational positioning: four informants (P1, P2, P4, P6) hold internal expertise on CDR technology projects, while two informants (P3, P5) hold advisory expertise related to organizational CDR work. These perspectives allowed me to capture a broad understanding of the current CDR technology landscape and the potential implications of hype in different organizational contexts. While the number of interviews (n=6) is relatively small, it is considered feasible within qualitative literature, which underscores that six to twelve interviews can already be sufficient (Guest et al., 2006). This small sample size also reflects the practical challenges of accessing experts on a rather contentious topic that is further constrained by the specialized setting of the study, which focuses on a single technology category within one country. Nonetheless, these six interviews provided valuable material for this study while also deepening my understanding of the phenomenon under study.

To collect data for this study, I utilized a semi-structured interview method to allow for a holistic yet in-depth view of the various perspectives on how organizations relate to hype and perceive hype management. In this regard, Eriksson and Kovalainen (2009) have specifically outlined semi-structured interviews as a suitable method for capturing the lived experiences of participants. In their view, this method is able to do so as, while it is comprehensive and systematic, it allows enough flexibility to represent the various realities of the participants. Furthermore, a semi-structured interview framework can also allow the interviewee to expand on topics that they consider important, which can strengthen the depth of the captured account (Von Rothkirch et al., 2024). This participant-led flexibility may also allow me to capture certain ideas that could be overlooked using other research methods, which may ultimately strengthen my understanding of the phenomenon under study. Semi-structured interviews can also support real-time reflection on the responses of the participants, which may better inform the formulation of the following questions (Beuving et al., 2015). This adaptability may signal that a semi-structured interview design is an appropriate approach for documenting the nuances that can arise across the participant accounts.

The interviews contained open-ended questions and were conducted in English, lasting around 40-60 minutes. The interview guide used for the semi-structured interviews is included in *Appendix A*. These questions were designed as a result of the research questions of the study as well as my understanding of the literature. With this in mind, the questions were designed to be open-ended while being contextually tied to CDR hype engagement. To ensure a semi-structured approach, I kept the interview guide flexible by omitting certain questions or adding follow-ups to enable depth in the participant's responses. The interview data was collected through notetaking, audio recordings, and following transcription, through which I translated the conversations to textual data. After the interviews were conducted, I transcribed the data and began preliminary coding of the findings.

3.3.2 Analysis Method

To analyze the collected interview data, I followed a structured and sequential thematic analysis approach. The data structure used for this process was largely informed by Gioia et al. (2013), who present a three-tiered approach to the thematic analysis of qualitative data, progressing from initial data to keywords and aggregate themes. I initiated this process with a reflexive reading of the initial transcriptions, during which I noted my preliminary impressions

of the data. After this, I began to apply first-order codes that encompassed and labeled specific ideas and issues occurring throughout the data (Roulston, 2014; Eriksson & Kovalainen, 2009). These first-order codes represent my initial attempt to begin condensing the dataset by labelling longer phrases into a few key words (Roulston, 2010). These first-order codes are descriptive and closely represent the direct expressions of the participants, showing limited analysis (Gioia et al., 2013; Thompson, 2022). For instance, where participants expressed their anticipation about potential market growth surrounding CDR technology methods, I labeled this as a first-order code, "*market growth,*" to capture the main implication of the phrase. Gubrium et al. (2012) view coding as the initial step in analysis that transforms the research from description to conceptualization.

After I had identified and labelled all of the relevant phrases with first-order codes, I started considering how the grouping of these codes could potentially begin to describe broader ideas surrounding my broader research questions. The second-order themes represent a substantial reduction in the data as I began to group the first-order codes into respective groups. This phase of the analysis advances towards more abstract inquiry of the data and seeks to explore how the data may elucidate the phenomena under study (Gioia et al., 2013). As a result of my interpretations of the relatedness between these first-order codes, I then began to categorize them into abstract second-order themes that represent a similar overarching idea between them (Thompson, 2022). For instance, my interpretation of the first order codes '*evaluation systems', 'internal structures', 'differentiating hype',* and *'holistic approach*' together represent tangible, strategic actions that organizations can use to potentially manage hype. As a result of this, I grouped these specific first-order codes into the second-order theme of '*concrete actions'*.

Finally, to arrive at the four aggregate dimensions, I began considering how the second-order themes could be further categorized to illustrate and create meaning for the phenomenon under study (Thompson, 2022). This final phase of analysis included the amalgamation of second-order themes into even broader aggregate theoretical dimensions (Gioia et al., 2013). For instance, the aggregate dimension '*Organizational Responses and Perceptions on Hype'* was developed from the interpreted significance of the second-order themes '*strategic influence' and 'sustainable progression*' in regard to how organizations engage with hype.

It is important to note that both the second-order themes, as well as the aggregate dimensions, are derived from an abductive process that is informed by the prior literature review that I

conducted and my understanding of the data itself (Atkinson et al., 2003). That is, during the analysis process, I followed an iterative process in which I moved between the interview data and the review of literature to support my understanding of my findings. Therefore, while the strengths of an abductive approach lie in its ability to theoretically inform the analysis of data, it is worthy to acknowledge its potential role in limiting the insights that can be developed outside of this existing position (Thompson, 2022).

3.4 Ethical Considerations and Limitations

It is necessary to elaborate on the ethical considerations and limitations that arise regarding this qualitative methodology. At the outset, I strive to remain transparent in my assumptions and interpretations by grounding them in the literature and clearly explaining my decisions. That is, in addition to the qualitative research evaluation criteria, exercising and demonstrating reflexivity throughout this study is paramount to ensuring its trustworthiness (Korstjens, & Moser, 2018). In this study, reflexivity refers to continuously reflecting on my role as a researcher and how my position can impact and inform the research (Korstjens, & Moser, 2018). Firstly, this master's thesis is part of the Aalto University research project '*Towards Sustainable Hope: Exploring the Harmful and Beneficial Effects of Techno-Optimism* (SUSTHOPE)'. In this sense, this research adopts a predefined study angle that focuses on exploring the multifaceted role of techno-optimism within sustainability settings. This set perspective may inform the scope of the study in addition to how I interpret the data.

Similarly, my position as a researcher is also largely informed by my personal and professional interests in sustainability, given that I am enrolled in the Creative Sustainability master's program at Aalto University. In this regard, I may apply a subconsciously critical lens in the analysis of sustainability topics, requiring continuous reflexivity throughout the research process to acknowledge where this perspective may overtly influence my assessment (Eriksson and Kovalainen, 2009). In this sense, it is essential to continuously acknowledge my philosophies, given that they can influence the congruency of my methodological approach (Mills and Birks, 2014). Identifying the potential influence of my subjectivities as a researcher, in addition to those of the participants, was particularly essential throughout the data collection and analysis processes (Eriksson & Kovalainen, 2009). In this regard, I aimed to follow a systematic approach throughout the coding process to minimize the potential influence of these subjectivities.

Through the analysis process, I strived to ensure that the primary instance of coding, namely the first-order codes, accurately reflect the ideas expressed by the informants. Although a qualitative research methodology can be viewed as a process of meaning-making, interpretation, and reflection, it is critical to remain transparent about the assumptions that inform these phases (Braun & Clarke, 2019). In practice, I aimed to transparently showcase how I advanced throughout the phases of the analysis process. Nonetheless, it is important to note that the findings from the thematic analysis are representative of my interpretations of the informant data, which may vary from those of other researchers. With this in mind, during the data collection process, I strived to ensure that the data that I collected remained relevant to the research questions to maintain internal consistency (Bansal et al., 2018). This was addressed by considering how the interview guide aligns with the research objectives, as well as the research questions, of this study.

It is also important to transparently point out that artificial intelligence tools, including Grammarly and ChatGPT, have been used to occasionally refine the writing style throughout this thesis. These models use the same language models as Aalto's own artificial intelligence assistant tool, which is encouraged for student use, particularly in the case of text clarification (Aalto University, n.d.). The use of these tools has acknowledged the guidelines for artificial intelligence '*research integrity and responsible conduct'* dictated by Aalto University (Aalto University, n.d.). I am therefore responsible for their outputs and the manner in which they have been applied to this study.

I also received consent for data to be collected, stored, and transcribed from each participant as a necessary means to comply with the European Union General Data Protection Regulation and the Data Protection Act of Finland (Gubrium et al., 2012). That is, each participant was informed of their rights as an interviewee and consented to the collection and storage of their data before participating in the interviews. Any direct identifiers were immediately removed during transcription as a means to maintain anonymity, and original recordings were stored in a protected location and deleted once transcriptions were developed. I pseudonymized all of the material in the transcription process by creating codes (P1, P2, …, P6) for all of the participants. The transcripts were securely stored on my personal computer and will also be deleted once this study has been approved. For this study, I did not collect or process any sensitive data.

4 Results

In this section, I will introduce the results that emerged from the thematic analysis conducted on the interview data with industry practitioners. At the outset, the data analysis revealed valuable insights into how practitioners perceive, respond to, and navigate CDR technology hype in practice and perceive its impacts on sustainability, as well as how hype management is understood within organizational settings. These findings are organized around four main aggregate dimensions, which are represented in *Figure 2*.

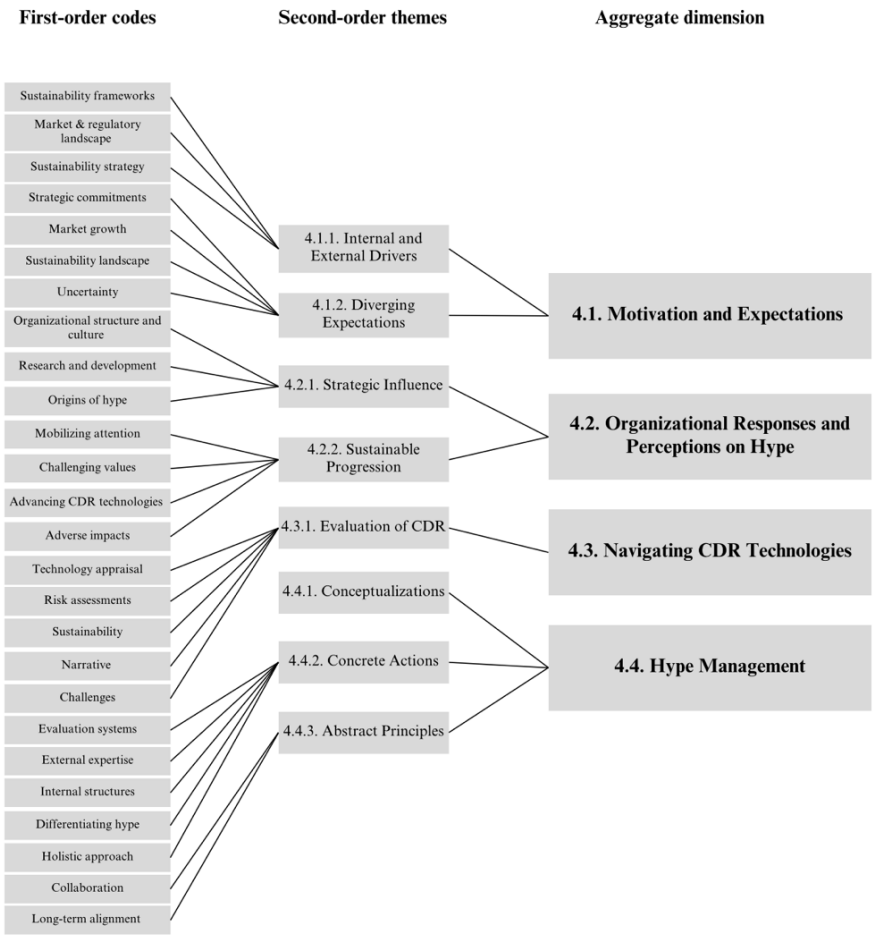

Figure 1: Data structure of the interview data represented by first-order codes, second-order themes, and aggregate dimensions.

Figure 1 uses the three-tiered data structure approach by Gioia et al. (2013) to graphically represent how my first-order codes were applied, through an abductive process, to inform the conceptual development of the second-order themes and aggregate dimensions. In this section, I will use this structure to elucidate how the first-order codes and themes represent the aggregate dimensions.

4.1 Motivation and Expectations

4.1.1 Internal and External Drivers

The first aggregate dimension, *Motivation and Expectations*, encompasses the second-order themes of internal and external drivers, as well as diverging expectations, which reflect the varying motives, influences, and anticipations potentially shaping CDR technology engagement at the practical level. Across the accounts of CDR technology engagement in this sample, there were some notable differences in whether engagement is driven by internal factors or through external compliance. Amongst these factors, the role of external sustainability frameworks frequently surfaced as a driver that had motivated organizational engagement with CDR technologies. For instance, prior commitments to sustainability frameworks specific to the organization's sector were found to guide engagement with CDR technologies: "*The main drivers for 'company name' to start being active in this space is that 'company name' is committed to the Net Zero 'Industry' Alliance* (…) *and the guidance provided by them is what we have followed*" (P4).

Similarly, the ambitions of these frameworks were observed to generate external pressures onto organizations to seek out various decarbonization technologies to respond to these demands. In this sample, this was represented by practitioners expressing engagement with emerging CDR methods that promise certain quantities of emissions reductions to satisfy the targets in these frameworks: "*Many especially Nordic companies have some kind of Science Based Targets, or they have some kind of climate targets, or there's immense pressure on them to make those targets (…) from the EU regulation, or just public onion, or customers, or wherever that kind of pressure comes from*" (P3). The role of external compliance in driving this engagement was also reflected in the need to address legislative demands. In particular, expectations from internal and external stakeholders, customers and owners, as well as changes in regulatory landscapes, were found to drive CDR engagement: "*It comes from the need from legislation and also from our owners and customers*" (P1); "*the expectations coming from the market, and that's basically what is then influencing our strategy (…) also what are the investors in the 'organization' telling us to do*" (P4).

On the other hand, in this sample, I observed that CDR engagement may be driven by pre-determined internal strategy to engage with these technologies. Some participants frequently

referred to the role of established organizational sustainability strategies as guiding this engagement. In particular, existing climate strategies were found to be a fundamental driver, prompting organizations to proactively search for technology-oriented solutions that address the objectives outlined in these strategies: "*we have set our own climate targets, and that guidance also recommends the 'organization' to order carbon removals instead of just doing avoidance credits* (…) *our own targets and the positive contribution target (…) that's basically what has guided us to start looking at this space*" (P4). In addition to addressing pre-existing sustainability objectives, the engagement with CDR technologies was also observed to be guided by stakeholder demand to achieve approaching decarbonization targets: "*our owner's strategy to be carbon neutral*" (P1).

In this sample, patterns of differing logics guiding CDR technology engagement were also observed. That is, some practitioners reported that engagement is guided by potential business opportunities, while others are driven by a climate-centric ethos. More specifically, general market expectations surrounding these technologies were found to steer involvement with these methods, in addition to the anticipation of prospective business opportunities that they may enable: "*I think the majority or most (…) of money that's channeled into these technologies to develop them is for the purpose of future business opportunities, combined obviously with the need of doing this*" (P5). The analysis also suggests that even when CDR engagement is guided by internal sustainability strategies, organizations may also be driven by potential business opportunities: "*it's the business opportunities that we are also interested in*" (P4). In other cases, the data suggests that CDR technology engagement may be driven by genuine sustainability concerns. That is, involvement with CDR technologies may be driven by climate-centric ethos that extends past traditional business logic; "*our organization was founded purely from a climate perspective, so that motivation was and still is, in the urgency of the climate crisis*" (P6); "*I guess in the end it is obviously all coming from the climate crisis, right. I mean that's sort of the ultimate background*" (P5).

The data also suggests that there may be differing levels of urgency surrounding CDR technology engagement. In particular, for organizations positioned in hard-to-abate industries, including heavy industry sectors that are notoriously challenging to decarbonize, it was observed that CDR technology engagement is perceived as a necessary means to attain emissions reduction targets: "*the last big action that we need to take in order to cut down the emissions*" (P1). Alternatively, another participant reported that engagement with CDR

technology is considered as just one of many different approaches to address their sustainability commitments: "*focusing on developing the portfolio of CDR projects, because we have a commitment to reduce our emissions from our own operations by 50% by 2030*" (P4). Together, these ideas reflect varying degrees of necessity surrounding CDR engagement.

In this sample, CDR technology engagement is demonstrated to be driven by a range of internal and external factors. The data suggests that externally, organizations may be driven by compliance with industry frameworks and legislation, as well as a variety of stakeholder demands. Internally, the data indicates that existing sustainability strategies largely guide organizational engagement with CDR technologies. Organizations may also operate under differing logics that guide this engagement, as some may be driven by the potential for business opportunities while others can be driven by sustainability concerns. As a specific point of tension in the data, it was observed that organizational engagement with CDR technologies can be simultaneously guided by their internal sustainability strategies and potential business opportunities. Organizations may also exert varying levels of urgency surrounding CDR engagement, as for some, CDR methods were observed as necessary to meeting their climate targets, while for others, they were just perceived as one among several approaches.

4.1.2 Diverging Expectations

In this sample, participants expressed diverging expectations about the future potential of CDR technologies within organizational sustainability landscapes. This was represented by positive anticipation and optimism, as well as general skepticism for these methods. In particular, some participants reported optimism for these methods by detailing their strategic commitments to further developing or even scaling CDR technology projects in the future: "*I'd say we see ourselves, the organization, playing a leading role in scaling high integrity carbon removal, both in volume and in systemic impact*" (P4). This was reflected through notions of continued research and development or stable investment directed towards CDR technologies, as well as potential deployment of validated methods. Strategic commitment to CDR was also expressed through ongoing pilot projects: "*we're also at the moment in the process of developing our first commercial scale 'type of' plant, which is going to be a major step to deploying solution (…) it will allow us to bring all of our learnings from the R&D side into practice*" (P6); "*we are planning to invest in the whole capacity already, so after that there are no new investments needed*" (P1).

In this sample, some practitioners were also observed to hold positive expectations regarding the future relevance of CDR technologies within organizational sustainability landscapes. That is, some practitioners expressed optimism surrounding the forecasted growing role and centrality of certain CDR technologies in organizational sustainability contexts. This was reported through the expectation that external sustainability accounting frameworks would evolve to require these methods across organizations, as well as through the expectation of CDR technologies becoming the main methods for decarbonizing certain industries: "*now it looks like it's going to be one of the key technologies going forward, decarbonizing the 'name' industry*" (P2); "*we also expect, for example, the science-based target initiatives to somehow include CDR in their upcoming corporate standard*" (P4).

Some of the practitioners also expressed expectations of potential market growth for these methods. For instance, practitioners in this sample have reported temporal changes in how CDR technologies are discussed and in the characterization of actors in the sector: "*We've seen a noticeable evolution in how CDR is discussed. Initially the conversations were dominated by high-tech centralized approaches (…) and now I think it's growing appreciation for methods like biochar (…), it's definitely getting broader"* (P6); "*expectations for CCS in the 'industry' are continuously growing and has been, it has changed a lot over the last three or four years*" (P2). Expectations about the potential for business opportunities from CDR technologies, driven by increased client traction, were also identified in the sample: "*we expect that that will open up new business opportunities also for 'company name' when it comes to clients* (…) *is trying to build new business opportunities in this space because obviously we see that it's going to be a big market in the future"* (P4).

On the other hand, some practitioners also reported skepticism and uncertainty regarding the future of CDR technologies. In one account, this was illustrated by concerns about the stability of the current CDR technology landscape and by conflicting expectations regarding market development: "*I think the expectation is that all of them will grow, but I think there will also be lots of, kind of, changes still coming (…) to these technologies to sort of how they are seen, what's the perception of those technologies, maybe we will find a new silver bullet somewhere else only in a few years*" (P5). The analysis also suggests that organizations may have contradictory expectations surrounding CDR technologies. That is, while some practitioners reported optimism for these methods, they also expressed uncertainty regarding the outlook of CDR methods due to market immaturity, stagnated organizational action, and the absence of

regulatory structures to support continued development: "*we are still waiting for the regulatory landscape to further develop before this becomes, really, a market- because no one is decarbonizing until they really have to*" (P2); "*the expectation from the company is that somebody else will do it, somebody else will scale the market"* (P3).

This section has shown the expectations that practitioners in the sample were observed to hold regarding CDR technologies. A notable pattern that emerged in this sample is that practitioners are both optimistic as they are skeptical about the future potential of these methods, while some express contradictory expectations simultaneously. In this sample, positive expectations were reflected in strategic commitments, planned investments, and anticipation of market growth and the long-term potential of CDR technologies. Other participants expressed uncertainty about the current stability and maturity of the market landscape. Taken together, these diverging expectations may hint at how organizations position themselves in relation to the hype surrounding these methods.

4.2 Organizational Responses and Perceptions on Hype

This section presents the findings on how practitioners in the sample were observed to respond to, and engage with, hype, and the extent to which it was found to shape certain decision-making processes. The thematic analysis suggests that organizations hold various perceptions and interpretations of the role of CDR technology hype in organizational settings, as well as differences in how they perceive its implications on sustainable progression. Through the second-order themes of "*strategic influence*" and "*sustainable progression*", this section will therefore explore organizational interpretations, as well as responsiveness, to technology hype.

4.2.1 Strategic Influence of Hype

Strategic influence emerged as a relevant second-order theme due to the centrality of this concept in how practitioners were observed to respond to hype and perceive its implications within organizational settings. The analysis revealed a generally cautious perspective on the influence of hype on the strategic direction of organizations. For instance, the findings show that organizations strive to avoid technology hype from impacting their strategic decisions: "*my hope is that we don't jump around from hype to hype in my organization (...) but I'm not sure if we don't, I think to some extent we do, we follow the hypes*" (P2); "*I think the hype is*

not really (…) playing a role in our own sustainability discussions (…) *doesn't really influence decision-making*" (P4). The analysis also identified that organizations may proactively challenge the influence of hype on internal processes: "*We are actively trying to push back against it to make sure that the solution we scale is serving the planet and not just the market*" (P6). The analysis also highlighted that hype may be viewed as an inherent component of nascent markets. With this perception in mind, its influences are also observed to be ordinary to emerging technology landscapes and subsequently corrected by market mechanisms: "*I would say that this type of phases are kind of characteristic to nascent markets, but then once that type of field starts to develop a bit more, I think that the hype typically has far less influence*" (P4). This caution was also apparent in the articulation of risks associated with hype from disappointment and the withdrawal of resources: "*these types of new technologies start to basically face too many challenges. So, they cannot find the real business cases, although the strategies are in place then the enthusiasm around the topic goes down*" (P4).

Where hype was expressed by some of the practitioners to implicitly impact the strategic direction of organizations, it was largely in reference to internal research and development initiatives: "*has an effect when it comes to what to stud**y** (…) but then when we make the decision, I think one of the most important reasons to select a technology is the readiness of that*" (P1); *"driving, of course, the strategic direction of our organization and the fact that we are allocating a lot of R&D and resources to develop the technology and then to roll out the technology in the market*" (P2). The analysis also revealed that hype is perceived to hold an information signaling role for organizations, indicating emerging topics to study: "*it's very important to study the business environment*" (P1); "*if we see, for example, an emerging topic that is receiving a lot of attention, for example in the markets, it probably then something that we will also have a look at and see whether this is somehow relevant for us* (…) *when it comes to any other type of decision making, then hype doesn't really play a role*" (P4).

While the analysis revealed that organizations are generally cautious towards hype and strive to limit its strategic influence, other practitioners cited its potential to shape long-term strategy. That is, the analysis showcased that the changing expectations associated with hype cycles can influence long-term organizational strategies surrounding CDR technologies, as expressed by one practitioner: "*these changing expectations have really helped shape our long-term strategy (…) moving from just proving the technology works to proving that it works well and at scale and with integrity*" (P6). The analysis also revealed that technology hype can influence the

technology portfolios of organizations, which signals another avenue through which it can shape the long-term strategies of organizations. That is, the extent to which organizations actually respond to various technology hypes in practice may be represented by the contents of their technology portfolios: "*we do have a portfolio of different decarbonization technologies, or environmental solutions or sustainability solutions (…) so in that sense, we are following the variety of hypes, at least the larger ones"* (P2). These findings nonetheless contradict the aforementioned claims of organizational agency in hype settings, and the minimal influence that hype was claimed to have on strategic decision-making.

The analysis also revealed that practitioners in the sample consider organizational structures and culture to have potential moderating effects on the degree of hype's strategic influence. That is, it was identified that hype is rarely expressed to translate to irrational decision making within organizations as a potential result of inherent organizational logic and processes: "*hype will usually not turn into making too irrational decisions, just out of the hype, because in the end its not necessarily that person that's hype (…) that makes all the decisions alone (…) it comes down in organizations to the very conservative view on the world of the CFO or someone else* (…) *the hype person being calmed down (..) by the rational and by the logics and by restrictions and limitations of organizational structures*" (P5). The size of the organization and its external connections may also hold a role in determining how hype influences strategic direction: "*the more mature companies as in the bigger companies just have such big teams, they have the experts, they have the connections to consultants (…) who can tell them (…) this is not a good idea, you need to focus on the actual things that matter to you*" (P3). Hype may therefore have greater influence on the strategic direction of newer organizations, both in new and existing markets: "*new companies who are trying to come to this market, (…) the hype is basically playing a much bigger role*" (P4); "*and now it is being taken into a different industry that has no experience on that* (..) *there's room for this kind of new technology hype*" (P1).

The analysis also revealed that other organizational aspects, such as the structuring of teams and their internal culture, may impact the extent to which hype shapes strategic decisions. That is, one practitioner suggested that teams with decision-making power within organizations are generally unresponsive to novel and emerging technologies promoted through hype as a result of established strategies: "*the companies are kind of like in this bubble where they're not necessarily touched by it, or at least the teams that have the main responsibility to decide what kinds of thing we should be focusing on* (…) *they understand that they need to focus on the*

things that they've already planned out" (P3). The make-up, or structure, of the organization itself may also impact how hype influences strategic direction: "*taking into consideration that we are municipally owned and they're basically owners and customers* (…) *we need to be very careful on the investment decisions that we make*" (P1). The culture present within the organization such as heightened risk aversion, was also found to potentially determine the strategic effect of hype, as one practitioner suggests: "*typically they have (…) strong strategic planning and they have a very strong risk management culture, so in that sense, the hype doesn't have an impact (…) on the actions and operations of a 'type of company' in the CDR space*" (P4).

The role of organizational sensemaking also emerged as an insight in potentially determining how organizations may respond to or perceive hype. The analysis revealed that the role of past controversies in the field was found to impact how organizations respond to and perceive hype in current contexts. For instance, the outcomes of these events have made organizations in the carbon removal sector hesitant in their response to hype: "*hype did play a role back in 2018 to 2020 when we saw this rise, and huge spur, in greenwashing (…) everybody was carbon neutral this and have carbon neutral that (…) there was this element of hype (…) big companies have now hired, in some cases, very big sustainability teams, they have experts now in weeding out make sure that we don't make the same mistakes we did like six years ago, and there such a critical public eye on greenwashing (…) companies are very weary of falling into hype anymore (…) it has to be rooted in analysis*" (P3).

In this sample, there emerged tentative differences in how practitioners respond to and perceive different sources of hype. That is, it was observed that some practitioners are generally apprehensive about engaging with media hype that is not supported by scientific evidence: "*we're really cautious about overcommitting to trends that are media amplified but not yet* (…) *scientifically grounded*" (P6). This cautious approach to media hype was also conveyed through the way that practitioners were found to perceive the role of media hype in practice. That is, the information conveyed through it was largely regarded as a valuable market information signal: "*we are following quite a lot what's happening on the field, so maybe that goes under the hype of the media* (…) *we are of course following those and other projects so that we can find out which technology providers they are using*" (P1). The analysis also observed that practitioners perceive general limitations from following media hype: *"oversimplify complex technologies and create unrealistic expectations*" (P6).

In this regard, practitioners in this sample largely view media hype as a source of initial information or as an indicator of industry developments. One practitioner also expressed doubt about the influence of media hype on organizations as a result of negative consequences of past events: "*I'm a little skeptical that companies respond to media hype* (…) *especially now were in this kind of maturing of sustainability* (…) *we're more mature than we were 6-7 years ago*". The maturation of organizations in the carbon removal sector has also led them to align more closely with their existing strategies, underlining the minimal influence of media hype: "*that has also made companies less likely to, kind of, go with any trend and the media hype around technologies is maybe just seen as* (…) *something that's going around, but we're going to stay focused on the things that we have planned or the things that we're working on*" (P3). Following media hype, nonetheless, may be lucrative for some organizations from a reputational perspective, as reported by one practitioner: "*if there's hype in the media, it could be kind of more interesting also from the reputational perspective*" (P4); "*boosts public interest and investor curiosity* (P6).

Consequently, when practitioners explored their perceptions of scientific hype, it was revealed to hold greater strategic influence at the organizational level than media-generated hype. For example, organizations were found to relate and respond to hype originating from scientific communities: "*we relate, of course, to what might be called scientific hypes*"; (P6) "*signals that there's something more substantial, like validated research, peer reviewed breakthroughs, and those signals tend to influence our R&D priorities and how we allocate resources for innovation*" (P2). The analysis also revealed that scientific hype may be perceived with greater credibility: "*coming from more, scientific bodies, it could be basically interesting in terms of is this the type of technology that could provide a new solution*" (P4). One of the practitioners (P1) highlighted that they especially value information on pilot projects that is conveyed through scientific hype: "*when it comes to scientific hype* (…) *at least in our case the kind of pilots that are done and studied in the scientific community, or course, everything starts from the pilots and small scale*". However, in their case, scientific hype was also found to serve a primarily informative role rather than exerting direct strategic influence: "*of course it's good, but it's not something that we would then go directly in as the first big customer because usually when they are scaled up, the price goes very high*" (P1).

Nonetheless, the analysis revealed that differentiating between media hype and scientific hype at the practical level can be challenging, which can undermine claims about media hype's

limited strategic influence: "*I'm not sure, do we differentiate*?" (P4); "*they are closely linked so if a scientific community starts hyping something, the media will follow*" (P2). Media conveyed hype was found to have a potentially intrinsic position in carbon removal technology contexts: "*always has been in this sort of technologies and carbon capture technologies or also carbon reducing methodologies* (…) *I would say it's media to a large extent* (…) *but it should be more science*" (P5). These findings may therefore reveal that, to some extent, hype remains largely perceived as a sum of its sources rather than as something distinguishable by its individual sources at the practical level.

At the outset, this section has shown that organizations generally approach hype with caution, aiming to minimize its strategic influence. At the same time, contradictions emerge, as organizations may also maintain technology portfolios that include hyped technologies, reflecting how hype can implicitly shape long-term strategy in practice. This can hint at potential contradictions in how organizations relate to hype in practice. The discrepancy can also be viewed in how organizations perceive and relate to media and scientific hype. In particular, while organizations often engage with media hype at a surface level for industry information, in practice, it can be challenging to differentiate it from scientific hype. Practitioners also emphasized the role of organizational structures and culture in moderating the impacts of hype, suggesting that, to some extent, hype may be automatically managed by the market logics that these systems uphold. Furthermore, past controversies in the carbon removal sector may have made organizations more cautious in their engagement with hype.

4.2.2 Sustainable Progression

In this sample, *Sustainable Progression* emerged as a second-order theme, reflecting the productive lens through which practitioners viewed hype's role in sustainability. That is, practitioners were observed to describe hype as capable of mobilizing attention, challenging values, and advancing CDR technologies. Where practitioners specifically acknowledged hype to have a significant role was regarding its ability to mobilize attention, in the form of favorable funding, talent, and policies, for sustainability-oriented technologies. This momentum was expressed to be able to simultaneously divert resources away from other functions that currently contradict sustainability initiatives. This mobilized attention may also bring about new companies to engage in the research and development of CDR technologies: "*it definitely attracts attention, it leads to attracting funding, talent and policy interests"* (P6); "*I think it's*

good to also have some initial excitement for emerging technologies, because that is also then the driving force that we start to look at them" (P4); "*interest for new companies to look into this not only through climate lenses, but also really from triggering almost internally kind of further research and development* (P5). The analysis also revealed that practitioners perceive benefits in generating additional hype to further propel attention towards sustainability initiatives and to advance the CDR market: "*I wish there was more hype. I feel like we were in a really good space at some point where climate was getting all the attention, and now it's not necessarily so I think*" (P3); "*we also need maybe a bit more hype in order to move anywhere, if we are just too careful, then we are not making any progress"* (P4).

In the context of sustainability, hype was also described as capable of challenging existing organizational values and incentivizing traditional business structures to engage with sustainability-oriented methods. In this sample, it was observed that engagement with CDR technology hype may also incentivize some organizations to set internal goals that challenge traditional business logic, which may advance organizational sustainability: "*no company has net zero targets before 2040, so now in 2025 (…) basically its 15 years (…) if the decision is just with the CFO or the procurement people in an organization, it would not happen until 2035, so it needs a hype*" (P5). The momentum of hype was also described to be able to motivate more businesses operating outside the realm of sustainability towards these initiatives: *"especially when you have more conservative companies on the market, maybe that hype is sometimes also needed in order to trigger some action at the company level*" (P4).

Specifically for CDR technologies, some practitioners reported that hype can help to advance these methods because of their ability to mobilize action towards their development. In turn, an increase in attention, capital, and capabilities brought about by hype may increase the rate of development of these methods, as expressed by one practitioner: "*overall its very good that there is hype around these technologies because then companies are studying those and having pilots and making investment decisions*" (P1). Penultimately, this momentum was expressed to play a part in increasing the availability and accessibility of these methods: "*the technologies are being developed all the time because of this and in time (…) it becomes cheaper and more modularized and more available to more companies*" (P1). In the long-rum, hype is found to be expressed to support the mainstreaming of these technologies: "*it really has helped shift the narrative from carbon removal being a fringe or future concept to a recognized pillar of achieving net zero even net negative targets*" (P6).

In this sample, the analysis observed that hype was rarely considered as an imminent risk for sustainability. There appeared to be only a few practitioners who perceived hype to have some adverse sustainability implications, particularly regarding inefficiencies, reputational issues, lost resources, and environmental damage. That is, where hype was reported to impact sustainability, it was in reference to misallocated resources and reputational risks from unmet expectations: "it *can also lead to misallocated resources, and broken trust in carbon removal* (…) *over-promising and under delivering can set the entire sector back regardless of how promising the underlying technologies are*" (P6). Some practitioners also reported that hype may create an illusion of technical readiness that can result in ill-informed action: "*the hype should not make the companies blind on this being a topic and the hype obviously is always the risk of just being a hype because it is hype and because it's just an interesting topic*" (P5). In this sample, hype was also found to be perceived as a mechanism that may cause ungrounded scaling of immature technologies: "*it can also lead to a rush to scale technologies*" (P6). One practitioner also reported that CDR technology engagement can adversely impact emissions reduction: "*if carbon removal is framed as a silver bullet, it can unintentionally delay or undermine emissions reductions*" (P6).

Concerning sustainability, practitioners in this sample largely framed the impacts of hype in a predominantly positive lens, highlighting its ability to mobilize resources, investments, and actors to towards advancing sustainability initiatives. This positioning to and perception of hype in sustainability contexts was also represented in this sample by reports for additional hype to advance climate initiatives. By contrast, the risks of hype were noted less often in comparison with expressions of its productive potential. Nonetheless, some of the risks that practitioners consider hype to have for sustainability include misallocated resources and reputational damage.

4.3 Navigating CDR Technologies

In this sample, '*Navigating CDR technologies*' emerged as a prominent aggregate dimension, reflecting various organizational sense-making practices. In this regard, the analysis highlighted that practitioners may proactively apply various sense-making approaches to interpret, evaluate, and assign meaning to emerging CDR technologies. This was reflected through the use of various evaluation criteria, risk assessments, and narrative framings to navigate and interpret the CDR technology landscape.

4.3.1 Evaluation of CDR Technologies

Practitioners in this sample were found to reflexively apply several evaluation processes in the navigation of the CDR technology landscape. The data suggests that organizations apply various evaluation criteria and risk assessments, to the extent that, if certain criteria are not met by these methods, progress may stall altogether: *"that's maybe then kind of stalled progress as well (…) people aren't willing to go into something unless they've really assessed it, and they know the business case and they figure it out*" (P3). Technology attributes were observed as a central evaluation criteria to assess CDR technologies, with permanence and durability emerging as the most significant: "*it's basically the permanence of the storage, because basically anything that we do in this space has to have high quality and it has to have high permanence*" (P4); "*credibility is really everything in the CDR field*" (P6). The data also suggests that organizations may prioritize established, validated methods in the navigation of emerging CDR methods: "*we are mainly focusing on the proven technology (…) we are looking into all technologies that are available and trying to find whether there would be an emerging technology that would very well fit us*" (P1).

Similarly, in this sample, risk assessments emerged as central evaluative mechanisms organizations use to interpret CDR technology engagement. Among these, financial risk emerged as a cross-cutting assessment across other CDR evaluations, as one practitioner reports its interconnectedness with technological risks: "*technological risks, that we are not able to sell our product because it's not good enough, which is, of course, then also a financial risk*" (P2). Other practitioners reported that financial considerations are the preliminary method through which CDR technologies are assessed: "*definitely financial, I would say is the put on the top one. I think, unfortunately, especially right now with the way the economy is, the number*

one question is: is this really where we want to put our resources?" (P3) "*when the safety topics and technology are handled, then everything basically comes down to the money (…) everything comes down to the money and the business case*" (P1).

Some practitioners also emphasized the role of reputational risks in the navigation and interpretation of CDR technologies. In particular, one practitioner reported that reputational risks have emerged as increasing concerns as a result of past scandals in the sector: "*reputational risk is still a big one. I think so many companies are still scarred from the kind of voluntary carbon market kind of scandals of the past years*" (P3). On the other hand, another practitioner reported that these methods may be particularly prone to reputational risks as they can enable continued fossil fuel use: "*reputational risk (…) you could say that CCS is prolonging the life of fossil energy source"* (P2).

At the same time, while some organizations may require CDR technologies to meet certain criteria, other practitioners report that evaluating these technologies in practice remains rather challenging. In particular, some practitioners emphasize that current market nascency, technological uncertainty, and limited internal organizational capabilities may pose difficulties for organizations to accurately evaluate and make sense of CDR technologies: "*the business is still very much in the nascent phase, so it's very difficult to see basically how it will look like*" (P4); "*they can't assess it really, they can really make the business case internally*" (P5). Similarly, accurate evaluations of CDR technologies may be limited by the internal capabilities organizations have to assess them, as reported by one practitioner: "*assessing these technologies is really tricky for organizations that are interested in sort of investing in them (…) to a very large extent they are just not capable to do this*" (P5). Taken together, partial evaluations may impact the extent to which the climate impacts of these technologies are understood, which may misinform decision-making: "*a lot of these technologies might still have implications on the climate, on other effects or other implications that not yet completely understood or foreseeable*" (P5).

In this sample, some patterns emerged regarding the role of sustainability strategies as a mechanism for interpreting CDR technologies. That is, in the same way that internal sustainability strategies were observed to drive engagement with CDR technologies, some practitioners also emphasized how strategic alignment to them is used to interpret these methods: "*we actively assess the other CDR approaches to stay aligned with the climate*

strategy and just to ensure our own work that it meets emerging standards" (P6); "*we have the strategic goal to cut down the emissions, after we have that goal, we need to decide how to do it* (…) *it really needs to fit our situation*" (P1). The analysis also identified that at the practical-level, organizations may use embedded practices to evaluate the sustainability practices of CDR technologies, such as due diligence processes, and Life Cycle assessments: "*that is basically the part of the due diligence that will assess whether these types of projects have any social and environmental impacts"* (P4).

Across this sample, there were also some observable disagreements on using external sustainability frameworks to evaluate CDR technologies. While some practitioners reported that external frameworks such as the Science Based Targets Initiative (SBTI), Oxford Principles, and Sustainable Development Goals (SDGs) are essential organizational tools for interpreting these methods, others disagreed on their reliability. Particularly, some practitioners reported that engagement with CDR technologies generally needs to align with the requirements of external sustainability frameworks: "*anything that were basically doing in this space, it needs to be aligned with the Oxford principles for net-zero aligned offsetting. That's very important for us*" (P4); "*it's mainly external advice that they receive on this (…) like the SBTI or the Oxford Principles, are sort of what they really read, what they look at, and what they are, and what their guiding stars are*" (P5). On the contrary, another practitioner highlighted that there are limitations to blindly following these frameworks: "*if you can ground your work in scientific, independent nonprofit frameworks, then you kind of you can kind of get away from just following the pack wherever it goes (…) But those aren't foolproof either*" (P3).

The data also points to the role of social and co-benefit evaluations in interpreting CDR technologies, while also suggesting differences in perceptions of their feasibility. That is, while some practitioners highlighted the importance of assessing the social implications of CDR technologies, others suggested that it is hardly possible for these methods. One practitioner outlined that their organization actively evaluates CDR through the lens of social implications: "*we always ask if the approach is creating burdens or liabilities for future generations and with 'technology type', the permanence of the carbon storage and low risk of reversal make it a favorable choice in that regard*" (P6). In contrast, another practitioners remained cautious about the extent to which the social implications of CDR technologies can be evaluated: "*for the more kind of technology focused one, a lot of times those are maybe missing the social*

aspects (…) *a lot of times there are no significant social benefits and there are no significant kind of (...) apart from kind of building the technology and that value change*" (P3).

A similar tension emerged in the data on how some participants evaluate CDR technology co-benefits. That is, one practitioner outlined that their CDR technology approach creates co-benefits: "*implemented almost anywhere (...) this opens the door for more distributed climate solutions that can help local communities, and it will create co-benefits*" (P6). On the other hand, another practitioner reported that CDR technologies are generally unable to create benefits outside of their emissions reduction potential: "*Sometimes they have not really any co-benefits specifically beyond the environmental impact obviously in CO2 impact"* (P5). In this sample, part of this tension may likely reflect the heterogeneity of CDR technologies that, despite being considered a single concept, consist of various technologies that subsequently include different evaluations.

The analysis also suggests that organizations may use narrative framing as a mechanism for interpreting and navigating the uncertainties surrounding CDR technologies. That is, this mechanism was found to hold a role in the sense-making processes of these technologies, as organizations may interpret CDR technologies through their storyline potential: "*they can just make the connection from kind of a storyline standpoint as well, that it makes sense that they're somehow advancing the technology that will make their whole industry better*" (P3). One practitioner also reported that organizations may use narrative framing to justify engagement: "*technology-oriented companies see themselves potentially being closer in terms of the narrative of why they get involved and how they want to be involved*" (P5).

In this context, organizations may utilize various evaluation methods to reflexively navigate and interpret the CDR technology landscape, as reported by a majority of the practitioners. The data suggests that organizations primarily employ evaluations that are based on technology and business oriented aspects, while also using risk assessments that center on financial risk. The data also suggests that the current nascent state of CDR methods may impact the extent to which organizations can conduct accurate firm-level assessments of these methods in practice. It is also shown that within these cases, organizations may also use alignment to internal sustainability strategies and to external sustainability frameworks as sensemaking mechanisms. Views diverge on the feasibility of social and co-benefit evaluations for these methods, which may point to the implications of the heterogeneity of CDR technologies.

4.4 Hype Management

4.4.1 Conceptualizations of Hype Management

The aggregate dimension of *Hype Management* explores various conceptualizations of hype management and articulations of its realization within organizational settings. To preface further reflections on hype management findings at the organizational level, it can be necessary to explore how practitioners conceptualize hype management and how they perceive its relevance in sustainability contexts. There were variations in how practitioners define and perceive hype management, reflecting both the concept's diversity and the differing logics with which organizations currently approach it.

In particular, one practitioner framed hype management as a mechanism that enables consistency: "*managing hype is to stay consistent within your communication and your view and your portfolio* (…) *consistency is a very, very key managing aspect*" (P2). On the hand, other practitioners defined hype management as a strategic process that can translate the momentum of hype to internal policy: "*its super important that from hype there is like a very strategic rational decision made on what we need to support and how to support those things*" (P5); "*managing hype, it's basically trying to basically do more concrete actions in an area then you start to basically see how things are working*" (P4). Hype management was also loosely framed as a technology appraisal mechanism that can support organizational credibility: "*it's very important to identify the real challenges and also opportunities in any new technology that when you're bringing it to the market, in order to show any stakeholders on the market that your actions are credible*" (P4). These varying definitions may therefore suggest that organizations apply varying understandings of hype management at the practical level.

The analysis also revealed some differences in the priority placed on the advancement of hype management at the organizational level. That is, the analysis showcased that there are diverging opinions on the extent to which hype management is essential in practice. Despite this, a majority of the practitioners stated that hype management is, nonetheless, invaluable in organizational landscapes both in terms of attaining strategic efficiency and addressing sustainability: "*I think it's very important, (...) it has a big, big, role*" (P1); "*I think that managing the hype is important if we want to be more effective, and if we want to have more*

credible sustainability actions" (P4); "*I think that when hype is managed well, it can be a powerful catalyst, drawing attention, investment, political attention, and that will help us toward climate solution"* (P6); "*the sustainability space has matured to an extent where you can't just rely on hype*" (P3). Another practitioner highlighted the relevance of hype management for supporting long-term organizational sustainability: "*managing hype is essential for ensuring that the sustainability actions are not only effective in the short term, but in the long term*" (P6). On the other hand, hype management was also regarded with less urgency and strategic priority by another practitioner: "*hype is usually managed automatically, I would say, in large organizations or in all organizations to some extent*" (P5).

Furthermore, across the accounts of hype management at the organizational level, practitioners were observed to loosely divide their reports between concrete actions and intangible, abstract principles. For this study, concrete actions refer to specific and actionable measures that organizations apply, or can apply, to manage the potential influences of hype. On the other hand, abstract principles represent intangible, overarching guidelines that organizations may apply in the management of hype. In this regard, abstract principles are widely applied ideas that aren't the result of any single, concrete action. These aspects will be discussed in greater detail below.

Taken together, the analysis suggests that organizations perceive hype management in different ways, as some conceptualize it through consistency and credibility, while others consider it as a mechanism for strategic translation. It is also observed that there are some divergences in the extent to which hype management is given strategic priority in practice. That is, although many practitioners in this sample consider advancing hype management an important pursuit in organizational landscapes, others express that it is already sufficiently addressed at the practical level.

4.4.2 Concrete Practices for Managing Hype

At the outset, the analysis indicates divergence over whether hype management practices already exist at the organizational level. That is, one practitioner noted that although some organizations may want to manage expectations, they lack formalized tools or frameworks dedicated to this function: "*I wish we had a framework for that*" (P3). On the other hand, the analysis suggests that other organizations may retrofit existing processes to identify unrealistic

claims and monitor expectations over time around CDR technologies. Organizations also appear to use existing risk management practices to identify unrealistic expectations about emerging technologies: "*risk management is the part which basically helps that realism to be built in our strategic targets and actions*" (P4). The extensiveness of existing risk assessment processes was also cited as a helpful method for monitoring changes in expectations over time: "*we are doing risk assessments which are covering quite many topics, I think that's also a good tool to actually notice changes* (…) *good tool to go through and of course some of the risks are related to expectations and decision-making*" (P1). In this regard, the data points to the role of informal hype management practices observed by practitioners in this sample.

The analysis also suggests that some organizations in the sample may utilize internal measures to address hype. That is, one practitioner reflected on the role of internal life cycle assessments as an existing organizational tool for identifying overestimations in CDR technology potential and for identifying the actual climate benefits of these methods: "*we also conduct regular life cycle assessments and update them as our processes evolve, and this helps us to stay transparent about the real climate benefit of our approach and avoid overestimating our contribution to net zero targets*" (P6). Organizations may also utilize sustainability indicators to track the outcomes of initial CDR claims over time: "*we track key indicators like permanence, biochar quality, feedstock sustainability and actual versus projected carbon removal volumes, and this allows us to assess whether our impact aligns with what was initially claimed or modeled and to adjust accordingly*" (P6). There may also be benefits from evaluating how the information from different sources of hype may impact decision-making in distinct ways: "*each one carries its own kind of influence and it's important to understand where attention is coming from, it definitely helps us to make smarter decisions*" (P6).

On the other hand, the analysis also shows that other practitioners in this sample may rely on external expertise, such as third-party service providers and independent scientific communities, due to lacking internal understandings of hype management and limited dedicated resources to navigating hype settings: "*most organizations have absolutely no tools in place or no understanding of this, I think that's just exactly why they rely to a larger extent on external advisors and consultants, MRV providers (...) rating agencies popping up in the field*" (P5); "*any kind of independent scientific frameworks that are put together by a body of organizations is where companies can look to really ground their climate work and their approaches*" (P3). These external service providers may be especially helpful in navigating

emerging technology contexts where organizations may lack necessary resources or knowledge: "*I think companies are indeed usually not equipped to do these decisions alone, so they just need tools which they don't have in house, at least not in the beginning*" (P5). The utilization of external service providers and frameworks may support organizations in differentiating between optimism and hype for emerging technologies: "*I think it needs third party verification and peer reviewed data and lifecycle assessments to tell the difference and alignment with certification and framework*" (P6).

External monitoring, reporting, and verification (MRV) organizations also emerged as a growing example of an external service provider supporting organizations to monitor initial expectations over time: "*we rely heavily on data and MRV for each project*" (P6). MRV may also support organizations in identifying the business case and sustainability implications of emerging technologies amidst hype: "*its super important because that's sort of where technology meets digital or different ways of like technological MRV solutions are applied to the technologies (...) to make sure that there is actually this business case of these are being more permanent and these have a positive effect also in some cases on the climate*" (P5).

The analysis also suggests that, while organizations strive to actively differentiate general optimism for emerging technologies from hype, the perceived line between these two concepts remains thin in practice. At the outset, one practitioner reported that the identification of these concepts hinges on the extent to which the organization is aware of the realities of technological development: "*responsible optimism, that really involves knowing that any technology will have 'teething issues' (...) the rollout will take probably twice as long as you think it will*" (P2). An existing understanding of these processes can help organizations identify unrealistic expressions about emerging technologies solving complex challenges: "*because then if you say, well all our problems are solved by then and this, and then you if you've been dealing with these technologies that its decades before we know*" (P2). The analysis also revealed that optimism is built on a comprehensive understanding of technology development that incorporates positive and negative information: "*I think in optimism, it's about believing in a technology's potential based on sound science, demonstrated results and a realistic pathway to impact that it is also open to uncertainty, acknowledges challenges, tradeoffs"* (P6). However, just as differentiating hype by its sources can prove challenging, differentiating hype from optimism may also be difficult in practice: "*the line between the two can be thin, but there still are some clear markers that we use to set them apart"* (P6).

In this sample, the data suggests that organizations may try to operationalize the line between general optimism and hype through internal methods. In a practical sense, practitioners mentioned specific methods for identifying unrealistic claims. For instance, existing organizational infrastructure, such as due diligence processes, may be used to assess and identify unrealistic claims: "*if you start to do due diligence, then it's basically where you start to get a more realistic picture about it, (…) you need to get enough data to understand what is the real opportunity and potential in a new technology before you make any decisions*" (P4). Unrealistic claims may also be identified through widespread research that includes analysis of available alternatives and different perspectives when searching for technological solutions: "*we are taking into consideration all the different options and all the different technologies for carbon capture even (…) in the early phase when doing development you just have to consider everything"* (P1); "*you need to collect basically enough information and different perspectives before you can actually know how realistic is it what they are basically promising*" (P4).

In the articulation of hype management approaches, some practitioners reflected on the importance of approaching CDR technologies through portfolio methods. Adopting a holistic CDR technology portfolio was found to potentially enable the simultaneous development of various CDR methods: "*I think the hype is starting to build up, but it's something that's also good to acknowledge that we need the other technologies as well* (…) *we need a portfolio of CDR, that it's not a competition, we need all of them*" (P6). The analysis also revealed that organizations may adopt a holistic approach to CDR technologies to mitigate risks from the uncertainties surrounding these methods: "*there's so many uncertainties still around that I think what most companies are actually doing is they invest not only in one technology, but they invest in multiple technologies, they go with the portfolio approach just to kind of de-risk a little bit their investments"* (P5). One practitioner underlined the role of consistency between the chosen technologies as a means to manage hype: "*we have this portfolio of decarbonization technologies (…) if we are consistent and have a reasonable explanation why we have landed on this portfolio, then I think that will be a useful hype management approach*" (P2).

The potential role of internal organizational structures also emerged throughout the discussions on hype management. This concept was found to relate to how organizations are structured and how this may influence their responses to hype and its subsequent internal impacts. In the same way that it was found to be used to mitigate the influence of hype, some practitioners also

explored how it can be used to strategically manage it. As one practitioner highlighted, having scattered teams with varying degrees of understanding on an emerging technology project can impede overall strategic direction and potentially enable hype related decision making: "if *it's only scattered teams that are being given these kinds of new technology projects that the whole overall coordination of the company's strategy is kind of overlooked (…) there's more room for this kind of hype related decision-making*" (P1). In the bridging of hype management with sustainability, some practitioners expressed lacking coordination and unified understanding surrounding internal sustainability targets and carbon removal: "*the carbon removal is something that is maybe something that somebody in the sustainability team is very interested in or has a personal kind of interest (…) I would call it very much like ad hoc interest*" (P3). Similarly, the analysis found potential merits in encouraging open dialogue to further activate organizational climate action: "*I think it needs a specific person at an organization that really says, OK we need to do this now, we actually see that far too few or far too little companies are actually doing it*" (P5).

However, in these discussions, there was divergence in how practitioners articulated the degree of inclusion of the team needed to support internal cohesion. On the one hand, one practitioner outlined that teams should be included incrementally as the project progresses: "*in the early phase, it's the development team and when we go forward, more and more teams are getting involved*" (P1). On the other hand, another practitioner outlined the collective inclusion of all relevant teams from the start: "*everyone, this is our new first and foremost key product, so in that sense, everyone is involved, at least in promoting and developing and signing*" (P2). The analysis also revealed that organizational culture may support hype management. For example, emphasizing values such as critical thinking and reflexivity may provide the organization with strategic stability: "*internally, we emphasize critical thinking and reflective culture, we're encouraging our team to question trends, assess risks, and stay focused on our mission not just on the market movements*" (P6).

It was revealed that assessments of co-benefits may also be particularly beneficial in identifying the sustainability implications of hyped technology: "*reflecting on the co-benefits and unintended consequences (…) how our work affects the soil health and the farmer livelihood, land use; we're gathering feedback from all of our partners*" (P6). Furthermore, identifying the role of carbon removal in broader organizational sustainability may also minimize the influence of hype: "*understanding what role is carbon removal playing in our bigger climate*

strategy and then making a plan for that, and then you can move forward in kind of a, little more level-headed way than going wherever the wind takes you" (P3).

These accounts illustrate that, while some practitioners in this sample reported the absence of formal hype management practices, they were found to utilize existing, embedded practices to identify unrealistic claims and monitor expectations over time surrounding CDR technologies. The data suggests that organizations may extend the scope of internal practices, such as risk assessments, due diligence processes, and Life Cycle Assessments, or rely on the guidance of external actors such as MRV providers. These findings point to differences in how practitioners in this sample currently perceive hype management at the practical level. Additionally, the data suggests that organizations actively strive to distinguish optimism from hype through various methods and their existing knowledge of technology development, though the line between the two can be thin in practice.

4.4.3 Abstract Principles for Managing Hype

In this sample, practitioners also reported various abstract principles that may be applied in the consideration of hype management. One of these, namely collaboration, was explored as a potential enabler of hype management at the practical level. It is perhaps noteworthy that both internal and external collaboration were highlighted to varying extents across reports on hype management. The analysis suggests that strengthened internal and external collaboration may support diversity and the application of a balanced approach towards CDR technologies: "*stakeholder dialogues both with our clients, NGOs, government (…) when you are looking at these types of issues from different perspectives, I think that is actually what brings a balanced approach*" (P4). Internal and external collaboration was also reported by one practitioner to potentially alleviate risks for certain business types: "*I would say that 'type of organization' since they are for example, very strong on risk management, (…) that is basically what is their mitigation towards this" (P4).* Strengthened internal collaboration can also support the identification of misaligned expectations, which may limit challenges associated with disappointment: "*we are communicating with the management very often, also with the board of the company, so I think this is a way where we are able to notice how it evolves"* (P1).

The data also suggests that allocating resources towards cross-sector dialogue may help organizations remain open-minded and navigate CDR technologies through a well-informed

perspective: "*we're also investing in cross-sector dialogue, and working with scientists, policy makers, farmers, certification bodies; they all help us ground our perspective and prevent us from getting siloed in the industry*" (P6). Collaboration was also observed to potentially enable CDR technologies to be an integrated part of a wider systemic transformation, as reported by one practitioner: "*we also recognized that carbon removal doesn't happen in isolation. It must be a part of broader transformation and how we manage energy, materials, and land-use*" (P6). These various articulations of collaboration may suggest that this concept is rendered valuable by practitioners in this sample through its ability to diversify decision-making processes. The concept of knowledge sharing also emerged in the data as a potential enabler of collaboration, which in turn can limit the strategic influence of hype: "*most important thing is to communicate within the organization and also stakeholders and to really spread awareness and knowledge so that when we are making the decisions, then everyone actually knows what they are deciding on (…) spreading knowledge is the most important thing"* (P1).

Long-term alignment also emerged in the data across the various accounts of hype management. As a notable finding, the analysis suggests that organizations may possess a limited understanding of the long-term potential of CDR technologies, which may be addressed through focused open dialogues: "*there's just way too little understood on what the applications in the long-term are and I think it just needs a very open conversation and discussion about this*" (P5). The data therefore points to organizations being focused on the short-term, which may impact the long-term potential of sustainability-oriented technologies: "*in this current time of political economic instability, I think it's hard to get companies to invest in anything but kind of the immediate problems that have*" (P3).

The analysis suggests that some of the practitioners in this sample consider long-term oriented evaluations of CDR technologies essential for assessing their sustainability impacts over time: "*we look at how each innovation contributes not just to carbon removal but also to improving soil health, reducing waste, supporting regenerative practices (…) that alignment ensures that were not creating short term wins for long-term sustainability*" (P6); "*look into the lifetime potential of technology (…) then becomes the assessment of whether CCS can play a role in the long-term picture of decarbonization and to us it does*" (P2). One practitioner also reported that the application of a systems based method was also observed to support alignment with long-term sustainability, planetary boundaries, and organizational values: "*we aren't assessing just technical feasibility, but also the social, ecological, and ethical implications which helps*

us to avoid chasing trends (…) *but misaligned with our values or planetary boundaries*" (P6). On the other hand, that data suggests that implementing long-term oriented considerations at the practical level may be limited by reported misalignments between departments: "*it's not something that is basically done within the group sustainability (…) it basically more what the business units are doing when they meet their clients*" (P4).

Within the limits of the data, organizations are observed to articulate hype management through various abstract principles, such as collaboration, knowledge sharing, diversified decision-making, and long-term alignment. A specific tension that emerges here is the system boundaries placed around CDR engagement, which may potentially determine the extent to which the impacts of its hype are managed. This was reflected in varying opinions on the extent to which collaboration should be conducted to manage hype. Some viewed it as an internal pursuit while, while others emphasized cross-sector dialogues and collaboration with external bodies. The implications of the nascency of CDR technologies also emerge as a point of tension. While the data suggests that organizations strive orient their understanding of CDR technology hype with the long-term, the nascency of these methods seemingly affects the extent to which this can be done in practice.

5 Discussion

This section will discuss the overarching contributions from the exploratory thematic analysis, in addition to how these central findings are situated within the existing literature. More specifically, this discussion aims to connect cross-cutting findings that emerged across the four identified aggregate dimensions, "*Motivation and Expectations*", "*Organizational Responses and Perceptions on Hype*", "*Navigating CDR Technologies*", and "*Hype Management*". This is to address the main research objectives of this study, namely, to understand how organizations perceive and respond to the hype surrounding CDR technologies and how hype can be managed in pursuit of sustainability. As a result, this section will first discuss my interpretations of how organizations perceive and strategically respond to hype, followed by reflections on hype management in organizational settings and its potential intersection with sustainability. The main themes and tensions that emerged across the second-order themes in the analysis are presented in *Table 2* below.

Aggregate Dimension	Second-order Codes	Main Themes	Main Tensions
4.1 Motivation and Expectations	**4.1.1 Internal and External Drivers**	Internal and external drivers for engagement; business opportunities; sustainability strategies.	Sustainability and business logic exist simultaneously; varying levels of urgency for CDR implementation.
	4.1.2 Diverging Expectations	Skepticism about CDR future; Planned CDR projects and established investment timelines.	Uncertainty about CDR role in organizational context
4.2 Organizational Responses and Perceptions on Hype	**4.2.1 Strategic Influence of Hype**	Reflexive position to hype; avoid direct influences of hype; hype as information signal; hypes inform R&D activity; hype as inherent in emerging markets; temporal changes; organizational structures and culture automatically manage hype.	Caution and opportunity; claims of minimal influence are coupled with portfolios that reflect hype; differentiating media hype and scientific hype hard in practice; long-term strategy adjusts to hype.
	4.2.2 Sustainable Progression	Hype is productive for sustainability, hype helps hard-to-abate orgs. find solutions; risks of delaying emissions reduction.	Previous greenwashing scandal in carbon removal sector; adverse implications of hype broadly overlooked.
4.3 Navigating CDR Technologies	**4.3.1 Evaluation of CDR Technologies**	Sense-making processes to interpret CDR technologies; evaluation criteria, risk assessments, sustainability strategy alignment; external frameworks.	Co-benefits and social implications divergences; technologies widely evaluated for sustainability, but hype is not
4.4 Hype Management	**4.4.1 Conceptualizations of Hype Management**	Varying practical understandings of hype management; hype management seen as invaluable for sustainability.	Varying degrees of strategic priority; manage different aspects of hype.
	4.4.2 Concrete Actions for Managing Hype	Existing methods function as informal hype management practices; utilize internal and external approaches.	Varying levels of awareness of hype management existence in practice; hype management sidelines strong sustainability in practice.
	4.4.3 Abstract Principles for Managing Hype	Internal and external collaboration; knowledge-sharing, cross-sector dialogues, diversity in decision-making; long-term alignment.	Challenges associated with nascency; differing system boundaries and understandings of CDR impact.

Table 3: The main themes and tensions of each second-order code emerging from the thematic analysis.

Organizational responses to hype are more reflexive than presumed

After conducting the analysis and labelling the aggregate dimensions, I realized that a key issue that emerged across the aggregate dimensions is the tension between opportunity and caution in how hype is approached and perceived in practice. This dichotomy was particularly reflected in sections *4.2.1 Strategic Influence of Hype* and *4.3.1 Evaluation of CDR Technologies,* which show how organizations may respond to and engage with hype. That is, these sections demonstrate that organizations selectively position themselves in relation to certain aspects of hype to potentially benefit or safeguard internal processes against it, while also critically assessing the technologies that the hype surrounds. This finding is arguably valuable as it represents reflexivity and hesitation in how organizations respond to hype, which may challenge existing hype literature that has widely rendered organizations complacent and responsive to the influences of this phenomenon (Bareis et al., 2023; Von Rothkirch et al., 2024). The emphasis on both opportunity and caution may also suggest that hype is rarely expressed to explicitly influence organizational decision-making processes. Instead, practitioners report that organizations employ various embedded methods to evaluate and research emerging technologies to assess their relevance to their organization's needs. This finding is interesting as it reflects practical implementation of evaluative practices of technological capabilities that hype management scholars have prompted as necessary for countering unwarranted influences of hype (Markusson et al., 2012; Maghazei et al., 2022; Funk, 2019; Simakova & Coenen, 2013; Gosalvez, 2024).

Where hype was perceived with opportunity was in terms of its role as an information signal, demonstrated in section *4.2.1 Strategic Influence of Hype,* and its performative capacity in advancing sustainability, portrayed in section *4.2.2 Sustainable Progression*. That is, section *4.2.1 Strategic Influence of Hype* shows that practitioners perceive the information conveyed through hype as a valuable signal of market developments and the business environment at large, which was found to nudge the direction of research and development initiatives, as well as pilot projects. Practitioners in this sample expressed general interest and even enthusiasm towards monitoring the information that hype conveys, citing its importance for their understanding of the market landscape. Particularly for organizations situated in hard-to-abate industries, the information conveyed by hype cycles was reported to be valuable by allowing them to find relevant decarbonization methods. Practitioners in this sample were therefore found to leverage the information that hype conveys as a means to benefit from the momentum

to an extent, which aligns with the literature that argues that organizations may strategically engage with hype to attain certain benefits (Konrad et al., 2012; Alkemade & Suurs, 2012; Pollock & Williams, 2010; Logue & Grimes, 2022). However, the fact that organizations broadly perceive hype solely as an information signal or as a research nudge particularly challenges the argument that organizations are incentivized by high rewards to engage with it (Bakker & Budde, 2012).

Additionally, section *4.2.2 Sustainable Progression* demonstrates that practitioners generally approach hype within sustainability contexts as an opportunity. This was reflected by reports of its productivity in mobilizing resources and attention, attracting investment and actors, challenging traditional business values, and advancing CDR technology pathways. This aligns with literature that has acknowledged the necessity of these technologies for advancing necessary 1.5 °C and 2 °C emissions reduction pathways (Fridahl et al. 2023; Ampah et al., 2024; Asayama, 2021; Field & Mach, 2017; McLaren, 2020). In light of this, some practitioners called for increased hype within these domains, as their implications were perceived to be synonymous with those of accelerated sustainable development. This findings complements existing literature on the role of hype in sustainability contexts: as it has acknowledged that hype can mobilize resources for sustainability initiatives (Goldfarb & Kirsch, 2020; Borup et al., 2006) and allow them to compete against mainstream approaches (Vaskelainen et al., 2022; Kriechbaum et al., 2021*)*. The way hype's impact on sustainability is currently understood at the practical level, nonetheless, highlights the possible value for organizations in identifying the potential negative outcomes of hype on sustainability.

On the other hand, sections *4.2.1 Strategic Influence of Hype* and *4.3.1 Evaluation of CDR Technologies* together highlight that practitioners in this sample present a cautious perspective regarding the larger strategic influence of hype on their internal processes. That is, the reports of some of the practitioners suggest that organizations selectively engage with hype through evaluation processes, risk assessments, piloting, and strategic alignment to contextualize and navigate the uncertainties surrounding emerging CDR technologies. This finding provides an alternative perspective to the literature on how organizations respond to hype, which largely argues that organizations actively adjust their strategies or other capacities in response to the phenomenon (Konrad et al., 2012; Kaniadakis & Linturn, 2022). Additionally, this may challenge the literature on hype, which suggests that it can lead to lock-in scenarios and path

dependencies, as technology hype does not appear to guide larger decisions at the practical level (Alkemade & Suurs, 2012; Bakker & Budde, 2012; Bareis et al., 2023).

This observation of selective engagement may also bridge sensemaking theory with hype literature, as it reflects how organizations interpret and translate hype into their internal processes (Demastus & Landrum, 2023; Weick et al., 2005; Angus-Lepann et al., 2010). That is, section *4.3.1 Evaluation of CDR Technologies* and *4.2.1 Strategic Influence of Hype* show that organizations widely assess the firm-level relevance of CDR methods, such as their technology attributes and business case, in addition to several risks, namely technical, financial, and reputational. This finding aligns with the existing literature on organizational sense-making that has widely explored how organizations navigate, interpret, and respond to uncertainty (Angus-Leppan et al. 2010). Yet, this finding simultaneously represents a divergence from existing hype management literature, which has overlooked the role of established sense-making practices as a means of navigating hype contexts. These findings contribute to existing sensemaking literature by representing how organizations navigate hype contexts in practice.

Hype's strategic impact is implicit and may emerge over time

The critical and reflexive position adopted by organizations in hype settings, demonstrated in section *4.2.1 Strategic Influence of Hype,* reflects rather minimal direct strategic influence of hype on organizations. This departs from previous understandings that have depicted hype as able to determine organizational decision-making processes (Bakker & Budde, 2012). Nonetheless, this may also uncover a subtle paradox in organizational thinking: that is, some practitioners claim minimal strategic influence of hype while showcasing technology portfolios that include selective uptake of previously hyped carbon removal methods, in addition to adopting CDR approaches that are surrounded by legitimized hype (Von Rothkirch et al., 2024). Similarly, one account outlined that changing expectations along the hype cycle do, inevitably, shape their engagement with CDR technologies in the long term.

These findings suggest that the strategic implications of CDR technology hype, and the way it may shape sustainability commitments, remain subtle and can emerge over time. This aligns with the literature, which acknowledges that the exact climate impacts deterred by current CDR expectations remain unknown (Markusson et al., 2018). While the direct, observable influences of hype appear limited across this sample, its implicit effects on strategy may only become

evident in the long term. The limited visibility of hype's impact in the interim or short-term may also explain why some organizations express paradoxical claims about its strategic influence. This nonetheless points to the value in identifying where hype's internal influences may emerge as a means to counter its adverse sustainability implications.

Another central observation that emerged across sections *4.2 Organizational Responses and Perceptions of Hype*, as well as *4.4 Hype Management*, is the impact of temporal changes on how organizations respond to and perceive hype. Several practitioners highlighted the maturation that has occurred in organizational sustainability work in the past half-decade, which has subsequently led organizations to become less reliant and responsive to the influences of hype. Previous greenwashing controversies in the Finnish carbon removal sector, along with their operational, reputational, and sustainability consequences, were found to validate the cautious position through which organizations now navigate hype. These controversies were also found to reinforce a shift in perception of different sources of hype, as practitioners were observed to be increasingly less responsive to media-driven hype and more reliant on hype generated by scientific communities. That is, in this sample, media-driven hype was perceived as an information signal while scientific hype was approached with greater strategic credibility, which may point to its ability to shape decision-making. However, in practice, it was observed that differentiating between different sources of hype can be challenging in practice.

This shift in organizational responsiveness to hype may demonstrate organizational sensemaking within the sector, given that organizations have used their interpretations of past controversies to inform their engagement with the contemporary CDR hype landscape (Demastus & Landrum, 2023). This temporal shift also reveals a perspective that remained overlooked in the review of literature on organizational responses to hype, published between 2003 and 2022 (Brown, 2003; Pollock and Williams, 2010; Alkemade and Suurs, 2012; Logue & Grimes, 2022). However, I cannot determine whether or not this finding is unique to Finland.

Organizations use informal hype management mechanisms

In this study, all practitioners saw some need to or value in managing hype in organizational landscapes. However, in light of its conceptualization, diverging interpretations emerged across the sample as a potential result of the lack of formalization of this principle. This tension

is particularly represented by section *4.4.1 Conceptualizations of Hype Management,* which demonstrates varying understandings among practitioners regarding how hype management should occur in practice, which aspects of hype should be managed, and the strategic priority of advancing hype management overall. Hype management was, nonetheless, conceptualized by one account through notions of adaptiveness, as it was described as a method for translating the momentum or excitement for emerging technologies to internal strategy, and as a mechanism for improving internal consistency by another. Emerging literature on hype management has also defined hype management as a means of strategically benefiting from the phenomenon (Logue and Grimes, 2022).

Consistent with emerging literature on hype management, it was found that practitioners in this sample lack standardized processes for managing hype and demonstrate varying levels of awareness regarding the extent to which it occurs in practice. Surprisingly, however, sections *4.4.2 Concrete Actions for Managing Hype* and *4.4.2 Abstract Principles for Managing Hype* reveal that organizations may manage hype through informal hype management practices that build on the purpose of existing processes. Practitioners in this sample reported that organizations utilize existing practices, such as evaluation criteria, risk assessments, due diligence processes, Life Cycle Assessments, external service providers, as well as embedded principles such as collaboration and knowledge sharing to assess and monitor expectations over time, surrounding CDR technologies. These existing practices and principles are used to identify unrealistic hyped claims and to differentiate them from general optimism for emerging technologies. This provides practical insights into how organizations might approach and implement some of the measures considered necessary by the hype management literature for mitigating its unwarranted impacts.

That is, some practitioners in this sample expressed that organizations may use hype management practices described in the literature, such as identifying hype claims (Van Lente et al., 2013; Intemann, 2022; Wade et al., 2020), evaluating the firm-level relevance of emerging technologies (Maghazei et al., 2022; Markusson et al., 2012), and conducting equal assessments of available alternatives for addressing carbon neutrality (Fuhrman et al., 2023; Von Rothkirch et al., 2024). Some of the practitioners also emphasized the role of internal and external collaboration for managing hype, as discussed in section *4.4.2 Abstract Principles for Managing Hype*. This finding also aligns with the hype management literature on diversified decision-making (Simakova & Coenen, 2013) and improving information transparency

(Markusson et al., 2018; Bareis et al., 2023; Van Lente et al., 2013; Rayner, 2012; Mitroff & Storesun, 2020).

While some practitioners were observed to hinge hype management practices on internal processes, others were found to rely on external approaches. That is, the role of external service providers, such as MRV organizations, emerged as a particularly relevant aspect in the sense-making of hyped claims surrounding emerging technologies. This idea aligns with a tension observed in section *4.3.1 Evaluation of CDR Technologies*; that is, some practitioners reported that accurate evaluations of CDR technologies may be constrained by current market nascency, technological uncertainty, and limited internal capabilities to conduct them. In this sense, the role of external actors in supporting organizations navigate hype settings appears as particularly important and potentially influential. To further conceptualize hype management, there may be merit in understanding how organizations can strengthen their internal capabilities.

Another unexpected finding that emerged from this study was the idea that hype may be automatically managed, to an extent, by existing organizational structures and cultures. That is, section *4.2.1 Strategic Influence of Hype* suggests that hyped claims may be instinctively moderated by business logic that is enforced by the organization's structures or by the culture it upholds. Hype is therefore observed to be managed either intentionally or as a byproduct of other organizational processes. An overarching consideration here is the embedded nature of informal hype management already present in organizations. This is to say, either through their structures, culture, or existing practices, organizations were found to inherently, automatically, or informally monitor certain expectations surrounding CDR technologies.

This idea contributes to emerging literature on hype management, which has called for a strengthened understanding of how hype is already managed at the venture-level (Logue and Grimes, 2022). That is, the findings empirically showcase that in addition to embedded practices, organizations may manage hype through unintentional, yet automatic, processes arising from organizational structures and culture. Together, these ideas suggest that many factors may affect how hype is managed in practice, which can help clarify how organizations already implement it. This understanding builds on existing literature that has overlooked the contribution of these existing factors in the development of emerging hype management theory (Logue and Grimes, 2022).

Sustainability considerations focus on technologies rather than on hype

It is important to note that a majority of the practitioners in this study view some form of hype management as invaluable for sustainability. However, consistent with existing literature on hype management, which remains disconnected from sustainability considerations, hype is rarely managed in practice due to its potential sustainability implications. Although practitioners reported that organizations apply a variety of sustainability-based evaluation criteria in the navigation of CDR technologies, this consideration rarely extended to their understandings of hype and conceptualizations of hype management. Organizations were reported to evaluate the sustainability potential of CDR technologies through various sustainability criteria and frameworks, as well as co-benefits; however, these considerations rarely carried forward to the management of hype itself. Identifying unrealistic hyped claims and monitoring expectations over time were largely conducted based on technical feasibility and business viability, rather than as a means of addressing the potential sustainability consequences of hype. While this suggests that the potentially harmful aspects of hype for sustainability remain largely overlooked at the practical level, it can also indicate the formative nature of hype management for sustainability.

This potential dissonance may also be reflected in the logics guiding CDR technology engagement, as represented in section *4.1.1. Internal and External Drivers*. Some practitioners reported that engagement is driven by both sustainability and business considerations, while others were led by one or the other. Nonetheless, the simultaneous presence of both business-oriented and sustainability logic may undermine the extent to which sustainability is prioritized in these settings. This idea may be further reinforced by the observation that practitioners rarely reported adverse implications of hype, especially in relation to sustainability. That is, section *4.2.1 Strategic Influence of Hype* shows that where hype was acknowledged to potentially lead to negative outcomes was largely in reference to business risks and inefficiencies, such as conducting misinformed action, investment risks, and challenges associated with scaling immature technologies.

In section *4.2.2 Sustainable Progression*, a few practitioners highlighted possible adverse implications of hype on sustainability, such as scaling immature technologies, delayed or undermined emissions reductions, environmental damage, and reputational risks for the carbon removal sector. This may, however, highlight the role of organizational values in hype

landscapes, as one of the practitioner's organization was founded on a climate-centric ethos. Nonetheless, the broader knowledge gap at the practical level on how hype may impact sustainability highlights the value in bridging hype management and sustainability in practice, and to clarify the potential sustainability gains from such management.

Hype management practices sideline strong sustainability

When viewed through the context of strong sustainability theory, the findings of this study suggest that current hype management practices broadly sideline strong sustainability principles (Ott et al., 2011; Landrum, 2018). This is because in practice, hype management is generally aligned with business considerations to support technology development pathways, potentially overlooking the sustainability aspects needed to create significant positive outcomes for society (Dyllick & Muff, 2016). As hype is broadly perceived as a productive force for sustainability across the sample, this likely influences how the imperatives for its management are framed. Moreover, even though organizations manage hype informally, this is primarily based on technical and business feasibility rather than on constraining its potential negative sustainability impacts. A transition towards hype management practices that foster strong sustainability would, inevitably, require a change in logic as to why hype is identified, assessed, and monitored (Landrum, 2018). Although sections *4.4.2 Concrete Actions for Managing Hype* and *4.4.3 Abstract Principles for Managing Hype* identified certain practices and ideas that may enable sustainability when managing hype, such as co-benefit assessments and social evaluations, the extent to which these mechanisms enable strong sustainability remains unknown. This finding corresponds to the literature that has recognized that understanding remains limited regarding how strong sustainability can be integrated into business models (Brozovic, 2020; Landrum, 2018).

In addition to this, having analyzed the interview data, I came to recognize that a potential challenge in the bridging of hype management and sustainability emerges from the limited practical understanding of the sustainability impacts of hype. That is, section *4.2.2 Sustainable Progression* shows that at the practical level, hype is broadly perceived as a productive force in sustainability contexts. This position is, however, paired with a limited understanding of its counterpart, namely the potential sustainability adversities of hype. Greater awareness of this dimension of hype at the practical level may be able to support the development of hype management practices that aim to prevent further environmental harm, which is a viewpoint

Gosalvez (2024) asserts is necessary to enhance industry dynamics and credibility. The review of literature also recognizes that such management structures could, in turn, provide financial, productivity, and resource gains (Funk, 2019).

When considering the intersection between hype management and sustainability, section *4.1.1. Internal and External Drivers* and *4.2.1 Strategic Influence of Hype* indicate that the role of organizational sustainability strategies is particularly unique. This is because organizations are both driven by these strategies to engage with CDR technologies, while also using strategic alignment as a sense-making mechanism in emerging technology contexts. In this regard, sustainability strategies may hold a valuable role in hype settings, which makes their content increasingly valuable for further enabling sustainability. For instance, this study found that although identifying co-benefits from CDR technologies can be challenging, this perspective remains necessary for identifying and constraining the unintended sustainability consequences of CDR use.

Another fundamental concern in the literature on hype's impact on sustainability is its short-term focus, which diverges from the long-term time horizons required to achieve decarbonization targets (Von Rothkirch et al., 2024). Through this study, I noted that some practitioners have observed previous hype cycles for technologies in their industry that led to outcomes now considered irrelevant to their operations. It is in this regard that scholars of hype management, such as Bakker and Budde (2012), advocate for practices such as stabilized stakeholder engagement to constrain the short-term impacts of hype. In the realm of CDR technologies, this short-termism outlook may also result in adverse climate implications, such as mitigation deterrence (Von Rothkirch et al., 2024; Ampah et al., 2024).

This gap may be further compounded by the challenges organizations face in accurately evaluating both the long-term potential and misalignments in expectations and integration of CDR technologies, which became apparent in section *4.3.1 Evaluation of CDR*, as well as *4.4.3 Abstract Principles for Managing Hype*. For this reason, evaluating the contributions of CDR technologies beyond their emissions reduction potential emerges as an important consideration in bridging hype management with strong sustainability. Identifying these long-term implications of hype may be valuable in the context of sustainability, especially regarding decarbonization targets that are generally set years or even decades in advance.

6 Conclusion

This concluding section will consolidate the main findings regarding the three research questions of this study, as well as their contributions to the literature. These findings are the result of the abductive, exploratory research design and are grounded in Finland's organizational context. With this in mind, the key findings are reflective of the Finnish market climate and its sustainability understandings, as well as my interpretations as a student researcher. Followingly, this section will suggest managerial implications from these findings, as well as limitations and considerations for future research.

6.1 Summary of Key Findings

How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?

In response to the first research question of this study, practitioners in this sample reflect a general dichotomy between caution and opportunity in their approaches to hype. The data suggest that organizations are cautious about hype's direct influence on internal decision-making, while also viewing it as an opportunity to convey market information and potentially advance sustainability. This suggests that organizations navigate hype reflexively, showcasing selective engagement that is informed by comprehensive sense-making processes. That is, organizations in this sample were found to use various internal methods, such as evaluation processes, risk assessments, piloting, and strategic alignment to sustainability strategies to contextualize and interpret emerging CDR technologies. In this context, organizations in this sample reflect agency in hype landscapes as they closely assess these claims to better understand the relevance of emerging technologies for their organization's needs. As a potential result of this critical position, hype is rarely seen to explicitly influence strategic decision-making.

At the same time, organizations also characterize hype as an opportunity and an informative component of nascent markets. Hype is seen to convey necessary market information that can signal the direction of research and development initiatives. Particularly for organizations in hard-to-abate industries, hype cycles are expressed as valuable for finding necessary carbon removal methods. The findings of this study suggest that organizations perceive the effects of hype on sustainability through a predominantly productive lens, sometimes welcoming

additional hype in sustainability contexts to advance their objectives. This dichotomy is also reflected in the distinctions that participants expressed in how they approach and respond to different sources of hype. Specifically, they were reported to be generally cautious in their engagement with media hype, while being more responsive to the information conveyed through scientific hype. Some variation was observed, as certain participants also considered the information conveyed from media hype to be of interest, particularly for reputational and public interest reasons. This finding nonetheless suggests that the source of hype plays a valuable role in how practitioners in this sample make sense of it.

However, sensemaking in hype landscapes is grounded in technical and business feasibility, which suggests that hype is navigated primarily through a business perspective. There is some variation, as one practitioner, whose organization was founded purely on a climate-centric ethos, extended their evaluation of hype to its adverse sustainability implications. This finding points to the potential role of organizational values in how practitioners in this sample may position and relate to hype. At a broader level, this highlights a potential operational gap, that is, while CDR technologies are evaluated for their alignment to sustainability strategies and objectives, the sustainability implications of hype itself are not. This suggests that the potentially harmful aspects of hype for sustainability may remain largely overlooked at the practical level.

The findings of this study also reveal the role of temporal changes and subsequent sector maturation, which have influenced practitioners in this sample to become less reliant and responsive to the influences of hype. This was represented in the impact that past carbon removal controversies have on how organizations now respond to hype. These controversies were also found to reinforce a shift in how organizations perceive different sources of hype; namely, becoming less responsive to media-driven hype and more reliant on hype generated by scientific communities. It is important to note that this interpretation is suggestive and sample-specific.

In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?

In light of the second research question, the way technology hype shapes sustainability commitments across practitioner reports in this sample appears more nuanced. As mentioned earlier, technology hype was rarely expressed to directly influence decision-making processes, including those related to organizational sustainability strategies. Instead, at a broader level, organizations used these strategies and pre-determined climate targets to interpret CDR technologies, rather than allowing hype to explicitly shape their content. Despite this, in the study, there were some observable subtleties in how technology hype may impact these commitments. That is, one participant outlined that although they strive to limit the strategic influence of hype, the composition of their technology portfolio, comprising previously hyped technologies in their sector, reflects how hype has shaped their decision-making. Similarly, another participant noted that changing expectations around technology hype influence how their organization engages with CDR technologies in the long term.

Hype was also observed in some instances to nudge the direction of research and development initiatives, which reflects an indirect way that hype may influence sustainability decisions. Taken together, the findings from this study suggest that technology hype can subtly shape sustainability commitments in ways that become apparent over time. As it was also expressed earlier, practitioners in this sample state that organizations strive to distinguish between media hype and scientific hype in their sensemaking within these landscapes. However, this study found that differentiating between sources of hype can be challenging in practice, which may suggest that media hype may shape sustainability decision-making beyond what is immediately evident.

What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?

In consideration of the final question, this study shows that organizations may already manage hype through informal hype management practices that extend existing processes and principles. That is, practitioners in this sample were found to identify, assess, and monitor expectations over time surrounding CDR methods, while also differentiating unrealistic claims from general optimism for emerging technologies. Hype was also found to be automatically managed, to an extent, by the business logic that the structures or culture of the organization

uphold. This study also finds that while some organizations use internal practices to informally manage expectations, others rely on external expertise, such as MRV providers, due to limited internal resources or knowledge. Beyond current practices, this study also finds that practitioners in this sample value collaboration and knowledge sharing as part of hype management.

Despite the presence of hype management at the organizational level, it was rarely undertaken for its potential sustainability implications. Therefore, to further embed sustainability with hype management, this study shows that organizations should strengthen their understanding of the scope and implications of hype in sustainability contexts. This is because organizations operate in hype settings with a partial perspective of hype that overlooks its potential adverse implications on broader sustainability. To align these management structures with strong sustainability, organizations would need to change or extend the logic through which expectations are currently managed to one that strives to create significant positive sustainability outcomes (Dyllick & Muff, 2016).

This study also shows that the way organizational sustainability strategies frame engagement with CDR technologies may help integrate sustainability into hype management contexts. That is, the data suggest that practitioners in this sample use their sustainability strategies as sense-making mechanisms that can determine which technologies they explore or integrate. Also, the role of evaluating co-benefits, social implications, and other sustainability contributions of CDR technologies emerged as a method to potentially ground CDR engagement with broader sustainability. While this idea was minimally discussed by some of the practitioners, the evaluation of co-benefits and social implications nonetheless offers a way to better understand the broader sustainability impacts of CDR technologies.

6.2 Theoretical Contributions

The findings of this study contribute to hype studies, CDR technology hype literature, hype management literature, sensemaking theory, and strong sustainability theory. The findings of this study extend the literature on hype (Brown, 2003; Borup et al., 2006) by empirically demonstrating that organizations selectively engage with hype and respond to its momentum with caution and even hesitation. This is reflected by the embedded methods organizations were found to apply in hype environments to evaluate the relevance of emerging technology

for their organization's needs. These findings align with the literature on the performative role of hype in industry (Alkemade & Suurs, 2012; Pollock & Williams), as organizations in this study largely perceive hype as an information indicator and signal for research and development initiatives. These findings also qualify the literature that argues that adopter organizations actively adjust their strategies and other operations in response to hype to leverage its momentum (Konrad et al., 2012; Kaniadakis & Linturn, 2022). That is, the findings of this study suggest that organizations indirectly respond to and engage with hype, and that its observable strategic impacts become evident over time.

This study also empirically demonstrates that organizations may make distinctions between different sources of hype, which illustrates that organizations may be more responsive to scientific hype than media hype. This empirical finding suggests a nuance to existing hype literature, which has overlooked the potential for organizations to assume a critical, or unresponsive, position in hype settings (Konrad et al., 2012; Bareis et al., 2023; Von Rothkirch et al., 2024). Furthermore, the results of this study also provide contemporary insight into the maturation of the Finnish carbon removal sector as a result of past controversies, reflected in a shift toward more critical approaches to hype. This finding contributes to the literature on organizational responses to hype, which has arguably understudied the role of past events in shaping how organizations approach hype (Kaniadakis & Linturn, 2022; Konrad et al., 2012; Ramiller, 2006).

This study also contributes to sensemaking theory in sustainability contexts (Weick et al., 2005; Demastus & Landrum, 2023; 2018 Dyllick & Muff, 2016; Demastus & Landrum, 2023; Angus-Leppan et al., 2010) by empirically showcasing its significance in the overlooked setting of hype. That is, this study found that organizations apply various sensemaking mechanisms, such as evaluation processes, risk assessments, piloting, and strategic alignment, to interpret uncertainties surrounding emerging CDR technologies. In doing so, this insight extends sensemaking theory by demonstrating how these mechanisms may be used to navigate hype environments.

At its core, this study contributes to the emerging literature on hype management (Gosalvez, 2024; Logue & Grimes, 2018; Wade et al., 2020) by illustrating how hype management is realized in practice, an insight that is arguably valuable for further developing hype management theory. In particular, this study demonstrates that existing organizational

practices, such as risk management, evaluation processes, and piloting, function as informal hype management practices at the firm level. These findings empirically show that organizations already apply some of the practices considered necessary by hype management scholars (Fuhrman et al., 2023; Maghazei et al., 2022; action (Von Rothkirch et al., 2024). This study also finds that organizational structures and culture can moderate the strategic influences of hype, revealing additional factors that may shape the management of hype in practice. The extent to which hype management is already embedded or inherent within organizations is a perspective largely understudied in the literature. Finally, this study shows that hype management is governed primarily by technical and business feasibility, rather than sustainability.

In this sense, the findings of this study further contribute to hype management literature (Gosalvez, 2024; Logue and Grimes, 2022) and to sustainability studies (Landrum, 2018) by revealing that, in this sample, organizational responses to hype often overlook sustainability considerations. That is, sustainability considerations are largely sidelined in organizational approaches to hype, even when systematic sustainability evaluation systems exist for the technologies themselves. This offers valuable insight for both literatures, as it illustrates an area where current organizational practices fall short of reinforcing sustainability commitments. In light of these findings, clarifying the extent to which hype management fosters sustainability is timely, given the emerging state of hype-management theory (Logue and Grimes, 2022). This insight also extends strong sustainability theory (Landrum, 2018) by showing that current organizational hype management practices minimally align with strong sustainability principles. This finding is valuable for strong sustainability literature, which has recognized the need to strengthen understandings of how strong sustainability principles can be advanced at the practical level (Landrum, 2018).

6.3 Managerial Implications

This study presents several managerial implications that may be valuable for addressing hype, hype management, and their intersection with sustainability in practice. Since hype management remains an emerging concept, it is particularly relevant for those responsible for or engaged in technology implementation projects to remain reflexive about the potential strategic influences of hype. This can potentially be realized by identifying and monitoring the specific ways in which the organization may adjust its operations when relevant emerging

technologies gain significant attention, which can help those in managerial roles recognize where its potential internal influences may emerge. In a similar vein, given that practitioners reported that hype is managed through embedded practices, there may be value in further developing these formative processes into institutionalized hype management mechanisms. This approach would require a formalized, organization-wide understanding of hype management, including both the aspects of hype to be managed and the rationale for doing so, as well as assigning teams with responsibility to monitor it.

As this study also recognized, organizations may fall short in their understanding and evaluation of the societal influences of hype, particularly with respect to sustainability. To address this, this study endorses those with responsibility to evaluate the specific ways in which hype may either complement or contradict the desired outcomes of existing organizational sustainability strategies, as well as identify the impacts of nascent technology projects on broader sustainable development. In a CDR technology context, this approach may be complemented by assessing how current emissions reduction efforts may be unintentionally affected by engagement with these methods (McLaren, 2020). In a broader sense, this approach encourages both critical assessment of claims about future sustainability gains and scrutiny of the long-term alignment of emerging sustainability-oriented technologies. Taken together, these managerial implications suggest that those with responsibility could explicitly evaluate the sustainability implications of hype separately from the technology itself.

This also alludes to a shift in the underlying logic of hype management that this study advocates for. That is, this study found that hype is currently managed at the firm-level primarily based on technical and business feasibility rather than its sustainability impacts. To better align hype management practices with sustainability, this study encourages those in managerial roles to integrate sustainability standards in the rationale for both how and why expectations are identified, assessed, and monitored. In practice, this could include establishing sustainability criteria for hype to better identify and mitigate misalignments between hype and sustainability objectives.

Additionally, this study encourages those with responsibility to evaluate all available CDR alternatives equally as a potential means of ensuring that a multitude of sustainability approaches are able to develop in society (Fuhrman et al., 2023). This includes both technical and non-technical options, as the literature acknowledges that concentrating resources on any

one solution risks crowding out feasible, often non-technical, alternatives (Funk, 2019). As observed by this study, this approach may also be facilitated by increasing diversity in the decision-making process in addition to strengthening internal and external collaboration, to ensure that technology development addresses broader societal issues.

6.4 Limitations and Suggestions for Future Research

Although this study has strived to exercise reflexivity across all stages of the research process, it is necessary to further consider the limitations that are specific to this study. At the outset, the findings of this study are representative of a small sample of organizational engagement with CDR technologies in Finland. This geographical context is arguably unique as organizational engagement with CDR technologies is nationally encouraged and decarbonization targets are widely established (Ministry of Economic Affairs and Employment, 2023). This context is also illustrated in this study by a limited sample size of six industry practitioners, subsequently reflecting a limited array of organizational perspectives, and relies on their subjectively accounted reports. The particularity of the context of this study, its sample size, and the composition and associated subjectivities of the sample may therefore impact the generalizability and replicability of the findings across other contexts. Substantial further research is therefore required to test how the patterns observed in the data of this study occur across other contexts.

The qualitative methodology of this study also presents notable limitations. The findings of this study are derived from one empirical data source, namely semi-structured interviews, which constrains the extent to which I was able to address the research questions. The quality of the findings also depends on the interview guide and the subsequent accuracy of its questions. The data were subsequently analyzed using one analysis method, the Gioia approach, which is based on my interpretation of the collected data and understanding of the phenomena under study, which can be subject to my potential biases, subjectivities, and values (Eriksson & Kovalainen, 2009). By using additional data sources or a mixed methods approach, this study may have strengthened the ability for its findings to be cross-checked and validated (Eriksson & Kovalainen, 2009).

It is also valuable to consider that the application of other research methods may have better addressed the three research questions of this study, as well as provided a deeper understanding

of the phenomenon under study. In this regard, a case study method may have been especially relevant for this study, as it could have provided a more extensive understanding of how CDR technology hype, as well as hype management, is understood and implemented at the organizational level. In this regard, the role and the following impact of my research skills and the time allocated for this study also most likely influenced the overall research design and findings of this study.

It is also worth considering that this study includes a narrow scope of sustainability. While I strive to engage with strong sustainability theoretically, the empirical analysis largely captures business and technical feasibility as a result of my interpretation of the data. In this regard, this study does not examine several other dimensions of sustainability, including social and environmental justice or biodiversity, reflecting a limited articulation of its complexity.

While the phenomenon of hype has been studied for multiple decades, research on the management of its unwarranted organizational and sustainability outcomes lags behind. For future research, this study recommends inquiry into the potential implications of hype management on sustainability as well as greater discussion surrounding the role of technology hype in sustainability environments, especially beyond the context of Finland. As this study has highlighted, the intersection of hype management and sustainability remains understudied in the literature, which points to a potentially lucrative avenue of research that can have a meaningful influence on furthering organizational sustainability. This study also remains curious about how hype management understandings can be further developed in pursuit of strong sustainability. All things considered, technology hype is one of many human-driven and socially constructed phenomena impacting our natural world. Its potential to be managed nonetheless signals hope that its adverse implications for sustainability can be mitigated.

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A. Interview Guide

Introduction and background	Would you like to introduce your role and responsibilities within your organization? Can you describe your experience working with CDR technologies? Can you tell me about your organization's current projects involving CDR technologies?
CDR technologies and integration RQ1: How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse?	Can you describe what initially motivated your organization to explore CDR technologies? How do CDR technologies fit within, or support, your broader sustainability strategy? How does your organization evaluate and integrate CDR technologies, and what are some of the factor that are considered in the process? How does your organization reflect on social, ethical, and environmental implications when assessing CDR technologies? What kinds of risks does your organization consider when evaluating emerging technologies like CDR?
Expectations and organizational sense-making RQ1: How do organizations make sense of and position themselves in relation to bold claims surrounding CDR technologies in sustainability discourse? RQ2: In what ways does technology hype shape how organizations frame and prioritize sustainability commitments?	What expectation surround CDR technologies, both internally and externally, and how have they influenced your organization's strategic direction? Have you noticed any changes over time in expectations about the potential of CDR technologies? In your experience, does hype or expectations play a role in navigating sustainability transitions? To what extent do you think that hype, and its cyclical nature, influences your organizations strategic decisions regarding emerging technologies?
Organizational responses to hype RQ2: In what ways does technology hype shape how organizations frame and prioritize sustainability commitments? RQ3: What kinds of organizational strategies emerge or could be developed to assess and	How does your organization decide whether and how to respond when emerging sustainability technologies gain significant attention? Do you differentiate between hype created by media and hype generated within the scientific community when evaluating emerging technologies? How do each influence your organization's strategy?

manage technological hype in the context of sustainability?	How do you think that the hype surrounding emerging technologies like CDR influences long-term sustainability goals?
Addressing hype at the firm-level RQ3: What kinds of organizational strategies emerge or could be developed to assess and manage technological hype in the context of sustainability?	How does your organization evaluate the long-term relevancy of emerging technologies like CDR, and monitor whether initial expectations are being met over time? How do you respond if there are misalignments between early expectations and actual implementation? What practices does your organization use, or could use, to manage the influence of hype and ensure a more balanced approach to sustainability? Could you describe how your organization balanced the initial excitement for emerging technologies with your long-term sustainability objectives? How do you differentiate between responsible optimism and unrealistic hype when navigating emerging technologies? In your view, how can managing hype contribute to more effective or credible sustainability actions? Can you describe a situation where your organization has reconsidered or discontinued support for a technology due to misaligned expectations / unforeseen risks / performance challenges?
Reflection and follow up	How do you imagine your organization's engagement with CDR evolving over the next 5-10 years? Is there anything else that you would like to add about the role of hype, CDR or emerging technologies in sustainability work?